

【特許請求の範囲】

【請求項1】

上面が放熱面である薄い放熱平板と、この放熱平板の下面に溶接接合し、その一方の表面と前記放熱平板との間に熱媒体が流動するつづら折り状の流路を形成する流路形成部材とを備えた消雪パネルにおいて、

前記放熱平板の周囲をL字状に折り曲げ、更にこの折り曲げ部に帯板を溶接接合したことを特徴とする消雪パネル。

【請求項2】

前記帯板の溶接接合部ではない他端側はL字状に折り曲げ加工されていることを特徴とする請求項1に記載の消雪パネル。

【請求項3】

前記流路形成部材は前記熱媒体が流入する第1のノズル部材と、前記熱媒体が流出する第2のノズル部材と、これらに間に配設され台形状断面を有する複数列の直線溝部材と、相隣る直線溝部材の端部が接続される複数のU字溝部材とからなり、前記直線部材、前記第1、第2のノズル部材及びU字溝部材との連結部に継目部を設け、当該継目部は固着されると共に、前記各直線溝部材はその短手方向のツバ部が長手方向の全長にわたって前記放熱平板に溶接接合されることを特徴とする請求項1又は2に記載の消雪パネル。

【請求項4】

請求項1乃至3のいずれかに記載の消雪消雪パネルを線路に沿って複数枚配置し、各々の消雪パネルは一端から持ち上げ可能とするとともに、熱媒体の供給管および排出管にフレキシブル管を用いて並列に接続し、前記帯板には、取手を設けたことを特徴とする消雪パネル。

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、積雪地帯に敷設された軌条の周囲に設置される消雪パネルに関する。

【背景技術】

【0002】

積雪地帯に敷設された鉄道路線においては、列車を安全に運行するために、軌条の周囲に消雪パネルを設置し、消雪パネル上に堆積した雪（除雪された及び降雪した雪）を消雪パネルの裏面を流動する熱媒体（例えば地下水などの温水）で溶融することが行われている。

【0003】

この種の消雪装置として、例えば特許文献1には、上面が放熱面である薄い平板と、この平板の下面に接合した、複数列の幅広で浅い凹部、およびこの凹部各列となり同士をつなぐ幅広で浅い凹部、からなる連続した凹部を有する溝付板と、この溝付板の連続した幅広で浅い凹部と前記平板とで形成される幅広で浅い流路の両端に設けた配管接続口と、からなる消雪用放熱器において、前記平板と溝付板との周囲を取り囲む帯薄板に延長部を設けて、前記溝付板の下面と敷設面との間に間隙を設け、該間隙に向けて前記配管接続口を開口した消雪用放熱器が記載されている。また、溝付板の周囲を取り囲む帯薄板は箱形を形成させて消雪用放熱器の強度を大きくさせることが記載されている。

【0004】

また、特許文献2には、特許文献1に記載の消雪用放熱器を水平に対して勾配を設けて設置することが記載されている。また、特許文献3には、特許文献1における溝付板を、台形状断面を有する直線溝部材と、U字溝部材とを接合して構成することが記載されている。そして、これらの消雪装置を構成する平板と溝付板とは専ら溶接接合されている。

【0005】

【特許文献1】特公平6-76681号公報

【特許文献2】特開平11-152701号公報

【特許文献3】特開2007-85057号公報

【発明の開示】

【発明が解決しようとする課題】

【0006】

しかしながら、特許文献1及び2に記載のものでは、接合の際には、大きな溶接歪が発生する。特に、平板の一面と溝付板とを溶接接合するために、平板の放熱面が凹となる歪が生じやすく、消雪の際には凹部が水溜りとなり放熱面に錆びが発生させることとなる。そのために、溶接接合の後に歪取り工程を必要としていた。特許文献3に記載のものは、この歪取り工程の削減を図ったものであるが、溶接歪を低減することはできるものの、歪取り工程を撲滅するには至っていない。

【0007】

また、箱形に形成させた帯薄板を溶接で溝付板の周囲に溶接しては製造コストが嵩むという問題を有していた。更に、この種の消雪パネルは銅板を主材料にして構成するので、その重量が約100kgになり、特許文献2に記載のようにメンテナンスのために開閉可能のように構成した場合、消雪パネルと設置ベースとの間に手を挟みやすいといった問題もあった。

【0008】

本発明は、上記の事項に留意してなされたもので、製造コストを抑えるとともに放熱板の歪を低減させ、放熱板の歪から生じる水溜りや耐食性の問題を解消した消雪パネルを提供することを目的としている。また他の目的は、メンテナンス時においても安全に作業することのできる消雪パネルを提供することである。

【課題を解決するための手段】

【0009】

本発明は、上面が放熱面である薄い放熱平板と、この放熱平板の下面に溶接接合し、その一方の表面と前記放熱平板との間に熱媒体が流動するつづら折り状の流路を形成する流路形成部材とを備えた消雪パネルにおいて、前記放熱平板の周囲をL字状に折り曲げ、更にこの折り曲げ部に帯板を溶接接合したことを特徴とする消雪パネルである。

【0010】

上記の構成によれば、放熱平板の周囲をL字状に折り曲げ、更にこの折り曲げ部に帯板を溶接接合したことを特徴としているので、一旦放熱平板と流路形成部材との溶接接合によって、放熱平板の放熱面が凹となるような溶接歪が発生するものの、折り曲げ部に帯板を溶接接合することによって、放熱平板の放熱面が凸となるような溶接歪が発生する。したがって、消雪の際の放熱面の水溜りの発生を防止することができる。

