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Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

— *with international search report (Art. 21(3))*

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(54) Title: THERMAL BUS BAR FOR A BLADE ENCLOSURE

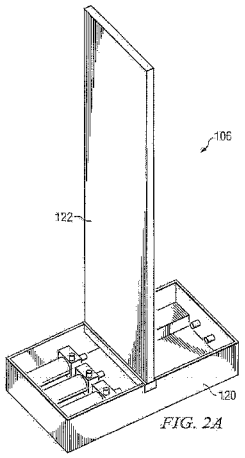

FIG. 2A

(57) Abstract: A cooling system for a blade enclosure is disclosed. The cooling system comprises a thermal bus bar (TBB) 1220 positioned in the middle of the blade enclosure. The TBB 122 has a front face and a back face. When blades are inserted into the blade enclosure, a heat transfer plate 584 on the blade makes thermal contact with either the front or back face of the TBB 122. The TBB 122 is cooled, thereby cooling the blades.

Thermal Bus Bar for a Blade Enclosure

BACKGROUND

[0001] Many datacenters are now populated with computer blades mounted in blade enclosures. A computer blade is defined as a device that accesses power and connections to other blades and devices through a shared infrastructure or enclosure. The computer blade may be rack mounted into the enclosure. A computer blade may also be defined as a device that provides power and connectivity to other blades and devices through the shared infrastructure or enclosure. A computer blade can fulfill a number of different functions. There are blade servers, Input/Output (I/O) blades, memory blades, power supply blades, I/O interconnect blades, and the like. As the computer blades have increased in power density, cooling the blades has become a challenge.

[0002] Blades are typically cooled by drawing ambient air through the blade enclosure to remove the heat generated by the components mounted on the blades. This solution requires the ambient air to be conditioned to a specific temperature and humidity. Without conditioning, the components may be subject to insufficient cooling, humidity damage, or contamination. Conditioning the air can use a significant portion of the energy required by the datacenter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] FIG. 1A is an isometric view of a blade enclosure 100 in an example embodiment of the invention.

[0004] FIG. 1B is a cut-away side view of blade enclosure 100 in an example embodiment of the invention.

[0005] FIG. 2A is an isometric view of cooling assembly 106 with the top cover of cooling base 120 removed, in an example embodiment of the invention.

[0006] FIG. 2B is a top view of cooling assembly 106 with the top cover of cooling base 120 removed, in an example embodiment of the invention.

[0007] FIG. 3 is a diagram of the cooling pathways in cooling assembly 106 in one example embodiment of the invention.

[0008] FIG. 4A is a diagram of the cooling pathways in cooling assembly 106 in another example embodiment of the invention.

[0009] FIG. 4B is a diagram showing the temperature gradient of the TBB from figure 4A in an example embodiment of the invention.

[0010] FIG. 5 is an isometric view of a blade in an example embodiment of the invention.

DETAILED DESCRIPTION

[0011] FIG. 1 - 5, and the following description depict specific examples to teach those skilled in the art how to make and use the best mode of the invention. For the purpose of teaching inventive principles, some conventional aspects have been simplified or omitted. Those skilled in the art will appreciate variations from these examples that fall within the scope of the invention. Those skilled in the art will appreciate that the features described below can be combined in various ways to form multiple variations of the invention. As a result, the invention is not limited to the specific examples described below, but only by the claims and their equivalents.

[0012] Figure 1A is an isometric view of a blade enclosure 100 in an example embodiment of the invention. Blade enclosure 100 comprises left and right side panels 102, top panel 104, and cooling assembly 106. The front face of blade enclosure 100 has a first column of smaller openings or slots 112 in the center of the front face and a left and right column (108 and 110) of larger openings or slots on either side of the column of smaller openings or slots. Cooling assembly 106 is located in the bottom of blade enclosure 100 and has a thermal bus bar (TBB) extending up through the middle of blade enclosure (see figure 2). In one example embodiment of the invention, the column of smaller slots 112 are configured to receive power supply blades and the two columns of larger slots are configured to receive a plurality of different types of computer blades.

[0013] Figure 1A shows the slots with a horizontal orientation, but in other example embodiments the slots may be oriented vertically. Figure 1A shows the center column of smaller slots 112 configured to receive power supply blades, but in other example embodiments the power supply slots may be the same size as the blade slots, or may be distributed in the enclosure as a number of rows. In one example embodiment of the invention, blade enclosure is symmetrical and the back face of the blade enclosure is a mirror image of the front face (i.e. three columns of slots). In other example embodiments of the invention the slot configuration on the back face may be different than the slot configuration on the front face.

[0014] Figure 1B is a cut-away side view of blade enclosure 100 in an example embodiment of the invention. Blade enclosure 100 comprises top panel 104, a plurality of slots on the front face 132, a plurality of slots on the back face 130, and cooling assembly 106. Cooling assembly 106 comprises cooling base 120 and thermal bus bar (TBB) 122. Cooling base is located in the bottom section of blade enclosure 100. TBB 122 attaches to the top side of cooling base 120 and extends up through the middle of blade enclosure 100.

[0015] TBB 122 provides cooling to blades inserted into the slots on the front and back face of blade enclosure 100. Blade 124 is shown positioned to be installed/inserted along axis X into one of the plurality of slots on the front side 132 of blade enclosure 100. Once inserted, the back end 126 of blade 124 will be in thermal contact with surface 128 on the front side of the TBB 122. Other blades (not shown) may be inserted into the slots on the back face of blade enclosure 100. Once inserted, the back end of the blade would make thermal contact with the back face of TBB 122.

