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Rubright(10) **Pub. No.: US 2010/0242523 A1**(43) **Pub. Date: Sep. 30, 2010**(54) **ELECTRIC COOLING SYSTEM FOR
ELECTRONIC EQUIPMENT****Publication Classification**(51) **Int. Cl.**
F25B 30/00 (2006.01)(52) **U.S. Cl.** **62/324.1**(57) **ABSTRACT**(76) **Inventor:** **Todd Rubright**, Fallbrook, CA
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ALISO VIEJO, CA 92656 (US)(21) **Appl. No.:** **12/732,787**(22) **Filed:** **Mar. 26, 2010****Related U.S. Application Data**(60) **Provisional application No. 61/211,465, filed on Mar.**
31, 2009.

A system for maintaining a temperature of electronic equipment within its normal operating temperature range is disclosed. The system includes a housing having an inner liner that behaves as a heat sink, an outer shell that protects the electronic equipment from weather or harsh environmental conditions and a thermal insulation material disposed between the outer shell and the inner liner to mitigate heat transfer between the interior cavity of the inner liner and the environment. The system may further include a heat transfer unit mounted to a rear portion of the inner liner so that heat is funneled through the rear portion of the inner liner when transferring heat between the interior cavity of the inner liner and the environment.

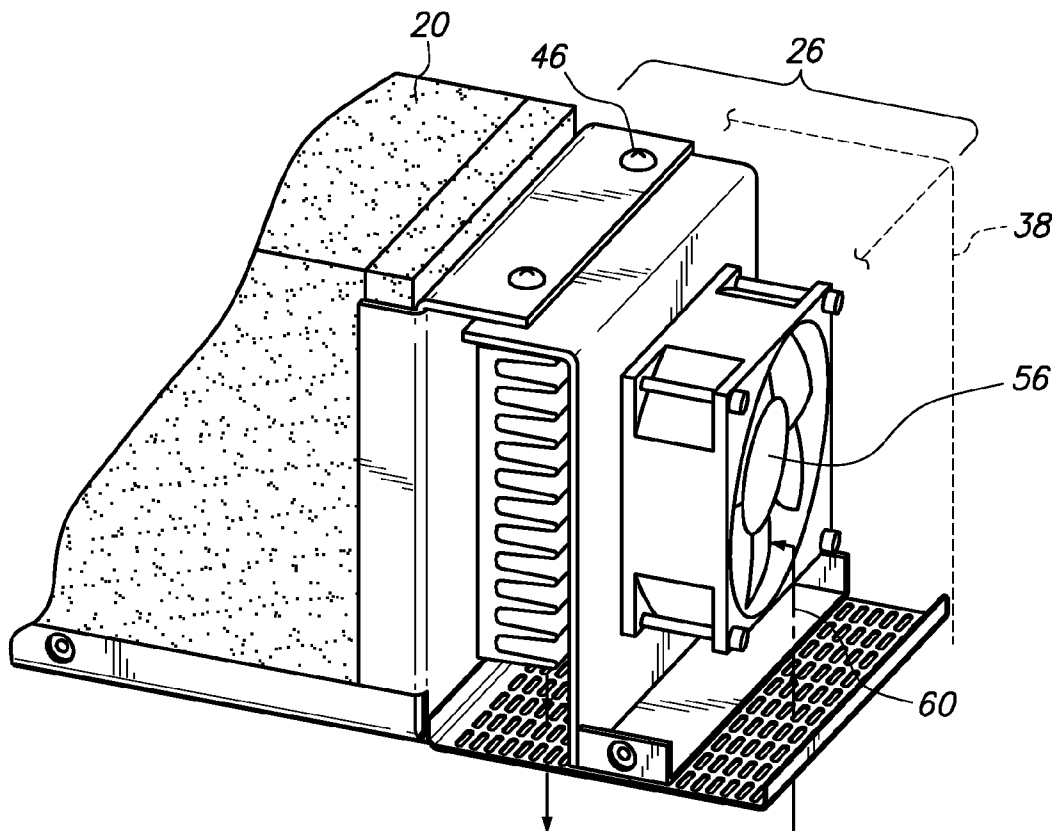


FIG. 1

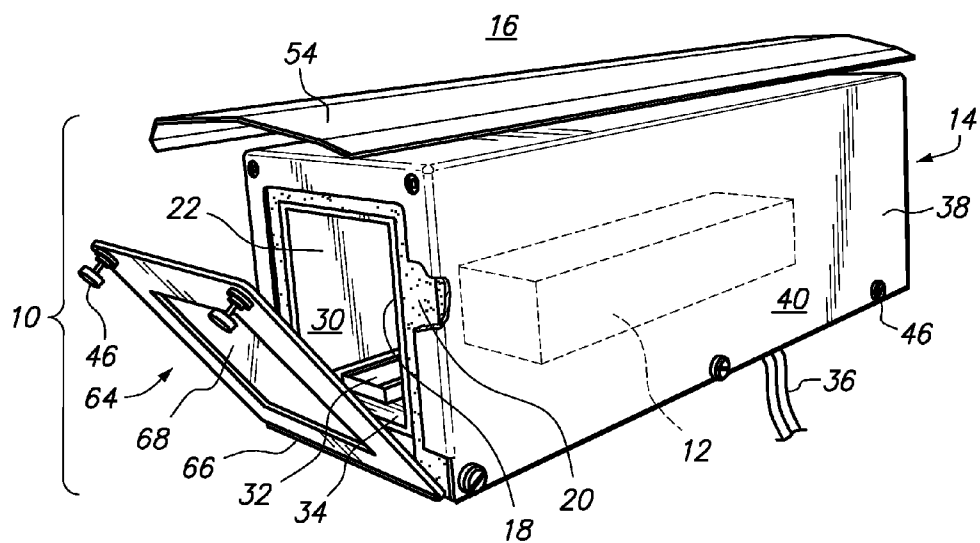
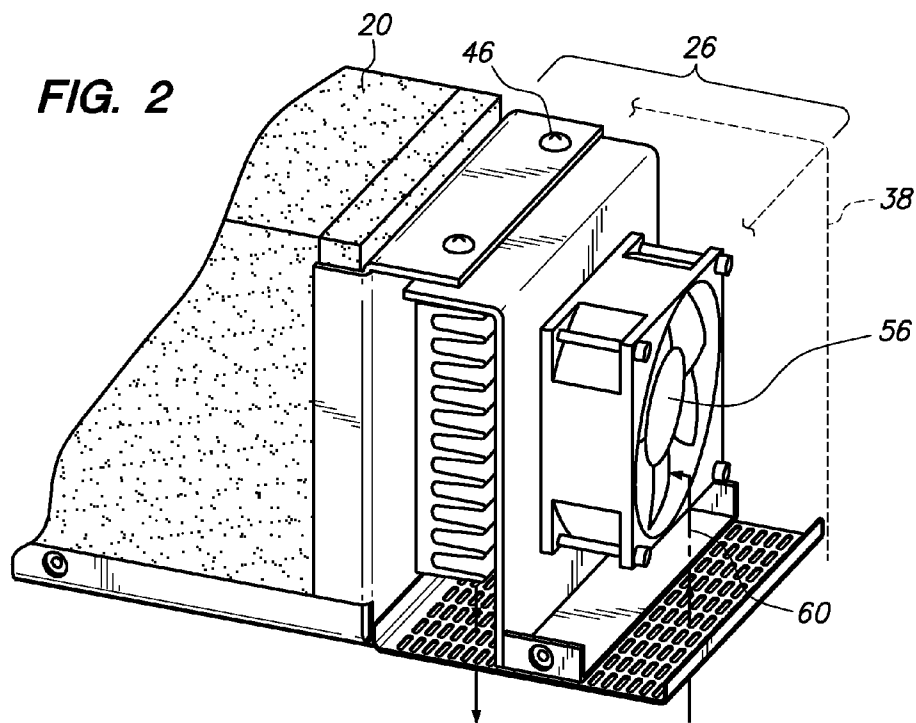
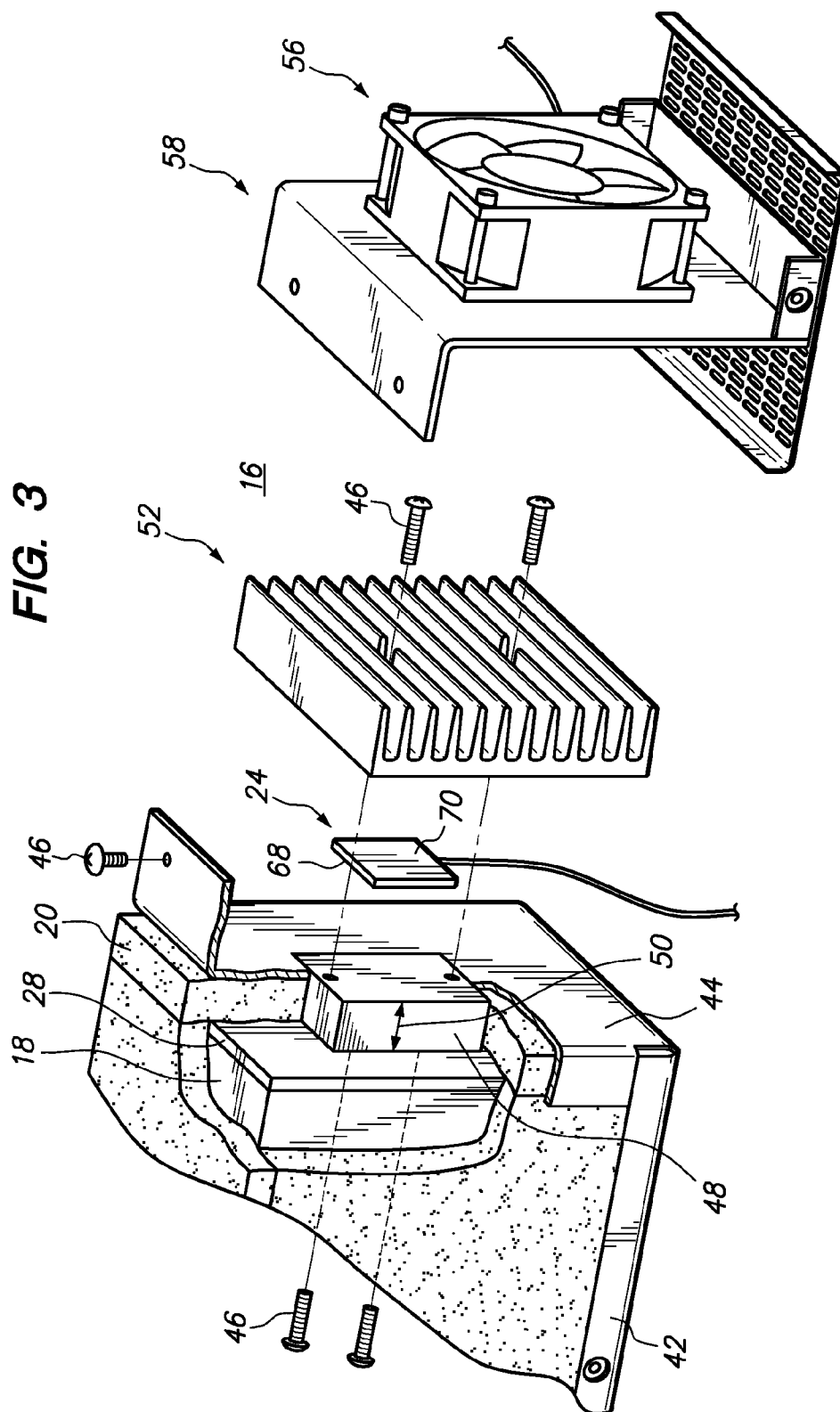
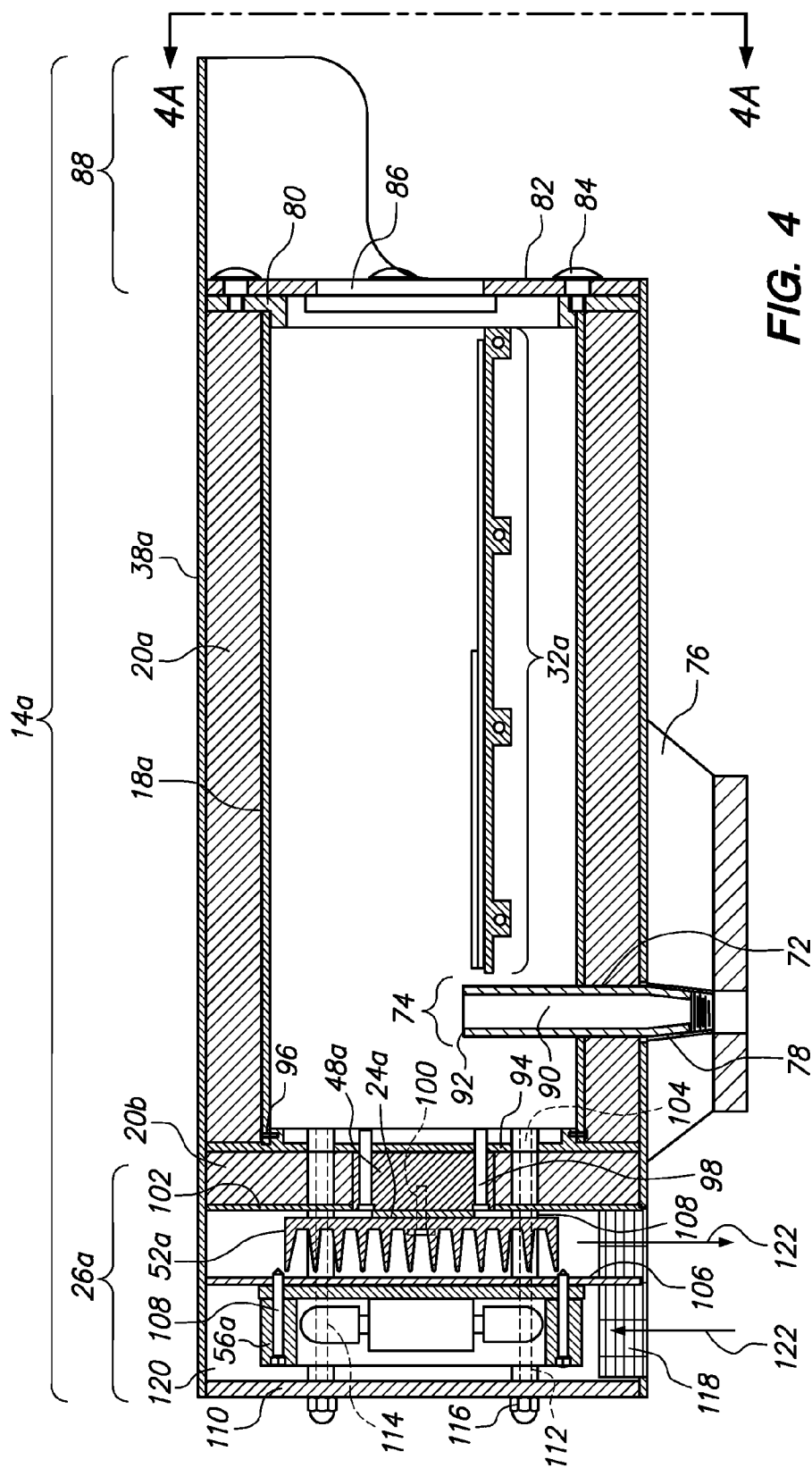


