A Heat Sink

THIS INVENTION relates to a heat sink and more particularly to a heat sink for cooling a heat source such as electronic components mounted on a printed circuit board.

The trend in the development of electronic devices is for heat generating components to be assembled in high packaging densities on printed circuit boards (PCBs). Therefore, the heat to be dissipated at both component and PCB levels has increased tremendously and conventional free or forced air convection cooling techniques have reached their maximum cooling capacity. Since the external surfaces of heat generating components mounted on a PCB are not always in the same plane, cooling all the components on a PCB by a single solid heat sink, such as a heat pipe, is very difficult.

Heat sinks with flexible surfaces have been proposed. The main objective for such heat sinks is to cool individual electronic components. Heat sinks incorporating flexible containers for cooling multiple electronic components have also been proposed. However, the cooling capacities of such designs are limited since no effective method has been proposed for dissipating the heat absorbed by a liquid inside the flexible container.

It is an object of the present invention to provide an improved method for cooling heat generating electronic components mounted on PCBs.

Accordingly, the present invention provides a heat sink comprising: a body having an envelope including a flexible portion for thermal contact with a heat source, the envelope being filled with a thermally conductive liquid; and a thermosyphon having one end disposed at least

partly within the liquid in the body to absorb heat from the heat source and another end disposed outside the envelope to dissipate heat.

In order that the present invention may be more readily understood, embodiments thereof will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a heat sink embodying the present invention, a cut-away portion illustrating the interior of a section of the heat sink;

Figure 2 is a schematic side view, partially in cross-section of the heat sink of Figure 1, two PCBs being shown in phantom either side of the heat sink;

Figure 3 is a schematic side view of another heat sink embodying the present invention, a single PCB being shown in phantom on one side of the heat sink;

Figure 4 is a schematic side view of a further heat sink embodying the present invention for use in cooling two PCBs; and

Figure 5 is a schematic side view of another heat sink embodying the present invention for use in cooling a single PCB.

Referring to the figures, a heat sink 1 embodying the present invention has a body 2 for engagement with heat generating components on at least one printed circuit board, a series of thermosyphons, or heat pipes, 3 and an array of cooling fins 4 mounted on the thermosyphons 3.

Referring to Figures 1 and 2, the body 2 comprises a substantially rectangular frame 5 made up of side walls 6, 7, a top wall 8 and a base 9. Two flexible membranes 10, 11 are attached to the frame 5 to create a volume within the body 2 which is enclosed by the side walls 6, 7, the top wall 8, the base 9 and the flexible membranes 10, 11. The flexible membranes 10, 11 are made from a flexible material having high thermal conductivity such as, for example, laminated aluminium foil or a 3M proprietary multi-layer film as used in 3M's liquid heat sink.

The top wall 8, is formed with a series of equi-spaced holes along its length each of which receives in friction fit and sealing engagement a thermosyphon 3. The end of the thermosyphon 3, inside the body 2, is known as the evaporator portion 12. The opposite end of the thermosyphon 3, which is located outside of the body 2 is known as the condenser portion 13. Each thermosyphon 3 is filled with a working fluid such as water.

The top wall 8 of the frame 5, is also provided with a pair of valves 14, 15, which are used to charge and pressurise a thermally conductive and electrically non-conductive liquid which can be introduced into the body 2. Preferably, the liquid in the body is 3M's Fluorinert (Trade Mark) liquid.

One of the valves 14 is used to bleed air or the like from the body 2 as the body 2 is being filled with liquid through the other of the valves 15. The condenser portions 14 of the thermosyphons 3 support the array of cooling fins 4. Each fin 4 comprises a rectangular plate manufactured from a thermally conductive material such as copper. The fins 4 are spaced apart from one another to

maximise the surface area which they present to promote efficient cooling.

In operation, the body 2 of a heat sink 1 embodying the present invention is sandwiched between two PCBs upon which are arranged an array of heat generating components requiring cooling. As shown in Figure 2, the components on the PCBs face inwardly towards the body 2 of the heat sink 1.

