A brazed channel plate includes a plurality of brazing sheets stacked on top of one another and bonded to each other with a channel formed therebetween, in which occurrence of clogging of the channel due to molten brazing material is suppressed. At least one of the outermost brazing sheets in the stacking direction has a brazing material escape aperture extending to a bonding surface facing the channel space.
BRAZED CHANNEL PLATE

CLAIM OF PRIORITY


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention
[0003] The present invention relates to a brazed channel plate used for a radiator, for example, for cooling a fluid flowing therethrough.
[0004] 2. Description of the Related Art
[0005] A cooling system for a central processing unit (CPU), which radiates heat (heat source), for example, basically consists of a cooling jacket mounted on the CPU to absorb heat, a radiator, and a fluid pump for circulating a coolant through the cooling jacket and the radiator. These components are designed to achieve a compact size and high reliability so that they can be mounted in a small machine such as a notebook personal computer.
[0006] Typically, a radiator includes a brazed channel plate made by bonding at least two brazing sheets, each consisting of a sheet core made of metal and a brazing material deposited on at least one of the top and bottom surfaces of the sheet core. The brazing sheets are stacked with a channel formed theretwixt and heated. This melts the brazing material, whereby the brazing sheets become bonded. Japanese Unexamined Patent Application Nos. 11-87584, 2005-283093, and 2005-166030, disclose bonding structures and methods of bonding of brazed channel plates consisting of brazing sheets.
[0007] Such a brazed channel plate, however, has a problem in that molten excess brazing material may clog a channel formed therebetween.
[0008] A radiator developed by the applicant needs to be extremely thin and small. The sectional area of each channel is as small as about 2 mm². Therefore, even a small amount of brazing material flowing through one of the channels may clog the channel.

SUMMARY

[0009] A brazed channel plate includes a plurality of brazing sheets stacked on top of one another and bonded to each other. Each of the plurality of brazing sheets includes a sheet core made of metal and a brazing material deposited on at least one of the top and bottom surfaces of the sheet core. The plurality of brazing sheets provide a channel therebetween. At least one of a pair of outermost brazing sheets in a stacking direction has a brazing material escape aperture penetrating part of the brazing sheet adjacent to part of the brazing sheet having a bonding surface facing the channel.
[0010] In one embodiment, the plurality of brazing sheets may include a middle sheet having a channel forming penetrating aperture, a top sheet, and a bottom sheet. The top and bottom sheets seal the channel forming penetrating aperture in the middle sheet, and have brazing material escape apertures penetrating bonding surfaces at positions not occupied by the channel forming penetrating aperture.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a plan view (back view) of a brazed channel plate according to one embodiment, in which the brazed channel plate is applied to a fluid cooling system of a notebook personal computer;
[0012] FIG. 2 is a front view of the brazed channel plate shown in FIG. 1;
[0013] FIG. 3 is a side view of the brazed channel plate shown in FIG. 1;
[0014] FIG. 4 is a plan view of four brazing sheets constituting the brazed channel plate applied to the fluid cooling system shown in FIG. 1;
[0015] FIG. 5 is a sectional view of the brazed channel plate shown in FIG. 1, taken along line I-IV;
[0016] FIG. 6 is a schematic sectional view of one of the brazing sheets;
[0017] FIG. 7 is a sectional view similar to FIG. 5, showing the brazed channel plate according to another embodiment;
[0018] FIG. 8 is a sectional view similar to FIGS. 5 and 6, showing a brazed channel plate according to another embodiment;
[0019] FIG. 9 is a plan view of a piezoelectric pump mounted on the fluid cooling system shown in FIG. 1;
[0020] FIG. 10 is a sectional view of the piezoelectric pump shown in FIG. 9, taken along line X-X;
[0021] FIG. 11 is a perspective view of a radiator;
[0022] FIG. 12 is a sectional view of the radiator shown in FIG. 11, taken along line XII-XII;
[0023] FIG. 13 is a sectional view of the radiator shown in FIG. 11, taken along line XIII-XIII; and
[0024] FIG. 14 is a plan view of a channel plate constituting a channel unit of the radiator.

