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(54) COOLING DEVICE FOR INFORMATION EQUIPMENT

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(57) ABSTRACT

A cooling device for an information equipment, comprises a heat receiving member composed of a base member thermally connected to a heat generating element, and a casing member, which are defined therebetween a closes space in which a coolant can flow, the base member is integrally incorporated with fins in a predetermined zone of its planar surface on the side remote from the heat generating element thermally connected to the base member, and the base member has a thickness which is thinner in the zone where the fins are formed than in the other zone where no fins are formed. With this configuration, the heat receiving member which can enhance the heat-exchanging performance of a liquid cooling system, can be manufactured at a low cost.

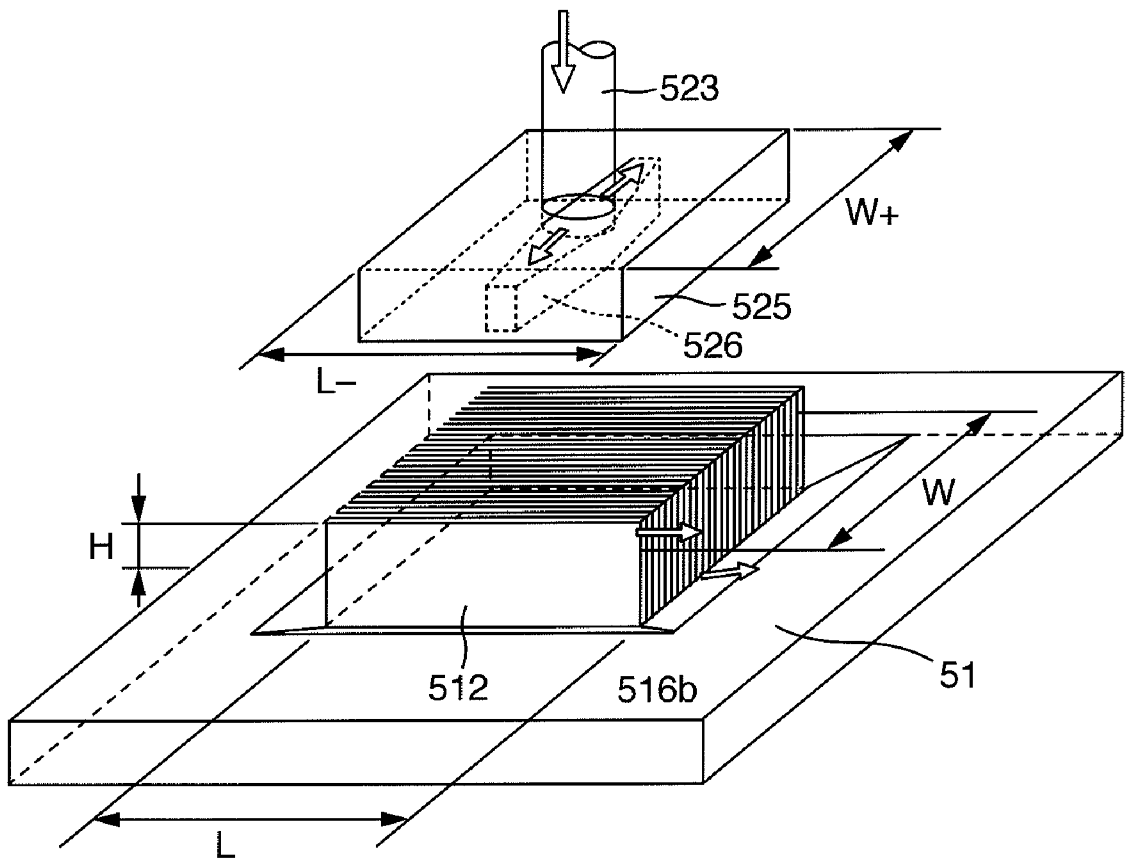


FIG. 1A

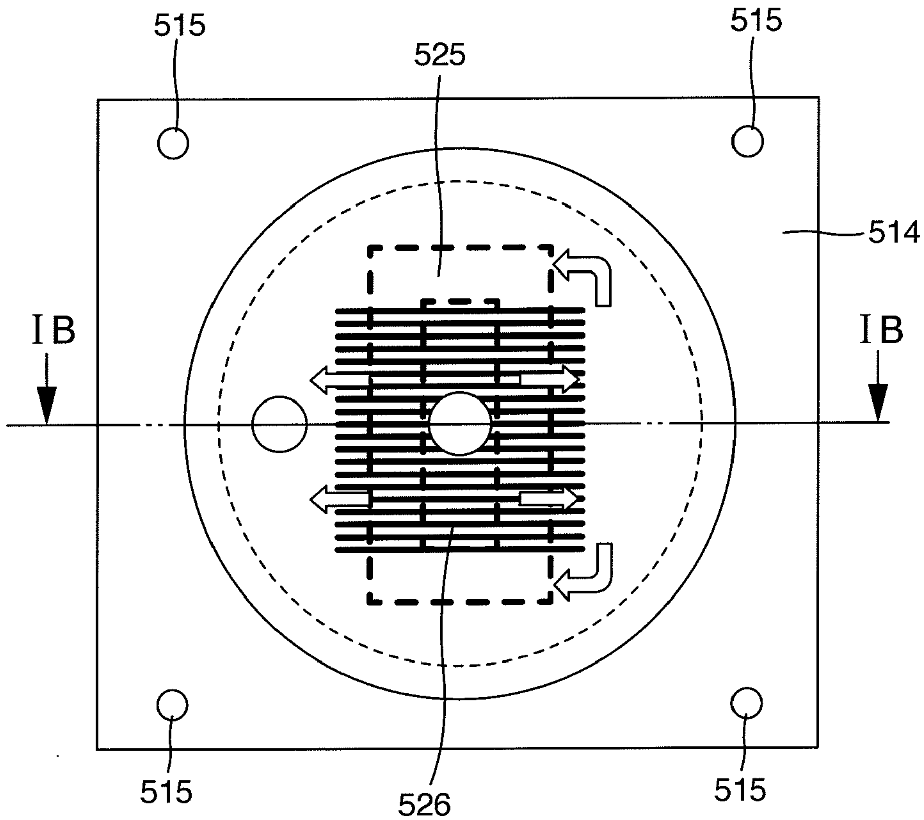

515
525
515
514
IB
IB
515
526
515

FIG. 1B

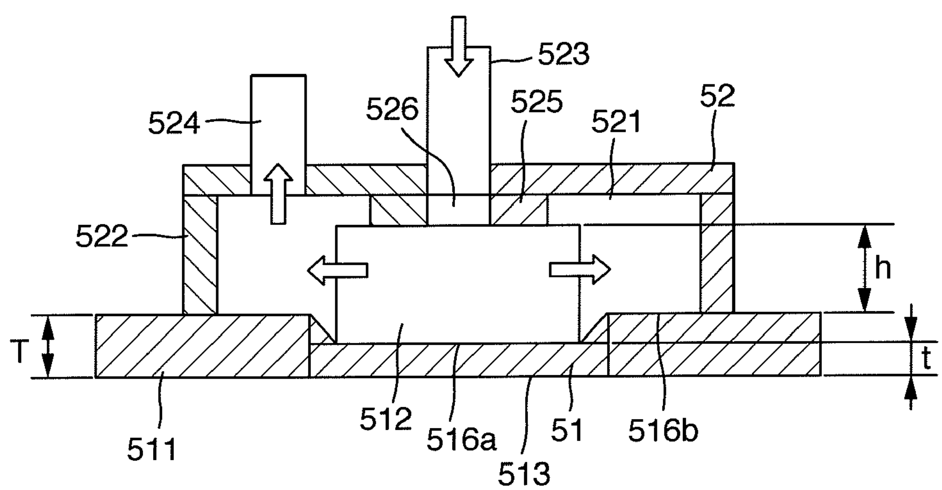

523
524
526
525
521
52
522
h
T
t
511
512
516a
513
51
516b

FIG. 2

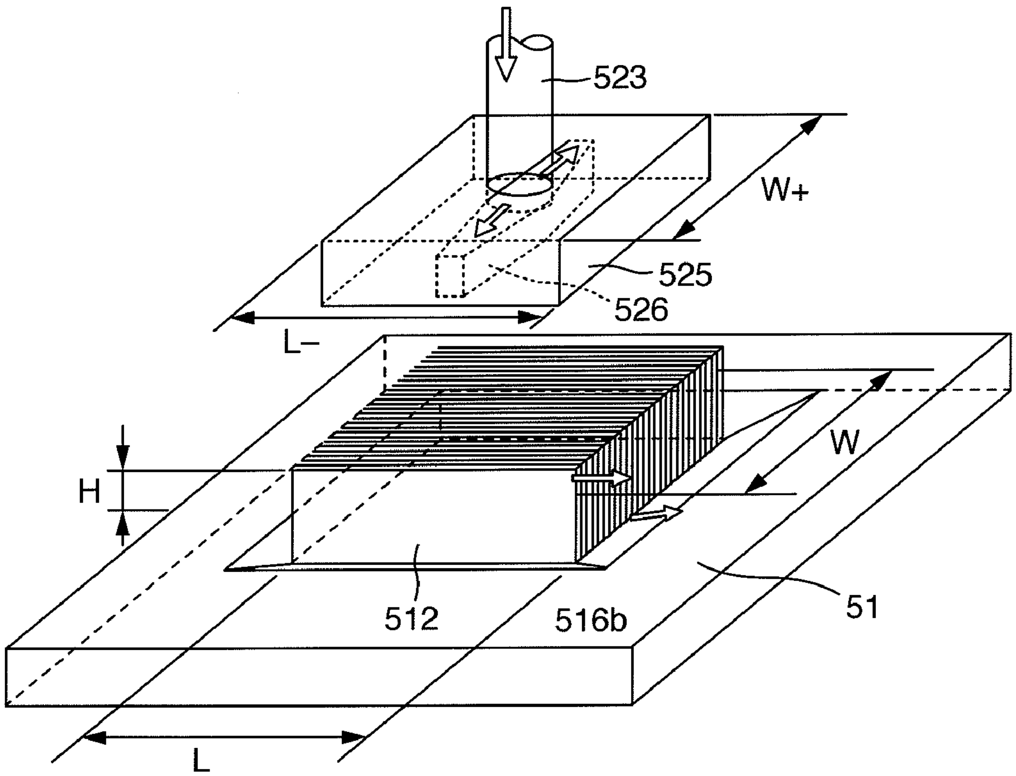


FIG. 3

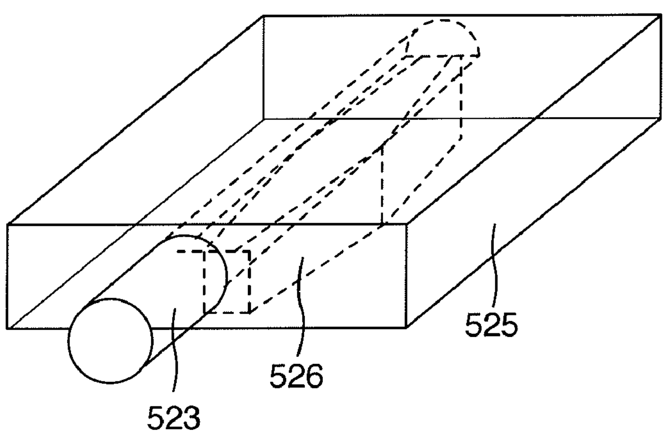
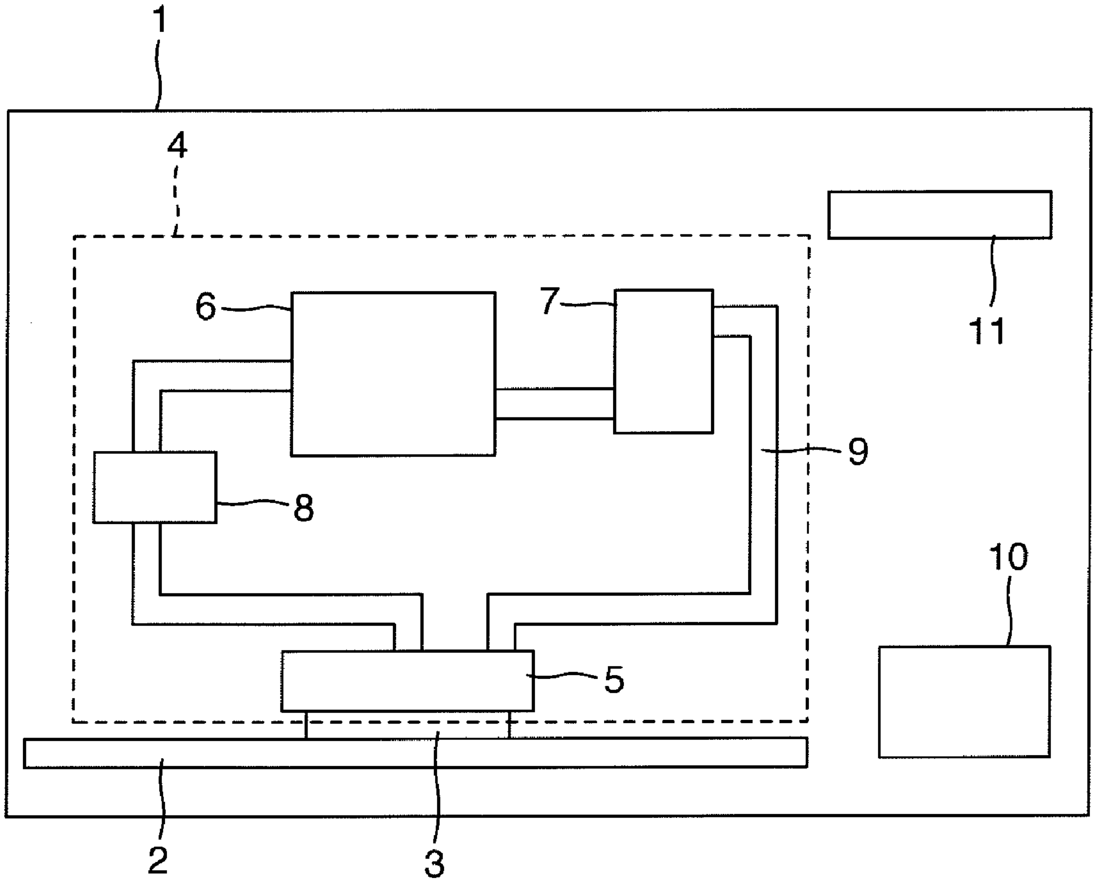


FIG. 4



COOLING DEVICE FOR INFORMATION EQUIPMENT

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from Japanese Patent Application JP 2007-052169, filed on Mar. 2, 2007, the content of which is hereby incorporated by reference into this application.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an information equipment such as a personal computer mounted therein with a semiconductor integrated circuit, and in particular, to a heat-exchange technology of cooling devices for efficiently cooling heat generated by a semiconductor integrated circuit in order to enhance the performance and the reliability of an information equipment.