The volume inside the body 2 is filled through one of the valves 14, 15 with the thermally conductive liquid. When filled, the liquid in the body 2 is then pressurised through one of the valves 14, 15 so that the flexible membranes 10, 11 expand to make good thermally conductive contact with the irregular surfaces presented by the electronic components on both the PCBs. In this manner, the maximum surface area of the electronic components on the PCBs is in contact with the surfaces of the thermally conductive membranes 10, 11 even though the components on the PCB are not necessarily all in the same plane. Preferably, the flexible membranes 10, 11 are coated with a thermally conductive gel to enhance the thermal conductivity between the components and the membranes 10, 11.

As the PCB components heat up, heat is conducted through the membranes 10, 11 to the liquid inside the body 2 which absorbs this heat and transmits the heat to the evaporator portions 12 of the thermosyphons 3. In forced convection embodiments of the invention, as shown in Figures 1 to 3 and in free convention embodiments of the invention as shown in Figures 4 and 5, as the evaporator portions of the thermosyphons 3 heat up, evaporation of the working fluid inside the thermosyphons 3 is caused, causing

the vapour to move up the thermosyphons 3 towards the condenser portions 13. As the vapour reaches the condenser portions 13 of the thermosyphons 3, the heat of the working fluid is conducted to the fins 4. In both forced and free convection embodiments, the heat from the condenser portions 14 is radiated outwardly via the cooling fins 4 to the atmosphere by forced air convection or free convection.

A variation on the embodiment of the heat sink shown in Figures 1 and 2 is shown in Figure 3. In this embodiment, one of the flexible membranes 11, is removed from the body 2 and replaced by a rigid metal plate 16. This embodiment is particularly well suited to cooling the components of a single PCB, the components of the PCB being placed in contact with the remaining flexible membrane 10.

The embodiments of the heat sink shown in Figures 1, 2 and 3 are particularly well suited to cooling by forced air convection whereas the embodiments shown in Figures 4 and 5 are particularly well suited to cooling by free convection. In the embodiments shown in Figures 4 and 5, the thermosyphons 3 are bent through 85° and the fins 4 are mounted vertically, i.e. parallel with the evaporator portions 13, within the body 2 so that heat is dissipated from the fins freely. The embodiment shown in Figure 4 is particularly well suited for cooling two printed circuit boards, whereas the embodiment shown in Figure 5 is particularly well suited for cooling a single PCB, one of the flexible membranes 11 being removed and replaced by a rigid metal plate 15.

When the heat sink body 2 is to be removed from between the PCBs, the body is simply depressurised by opening one of the valves 14, 15 to bleed off air and/or liquid to allow the flexible membrane or membranes 10, 11 to collapse away from the PCB(s).

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CLAIMS

1. A heat sink comprising: a body having an envelope including a flexible portion for thermal contact with a heat source, the envelope being filled with a thermally conductive liquid; and a thermosyphon having one end disposed at least partly within the liquid in the body to absorb heat from the heat source and another end disposed outside the envelope to dissipate heat.

2. A heat sink according to Claim 1, wherein the envelope is provided with two flexible portions.

3. A heat sink according to Claim 2, wherein the two flexible portions are located on opposed sides of the envelope.

4. A heat sink according to Claim 1, wherein the flexible portion is located on one side of the envelope and a rigid plate is located on the opposed side of the envelope.

5. A heat sink according to any preceding claim, wherein the or each flexible portion is made from a thermally conductive material.

6. A heat sink according to any preceding claim, wherein the or each flexible portion comprises a flexible membrane.

7. A heat sink according to Claim 6, wherein the or each membrane is mounted on a frame.

8. A heat sink according to Claim 7, wherein the frame and membrane are electrically non-conductive.

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9. A heat sink according to any preceding claim, wherein the envelope is provided with one or more valves through which the liquid is charged or discharged into or out of the envelope and through which the envelope is pressurised or depressurised.

10. A heat sink according to any preceding claim, wherein a plurality of thermosyphons are provided.

11. A heat sink according to any preceding claim, wherein one or more cooling fins are attached to the or each thermosyphon outside the envelope.

