(19) Japan Patent Office (JP) (12) **Unexamined Patent Gazette** (A) (11) Japanese Unexamined Patent Application Publication Number

2002–151638
(P2002–151638A)

(43) Publication date: May 24, 2002 (5/24/2002)

(51) Int. Cl.[7]	Identification codes	FI			Theme codes (reference)
H01L 23/473		H05K	7/20	N	5E322
H05K 7/20		H01L	23/46	Z	5F036

Request for examination: Not yet requested Number of claims: 1 OL (Total of 5 pages)

(21) Application number: Japanese Patent Application 2000–345470 (P2000–345470)

(22) Filing date: November 8, 2000 (11/8/2000)

(71) Applicant: 000005108
Hitachi Ltd.
6 Kanda Surugadai 4-chome, Chiyoda-ku, Tokyo-to

(72) Inventor: SHIN, Takayuki
c/o Hitachi Ltd. Mechanical Engineering Research Laboratory, 502 Kandatsu-machi, Tsuchiura-shi, Ibaraki-ken

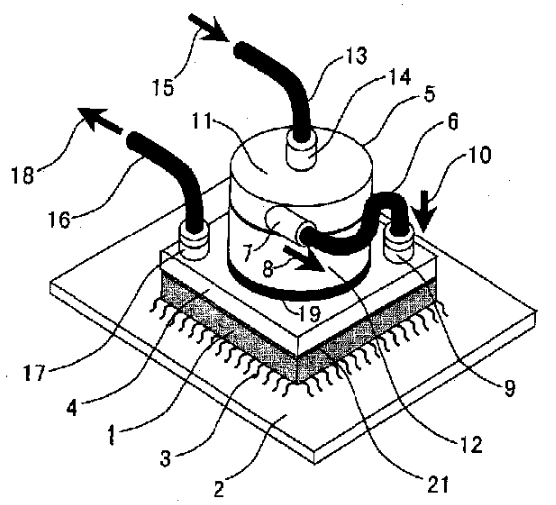
(74) Agent: 100075096
Patent Attorney SAKUTA, Yasuo

F-terms (reference) 5E322 AA07 AA11 AB02 AB06 DA01
FA01 FA05
5F036 AA01 BA05 BB01 BB43 BC35

(54) [Title of the invention] Cooling device for electronic equipment

(57) [Abstract] (With corrections)
[Problem] A cooling structure for compactly mounting a liquid cooled heat sink and pump inside a case.
[Solution] A pump 5 is installed on the top part of a liquid cooled heat sink 4 and made into a structure allowing the pump 5 and liquid cooled heat sink 4 to be handled as an integral structure, making it possible to implement a liquid cooling system of high cooling performance, low noise and high reliability that can be compactly installed in an electronic equipment case without major changes to the case structure of conventional air cooled electronic equipment

FIG. 1



DOCKET ALARM
Find authenticated court documents without watermarks at docketalarm.com.

[Scope of patent claims]

[Claim 1] A cooling device for electronic equipment comprising a wiring board, a heat generating element including an electronic circuit component such as an LSI chip installed on said wiring board, a liquid cooled heat sink installed on said heat generating element in thermal contact therewith, and a pump which pressurizes and circulates a liquid coolant, characterized in that said pump is installed on the top part of said liquid cooled heat sink.

[Detailed description of the invention]

[0001]

[Technical field of the invention] The present invention pertains to a cooling structure for liquid cooling of heat generating electronic circuit components such as LSI chips installed on a wiring board, relating in particular to a cooling structure for compactly mounting a liquid cooled heat sink and pump.

[0002]

[Prior art] In recent years, the amount of heat generated by electronic equipment, as represented by computers, communication equipment, multimedia equipment, etc., has tended to increase markedly. In particular, the cooling of CPUs, which perform centralized computation processing, image processing LSI chips, power amplifiers and the like, has become a very important problem.

