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(54) **EVAPORATIVELY COOLED THERMOSIPHON**

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(57) **ABSTRACT**

A thermosiphon cooling assembly cools an electronic device with a first refrigerant disposed in the lower boiling chamber of a housing for liquid-to-vapor transformation and a second refrigerant disposed in an upper evaporating chamber of a housing for liquid-to-vapor transformation. The partition separating the lower boiling chamber of the housing from the upper evaporating chamber of the housing creates a series of vapor chambers within the lower boiling portion for condensing vapor boiled off the first refrigerant. The upper evaporating chamber contains a series of refrigerant pockets interleaved vertically with the vapor chambers to increase the surface area for heat transfer between the refrigerant vapor and the second refrigerant for absorbing heat by the second refrigerant for liquid-to-vapor transformation.

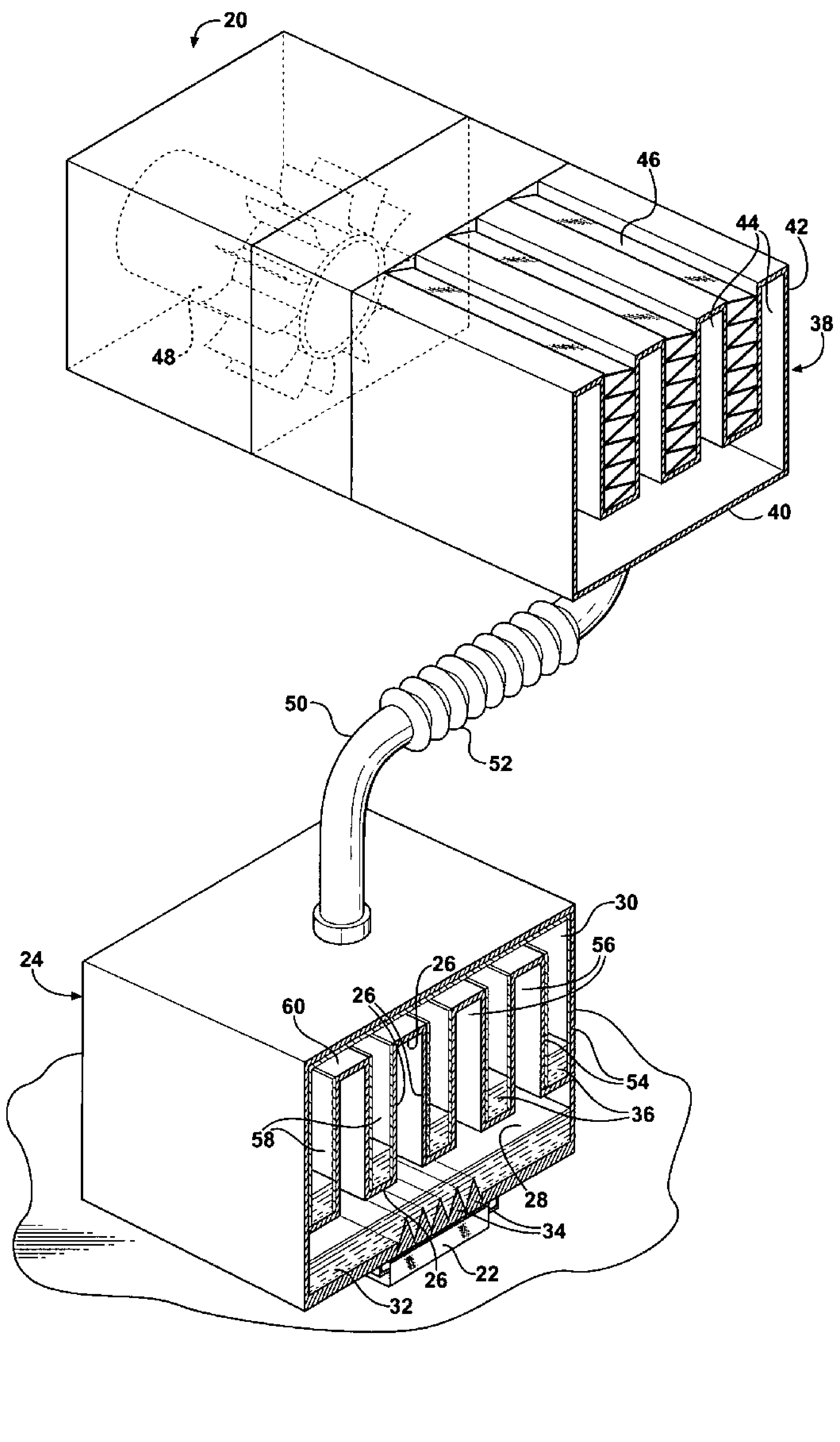


FIG - 1

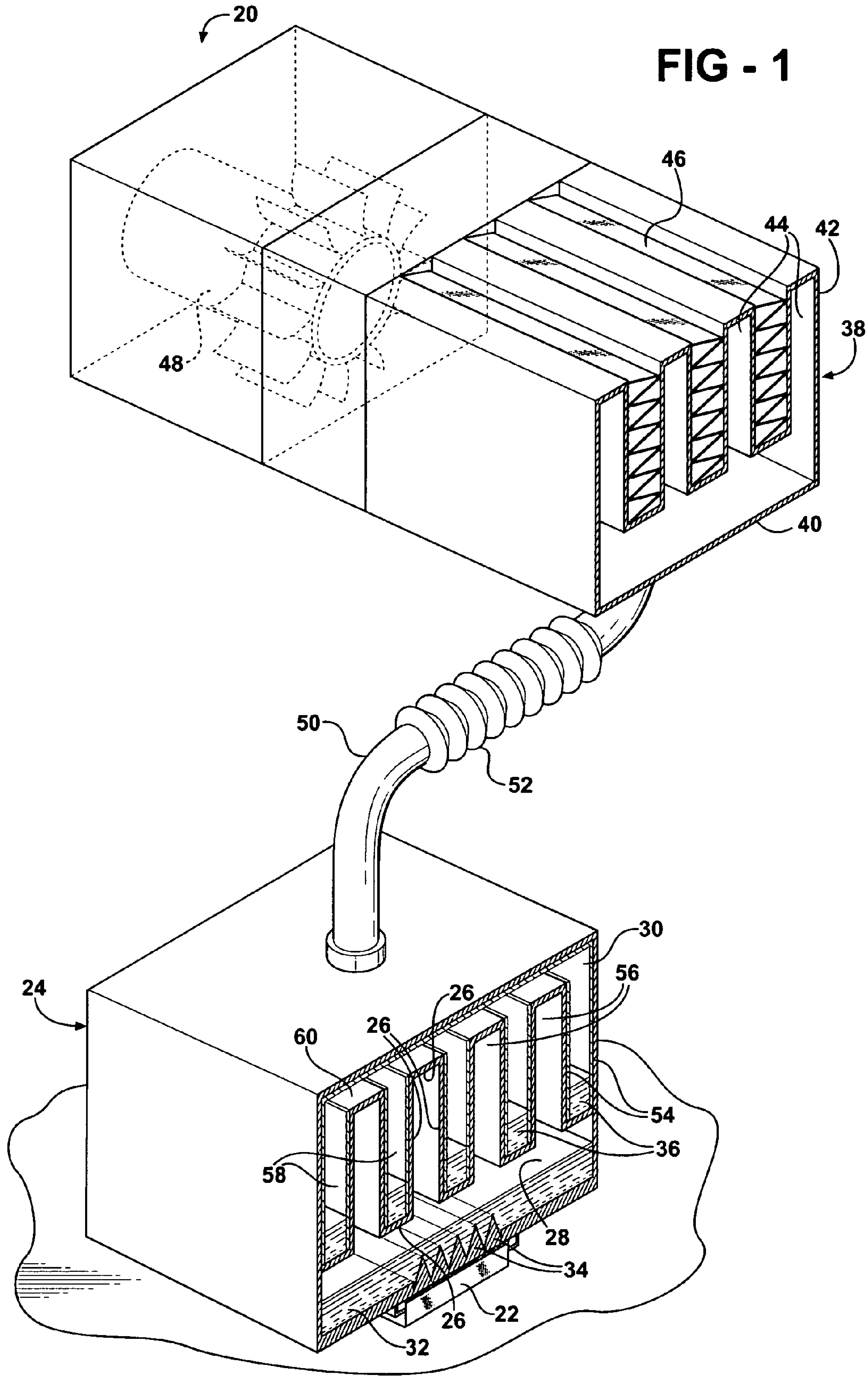
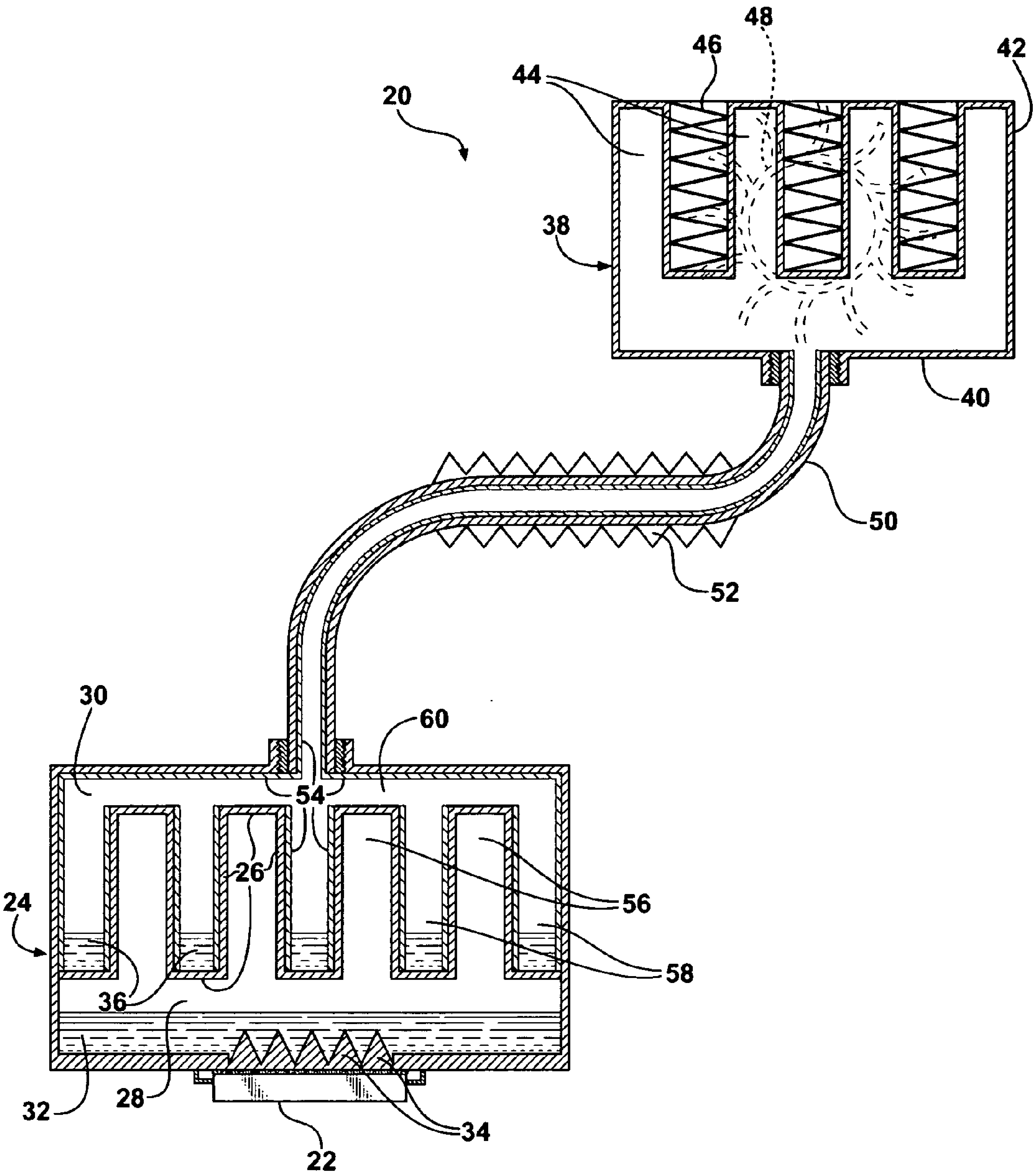