[0016] Figure 2A is an isometric view of cooling assembly 106 with the top cover of cooling base 120 removed, in an example embodiment of the invention. TBB 122 is a generally rectangular part positioned perpendicular with, and positioned in the middle of, the top of cooling base 120. TBB 122 is filled with a number of fluid channels that allow cooling fluid to be pumped from cooling base 120, up and around the TBB 122, and then back into cooling base 120 (see figure 3). Cooling base 120 is generally a rectangular enclosure that holds the piping, pumps and heat exchanger for TBB 122.

[0017] Figure 2B is a top view of cooling assembly 106 with the top cover of cooling base 120 removed, in an example embodiment of the invention. Cooling assembly comprises TBB 122, a plurality of TBB pumps 252, a heat exchanger 244, and a heat exchanger pump 246. A plurality of pipes couple the different elements in cooling assembly together, but are not shown for clarity. A first fluid system is fully contained within cooling assembly 106. The first fluid cooling system runs from a TBB fluid inlet 248, up through the fluid channels in the TBB 122, out of the TBB fluid outlet 250, through the heat exchange 244, to pumps 252, and then back to the TBB fluid inlet 248. The first fluid system is configured to cool the TBB 122, thereby cooling blades in thermal contact with the TBB 122. The first fluid cooling system dumps the heat from the TBB into heat exchanger 244. In some example embodiments of the invention, the plurality of TBB pumps 252 may be redundantly configured to provide circulation through the first fluid system even after one or more of the pumps have failed.

[0018] The second fluid cooling system runs from external cooling system inlet 242 to heat exchanger pump 246, through heat exchanger 244, and then to external cooling system exit 240. In operation, the external cooling system inlet 242 and external cooling system exit 240 will be coupled to an external fluid cooling system that provides cooled fluid to the external cooling system inlet 242 and removes the heated fluid from the external cooling system exit 240. In some example embodiments of the invention, heat exchanger pump 246 may be located external to blade enclosure 100. In some example embodiments of the invention, the first and second cooling systems may be combined into only one fluid cooling system.

[0019] Figure 3 is a diagram of the cooling pathways in cooling assembly 106 in one example embodiment of the invention. Figure 3 shows a plurality of input cooling channels 350 that go up the TBB 122, interleaved with a plurality of return cooling channels 352 that go back down TBB 122. In operation, cooled fluid is pumped up the cooling channels 350 and back down the return cooling channels 352. As the cooled fluid travels around TBB 122, heat is removed from any blades in thermal contact with TBB 122. The heated fluid exits the TBB and flows through the heat exchanger (represented by crossed arrows 354 and 356). Heat from the blades is transferred to an

externally cooled fluid in the heat exchanger, and then the cooled fluid is returned to the TBB 122. Fluid cooled externally flows into cooling assembly 106 (represented by arrow 356), through heat exchanger, and then exits cooling assembly 106. As the externally cooled fluid passes through the heat exchanger, the heat from the blades is transferred to the externally cooled fluid, and then flows out of cooling assembly 106.

[0020] In one example embodiment of the invention, the input cooling channels 350 are interleaved with the return cooling channels 352. By interleaving the input cooling channels with the return cooling channels, the temperature gradient across TBB 122 remains fairly constant. Figure 4A is a diagram of the cooling pathways in cooling assembly 106 in another example embodiment of the invention. Figure 4A shows all the input cooling channels 460 going up one side of TBB 122 and all the return cooling channels 462 going down the other side of TBB 122. This will produce an uneven temperature gradient across TBB 122.

[0021] Figure 4B is a diagram showing the temperature gradient of the TBB from figure 4A in an example embodiment of the invention. On the bottom right side (area 464) where the cool fluid first enters the TBB 122 the temperature gradient is the largest. This area 464 would provide the highest level of cooling in the blade enclosure. As the cooling fluid travels up the right side of TBB 122, and then down the left side of TBB 122, the fluid is warmed up as it removes heat from any blades in thermal contact with TBB 122. Once the cooling fluid reaches the lower left side of TBB 122 (area 466) the fluid is the warmest and the thermal gradient is the smallest. This area 466 on the TBB 122 would provide the least amount of cooling for the blade enclosure.

[0022] In other example embodiments, the cooling channels in TBB 122 may be arranged in other configurations, for example having channels that flow across the TBB (instead of up and down). These channels may be configured to provide uniform cooling across the TBB, or may be configured to create zones of higher and lower cooling areas across TBB 122.

[0023] Figure 5 is an isometric view of a blade 580 in an example embodiment of the invention. Blade 580 comprises printed circuit (PC) board 582, heat transfer plate

584, component 586, and a plurality of heat pipes 588. Heat transfer plate 584 is a generally rectangular plate mounted at the back end of PC board 582. Heat transfer plate has a front side 590 and a back side (not shown). Heat transfer plate is mounted perpendicular with the top surface of PC board 582. Component 586 is mounted to the top surface of PC board 582. The hot ends of the plurality of heat pipes 588 are positioned on top of component 586. The cool ends of the plurality of heat pipes 588 are coupled to heat transfer plate 584. In some example embodiments of the invention, electrical signals and power signals from blade 580 may connect to blade enclosure 100 through the back end of blade 580, but these connections are not show for clarity.