[0003] Furthermore, as the cooling scheme, conventionally, an air cooling scheme combining air cooling fins with a fan has been frequently used. However, air cooling schemes have a low cooling limit compared to liquid cooling schemes, so recently, schemes have been considered for liquid cooling of high heat output LSI chips such as CPUs alone using a liquid coolant such as water.

[0004] For example, Japanese Unexamined Patent Application Publication H8–32262 discloses a liquid cooling scheme as illustrated in FIG. 4. LSI chips 51, which do not have a high heat output and can be air-cooled, and LSI chips which are cooled by a water cooled heat sink 40 due to their high heat output, are installed on the same wiring board 50. The air-coolable LSI chips 51 are air-cooled by means of two fans 47. Cooling air is supplied from outside, as shown by 48, and is exhausted as shown by 49. The water cooled heat sink 40 installed on LSI chips of high heat output is connected via a hose 41 to an outlet pipe 42, and the cooling water warmed at 40 is cooled in heat exchanger 43 by the air of the fans 47. The cooled cooling water flows through coolant pipe 44 to pump 45 and is pressurized and then passes through inlet pipe 46 and is supplied again to the water cooled heat sink 40.

[0005]

[Problem to be solved by the invention] In the cooling structure disclosed in Japanese Unexamined Patent Application Publication H8–32262, the pump 45 is installed away from the wiring board 50 and water cooled heat sink 40, so space for mounting the pump 45 is required inside the case separately from the space for the pipes which are connected to the pump 45, and so there is the problem that the electronic equipment case cannot be made compact.

[0006] It is an object of the present invention to provide a cooling structure for electronic devices which is compact, has low noise, superior cooling performance and high reliability.

[0007]

[Means for solving the problem] To achieve the aforesaid object, the present invention, assuming a cooling device for electronic equipment comprising a wiring board, a heat generating element including an electronic circuit component such as an LSI chip installed on the wiring board, a liquid cooled heat sink installed on the heat generating element in thermal contact therewith, and a pump which pressurizes and circulates a liquid coolant, adopts a structure wherein the pump is installed on the top part of the liquid cooled heat sink.

[0008] Furthermore, the pump is secured to the top part of the liquid cooled heat sink, forming a structure that allows the pump and liquid cooled heat sink to be handled as an integral structure.

[0009] Furthermore, a structure is formed wherein the liquid coolant discharge section of the pump is directly connected to the liquid cooled heat sink by means of a pipe, etc.

[0010] Furthermore, an arrangement is adopted whereby the pump operates from a direct current power supply.

[0011] Moreover, a structure is formed whereby the pump is secured to the liquid cooled heat sink across a vibration absorption member or the like.

[0012]

[Embodiments of the invention] A first embodiment example of the present invention will be described using FIG. 1. The heat generating element 1, which includes an electronic circuit component such as an LSI chip, is installed on a wiring board 2 in electrical contact via wiring pins 3, solder balls or the like. The heat generating element 1 is, for example, a computer CPU, image processing LSI chip, FET power amplifier, etc. On the heat generating element 1, a liquid cooled heat sink 4 for liquid cooling of the heat generating element 1 is installed in thermal contact therewith across a thermally conductive compound 21, thermally conductive grease, thermally conductive sheet, or the like. Furthermore, a pump 5 which pressurizes and circulates liquid coolant is installed on the top part of the liquid cooled heat sink 4.