FIG - 2



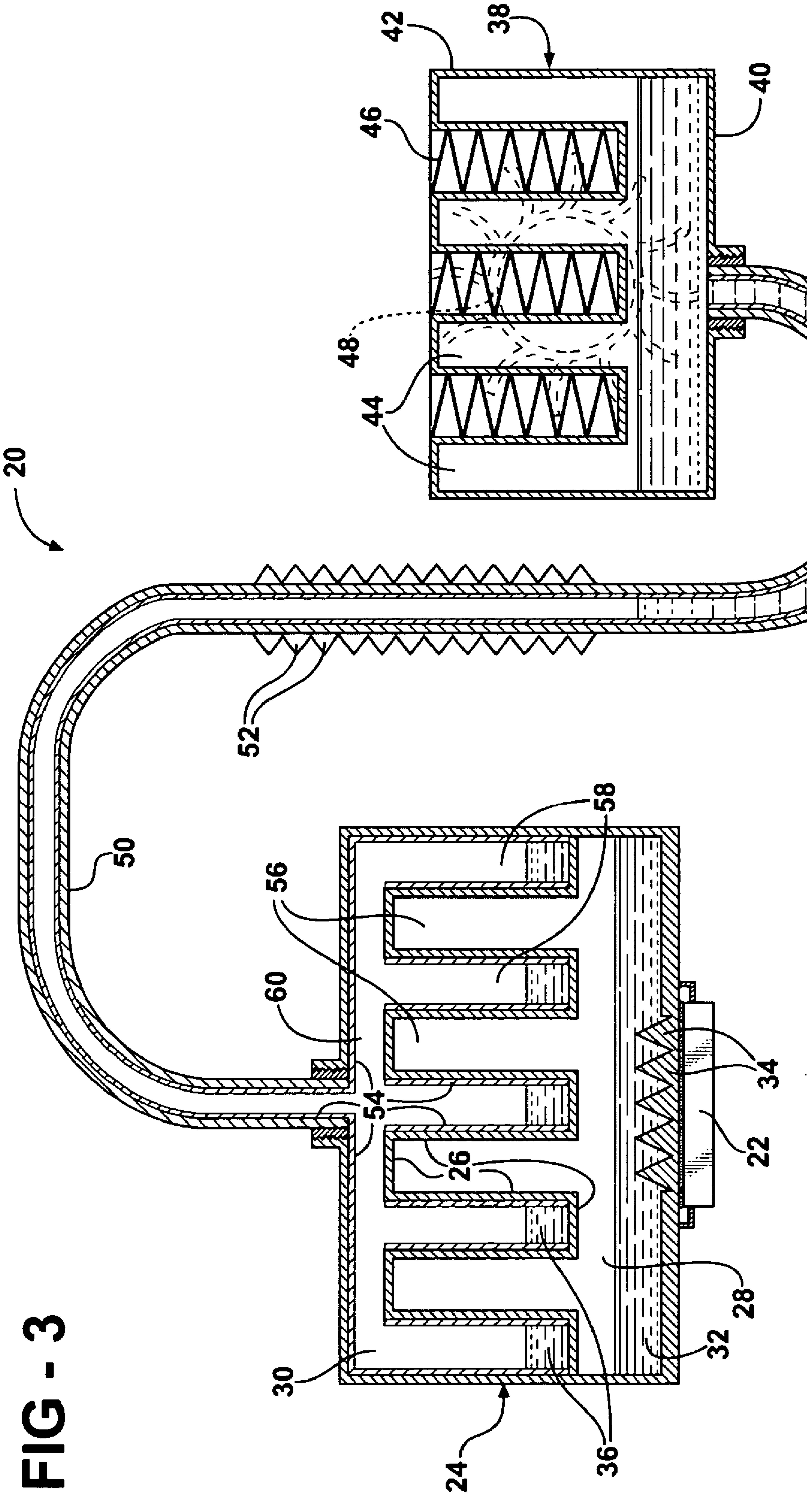


FIG - 3

EVAPORATIVELY COOLED THERMOSIPHON

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The subject invention relates to a thermosiphon cooling assembly for cooling an electronic device.

[0003] 2. Description of the Prior Art

[0004] The operating speed of computers is constantly being improved to create faster and faster computers. With this, comes increased heat generation and a need to effectively dissipate that heat.