DESCRIPTION OF THE EMBODIMENTS

[0025] FIGS. 1 to 3 show an embodiment in which a brazed channel plate is applied to a channel sheet (heat radiation sheet) 10 of a fluid cooling system for cooling a CPU 101 and a graphics processing unit (GPU) 102 of a notebook personal computer. The CPU 101, the GPU 102, a piezoelectric pump 20, a radiator 40, and a reserve tank 50 are mounted on one of the top and bottom surfaces of the channel sheet 10. The CPU 101 and the GPU 102 are mounted on the channel sheet 10 with cooling jackets 101a and 102a provided therebetweeen, respectively.

[0026] The channel sheet 10 includes a channel 11. The way in which the channel 11 extends from the piezoelectric pump 20 will now be described. The channel 11 includes five portions, namely, channels 11a, 11b, 11c, 11d, and 11e. The channel 11a extends from a discharge port 34 of the piezoelectric pump 20 to an inlet hole 51 in the reserve tank 50. The channel 11b extends from an outlet hole 52 in the reserve tank 50, along the periphery of the channel sheet 10, to an inlet hole 102c in a channel 102b of the cooling jacket 102a for the CPU 101. The channel 11c extends from an outlet hole 102d in the channel 102b to an inlet hole 101c in a channel 101b of the cooling jacket 101a for the CPU 101. The channel 11d extends from an outlet hole 101d in the channel 101b to an inlet hole 47 in the radiator 40. A channel in the radiator 40 connects the inlet hole 47 to an outlet hole 48, from where the channel lies extends to an intake port 35 of the piezoelectric
A cooling fan (sirrocco fan) 60 (shown in FIG. 1) is provided on a side of the radiator 40. A channel sheet such as the channel sheet 10 is usually installed in the keyboard of a notebook personal computer in such a manner that the piezoelectric pump 20, the radiator 40, the reserve tank 50, the cooling jacket 10a (for the CPU 101), and the cooling jacket 10b (for the GPU 102) face downward. However, for convenience of illustration, some figures are illustrated upside down.

In the above-described fluid cooling system, a fluid discharged from the piezoelectric pump 20 passes through the cooling jacket 10a for the CPU 101 and the cooling jacket 10b for the GPU 102 while absorbing heat. This raises the temperature of the fluid. The heated fluid is then cooled by the cooling air sent from the sirrocco fan 60 while passing through the radiator 40, and flows back to the piezoelectric pump 20. The fluid continuously circulates in this way. The heat of the fluid is also partially released through the channel sheet 10 while the fluid is flowing in the channel 11. This makes the heat distribution of the entire cooling system uniform.

FIGS. 4 to 6 show a more specific embodiment of the channel sheet 10 used in the above-described fluid cooling system. The channel sheet 10 according to the embodiment includes four brazing sheets 12A, 12B, 12C, and 12D having the same thickness (for example, 0.4 mm) that are stacked on top of one another and bonded to each other. Known brazing sheets may be used as the brazing sheets 12A to 12D. As schematically shown in FIG. 6, each of the brazing sheets 12A to 12D includes a sheet core s made of a metal (typically, aluminum alloy) and a brazing material r deposited on both the top and bottom surfaces of the sheet core s. The brazing sheets 12A to 12D may be provided with a penetrating aperture of any shape by presswork, and may be bonded together by bringing them together and heating them under pressure, which melts the brazing material r. A typical brazing sheet has a thickness of about 0.2 mm to 0.5 mm. However, the present invention is not limited to this type of brazing sheet.

Referring to FIG. 4, the middle two brazing sheets 12B and 12C have the same shape, each including channel forming apertures 13 constituting the channels 11a to 11e and brazing material escape apertures 14 provided (bored) at positions not occupied by the channel forming apertures 13. In FIG. 4, the channel forming apertures 13 are indicated by hatching. The brazing material escape apertures 14, each having an elongated shape, are provided intermittently along the channel forming apertures 13. Some of the channel forming apertures 13 extend straight and parallel to each other. The brazing material escape apertures 14 are provided between adjoining channel forming apertures 13 so as to be parallel to them.