12. A heat sink substantially as hereinbefore described with reference to and as shown in the Figures.

13. Any novel feature of combination of features disclosed therein.

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ABSTRACT

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A Heat Sink

A heat sink comprising: a body having an envelope including a flexible portion for thermal contact with a heat source, the envelope being filled with a thermally conductive liquid; and a thermosyphon having one end disposed at least partly within the liquid in the body to absorb heat from the heat source and another end disposed outside the envelope to dissipate heat.

FIGURE 1

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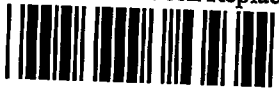

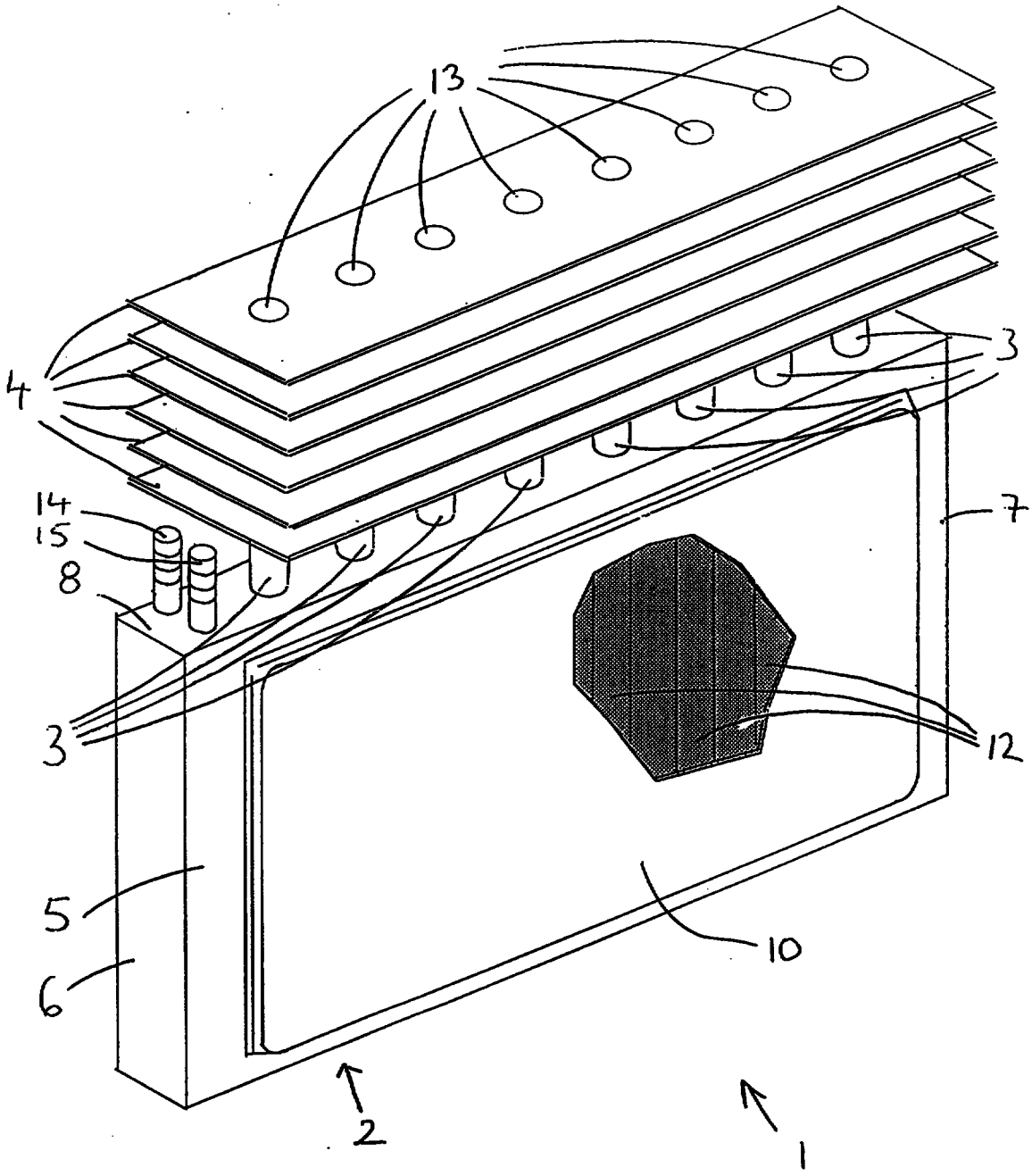

FIGURE 1

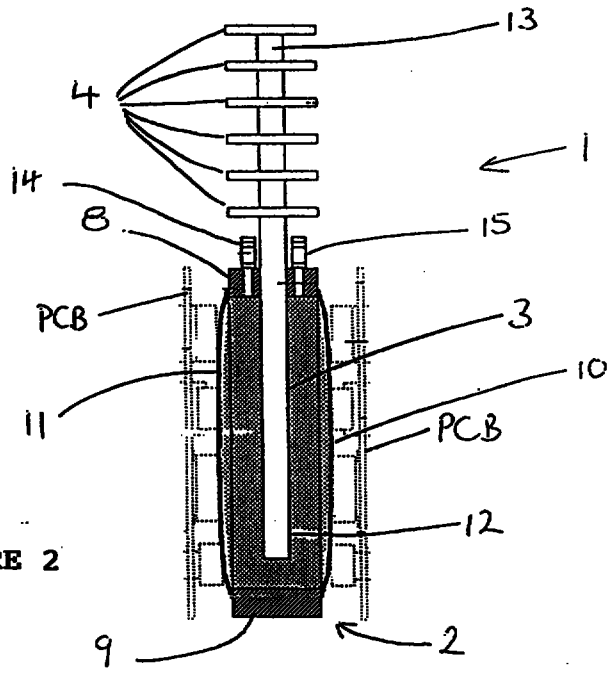

FIGURE 2

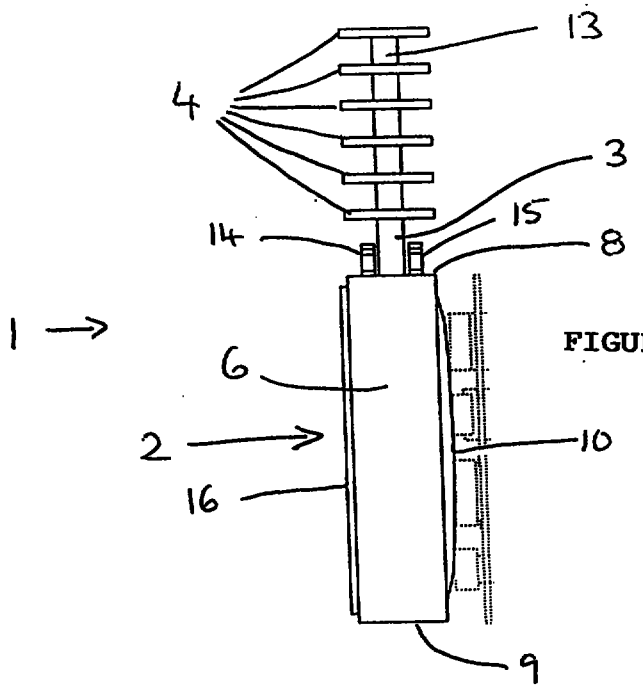

FIGURE 3

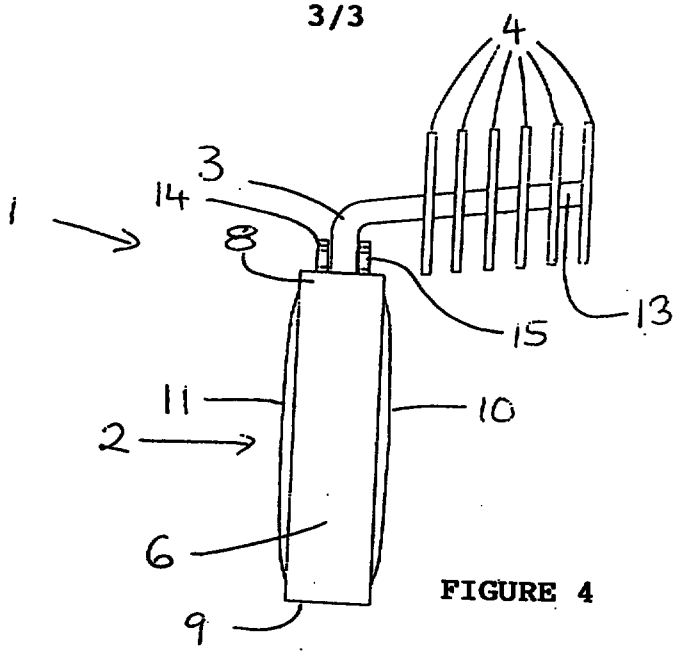

FIGURE 4

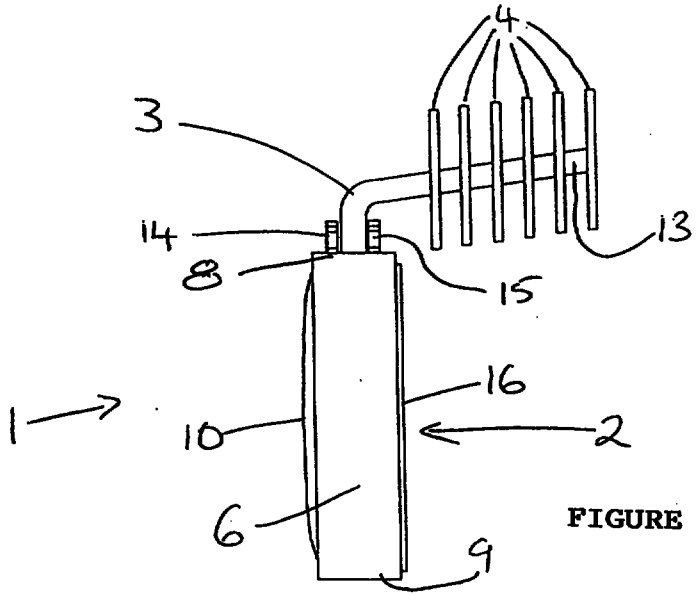

FIGURE 5

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CLAIMS

1. A heat sink comprising: a body having: an envelope including a flexible portion for thermal contact with a heat source; a rigid surface opposite the flexible portion; and an upper surface, the envelope