A cooling chamber for computers and electronic components includes a conductive chamber containing a low boiling point fluid. The components are mounted in the chamber to be bathed by the fluid. The heat energy developed by the components causes the fluid to reach a temperature above the boiling point thus forming bubbles. Bubble guide tubes guide the bubbles upwardly, and fluid confined in the tubes between the bubbles is moved (pushed) upwardly. The cumulative action of the bubbles will cause circulation of the fluid in the chamber thus circulating fluid flow around the electronic components and flow around the chamber. Cooling fins mounted on the exterior of the chamber dissipate the heat generated by the components.
COMPUTER AND ELECTRONIC CABINET COOLING CHAMBER

[0001] This application claims the benefit of the earlier filing date of the provisional application Ser. No. 61/516,212, filed on Mar. 31, 2011 of the same title and of the same inventor, Troy W. Livingston.

BACKGROUND OF INVENTION

[0002] The present invention relates to a system for removing heat from generating components, and more particularly to a method and system for removing heat from electronic circuit boards and electronic chips.

[0003] As is well known in the electronics industry, that the heat created by circuit boards and electronic chips during operation is a serious problem. Heat build-up may cause a circuit board or electronic chip to malfunction and cause the entire system to also malfunction or to shut down. The problem becomes even more acute due to the fact that circuit boards have become smaller and/or more highly populated with components thus causing the source of heat to become more intense. Accordingly, the heat build-up in circuit boards and IC chips must be efficiently dissipated.

[0004] There are many existing methods of heat dissipation from electronic circuit boards, IC chips and electronic systems. These include providing layers of exotic metals, forced gas and liquid cooling, heat convection, pulsating heat pipes, coolant baths and heat transfer directly to the system housing. Liquid cooling systems mentioned above, which are generally the most effective, require a pump to move a coolant from the heat source to a remote heat sink where the heat is dissipated. These latter systems are voluminous and heavy.

[0005] There is a need for providing a method and system for a circuit board and IC chip cooling system which will enable designers and engineers to create and operate electronic systems that are smaller in size and lighter in weight. It is thus an object and purpose of the present invention to address the foregoing problem and to provide a system and method for efficiently removing heat from circuit boards and IC chips which system is itself small and of light weight.

SUMMARY OF THE INVENTION

[0006] A cooling chamber for computers and for electronic components is disclosed. The cooling chamber comprises an enclosed heat conductive chamber for containing a fluid having a selected low boiling point. The electronic components that are to be cooled are operatively mounted in the chamber to be bathed by the fluid. The heat energy developed by the electronic components causes the fluid immediately adjacent the component to reach a temperature above the boiling point, and bubbles are created. Fluid turbulence will be induced adjacent to the electronic component. Fluid will circulate, swirl and rotate in the immediate vicinity of the component. The bubbles will rise and cause the fluid to be moved as the bubble rises toward the top level of the fluid. There are of course a large number of bubbles formed and the cumulative action of the bubbles will cause circulation of the fluid in the chamber thus provide circulating fluid flow around the electronic components and around the chamber. Cooling radiators and fins are mounted on the exterior of the chamber to dissipate the heat generated by the components and conveyed by the fluid to the radiators and fins.

[0007] The foregoing features and advantages of the present invention will be apparent from the following more particular description of the invention. The accompanying drawings, listed herein below, are useful in explaining the invention.

DRAWINGS

[0008] FIG. 1 is an isometric view to show the environment in which the present invention is utilized;

[0009] FIG. 2 is an end view partially in cross section of the inventive cooling chamber;

[0010] FIG. 3 is an isometric view of the chamber of FIG. 2;

[0011] FIG. 4 is a top view of the cooling chamber;

[0012] FIG. 5 is a relatively enlarged view depicting the whiskers formed by the electro deposition of copper;

[0013] FIGS. 6A, 6B, and 6C show three means for forming sharp points to enhance the formation of methane chloride bubbles;

[0014] FIG. 7 shows a modification of the bubble guide tubes wherein the tubes are tapered;

[0015] FIG. 8 shows the mounting of the chamber at an angle relative to the horizontal; and,

[0016] FIG. 9 shows the positioning of an IC chip at an angle to enhance the production of bubbles.

