HEAT REMOVAL ASSEMBLY  

EVAPORATOR BLOCK  

HEAT PIPE  

CONDENSER PLATE  

Fig. 3
Declartions under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))

Published:

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HEAT REMOVAL ASSEMBLY

BACKGROUND

[0001] Electronic components or electronic devices have temperature requirements. Heat from the use of the electronic components is removed using an assembly and/or a system to remove the heat. Removal of heat from electronic components varies depending on the type of electronic components and the structure surrounding of electronic components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Non-limiting examples of the present disclosure are described in the following description, read with reference to the figures attached hereto and do not limit the scope of the claims. In the figures, identical and similar structures, elements or parts thereof that appear in more than one figure are generally labeled with the same or similar references in the figures in which they appear. Dimensions of components and features illustrated in the figures are chosen primarily for convenience and clarity of presentation and are not necessarily to scale. Referring to the attached figures:

[0003] FIG. 1 illustrates a block diagram of a system to remove heat according to an example;

[0004] FIG. 2 illustrates a schematic diagram of the system of FIG. 1 according to an example;

[0005] FIG. 3 illustrates a block diagram of a heat removal assembly according to an example;

[0006] FIG. 4 illustrates a perspective view of the assembly of FIG. 3 according to an example;

[0007] FIG. 5 illustrates a cross-sectional view of a heat pipe according to an example;

[0008] FIG. 6 illustrates a block diagram of a heat removal assembly according to an example; and

[0009] FIGS. 7-9 illustrate perspective views of the assembly of FIG. 6 according to examples.
DETAILED DESCRIPTION

[0010] In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which is depicted by way of illustration specific examples in which the present disclosure may be practiced. It is to be understood that other examples may be utilized and structural or logical changes may be made without departing from the scope of the present disclosure.

[0011] Electronic components are designed to balance conflicts between power density, spatial layout, temperature requirements, acoustic noise, and other factors. Air cooling systems typically use heat sinks and fans to remove "waste" heat from the electronic component. The use of fans for air cooling may increase the electrical power required to operate the electronic component and may also cause excessive acoustic noise and lower system density. Removal of heat using air cooling typically becomes less efficient as power density increases. Liquid cooling is typically more efficient than air cooling, especially at higher power density; however, liquid cooling typically includes plumbing connections within the electronic components. As the liquid goes through the plumbing connections the risk of leakage of liquid within the electronic component is introduced.

[0012] In examples, a heat removal assembly is provided. The heat removal assembly includes an evaporator block, a heat pipe, and a condenser plate. The evaporator block removes heat from an electronic component. The evaporator block engages with the electronic component and forms a thermal connection therebetween that removes the heat from the electronic component. The heat pipe connects to the evaporator block to remove heat from the evaporator block. The condenser plate connects to the heat pipe and receives heat from the heat pipe. The condenser plate includes a thermal mating surface that mates with a thermal member, such that the heat is removed from the assembly via the thermal mating surface. The assembly removes the heat from the electronic component using heat pipes to allow the liquid cooling to occur.
away from the electronic component, reducing the risk of fluid leakage within the electronic component.

[0013] FIG. 1 illustrates a block diagram of a system 100 to remove heat according to an example. The system 100 includes an electronic component 110 and a heat removal assembly 120 that removes heat from the electronic component 110. The heat removal assembly 120 includes an evaporator block 140, a heat pipe 160, and a condenser plate 180. The evaporator block 140 engages with the electronic component 110 and forms a thermal connection therebetween. The heat pipe 160 connects to the evaporator block 140 and removes heat from the evaporator block 140. The condenser plate 180 connects to the heat pipe 160 and receives heat from the heat pipe 160. The condenser plate 180 includes a thermal mating surface that aligns with a thermal member, such that heat is removed from the heat removal assembly 120 via the thermal mating surface.

