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United States Patent	12396135
Kind Code	B2
Date of Patent	August 19, 2025
Inventor(s)	Sanada; Tsuyoshi

Cooling device for electronic equipment

Abstract

A fan duct (cooling device) includes: a plurality of ribs that have two different types of forms alternately arranged, the ribs each being disposed from the branch wall toward the fins in a manner of being parallel to the fins and including an apex portion at a tip end thereof being inserted between adjacent ones among the fins, a base of the rib being connected to the branch wall, the rib being configured to branch, at the tip end, the flow of air passing between the fins into two directions; and an exhaust port configured to exhaust the air branched by the rib and the branch wall. Among the ribs inserted between the adjacent ribs, at least ribs of one form are in contact with the fins.

Inventors:	Sanada; Tsuyoshi (Susono Shizuoka, JP)
Applicant:	TOSHIBA TEC KABUSHIKI KAISHA (Tokyo, JP)
Family ID:	1000008766556
Assignee:	TOSHIBA TEC KABUSHIKI KAISHA (Tokyo, JP)
Appl. No.:	18/361956
Filed:	July 31, 2023

Prior Publication Data

Document Identifier	Publication Date
US 20240155813 A1	May. 09, 2024

Foreign Application Priority Data

JP	2022-178571	Nov. 08, 2022
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Publication Classification

Int. Cl.: H05K7/20 (20060101)

U.S. Cl.:

CPC H05K7/20409 (20130101); **H05K7/20172** (20130101);

Field of Classification Search

CPC: H01L (23/3672); H01L (23/4093); G06F (1/20); G06F (1/206); G06F (2200/201); G06F (1/203); H05K (7/20154); H05K (7/20145); H05K (7/2039); H05K (7/20172); H05K (7/20409); H05K (7/20727); H05K (7/20745); F24F (1/0029); F24F (1/0059); F24F (13/082); F24F (13/20); F24F (2013/0616); B60H (1/00042); B60H (1/00); B01D (2267/70); B01D (2273/14); B01D (2279/50); B01D (46/0006); B01D (46/12); B01D (46/18); F28D (2021/0029); F28D (5/00)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
6478082	12/2001	Li	257/E23.102	F28F 13/003
7040384	12/2005	Shiang-Chich	165/104.34	H01L 23/4093
7414842	12/2007	Hao	257/E23.099	H01L 23/467
7492590	12/2008	Chen	174/16.3	H05K 7/20172
7515414	12/2008	Horng	361/695	H01L 23/467
2005/0041392	12/2004	Chen	361/695	H05K 7/20727
2007/0035926	12/2006	Xia	257/E23.099	H01L 23/467
2007/0041159	12/2006	Bate	N/A	G11B 33/142
2007/0091566	12/2006	Sun	361/695	G06F 1/20
2007/0097630	12/2006	Lee	257/E23.099	H01L 23/427
2007/0144727	12/2006	Hirayama	165/203	B60H 1/0005
2007/0165374	12/2006	Chen	257/E23.099	H01L 23/467
2007/0256433	12/2006	Bhatti	62/304	F24F 1/035
2008/0062641	12/2007	Lai	257/E23.099	H01L 23/467
2009/0129018	12/2008	Zhou	361/697	H01L 23/467
2012/0181003	12/2011	Zurowski	165/121	H05K 7/20154
2014/0251322	12/2013	Miller	128/201.13	A61M 16/0891
2020/0148025	12/2019	Tashima	N/A	B60H 1/3407
2024/0075754	12/2023	Mima	N/A	B41J 29/377
2024/0410598	12/2023	Sekito	N/A	F24F 13/24

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
2003-283171	12/2002	JP	N/A

Primary Examiner: Matey; Michael A

Attorney, Agent or Firm: Amin, Turocy & Watson, LLP

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2022-178571, filed on Nov. 8, 2022, the entire contents of which are incorporated herein by reference.

FIELD

(2) Embodiments described herein relate generally to a cooling device for electronic equipment.

BACKGROUND

(3) In the related art, electronic equipment such as a personal computer (PC) includes a component whose temperature increases to a high temperature, such as a central processing unit (CPU). A heat sink is generally attached to such a component for heat dissipation. The air suctioned by a fan disposed upstream flows to the heat sink and is exhausted downstream of the heat sink, whereby heat is dissipated.

(4) Recently, to meet requirements for miniaturization of electronic equipment, components such as input and output equipment of a CPU and a connector may be disposed downstream of a heat sink in a housing of electronic equipment. Such a component is not preferable because a smooth flow of a gas passing through the heat sink is hindered and the heat dissipation performance is deteriorated.