【0011】

また、本発明において、前記帯板の溶接接合部ではない他端側はL字状に折り曲げ加工されていることが望ましい。

この構成によれば、消雪パネル全体の強度を更に高められるとともに、帯板の先端で手を切創する事故を防止することができる。

【0012】

また、上記発明において、前記流路形成部材は前記熱媒体が流入する第1のノズル部材と、前記熱媒体が流出する第2のノズル部材と、これらの間に配設され台形状断面を有する複数列の直線溝部材と、相隣る直線溝部材の端部が接続される複数のU字溝部材とからなり、前記直線部材、前記第1、第2のノズル部材及びU字溝部材との連結部に継目部を設け、当該継目部は固着されると共に、前記各直線溝部材はその短手方向のツバ部が長手方向の全長にわたって前記放熱平板に溶接接合されることが好ましい。

上記の構成によれば、流路形成部材を放熱平板に溶接する際の溶接歪を低減できるとともに製造コストを抑えることができる。

【0013】

また、請求項1乃至3のいずれかに記載の消雪消雪パネルを線路に沿って複数枚配置し、各々の消雪パネルは一端から持ち上げ可能とするとともに、熱媒体の供給管および排出管にフレキシブル管を用いて並列に接続し、前記帯板には、取手を設けることができる。

この構成によれば、メンテナンスのために消雪パネルを開閉した場合においても消雪パネルと設置ベースとの間に手を挟んだりする事故を防止することができる。

【発明の効果】

【0014】

本発明にかかる消雪パネルによれば、放熱平板の周囲をL字状に折り曲げ、更にこの折り曲げ部に帯板を溶接接合したことを特徴としているので、一旦放熱平板と流路形成部材との溶接接合によって、放熱平板の放熱面が凹となるような溶接歪が発生するものの、折り曲げ部に帯板を溶接接合することによって、放熱平板の放熱面が凸となるような溶接歪が発生する。したがって、消雪の際の放熱面の水溜りの発生を防止することができる。

【発明を実施するための最良の形態】

【0015】

以下に、本発明に係る消雪パネルの一実施例を添付図面に基づいて詳述する。

図1は本発明に係る消雪パネルの一実施例の底面図、図2は図1におけるA-A断面図である。図3は直線溝部材を示し、図4はU字形部材を示している。図5は図1におけるC-C断面図を示している。図6は本発明に係る消雪パネルの製造工程を示す消雪パネルの断面図、図7は溶接工程における溶接歪の状態を示す模式側面図である。また図8は本発明に係る消雪パネルを設置した状態を示す断面図である。

【0016】

図1及び図2に示すように、消雪パネル1は、略長方形の薄板鋼板製の放熱平板2と、流体が流入する第1ノズル部41と流体が排出される第2ノズル部43とを連なるように、つづら折り状に流路を形成する流路形成部材10と、放熱平板2を囲むように設けた帯板20とから主に構成している。流路形成部材10は、薄板鋼板を断面略台径に折り曲げ加工した長尺の直線溝部材11を複数列並べ、この直線溝部材11の端部同士をU字溝部材13で接続して第1ノズル部41から第2ノズル部43まで流体が流動する流路を形成している。また、消雪パネル1の長辺の一つには蝶番部17が設けられ、短辺側の帯板20には設置ベースに固定するための固定部45が設けられている。更に、消雪パネル1全体がねじれたり変形したりしないように補強部材15が（図中では3箇所）設けられている。

【0017】

放熱平板2は、図2に示すように、その周囲はL字状に折り曲げられた折り曲げ部2aが形成されている。そして、帯板20には、一端が消雪パネルの内側になるようにL字状に折り曲げられたエッジ部23と、他端側が放熱平板2の折り曲げ部2aと重なり合わせるための溶接部21が形成されている。

【0018】

図3に示すように、直線溝部材11は、その内部を流動する温水と放熱平板2との接触面積を広げるために、断面が台形状（上辺の幅Wb、底辺の幅Wa）に形成され、両側の全長（L2）にわたってツバ部11aを有した長尺の部材である。

【0019】

また、図4に示すようにU字溝部材13は、半円形部13aと、段付部13bからなる。図6に示すように、各U字溝部材13は、段付部13bに直線溝部材11の端部が差し込まれるように設置されている。これらのU字溝部材13は、直線溝部材11の両方の端部に並置されており、U字溝部材13と直線溝部材11とにより、相隣り合う直線溝部材同士が連通して、単一の流路が形成される（図1参照）。

【0020】

続いて、消雪パネル1の製造工程について、図6、図7を参照して詳細に説明する。

まず、図6（a）に示すように、放熱平板2に直線溝部材11を所定の数だけ複数本並べる。また、図示しないU字溝部材13をつづら折流路を形成するように直線溝部材11の端部に配置する（図1参照）。そして、直線溝部材11の両端に形成したツバ部11aと放熱平板2とを流路形成部材10の全長に亘って、溶接接合する。溶接接合は、シーム溶接又はアーク溶接が好適である。

【0021】

このとき、放熱平板2には、流路形成部材10を溶接接合する面のみが加熱されることとなる。すると、溶接を施したツバ部11aが収縮し、直線溝部材11の熱影響を受けていない部分（直線溝部材11のツバ部11aを除いた大部分）としては収縮しないので、図7（a）に示すように、薄板からなる放熱平板2の放熱面2bが凹面となるように歪が発生する。このままの状態では、消雪パネルで消雪した水が凹面に溜まり、その部分から放熱平板2を腐食させてしまうこととなる。