[0014] FIG. 2 illustrates a schematic diagram of the system 100 of FIG. 1 according to an example. The system 100 includes an electronic component 110 and a heat removal assembly 120 that removes heat from the electronic component 110. The system 100 as illustrated also includes a cooling assembly 200 that receives the heat from the heat removal assembly 120. The heat removal assembly 120 includes an evaporator block 140, a heat pipe 160, and a condenser plate 180. The evaporator block 140 engages with the electronic component 110 and forms a thermal connection 246 therebetween. For example, the evaporator block 140 is illustrated as a first and a second evaporator block 140, 240. Each of the evaporator blocks 140, 240 have an evaporator thermal surface 242, 244 that lie flush with a surface 212, 214 of the electronic component 110 and form the thermal connections therebetween 246, 248. The thermal connections 246, 248 enable transfer of heat from the electronic component 110 to the evaporator blocks 140, 240. The transfer removes heat from the electronic component 110.

[0015] The heat pipe 160 thermally connects to the evaporator block 140 and passively removes heat from the evaporator block 140. The heat pipe 160 is illustrated as a first heat pipe 160 and a second heat pipe 260. The first heat
pipe 160 connects to the first evaporator block 140 and the second heat pipe 260 connects to the second evaporator block 240.

[0016] The condenser plate 180 thermally connects to the first and second heat pipes 160, 260 and receives heat from the first and second heat pipes 160, 260. The condenser plate 180 includes a thermal mating surface 282 that aligns with a thermal member 202. The transferred heat is removed from the heat removal assembly 120 via the thermal mating surface 282. The thermal mating surface 282 lies flush with a receiving surface 204 of the thermal member 202 and forms a thermal connection 284 therebetween. For example, the thermal member 202 is part of the cooling assembly 200 that removes the heat from the system 100 to enable the cooling of the electronic component 110.

[0017] The configuration of the second heat pipe 260 may vary to accommodate various electronic components 110 and pivot or rotate during assembly at a pivot point or a hinge. For example, the second heat pipe 260 includes a first portion, a second portion, and a bellow therebetween. The first portion of the second heat pipe 260 connects to the condenser plate 180. The bellow enables the second portion of the second heat pipe 260 to pivot with reference the first portion of the second heat pipe 260 and maintain a thermal connection therebetween. In an alternate example, the second heat pipe 260 hingedly connects to the condenser plate 180, such that, the second heat pipe 260 rotates the second evaporator block 240 into and out of alignment with the electronic component 110. The second heat pipe 260 and the condenser plate 180 are thermally connected to allow the heat to transfer to the condenser plate 180 and exit the heat removal assembly 120.

[0018] The condenser plate 180 may alternatively or in addition include a first plate and a second plate. The first plate includes a first thermal mating surface and the second plate includes a second thermal mating surface. The first plate and the second plate of the condenser plate 180 are aligned such that the first thermal mating surface and the second thermal mating surface align with the thermal member 202. The first plate and the second plate are aligned using, for example, an alignment member formed between the first and second.
plate. The alignment member aligns the first plate and the second plate of the condenser plate 180, such that the first thermal mating surface and the second thermal mating surface align with the thermal member 202 and provides a thermal connection that transfers the heat from the first and second heat pipes 160, 260 to the condenser plate 180. An example of an alignment member includes a pin that fits into an aperture formed between the first plate and the second plate of the condenser plate 180.

[0019] FIGS. 3 illustrates block diagram of a heat removal assembly 120 according to an example. The heat removal assembly 120 includes an evaporator block 140, a heat pipe 160, and a condenser plate 180. The evaporator block 140 removes heat from an electronic component. The evaporator block 140 engages with the electronic component 110 and forms a thermal connection therebetween. The heat pipe 160 thermally connects to the evaporator block 140 to passively remove heat from the evaporator block 140.

[0020] The condenser plate 180 thermally connects to the heat pipe 160. The condenser plate 180 receives heat from the heat pipe 160. The condenser plate 180 includes a thermal mating surface 282 that aligns with a thermal member 202, such that the heat is transferred from the heat removal assembly 120 via the thermal mating surface 282, as illustrated in FIG. 2.