Description

DESCRIPTION OF THE DRAWINGS

- (1) FIG. 1 is a perspective view illustrating an example of a fan duct;
- (2) FIG. 2 is a perspective view illustrating an example of a schematic structure of electronic equipment to which the fan duct is attached;
- (3) FIG. 3 is a perspective view illustrating an example of a vent hole provided in an electronic equipment;
- (4) FIG. 4 is a plan view illustrating an example of a shape of the fan duct;
- (5) FIG. 5 is a longitudinal side view illustrating the example of the shape of the fan duct;
- (6) FIG. 6 is a longitudinal side view for illustrating a positional relationship between the fan duct and components near an exhaust port;
- (7) FIG. 7 is a diagram illustrating an example of a shape of a rib; and
- (8) FIG. 8 is a plan view illustrating another example of the shape of the fan duct.

DETAILED DESCRIPTION

(9) In general, according to one embodiment, a cooling device for electronic equipment that can obtain good heat dissipation performance even when an obstacle is present on a leeward side of a heat sink is provided.

(10) A cooling device for electronic equipment according to one embodiment includes an intake port, a heat sink, a branch wall, a plurality of ribs, and an exhaust port. The intake port is provided with a fan and introduces air. The heat sink dissipates heat generated from electronic equipment by allowing air introduced from the intake port to pass between a plurality of fins. The branch wall is disposed downstream of a flow of air across the plurality of fins of the heat sink in a manner of being orthogonal to a longitudinal direction of the fins, and branches the flow of air passing between the fins into two directions. The plurality of ribs are each a plate-like member including an apex portion at a tip end thereof. The rib is disposed from the branch wall toward the fins in a manner of being parallel to the fins, and branches, at the tip end, a flow of air passing between the fins into two directions. The tip end of the rib is inserted between adjacent ones among the fins. A base of the rib is connected to the branch wall. The ribs have two different types of forms in a side

view, and are alternately inserted between the adjacent fins. At least ribs of one form are in contact with the fins. The exhaust port discharges air branched by the ribs and the branch wall.

First Embodiment

(11) A first embodiment in which a cooling device of the present disclosure is applied as a fan duct **1** will be described with reference to the drawings.

(12) Schematic Structure of Fan Duct A schematic structure of the fan duct **1** as an example of a cooling device of the present disclosure will be described with reference to FIG. **1**. FIG. **1** is a perspective view illustrating the example of the fan duct according to the embodiment. For convenience of description, a three-dimensional coordinate system XYZ shown in FIG. **1** is set. In the three-dimensional coordinate system XYZ, a width direction (left-right direction) of the fan duct **1** is defined as an X-axis direction, a depth direction (front-rear direction) is defined as a Y-axis direction, and a height direction (up-down direction) is defined as a Z-axis direction.

(13) As illustrated in FIG. **1**, the fan duct **1** is a cover member that has a substantially box shape and that covers a heat sink **2** and a suction fan **3** for blowing air to the heat sink **2**. The fan duct **1** is a member having so-called intake duct and exhaust duct, in which air suctioned by the suction fan **3** from an intake port **11** passes between fins **22** of the heat sink **2** installed inside a ventilation pipe (duct) and is exhausted from an exhaust port **12**.

(14) The suction fan **3** suctions air outside the fan duct **1**, introduces the suctioned air into the fan duct **1**, and blows the air in a -Y-axis negative direction. The suction fan **3** is an example of a fan disclosed herein. In the fan duct **1**, the intake port **11** is provided at a position upstream in an air blowing direction of the suction fan **3**, and the exhaust port **12** is provided at a position downstream.

(15) Hereinafter, the simple term “upstream” means upstream (or windward) in the air blowing direction of the suction fan **3**. Similarly, the simple term “downstream” means downstream (or leeward) in the air blowing direction of the suction fan **3**.

(16) The heat sink **2** is attached to an electronic component that generates heat, for example, a central processing unit (CPU). The heat generated by the CPU is conducted through the heat sink **2**. The heat transferred through the heat sink **2** is dissipated to the surrounding air. Accordingly, malfunction or the like due to overheating of the CPU is prevented.

(17) The heat sink **2** includes a base portion **21** and a plurality of fins **22**. The fin **22** is erected on the base portion **21**. The plurality of fins **22** are adjacent to each other at a predetermined interval. The base portion **21** is in contact with the CPU, and the heat of the CPU is conducted thereto. The fins **22** dissipate the heat conducted from the base portion **21** into the air.

(18) The heat sink **2** is fixed on frames **41**, **42**, and **43**, which are layered at predetermined intervals, with coiled springs **44** and screws **45**. A motherboard **101** (see FIG. **2**) is sandwiched between the frame **41** and the frame **42**.