[0024] When blade 580 is inserted into one of the plurality of blade slots in the front face of blade enclosure 100, the back side of the heat transfer plate 584 will make thermal contact with the front face 128 of TBB 122. During operation, heat generated by component 586 will be transferred into the hot side of the plurality of heat pipes 588. The heat pipes will transfer the heat into heat transfer plate 584. The heat from the heat transfer plate will be transferred into the TBB. The cooled fluid circulating inside the TBB will remove the heat from the TBB thereby cooling blade 580. In other example embodiments of the invention, heat from component 586 may be transferred to heat transfer plate 584 using other methods instead of, or in addition too, the plurality of heat pipes. Blade 580 may comprise other element that have been removed for clarity, for example the blade sides, the blade end cover, locking devices, additional components, and the like.

CLAIMS

What is claimed is:

1. A blade enclosure, comprising:

an enclosure structure having a first side 102 and a second side 102 opposite the first side, a front side 132 and a back side 130 opposite the front side, the front side and the back side both having a plurality of openings configured to accept a plurality of blades;

a cooling assembly 106 mounted in the enclosure structure, the cooling assembly comprising:

a thermal bus bar (TBB) 122 having a generally rectangular shape wherein the TBB 122 is located inside the blade enclosure, parallel with the front side of the enclosure structure, the TBB 122 is positioned between the front side and the back side of the enclosure structure;

a plurality of cooling fluid channels running through the TBB 122;

a cooling fluid inlet 248 coupled to at least one of the plurality of cooling fluid channels and a cooling fluid outlet 250 coupled to at least one of the cooling fluid channels wherein a fluid cooling path is formed between the cooling fluid inlet 248, the cooling fluid channels and the cooling fluid outlet 250;

a front face 128 of the TBB 122 open to the plurality of slots in the front side 132 of the enclosure structure and configured to make thermal contact with a back end 126 of a blade when the blade is installed into one of the plurality of slots in the front side of the enclosure structure;

a back face of the TBB 122 open to the plurality of slots in the back side 130 of the enclosure structure and configured to make thermal contact with a back end of a blade when the blade is installed into one of the plurality of slots in the back side of the enclosure structure.

2. The blade enclosure of claim 1, wherein the cooling assembly further comprises:

a cooling base 120 forming a generally rectangular enclosure, the cooling base located in a bottom section of enclosure structure, the TBB 122 mounted on top of the cooling base 120;

at least one TBB pump 252 located inside the cooling base 120;

a heat exchanger 244 located inside the cooling base 120;

a first piping system coupled to the at least one TBB pump 252, the heat exchanger 244, the cooling fluid inlet 248, and the cooling system outlet 250, wherein the first piping system forms a re-circulating fluid pathway between the TBB 122, the heat exchanger 244 and the at least one TBB pump 252.

3. The blade enclosure of claim 2, wherein the cooling assembly further comprises:

a plurality of TBB pumps 252 wherein the first piping system is configured to redundantly couple the plurality of TBB pumps 252 with the re-circulating fluid pathway.

4. The blade enclosure of claim 2 and 3, wherein the cooling assembly further comprises:

an external fluid inlet 242 and an external fluid outlet 240;

a second piping system wherein the second piping system couples the external fluid inlet 242 and the external fluid outlet 240 with the heat exchanger 244;

an external fluid cooling system coupled to the external fluid inlet and the external fluid outlet and configured to provide cooled fluid to the external fluid inlet and remove heated fluid from the external fluid outlet.

5. The blade enclosure of claim 1, wherein the cooling fluid inlet 248 and the cooling fluid outlet 250 are coupled to an external cooling fluid supply system configured to provide cool fluid to the cooling system inlet and remove heated fluid from the cooling system outlet.

6. The blade enclosure of all of the above claims, wherein the plurality of cooling fluid channels comprise a first set of input channels 350 and a second set of output

channels 352 and the first set of input channels 350 are interspaced with the second set of output channels 352.

7. The blade enclosure of all of the above claims, wherein the plurality of cooling fluid channels are configured to provide a highest level of cooling for a first set of the plurality of slots and a lowest level of cooling for a second set of the plurality of slots.

8. The blade enclosure of all of the above claim, further comprising:

at least one blade inserted into one of the plurality of slots on the front side of the enclosure structure wherein a back side of the blade makes thermal contact with the front face of the TBB.

9. The blade enclosure of claim 8, wherein the computer blade is selected from one of the following types of computer blades: a blade server, a memory blade, an input/output (I/O) blade, a blade fabric, and a power supply blade.

10. A method for cooling a blade enclosure, comprising:

providing a plurality of blade mounting slots in a front side of the blade enclosure, wherein when a blade is installed into one of the plurality of blade mounting slots in the front side of the blade enclosure, a heat transfer plate on a back end of the blade makes thermal contact with a front face of a thermal bus bar (TBB) positioned in a middle of the blade;

providing a plurality of blade mounting slots in a back side of the blade enclosure, wherein when a blade is installed into one of the plurality of blade mounting slots in the back side of the blade enclosure, a heat transfer plate on a back end of the blade makes thermal contact with a back face of the TBB;

cooling the TBB.

11. The method for cooling a blade enclosure of claim 10, further comprising:

installing a computer blade into the blade enclosure thereby thermally coupling a heat transfer plate on the computer blade to the TBB in the blade enclosure.

12. The method for cooling a blade enclosure of claim 11, wherein the computer blade is selected from one of the following types of computer blades: a blade server, a memory blade, an input/output (I/O) blade, a blade fabric, and a power supply blade.