DESCRIPTION OF THE INVENTION

[0017] FIG. 1 is an isometric view of printed circuit board 14, with discrete components 15 and IC chips 12, all being of well known types, to show the environment in which the present invention is utilized.

[0018] FIG. 2 depicts one embodiment of inventive system 10 comprising a fluid cooling chamber 11 for integrated circuit (IC) chips 12 and discrete components 15 mounted on an electronic circuit board indicated at 14. FIG. 3 is an isometric view of the inventive system 10 and FIG. 4 is a top view of the chamber 11 which in combination with FIG. 1 clearly show the structure of the chamber 11.

[0019] FIG. 2 is a front cut-a-way section which depicts the internal structure of the chamber 11. Chamber 11 is enclosed in a metal housing 24 and spaced metal fins 25 to provide cooling additional structure are affixed around the housing. Chamber 11 is sealedly mounted on printed circuit board (PC) 14. A number of electrical conductive pins 16 extend from chips 12 and from electronic components 15 and are affixed to PC board 14. As is known, in operation certain of the chips 12 and electronic components 15 can become undesirable very hot and adversely affect the operation of all the components on the IC chip, as well as the overall electronic system.

[0020] Cooling chamber 11 comprises an enclosed fluid container 16 having a fill port 17 (see FIG. 3) with a suitable plug. A fluid expansion space 18 is provided at the top of the container 16. In the embodiment of FIG. 1, container 16 is filled as (indicated in FIG. 2) with a fluid 19 which is methylene chloride (dichloromethane). The fluid level is indicated by the wavy line 19C. Methylene chloride is a volatile chemical and will boil at about one hundred three (104) degrees Fahrenheit. Other fluids that have a low boiling point could likewise be used, however, methylene chloride is readily available, effective and inexpensive. As will be explained further herein below, a basic principal of the invention is the concept of generating bubbles 20 in the hot fluid 19 to provide movement and turbulence to the fluid from a source of heat.
and provide a fluid flow from the heat source to heat dissipators/sinks to dissipate the heat energy.

[0021] It is known that in the electro deposition of copper whisker growth will occur and normally these phenomenon of whisker growth is an undesired result. However, refer now also to FIG. 5, in one embodiment of the present invention, copper electro deposits indicated by the line 21 are made on the PC board 14 to purposefully enhance whisker growth indicated at 22. FIG. 5 which is relatively enlarged drawing of the IC chip 12, clearly depicts the whiskers 22 and bubbles 20A formed on the whiskers. The whiskers formed on the copper electro deposits 22 provide multiple sharp points that function to provide multiple initiating points for formation of the bubbles 20A. Note that as shown in FIG. 5, a copper electro deposit 22 may be applied to both sides of the IC chip 12 to provide bubbles from both sides of the PC board 14.

[0022] Referring back to FIG. 2, as the methylene chloride fluid 19 is heated above its boiling point, bubbles 20 of methylene chloride will form and rise to the top of the fluid, as depicted in FIG. 2. As the bubbles 20 form and rise, the fluid 19 around the bubbles will be disturbed and moved about. Also as depicted in FIG. 2 the initial bubbles 20A formed adjacent the whiskers will tend to be small bubbles. As multiple bubbles 20A, continue to be formed adjacent the heat source, the bubbles will tend to coalesce (come together) and form larger bubbles 20. The bubbles 20 will rise toward the top of the container 16, fluid flow moving upward will result. As the fluid 19 is heated it will expand somewhat and fluid expansion space 18 is provided at the top of container 16.

[0023] A number of bubble guide tubes 27 are mounted in positions above the IC chip(s) 12 and components 15. The lower ends of the tubes are formed in a funnel shape 28 to provide an enlarged opening to intercept the upwardly moving bubbles 20. Thus when the IC chip components 15 become hot and heat the methylene chloride adjacent the hot component to its boiling point of 39.6 degrees C. (104 F), bubbles 20A will be produced and will coalesce into bigger bubbles 20A. As the bubbles rise up, the funnel shape 28 shape of the guide tubes will intercept and guide the bubbles 10 up the guide tube 27.

