SERIAL FAN MODULE AND FRAME STRUCTURE THEREOF

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Appl. No.: 12/109,889
Filed: Apr. 25, 2008

Foreign Application Priority Data
Jul. 31, 2007 (TW) ........................... 96127970

Abstract

A serial fan module includes a first fan, a second fan and a plurality of guide elements which are disposed between the first fan and the second fan. The first fan has a first frame body and a first impeller. The second fan has a second frame body and a second impeller. Each of the guide elements has an axial extended part and an inclined part, and the inclined part meets the axial extended part at a camber angle. The guide elements guide an airflow from the first fan into the second fan. Also, a frame structure is disclosed. The frame structure includes a first frame body, a second frame body and a plurality of guide elements disposed between the first frame body and the second frame body. Each of the guide elements comprises an axial extended part and an inclined part and the inclined part meets the axial extended part at a camber angle.
FIG. 1 (PRIOR ART)
SERIAL FAN MODULE AND FRAME STRUCTURE THEREOF

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a serial fan module and a frame structure thereof, and more particularly to a serial fan module and a frame structure thereof capable of increasing static pressure of the outlet airflow, reducing noise and improving unstable flow field.

[0003] 2. Description of the Related Art

[0004] As efficacy of electronic devices continue to increase, heat dissipating devices and heat dissipating systems are playing more critical roles within the electronic devices. Poor heat dissipation can lead to equipment damage or failure.

[0005] Heat dissipating devices play a greater role for microelectronic elements and devices (e.g., integrated circuit, IC). Due to increased integration and advancement of packaging technology, integrated circuit area is increasingly being reduced and heat per unit area is thus increasingly being increased. Thus, high efficacy heat dissipating devices have continually been under active development by those in the field.

[0006] Heat per unit area of electronic products is increasingly being increased and cannot be effectively dissipated by using a single fan. Thus, several fans are combined to solve the problem of the poor heat-dissipating capability of a single fan. Referring to FIG. 1, a cross section of a conventional combination of two fans is shown, wherein the ribs 12 of the inlet fan 11a only function as connecting the frame body 111 and the motor base 17 rather than guiding airflow. Thus, the airflow from the inlet fan 11a becomes turbulent when arriving at the outlet fan 11b, so that the flow field is unstable. As the results, the outlet fan 11b fails to perform normally, the air pressure at the outlet fan 11b is reduced, and the combination of fans 1 does not perform as expected. Furthermore, due to the unstable flow field, the airflow exiting from the outlet fan 11b is not entirely directed to the target heat source. Thus, the combination of fans 1 does a lot of virtual work. Furthermore, the combination of fans 1 produces noise and vibrations during operation.

BRIEF SUMMARY OF THE INVENTION

[0007] To avoid the problems of conventional combination of fans, the present invention provides a serial fan module and a frame structure thereof, wherein the problem of unstable flow field of serial fan module is solved, the entire air pressure and air volume are raised and vortex is reduced, so as to achieve greater heat dissipating efficiency and reduced noise.

[0008] An embodiment of the present invention provides a frame structure including a first frame body, a second frame body and a plurality of guide elements. The guide elements are disposed between the first frame body and the second frame body. Each of the guide elements has an axial extended part and an inclined part and the inclined part meets the axial extended part at a camber angle. The guide elements guide an airflow from the first fan into the second fan.

[0009] For the serial fan module and the frame structure thereof, the camber angle is between 20 degrees and 50 degrees. The inclined part has a first height, the axial extended part has a second height, and a ratio of the first height to the second height is between 0.2 and 5. The sum of the first height and the second height exceeds or equals 15 millimeters when the first frame body and/or the second frame body have a height about 38 mm. The axial extended part parallels an axis of the frame structure or inclines to the axis of the frame structure by an angle which is smaller than or equal to 20 degrees. Each of the inclined parts and the corresponding axial extended part are integrated as a single piece, or the inclined part is connected to the first frame body as a single piece.

[0010] Each of the inclined parts and the corresponding axial extended part are combined to form the guide element. For example, each of the inclined part is connected to the first frame body as a single piece, and the corresponding axial extended part is connected to the second frame body as another single piece. Or, each of the inclined part is connected to the first frame body as a single piece, and the corresponding axial extended part is an independent element. The first frame body is connected to the second frame body via the guide elements. The first frame body, the second frame body and the guide elements are integrated as a single piece.