[0004] 2. Description of Related Art

[0005] These years, information equipments are mounted thereon with high-performance semiconductor integrated circuits as typified by a CPU used in a personal computer. Such semiconductor integrated circuits have been tried to increase a processing speed and an integration degree thereof, and as a result, the heating value thereof has been increased due to such a demand that the information equipment has to have a high performance. If the temperature of the semiconductor integrated circuit exceeds a predetermined value, it could not maintain its inherent performance, and should it be overheated, it would be damaged at worst. Thus, it is necessary to cool the semiconductor integrated circuits in information equipments.

[0006] For cooling the semiconductor integrated circuits in the information equipment, there has been in general used such an air-cooling system that a semiconductor integrated circuit is thermally connected to a heat sink, to which cooling air is blown by a fan so as to cool it. It is noted here that the air cooling system as stated above requires installation of a large-sized or high speed fan so as to increase an air blow capacity in order to enhance the cooling capacity corresponding to an increase in a heating temperature of the heat generating element. Meanwhile, portable and small-sized information equipments have been abruptly developed since the use of information equipments is diversified. That is, a cooling device for a semiconductor integrated circuit in a information equipment must be small-sized and have a high performance, which cannot be solved in a cooling device of an air-cooling type, as well as the noise problem. Thus, a liquid-cooling system in which heat-transfer is made though a liquid coolant is highlighted in order to enhance the cooling performance.

[0007] Further, it is required to miniaturize the above-mentioned liquid cooling system while its cooling performance is enhanced, which is required to enhance the heat-exchanging performance by the liquid coolant. In other words, the amount absorbed by the liquid coolant in heat from the heat generating element has to be increased, and the amount radiated in the heat absorbed by the coolant has to be increased.

[0008] With respect to the above-mentioned heat-exchanging performance, it has been progressed to make fins minute in order to enhance the efficiency of heat transfer to a coolant in a heat-exchanger. JP-A-48-57242 discloses, as a method of forming fins, a skiving process in which an outer surface of a substrate is carved at fine pitches so as to turn up fins having a small thickness by a cutting tool in order to form a plurality of thin fins integrally incorporated with the substrate. Further, JP-A-2001-326308 discloses a technology for enhancing the effect of heat radiation of fins by the skiving process.

[0009] Further, with respect to a liquid cooling system, JP-A-2005-338715 discloses a technology in which coolant passages in a heat receiving member are defined by micro fins of micro-fabrication. Furthermore, JP-A-2003-243590 discloses such a technology that a substrate of a semiconductor device is formed therein with micro channels by an etching process or the like so as to enhance the heat receiving efficiency, and liquid coolant is evaporated at a heat receiving member so as to simplify a liquid coolant circulation type cooling device with the use of the heat receiving member although this cooling system is specifically used for cooling a semiconductor device.

[0010] A heat-exchanger in a liquid cooling system has a technical problem in the above-mentioned conventional technologies, which should be solved in order to materialize a high performance heat receiving member which is small-sized and inexpensive.

[0011] The heat-exchanger disclosed in the above-mentioned JP-A-48-57242 has cooling fins which are integrally incorporated with the outer surface of an aluminum pipe by a skiving process, which is disclosed as an inexpensive method for fabricating a heat-exchanger. However, these fins are formed as heat radiation fins in an air cooling system, that is, this document does never disclose a technical contrivance as to passages of a heat receiving member in a liquid cooling system.

[0012] The heat radiation member disclosed in the JP-A-2001-326308 is a heat sink which is integrally incorporated with heat radiation fins by a skiving process similar to that disclosed in JP-A-48-57242, and a method is disclosed for improving a strength problem in such a case that the heat sink is made of a copper group material having a high heat conductivity so as to cool a heat generating element having a high heating value, such as a CPU. However, this document only discloses a technology relating to a material of which skived heat radiation fins are made, but does never disclose, similar to the JP-A-48-57242, the technology relating to the configuration and structure of fins used as passages of a heat receiving member in a liquid cooling system in order to enhance the heat-exchanging performance.

[0013] Further, the cooling structure disclosed in the JP-A-2005-338715, which is used in a liquid cooling device for cooling a small-sized mirror for reflecting a light beam from a light source in a projection type optical apparatus such as a liquid crystal projector, is provided with micro fins which are formed at fine pitches by an etching process or the like, in order to ensure an enlarged coolant contact area in a coolant passage space within a heat receiving jacket for receiving a heat from the small-sized mirror. With the provision of the micro fins in the heat receiving member in the cooling device through which a coolant flows, there may be provided a heat receiving jacket having a high heat absorbing efficiency. Accordingly, although this document discloses a necessity of consideration for preventing the thus formed micro fins from hindering the circulation of the coolant and for enhancing the workability, no specific technical solution is disclosed.