13. The method for cooling a blade enclosure of claim 10, 11 and 12, wherein the TBB is cooled by a re-circulating fluid cooling system contained in the blade enclosure.

14. The method for cooling a blade enclosure of claim 10, 11, 12 and 13, wherein the TBB is cooled evenly across the TBB.

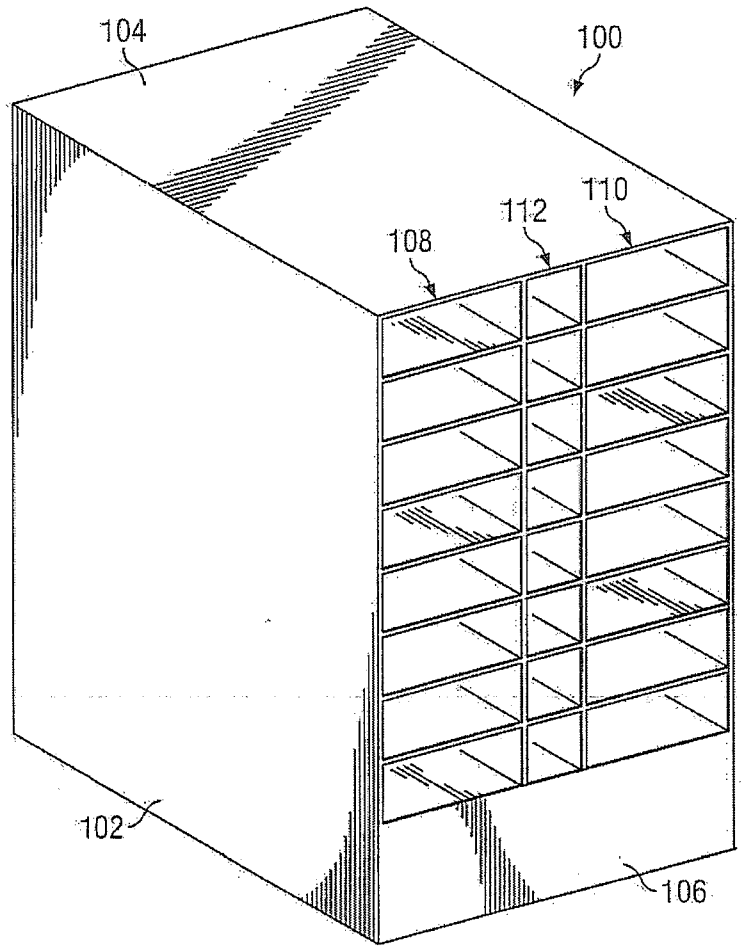

FIG. 1A

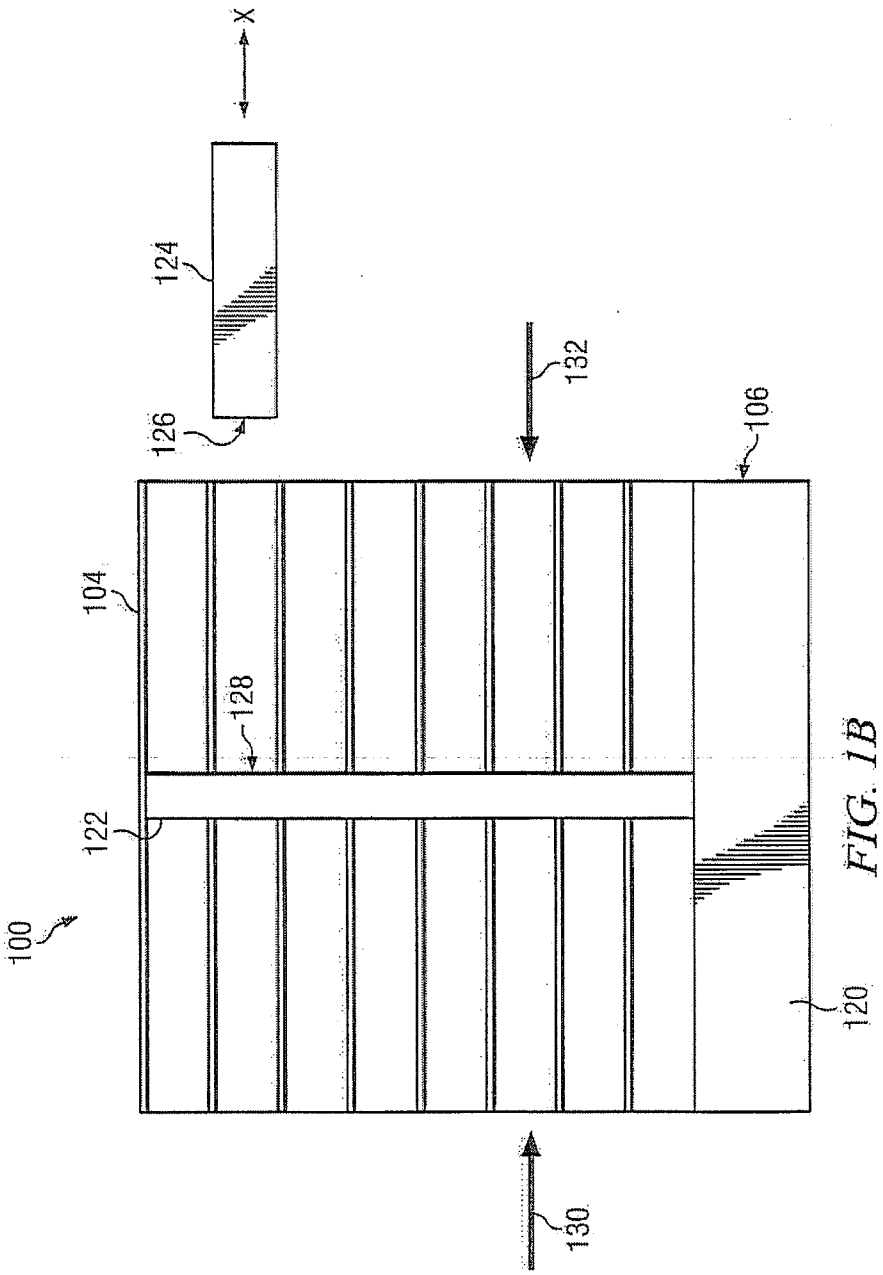

FIG. 1B

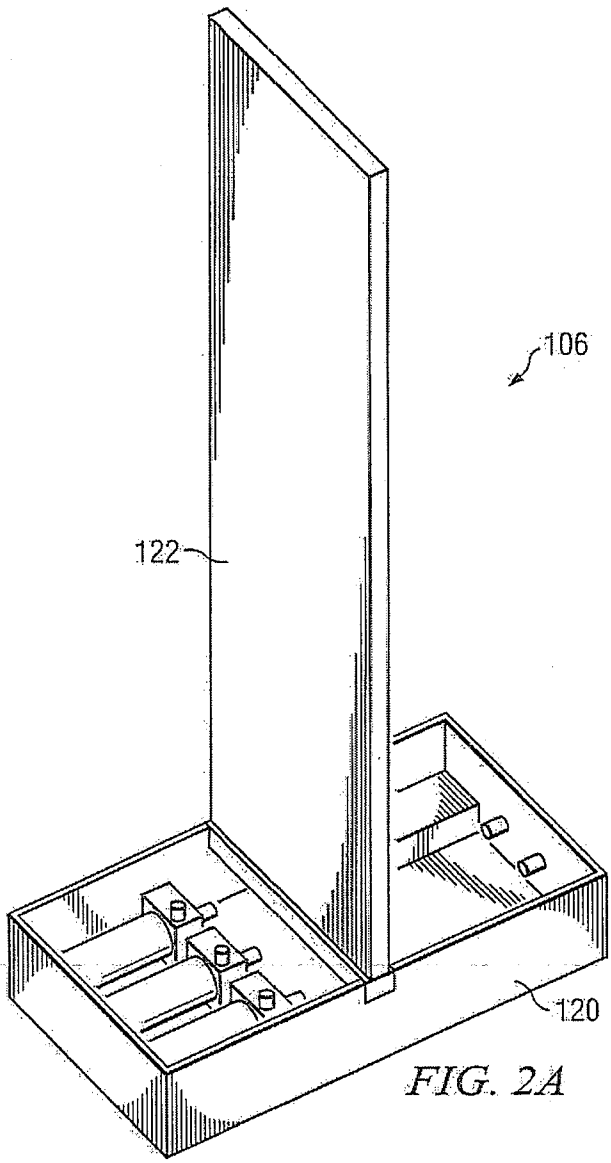

FIG. 2A

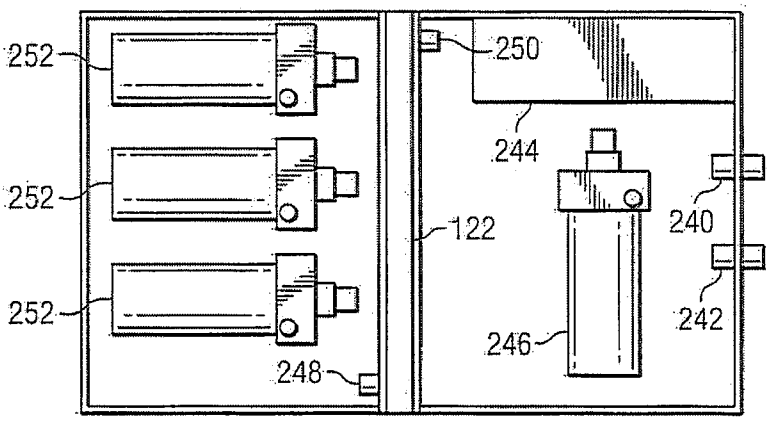

FIG. 2B

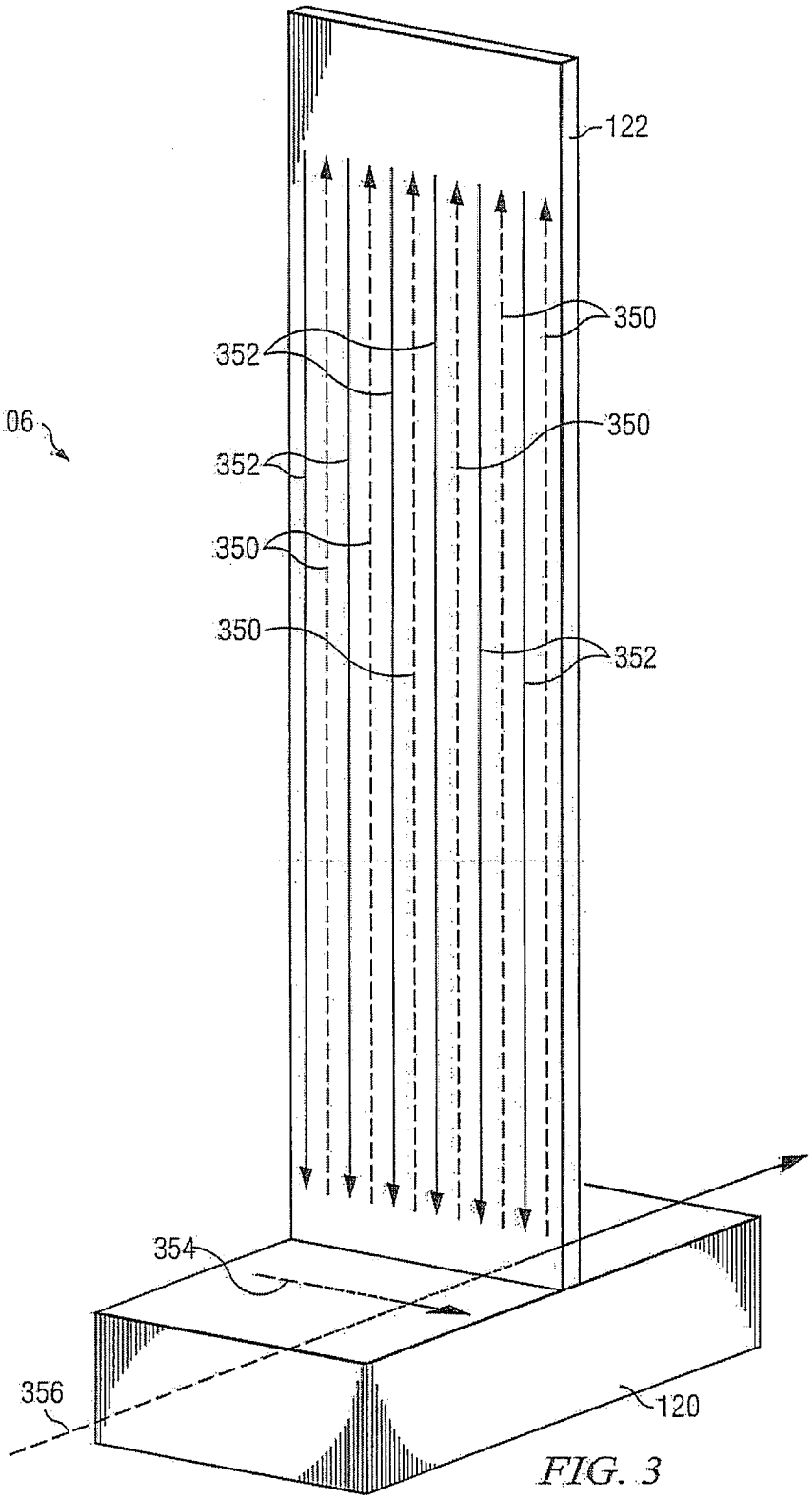

FIG. 3

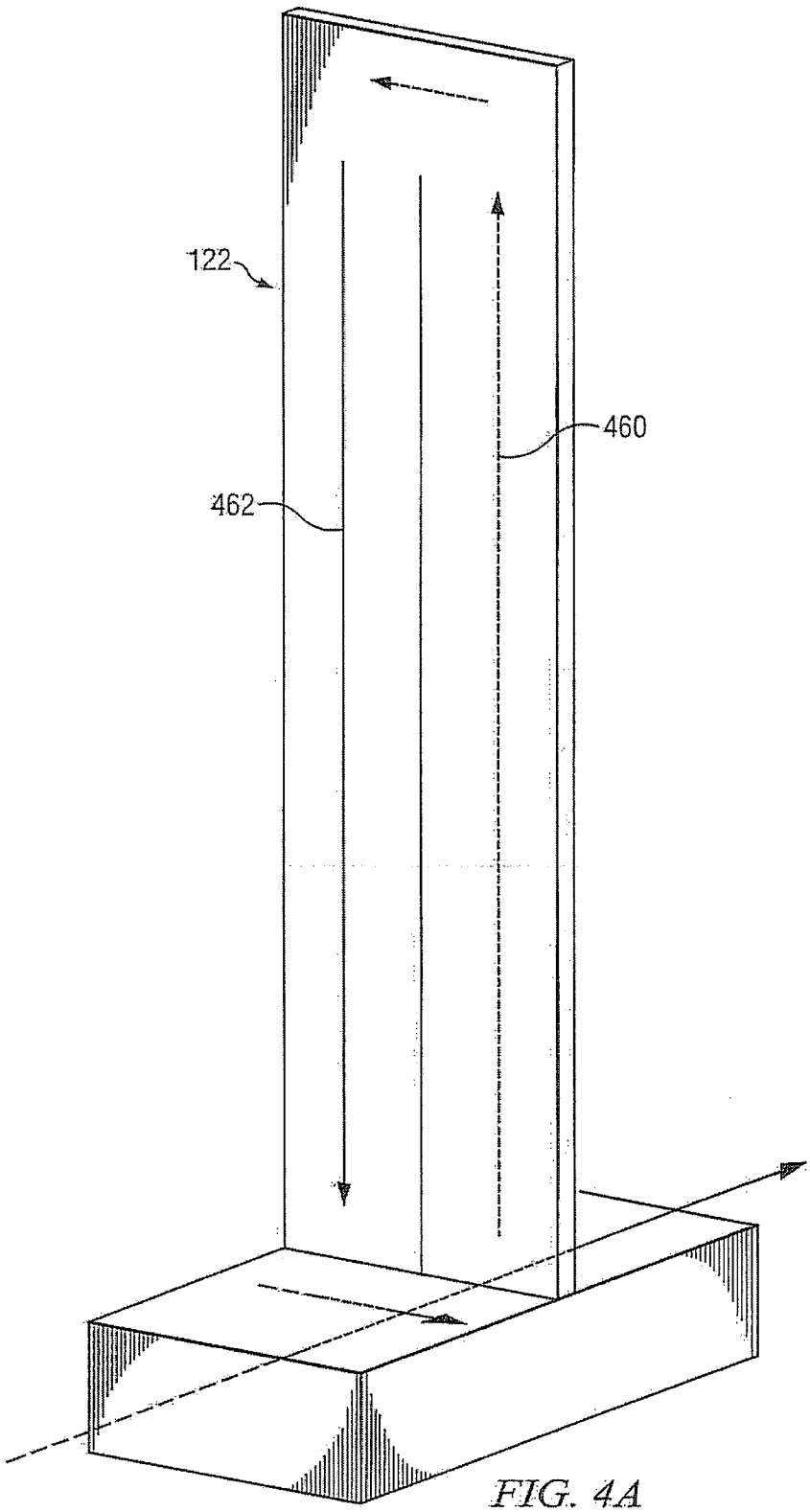

FIG. 4A

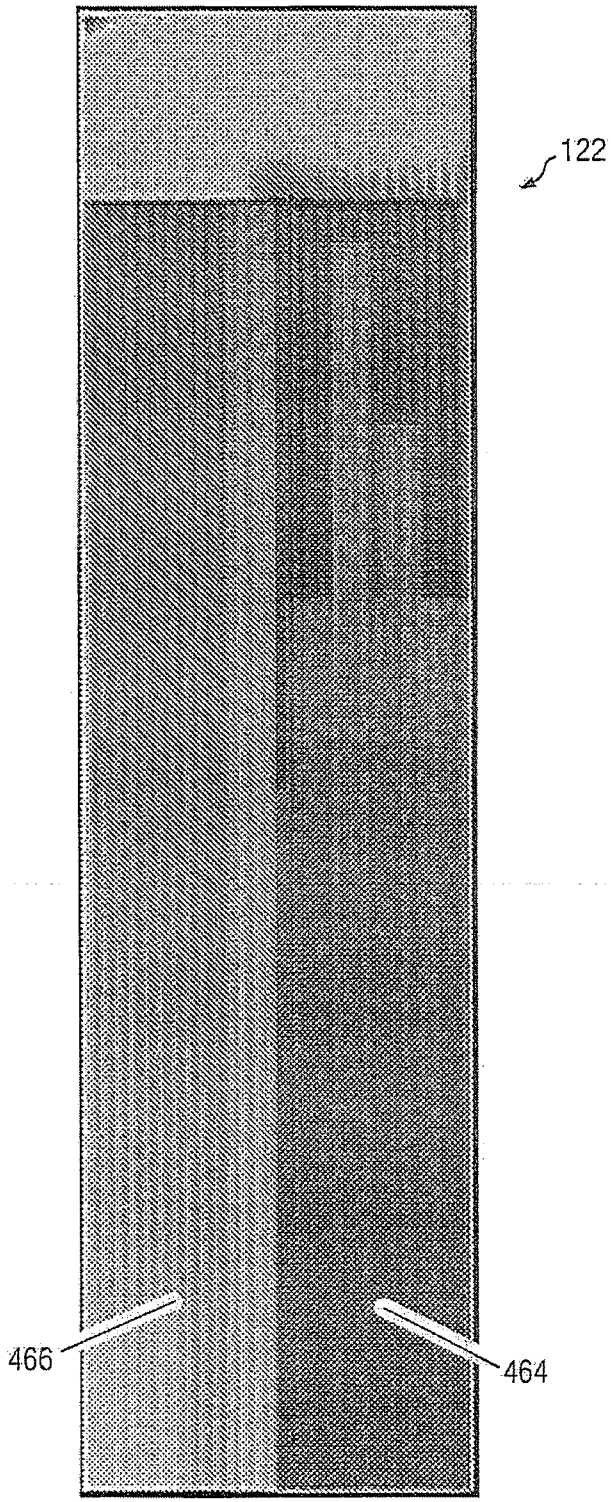

FIG. 4B

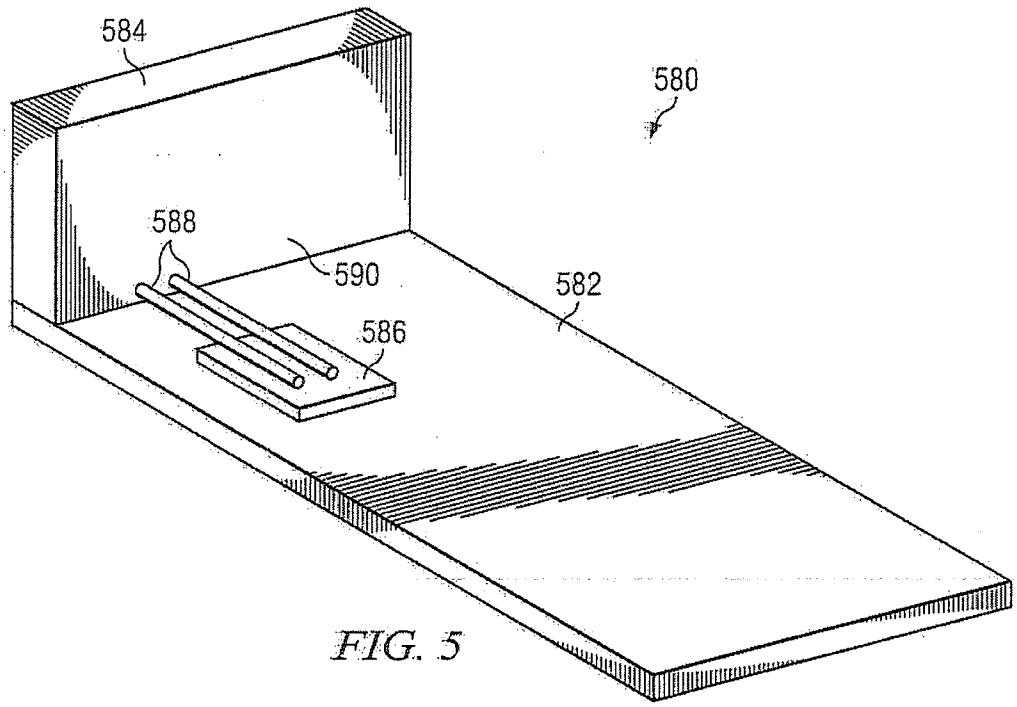

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/062703

A. CLASSIFICATION OF SUBJECT MATTER