[0021] FIG. 4 illustrates a perspective view of the assembly of FIG. 3 according to an example. The heat removal assembly 120 includes an evaporator block 140, a heat pipe 160, and a condenser plate 180. The evaporator block 140 removes heat from an electronic component. The evaporator block 140 engages with the electronic component 110 and forms a thermal connection 440 therebetween. For example, the engagement between the evaporator block 140 and the electronic component 110 occurs at an evaporator thermal surface 442 that lies flush with a portion 412 of the electronic component 110 to remove heat therefrom. The thermal connection 246 is formed by the contact between the surfaces and a thermally conductive substance 444, such as ShinEtsu G750 or GrafTech HiTherm thermal grease, may be used between the evaporator thermal surface 442 and the portion 412 of the electronic component 110 to improve the thermal connection 440. It is
important that a proper thermal connection 440 is formed to efficiently and effectively remove the heat from the electronic component 110.

[0022] The heat pipe 160 connects to the evaporator block 140 to passively remove heat from the evaporator block 140. FIG. 5 illustrates a cross-sectional view of a heat pipe 160 according to an example. Referring to FIG. 5, the heat pipe 160 includes a heat pipe wall 510, a wicking portion 520, and a vapor channel 530. The heat pipe 160 is formed of, for example, copper tubing. The copper tubing receives heat 550 from a heat source, such as electronic component 110, via the evaporator block 140. Heat 550 is transferred from the evaporator block 140 through the heat pipe wall 510 of the heat pipe 160, into the wicking portion 520. The wicking portion 520 includes, for example, sintered type wicks, groove type wicks, wire bundle wicks, or wire mesh wicks. A liquid phase working fluid 522 such as water is present in the wicking portion 520 adjacent to evaporator block 140. The liquid phase working fluid 522 is heated and changes to a vapor 535.

[0023] The expansion inherent in vaporization causes the vapor 535 from the liquid phase working fluid 522 to travel along the vapor channel 530, as illustrated by the vapor arrows 532. As the vapor 535 travels down the vapor channel 530 it carries heat along with it. At the opposite end of the heat pipe 160, adjacent to the condenser plate 180, the heat pipe walls 510 are held at a lower temperature, by contact with the condenser plate 180. It is necessary to maintain a temperature differential or the heat pipe 160 will cease to efficiently transfer heat 550. In other words, the heat is continuously removed from the heat pipe 160 by the condenser plate 180 to maintain the temperature differential that allows the heat pipe 160 to work efficiently.

[0024] The lower temperature causes the liquid phase working fluid 522 to condense onto the wicking portion 520, transferring heat 550 into the heat pipe wall 510, and out to the condenser plate 180. As the vaporous working fluid 522 condenses into the wicking portion 520, it is drawn back toward the evaporator block 140 end of the heat pipe 160 by capillary action. This cycle can repeat indefinitely as long as a sufficient temperature differential exists between the evaporator block 140 and condenser plate 180 ends of the heat
pipe 160. The heat 550 is removed from the heat pipe 160 via the condenser plate 180 that collects the heat 550 from the vapor 535.

[0025] The quantity, size and shape of the heat pipes 160 may vary depending upon the configuration of the electronic component 110, the evaporator block 140, and the condenser plate 180 that connects to the heat pipe 160. The connection between the evaporator block 140 and the condenser plate 180 is typically rigid. For example, the heat pipe 160 is soldered to the evaporator block 140 and the condenser plate 180.

[0026] Referring back to FIG. 4, the condenser plate 180 connects to the heat pipe 160. The condenser plate 180 receives heat from the heat pipe 160. The condenser plate 180 includes a thermal mating surface 282 that aligns with a thermal member 202, such that the heat is removed from the heat removal assembly 120 via the thermal mating surface 282, as illustrated in FIG. 2. The thermal mating surface 282 lies flush with a receiving surface 204 of the thermal member 202. For example, the thermal mating surface 282 is a contiguous mating surface that mates with the receiving surface 204 of the thermal member 202. A thermal connection 284 is formed between the thermal mating surface 282 and the receiving surface 204 by direct contact or using a thermally conductive substance 444 such as ShinEtsu G750 or GrafTech HiTherm thermal grease. It is important that the thermal connection 284 is properly formed to efficiently and effectively transfer the heat from the heat removal assembly 120 to the thermal member 202.