[0014] Further, the cooling device disclosed in the JP-A-2003-243590 is adapted to enhance the reliability of thermal connection between a semiconductor device and a heat receiving member by forming micro channels in the substrate of the semiconductor device through an etching process. However, although it is possible to micro-fabricate fins at fine pitches on the silicon semiconductor device by the etching process, there are caused such problems that it is difficult to increase the height of the fins for enlarging the contact area with respect to the coolant which flows through a liquid cooling type cooling device, and that the etching process therefor is more expensive.

SUMMARY OF THE INVENTION

[0015] The present invention is devised in view of the problems of the heat receiving member inherent to the above-mentioned conventional cooling devices, and accordingly, an object of the present invention is to provide a cooing device for information equipments, which has a high performance and which can aim at enlarging the scope of element to be cooled by forming a liquid cooling type heat receiving member that can be formed with fine fins at low costs and that can enhance the heat-exchanging efficiency.

[0016] In order to solve the problems inherent to the conventional cooling devices, according to the present invention, there is provided a cooling device for cooling a heat generating element mounted in a information equipment with the use of heat-transfer through a coolant. The cooling device comprises a heat receiving member for receiving a heat from the heat generating element through the coolant, a heat radiation member for radiating the heat received through the coolant, and a piping member arranged between the heat receiving member and the heat radiation member, for circulating the coolant therebetween. The heat receiving member is formed therein a closed space capable of passing the coolant therethrough, which is defined by a base member thermally connected to the heat generating element and a casing member, and has fins which define passages for introducing the coolant into the closes space and are integrally incorporated with a surface of the base member on the side opposite to the surface which is thermally connected to the heat generating element, in a predetermined place, the thickness of the base member in a zone where the fins are formed being set to be smaller than the thickness of the base member in the other zone where no fins are formed.

[0017] Further, the fins formed on the base member are turned up by a skiving process at concaved positions where the base member is carved.

[0018] Further, the base member is formed with inclined surfaces at opposite end parts of the flow passages defined between the fins formed in the base member, each inclined surface being extended from the height position of the thin wall part of the base member formed thereinwith the fins, to the height position of the thick wall part thereof.

[0019] Further, the base member has a pressing member which is integrally incorporated with the base member or which is formed separate therefrom and is then joined thereto, the pressing member pressing the top end parts of the fins when defining the heat receiving member with the casing member. The size of the fin pressing member is set to be shorter than the width of the fins in the longitudinal direction of the passages of the fins but longer than the length of a row of the fins in the direction orthogonal to the passages of the fins.

[0020] Further, the casing member is formed in its top surface with an inlet port for the coolant, and is provided with a header for introducing the coolant flowing from the inlet port, to the upper parts of the fins, the header being positioned above the fins and having a length substantially equal to the length of the row of the fins in the direction orthogonal to the passages between the fins.

[0021] According to the present invention, the heat receiving member is formed so as to have a structure which is excellent in productivity, thereby it is possible to provide a cooling device for a information equipment, which is capable of efficiently cooling a heat generating element with an increased heating value.

[0022] Other objects, features and advantages of the invention will become apparent from the following description of the embodiments of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[0023] FIG. **1**A is a plane view illustrating a heat receiving member in a cooling device according to the present invention, and FIG. **1**B is a section view taken along a IB-IB line in FIG. **1**A;

[0024] FIG. **2** is a perspective view illustrating configurations of fins defining flow passages and a pressing member;

[0025] FIG. **3** is a perspective view illustrating a configuration of a pressing member in a case that a port is laid sidelong; and

[0026] FIG. **4** is a schematic block diagram illustrating a information equipment mounted therein with a cooling device according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] Explanation will be hereinbelow made of an embodiment according to the present invention with reference to the accompanying drawing.

[0028] Referring to FIG. **4** which is a schematic block diagram illustrating a information equipment mounted therein with a cooling device according to the present invention, the information equipment **1** is mounted with a circuit board **2**, a power source **10**, an HDD **11** and the like. The circuit board **2** has a heat generating element **3** such as a semiconductor device.

[0029] Further, the information equipment **1** is mounted therein with a cooling device **4** for cooling the heat generating element **3**. The cooling device **4** is compose of the following components: a heat receiving member **5** which is thermally connected to the heat generating element **3** so as to make a coolant flowing in the heat receiving member absorb heat through heat transfer; a heat radiation member **6** in which cooling air is blown through a heat radiation pipe or the like so as to radiate the heat absorbed in the coolant, outside of the information equipment, through the heat transfer; a tank **7** which reserves the coolant for the cooling device **1**; a pump **8** for circulating the coolant between the heat receiving member **5** and the heat radiation member **6**; and a pipeline **9** connecting the heat receiving member **5**, the heat radiation member **6**, the tank **7** and the pump **8** together, for circulating the coolant thereamong.