FIG. 2







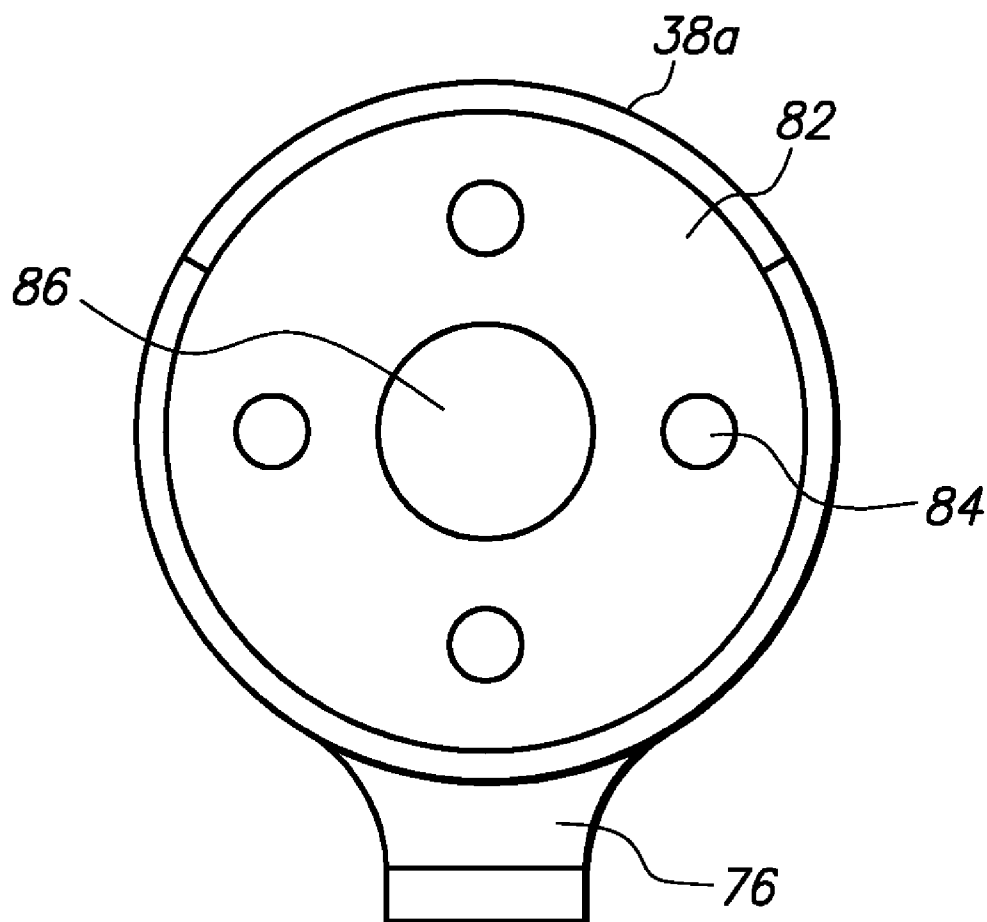


FIG. 4A

ELECTRIC COOLING SYSTEM FOR ELECTRONIC EQUIPMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Pat. App. Ser. No. 61/211,465, filed on Mar. 31, 2009, the entire content of which is expressly incorporated herein by reference.

STATEMENT RE: FEDERALLY SPONSORED RESEARCH/DEVELOPMENT

[0002] Not Applicable

BACKGROUND

[0003] The present invention relates to a system for maintaining a temperature inside a housing with an electronic equipment or temperature sensitive component within a normal operating temperature range.

[0004] Electronic equipment may be sensitive to temperature variation. When the electronic equipment is exposed to the environment, the electronic equipment may further experience wide variation in temperature fluctuations. By way of example and not limitation, electronic equipment when placed in a desert environment may experience wide temperature ranges that may exceed the normal operating temperature range of the electronic equipment both in its upper and lower ends. If the electronic equipment experiences temperatures outside of its normal operating range, then the electronic equipment may malfunction. Accordingly, there is a need in the art for an improved housing for maintaining the temperature of electronic equipment within the normal operating temperature range of the electronic equipment.

BRIEF SUMMARY

[0005] The present invention addresses the needs discussed above, discussed below and those that are known in the art.