(19) For example, blades rotated by an electric motor continuously blow air in one direction, whereby the suction fan **3** blows air. In the embodiment, the intake port **11**, the suction fan **3**, the heat sink **2**, and the exhaust port **12** are arranged in this order from the upstream side to the downstream side in the air blowing direction of the suction fan **3**.

(20) In order to sufficiently exhibit the effect of the fan duct **1** described above, it is desirable that no component (obstacle) that hinders exhaust is provided on the leeward side of the exhaust port **12**. However, due to a size of electronic equipment **100** (see FIG. **2**) including the fan duct **1**, arrangement of built-in components, and the like, an obstacle may be arranged downstream of the exhaust port **12**.

(21) In order to exhaust air while avoiding such obstacles on the leeward side, the fan duct **1** includes a branch wall **13** and a plurality of ribs **14** and **15** illustrated in FIG. **1**. The branch wall **13** branches a flow of air passing between the fins **22** of the heat sink **2** into two directions. The ribs **14** and **15** are disposed on a wall surface of the branch wall **13**, in parallel to the fins **22** of the heat sink **2**, and branch the flow of air passing between the fins **22** of the heat sink **2** into two directions.

The branch wall **13** and the ribs **14** and **15** will be described in detail later (see FIGS. **4** and **5**).

(22) Schematic Structure of Electronic Equipment Electronic equipment attached with a fan duct will be described with reference to FIGS. **2** and **3**. FIG. **2** is a perspective view illustrating an example of a schematic structure of the electronic equipment attached with the fan duct. FIG. **3** is a perspective view illustrating an example of a vent hole provided in the electronic equipment.

(23) As illustrated in FIG. **2**, the electronic equipment **100** includes the motherboard **101**, a CPU **102**, a memory **103**, a solid state drive (SSD) **104**, a riser card **105**, and input and output boards **106** and **107** inside a housing **110**.

(24) The motherboard **101** is an example of a circuit board mounted with an electronic component (the CPU **102** in the embodiment) that dissipates heat through the heat sink **2**. The memory **103** and the SSD **104** also generate heat due to operations thereof. The heat is also dissipated by a flow of air in the housing **110** that is generated by the air blown by the suction fan **3**.

(25) The input and output boards **106** and **107** are connected to the motherboard **101** via an insertion port (slot) of the riser card **105**. Since the input and output boards **106** and **107** are arranged in parallel to the motherboard **101** by being connected to the insertion port of the riser card **105**, it is possible to reduce a height dimension of the housing **110**.

(26) However, when the input and output boards **106** and **107** are located downstream of the exhaust port **12** due to the above-described arrangement, the input and output boards **106** and **107** become obstacles that hinder the exhaust. In the embodiment, the exhaust from the fan duct **1** avoids the input and output boards **106** and **107**.

(27) As illustrated in FIG. **3**, the fan duct **1** is accommodated inside the housing **110** of the electronic equipment **100**. Vent holes **161**, **162**, and **163** for taking in air to be introduced into the fan duct **1** and vent holes **164**, **165**, **166**, and **167** for exhausting air passing through the fan duct **1** are provided in the housing **110**.

(28) The vent holes **161**, **162**, and **163** are provided in a front cover **111** that constitutes a front face of the housing **110**. The vent holes **164** and **165** are provided in a rear cover **112** that constitutes a rear face of the housing **110**. The vent holes **166** and **167** are provided in an input and output panel **113** that constitutes a part of the rear face of the housing **110**. The input and output panel **113** includes connection terminals of various types of peripheral equipment for connecting to the electronic equipment **100**.

(29) In the electronic equipment **100** of the embodiment, the input and output boards **106** and **107** are arranged behind the CPU **102**. Therefore, the exhaust port **12** of the fan duct **1** is divided into an upper exhaust port **121** that opens toward upward and a lower exhaust port **122** that opens toward downward, so that the exhaust avoids the input and output boards **106** and **107** (see FIG. **1**).

Specifically, the exhaust port **12** is divided into the upper exhaust port **121** and the lower exhaust port **122** by the branch wall **13** and the ribs **14** and **15** illustrated in FIG. **1**. The ribs **14** and **15** are erected from the branch wall **13** toward the heat sink **2**. Further, a plurality of the ribs **14** and **15** are provided along the X axis (side by side in the left-right direction) at fixed intervals. Details will be described later (see FIGS. **4** and **5**).

(30) Structures of Branch Wall and Rib

(31) Structures of the branch wall **13** and the ribs **14** and **15** will be described with reference to FIGS. **4** and **5**. FIG. **4** is a plan view illustrating an example of a shape of the fan duct. FIG. **5** is a longitudinal sectional view illustrating the example of the shape of the fan duct.