[0005] Heat exchangers and heat sink assemblies have been used that apply natural or forced convection cooling methods to dissipate heat from electronic devices that are highly concentrated heat sources such as microprocessors and computer chips. These heat exchangers typically use air to directly remove heat from the electronic devices; however air has a relatively low heat capacity. Thus, liquid-cooled units called LCUs employing a cold plate in conjunction with high heat capacity fluids have been used to remove heat from these types of heat sources. Although LCUs are satisfactory for moderate heat flux, increasing computing speeds have required more effective heat sink assemblies.

[0006] Accordingly, thermosiphon cooling units (TCUs) have been used for cooling electronic devices having a high heat flux. A typical TCU absorbs heat generated by the electronic device by vaporizing the working fluid housed on the boiler plate of the unit. The boiling of the working fluid constitutes a phase change from liquid-to-vapor state and as such the working fluid of the TCU is considered to be a two-phase fluid. The vapor generated during boiling of the working fluid is then transferred to a condenser, where it is liquified by the process of film condensation over the condensing surface of the TCU. The heat is rejected into a stream of air flowing through a tube running through the condenser or flowing over fins extending from the condenser. The condensed liquid is returned back to the boiler plate by gravity to continue the boiling-condensing cycle.

[0007] The ability of a TCU to dissipate heat can be further improved by adding an additional working fluid cycle. The TCU would absorb heat generated by the electronic device by vaporizing the first working fluid housed on the boiler plate of the unit. The vapor generated during boiling of the first working fluid is then transferred to a first condenser, where it is liquified by the process of a second evaporator chamber absorbing the heat generated by the vapor. The second evaporator chamber would absorb the heat generated by the vapor by vaporizing the second working fluid housed within the second evaporator chamber. The vapor generated during the boiling of the second working fluid is then transferred to a second condenser, where it is liquified by the process of film condensation. The heat is rejected into air flowing over or through the condenser, or alternatively into another refrigerant.

[0008] Additionally, with the decreasing size of computers and the increasing portability, new challenges have been presented regarding the ability of cooling units to effectively dissipate heat. The decreasing size has created a demand for smaller cooling units that are able to be fit into tighter spaces. To meet this demand, many TCUs have been created out of a flexible material to allow for an increased ability to be positioned in cramped spaces. The portability of computers has created the need for TCUs that are able to function without the assistance of gravity. Wicking materials have been developed which allow a TCU to transport a liquid regardless of the effect of gravity. A typical TCU utilizing a wicking material contains an evaporator, a condenser, and capillary tubes lined with a wicking material interconnecting the evaporator and condenser. The capillary tubes lined with the wicking material allow refrigerant vapor to flow from the evaporator to the condenser while the wicking material returns the condensed refrigerant in the condenser to the evaporator without the assistance of gravity.

[0009] An example of a cooling system for electronic devices is disclosed in U.S. Pat. No. 5,647,429 to Oktay. The Oktay patent discloses an assembly for cooling an electronic device having a flexible housing including an evaporator and a condenser joined by a hollow adiabatic section containing a wicking material. The assembly is additionally adapted so that two or more consecutive assemblies can be joined together by connecting the condenser of one housing to the evaporator of a subsequent housing. The Oktay patent provides for multiple TCUs to be joined together in series to effectively cool a single electronic device.

[0010] Although the prior art dissipates heat from electronic devices, as computing speeds increase, there is a continuing need for alternative cooling devices having more efficient heat transfer capabilities.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0011] In accordance with the subject invention, heat generated by an electronic device is transferred to a housing having a lower boiling chamber and an upper evaporating chamber. A first refrigerant is disposed within the lower boiling chamber of the housing for liquid-to-vapor transformation, and a second refrigerant is disposed in the upper evaporating chamber of the housing for liquid-to-vapor transformation. The assembly employs a partition to define the lower boiling chamber of the housing, and the partition forms a series of vapor chambers in the lower boiling chamber. The heat generated by the electrical device is transferred to the lower boiling chamber of the housing and is absorbed by the first refrigerant causing the first refrigerant to boil. The vapor boiled off the first refrigerant as a result of the heat absorbed from the electronic device gathers in the vapor chambers and heat is transferred from the vapor contained within the vapor chambers to a plurality of refrigerant pockets contained within the upper boiling portion of the housing that are interleaved with the vapor chambers. The second refrigerant that is disposed within the upper evaporating chamber of the housing gathers in these refrigerant pockets and absorbs the heat transferred from the vapor chambers. The vapor boiled off the second refrigerant as a result of the heat condenses in an open space above the refrigerant pockets and returns to the refrigerant pools occupying the pockets.

[0012] The present invention utilizes the series of vapor chambers in the lower boiling portion of the housing interleaved with the series of refrigerant pockets in the upper evaporating portion of the housing to increase the surface area between the lower boiling portion of the housing and the upper evaporating portion of the housing to enhance heat transfer between the lower and upper portions of the housing. The series of vapor chambers and refrigerant pockets increases the rate of heat transfer providing for smaller TCUs that more effectively dissipate heat from an electronic device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0014] FIG. **1** is a perspective view of the thermosiphon cooling assembly showing the housing and condensing unit cut away;

[0015] FIG. **2** is a cross sectional view of the assembly shown in FIG. **1**; and

[0016] FIG. **3** is a cross sectional view of the assembly shown in FIG. **1** with the condensing unit placed below the housing.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Referring to the Figures, wherein like numerals indicate corresponding parts throughout the several views, a thermosiphon cooling assembly **20** is shown generally for cooling an electronic device **22**.