The top and bottom brazing sheets 12A and 12D (the outermost brazing sheets in the stacking direction) do not have apertures at positions facing the channel forming apertures 13 in the middle brazing sheets 12B and 12C. The brazing sheets 12A and 12D, when stacked on and bonded to the brazing sheets 12B and 12C, respectively, seal the channel forming apertures 13 from the top and bottom, thereby forming the channels 11a to 11e. The brazing sheets 12A and 12D have brazing material escape apertures 15 provided (bored) at positions corresponding to the brazing material escape apertures 14 in the brazing sheets 12B and 12C. Each of the brazing material escape apertures 15 penetrates part of the brazing sheet adjacent to the part of the brazing sheet having the bonding surface facing the channels (space) 11a to 11e. In other words, the bonding surfaces between the brazing sheets 12A and 12B, the bonding surfaces between the brazing sheets 12B and 12C, and the bonding surfaces between the brazing sheets 12C and 12D face the channels (space) 11a to 11e. Each of the brazing material escape apertures 14 and 15 penetrates part of the brazing sheet adjacent to the part of the brazing sheet having the bonding surface.

As shown in FIG. 4, the brazing sheet 12D (the surface of the channel sheet 10, on which the CPU 101, the GPU 102, the piezoelectric pump 20, the radiator 40, and the reserve tank 50 are mounted) has channel apertures 35' and 34' communicating with the discharge port 34 and the intake port 35 of the piezoelectric pump 20, respectively; channel apertures 51' and 52' communicating with the inlet hole 51 and the outlet hole 52 in the reserve tank 50, respectively; channel apertures 102'a and 102'b communicating with the inlet hole 102c and the outlet hole 102d in the cooling jacket 102a, respectively; channel apertures 101'c and 101'd communicating with the inlet hole 101c and the outlet hole 101d in the cooling jacket 101a, respectively; and channel apertures 47' and 48' communicating with the inlet hole 47 and the outlet hole 48 of the radiator 40, respectively. These channel apertures communicate with the channel 11 (channel forming apertures 13).

When these brazing sheets 12A to 12D are aligned and bonded together, the channel forming apertures 13 in the (middle) brazing sheets 12B and 12C are sealed by the (top and bottom) brazing sheets 12A and 12D, thereby forming the channel 11 (channels 11a to 11e). At this time, part of the brazing material r that will flow into the channels 11a to 11e escapes to the outside through the brazing material escape apertures 14 and 15. Accordingly, occurrence of clogging of the channel due to the brazing material may be suppressed. Further, because these brazing material escape apertures 14 and 15 are exposed to the outside air, the surface area of the channel sheet 10 exposed to the outside air is increased. Therefore, the heat release effect of the channel sheet 10 may be increased.

In the above-described embodiment, the middle brazing sheets 12B and 12C have the brazing material escape apertures 14, which communicate with the brazing material escape apertures 15 in the top and bottom brazing sheets 12A and 12D. In this case, the brazing material escape apertures 15 penetrating the channel sheet 10 effectively discharge any excess brazing material r. However, even if the middle brazing sheets 12B and 12C do not have the brazing material escape apertures 14, that is, only the top and bottom brazing sheets 12A and 12D have the brazing material escape apertures 15, discharge of the brazing material r is possible to some extent.

The above-described embodiment is advantageous in that, using the brazing sheets 12A to 12D having the same thickness, a desired sectional area of the channels can be obtained (designed) by increasing or decreasing the number of the middle brazing sheets 12B and 12C. Needless to say, use of a single middle brazing sheet 12B' as shown in FIG. 7 is also possible. In FIG. 7, components the same as those in FIG. 6 are denoted by like numerals. In this embodiment, the thickness of the middle brazing sheet 12B' may be changed in accordance with the desired sectional area of the channels.