(32) The branch wall **13** is disposed at an inner side of an edge of the exhaust port **12**, and has a substantially V-shaped cross section in a side view as illustrated in FIG. **5**, and a bent portion thereof protrudes toward the heat sink **2**. The flow of air passing between the fins **22** of the heat sink **2** is divided into two by the branch wall **13**.

(33) The branch wall **13** is disposed downstream in the flow of air across the plurality of fins **22** of the heat sink **2** in a manner of being orthogonal to a longitudinal direction of the fins **22**. The branch wall **13** includes an upper wall portion **131** and a lower wall portion **132**. The upper wall

portion **131** and the lower wall portion **132** are connected at sides along the X axis upstream in the air blowing direction of the suction fan **3**. The upper wall portion **131** and the lower wall portion **132** are inclined with respect to the air blowing direction of the suction fan **3** such that a distance therebetween increases toward the downstream side in the air blowing direction of the suction fan **3**. The upper wall portion **131** guides the flow of air, which passes between the fins **22** of the heat sink **2**, in an obliquely upward direction. The lower wall portion **132** guides the flow of air, which passes between the fins **22** of the heat sink **2**, in an obliquely downward direction. In this way, the branch wall **13** guides the exhaust so as to avoid a partial range downstream of the branch wall **13** (a range where the input and output boards **106** and **107** are disposed (see FIG. 6)) and branches the exhaust.

(34) The branch wall **13** divides the exhaust port **12** into the upper exhaust port **121** and the lower exhaust port **122**. The upper exhaust port **121** discharges the exhaust, which flows along the upper wall portion **131**, from the vent hole **164** (see FIG. 3) to the outside of the housing **110**. The lower exhaust port **122** discharges the exhaust, which flows along the lower wall portion **132**, from the vent holes **165**, **166**, and **167** (see FIG. 3) to the outside of the housing **110**. As illustrated in FIG. 5, the branch wall **13** has a substantially V-shaped cross section in a side view, and the bent portion thereof protrudes toward the heat sink **2**. The flow of air passing between the fins **22** of the heat sink **2** is divided into two by the branch wall **13**.

(35) The upper wall portion **131** and the lower wall portion **132** of the branch wall **13** are provided with a plurality of ribs **14** that are directed toward the fins **22** of the heat sink **2** and that are parallel to the fins **22**. Each rib **14** is formed of, for example, a resin material or a metal material, and is a plate-like member including a pointed apex portion **141** at a tip end thereof. A base of the rib **14** is connected to the upper wall portion **131** at a rib upper rear end Pa and connected to the lower wall portion **132** at a rib lower rear end Pb. The rib **14** is inserted between the fins **22**. A region of the rib **14** that is inserted between the fins **22** is not in contact with the fin **22**.

(36) The lower wall portion **132** of the branch wall **13** is provided with a plurality of ribs **15** that face the fins **22** of the heat sink **2** and that are parallel to the fins **22**. The ribs **15** are each formed of, for example, a resin material or a metal material, and is a plate-like member including a pointed apex portion **151** at a tip end thereof. A base of the rib **15** is connected to the lower wall portion **132** at a rib upper rear end Pc and a rib lower rear end Pd. The rib **15** is inserted between the fins **22**. Both surfaces of a region of the rib **15** that is inserted between the fins **22** are in contact with the fin **22**.

(37) As described above, the rib **14** and the rib **15** have different lengths and orientations, and the rib **14** and the rib **15** are alternately formed along the X axis. That is, the fan duct **1** includes the rib **14** and the rib **15** that have two different types of forms.

(38) Each of an upper edge portion **142** and a lower edge portion **143** of the rib **14** is formed in a straight line in a side view of the rib **14**. A deflection angle θ_a between the upper edge portion **142** of the rib **14** and an exhaust direction of the air passing between the fins **22** of the heat sink **2** (−Y-axis negative direction) is formed to be 30° or less. Further, a deflection angle θ_b between the lower edge portion **143** of the rib **14** and the exhaust direction of the air passing between the fins **22** of the heat sink **2** (−Y-axis negative direction) is also formed to be 30° or less. The upper edge portion **142** and the lower edge portion **143** may be formed in a curved line. Further, the upper edge portion **142** and the lower edge portion **143** may be formed in a combination of a straight line and a curved line. Details will be described later (see FIG. 7).