[0027] The thermal member 202 may be part of a cooling assembly 200, such as a thermal bus bar that provides rack level cooling away from the electronic components 110. The heat removal assembly 120 connects to the cooling assembly 200 using, for example, fasteners and/or brackets 490 that connect and/or secure the condenser plate 180 to a portion of the cooling assembly 200, such as a portion that allows the condenser plate 180 and the thermal member 202 to mate and form a thermal connection 482 therebetween.

[0028] The electronic component 110 usable with the heat removal assembly 120 may include one or more heat producing supplementary devices 464, such as memory attached to the electronic component 110. For instance,
large devices such as a Graphical Processing Unit may be surrounded by memory on both sides or surfaces of the printed circuit board (PCB). The heat producing supplementary devices 464 may also be contained within the heat removal assembly 120. For example, memory, power supply devices, or other supplementary electronic devices 464 may also be installed on the mounting of the PCB. The heat producing supplementary devices may also be thermally attached to the evaporator block 140 for removal of waste heat.

[0029] FIG. 6 illustrates block diagram of a heat removal assembly 120 according to an example. The heat removal assembly 120 includes a first evaporator block 140, a first heat pipe 160, a second evaporator block 240, a second heat pipe 260, and a condenser plate 180. The first evaporator block 140 removes heat from a first surface 212 of an electronic component 110. The first evaporator block 140 engages with the first surface 212 of the electronic component 110 and forms a first thermal connection 246 therebetween. For example, engagement between the first evaporator block 140 and the electronic component 110 occurs at an evaporator thermal surface (i.e., 242 of FIGS. 2 and 4) that lies flush with a surface (i.e., 212 of FIGS. 2 and 4) of the electronic component 110 to remove heat from the electronic component 110. The first heat pipe 160 connects to the first evaporator block 140 to remove heat from the first evaporator block 140.

[0030] The second evaporator block 240 removes heat from a second surface 214 of the electronic component. The second evaporator block 240 engages with the electronic component 110 and forms a second thermal connection 248 between evaporator thermal surface 244 and the second surface 214 of the electronic component. For example, engagement between the second evaporator block 240 and the electronic component 110 occurs at an evaporator thermal surface (i.e., 244 of FIG. 2) that lies flush with a surface (i.e., 214 of FIGS. 2 and 4) of the electronic component 110 to remove heat from the electronic component 110. The second heat pipe 260 connects to the second evaporator block 240 to remove heat from the second evaporator block 260. The configuration of the second heat pipe 260 may vary to accommodate
various electronic components 110 and pivot or rotate during assembly at a pivot point or a hinge.

[0031] The condenser plate 180 connects to the first and second heat pipes 160, 260 and receives heat from the first and second heat pipes 160, 260. The condenser plate 180 includes a thermal mating surface 282 that mates or aligns with a thermal member 202, as illustrated in FIGS. 2 and 4. The thermal mating surface 282 mates with the thermal member 202, for example, in a position flush with a receiving surface 204 of the thermal member 202. The thermal member 202 is part of the cooling assembly 200 that removes the heat from the system 100 to enable the cooling of the electronic component 110. The heat is removed from the heat removal assembly 120 via the thermal mating surface 282.

[0032] FIGS. 7-9 illustrate perspective views of the assembly of FIG. 6 according to examples. Each assembly includes two evaporator blocks 140, 240 to cool an electronic component 110. The two evaporator blocks 140, 240 are each on a distinct side of the electronic component 110, illustrated on two opposing sides in FIGS. 7-9. The heat removal assembly 120 cools both sides of the electronic component 110 when for example, there are chips on both sides of a system board, such as a general purpose graphical processing unit (GPGPU) or a graphical processing unit (GPU) with dynamic random-access memory (DRAM) chips on two opposing surfaces of the system board (i.e., a top and bottom surface of the system board). Other examples of electronic components 110 includes a central processing unit (CPU), dual in-line memory modules (DIMMs), a power supply board, a disk device, and a battery.