【0022】

そこで、図6（b）に示すように、放熱平板2の周囲をプレス等を用いて折り曲げ加工して折り曲げ部2aを形成する。そして、この折り曲げ部2aに帯板20の溶接部21を重ね合わせ、溶接接合する。すると、図7（b）に示すように、帯板20の溶接の影響を受けて折り曲げ部2aが収縮するので、放熱平板2の放熱面2bが凸面となるような歪を生じる。最後に、流路形成部材10の両端に第1ノズル部材41及び第2ノズル部材43を接続し、溶融亜鉛メッキ処理を施して消雪パネル1が得られる。放熱面2bが凸面となるように設けていれば、放熱面に水が溜まることはなく、消雪パネルが腐食することを防止できる。

なお、溶接によって生じる歪量は、溶接長さや溶接熱量を調整することで、増減することが可能である。

【0023】

続いて、消雪パネル1の使用状態について、図8を用いて詳細に説明する。

図8（a）に示すように、線路等の軌道に沿って、コンクリート製の基礎61が設けられる。基礎61には、雨水を排出したり電線等を配設したりするための側溝63が形成されている。そして、側溝壁65に沿って、消雪パネル1への熱媒体を給排水する供給管51、排水管53が設けられる。基礎61の上には設置ベース50が設けられ、この設置ベース50の上に消雪パネル1が一辺を蝶番部17（図1参照）で開閉可能のように設置される。

【0024】

そして、消雪パネル1の第1ノズル、第2ノズルにはスィベルジョイント57が接続され、供給管51、排水管53との間はフレキシブル管55で接続されている。なお、この消雪パネル1は、軌道に沿って複数枚設置される。

【0025】

熱媒体には例えば不凍液が用いられ、積雪が始まると図示しないボイラ室で不凍液を10℃程度に加熱して、ポンプによって供給管51を経由し、消雪パネル1に供給される。消雪パネル1に積雪した雪は、ここで熱交換して融かされ、不凍液は排水管53を経由してボイラ室へ戻され再び10℃程度に加熱される。

【0026】

ところで、側溝63に配設した電線等のメンテナンスが必要な場合がある。その場合には、図8（b）に示すように、取手59を利用して消雪パネル1を上方に開くことができるようになっている。取手59を用いて消雪パネル1の開閉作業を行うことで、指を挟んでしまうような事故を防止することができる。

【図面の簡単な説明】

【0027】

【図1】本発明に係る消雪パネルの一実施例の底面図である。

【図2】図1におけるA-A断面図である。

【図3】直線溝部材を示し、（a）は正面図、（b）は平面図である。

【図4】U字形部材を示し、（a）は平面図、（b）は（a）のB-B線断面図である。

【図5】図1におけるC-C断面図である。

【図6】本発明に係る消雪パネルの製造工程を示す消雪パネルの断面図である。

【図7】溶接工程における溶接歪の状態を示す模式側面図である。

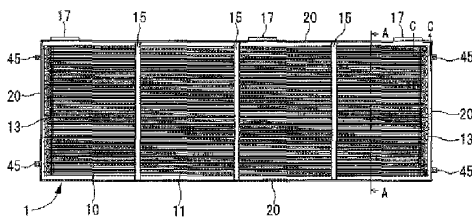
【図8】本発明に係る消雪パネルを設置した状態を示す断面図である。

【符号の説明】

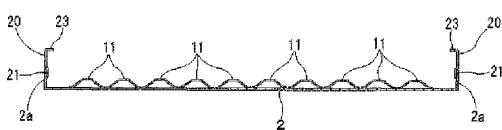
【0028】

1：消雪パネル、2：放熱平板、2a：折り曲げ部、2b：放熱面、
 10：流路形成部材、11：直線溝部材、11a：ツバ部、13：U字溝部材、13a：
 半円径部、13b：段付部（継目部）、15：補強部材、17：螺番部、
 20：帯板、21：溶接部、23：エッジ部、
 41：第1ノズル部材、43：第2ノズル部材、45：固定部、
 50：設置ベース、51：供給管、53：排水管、55：フレキシブル管、57：スィベ
 ルジョイント、59：取手、
 61：基礎、63：側溝、65：側溝壁、

【図1】

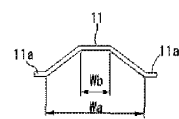


【図2】

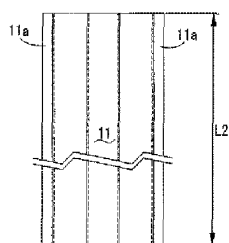


【図3】

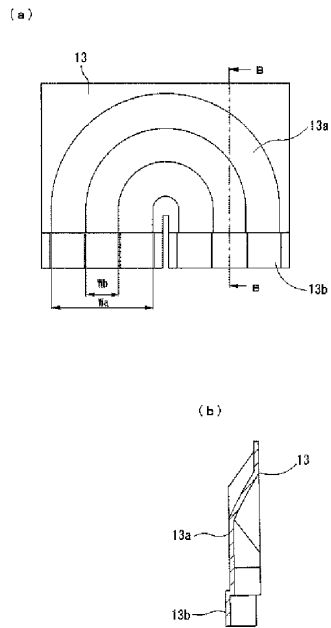
(a)



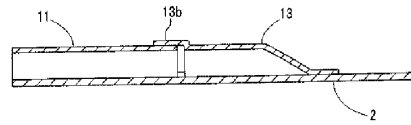
(b)