(39) Each of an upper edge portion **152** and a lower edge portion **153** of the rib **15** is formed in a straight line in a side view of the rib **15**. A deflection angle θ_c between the upper edge portion **152** of the rib **15** and the exhaust direction of the air passing between the fins **22** of the heat sink **2** (−Y-axis negative direction) is formed to be 30° or less. Further, a deflection angle θ_d between the lower edge portion **153** of the rib **15** and the exhaust direction of the air passing between the fins **22** of the heat sink **2** (−Y-axis negative direction) is also formed to be 30° or less. The upper edge

portion **152** and the lower edge portion **153** may be formed in a curved line. Details will be described later (see FIG. 7).

(40) The bases of the ribs **14** and **15** are smoothly connected to the branch wall **13**. Details will be described later (see FIG. 7).

(41) In the example of FIGS. 4 and 5, the rib **14** is formed over the upper wall portion **131** and the lower wall portion **132**, and the rib **15** is formed in a region of the lower wall portion **132**, and the present disclosure is not limited thereto. That is, the rib **14** and the rib **15** may be formed over both the upper wall portion **131** and the lower wall portion **132**, or in a region of either one.

(42) Here, at least the rib **15** in contact with the fin **22** of the heat sink **2** may be formed of a material having high thermal conductivity (for example, a metal such as aluminum or copper, or a resin material such as a high-thermal-conductivity polycarbonate resin). Accordingly, an apparent surface area of the fins **22** of the heat sink **2** is increased, thereby further improving the cooling performance.

(43) Positional Relationship Between Exhaust Port of Fan Duct and Mounted Components

(44) A positional relationship between the fan duct **1** of the embodiment and components mounted near the exhaust port will be described with reference to FIG. 6. FIG. 6 is a longitudinal sectional side view illustrating a positional relationship between the fan duct and components near the exhaust port.

(45) As illustrated in FIG. 6, the input and output boards **106** and **107** mounted near the exhaust port are disposed at a position not exposed to the exhaust from the upper exhaust port **121** and the exhaust from the lower exhaust port **122**. Accordingly, the fan duct **1** enables components to be arranged downstream of the fan duct **1** without hindering the cooling performance for the CPU **102** in the electronic equipment **100** (see FIG. 2).

(46) In such a configuration, when the electronic equipment **100** is energized, the CPU **102**, the memory **103**, the SSD **104**, and the like generate heat, and temperatures thereof rise. When the suction fan **3** operates to blow air, the air flows inside the fan duct **1**, and thus the CPU **102** for which the heat sink **2** is disposed is cooled. Further, at this time, among the exhaust from the upper exhaust port **121** and the lower exhaust port **122**, air that is not discharged to the outside of the housing **110** (see FIG. 2) moves, for example, toward the intake port **11** inside the housing **110**. Accordingly, since a flow of air is also generated outside the fan duct **1**, the memory **103**, the SSD **104**, and the like for which the heat sink **2** is not disposed are also cooled by the flow of air.

(47) Shape of Edge of Rib

(48) Specific shapes of the upper edge portions **142** and **152** and the lower edge portions **143** and **153** of the ribs **14** and **15** will be described with reference to FIG. 7. FIG. 7 is a diagram illustrating an example of the shape of the rib.

(49) In the rib **14** illustrated in FIG. 7, the upper edge portion **142** and the lower edge portion **143** both have a curved shape. The upper edge portion **142** is connected to the upper wall portion **131** at the rib upper rear end Pa. The lower edge portion **143** is connected to the lower wall portion **132** at the rib lower rear end Pb.

(50) At this time, a tangent of the upper edge portion **142** at the rib upper rear end Pa coincides with a tangent of the upper wall portion **131** at the rib upper rear end Pa. That is, the upper edge portion **142** and the upper wall portion **131** are smoothly connected at the rib upper rear end Pa. Further, a tangent of the lower edge portion **143** at the rib lower rear end Pb coincides with a tangent of the lower wall portion **132** at the rib lower rear end Pb. That is, the lower edge portion **143** and the lower wall portion **132** are smoothly connected at the rib lower rear end Pb.

(51) Further, in the rib **15** illustrated in FIG. 7, the upper edge portion **152** and the lower edge portion **153** both have a curved shape. The upper edge portion **152** is connected to the upper wall portion **131** at the rib upper rear end Pc. The lower edge portion **153** is connected to the lower wall portion **132** at the rib lower rear end Pd.

(52) At this time, a tangent of the upper edge portion **152** at the rib upper rear end Pc coincides

with a tangent of the upper wall portion **131** at the rib upper rear end Pc. That is, the upper edge portion **152** and the upper wall portion **131** are smoothly connected at the rib upper rear end Pc. A tangent of the lower edge portion **153** at the rib lower rear end Pd coincides with a tangent of the lower wall portion **132** at the rib lower rear end Pd. That is, the lower edge portion **153** and the lower wall portion **132** are smoothly connected at the rib lower rear end Pd.