F28D 15/02(2006.01)i, H05K 7/20(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F28D 15/02; H01L 23/10; H01L 23/34; H02B 1/20; H02M 7/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: computer, cooling & blade

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2004-0052065 A1 (SMITH, J. V. et al.) 18 March 2004 See paragraph 49 - paragraph 50; figures 1,8.	1-3,5,9-12
A	US 2003-0057546 A1 (MEMORY, S. B. et al.) 27 March 2003 See claim 1 - claim 15; figure 1	1-3,5,9-12
A	JP 07-087742 A (MITSUBISHI ELECTRIC CORP) 31 March 1995 See claim 1 - claim 4; figure 1	1-3,5,9-12
A	US 5990549 A1 (CHIA-PIN CHIU. et al.) 23 November 1999 See claim 1 - claim 15; figure 2	1-3,5,9-12

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 JUNE 2010 (28.06.2010)	**28 JUNE 2010 (28.06.2010)**

Name and mailing address of the ISA/KR

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Facsimile No. 82-42-472-7140

Authorized officer

PARK, Hwan Su

Telephone No. 82-42-481-5418

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/062703

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4, 6-8, 13-14
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2009/062703

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004-0052065 A1	18.03.2004	AU 2003-243365 A1	19.12.2003
		AU 2003-265993 A1	08.04.2004
		AU 2003-265993 A8	08.04.2004
		AU 2003-266017 A1	23.04.2004
		AU 2003-266017 A8	23.04.2004
		CA 2488037-A1	11.12.2003
		CN 101520680 A	02.09.2009
		CN 101520680 A	02.09.2009
		CN 1739326 C0	22.02.2006
		EP 1532852 A1	25.05.2005
		EP 1668968 A2	14.06.2006