FIG. 8 shows still another embodiment, in which a pair of brazing sheets (the top and bottom sheets) 12E and 12F form the channel sheet 10. The brazing sheet 12E has a...
channel recess 16 serving as the channels 11a to 11e. One of the brazing sheets 12E and 12F or both of the brazing sheets 12E and 12F have the brazing material escape apertures 15 extending to extension planes of bonding surfaces facing the channels 11a to 11e, the former and latter cases being illustrated on the right and left sides of the channel recess 16 in FIG. 8, respectively. In the case where both the brazing sheets 12E and 12F have the brazing material escape apertures 15, the brazing material escape apertures 15 may be either aligned (as shown on the left side in FIG. 8) or non-aligned. By at least partially aligning the brazing material escape apertures 15, the brazing material r can be more easily discharged to the outside.

[0037] In the present invention, the configuration of the piezoelectric pump 20 and the radiator 40 is not particularly limit. The configurations of the piezoelectric pump 20 and the radiator 40 according to the present embodiment, which are shown in FIGS. 9 and 10, will be described. The piezoelectric pump 20 has a lower housing 21 and an upper housing 22 as shown in FIGS. 9 and 10.

[0038] The lower housing 21 has the discharge port 34 and the intake port 35 provided parallel to each other and extending in the direction perpendicular to the thickness of the lower housing 21. The discharge port 34 and the intake port 35 are connected to the channel apertures 34 and 35 in the channel sheet 10 in a fluid tight manner with any fluid tight parts. A piezoelectric diaphragm 28 is tightly supported between the lower housing 21 and the upper housing 22 in a fluid tight manner with an o-ring 29. The piezoelectric diaphragm 28 and the lower housing 21 form a pump chamber 21 therebetween. The piezoelectric diaphragm 28 and the upper housing 22 form an air chamber A therebetween.

[0039] The piezoelectric diaphragm 28 is of a unimorph type having a main shim 28a and a piezoelectric element 28b, which is formed by lamination and is deposited on one of the top and bottom surfaces of the shim 28a (the top surface in FIG. 10). The shim 28a faces the pump chamber 21 and contacts the fluid. The shim 28a is made of a conductive sheet metal, such as a stainless steel sheet or a 42 alloy sheet having a thickness of about 30 to 300 μm. The piezoelectric element 28b is composed of PZT (Pb(Zr, Ti)O3) having a thickness of about 300 μm, for example, and is polarized in the top surface and bottom surface directions. Piezoelectric diaphragms of this type are well known.

[0040] Check valves (umbrella check valves) 32 and 33 are fitted to the intake port 35 and the discharge port 34 of the lower housing 21, respectively. The check valve 32 is an intake check valve, which allows a fluid to flow from the intake port 35 to the pump chamber P and does not allow a fluid to flow in the opposite direction. The check valve 33 is a discharge check valve, which allows a fluid to flow from the pump chamber P to the discharge port 34 and does not allow a fluid to flow in the opposite direction.

[0041] The check valves 32 and 33 have the same shape, including perforated plates 32a and 33a fixedly attached to the channel, and umbrellas 32b and 33b made of an elastic material and attached to the perforated plate 32a and 33a, respectively. Check valves of this type (umbrella check valve) are well known.

[0042] In the piezoelectric diaphragm 28, when the piezoelectric diaphragm 28 is elastically deformed (vibrated) in vertical directions in the direction of the diameter, the intake check valve 32 opens and the discharge check valve 33 closes as the free volume of the pump chamber P increases. This introduces the fluid into the pump chamber P through the intake port 35 (the channel aperture 35 of the channel sheet 10). On the other hand, the discharge check valve 33 opens and the intake check valve 32 closes as the free volume of the pump chamber P decreases. This discharges the fluid from the pump chamber P through the discharge port 34 (the channel aperture 34 of the channel sheet 10). Accordingly, a pumping action is produced by elastically deforming (vibrating) the piezoelectric diaphragm 28 in vertical directions in the direction of the diameter continuously, whereby the fluid circulates in the channels 11a to 11e.

[0043] Referring to FIGS. 11 to 14, the radiator 40 includes a plurality of stacked channel units 41. All the channel units 41 have the same shape, except for the uppermost channel unit 41.