(53) Although a specific shape of a curve forming the upper edge portion **142** and the lower edge portion **143** of the rib **14** is not limited, the deflection angle θ_a of the upper edge portion **142** of the rib **14** gradually increases from the apex portion **141** to the rib upper rear end Pa, and is formed to be 30° or less from the apex portion **141** to the rib upper rear end Pa. The deflection angle θ_b of the lower edge portion **143** of the rib **14** gradually increases from the apex portion **141** to the rib lower rear end Pb, and is formed to be 30° or less from the apex portion **141** to the rib lower rear end Pb. The upper edge portion **142** and the lower edge portion **143** of the rib **14** may be formed in a combination of a curved line and a straight line.

(54) Further, although a specific shape of a curve forming the upper edge portion **152** and the lower edge portion **153** of the rib **15** is not limited, the deflection angle θ_c of the upper edge portion **152** of the rib **15** gradually increases from the apex portion **151** to the rib upper rear end Pc, and is formed to be 30° or less from the apex portion **151** to the rib upper rear end Pc. The deflection angle θ_d of the lower edge portion **153** of the rib **15** gradually increases from the apex portion **151** to the rib lower rear end Pd, and is formed to be 30° or less from the apex portion **151** to the rib lower rear end Pd. The upper edge portion **152** and the lower edge portion **153** of the rib **15** may be formed in a combination of a curved line and a straight line.

Operations and Effects of First Embodiment

(55) As described above, the fan duct **1** (cooling device) according to the first embodiment includes: the intake port **11** provided with the suction fan **3** (fan) and configured to introduce air; the heat sink **2** configured to dissipate heat generated from the electronic equipment by allowing air introduced from the intake port **11** to pass between the plurality of fins **22**; the branch wall **13** disposed downstream in the flow of air across the plurality of fins **22** of the heat sink **2** in a manner of being orthogonal to the longitudinal direction of the fins **22**, and configured to branch the flow of air passing between the fins **22** into two directions; the plurality of ribs **14** and **15** that have two different types of forms alternately arranged, the ribs **14** and **15** each being a plate-like member disposed from the branch wall **13** toward the fins **22** in a manner of being parallel to the fins **22** and including the apex portions **141** and **151** at the tip end thereof, the ribs **14** and **15** being configured to branch, at the tip end, the flow of air passing between the fins **22** into two directions, the tip end of the rib being inserted between adjacent ones among the fins **22**, the base of the ribs being connected to the branch wall **13**; and the exhaust port **12** configured to exhaust the air branched by the ribs **14** and **15** and the branch wall **13**. Among the ribs **14** and **15** alternately inserted between the adjacent fins **22**, at least the ribs **14** or the ribs **15** of one form is in contact with the fin **22**. Accordingly, even when there is an obstacle leeward of the heat sink **2**, good cooling performance can be obtained. In addition, a size of the heat sink **2** can be increased as much as possible in a limited space by inserting the rib **14** between the fins **22** of the heat sink **2**, and thus both the miniaturization of the electronic equipment **100** and the improvement of the cooling performance can be achieved. Further, since at least one of the rib **14** and the rib **15** inserted between the fins **22** of the heat sink **2** comes into contact with the fin **22**, the apparent surface area of the fins **22** of the heat sink **2** can be increased. Accordingly, the cooling performance can be further improved.

Further, even when there is a shift between a pitch of the fins **22** of the heat sink **2** and a pitch of the ribs **14** and **15**, the shift of the pitch can be absorbed by the elasticity of the ribs **14** and **15**, and the fins **22** of the heat sink **2** can be reliably brought into contact with the ribs **14** or the ribs **15**.

(56) In the fan duct **1** (cooling device) according to the embodiment, among the ribs **14** and **15**, at least the ribs in contact with the fin **22** are formed of a material having high thermal conductivity. Accordingly, the apparent surface area of the fins **22** of the heat sink **2** can be increased.

Accordingly, the cooling performance can be further improved.

(57) In the fan duct **1** (cooling device) according to the embodiment, the tangents of the ribs **14** and **15** and the tangents of the branch wall **13**, at the connection points between the bases of the ribs **14** and **15** and the branch wall **13** (the rib upper rear end Pa and the rib lower rear end Pb of the rib **14** and the rib upper rear end Pc and the rib lower rear end Pd of the rib **15**), coincide with each other correspondingly in the side view of the ribs **14** and **15**. Accordingly, the air branched at the apex portion **141** of the rib **14** can smoothly flow from the upper edge portion **142** to the upper wall portion **131**. The air branched at the apex portion **141** of the rib **14** can smoothly flow from the lower edge portion **143** to the lower wall portion **132**. The air branched at the apex portion **151** of the rib **15** can smoothly flow from the upper edge portion **152** to the upper wall portion **131**. The air branched at the apex portion **151** of the rib **15** can smoothly flow from the lower edge portion **153** to the lower wall portion **132**. Accordingly, smooth exhaust can be performed.