		JP 2006-512627 A	13.04.2006
		JP 2008-102964 A	01.05.2008
		JP 2008-102965 A	01.05.2008
		JP 2008-102966 A	01.05.2008
		JP 2008-140406 A	19.06.2008
		KR 10-0772084 B1	31.10.2007
		KR 10-0911700 B1	10.08.2009
		KR 10-0913511 B1	21.08.2009
		KR 10-0913512 B1	21.08.2009
		KR 10-0913513 B1	21.08.2009
		US 2003-0221817 A1	04.12.2003
		US 2003-0223196 A1	04.12.2003
		US 2003-0223199 A1	04.12.2003
		US 2003-0224645 A1	04.12.2003
		US 2004-0057216 A1	25.03.2004
		US 2004-0059903 A1	25.03.2004
		US 2004-0264145 A1	30.12.2004
		US 2005-0024825 A1	03.02.2005
		US 6680846W D	20.01.2004
		US 6801428 B2	05.10.2004
		US 6836030 B2	28.12.2004
		US 6842334 B2	11.01.2005
		US 6909611 B2	21.06.2005
		WO 03-103359 A1	11.12.2003
		WO 2004-027549 A2	01.04.2004
		WO 2004-027549 A3	01.04.2004
		WO 2004-031037 A2	15.04.2004
		WO 2004-031037 A3	15.04.2004
		WO 2004-102324 A2	25.11.2004
		WO 2004-102324 A3	25.11.2004
US 2003-0057546 A1	27.03.2003	CN 1314306 C	02.05.2007
		CN 1314306 C0	02.05.2007
		CN 1409589 A	09.04.2003
		CN 1409589 A0	09.04.2003
		DE 60232849 D1	20.08.2009
		EP 1298975 A2	02.04.2003
		EP 1298975 A3	16.11.2005

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2009/062703

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		EP 1298975 B1	08.07.2009
		EP 2094069 A1	26.08.2009
		JP 2003-179375 A	27.06.2003
		JP 2003-179375 A	27.06.2003
		US 2003-057546 A1	27.03.2003
		US 6828675 B2	07.12.2004
JP 07-087742 A	31.03.1995	None	
US 5990549 A1	23.11.1999	AU 1999-20254 A1	23.08.1999
		JP 2002-503032 A	29.01.2002
		KR 10-0373228 B1	25.02.2003
		WO 99-40625 A1	12.08.1999