[0011] The second frame body has a plurality of static blades and an expanded part at an outlet of the serial fan module, and the airflow guided by the guide elements passes through the static blades and exits out of the second frame body from the expanded part. The static blades and the inclined parts are of the same structures.

[0012] Further, the first fan and the second fan may be disposed back to back, and the first fan and the second fan are the same. A motor base of the second fan is connected to the second frame body via the axial extended parts, and the rotating directions of the first impeller and the second impeller are different.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

[0014] FIG. 1 depicts a cross section of a conventional combination of two fans.

[0015] FIGS. 2A and 2B are two schematic views of a serial fan module in accordance with an embodiment of the present invention, respectively observed from opposite directions.

[0016] FIG. 2C depicts a cross section of the serial fan module of FIG. 2A.

[0017] FIG. 2D is a cross section of the guide element and a schematic view of the direction of airflow of FIG. 2B.

[0018] FIG. 3 is a schematic view of another form of the serial fan module in accordance with an embodiment of the present invention.

[0019] FIGS. 4A and 4B depict other embodiments of the serial fan module containing independent guide elements in accordance with the present invention.
FIG. 5 depicts a cross section of a continuous-unity serial fan module in accordance with an embodiment of the present invention.

FIG. 6 depicts a serial fan module without static blades at the outlet in accordance with the present invention.

FIGS. 7A to 7D depict various embodiments of the serial fan module with two fans being disposed back to back in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGS. 2A and 2B are two schematic views of a serial fan module in accordance with an embodiment of the present invention, and FIG. 2C depicts a cross section of the serial fan module of FIG. 2A. The serial fan module 2 includes a first fan 21a, a second fan 21b, and a plurality of guide elements 22. The first fan 21a has a first frame body 211a and a first impeller 23a, the second fan 21b has a second frame body 211b and a second impeller 23b, and the first fan 21a and the second fan 21b can be of the same structures or different structures. The guide elements 22 are disposed between the first fan 21a and the second fan 21b, and the guide elements 22 guide an airflow from the first fan 21a into the second fan 21b and then the airflow finally leaves the serial fan module 2 from the second fan 21b.

Referring to FIG. 2C and FIG. 2D, a cross section of the guide element and a schematic view of the direction of airflow of FIG. 2B are shown. Each of the guide elements 22 has an inclined part 221 and an axial extended part 222, and the inclined part 221 meets the axial extended part 222 at a camber angle “a” which ranges between 20 degrees and 50 degrees. Take the serial fan module with two frame bodies whose heights are both about 38 mm as the example, the inclined part 221 has a first height H1, the axial extended part 222 has a second height H2, and the sum of the first height H1 and the second height H2 exceeds or equals 15 millimeters. Also, the axial extended part 222 parallels an axis x of the serial fan module 2, as shown in FIG. 2D. The present invention, however, is not limited thereto. Rather, the axial extended part 222 can incline to the axis x of the serial fan module 2 by an angle (not shown). When the angle is smaller than or equal to 20 degrees, the guiding efficiency of the serial fan module is still optimized.

When the serial fan module 2 operates, the airflow f firstly enters the first fan 21a from the inlet 24 in an approximately vertical direction with respect to the inlet 24. Then, the airflow f is guided by the impeller 23a of the first fan 21a, and thus the direction of the airflow is changed as indicated by reference numeral f. The velocity of the airflow f includes a tangent velocity component “a” and a vertical velocity component “b”.

Because the guide elements 22 are disposed between the first fan 21a and the second fan 21b of the serial fan module 2, the airflow f does not directly enter the second fan 21b. Rather, the airflow f passes through the guide elements 22 before entering the second fan 21b. The inclined angle of each inclined part 221 is approximately equal to that of the airflow f. Furthermore, the inclined parts 221 and the axial extended parts 222 constitute a streamlined wing structure, so that after passing through the inclined parts 221 of the guide elements 22, the airflow f can be smoothly guided to the location where the inclined part 221 and the axial extended part 222 meet. Meanwhile, the tangent velocity component “a” of the airflow f is partially converted into the vertical velocity component “b”, then, the airflow f is guided by the axial extended parts 222 to completely convert the tangent velocity component “a” into the vertical velocity component “b”, and exits from the first fan 21a. Thus, the airflow f meets the inlet of the second fan 21b at a right angle when it is guided from the first fan 21a into the second fan 21b. Therefore, the operation and the power consumption of the second fan 21b are similar to those of the first fan 21a. Finally, the airflow f is guided by the impeller 23b of the second fan 21b and exits from the outlet 25 of the second fan 21b to dissipate heat generated by the heat source, such as CPU.