(58) In the fan duct **1** (cooling device) according to the embodiment, an interval between the upper edge portion **142** and the lower edge portion **143** of the rib **14** increases toward the base of the rib **14**, and the upper edge portion **142** and the lower edge portion **143** are both formed in a straight line, a curved line, or a combination thereof in a side view of the rib **14**. Further, an interval between the upper edge portion **152** and the lower edge portion **153** of the rib **15** increases toward the base of the rib **15**, and both the upper edge portion **152** and the lower edge portion **153** are formed in a straight line, a curved line, or a combination thereof in a side view of the rib **15**. Accordingly, the air branched at the apex portion **141** of the rib **14** and the air branched at the apex portion **151** of the rib **15** can smoothly flow downstream.

Second Embodiment

(59) A second embodiment in which a cooling device of the present disclosure is applied as a fan duct **10** will be described with reference to the drawings.

(60) Another Form of Rib

(61) Forms of ribs **16** and **17** provided in the fan duct **10** serving as an example of the cooling device of the present disclosure will be described with reference to FIG. **8**. FIG. **8** is a plan view illustrating another example of the shape of the fan duct.

(62) Similarly to the first embodiment described above, the fan duct **10** includes the branch wall **13** that branches a flow of air passing between the fins **22** of the heat sink **2** into two directions. Similarly to the first embodiment, the branch wall **13** includes the upper wall portion **131** and the lower wall portion **132**.

(63) The upper wall portion **131** and the lower wall portion **132** of the branch wall **13** are provided with a plurality of ribs **16** that are directed toward the fins **22** of the heat sink **2** and that are parallel to the fins **22**. The lower wall portion **132** of the branch wall **13** is provided with a plurality of ribs **17** that are directed toward the fins **22** of the heat sink **2** and that are parallel to the fins **22**.

(64) Similarly to the ribs **14** and **15** described in the first embodiment, the ribs **16** and the ribs **17** provided in the fan duct **10** have different forms in a side view. A base portion **144** of the ribs **16** and a base portion **154** of the ribs **17** have substantially the same thickness. An interval between the base portion **144** of the ribs **16** and the base portion **154** of the ribs **17** is smaller than an interval between the fins **22** of the heat sink **2**.

(65) Further, the ribs **16** are each formed such that a thickness of a tip end portion **145** thereof including the apex portion **141** is larger than the thickness of the base portion **144**. Both surfaces of the tip end portion **145** are in contact with the fin **22**. The ribs **17** are each formed such that a thickness of a tip end portion **155** thereof including the apex portion **151** is larger than the thickness of the base portion **154**. Both surfaces of the tip end portion **155** are in contact with the fin **22**. That is, the tip end portion **145** of the rib **16** and the tip end portion **155** of the rib **17** alternately contact the fin **22** at different positions.

(66) With such a contact structure, even when there is a shift between a pitch of the fins **22** of the heat sink **2** and a pitch of the ribs **16** and **17**, the shift of the pitch is absorbed by elasticity of the

ribs **16** and **17**, and thus the fins **22** of the heat sink **2** and the ribs **16** and **17** are reliably brought into contact with each other.

Operations and Effects of Second Embodiment

(67) As described above, in the fan duct **10** (cooling device) according to the second embodiment, all of the ribs **16** and **17** having two types of forms, which are alternately inserted between the adjacent fins **22**, are alternately in contact with the fins **22** at different positions. Accordingly, a dimensional error between the pitch of the fins **22** of the heat sink **2** and the pitch of the ribs **16** and **17** can be absorbed, and the fins **22** of the heat sink **2** and the ribs **16** and **17** can be more reliably brought into contact with each other.

(68) While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the embodiments. The novel embodiments can be implemented in various other forms, and various omissions, replacements, and modifications can be made without departing from the gist of the embodiments. The embodiments and modifications thereof are included in the scope and the gist of the embodiments, and are included in the disclosure described in the claims and the scope of equivalents of the disclosure.