[0033] Cooling two opposing sides of the electronic component 110 is challenging when using evaporator blocks. Evaporator blocks 140, 240 are more efficient and effective than air for cooling electronic components 110 when the evaporator blocks include a very flat surface to mate or align with the electronic component 110. Heat pipes 160, 260 are typically rigidly soldered between the evaporator blocks 140, 240 and the condenser plate 180. The condenser plate 180 is also more efficient and effective when a very flat surface of the condenser plate 180 mates or aligns with a thermal member 202. The
surface profile of the electronic component 110, such as a system board, makes it virtually impossible to install two rigidly joined evaporator blocks 140, 240 between the system board without compromising the surface flatness of the evaporator blocks 140, 240 and/or the condenser plate 180.

[0034] Referring to FIGS. 7-9, the first and second evaporator blocks 140, 240 are similar to one another, and the first heat pipe 160 is not altered. However, the second heat pipe 260 and/or the condenser plate 180 are modified to accommodate the electronic component 110 between two evaporator blocks 140, 240 and provide proper thermal connections between the electronic component 110 and both of the first and second evaporator blocks 140, 240. FIGS. 7-8 each illustrate an example of modifications to the configuration of the second heat pipe 260 that pivots or rotates during assembly to accommodate the electronic component 110 and aligns with the electronic component 110 to efficiently cool the electronic component 110.

[0035] Referring to FIG. 7, the second heat pipe 260 includes a first portion 762, a second portion 764, and a bellow 766. The first portion 762 of the second heat pipe 260 connects to the condenser plate 180. The second portion 764 of the second heat pipe 260 connects to the second evaporator block 240. The bellow 766 is formed between the first portion 762 and the second portion 764. FIG. 7 illustrates a cut-out of a portion of the bellow 766 that includes a wick member 770, for example a wire bundle or wire mesh to enhance internal fluid return in the area of the bellow 766. The outer surface 768 of the bellow 766 is formed of a conductive material, such as copper that enables a thermal connection 765, 767 to remain between the first portion 762 and the second portion 764 of the heat pipe 260.

[0036] The bellow 766 enables the second portion 764 of the second heat pipe 260 to rotate a with reference to the first portion 762, i.e., about an axis A extending from the first portion 762 of the second heat pipe 260. For example, the second portion 764 rotates between two positions $\alpha_1, \alpha_2$, such that the second heat pipe 260 moves the evaporator block 240 into and out of alignment with the electronic component 110. For example, the bellow 766 provides a predefined amount of separation between the first and second
evaporator blocks 140, 240 that allow space to position the electronic component 110 between the first and second evaporator blocks 140, 240. The bellow 766 enables the second evaporator block 240 to move between two positions. In a first position $\alpha_1$, the second evaporator block 240 is flush or contacts a portion of the electronic component 110 when assembled such that a thermal connection 246, 248 is formed between the electronic component 110 and both the first evaporator block 140 and the second evaporator block 240. For example, each evaporator thermal surface 242, 244 mates or aligns with an electronic surface 212, 214 of the electronic component 110.

[0037] The thermal connection may be improved by adding a thermally conductive substance 444, such as ShinEtsu G750 or GrafTech HiTherm thermal grease, between the evaporator thermal surfaces 242, 244 of the evaporator blocks 140, 240 and the electronic surfaces 212, 214. In a second position $\alpha_2$, the second evaporator block 240 rotates to increase the amount of space or separation between the first and second evaporator blocks 140, 240 to allow insertion of the electronic component 110. For example, if the electronic component 110 installed needs to be removed and/or a new electronic component needs to be installed, the second heat pipe 260 rotates the second evaporator block 240 to the second position $\alpha_2$, which is out of contact with the electronic component 110. The flexible structure of the bellow 766 allows rotation of the evaporator block 240 to install and/or remove the electronic component 110.