[0013] In the present embodiment example, a structure is employed whereby the pump 5 is secured to the liquid cooled heat sink 4 across a vibration absorbing member 19. Thus, a structure is formed whereby the vibration of the pump 5 does not readily have a direct effect on the CPU or other electronic component. The pump 5 is connected to the liquid cooled heat sink 4 by a flexible hose 6. The hose 6 is connected at one end to a coolant discharge section coupler 7 of the pump 5 and is connected at the other end to a water supply coupler 9 of the liquid cooled heat sink 4, and pressurized coolant flows as shown by 8 and then flows directly into the liquid cooled heat sink 4 as shown by 10. The liquid coolant, after flowing into the liquid cooled heat sink 4, is split into a plurality of channels formed inside the heat sink and flows in snaking fashion, absorbing the heat of the heat generating element 1. The heated liquid coolant flows through drainage coupler 17 and hose 16 into a heat exchange section (not illustrated) which cools the liquid coolant, as shown by 18. Liquid coolant which has been cooled in the heat exchange section returns, as shown by 15, and is sucked into pump 5 via hose 13 and coolant intake section coupler 14, and is again pressurized and supplied to the liquid cooled heat sink 4.

[0014] It will be noted that the aforementioned couplers 7, 9,

DOCKET ALARM Find authenticated court documents without watermarks at docketalarm.com.

14 and 17 make it easy to connect and disconnect the hoses 6, 13 and 16, thus implementing a structure with good assembly characteristics and maintenance characteristics.

[0015] Forming a structure in which the pump 5 is installed on the top part of the liquid cooled heat sink 4, as described above, eliminates the need for providing space inside the electronic equipment case for separately installing the pump 5 and makes it possible to shorten the hose going from the pump to the liquid cooled heat sink 4, thus making it possible to compactly install the liquid cooling system inside the electronic equipment case. Thus, it becomes possible to install a liquid cooling system with high cooling performance and low noise without making major changes to the structure of conventional air cooled electronic equipment cases.

[0016] Furthermore, securing the pump 5 to the top part of the liquid cooled heat sink 4 and making it possible to handle the pump and liquid cooled heat sink as an integral structure reduces the number of components at the time of assembly and makes it possible to install an integral component kit comprising this pump and liquid cooled heat sink instead of an air cooled heat sink with fan as commonly used in conventional personal computers, etc., thus allowing a liquid cooling system to be adopted without difficulty.

[0017] Furthermore, a structure is created wherein the coolant discharge section 7 of the pump 5 is directly connected by means of a pipe, etc. to the water supply coupler 9 of the liquid cooled heat sink 4. Thus, the hose from the pump 5 to the liquid cooled heat sink 4 can be made very short, allowing flow loss of liquid coolant in the hose to be reduced and as a result making it possible to reduce the lift capacity of the pump 5 and ultimately reduce motor power and make the pump more compact.

[0018] The pump 5 comprises an impeller case 11 and motor 12. In the present embodiment example, the pump 5 illustrates an example of a centrifugal type pump which pressurizes liquid coolant by rotating an impeller arranged inside the impeller case 11, but a volumetric type pump which pressurizes the liquid coolant through mechanical volume change using a diaphragm, etc. may be used as well. Furthermore, in the present embodiment example, the shaft of the motor and impeller are installed so as to be perpendicular to the top surface of the liquid cooled heat sink 4, so the bottom surface of the motor is joined to the top surface of the liquid cooled heat sink 4 across the vibration absorption member 19, thus making it possible to implement a structure with good seating of the motor.

[0019] The motor 12 is a DC motor driven by a direct current power supply. Using a DC motor allows the motor speed to be easily changed by changing the DC voltage, thus enabling control of cooling power. Moreover, making the motor into a DC brushless motor makes it possible to implement a pump of low noise and long service life.

[0020] If the flow rate of liquid coolant is relatively low, on the order of 0.1 (liters/minute), making the drive voltage such that it can be driven by dry cells of, for example, about 1 to 1.5 (V), allows for battery driving of the pump, making it possible to create a liquid cooling system of high reliability. Furthermore, if the flow rate of liquid coolant is relatively high, on the order of 1 (liter/minute), making the drive voltage into a voltage of about 2 to 12 (V), which can be supplied by the DC power supply of electronic equipment, makes it possible to create a compact and inexpensive liquid cooling system, because there is no need to provide a dedicated power supply for the pump. However, the present invention does not necessarily limit the motor 12 to a DC motor, and an AC motor driven by alternating current of, for example, 100 (V) or 200 (V) may be used as well.