[0018] A thermosiphon cooling assembly **20** comprises a housing **24** generally indicated having a partition **26** defining a lower boiling chamber **28** for receiving heat from the electronic device **22** and an upper evaporating chamber **30**. The assembly **20** is used to cool the electronic device **22** engaging or secured to the exterior of the lower boiling chamber **28** of the housing **24**. The housing **24** is generally rectangular with the lower boiling chamber **28** being hermetically sealed to contain a first refrigerant **32** for liquid-to-vapor transformation.

[0019] The first refrigerant **32** is disposed below the partition **26** in the lower boiling chamber **28** of the housing **24** for liquid-to-vapor transformation. The first refrigerant **32** is confined to the lower boiling chamber **28** of the housing **24** and absorbs heat generated by the electronic device **22** and transferred into the lower boiling chamber **28** of the housing **24**. The first refrigerant **32** is boiled and evaporated by the heat transferred from the electronic device **22** and the resultant vapor is later condensed and returned to the refrigerant pool. The first refrigerant **32** is preferably essentially dielectric in character to prevent any electrocution hazard in the event of leakage of the fluid. A refrigerant like R-134a is suitable for this purpose.

[0020] A plurality of boiler fins **34** extend from the bottom of the lower boiling chamber **28** of the housing **24** for increasing heat transfer from the electronic device **22** to the interior of the lower boiling chamber **28** of the housing **24**. The boiler fins **34** extend upwardly toward the upper evaporating chamber **30** of the housing **24**. The boiler fins **34** are disposed in the lower boiling chamber **28** of the housing **24** for transferring heat from the electronic device **22** disposed on the exterior of the lower boiling chamber **28** of the housing **24** by boiling the first refrigerant **32** in the lower boiling chamber **28** of the housing **24**.

[0021] A second refrigerant **36** is disposed above the partition **26** in the upper evaporating chamber **30** of the housing **24** for liquid-to-vapor transformation. The second refrigerant **36** absorbs heat transferred to the upper evaporating chamber **30** by the first refrigerant **32** disposed within the lower boiling chamber **28**. The second refrigerant **36** has a thermal conductivity larger or greater than that of air for increasing the heat transfer between refrigerant vapor and the second refrigerant **36**. The second refrigerant **36** is also preferably essentially dielectric in character to prevent any electrocution hazard in the event of leakage of the fluid. A refrigerant like R-134a is suitable for this purpose.

[0022] The assembly **20** has a condensing unit **38** generally indicated having a lower portion **40** and an upper portion **42** with the upper portion **42** having a plurality of spaced radiation chambers **44** extending through the condensing unit **38**. The lower portion **40** of the housing **24** is generally rectangular and the upper portion **42** generally consists of a plurality of rectangular radiation chambers **44** extending perpendicular to the lower portion **40** of the condensing unit **38** at spaced intervals. The radiation chambers **44** house refrigerant vapor awaiting condensation while the lower portion **40** provides a reservoir for the cooled liquid refrigerant. The condensing unit **38** is preferably oriented as illustrated in FIG. **2** so that the radiation chambers **44** are positioned above the lower portion **40**.

[0023] A plurality of condensing fins **46** extend from the exterior of the radiation chambers **44** of the condensing unit **38** for increasing the heat transfer from refrigerant vapor contained within the radiation chambers **44** to the exterior environment. The condensing fins **46** as illustrated in FIG. **1** preferably extend from one radiation chamber **44** to an adjacent radiation chamber **44** and back to the original radiation chamber **44** forming a channel for air to pass through. The condensing fins **46** are disposed within the radiation chambers **44** for transferring heat contained within the condensing unit **38** to the exterior environment of the assembly **20**.

[0024] As illustrated in FIG. **1**, an air moving device **48** for moving air through the radiation chambers **44** and over the condensing fins **46**, here shown as a single axial fan, can be positioned within the proximity of the condensing unit **38**. The air moving device **48** increases the flow of air over the condensing fins **46** to increase the rate at which heat contained within the condensing unit **38** is transferred to the surrounding environment. The air moving device **48** can either be of the push or pull type.

[0025] A capillary tube **50** interconnects the upper evaporating chamber **30** of the housing **24** and the lower portion **40** of the condensing unit **38** to transfer vapor from the upper evaporating chamber **30** of the housing **24** to the lower portion **40** of the condensing unit **38** and to transfer condensed vapor from the lower portion **40** of the condensing unit **38** to the upper evaporating chamber **30** of the housing **24**. The upper evaporating chamber **30** of the housing **24** and the condensing unit **38** are hermetically sealed about the capillary tube **50** to contain the second refrigerant **36** for liquid-to-vapor transformation. The capillary tube **50** is preferably operatively attached to the top surface of the upper evaporating chamber **30** opposite the second refrigerant **36** and preferably operatively attached to the bottom surface of the lower portion **40** of the condensing unit **38** opposite the radiation chambers **44** as illustrated in FIG. **2**.

[**0026**] The capillary tube **50** is flexible to move the condensing unit **38** relative to the housing **24** for increasing the ability to position the assembly **20** in tight spaces. The condensing unit **38** may be either positioned above the housing **24** as illustrated in FIG. **2** or the condensing unit **38** may be positioned below the housing **24** as illustrated in FIG. **3**.

[**0027**] A plurality of capillary fins **52** extend from the exterior of the capillary tube **50** for increasing heat transfer. The capillary fins **52** preferably extend perpendicularly from the capillary tube **50**. The capillary fins **52** are disposed on the capillary tube **50** for transferring heat from refrigerant vapor contained within the capillary tube **50** to the exterior environment of the assembly **20**.