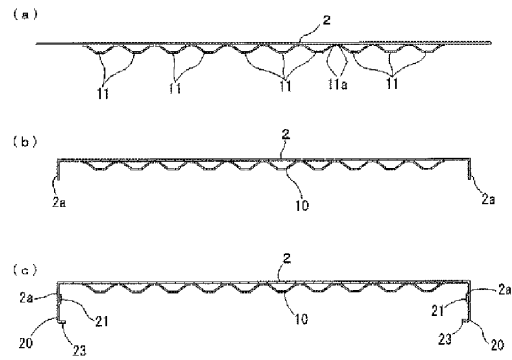
【図4】



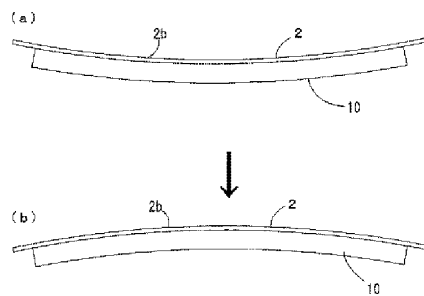
【図5】



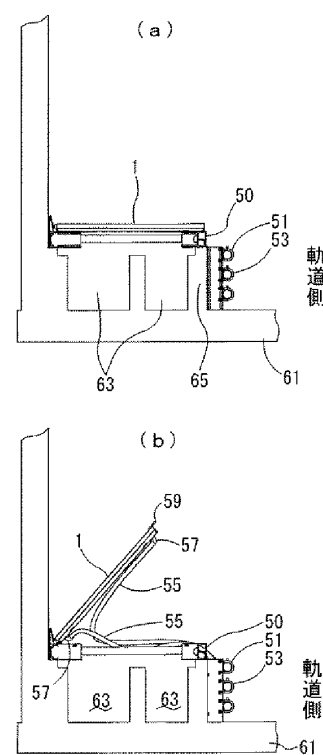
【図6】



【図7】



【図8】



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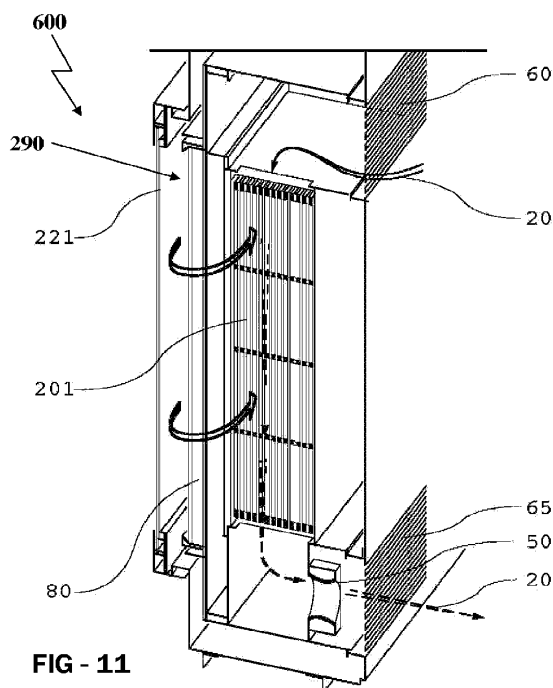
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(54) Title: THERMAL CONTROL SYSTEM FOR AN ELECTRONIC DISPLAY



(57) Abstract: A cooling assembly for an electronic image assembly and a display assembly containing the same. Some embodiments use ambient gas to cool power modules and/or an image assembly (sometimes backlight). Other embodiments use a closed loop of circulating gas which passes across the front surface of an image assembly and through a heat exchanger. An open loop passes through the heat exchanger and extracts heat from the circulating gas. Ambient air may be used as the ambient gas. An optional additional channel may be used to cool the back portion of the image assembly or backlight with ambient gas. Some embodiments also use thermally conductive plates and ribs to distribute the heat and avoid hot spots in the display. The cooling assembly can be used with any type of electronic assembly for producing an image.

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Thermal Control System for an Electronic Display

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Technical Field

[0001] The exemplary embodiments generally relate to cooling systems and in particular to cooling systems for electronic displays.

Background of the Art

[0002] Conductive and convective heat transfer systems for electronic displays generally attempt to remove heat from the electronic components in a display through as many sidewalls of the display as possible. In order to do this, the systems of the past have relied primarily on fans for moving internal air within the housing past the components to be cooled and out of the display. These components are typically power supplies. In some cases, the heated air is moved into convectively thermal communication with fins.

[0003] While such heat transfer systems have enjoyed a measure of success in the past, improvements to displays and new display applications require even greater cooling capabilities. In particular, cooling devices for electronic displays of the past have generally used convective heat dissipation systems that function to cool only the rear interior portion of the display. When used outdoors or in other warm environments, this is not adequate, especially when radiative heat transfer from the sun through a front display surface becomes a major factor. In many applications 200 Watts or more of power through a front display surface is common. Furthermore, the market is demanding larger screen sizes for displays. With increased electronic display screen size and corresponding front display surface size more heat will be generated and more heat will be transmitted into the displays. Also, when displays are used in outdoor environments the ambient air may contain contaminants (dust, dirt, pollen, water vapor, brake dust, sand, smoke, etc.) which, if ingested into the display for cooling the interior can cause damage to the interior components of the display.