[0021] For the liquid coolant, water, which is easy to obtain, is suitable, and especially with pure water, the thermal capacity is high, so the cooling performance can be increased, the resistance against corrosion is better, and impurities do not tend to become deposited in the channels, thus making it possible to implement a high performance liquid cooling system. Furthermore, if a non-freezing liquid obtained by adding ethylene glycol or the like to water is used as the liquid coolant, damage to the channels due to freezing of the liquid coolant during cold can be prevented. Furthermore, if a nonconductive coolant such as perfluorocarbon is used for the liquid coolant, accidents such as shorting of electronic circuits can be prevented in the event of liquid leakage.

[0022] A second embodiment example of the present invention will be described using FIG. 2. In the present embodiment example, the shaft of the motor 5 and impeller is installed so as to be substantially parallel to the top surface of the liquid cooled heat sink 4. As a result, even high output pumps with a high motor output and thus a long length of the motor in the axial direction can be compactly installed on the liquid cooled heat sink 4. In the present embodiment example, the pump 5 is secured to a bracket 20 on the liquid cooled heat sink 4. By making the bracket 20 into a vibration absorbing member or by using a vibration absorbing member for a portion thereof, a structure can be created whereby vibration of the pump 5 does not readily have a direct affect on the electronic component such as a CPU. Except for the above, the second embodiment example is the same as the first embodiment example.

[0023] A third embodiment example of the present invention will be described using FIG. 3. The present embodiment example illustrates an example in which the liquid cooling system with integral pump and liquid cooled heat sink presented in the first embodiment example has been installed inside an actual electronic equipment case.

[0024] The heat generating element 1, such as an LSI chip, is installed on a wiring board 2, which is a motherboard. A liquid cooled heat sink 4 for cooling the heat generating element 1 is installed on the heat generating element 1. Furthermore, a pump 5 is installed on the top part of the liquid cooled heat sink 4. Besides the heat generating element 1, heat generating elements 22a, 22b, 22c, such as memory LSI and driver LSI chips, which can be cooled by air cooling, as well as an IO card, memory card, hard disk or other card mounting board 23 are also installed on the wiring board 2. The wiring board 2 is housed inside case 24, which is an electronic equipment case. An air cooling fan 34 is installed in the case 24, and the aforementioned multiple air cooled components are air-cooled by cooling air 25.

[0025] Liquid coolant which has been heated in the liquid cooled heat sink 4 flows through hose 16, as shown by 18, which is connected via a connecting coupler 26 to a heat exchanger 27 installed on a side panel 32 of the case. In the present embodiment example, the pipes of the heat exchanger 27 are installed in thermal contact with the side

DOCKET ALARM Find authenticated court documents without watermarks at docketalarm.com.

panel 32, and the liquid coolant flows upward while snaking through the inside of the heat exchanger as shown by 28 and 29. The heat of the liquid coolant spreads through thermal conduction to the entirety of the side panel 32 and is then released with the aid of the cooling air 25 provided by the fan 34 and air flow 33 provided by natural convection around the electronic equipment case.

[0026] The cooled liquid coolant flows as shown by 30, and is connected to the return side hose 13 via connecting coupler 31 and returns to the pump 5 as shown by 15, and is again pressurized and supplied to the liquid cooled heat sink 4.