[0030] It is noted here that the information equipment **1** should not be limited to a specific one, and further, although explanation is made such that the semiconductor device is the heat generating element **3**, the heat generating element **3** should not be limited to the semiconductor element in the present invention, that is, the cooling device **4** may preferably be used for another heat generating element such as the HDD.

[0031] Next, the heat receiving member **5** in the cooling device **4** according to the present invention will be explainer in detail. FIG. **1**A is a schematic plane view illustrating the heat receiving member in the cooling device according to the present invention, and FIG. **1**B is a sectional view taken along a IB-IB line in FIG. **1**A. FIG. **2** is a perspective view which shows configurations of fins defining flow passages and a pressing member.

[0032] As shown in FIG. **1**, the heat receiving member **5** has such a structure that two members, that is, a base member **51** and a casing member **52** are combined and joined together so as to define therebetween a closed space for introducing the coolant. In this embodiment, the base member **51** is made of an aluminum base material which is excellent in view of workability and cost performance. However, a copper material or the like which is excellent in heat conductivity may also be used in order to enhance the heat-exchanging efficiency.

[0033] The base member **51** which serves as a functional component, is composed of a base **511** and fins **512** which are integrally incorporated with each other. The base **511** of the base member **51** has a thermal contact surface **513** thermally connected to the heat generating element **3**. That is, the heat receiving member **5** is thermally connected with the heat generating element **3** at the thermal contact surface **513**, and coupled to and held in the information equipment **1** by means of screws (which are not shown) fitted in a plurality of screw holes **515** or the like formed in a flange part **514**.

[0034] The fins **512** are formed being turned up through a skiving process at fine pitches on the center zone **516***a* of the opposite surface **516** of the base member **51** on the side remote from the thermal contact surface **513**, having a predetermined height (H). Further, a peripheral part **516***b* around the fins **512** formed on the base member **51** is flush with the flange part **514** for convenience of the fabrication. The zone where the fins **512** are formed has a wall thickness (t) from the thermal contact surface **513**, as will be detailed later, and is smaller than the wall thickness (T) of the outer peripheral part of the base **511**.

[0035] It is noted here that the fins **512** formed by machining are formed, being arranged in a row at pitches in a range from about 0.1 to 1.0 mm by carving and turning up the opposite surface **516***a* of the base **511**, passages for the coolant being defined between the wall surfaces of the adjacent parallel fins **512**.

[0036] Then, explanation will be made of the casing member **52** which is joined to the base member **51** so as to define the passages for the coolant, between the fins **512** carved and turned up. The casing member **52** has a cylindrical structure, being composed of a planar part **521** and a side wall part **522**. The end surface of the side wall part **522** is connected to the outer peripheral part **516***b* of the opposite surface **516** of the base **511** through the intermediary of a shield ring for preventing leakage, by a coupling process (which is not shown) such as joining or bonding (not shown).

[0037] The casing member **52** is provided with a pressing member **525** which is integrally incorporated with the base member **52** or which is formed separate from the base member **52**, and is then joined to the base member **52** (FIG. **2**), being opposed to the fins **512**, and accordingly, the top parts of the fins **512** are covered with the pressing member **525** so as to define passages between the fins **512**. Since the fins **512** are formed by the skiving process as they are, the height (H) of the fins **512** is uneven more or less. The pressing member **525** presses the top parts of the fins **512** so as to clamp the fins **512** with a height (h) which is reduced from the height (H) so as to define the passages so that no leakage of the coolant is caused from the top parts thereof.

[0038] Further, the planar shape of the pressing member **525** has a size (W+) which is set to be larger than the length (W) of the row of the fins **512** in order to define the passages by all fins **512**, but smaller (L−) than the width (L) of the fins **512** in order to make the flow of the coolant smoother, as will be detailed later.

[0039] It is noted that the planar part **521** of the casing member **52** is formed therein with a coolant inlet port **523** in the center part thereof above the fins **512**, and a coolant outlet port **524** on one side of the fins **512** thereabove. It is noted that the outlet port **524** may be formed in the side wall part **522** of the casing member **52**, in addition to the planar part **521** thereof. Further, the inlet port **523** may be formed sidelong as shown in FIG. **3** whenever it is necessary.

[0040] The pressing member **525** incorporated in the casing member **52** has a header **526** for spreading the coolant flowing from the inlet port **523** with a length substantially equal to the length (W) of the row of the fins **512** so as to effectively use the length of the row of the fins **512** for the coolant passages in its entirety in the direction orthogonal to the passages between the fins **512**. It is noted that if the shapes of some of the fins **512** existing at the end are not appropriate for use due to such a problem that the height of the fins are instable in view of the fabrication thereof, the opening of the header **526** is formed in the extent of the fins **512** which are desired to be used. Further, in this case, the pressing member **525** may have a size which is the extent of the fins **512** desired to be used by a value $+\alpha$.