[0006] A temperature controlled system is disclosed herein wherein the system may include a housing and a heat transfer unit. The heat transfer unit maintains a temperature of an interior cavity of the housing within a normal operating temperature range of the electronic equipment disposed within the housing. The housing may include an outer shell and an inner liner which sandwiches a thermal insulation material. The thermal insulation material mitigates heat transfer from the interior of the inner liner to the environment, and vice versa. The outer shell protects the system from harsh environmental weather. The inner liner behaves to draw heat from the interior cavity of the inner liner when attempting to cool down the interior cavity. Conversely, when attempting to heat up the interior cavity of the inner liner, the inner liner behaves as a heater. Accordingly, the inner liner is fabricated from a material having a high coefficient of heat transfer.

[0007] The heat transfer unit may be mounted to the rear of the housing and connected to a rear portion of the inner liner. The heat transferred between the interior cavity of the inner liner and the environment may occur through the rear portion of the inner liner. Heat may be funneled to the rear portion of the inner liner or dispersed back into the interior cavity by way of the rear portion of the inner liner. The heat transfer unit may comprise a peltier module and a heat fin. The peltier module behaves as a heat pump to direct heat out of the interior cavity of the inner liner or direct heat into the interior cavity of the inner liner.

[0008] More particularly, a system for regulating temperature of electronic equipment is disclosed. The system may comprise an outer shell, an inner liner, thermal insulation material and a heat pump. The outer shell may protect the electronic equipment from environmental factors. The outer shell may have an aperture. The inner liner may be fabricated from a material having a high heat transfer coefficient. The inner liner may be disposed within the outer shell. The inner liner may define an interior cavity and an outer surface wherein the electronic equipment is disposed within the interior cavity. The thermal insulation material may be disposed between the outer shell and the inner liner for mitigating heat transfer between an environment and the interior cavity of the inner liner. The heat pump may be thermally mounted to the inner liner through the aperture of the outer shell for transferring heat between the environment and the interior of the inner liner.

[0009] The system may further comprise a heat transfer block defining first and second opposed surfaces. The first surface of the heat transfer block may be thermally mounted to the outer surface of the inner liner and aligned to the aperture of the outer shell. The heat pump may be thermally mounted to the second surface of the heat transfer block.

[0010] The inner liner may be fabricated from aluminum.

[0011] The system may further comprise a heat sink attached to the heat pump and a fan for blowing air onto the heat sink. The heat pump may be a peltier module. The heat pump may transfer heat out of the interior cavity of the inner liner.

[0012] The inner liner may define an end cap. The heat transfer block may be thermally mounted to the end cap to flow heat through a rear of the inner liner.

[0013] The system may further comprise a roof mounted atop the outer shell and gapped away from the outer shell.

[0014] The system may further comprise a fan mounted to a mounting plate. The mounting plate may be gapped away from a thermal plate attached to the inner liner by way of a spacer, rod and nut. The spacer may be disposed between the thermal plate and the mounting plate. The rod may be disposed through the spacer and fixed to the thermal plate. The locking nut may be threaded onto a threaded distal end portion of the rod to tighten the mounting plate to the thermal plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] These and other features and advantages of the various embodiments disclosed herein will be better understood with respect to the following description and drawings, in which like numbers refer to like parts throughout, and in which:

[0016] FIG. 1 is a perspective view of an electric cooling system for electronic equipment;

[0017] FIG. 2 is a perspective view of a heat transfer unit for pumping heat out of the system or into the system;

[0018] FIG. 3 is an exploded perspective view of the heat transfer unit shown in FIG. 2;

[0019] FIG. 4 is a side cross sectional view of an alternate embodiment; and

[0020] FIG. 4A is a front view of the housing shown in FIG. 4.

DETAILED DESCRIPTION

[0021] Referring now to the drawings, a system **10** for regulating temperature of an electronic equipment or a tem-

perature sensitive component 12 is shown. The temperature sensitive component 12 (e.g., electronic equipment, camera, etc.) may be disposed within a housing 14 designed to transfer heat out of the housing 14 back into an environment 16 or transfer heat into the housing 14 to maintain the temperature of the temperature sensitive component 12 within its operating range. This is accomplished by disposing the temperature sensitive component 12 within an inner liner 18 that is fabricated from a material having a high coefficient of heat transfer. Thermal insulation 20 is disposed around the inner liner 18 to mitigate heat transfer between an interior cavity 22 of the inner liner 18 and the environment 16. To remove heat from the interior cavity 22 of the inner liner 18, heat is absorbed into the inner liner 18 and drawn toward a peltier module 24 (see FIG. 3) that pumps the heat to the environment 16. Heat is removed from the interior cavity 22 of the housing 14 when the temperature of the environment 16 is greater than the operating temperature of the temperature sensitive component 12. When the temperature of the environment 16 is below the operating temperature of the temperature sensitive component 12, heat is transferred from the environment 16 into the interior cavity 22 of the inner liner 18 to raise a temperature of the interior cavity 22 to within the operating range of the temperature sensitive component 12.