[0038] Referring to FIG. 8, the second heat pipe 260 hingedly connects to the condenser plate 180. The hinge 860 is formed for example, using a pin 880 that extends through the second heat pipe 260 and the condenser plate 180. The hinge 860 enables the second heat pipe 260 to pivot or rotate, $\beta$, about a point b on an axis B that extends through the pin 880. The hinge 860 enables the second evaporator block 240 to move into and out of alignment with the electronic component 110, i.e., positions $\beta_1$ and $\beta_2$. The movement of the second evaporator block 240 via the hinge 860 enables the electronic component 110 to be reversed and/or inserted. A thermal connection is provided between the second heat pipe 260 and the condenser plate 180 to
allow the heat to transfer to the condenser plate 180 and exit the heat removal assembly 120. For example, not only is the second heat pipe 260 and the condenser plate 180 formed of a thermal material, such as copper. Additionally, a thermally conductive substance 444, such as ShinEtsu G750 or GrafTech HiTherm thermal grease, may also be used between the hinge 860 to transfer heat and increase the thermal connection therebetween. [0039] Referring to FIG. 9, the second heat pipe 260 is soldered between the second evaporator block 240 and the condenser plate 180. The condenser plate 180 is modified to include two portions, a first plate 982 and a second plate 984. The first plate 982 includes a first thermal mating surface 983 and the second plate 984 of the condenser plate 180 includes a second thermal mating surface 985. The first and second plate 982, 984 of the condenser plate 180 are aligned such that the first thermal mating surface 983 and the second thermal mating surface 985 align with a thermal member 202, i.e., the thermal member 202 may be part of a cooling assembly 200, as illustrated in FIG. 2. [0040] For example, the first and second thermal mating surfaces 983, 985 are formed of two contiguous mating surfaces that mate with the receiving surface 204 of the thermal member 202. A thermal connection 987, 989 is formed between each of the first and second thermal mating surfaces 983, 985 and the receiving surface 204 by direct contact and/or a thermally conductive substance 444 such as ShinEtsu G750 or GrafTech HiTherm thermal grease. It is important that the thermal connections 987, 989 are properly formed to efficiently and effectively transfer the heat from the heat removal assembly 120 to the thermal member 202. [0041] Proper alignment between the first and second plate 982, 984 aids with forming and maintaining the proper thermal connections 987, 989. For example a first thermal connection is needed between the first thermal mating surface 983 and the receiving surface 204 of the thermal member 202, and a second thermal connection is needed between the second thermal mating surface 985 and the receiving surface 204 of the thermal member 202. The first plate 982 transfers the heat from the first heat pipe 160 from the heat removal assembly 120 to the thermal member 202 and the second plate 984 transfers.
heat from the second heat pipe 260 to the thermal member 202. It is important that the first plate 982 and the second plate 984 each have a thermal connection with the thermal member 202 (i.e., a thermal connection between the first thermal mating surface 983 and the receiving surface 204 and the second thermal mating surface 985 and the receiving surface 204) to efficiently and effectively remove heat from the heat removal assembly 120. However, when there is a thermal connection between the first plate and the thermal member 202 and the second plate 984 and the thermal member 202, there is no need for a thermal connection to exist between the first and second plates 982, 984 since the heat removed by the first and second thermal mating surfaces 983, 985 of the first and second plates 982, 984, respectively.

[0042] The first and second plates 982, 984 are formed such that the two plates may be moved into and out of alignment with one another (i.e., separated and realigned), as illustrated by movement arrow 990 and the dotted portions of the assembly 120. For example, the second plate 984 may be moved up and down relative to the first plate 982 to provide an amount of clearance between the first and second evaporator blocks 140, 240 that allows the electronic component 110 to fit between the first and second evaporator blocks 140, 240. Although FIG. 9 illustrates the second heat pipe 260 soldered to the evaporator block 240 and condenser plate 180 without a bellow 766 or hinge 860, the second heat pipe 260, as illustrated in FIGS. 7-8 may also be used with the condenser plate 180 having two portions, as illustrated in FIG. 9.