[0027] As an example of the method of constructing the side panel 32 and heat exchanger 27, there is the method whereby the side panel 32 is fashioned from a metal material such as aluminum, magnesium or steel, the pipes of the heat exchanger are also fashioned from metal material, and the two are connected through metal joining, such as brazing or soldering, or by using a thermally conductive adhesive, or the like. In this case, the thermal conductivity can be improved, making it possible to improve the cooling performance of the liquid cooling system. Furthermore, by using a fabrication method such as roll bonding, in which two metal plates are joined in a state with snaking channels of a heat exchanger being formed, and the side panel and heat exchanger are integrally molded, the heat exchanger can be produced more inexpensively. However, the effect of the present invention can be achieved even if the side panel 32 is made of a non-metal material such as resin and the pipes of the heat exchanger 27 are a non-metal material.

[0028] Based on the foregoing, employing the configuration of the present embodiment example eliminates the need to provide space inside the electronic equipment case for separately installing a pump 5 and allows the hose from the pump to the liquid cooled heat sink 4 to be shortened, thus making it possible to compactly install the liquid cooling system in an electronic equipment case.

[0029] Furthermore, it becomes possible to implement a liquid cooling system of high cooling performance and low noise simply by adding a side panel 32 equipped with a heat exchanger 27, a liquid cooled heat sink with integral pump, and two connecting hoses 13 and 16, without making major changes to the structure of conventional air cooled electronic equipment cases.

[0030] Furthermore, an integral component kit comprising this pump and liquid cooled heat sink can be installed instead of an air cooled heat sink with fan as frequently used in conventional personal computers and the like, making it possible to adopt a liquid cooling system into electronic devices without difficulty. If the power supply of the pump is compatible with the fan power supply for an air cooled heat sink with fan, the adoption of course becomes even easier.

[0031]

[Effect of the invention] According to the present invention, as described above, first, a liquid cooling system can be compactly installed inside an electronic equipment case.

[0032] Second, a liquid cooling system of high cooling performance, low noise, and high reliability can be installed without making major changes to the structure of conventional air cooled electronic equipment cases.

[0033] Third, the number of components during assembly can be reduced, and an integral component kit comprising a pump and liquid cooled heat sink can be installed instead of an air cooled heat sink with fan, so a liquid cooling system can be adopted into electronic devices without difficulty.

[0034] Fourth, the lift capacity of the pump and the power of the motor can be reduced, allowing for miniaturization.

[0035] Fifth, a liquid cooling system can be created which allows control of cooling power by changing the rotational speed of the pump.

[Detailed description of the invention]

[FIG. 1] A perspective view of a cooling device for electronic equipment constituting a first embodiment example of the present invention.

[FIG. 2] A perspective view of a cooling device for electronic equipment constituting a second embodiment example of the present invention.

[FIG. 3] A perspective view of a cooling device for electronic equipment constituting a third embodiment example of the present invention.

[FIG. 4] A perspective view illustrating an example of a conventional cooling device for electronic equipment.

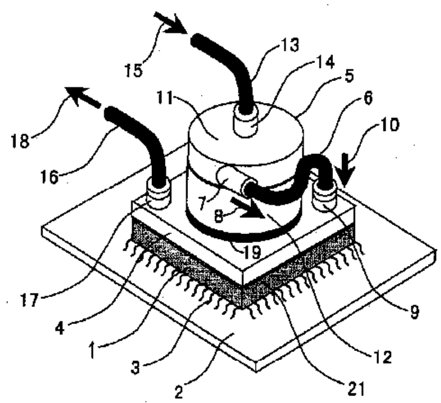
[Description of reference symbols]