[0022] More particularly, now referring to FIG. 1, the system 10 may include the housing 14 (see FIG. 1) as well as a heat transfer unit 26 (see FIG. 2). The housing 14 may include the inner liner 18 which has a generally elongate hollow configuration (e.g., square tube, etc.). A first end of the inner liner 18 may be open to allow the temperature sensitive component 12 to be inserted and removed from the housing 14 of the system 10. A second end (see FIG. 3) of the inner liner 18 may be closed by end cap 28. The inner liner 18 including the end cap 28 may be fabricated from a material having a high coefficient of heat transfer so that heat generated from the electronic component or temperature sensitive component 12 is readily absorbed by the inner liner 18 and the end cap 28.

[0023] An interior surface 30 of the inner liner 18 may be smooth. Alternatively, the interior surface 30 of the inner liner 18 may have fins or ridges to increase the surface area of the interior surface 30 to improve heat transfer characteristics thereof. Additionally, a sliding rack 32 may be secured to a bottom surface 34 of the inner liner 18. The sliding rack 32 comprises two parts, namely, a stationary part fixed to the bottom surface 34 of the inner liner 18 and a sliding part that slides on the stationary part and extends in and out from the front of the housing 14. The temperature sensitive component 12 may be mounted to the sliding part so that the temperature sensitive component 12 may be slid out of the housing 14 for servicing and replacement and slid back into the housing 14 during operation. If any electricity or electrical communication is needed with the temperature sensitive component 12, cables 36 may be routed as needed such as into the inner liner 18.

[0024] Thermal insulation 20 is disposed about the exterior of the inner liner 18 as well as behind the end cap 28, as shown in FIG. 2. More particularly, thermal insulation 20 is disposed above, below and on both sides of the inner liner 18 as well as behind the end cap 28, as shown in FIG. 3. The thermal insulation 20 mitigates undesired heat transfer between the interior cavity 22 and the environment 16 during operation.

[0025] An outer shell 38 (see FIG. 1) encapsulates the thermal insulation 20 as well as the inner liner 18. The outer shell 38 is durable and weather resistant to protect the thermal

insulation 20, inner liner 18 and the temperature sensitive component 12 from harsh environmental conditions. The outer shell 38 may be fabricated from a durable metallic material with a low coefficient of heat transfer. Additionally, an outer surface 40 of the outer shell 38 may be coated with a heat reflective material. The outer shell 38 may be attached to a lower plate 42 (see FIG. 3) at three places on each side with screws 46 (see FIG. 1). The lower plate 42 may have a back plate 44 that extends upward behind the end cap 28. Thermal insulation 20 is disposed between the end cap 28 and the back plate 44 as shown in FIG. 3. The thermal insulation 20 as well as the back plate 44 may have an aperture sized and configured to receive a heat transfer block 48. The heat transfer block 48 may be attached to the end cap 28 by way of screws 46 from inside of the inner liner 18. A thickness 50 of the heat transfer block 48 may be equal to or greater than the thickness of the thermal insulation 20 disposed between the end cap 28 and the back plate 44 plus a thickness of the back plate 44. The peltier module 24 may be mounted to the heat transfer block 48 by sandwiching the peltier module 24 between the heat transfer block 48 and a heat fin 52 by way of screws 46. All interconnecting surfaces may be covered with thermal paste. By way of example and not limitation, the interface between the inner liner 18 and end cap 28, the end cap 28 and the heat transfer block 48, the heat transfer block 48 and the peltier module 24 and the peltier module 24 and the heat fin 52 may all be coated with heat thermal paste to promote heat transfer between these components.

[0026] A roof 54 may be disposed above the outer shell 38, as shown in FIG. 1. The roof 54 may be in direct contact with the sun's rays such that the sun's rays do not directly contact the outer shell 38, at least the top of the outer shell 38. The roof 54 may be attached to the outer shell 38 with spacers or other means known in the art. The roof 54 may be fabricated from a metallic material and be coated with a heat reflective coating.

[0027] A fan 56 may be mounted adjacent the heat fin 52 to blow air across the heat fin 52 to promote heat transfer. The fan 56 may be mounted to a bracket 58 which is attached to the back plate 44 with screws 46. The fan 56 blows air in the direction shown by arrows 60 (see FIG. 2). A bottom plate 62 of the bracket 58 may be perforated to allow air flow as shown by arrow 60 but prevent large items such as animals, trash, etc. from interfering with operation of the fan 56. The outer shell 38 may encapsulate the inner liner 18, thermal insulation 20 as well as the heat transfer unit 26 as shown by the dash lines in FIG. 2.

[0028] The front of the outer shell 38 may have a door 64, as shown in FIG. 1. The door 64 may be pivotable about a lower edge 66 of the outer shell 38. The door 64 may be secured to the outer shell 38 by way of screws 46. The door 64 may additionally have a window 68.

[0029] The electronic equipment 12 or temperature sensitive component 12 may be a camera. The camera may provide a view outside of the system 10 through the window 68 of the door 64.

[0030] During operation, when the temperature of the environment 16 is greater than the operating temperature of the temperature sensitive component 12, eventually, the temperature of the interior cavity 22 of the inner liner 18 exceeds or approaches the upper range or end of the normal operating temperature of the electronic equipment 12. The heat within the inner liner 18 is transferred into the inner liner 18 and the end cap 28 and pumped to the environment 16 as follows.