[0004] Modern displays (especially those which are used outdoors) have become increasingly brighter, with some backlights producing 1,000-2,000 nits or more. In order to produce this level of brightness, illumination devices such as CCFL assemblies, LEDs, organic LEDs, and plasma assemblies may produce a relatively large amount of heat. Further, the illumination devices require a relatively large amount of power in order to generate the required brightness level. This large amount of power is typically supplied through one or more power supplies for the display. These power supplies may also become a significant source of heat for the display.

[0005] A large fluctuation in temperature is common when devices of the past are used in outdoor environments, direct sunlight, or other difficult thermal environments. Such temperature fluctuation adversely affects both the lifetime and the performance of the electronic components in these devices.

Summary of the Exemplary Embodiments

[0006] While the systems of the past have attempted to remove heat only through the non-display sides and rear components of an electronic display, a preferred embodiment may cause convective heat transfer from the front face of the image assembly as well (the side which faces an intended viewer). These preferred embodiments may comprise two separate flow paths for gas through an electronic display. A first flow path may be a closed loop and a second flow path may be an open loop. The closed loop path travels across the front surface of the image assembly, continues to the rear of the display where it may enter a heat exchanger, finally returning to the front surface of the image assembly. The open loop path draws gas (ex. ambient air) through the rear of the display (possibly through a heat exchanger) and then exhausts it out of the display housing. A heat exchanger may be used to transfer heat from the closed loop to the open loop and exhausted out of the display. Optionally, the open loop may also be forced behind the image assembly (sometimes a backlight other times an OLED or other type of image-producing assembly), in order to cool the image assembly and/or backlight assembly (if a backlight is necessary for the

particular type of display being used). A cross-flow heat exchanger may be used in an exemplary embodiment.

[0007] Other embodiments relate to a system for cooling the following portions of an electronic display, either alone or in combination: (1) power module(s), (2) backlight, and (3) front display surface. Power modules with heat dissipating assemblies (ex. cold plates and/or heat sinks) may be used with some embodiments where the side of the power module containing the heat dissipating assembly is placed in the path of ambient gas while the side of the power module containing sensitive electrical components remains in a separate environment. An isolating structure may provide the necessary gaseous (and sometimes particulate/contaminate) isolation between the two sides of the power modules. The closed loop may or may not be used when cooling the power modules with an open loop of ambient gas.

[0008] Backlights with a front and rear sides may be used with some embodiments for LCD displays where the front side contains the illumination devices and the rear side contains a thermally conductive surface for dissipating the heat from the illumination devices. Ideally, there should be a low level of thermal resistance between the front and rear sides of the backlights.

[0009] Other embodiments may place the power modules in thermal communication with a plurality of thermally conductive ribs where the ribs are placed in the path of cooling air (sometimes ambient gas). The heat from the power modules is distributed throughout the ribs and removed by the cooling air. It has been discovered that forcing air through the relatively narrow channels defined by the ribs improves the ability to remove heat from the power modules.

[0010] In another embodiment, both the power modules and the display backlight (or image assembly) are in thermal communication with the ribs. In this way, a single path of cooling air (sometimes ambient gas) can be used to cool two of the warmest components of a typical electronic display. For example, and not by way of limitation, LED arrays are commonly used as the illumination devices for LCD displays. It has been found that the optical properties of LEDs (and other illumination devices) can vary depending on temperature. Thus, when an LED is exposed to room temperatures, it may output light with a certain luminance, wavelength, and/or color temperature.

However, when the same LED is exposed to high temperatures, the luminance, wavelength, color temperature, and other properties can vary. Thus, when a temperature variation occurs across an LED backlight (some areas are at a higher temperature than others) there can be optical inconsistencies across the backlight which can be visible to the observer. By using the embodiments herein, heat buildup can be evenly distributed across the ribs and removed from the display. This can prevent any potential 'hot spots' in the backlight which may become visible to the observer because of a change in optical properties of the illumination devices (sometimes, but not always LEDs). In other embodiments, the image assembly (rather than a backlight) is in thermal communication with the ribs. The image assembly may comprise any form of electronic assembly for generating an image, including but not limited to: LCD, light emitting diode (LED), organic light emitting diode (OLED), field emitting displays (FED), light-emitting polymers (LEP), plasma displays, and any other flat/thin panel displays.

[0011] The ribs may provide an isolated chamber from the rest of the display so that ambient air can be ingested and used to cool the ribs. This is beneficial for situations where the display is being used in an outdoor environment and the ingested air may contain contaminants (pollen, dirt, dust, water, smoke, etc.) that would damage the sensitive electronic components of the display.

[0012] If a backlight is used with the particular display application, a backlight with front and rear sides may be used where the front side contains the illumination devices and the rear side contains a thermally conductive surface for dissipating the heat from the illumination devices. Ideally, there should be a low level of thermal resistance between the front and rear sides of the backlights. An exemplary embodiment contains a metal core PCB with LEDs on the front side and a metallic surface on the rear side.

[0013] By the aspects described below, the exemplary embodiments herein have made consistent cooling possible for large electronic displays, even in hot climates and placed in direct sunlight. The embodiments also do not require any form of air conditioner (although it may be used if desired), which reduces the space and energy requirements for the display.

[0014] The foregoing and other features and advantages of the exemplary embodiments will be apparent from the following more detailed description of the particular embodiments of the invention, as illustrated in the accompanying drawings.