1 ··· heat generating element; 2 ··· wiring board; 3 ··· wiring pin; 4 ··· liquid cooled heat sink; 5 ··· pump; 6 ··· hose; 7 ··· coolant discharge section coupler; 8 ··· liquid coolant flow; 9 ··· water supply coupler; 10 ··· liquid coolant flow; 11 ··· impeller case; 12 ··· motor; 13 ··· hose; 14 ··· coolant intake section coupler; 15 ··· liquid coolant flow; 16 ··· hose; 17 ··· drainage coupler; 18 ··· liquid coolant flow; 19 ··· vibration absorbing member; 20 ··· bracket; 21 ··· thermally conductive compound; 22a ··· air-coolable heat generating element; 22b ··· air-coolable heat generating element; 22c ··· air-coolable heat generating element; 23 ··· card mounting board; 24 ··· electronic equipment case; 25 ··· cooling air; 26 ··· connecting coupler; 27 ··· heat exchanger; 28 ··· snaking liquid coolant flow; 29 ··· snaking liquid coolant flow; 30 ··· liquid coolant flow; 31 ··· connecting coupler; 32 ··· side panel; 33 ··· air flow; 34 ··· fan; 40 ··· water cooled heat sink; 41 ··· hose; 42 ··· outlet pipe; 43 ··· heat exchanger; 44 ··· coolant pipe; 45 ··· pump; 46 ··· inlet pipe; 47 ··· fan; 48 ··· cooling air; 49 ··· cooling air; 50 ··· wiring board; 51 ··· air-coolable LSI chip.

DOCKET ALARM Find authenticated court documents without watermarks at docketalarm.com.

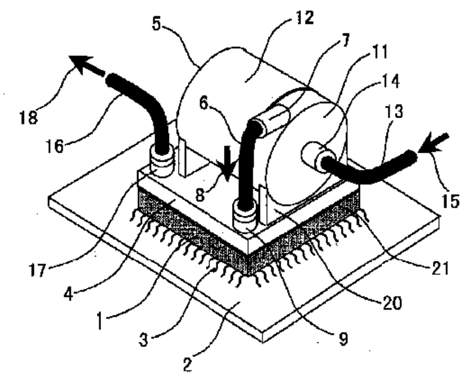
[FIG. 1]

FIG. 1



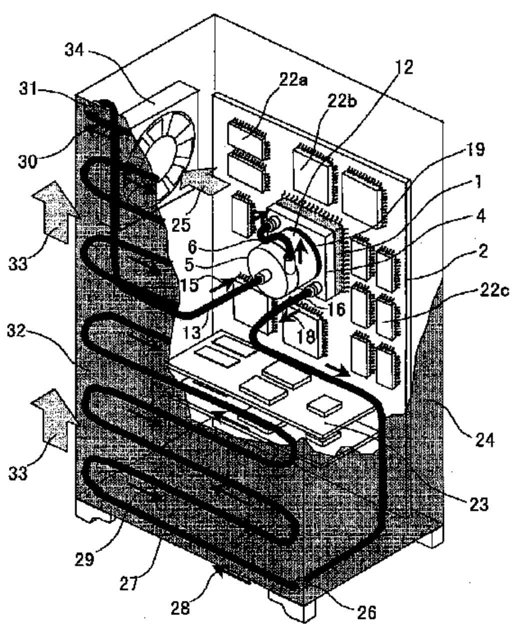
[FIG. 2]

FIG. 2



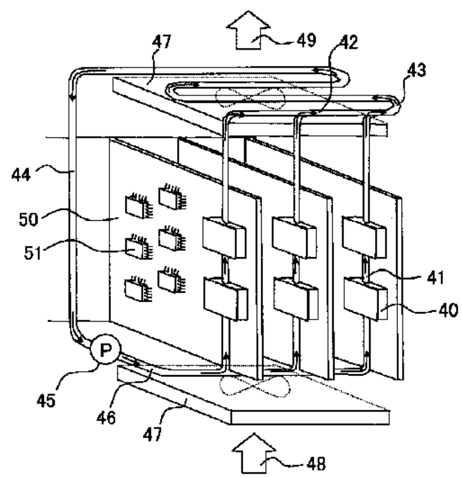
[FIG. 3]

FIG. 3



[FIG. 4]

FIG. 4



DOCKET ALARM Find authenticated court documents without watermarks at docketalarm.com.

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.

WHAT WILL YOU BUILD? | sales@docketalarm.com | 1-866-77-FASTCASE

fastcase® Smarter legal research.