being filled with a thermally conductive liquid; a thermosyphon having one end disposed at least partly within the liquid in the body to absorb heat from the heat source and another end disposed outside the envelope above the upper surface to dissipate heat; and one or more valves located on the body through which the liquid is charged or discharged into or out of the envelope and through which the envelope is pressurised or depressurised.

2. A heat sink according to Claim 1, wherein the flexible portion is made from a thermally conductive material.

3. A heat sink according to Claim 1 or 2, wherein the flexible portion comprises a flexible membrane.

4. A heat sink according Claim 3, wherein the flexible portion is mounted on a frame.

5. A heat sink according to Claim 4, wherein the frame and membrane are electrically non-conductive.

6. A heat sink according to any preceding claim, wherein a plurality of thermosyphons are provided.

7. A heat sink according to any preceding claim, wherein one or more cooling fins are attached to the or each thermosyphon outside the envelope.

8. A heat sink substantially as hereinbefore described with reference to and as shown in the Figures.

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CLAIMS

1. A heat sink comprising: a body having: an envelope including a flexible portion for thermal contact with a heat source; a rigid surface opposite the flexible portion; and an upper surface, the envelope being filled with a thermally conductive liquid; a thermosyphon having one end disposed at least partly within the liquid in the body to absorb heat from the heat source and another end disposed outside the envelope above the upper surface to dissipate heat; and one or more valves located on the body through which the liquid is charged or discharged into or out of the envelope and through which the envelope is pressurised or depressurised.

2. A heat sink according to Claim 1, wherein the flexible portion is made from a thermally conductive material.

3. A heat sink according to Claim 1 or 2, wherein the flexible portion comprises a flexible membrane.

4. A heat sink according Claim 3, wherein the flexible portion is mounted on a frame.

5. A heat sink according to Claim 4, wherein the frame and membrane are electrically non-conductive.

6. A heat sink according to any preceding claim, wherein a plurality of thermosyphons are provided.

7. A heat sink according to any preceding claim, wherein one or more cooling fins are attached to the or each thermosyphon outside the envelope.

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