[**0028**] A wick material **54** is disposed in the upper evaporating chamber **30** of the housing **24** and extending into the capillary tube **50** for conveying liquid from the condensing unit **38** to the upper evaporating chamber **30** of the housing **24**. Refrigerant vapor travels through the capillary tube **50** to the condensing unit **38** to be cooled whereupon the wick material **54** is able to return the liquid refrigerant back to the upper evaporating chamber **30** of the housing **24** substantially unaided by gravity. A wick material **54** formed by a cladless metal coating process, which is capable of yielding about fifty percent porosity required to wick the refrigerant liquid, could be used.

[**0029**] As illustrated by FIG. **2**, the partition **26** separating the lower boiling chamber **28** of the housing **24** from the upper boiling chamber of the housing **24** defines a plurality of spaced vapor chambers **56** extending upwardly above the lower boiling chamber **28** for condensing vapor boiled off the first refrigerant **32**. The vapor chambers **56** are rectangular and extend from the lower boiling chamber **28** towards the upper evaporating chamber **30**. The vapor chambers **56** provide a receptacle for refrigerant vapor boiled off the first refrigerant **32**.

[**0030**] The refrigerant vapor is able to occupy the vapor chambers **56** until it is condensed to liquid form whereupon gravity will return the condensed refrigerant to the reservoir for the first refrigerant **32**. The vapor chambers **56** preferably extend perpendicularly above the lower boiling chamber **28**.

[**0031**] The upper evaporating chamber **30** of the housing **24** includes a plurality of refrigerant pockets **58** interleaved with the vapor chambers **56** for holding the second refrigerant **36** and an open space **60** above the refrigerant pockets **58** for condensing vapor boiled off the second refrigerant **36**. FIG. **2** illustrates the refrigerant pockets **58** containing the second refrigerant **36**. The refrigerant pockets **58** are preferably rectangular in shape and extend from the upper evaporating chamber **30** towards the lower boiling chamber **28** and are adjacent to two separate vapor chambers **56**. The refrigerant pockets **58** also preferably extend downwardly from the upper evaporating chamber **30** creating a depth that is equal to the height the vapor chambers **56** extend upwardly from the lower boiling chamber **28**. As shown in FIG. **2**, the vapor chambers **56** and refrigerant pockets **58** are located adjacent to one and other where the partition **26** is a common side to two adjacent chambers **28**, **30**, **44**, **56**. The refrigerant pockets **58** increase the surface area between the upper evaporating chamber **30** and the lower boiling chamber **28** for increasing the heat transfer from the evaporated refrigerant collected within the vapor chambers **56** and the second refrigerant **36** contained within the refrigerant pockets **58**.

[**0032**] The wick material **54** is disposed on the refrigerant pockets **58** for enhancing heat transfer from the vapor chambers **56** to the refrigerant pockets **58**. The wick material **54** lining the refrigerant pockets **58** enhances heat transfer by promoting nucleate boiling within the upper evaporating chamber **30**. A wick material **54** formed by a cladless metal coating process, which is capable of yielding about fifty percent porosity required to wick the refrigerant liquid, could be used.

[**0033**] The present invention utilizes the first refrigerant **32** disposed in the lower boiling chamber **28** of the housing **24** and the second refrigerant **36** disposed in the upper evaporating chamber **30** of the housing **24** to remove heat by ebullition. The heat transfer rate of the second refrigerant **36** for liquid-to-vapor transformation is inherently higher than that of air or a single-phase fluid enhancing the cooling capacity of the TCU. Thus to ensure the second refrigerant **36** will undergo liquid-to-vapor transformation, the second refrigerant **36** preferably has a boiling temperature less than the boiling temperature of the first refrigerant **32**. Assuming the assembly **20** initially starts with a negligible amount of energy, a certain amount of energy will be transferred to the assembly **20** as heat from the electronic device **22** causing the first refrigerant **32** to boil, and a specific amount of energy determined by the heat of vaporization of the first refrigerant **32** will be used up to completely vaporize a unit of the first refrigerant **32**. As a result, an amount of energy less than that required to boil the first refrigerant **32** will be transferred from the refrigerant vapor to the second refrigerant **36**. Therefore, having a second refrigerant **36** with a lower boiling temperature than the first refrigerant **32** will ensure ebullition of the second refrigerant **36** and increase the effectiveness of the assembly **20**.

[**0034**] The present invention additionally utilizes a criterion that the heat capacity of the first refrigerant **32** must be equal to the heat capacity of the second refrigerant **36** in order to ensure a proper charge balance. The efficiency of any cooling system suffers if there is too much or too little refrigerant charge. In a single coolant system, if there is too little charge the evaporator capacity is reduced because less of its surface is wetted and the average evaporator temperature differential increases across the evaporator. If there is too much charge, refrigerant may back up in the condenser reducing the effective surface area of the condenser and increasing the average temperature differential across the condenser. Therefore, to ensure efficient heat transfer in the present assembly **20**, the charge between the first refrigerant **32** and the second refrigerant **36** must be balanced so as to not affect the charge balance of the assembly **20**. If the charge between the first refrigerant **32** and the second refrigerant **36** is too high, the evaporator capacity of the lower boiling portion of the housing **24** will be reduced. If the charge between the first refrigerant **32** and the second refrigerant **36** is too low, the evaporator capacity of the upper evaporating chamber **30** of the housing **24** will be reduced. Therefore, to ensure efficient heat transfer, the charges of the two refrigerants **32**, **36** must be balanced by equating the heat capacities of the two refrigerants **32**, **36**. The first refrigerant **32** has a heat capacity equal to $(mh_{fg})_1$ and the second refrigerant **36** has a second heat capacity equal to $(mh_{fg})_2$ and the charge balance of the two refrigerants **32**, **36** is based on the criterion that the heat capacity of the two refrigerants **32**, **36** must be equal. Thus

$$(mh_{fg})_1=(mh_{fg})_2 \tag{1}$$

[0035] where the subscripts 1 and 2 refer to the two refrigerants **32**, **36** and