Brief Description of the Drawings

[0015] A better understanding of an exemplary embodiment will be obtained from a reading of the following detailed description and the accompanying drawings wherein identical reference characters refer to identical parts and in which:

[0016] **FIGURE 1** is a perspective view of a typical power module;

[0017] **FIGURE 2** is a perspective view of two power modules installed within an isolating structure;

[0018] **FIGURE 3** is a perspective view of an embodiment where the cooling air may be used to cool the power modules and a backlight assembly;

[0019] **FIGURE 4** is a perspective view of an embodiment which is similar to that which was shown in Figure 3 with the exception that a heat sink is now being used with the power modules;

[0020] **FIGURE 5** shows a perspective view of an embodiment where a plurality of channels are created between the backlight assembly and the isolating structure;

[0021] **FIGURE 7** shows a perspective section view of another embodiment which uses a thermally-conductive plate and thermally-conductive ribs;

[0022] **FIGURE 8** shows a perspective section view of another embodiment where the ribs are used to distribute heat from and cool a backlight assembly;

[0023] **FIGURE 9** is a rear perspective view of an embodiment where the rear cover of the display has been removed;

[0024] **FIGURE 10A** is a perspective section view of another embodiment showing the closed loop and open loop channels;

[0025] **FIGURE 10B** is a perspective section view similar to the view shown in Figure 10A where the rear and side covers have been removed;

[0026] FIGURE 11 is a perspective section view of another embodiment showing inlet and exhaust apertures for the ambient gas which is used only within the heat exchanger and not within additional optional channels; and

[0027] FIGURE 12 is a perspective section view of an exemplary embodiment where a cross-flow heat exchanger is used to separate high power and low power electrical assemblies.

Detailed Description

[0028] FIGURE 1 shows one embodiment of a typical power module 7 which may be used with some of the embodiment described herein. A printed circuit board 6 may be attached to the power module 7 and may contain a plurality of electronic components 5 which may be necessary to operate and control the power module 7. These electronic components 5 may include, but are no means limited to resistors, capacitors, op-amps, wire harnesses, connectors, and inductors. A baseplate 8 may be attached to the power module 7 and may act as a heat dissipating assembly for the power module 7, such that heat which is generated by the power module 7 is transferred to the baseplate 8. In some embodiments there may be more components used, such as a conductive pad located between the power module and the baseplate 8. Also, as discussed further below, any type of heat sink or fin assembly may be used with the baseplate 8 to further enhance its thermodynamic properties. There may be conductive pads placed between the baseplate 8 and a heat sink assembly also.

[0029] FIGURE 2 shows two power modules installed within an isolating structure 9 which substantially prevents gaseous and contaminate communication between the two sides of the power module. The baseplates 8 of the power modules are shown on the side of the isolating structure 9 where surrounding-environment cooling air 4 is designed to pass over the baseplates 8. Gaskets 11 may be used to provide a gaseous (and/or contaminate) seal between the power modules and the isolating structure 9. Cooling air 4 is sometimes drawn from the environment surrounding the display. This environment may contain harmful contaminants which could damage various electrical components in the display. These harmful contaminants include, but

are not limited to: dust, smoke, pollen, water vapor, other harmful particulate and other harmful gases. Thus, one of the purposes for the isolating structure 9 is to prevent the surrounding-environment cooling air 4 from contacting some of the sensitive electronic components of the display, including but not limited to the electronic components 5 (shown in Figure 1) which are required to operate and control the power modules. By mounting the power modules within the isolating structure 9, surrounding-environment cooling air 4 can be drawn into the display housing and forced over the baseplates 8 (and optional heatsinks and fins) in order to cool the power modules. This can be accomplished without exposing sensitive electronic components to the potentially harmful surrounding-environment cooling air 4.

[0030] FIGURES 3 and 4 show embodiments where the cooling air 4 may be used to cool the power modules and a backlight assembly 140. These embodiments show a backlight assembly 140 which contains a plurality of illumination devices (ex. LEDs) 141 which are mounted to a printed circuit board (PCB). An exemplary embodiment would use a metal core PCB or any other mounting structure which would have a relatively low level of thermal resistance so that heat can transfer from the illumination devices 141 to the rear surface of the backlight assembly 140 where it can be removed by the cooling air 4. The illumination devices 141 could be LED, halogen, CCFL, or any other device which produces light. Further, a backlight assembly may not even be necessary for some embodiments such as plasma, OLED, LEP, or FED displays. However, these display types are also known to generate heat and where backlight cooling is described in this application these methods could also be applied to the cooling of rear surfaces of these electronic image assemblies. Thus, where backlight assemblies are shown, a plasma, OLED, FED, or LEP image assembly could be substituted. The electronic components 5 may be isolated from the cooling air 4 by using the isolating structure 9.

[0031] FIGURE 4 shows an embodiment which is similar to that which was shown in Figure 3 with the exception that a heat sink 12 is now in thermal communication with the power modules in order to further facilitate the transfer of heat away from the power modules. It should of course be noted that many types of heat sinks are available which are made of many different materials and have many different geometry types.

Any form of heat sink is particularly contemplated with various embodiments and may be used to satisfy different operating conditions.

[0032] FIGURE 5 shows another embodiment where a plurality of channels 15 are created between the backlight assembly 140 and the isolating structure 9. Channel separators 16 may be used to separate each channel 15 and provide structural rigidity to the overall assembly. The channel separators 16 would preferably be fabricated out of thermally conductive material so that they may also transfer heat between the backlight assembly 140 and the isolating structure 9. A thermally conductive channel separator 16 can also extract heat from either the backlight assembly 140 or the isolating structure 9 and may dissipate the heat into the air moving through the channel 15. Thus, some channel separators 16 may contain fins or heat sinks in order to facilitate heat transfer to the air moving through the channel 15.