Referring to FIG. 3, a first side 68 of the peltier module 24 is cooler than a second side 70 of the peltier module 24. The peltier module 24 pumps heat from the inner liner 18 to the end cap 28, to the heat transfer block 48 through the peltier module 24 and out of the heat fins 52. The fan 56 blows air across the heat fins 52 to heat the ambient air and force the heated ambient air out of the system 10. This process reduces the temperature of the interior cavity 22. The inner liner 18 and the end cap 28 behave as a heat sink. Conversely, when the temperature of the environment 16 is below the operating temperature of the heat sensitive component 12, the temperature of the interior cavity 22 of the inner liner 18 eventually approaches the lower range of the temperature sensitive component's 12 operating range or dips below such level. In this instance, the second side 70 of the peltier module 24 is cooler than the first side 68 of the peltier module 24. This reduces the temperature of the heat fins 52 below the ambient temperature of the environment 16. As ambient air is blown across the heat fin 52 by way of the fan 56, heat from the ambient air is transferred to the heat fin 52, transferred through the peltier module 24 into the heat block 48, end cap 28 and the inner liner 18 and ultimately into the interior cavity 22 of the inner liner 18. This raises the temperature of the interior cavity 22 of the inner liner 18 to within the normal operating temperature of the temperature sensitive component 12.

[0031] It is also contemplated that the peltier module 24 may be in electrical communication with a logic control unit. A temperature sensor may be mounted to the interior of the inner liner. The peltier module 24 may be activated and deactivated based on the temperature of the temperature sensor. Also, the peltier module 24 may be reversed so that the heat flows into or out of the inner liner 18 based on the temperature sensed by the temperature sensor.

[0032] It is contemplated that the electronic equipment or temperature sensitive component may be an audio, computer, navigation, or other electronic device. Additionally, it is contemplated that the fan and the peltier module may be powered by a solar panel, city powered electricity, rechargeable batteries, etc. It is also contemplated that the peltier module 24 may be attached to an AC to DC power converter to power the peltier module. Also, to reverse operation of the peltier module 24, the polarity of the peltier module may be reversed to either heat or cool the interior cavity of the housing 14.

[0033] Referring now to FIG. 4, an alternate embodiment of the housing 14a is shown. The housing 14a may have an elongate circular configuration. FIG. 4A illustrates the circular front view of the housing 14a. Although the embodiment shown in FIGS. 4 and 4A are described in relation to a circular configuration, other configurations are also contemplated such as square, triangular, octagonal, polygonal, etc. As will be discussed herein, the embodiments shown in FIGS. 4 and 4A stack various components of the housing 14a so that the other configurations are also possible.

[0034] The housing 14a may include an inner liner 18a, thermal insulation 20a and an outer shell 38a. The thermal insulation 20a may be sandwiched or disposed between the inner liner 18a and the outer shell 38a. Thermal insulation 20a may extend across the entire length of the inner liner 18a. To align the inner liner 18a to the outer shell 38a, through hole 72 may be formed through the inner liner 18a, thermal insulation 20a and the outer shell 38a. A locking pin 74 may extend through the through hole 72 and be threaded into a threaded base mount 76 at threads 78. The base mount 76 may be fixedly attached (e.g., welded) to the outer shell 38a at a

bottom side of the housing 14a. The locking pin 74 prevents horizontal lateral movement between the inner liner 18a, thermal insulation 20a and the outer shell 38a.

[0035] At the front of the housing 14a, a face plate mounting brace 80 may be secured to the inner liner 18a. By way of example and not limitation, the face plate mounting brace 80 may be welded, adhered, friction fit, etc. to the inner liner 18a so that the face plate mounting brace 80 does not become dislodged from the inner liner 18a during operation. Additionally and/or alternatively, the face plate mounting brace 80 may be fixedly attached (e.g., welded, adhered, bonded, etc.) to the outer shell 38a. A front window cover may be attached to the face plate mounting brace 80 by way of screws 84. The front window cover may additionally have a window 86 so that a camera mounted within the housing 14a may record events or view events outside of the housing 14a through the window 86. The outer shell 38a may extend past the front window cover 82 to form an awning 88 so that sunlight does not impede the camera's view through the window 86 due to reflections, etc.

[0036] Additionally, the housing 14a may include a sliding rack 32a. The sliding rack 32a may include a stationary part or mounting tray as well as a sliding part or mounting slide. The electronic equipment or temperature sensitive component 12 may be mounted to the sliding part so that the temperature sensitive component 12 may be slid out of the housing 14a for servicing and other purposes. The locking pin 74 and the base mount 76 may have a through hole 90 that may accept cables of the electronic equipment or temperature sensitive component 12. An upper end 92 may be disposed slightly above or at the same level as the sliding rack 32a. The upper end 92 is above the lower or bottom side of the inner liner 18a to keep the cables and electronic equipment 12a as high as possible. The reason is that heat generally rises to the top thereby making the bottom side colder than the top side. This may particularly be beneficial when the housing 14a is in colder environments and the temperature of the electronic equipment 12 needs to be raised to a higher level above ambient temperature.