[0044] Each of the channel units 41 includes a pair of channel plates 42U and 42L to be joined together. The channel plates 42U and 42L are made of, for example, press-formed metal members (brazing sheets) having high heat conductivity. The channel plates 42U and 42L have the same shape and are arranged in symmetrical to each other with respect to the planes to be joined (stacking surfaces). FIG. 14 shows the shape of the channel plate 42U (42L) has an elongated shape, having a flat bonding surface 45 arranged around a flat U-shaped channel recess 46. The U-shaped channel recess 46 has spacer portions 47S and 48S at both ends (ends opposite the curved portion of the U-shape), which outwardly project from the U-shaped channel recess 46. The spacer portions 47S and 48S have an inlet hole 47 and an outlet hole 48, respectively.

[0045] The channel plates 42U and 42L are assembled such that the channel recesses 46 face each other, and bonded together by brazing, for example, at the bonding surfaces 45. The U-shaped channel recesses 46 projecting upwardly and downwardly form a flat U-shaped channel 11X. Further, the spacer portions 47S and 48S of the stacked channel units 41 are joined, whereby communication between the inlet holes 47 in the upper and lower channel units 41 is established, and communication between the outlet holes 48 in the upper and lower channel units 41 is established. Cooling air passage spaces 5 (shown in FIG. 13) are formed between the stacked channel units 41, and the cooling air sent from the sirocco fan 60 flows through the spaces 5. The spacer portions 47S and 48S of the upper channel plate 42U of the uppermost channel unit 41 do not have the inlet hole 47 and outlet hole 48, respectively. The inlet hole 47 and the outlet hole 48 in the lowermost channel unit 41 communicate with the channel apertures 47 and 48 in the brazing sheet 12D (channel sheet 10), respectively, in a fluid tight manner. It is to be noted that the channel units 41 may be provided with a brazing material escape aperture of the present invention.

What is claimed is:

1. A brazed channel plate comprising:
   a plurality of brazing sheets stacked on top of one another and bonded to each other, each of the plurality of brazing sheets including a sheet core made of metal and a brazing material deposited on at least one of top and bottom surfaces of the sheet core, the plurality of brazing sheets providing a channel therebetween, at least one of a pair
of outermost brazing sheets in a stacking direction having a brazing material escape aperture penetrating part of the brazing sheet adjacent to part of the brazing sheet having a bonding surface facing the channel.

2. The brazed channel plate according to claim 1, wherein the plurality of brazing sheets comprise:
   a middle sheet having a channel forming penetrating aperture;
   a top sheet; and
   a bottom sheet,
   wherein the top and bottom sheets seal the channel forming penetrating aperture in the middle sheet, and have brazing material escape apertures penetrating bonding surfaces at positions not occupied by the channel forming penetrating aperture.

3. The brazed channel plate according to claim 2, wherein the middle sheet further has a brazing material escape aperture communicating with the brazing material escape apertures in the top and bottom sheets.

4. The brazed channel plate according to claim 2, wherein the middle sheet is provided in a plurality, the middle sheets having the same shape and being stacked on top of one another, and wherein the number of each of the top sheet and the bottom sheet is one.

5. The brazed channel plate according to claim 1, wherein the plurality of brazing sheets comprise:
   a pair of a top brazing sheet and a bottom brazing sheet,
   at least one of the pair of top and bottom brazing sheets having a channel recess, and at least one of the pair of top and bottom brazing sheets having a brazing material escape aperture at a position not occupied by the channel recess.

6. The brazed channel plate according to claim 5, wherein the top and bottom brazing sheets have the brazing material escape apertures at least partially aligned with each other.

7. The brazed channel plate according to claim 1, wherein the brazing material escape aperture has an elongated shape extending along the channel.

8. The brazed channel plate according to claim 1, wherein the brazing material escape aperture is provided in a plurality intermittently along the channel.

9. The brazed channel plate according to claim 7, wherein the channel has a plurality of straight portions parallel to each other, and wherein the brazing material escape aperture is provided between adjoining straight portions so as to be parallel to the straight portions.

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