In addition to the above descriptions, the guide elements 22 of the present invention can be implemented in other ways. Referring to FIG. 3, for example, the inclined part 221 and the axial extended part 222 of the guide elements 22 are integrated to form an independent element for convenient production and assembly. Thus, regardless of whether rotating directions of the first impeller 23a and the second impeller 23b are different or the same, the guide elements 22 are always applicable. If the guide elements 22 are damaged, a replacement of the damaged part therefrom will be convenient, thereby increasing the using life of the serial fan module 2.

For another example, as shown in FIG. 2C, the guide elements 22 can be integrated with the first frame body 211a or the second frame body 211b as a single piece for reducing assembling procedures for the serial fan module 2. Thus, the assembling time of the serial fan module 2 will be shorter and raise competitive manufacturing of the product.

For another example, the guide elements 22 are formed by combining the inclined part 221 and the axial extended part 222. Referring to FIGS. 4A and 4B, two embodiments of the serial fan module formed by independent guide elements in accordance with the present invention are shown. FIG. 4A depicts the first embodiment, wherein the inclined part 221 of the serial fan module 2 are integrally formed with the first frame body 211a as a continuous-unity structure, and the axial extended part 222 is an independent element. The serial fan module 2 is formed by assembling the axial extended part 222 and the first frame body 211a. FIG. 4B depicts the second embodiment, wherein the serial fan module 2 are formed by combining the inclined part 221 and the axial extended part 222, wherein the inclined part 221 is integrally formed with the first frame body 211a as a continuous-unity structure and the axial extended part 222 is integrally formed with the second frame body 211b as another continuous-unity structure. In both embodiments, the performance of the guide elements is good.

Referring to FIG. 5, a cross section of a continuous-unity serial fan module in accordance with the present invention is shown. For purposes of structural simplification, the guide elements 22 are integrally formed with the first frame body 211a and the second frame body 211b as a continuous-unity structure to form the serial fan module 2 of the present invention, which achieves the same guiding efficiency as the fans in accordance with the present invention.

In order to guide airflow toward a predetermined direction, a plurality of static blades 22a can be designed to be disposed at an outlet 25 of the second fan 21b, and the static blades 22a and the inclined parts 221 are of the same guide structures. Thus, the airflow f can be guided by static blades 22a to the area where maximum heat accumulates for achieving heat dissipation. On the other hand, in order to provide large-sized heat-dissipating area, an expanded part 26 can be set at the outlet 25. The airflow f passing through the static
blades 22a is guided by the expanded part 26 to leave the outlet 25 for achieving heat dissipation, as shown in FIG. 5. [0033] Referring to FIG. 6, a serial fan module without static blades at the outlet in accordance with the present invention is shown. No static vane 22a and expanded part 26 are installed at the outlet 25 of the second fan 21b. Thus, the installation of the serial fan module is flexible, the noise is reduced, and the produced air quantity is increased.

[0034] For design of the serial fan module 2, the relational disposition may vary dependent upon requirements. For example, the first fan and the second fan both face the same directions (in FIG. 2A-6), or the first fan and the second fan can be disposed back to back. Referring to FIGS. 7A to 7D, various embodiments of the serial fan module with two fans being disposed back to back in accordance with the present invention are shown. In detail, the first fan 21a and the second fan 21b can be design to be disposed back to back. A motor base of the second fan 21b is connected to the second frame body 211b via the axial extended parts 222 of the guide elements 22. The disposition of the first frame body 211a, the second frame body 211b and the guide elements 22 are similar to that of the above embodiments. Thus, the guide elements 22 can be assembled in accordance with various designs to extend the application scope.