[0041] Then, the header **526** basically define therein a rectangular parallelepiped space, which may have such a sectional shape that a wedge-like shape is defined from the center to the periphery of the space so as to increase the flow rate of the coolant flowing toward a part of the heat generating element **3** in which the heating value is large in view of a heat transfer from the heat generating element to the fins **512**.

[0042] Further, around the fins **512** which are formed by carving the base **511** through the skiving process is formed an inclined surface, which is extended between the surface **516***a* at the height position of the thin wall part of the base member on which the fins **512** are formed, and the surface **516***b* at the height position of the thick wall part of the base member.

[0043] Next, explanation will be made of the flow of the coolant.

[0044] In the cooling device **4** shown in FIG. **4**, the coolant is driven so as to be circulated. The heat receiving member **5** assembled with the base member **51** and the casing member **52**, is shown in FIGS. **1**A and **1**B. The coolant is introduced into the heat receiving member **5** as indicated by the arrow.

[0045] The circulated coolant flows into the heat receiving member **5**, after flowing down from the coolant inlet port **523** in a substantially center part of the fins in view of the width of the fins and the length of the row of the fins. The coolant flows through the header **526** which is arranged above the fins **512** within the heat receiving member **5**, and into the passages between the fins **512** so as to be distributed left and right in the drawing. At this stage, the heat from the heat generating element **3** is transmitted to the fins **512** through the thermal contact surface **513** thermally connected thereto, and accordingly, the transmitted heat is received by the coolant through heat transfer.

[0046] Incidentally, it is desired to decrease the thickness of the base member in order to increase the heat transfer, and accordingly, the base member is preferably thin. However, should the base member be thinner, there would be caused a risk of insufficient strength. Thus, the base member is carved in the zone where the fins **512** are formed so as to have a thin wall thickness (t), while the peripheral part of the base member has a thick wall thickness (T) for ensuring a sufficient strength.

[0047] It is noted that the fins **512** have such a configuration that they are carved and turned up in the part of the base **513** having a thin wall thickness (t), and accordingly, this configuration has a role of reinforcing the base **513**. The thickness and gaps of the fins also relate to the structure reinforcement of the base **513**, and accordingly, the fins **512** preferably have a thickness which is not less than 0.5 times as large as the gaps of the fins. Further, in order to transfer the heat from the fins **512** to the coolant, the fins are formed at fine pitches by the skiving process so as to aim at increasing their surface areas exposed to the coolant.

[0048] Incidentally, since the fins are formed by carving, the height of the coolant passages is the sum of the height (h) of the fins and the carved depth (T−t), whereas the terminal parts of the coolant passages between the fins **512** are decreased to the passage height (h) between the pressing member **525** and the thick wall part **516***b* of the base **51**, and accordingly, the coolant is hindered from smoothly flowing.

[0049] Thus, the inclined surface is formed by extending from the surface **512***a* at the roots of the fins **512** to the thick wall part **516***b* of the base **511**, and the length of the pressing member **525** in the passage direction is set to be smaller than the widthwise length (L) of the passages between the fins. Accordingly, the coolant can flow out even from the upper parts of the fins **512**, thereby it is possible to aim at allowing the coolant to smoothly flow. It is noted that if the fins can have a sufficient height, or L− can be set to be sufficiently small in comparison with L, the necessity of the above-mentioned inclined surface can be eliminated.

[0050] The coolant having flown through the fins **512** turns around in the space defined between the fins **512** and the casing member **522**, and flows out from the outlet port **524** formed in the casing member **522**, and accordingly, the conducted heat is radiated from the heat radiation member **6** which is connected to the heat receiving member **5** through the intermediary of the pipe line **9** and to which the heat is transmitted from the coolant. It is noted that the heat transfer performance can be enhanced between the fins **512** and the coolant since the coolant flows down from the center part of the heat receiving member **5** above the passages therein.

[0051] As stated above, since the passages are defined between the fine fins which are made of a highly heat-conductive material and which are integrally carved and turned up, the contact surface areas of the fins with respect to the coolant can be greatly increased, and since the coolant flows down toward the fins, it is possible to aim at enhancing the heat transfer toward the coolant. Further, since the thickness of the base can be thinned in the part below the fins, the heat transfer can be efficiently made from the heat generating element to the coolant, thereby it is possible to materialize a high performance heat exchanger with a high degree of productivity.

[0052] It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the invention, the invention is not limited thereto and various changes and modifications may be made without departing from the spirit of the invention and the scope of the appended claims.

1. A cooling device for a information equipment, for cooling a heat generating element mounted in the information equipment through heat transfer by a coolant,

said cooling device comprising:

a heat receiving member for receiving heat from said heat generating element through said coolant,

a heat radiation member for radiating the heat received through said coolant, and

a pipe line member arranged so as to circulate said coolant between said heat receiving member and said heat radiation member,

wherein said heat receiving member includes therein a closed space defined by a base member thermally connected to said heat generating element and a casing member, said closed space enabling said coolant to flow therethrough, said base member is integrally incorporated with fins defining therebetween passages through which said coolant flows in said closed space, in a predetermined zone on an opposite surface to a surface with which the base member is thermally connected with the heat generating element, and said base member has a thickness which is thinner in a zone thereof where said fins are formed, than in the other zone where no fins are formed.