[0037] The rear of the housing 14a may house the heat transfer unit 26a. At the backside of the inner liner 18a, a thermal plate 94 which may be fabricated from a material having a high coefficient of thermal transfer such as aluminum may cap off the backside of the inner liner 18a. The thermal plate 94 may be attached to the inner liner 18a by way of pins or screws 96 or other means known in the art or developed in the future. Thermal plate 94 may be truncated so that the outer peripheral portion thereof does not extend to the outer shell 38 but only corresponds closely to the inner liner 18a. The heat transfer unit 26a may be held in place by mounting the heat transfer unit 26a to the thermal plate 94. In particular, the heat transfer block 48a may be attached to the thermal plate 94 by way of screws 98. The heat fin 52a may be mounted to the heat transfer block 48a by way of screws 100. The screws 100 are disposed adjacent to the peltier module or thermal control unit 24. The thermal control unit or peltier module 24 may be held in place by tightening the screws 100 so that the peltier module or thermal control unit 24 is sandwiched or disposed between the heat transfer block 48a and the heat fin 52. The screws 100 are adjacent the peltier module or thermal control unit 24. Thermal paste may be disposed between the heat fin 52a, peltier module 24a, heat transfer block 48a, thermal plate 94 and the inner liner 18a.

[0038] Thermal insulation **20b** may be inserted or disposed behind the thermal plate **94**. A separation plate **102** may be disposed behind the thermal insulation **20b**. Spacer **104** may be disposed between the separation plate **102** and the thermal plate **94** to encapsulate the thermal insulation **20b**. Fan mounting plate **106** may be disposed behind the heat fin **52a** and gapped away from the heat fin **52a** by way of spacer **108**. The fan **56a** may be secured to the fan mounting plate **106** by way of screws **108**. A rear cover plate **110** may be secured to the rear of the housing **14a** by way of spacer **112**. A rod **114** may be disposed through the spacers **104**, **108** and **112** and threaded into the thermal plate **94**. Locking nuts **116** may tighten the assembly together. This holds the fan **56a** in place. A screen **118** may be disposed at the bottom side of the outer shell **38a** to prevent large objects from entering the cavity **120**. When the fan **56a** is turned on, air flow may proceed in the direction of arrows **122**.

[0039] The system **10** shown in FIGS. 4 and 4A operates identical to the system shown in FIGS. 1-3. The housing **14a** is scalable to accommodate various sized electronic equipment or temperature sensitive components **12**. Additionally, the housing **14a** provides easy manufacture so that the housing **14a** may have other configurations such as round, square, triangular, etc. as discussed herein. The housing **14a** provides a modular or stacked construction to enable such scalability and configurability.

[0040] The above description is given by way of example, and not limitation. Given the above disclosure, one skilled in the art could devise variations that are within the scope and spirit of the invention disclosed herein, including various ways of providing thermal insulation. Further, the various features of the embodiments disclosed herein can be used alone, or in varying combinations with each other and are not intended to be limited to the specific combination described herein. Thus, the scope of the claims is not to be limited by the illustrated embodiments.

What is claimed is:

1. A system for regulating temperature of electronic equipment, the system comprising:

an outer shell for protecting the electronic equipment from environmental factors, the outer shell having an aperture;

an inner liner fabricated from a material having a high heat transfer coefficient, the inner liner disposed within the outer shell, the inner liner defining an interior cavity and an outer surface wherein the electronic equipment is disposed within the interior cavity;

a thermal insulation material disposed between the outer shell and the inner liner for mitigating heat transfer between an environment and the interior cavity of the inner liner; and

a heat pump thermally mounted to the inner liner through the aperture of the outer shell for transferring heat between the environment and the interior of the inner liner.

2. The system of claim 1 further comprising a heat transfer block defining first and second opposed surfaces, the first surface of the heat transfer block being thermally mounted to the outer surface of the inner liner and aligned to the aperture of the outer shell, the heat pump being thermally mounted to the second surface of the heat transfer block.

3. The system of claim 1 wherein the inner liner is fabricated from aluminum.

4. The system of claim 1 further comprising a heat sink attached to the heat pump and a fan for blowing air onto the heat sink.

5. The system of claim 1 wherein the heat pump is a peltier module.

6. The system of claim 1 wherein the heat pump transfers heat out of the interior cavity of the inner liner.

7. The system of claim 2 wherein the inner liner defines an end cap, the heat transfer block being thermally mounted to the end cap to flow heat through a rear of the inner liner.

8. The system of claim 1 further comprising a roof mounted atop the outer shell and gapped away from the outer shell.

9. The system of claim 1 further comprising a fan mounted to a mounting plate, the mounting plate being gapped away from a thermal plate attached to the inner liner by way of a spacer, rod and nut, the spacer being disposed between the thermal plate and the mounting plate, the rod being disposed through the spacer and fixed to the thermal plate, the locking nut threaded onto a threaded distal end portion of the rod to tighten the mounting plate to the thermal plate.

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