[0035] Furthermore, the number of the first fan 21a can be increased to meet practical requirements. The first fans 21a are connected to each other by guide elements 22. Then, the assembled first fan 21a and the second fan 21b are combined to form the serial fan module 2 and achieve great dissipating efficiency and various applications.

[0036] For the above descriptions, the serial fan module 2 are provided with the guide elements 22 to solve the problem of unstable flow field arising from vortex at the outlet 25, and raise the entire air pressure and air volume, so as to achieve greater heat dissipating efficiency and reduced noise. Furthermore, the first fan 21a and the second fan 21b are of similar characteristics due to the use of guide elements 22, which is advantageous to design and development of the product. Various ways of assembling the guide elements 22 provide flexibility in production and assembly.

[0037] While the present invention has been described by way of example and in terms of preferred embodiment, it is to be understood that the present invention is not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:
1. A serial fan module, comprising:
a first fan, comprising a first frame body and a first impeller disposed within the first frame body;
a second fan, comprising a second frame body and a second impeller disposed within the second frame body; and
a plurality of guide elements, guiding an airflow from the first fan into the second fan and being disposed between the first impeller and the second impeller;
wherein the first fan and the second fan are serially connected, each of the guide elements comprises an axial extended part and an inclined part, and the inclined part meets the axial extended part at a camber angle.
2. The serial fan module as claimed in claim 1, wherein the camber angle ranges between 20 degrees and 50 degrees.
3. The serial fan module as claimed in claim 1, wherein the inclined part has a first height, the axial extended part has a second height, and a ratio of the first height to the second height is between 0.2 and 5.
4. The serial fan module as claimed in claim 1, wherein the inclined part has a first height, the axial extended part has a second height, and the sum of the first height and the second height exceeds or equals 15 millimeters when the first frame body and/or the second frame body have a height about 38 mm.
5. The serial fan module as claimed in claim 1, wherein the axial extended part parallels an axis of the serial fan module, or the axial extended part inclines to the axis of the serial fan module by an angle which is smaller than or equal to 20 degrees.
6. The serial fan module as claimed in claim 1, wherein each of the inclined parts and the corresponding axial extended part are integrated as a single piece.
7. The serial fan module as claimed in claim 1, wherein the guide elements are connected to the first frame body as a single piece.
8. The serial fan module as claimed in claim 1, wherein each of the inclined parts and the corresponding axial extended part are combined to form the guide element.
9. The serial fan module as claimed in claim 8, wherein each of the inclined part is connected to the first frame body as a single piece, and the corresponding axial extended part is connected to the second frame body as another single piece.
10. The serial fan module as claimed in claim 8, wherein each of the inclined part is connected to the first frame body as a single piece, and the corresponding axial extended part is an independent element.
11. The serial fan module as claimed in claim 1, wherein the first frame body is connected to the second frame body via the guide elements.
12. The serial fan module as claimed in claim 1, wherein the first frame body, the second frame body and the guide elements are integrated as a single piece.
13. The serial fan module as claimed in claim 1, wherein the second frame body has a plurality of static blades and an expanded part at an outlet, and the airflow guided by the guide elements passes through the static blades and exits out of the second frame body from the expanded part.
14. The serial fan module as claimed in claim 13, wherein the static blades and the inclined parts are of the same structures.
15. The serial fan module as claimed in claim 1, wherein the first fan and the second fan both face the same directions, or the first fan and the second fan are disposed back to back.
16. The serial fan module as claimed in claim 15, wherein when the first fan and the second fan are disposed back to back, a motor base of the second fan is connected to the second frame body via the axial extended parts.
17. The serial fan module as claimed in claim 1, wherein rotating directions of the first impeller and the second impeller are the same or different.
18. The serial fan module as claimed in claim 1, wherein the first fan and the second fan are the same.
19. A frame structure, comprising:
a first frame body;
a second frame body; and
a plurality of guide elements disposed between the first frame body and the second frame body,
wherein each of the guide elements comprises an axial extended part and an inclined part and the inclined part meets the axial extended part at a camber angle.

20. The frame structure as claimed in claim 19, wherein the inclined part has a first height, the axial extended part has a second height, a ratio of the first height to the second height is between 0.2 and 5, and the camber angle ranges between 20 degrees and 50 degrees.

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