2. The cooling device as set forth in claim **1**, wherein said fins formed in said base member are carved and turned up through a skiving process in a recession place carved in the base member.

3. The cooling device as set forth in claim **1**, wherein said base member has inclined surfaces at opposite end parts of said passages defined between said fins formed in said base member, each of the inclined surfaces being extended from a height position of a thin wall part of said base member in which said fins are formed, to a thick wall part of said base member.

4. The cooling device as set forth in claim **2**, wherein said base member has inclined surfaces at opposite end parts of said passages defined between said fins formed in said base member, each of the inclined surfaces being extended from a height position of a thin wall part of said base member in which said fins are formed, to a thick wall part of said base member.

5. The cooling device as set forth in claim **1**, wherein said casing member has a pressing member which is integrally incorporated with said casing member or which is formed, separate from said casing member, and is then jointed to said casing member, for pressing upper end parts of said fins when constituting the heat receiving member in cooperation with the base member, a size of said fin pressing member is smaller than a widthwise length of said fins in a longitudinal direction of said passages between said fins, and greater than a length of a row of said fins in a direction orthogonal to said passages between said fins.

6. The cooling device as set forth in claim **2**, wherein said casing member has a pressing member which is integrally incorporated with said casing member or which is formed, separate from said casing member, and is then jointed to said casing member, for pressing upper end parts of said fins when constituting the heat receiving member in cooperation with the base member, a size of said fin pressing member is smaller than a widthwise length of said fins in a longitudinal direction of said passages between said fins, and greater than a length of a row of said fins in a direction orthogonal to said passages between said fins.

7. The cooling device as set forth in claim **1**, wherein said casing member is provided at its upper surface with an inlet port for said coolant, and is provided above said fins with a header for introducing said coolant flowing from said inlet port through upper parts of said fins, said header having a length which is substantially equal to the length of the row of said fins in a direction orthogonal to said passages between said fins.

8. The cooling device as set forth in claim **2**, wherein said casing member is provided at its upper surface with an inlet port for said coolant, and is provided above said fins with a header for introducing said coolant flowing from said inlet port through upper parts of said fins, said header having a length which is substantially equal to the length of the row of said fins in a direction orthogonal to said passages between said fins.

9. The cooling device as set forth in claim **3**, wherein said casing member is provided at its upper surface with an inlet port for said coolant, and is provided above said fins with a header for introducing said coolant flowing from said inlet port through upper parts of said fins, said header having a length which is substantially equal to the length of the row of said fins in a direction orthogonal to said passages between said fins.

10. The cooling device as set forth in claim **4**, wherein said casing member is provided at its upper surface with an inlet port for said coolant, and is provided above said fins with a header for introducing said coolant flowing from said inlet port through upper parts of said fins, said header having a length which is substantially equal to the length of the row of said fins in a direction orthogonal to said passages between said fins.

11. The cooling device as set forth in claim **5**, wherein said casing member is provided at its upper surface with an inlet port for said coolant, and is provided above said fins with a header for introducing said coolant flowing from said inlet port through upper parts of said fins, said header having a length which is substantially equal to the length of the row of said fins in a direction orthogonal to said passages between said fins.

12. The cooling device as set forth in claim **6**, wherein said casing member is provided at its upper surface with an inlet port for said coolant, and is provided above said fins with a header for introducing said coolant flowing from said inlet port through upper parts of said fins, said header having a length which is substantially equal to the length of the row of said fins in a direction orthogonal to said passages between said fins.

13. A cooling device for cooling a heat generating element mounted in an information equipment through heat transfer by coolant, comprising:

narrow pitch fins for thermally transferring heat generated from said heat generating element, to said coolant,

a fin base thermally connected to the heat generating element, having a thickness which is thinner in a zone where said narrow pitch fins are formed, than in a zone where no narrow pitch fins are formed, and

a casing connected to said fin base and forming therein a closed space in which said coolant flows.

14. The cooling device as set forth in claim **13**,

wherein said fin base has an inclined surface extended from a height position of a thin wall part of said base member where said fins are formed, to a height position of a thick wall part of said base member.

15. The cooling device as set forth in claim **13**,

wherein said narrow pitch fins which are arranged in parallel with one another in one direction of said fin base so as to allow the coolant to flow, and

there is provided a coolant inflow header having a space which is extended orthogonally to said fins, on one side of said narrow pitch fins, which is remote from said fin base.

16. The cooling device as set forth in claim **13**,

wherein the coolant flowing into from said inflow header flows through between said narrow pitch fins in a downflow pattern, and is discharged in a longitudinal direction of said narrow pitch fins.

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