[0033] FIGURE 6 shows a view down a single channel 15 which contains the heat sink 12 for a power module which is mounted within the isolating structure 9. Some channels 15 may contain power modules and others may not. A channel fan 17 may be used to draw air through the channel 15 in order to cool the heat sink 12 (if used) and the channel separators 16 (if thermally conductive) as well as the backlight 140 (or LED assembly for an LED display). Each channel 15 may contain one or more channel fans 17. Some channels may not contain a fan at all, but may rely solely on natural convection to allow heat to rise and exit the channel. As will be discussed at length below, the fans can be placed anywhere in the display assembly and may be used to draw air through the channels, push air through the channels, or a combination of both.

[0034] While the display is in operation, the channel fans 17 may run continuously. Alternatively, temperature sensing devices (not shown) may be placed in each channel and used to measure the temperature within the channel or any of the channel components (backlight or display assembly, isolating structure, or channel separators). Based on data received from these temperature sensing devices, the various fans may be selectively engaged depending on which channel requires cooling. Thus, fans 17 which draw air through channels 15 which contain power modules may run more often or at higher speeds due to the greater amount of heat coming from the power modules.

Also, channels which contain power modules may contain larger fans or a plurality of fans in order to cool the channel.

[0035] FIGURE 7 shows another embodiment which uses a thermally-conductive plate 10 and ribs 18. In one embodiment, the baseplate 8 of the power module would be in thermal communication with the thermally-conductive plate 10. In other embodiments, a baseplate 8 may not be used and instead, the power module 7 would be in direct thermal communication with the thermally conductive plate 10. Due to the thermally-conductive nature of the plate 10 and ribs 18 and the thermal communication between them, heat which is produced by the power modules would be distributed throughout the plate 10 and ribs 18. In an exemplary embodiment, a path of cooling air 20 (ambient gas) is used to remove the heat which has accumulated on the plate 10 and ribs 18. Alternatively, a natural convection process could also be used to allow the heat to escape the plate 10 and ribs 18.

[0036] A plurality of mounting posts may be used to mount electronic assemblies such as PCBs, hard drives, timing and control boards, inductors, and even the power modules if desired. The mounting posts may also be thermally conductive so that the heat which is generated by these electronic assemblies can also be transferred to the plate 10 and the ribs 18 and removed by the cooling air 20.

[0037] In an exemplary embodiment, the plate 10 would provide a gaseous and contaminate barrier between the side containing the ribs 18 (and cooling air 20) and the side containing the mounting posts, power modules, and any other electronic assemblies. If the plate 10 provides an adequate barrier, ambient air may be ingested as cooling air 20 and the risk of contaminants entering the side of the plate 10 containing the sensitive electronic components may be reduced or eliminated. An inlet aperture 25 may be used to accept the cooling air 20 and direct it along the ribs 18.

[0038] The ribs 18 shown in this embodiment contain a hollow rectangular cross-section, but this is not required. Other embodiments may contain ribs with I-beam cross-sections, hollow square cross-sections, solid rectangular or solid square cross-sections, 'T' cross-sections, 'Z' cross-sections, corrugated or honeycomb cross-section, or any combination or mixture of these. It is preferable that the ribs 18 are thermally conductive. Metal may be used to produce the ribs 18 in some embodiments.

[0039] FIGURE 8 shows another embodiment where the ribs 18 are used to distribute heat from and cool a backlight assembly. The backlight assembly in this embodiment includes a plurality of illumination devices 32 which are mounted on a thermally conductive substrate 30. In an exemplary embodiment, the illumination devices 32 would be LEDs and the thermally conductive substrate 30 would be a PCB and more preferably a metal core PCB. On the surface of the thermally conductive substrate 30 which faces the ribs 18 there may be a thermally conductive surface 35. In an exemplary embodiment, the thermally conductive surface 35 would be metallic and more preferably aluminum. It is preferred that the ribs 18 are in thermal communication with the rear surface 35 and that the rear surface 35 is in thermal communication with the thermally conductive substrate 30. In some embodiments however, the thermally conductive substrate 30 may comprise traditional PCB materials rather than a metal core PCB or any highly thermally conductive materials. It is most preferable that there is a low level of thermal resistance between the illumination devices 32 and the ribs 18. Cooling air 20 may again be forced along the ribs 18 in order to remove heat from the backlight assembly. Of course, this could also occur through natural convection, but more efficient cooling has been typically observed through forced convection. An image assembly (such as an OLED display which may not utilize a backlight) could also be used in place of the backlight assembly in order to cool the image assembly.

[0040] As noted above, many illumination devices (especially LEDs and OLEDs) may have performance properties which vary depending on temperature. When 'hot spots' are present within a backlight or illumination assembly, these hot spots can result in irregularities in the resulting image which might be visible to the end user. Thus, with the embodiments described herein, the heat which may be generated by the backlight assembly can be distributed throughout the various ribs and thermally-conductive surfaces to remove hot spots and cool the backlight.

[0041] In an exemplary embodiment, the ribs 18 may be used to cool both the backlight assembly and the power modules. In a further exemplary embodiment, the ribs 18 can also be used to cool any additional electronic assemblies by placing them in thermal communication with the thermally-conductive plate 10. Thus, with the ribs 18 in a central location, the 'front' would be towards an intended observer of the display while

the 'back' would be on the opposite side of an intended observer. Therefore, the front side of the ribs 18 would be in thermal communication with a backlight assembly (or other illumination or image-producing assembly) and the rear side of the ribs would be in thermal communication with a rear plate (i.e. thermally-conductive plate 10). A single path of cooling air can then be used to cool the interior of the display while the various hot spots can distribute heat throughout the ribs and other thermally conductive surfaces to provide the most efficient cooling. This can be accomplished without having to expose sensitive electrical components to the contaminants and/or particulate of ambient gas.