[0024] After the initially small bubbles 20A coalesce into larger bubbles 20 the resulting bubbles are approximately 4 mm in diameter. Bubbles guide tubes 27 through which the bubbles move also have an internal diameter of 4 mm. As the fluid 19 continues to boil, more bubbles 20A are formed adjacent the hot IC chips components 15 and rise up the tube 27. The hot fluid 19A above the bubbles 20A is confined in tube 27 in the spacing between the bubbles. It has been found that the bubbles 10 push (carry) the hot fluid 19A confined between the bubbles upwardly through the guide tubes 27 (as depicted by the arrow lines generally labeled 29). The rising bubbles 10 thus provide a positive pumping, pushing and driving action to move the hot fluid 19A. When the bubbles 20 are of the same diameter of the guide tubes 27, the bubbles will also tend to siphon the fluid 19A immediately beneath the bubbles upwardly as the bubbles 20A move upward.

[0025] The hot methylene chloride fluid 19A is thus pumped and moved up tubes 27 by the rising bubbles 20A, and as the hot fluid moves up the guide guide tubes, the fluid moves heat energy away from the hot IC chips and components. Thus the hot fluid 19A is moved up the tubes 27 and flows out of the tops of the tubes. Liquid 19B then returns down around the outside of the tubes 27.

[0026] The returning fluid 19B, flows down the inside surfaces of housing 24 and the cooling fins 25 affixed thereto. The metal housing 24 and cooling fins 25 function as heat sinks/heat receptors to remove heat from the fluid 19. The housing 24 is configured to have some thicker wall areas at 24A and then tapers to thinner wall at 24B. The thicker wall area will more effectively absorb the heat energy from the hot fluid 19. The bottom of wall 24B can be thinner and lighter since the liquid 19 is cooler at the bottom of the housing 24. The fins 25 are likewise configured in the same tapered manner to better absorb and dissipate the heat from the hotter fluid 19 at the top of the container 16.

[0027] Thus heat energy is absorbed from the fluid 19 and conveyed to the housing 24 and the fins 25 and other external heat dissipating structure. The cooled fluid 19 returns down to the PC board 21 and the cycle is repeated. The apparatus of FIG. 1 thus comprises a heat transfer chamber powered by a passive heat pump.

[0028] Heat receptors or radiator fins 25 are affixed to container 18 which is formed of a copper metal (or other good heat conducting metal) and as the fluid 19 flows down the sides of the container 18, the container and the radiator fins 25 will remove heat energy from the hot fluid. This action will continue as long as the temperature of the fluid is above the fluid boiling point and bubbles 20 continue to be formed.

[0029] As the fluid 19 is cooled down, and/or as the bubbles get near the top of the chamber and condense, the bubbles break up as the fluid becomes cooler and as heat is extracted from the moving fluid. The bubbles 20 may provide the pushing or driving force to move the hot fluid in a recirculating loop.

[0030] Also, the bubbles 20 developed by the hot components 15 on the circuit board or IC chip are utilized to generate turbulence and movement in the fluid 19 to cause the fluid to move about or circulate in the container 16. As the bubbles 20 move the hot fluid 19 upwardly to the top level of the fluid, the heat receptors absorb the heat energy from the fluid, thus cooling the hot fluid and causing the now cooled fluid to circulate or move back down toward the lower levels of the fluid as the heat transfer cycle repeats.

[0031] FIGS. 5A, 5B, and 5C show three modifications of the concept of providing sharp points for initiating the formation of bubbles 20A. FIG. 5A show the electro deposition of a copper layer as described above that provide whiskers 22 to provide the sharp points for the bubble formation. FIG. 6A depicts the provision of glass bristles or shavings spread on a thin layer of glue 33 to provide the sharp points for bubble formation. FIG. 5C depicts forming sharp triangular points 34 by shaping/forming the sharp points on the IC chip 12.