Claims

1. A cooling device for an electronic equipment, comprising: an intake port comprising a fan and configured to introduce air; a heat sink configured to dissipate heat generated from the electronic equipment by allowing air introduced from the intake port to pass between a plurality of fins; a branch wall disposed downstream in a flow of the air across the plurality of fins of the heat sink in a manner of being orthogonal to a longitudinal direction of the fins, and configured to branch a flow of air passing between the plurality of fins into two different directions; a plurality of ribs that have two different types of forms alternately arranged, each rib being a plate-like member disposed from the branch wall toward the fins in a parallel manner to the fins and comprising an apex portion at a tip end thereof, the plurality of ribs being configured to branch, at the tip end, the flow of air passing between the fins into two different directions, the tip end of the rib being inserted between adjacent ones among the fins, a base of each rib being connected to the branch wall; and an exhaust port configured to exhaust the air branched by the rib and the branch wall, wherein among the ribs alternately inserted between the adjacent fins, at least ribs of one form are in contact with the fins.
2. The cooling device according to claim 1, wherein all of the ribs having one type of two types of forms, which are alternately inserted between the adjacent fins, are alternately in contact with the fin at different positions.
3. The cooling device according to claim 1, wherein among the plurality of ribs, at least the ribs in contact with the fins are formed of a material having high thermal conductivity.
4. The cooling device according to claim 3, wherein a tangent of each rib and a tangent of the branch wall, at a connection point between the base of each of the plurality of the ribs and the branch wall, coincide with each other in a side view of the rib.
5. The cooling device according to claim 4, wherein an interval between an upper edge portion and a lower edge portion of the rib increases toward the base of the rib, and both the upper edge portion and the lower edge portion are formed in a straight line, a curved line, or a combination thereof in a side view of the rib.
6. The cooling device according to claim 1, wherein the branch wall is disposed at an inner side of an edge of the exhaust port and has a substantially V-shaped cross section.
7. The cooling device according to claim 1, wherein the plurality of fins are adjacent to each other at a predetermined interval.
8. The cooling device according to claim 1, wherein the electronic equipment comprises at least one of a central processing unit, a motherboard, a memory, a solid state drive, a riser card, and an

I/O board.

9. The cooling device according to claim 1, wherein the plurality of ribs are adjacent to each other at a predetermined interval.

10. The cooling device according to claim 1, wherein the heat sink is fixed onto two frames layered at predetermined intervals, by helical springs and screws.

11. A personal computer, comprising: central processing unit; and a cooling device, comprising: an intake port comprising a fan and configured to introduce air; a heat sink configured to dissipate heat generated from the central processing unit by allowing air introduced from the intake port to pass between a plurality of fins; a branch wall disposed downstream in a flow of the air across the plurality of fins of the heat sink in a manner of being orthogonal to a longitudinal direction of the fins, and configured to branch a flow of air passing between the plurality of fins into two different directions; a plurality of ribs that have two different types of forms alternately arranged, each rib being a plate-like member disposed from the branch wall toward the fins in a parallel manner to the fins and comprising an apex portion at a tip end thereof, the plurality of ribs being configured to branch, at the tip end, the flow of air passing between the fins into two different directions, the tip end of the rib being inserted between adjacent ones among the fins, a base of each rib being connected to the branch wall; and an exhaust port configured to exhaust the air branched by the rib and the branch wall, wherein among the ribs alternately inserted between the adjacent fins, at least ribs of one form are in contact with the fins.

12. The personal computer according to claim 11, wherein all of the ribs having one type of two types of forms, which are alternately inserted between the adjacent fins, are alternately in contact with the fin at different positions.

13. The personal computer according to claim 11, wherein among the plurality of ribs, at least the ribs in contact with the fins are formed of a material having high thermal conductivity.

14. The personal computer according to claim 13, wherein a tangent of each rib and a tangent of the branch wall, at a connection point between the base of each of the plurality of the ribs and the branch wall, coincide with each other in a side view of the rib.

15. The personal computer according to claim 14, wherein an interval between an upper edge portion and a lower edge portion of the rib increases toward the base of the rib, and both the upper edge portion and the lower edge portion are formed in a straight line, a curved line, or a combination thereof in a side view of the rib.

16. The personal computer according to claim 11, wherein the branch wall is disposed at an inner side of an edge of the exhaust port and has a substantially V-shaped cross section.

17. The personal computer according to claim 11, wherein the plurality of fins are adjacent to each other at a predetermined interval.

18. The personal computer according to claim 11, further comprises at least one of a motherboard, a memory, a solid state drive, a riser card, and an I/O board.

19. The personal computer according to claim 11, wherein the plurality of ribs are adjacent to each other at a predetermined interval.

20. The personal computer according to claim 11, wherein the heat sink is fixed onto two frames layered at predetermined intervals, by helical springs and screws.