[0043] The first plate 982 and the second plate 984 of the condenser plate 180 are aligned or realigned using, for example, an alignment member 986 formed between the first and second portion of the condenser plate 180. The alignment member 986 aligns the first plate 982 and the second plate 984 of the condenser plate 180, such that the first thermal mating surface 983 and the second thermal mating surface 985 align with the thermal member 202 and provide the thermal connections 987, 989 that transfer the heat from the first and second heat pipes 160, 260 to the condenser plate 180. The alignment member 986 aligns the first and second plates 982, 984 to position the first and second thermal mating surfaces 983, 985 together to form a very flat surface to
mate with a thermal member 202. The use of the alignment member 986 is used to aid in easily and consistently positioning the first and second thermal mating surfaces 983, 985 to allow both the first and second plates 982, 984 to efficiently and effectively transfer heat from the heat removal assembly 120 to the thermal member 202.

[0044] An example of an alignment member 986 includes a pin 992 that fits into an aperture 994 formed between the first and second plates 982, 984 of the condenser plate 180. For example, the aperture 994 is illustrated as formed in the first plate 982 and the pin 992 is formed in the second plate 984; however, the aperture 994 may be formed in the second plate 984 and the pin 992 may be formed in the first plate 982. Alternatively the pin 992 may be separate from the first and second plates 982, 984 and both the first and second plates 982, 984 may include an aperture 994 formed therein to receive the pin 992 and align the first and second plates 982, 984. The first and second plate 982, 984 are then held together using fasteners 996, such as screws or clips.

[0045] The present disclosure has been described using non-limiting detailed descriptions of examples thereof and is not intended to limit the scope of the present disclosure. It should be understood that features and/or operations described with respect to one example may be used with other examples and that not all examples of the present disclosure have all of the features and/or operations illustrated in a particular figure or described with respect to one of the examples. Variations of examples described will occur to persons of the art. Furthermore, the terms "comprise," "include," "have" and their conjugates, shall mean, when used in the present disclosure and/or claims, "including but not necessarily limited to."

[0046] It is noted that some of the above described examples may include structure, acts or details of structures and acts that may not be essential to the present disclosure and are intended to be exemplary. Structure and acts described herein are replaceable by equivalents, which perform the same function, even if the structure or acts are different, as known in the art. Therefore, the scope of the present disclosure is limited only by the elements and limitations as used in the claims.
CLAIMS

WHAT ISCLAIMED IS:

1. A heat removal assembly comprising:
   an evaporator block to remove heat from an electronic component,
   the evaporator block to engage with the electronic component and
   form a thermal connection therebetween that removes heat from
   the electronic component;
   a heat pipe connects to the evaporator block to remove heat from
   the evaporator block;
   a condenser plate connects to the heat pipe to receive heat from
   the heat pipe, the condenser plate including a thermal mating
   surface that mates with a thermal member, such that the heat is
   removed from the assembly via the thermal mating surface.

2. The assembly of claim 1, wherein the thermal mating surface lies flush
   with a receiving surface of the thermal member.

3. The assembly of claim 1, wherein the evaporator block further comprises
   an evaporator thermal surface that lies flush with a portion of the electronic
   component to remove heat therefrom.

4. The assembly of claim 1, wherein the condenser plate comprises a first
   plate and a second plate, the first plate including a first thermal mating surface
   and the second plate including a second thermal mating surface, the first plate
   and the second plate aligned such that the first thermal mating surface and the
   second thermal mating surface mate with the thermal member.

5. The assembly of claim 4, further comprising an alignment member
   formed in the condenser plate to align the first plate and the second plate such
that the first thermal mating surface and the second thermal mating surface mate with the thermal member.

6. The assembly of claim 1, wherein the heat pipe includes a first portion, a second portion, and a bellow therebetween, the first portion connects to the condenser plate, the bellow enables the second portion of the heat pipe to pivot with reference to the first portion of the heat pipe.

7. The assembly of claim 1, wherein the heat pipe pivotally connects to the condenser plate, the heat pipe and the condenser plate provides a thermal connection that transfers the heat from the heat pipe to the condenser plate.