[0032] FIG. 8 depicts the positioning of the chamber 11 at a 45 degree angle with a horizontal axis. It has been found that the bubbles 10 will form and rise at an angle of approximately eight degrees to the horizontal, hence the chamber 11 may be mounted in a wide range of orientations. FIG. 8 shows that the bubbles 20 and the hot fluid 19 will move (flow) to the top of the container 16, and the cooler fluid will return downwardly, as previously described.

[0033] FIG. 7 shows an embodiment of the bubble guide tubes 27A wherein the tubes are tapered from a wider diameter at the lower end to a smaller diameter at the top of the tube. As stated above, the small bubbles 10A which are initially formed, coalesce to form the bigger bubbles 10. As the bubbles 10 move up the bubble guide tubes 27, they may tend to become smaller in diameter. To assure each of the bubbles
10 continues to fill the tube, the diameter of the tubes may be reduced. This enables each of the bubbles 10 and thus continue to push the fluid 19 upwardly and not let the fluid slide down past the bubble even though the bubble may have become smaller.  

[0034] FIG. 9 is a modification of the embodiment shown in FIG. 1 wherein the IC chip 12 is mounted at a slightly inclined upward angle. The purpose of this construction is to allow bubbles 10A formed on the bottom of IC chip 12 to more freely move upwardly through fluid 19. This provides enhanced cooling to both the bottom and the top of the IC chips 12.  

[0035] While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

1. A computer and electronic cooling chamber for cooling a heat source such as a hot component or other hot spot on a circuit board, said chamber comprising:
   a) an enclosed container;
   b) a fluid having a selectable boiling point contained in said container;
   c) heat sink means thermally coupled to a first section of said container;
   d) inserting at least a portion of said heat source in said fluid to provide heat energy to said fluid for generating in a second section of said container spaced fluid bubbles;
   e) mounting said container to enable said bubbles to move in said container;
   f) said bubbles creating a pressure force for moving and stirring said fluid to circulate toward said second section of said container wherein said heat sink means are positioned; and
   g) said heat sink means removing heat energy from said fluid.

2. A cooling chamber for cooling an electronic heat source comprising:
   a) an enclosed container;
   b) a fluid having a selectable boiling point contained in said container;
   c) heat sink means thermally coupled to a first section of said container;
   d) thermally coupling said heat source to provide heat energy to said fluid for generating in a second section of said container spaced fluid bubbles with hot fluid between said bubbles;
   e) mounting said container to enable said bubbles to rise up said container;
   f) said rising bubbles moving said fluid between the bubbles in the direction of the rising bubbles and toward said second section of said container wherein said heat sink means are positioned; and
   h) said heat sink means removing heat energy from said fluid.

3. A passive heat transfer pump for cooling a source of heat comprising:
   a) a closed tubular loop;
   b) a fluid having a low boiling point contained in said tubular loop and flowable through said loop;
   c) heat sink means thermally coupled to first sections of said loop;
   d) thermally coupling said heat source to provide heat energy to said fluid for generating spaced fluid bubbles in a section of said tubular loop;
   e) mounting said second section of said loop to enable said bubbles to rise up said second section of said tubular loop;
   f) conforming the dimensions of said second section and the dimensions of said bubbles section to confine hot fluid in said spaces between rising bubbles;
   g) said rising bubbles pushing and pumping said hot fluid through said second section of said loop toward said first section of said loop wherein said heat sink means are mounted; and
   h) said heat sink means removing heat energy from said hot fluid.

4. A heat dissipation assembly for circuit boards and IC chips utilizing a liquid cycling heat transfer pump comprising:
   a) a housing including heat concentrators for said assembly;
   b) fluid retaining tubes within said assembly;
   c) methylene chloride which has a low boiling point contained within said assembly;
   d) said tubes forming fluid pathways;
   e) means for mounting said housing adjacent a heat source;
   f) said methylene chloride forming bubbles when heated above said boiling point;
   g) positioning at least one of said tubes pathways to direct said bubbles to move upwardly away from said heat source;
   h) said bubbles pushing methylene chloride toward at least one heat concentrator to remove heat from said methylene chloride; and
   i) fluid return pathways for cycling said cooled methylene chloride back toward said heat source and repeating the cycle.

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