[0036] m is the refrigerant mass, lb_m

[0037] h_{fg} is the latent heat of evaporation of the refrigerant, Btu/lb_m

[0038] The latent heat of evaporation of the refrigerant is given by the relation

$$h_{fg}\alpha(1-T/T_c)^{3/8} \tag{2}$$

[0039] where

[0040] α is a constant defined below, Btu/lb_m

[0041] T is the absolute temperature of interest, °R

[0042] T_c is the critical temperature of the refrigerant, °R

$$\alpha=\beta RT_c/J \tag{3}$$

[0043] where

[0044] β is a dimensionless constant defined below

[0045] R is the gas constant of the refrigerant, $ft*lb_f/lb_m*°R$

[0046] T_c is the critical temperature of the refrigerant, °R

[0047] J is mechanical-to-thermal energy conversion factor=778.163 $ft*lb_f/Btu$

$$\beta=\ln(P_n/P_c)/(1-T_c/T_n) \tag{4}$$

[0048] where

[0049] P_n is the atmospheric pressure, lbf/ft^2

[0050] P_c is the critical pressure of the refrigerant, lbf/ft^2

[0051] T_c is the critical temperature of the refrigerant, °R

[0052] T_n is the normal boiling temperature of the refrigerant, °R

[0053] Based on the foregoing simple relations the charge balance for the two refrigerants **32**, **36** can be determined in a straightforward fashion as follows:

[0054] 1. Determine the dimensionless constant β for the first refrigerant **32** from Eq. (4) knowing the refrigerant specific constant values.

[0055] 2. Determine the dimensionless constant β for the second refrigerant **36** from Eq. (4) knowing the refrigerant specific constant values.

[0056] 3. Determine the dimensional constant α for the first refrigerant **32** from Eq. (3) knowing the refrigerant specific constant values.

[0057] 4. Determine the dimensional constant α for the second refrigerant **36** from Eq. (3) knowing the refrigerant specific constant values.

[0058] 5. Determine the latent heat of evaporation h_{fg} of the first refrigerant **32** in the lower boiling chamber **28** corresponding to $T=T_b$ where T_b is the boiler plate temperature.

[0059] 6. Determine the latent heat of evaporation h_{fg} of the second refrigerant **36** in the upper evaporating chamber **30** corresponding to $T=T_{60}$ where T_α is the cooling medium temperature.

[0060] 7. Knowing h_{fg} values of the two refrigerants **32**, **36** from steps 5 and 6 determine the mass ratio of the two refrigerants **32**, **36** from Eq. (1).

[0061] The operation of the assembly **20** is incorporated into a liquid cooling system as illustrated in FIG. **1**. The electronic device **22** generates an amount of heat to be dissipated and the heat is transferred from the electronic device **22** to the lower boiling chamber **28** of the housing **24**. The heat is then conducted from the lower boiling chamber **28** to the boiler fins **34** and thence to the first refrigerant **32**. Vapor boiled off the first refrigerant **32** generates an amount of heat to be dissipated and the heat is transferred from the vapor to the upper evaporating chamber **30** of the housing **24**. The heat is then conducted from the upper evaporating chamber **30** to the second refrigerant **36**. Vapor boiled off the second refrigerant **36** generates an amount of heat to be dissipated and the heat is transferred from the vapor through a capillary tube **50** to a condensing unit **38**. The heat is then conducted from the condensing unit **38** to condensing fins **46** to air forced through the condensing fins **46** by an air moving device **48**.

[0062] The invention therefore provides a method of cooling an electronic device **22** by transferring heat generated by an electronic device **22** to a lower boiling chamber **28** of a housing **24**, boiling a first refrigerant **32** in the lower boiling portion of the housing **24** from liquid-to-vapor at a first temperature, and transferring heat from the vapor of the first refrigerant **32** to a second refrigerant **36** in an upper evaporating chamber **30** of the housing **24**. The method is distinguished by boiling the second refrigerant **36** in the upper evaporating chamber **30** of the housing **24** from liquid-to-vapor at a second temperature lower than the first temperature. The method is further distinguished by condensing the vapor of the second refrigerant **36** in a condensing unit **38** and wicking the condensed liquid refrigerant through a capillary tube **50** to the upper evaporating chamber **30** of the housing **24**.

[0063] Obviously, many modifications and variations of the present invention are possible in light of the above teachings. The invention may be practiced otherwise than as specifically described within the scope of the appended claims.

What is claimed is:

1. A thermosiphon cooling assembly for cooling an electronic device, comprising;

a housing having a partition defining a lower boiling chamber for receiving heat from the electronic device and an upper evaporating chamber,

a first refrigerant disposed below said partition in said lower boiling chamber of said housing for liquid-to-vapor transformation, a second refrigerant disposed above said partition in said upper evaporating chamber of said housing for liquid-to-vapor transformation,

said partition defining a plurality of vapor chambers extending upwardly above said lower boiling chamber for condensing vapor boiled off said first refrigerant, and

said upper evaporating chamber including a plurality of refrigerant pockets interleaved with said vapor chamber for holding said second refrigerant and an open space above said refrigerant pockets for condensing vapor boiled off said second refrigerant.

2. An assembly as set forth in claim 1 wherein said first refrigerant has a higher boiling temperature than the boiling temperature of said second refrigerant.