8. A system to remove heat comprising:

   an electronic component; and

   a heat removal assembly including:

   an evaporator block to remove heat from the electronic component, the evaporator block to engage with the electronic component and form a thermal connection therebetween that removes heat from the electronic component;

   a heat pipe connects to the evaporator block to remove heat from the evaporator block; and

   a condenser plate connects to the heat pipe to receive heat from the heat pipe, the condenser plate including a thermal mating surface that aligns with a thermal member, such that the heat is removed from the assembly via the thermal mating surface.
9. The system of claim 8, wherein:
   the thermal mating surface lies flush with a receiving surface of
   the thermal member; and
   the evaporator block further comprises an evaporator thermal
   surface that lies flush with a portion of the electronic component to
   remove heat therefrom.

10. The system of claim 8, wherein the condenser plate comprises a first
    plate and a second plate, the first plate including a first thermal mating surface
    and the second plate including a second thermal mating surface, the first plate
    and the second plate aligned such that the first thermal mating surface and the
    second thermal mating surface aligns with the thermal member.

11. The system of claim 10, further comprising an alignment member formed
    between the first and second portion of the condenser plate to align the first
    plate and the second plate of the condenser plate, such that
    the first thermal mating surface and the second thermal mating
    surface align with the thermal member, and
    the first thermal mating surface and the second thermal mating
    surface provide a thermal connection that transfers the heat from
    the heat pipe to the condenser plate.

12. The system of claim 11, wherein the alignment member comprises a pin
    that fits into an aperture formed between the first plate and the second plate of
    the condenser plate.

13. The system of claim 8, wherein
    the heat pipe comprises a first heat pipe and a second heat pipe; and
the evaporator block comprises a first and second evaporator block,

the first heat pipe connects to the first evaporator block and
the second heat pipe connects to the second evaporator block,

the second heat pipe including a first portion, a second portion, and a bellow therebetween, the first portion of the second heat pipe connects to the condenser plate, the bellow enables the second portion of the second heat pipe to pivot with reference to the first portion of the second heat pipe and maintain a thermal connection therebetween.

14. The system of claim 8, wherein

the heat pipe comprises a first heat pipe and a second heat pipe; and

the evaporator block comprises a first and second evaporator block,

the first heat pipe connects to the first evaporator block and
the second heat pipe connects to the second evaporator block,

the second heat pipe hingedly connects to the condenser plate such that the second heat pipe:

- rotates the second evaporator block into and out of alignment with the electronic component, and
- provides a thermal connection between the second heat pipe and the condenser plate.
15. A heat removal assembly comprising:

- a first evaporator block to remove heat from a first surface of an electronic component, the first evaporator block to engage with the first surface of the electronic component and form a first thermal connection therebetween that removes heat from the electronic component;

- a first heat pipe connects to the first evaporator block to remove heat therefrom;

- a second evaporator block to remove heat from a second surface of the electronic component, the second evaporator block to engage with the electronic component and form a second thermal connection therebetween that removes heat from the electronic component;

- a second heat pipe connects to the second evaporator block to remove heat therefrom; and

- a condenser plate connects to the first heat pipe and the second heat pipe to receive heat therefrom, the condenser plate including a thermal mating surface that mates with a thermal member, such that the heat is removed from the assembly via the thermal mating surface.
HEAT REMOVAL ASSEMBLY

EVAPORATOR BLOCK

HEAT PIPE

CONDENSER PLATE

Fig. 3
FIG. 5

HEAT REMOVAL ASSEMBLY

EVAPORATOR BLOCK

HEAT PIPE

CONDENSER PLATE

Fig. 6
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
H05K 7/20(2006.01)i, H01L 23/34(2006.01)i, F28D 15/02(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)
H05K 7/20; F28D 015/00; F28D 15/00; F28F 13/12; H01L 23/34; F28D 15/02

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: evaporate, heat pipe, condenser, electronic component, heat removal, thermal member, cool, heat exchange

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>A</td>
<td>US 6209626 B1 (BHATIA, RAKESH) 03 April 2001 See abstract, columns 2-6 and figures 2-6.</td>
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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
"I" 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: 25 September 2013 (25.09.2013)

Date of mailing of the international search report: 25 September 2013 (25.09.2013)

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer: KIM Sung Gon
Telephone No. +82-42-481-8746

Form PCT/ISA/210 (second sheet) (July 2009)
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