3. An assembly as set forth in claim 2 wherein said first refrigerant has a first heat capacity $(mh_{fg})_1$ and said second refrigerant has a second heat capacity $(mh_{fg})_2$ and

$$(mh_{fg})_1=(mh_{fg})_2$$

wherein

m is the refrigerant mass and

h_{fg} is the latent heat of evaporation of the refrigerant and is defined as

$$h_{fg}=\alpha(1-T/T_c)^{3/8}$$

wherein

T is the absolute temperature of interest and

T_c is the critical temperature of the refrigerant and

α is a constant and is defined as

$$\alpha=\beta RT_c/J$$

wherein

R is the gas constant of the refrigerant and

T_c is the critical temperature of the refrigerant and

J is the mechanical-to-thermal energy conversion factor and is

$$J=778.163\ ft*lb_f/Btu$$

β is a dimensionless constant and is defined as

$$\beta=\ln(P_n/P_c)/(1-T_c/T_n)$$

wherein

P_n is the atmospheric pressure and

P_c is the critical pressure for the refrigerant and

T_c is the critical temperature of the refrigerant and

T_n is the normal boiling temperature of the refrigerant.

4. An assembly as set forth in claim 2 including a condensing unit operatively attached to said upper evaporating unit.

5. An assembly as set forth in claim 4 including a capillary tube interconnecting said upper evaporating chamber of said housing and said condensing unit.

6. An assembly as set forth in claim 5 including a wick material disposed on said refrigerant pockets and said wick material disposed in said upper evaporating chamber of said housing and extending into said capillary tube for conveying liquid from said condensing unit to said refrigerant pockets.

7. An assembly as set forth in claim 6 wherein said capillary tube is flexible for moving said condensing unit relative to said housing.

8. An assembly as set forth in claim 4 wherein said condensing unit defines a lower portion and an upper portion with said upper portion having a plurality of spaced radiation chambers extending through said condensing unit and a plurality of condensing fins disposed within said radiation chambers.

9. An assembly as set forth in claim 8 including an air moving device for moving air through said radiation chambers and over said condensing fins.

10. An assembly as set forth in claim 2 including a plurality of boiler fins disposed in said lower boiling chamber of said housing for enhancing heat transfer to said first refrigerant.

11. An assembly as set forth in claim 5 including a plurality of capillary fins disposed on said capillary tube for enhancing heat transfer from said second refrigerant.

12. A thermosiphon cooling assembly for cooling an electronic device, comprising;

a housing having a partition defining a lower boiling chamber for receiving heat from the electronic device and an upper evaporating chamber,

a first refrigerant disposed below said partition in said lower boiling chamber of said housing for liquid-to-vapor transformation,

a plurality of boiler fins disposed in said lower boiling chamber of said housing for enhancing heat transfer to said first refrigerant,

a second refrigerant disposed above said partition in said upper evaporating chamber of said housing for liquid-to-vapor transformation,

a condensing unit defining a lower portion and an upper portion with said upper portion having a plurality of spaced radiation chambers extending through said condensing unit,

a plurality of condensing fins disposed within said radiation chambers,

an air moving device for moving air through said radiation chambers and over said condensing fins,

a capillary tube interconnecting said upper evaporating chamber of said housing and said lower portion of said condensing unit,

said capillary tube being flexible for moving said condensing unit relative to said housing,

a plurality of capillary fins disposed on said capillary tube for enhancing heat transfer from said second refrigerant,

a wick material disposed in said upper evaporating chamber of said housing and extending into said capillary tube for conveying liquid from said condensing unit to said upper evaporating chamber of said housing, said partition defining a plurality of spaced vapor chambers extending upwardly above said lower boiling chamber for condensing vapor boiled off said first refrigerant,

said upper evaporating chamber including a plurality of refrigerant pockets interleaved with said vapor chambers for holding said second refrigerant and an open space above said refrigerant pockets for condensing vapor boiled off said second refrigerant,

said wick material disposed on said refrigerant pockets, and

said first refrigerant having a higher boiling temperature than the boiling temperature of said second refrigerant,

13. An assembly as set forth in claim 12 wherein said first refrigerant has a first heat capacity $(mh_{fg})_1$ and said second refrigerant has a second heat capacity $(mh_{fg})_2$ and

$$(mh_{fg})_1=(mh_{fg})_2$$

wherein

m is the refrigerant mass and

h_{fg} is the latent heat of evaporation of the refrigerant and is defined as

$$h_{fg}=\alpha(1-T/T_c)^{3/8}$$

wherein

T is the absolute temperature of interest and

T_c is the critical temperature of the refrigerant and

α is a constant and is defined as

$$\alpha=\beta RT_c/J$$

wherein

R is the gas constant of the refrigerant and

T_c is the critical temperature of the refrigerant and

J is the mechanical-to-thermal energy conversion factor and is

$J=778.163\ ft^*lb_f/Btu$

β=is a dimensionless constant and is defined as

$$\beta=\ln(P_n/P_c)(1-T_c/T_n)$$

wherein

P_n is the atmospheric pressure and

P_c is the critical pressure for the refrigerant and

T_c is the critical temperature of the refrigerant and

T_n is the normal boiling temperature of the refrigerant.

14. A method of cooling an electronic device comprising the steps of;

generating heat by an electronic device,

transferring the heat generated by the electronic device to the lower boiling chamber of a housing,

a boiling a first refrigerant in the lower boiling chamber of the housing from liquid-to-vapor at a first temperature,

transferring heat from the vapor of the first refrigerant to a second refrigerant in the upper evaporating chamber of the housing, and

boiling the second refrigerant in the upper evaporating chamber of the housing from liquid-to-vapor at a second temperature lower than the first temperature.

15. A method as set forth in claim 14 including condensing the vapor of the second refrigerant in a condensing unit and wicking the condensed liquid refrigerant through a capillary tube to the upper evaporating chamber of the housing.

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