[0042] **FIGURE 9** shows the rear of an exemplary electronic display 100, where the rear cover for the display housing has been removed in order to show the internal components. In this embodiment, fan assemblies 102 and 103 for a closed loop of circulating gas may be placed along two opposing edges of a heat exchanger 101. Preferably, fan assembly 102 is the inlet for the heat exchanger and fan assembly 103 is the exit for the heat exchanger 101. These assemblies can optionally be reversed however, where fan assembly 103 is the inlet and fan assembly 102 is the exit. Further, both assemblies 102 and 103 are not required. Some embodiments may use only one fan assembly for the closed loop of circulating gas. If only one fan assembly is used, it is preferable to place the fan assembly at the inlet of the heat exchanger 101, so that the circulating gas is 'pulled' across the front of the image assembly and pushed through the heat exchanger 101. This is not required however; other embodiments may pull the isolated gas through the heat exchanger 101. Other embodiments may push the isolated gas across the front of the image assembly. Fan assemblies 104 and 105 for an open loop of ambient gas may be placed along two opposing edges of the display housing. Again, both assemblies 104 and 105 are not required as some embodiments may use only one assembly and may use the open loop fan assemblies in a push or pull design. Therefore, when referring to the placement of the various fan assemblies, the terms 'push', 'pull', 'force', and 'draw' will be used interchangeably and any orientation may be used with the various embodiments herein.

[0043] The circulating gas which is being forced by the closed loop fan assemblies is primarily circulating around the display. For example, the circulating gas travels in a

loop where it contacts the front surface of the image assembly (see Figures 10A-10B) and transfers heat from the image assembly to the circulating gas. The circulating gas is then preferably directed (or forced, pulled, etc.) into the heat exchanger 101 in order to transfer heat from the circulating gas to the ambient gas. Afterwards, the circulating gas exits the heat exchanger 101 and may return to the front surface of the image assembly. The circulating gas may also pass over several electronic components 110 in order to extract heat from these devices as well. The electronic components 110 may be any components or assemblies used to operate the display including, but not limited to: transformers, circuit boards, resistors, capacitors, batteries, power modules, motors, inductors, illumination devices, wiring and wiring harnesses, lights, thermo-electric devices, and switches. In some embodiments, the electrical components 110 may also include heaters, when the display assembly might be used in cold-weather environments.

[0044] In order to cool the circulating gas (as well as optionally cooling a backlight assembly or image assembly as taught above) ambient gas is ingested into the display housing by the open loop fan assembly 104 and/or 105. The ambient gas may simply be ambient air which is surrounding the display 100. In some embodiments, the ambient gas may be air conditioned prior to being drawn into the display by one or more air conditioning assemblies (not shown). Once the ambient gas is ingested into the display, it may be directed (or forced) through the heat exchanger 101 and optionally also across the rear surface of the backlight assembly or image assembly (see Figures 10A-10B) or through ribs/channels as shown above or across power modules as shown above. By using the heat exchanger 101, heat is transferred from the circulating gas to the ambient gas. The heated ambient gas is then expelled out of the display housing.

[0045] Although not required, it is preferable that the circulating gas and ambient gas do not mix. In a preferred embodiment, the heat exchanger 101 would be a cross-flow heat exchanger. However, many types of heat exchangers are known and can be used with any of the embodiments herein. The heat exchanger 101 may be a cross-flow, parallel flow, or counter-flow (tube-within-a-tube or otherwise) heat exchanger. In an exemplary embodiment, the heat exchanger 101 would be a cross-flow and would be comprised of a plurality of stacked layers of thin plates. The plates may have a

corrugated or honeycomb design, where a plurality of channels or pathways travel down the plate length-wise. The plates may be stacked such that the directions of the pathways are alternated with each adjacent plate, so that each plate's pathways are substantially perpendicular to the pathways of the adjacent plates. Thus, gas may enter the heat exchanger only through plates whose channels or pathways travel parallel to the path of the gas. Because the plates are alternated, the closed loop and ambient gases may travel in plates which are adjacent to one another and heat may be transferred between the two gases without mixing the gases themselves (if the heat exchanger is adequately sealed, which is preferable but not required).

[0046] In an alternative design, an open gap may be placed in between pairs of channelized or honeycomb plates. The open gap may travel in a direction which is perpendicular to the channels of the plates. This open gap may be created by running two strips of material or tape (esp. very high bond (VHB) tape) between two opposite edges of the plates in a direction that is perpendicular to the direction of the channels in the adjacent plates. Thus, gas may travel through the open gap (parallel to the strips or tape) but would not pass through the open gap in a direction which is perpendicular to the strips or tape (parallel to the channels of the adjacent plates).

[0047] Other types of cross-flow heat exchangers could include a plurality of tubes which contain the first gas and travel perpendicular to the path of the second gas. As the second gas flows over the tubes containing the first gas, heat is exchanged between the two gases. Obviously, there are many types of cross-flow heat exchangers and any type would work with the embodiments herein.

[0048] An exemplary heat exchanger may have plates where the sidewalls are relatively thin so that heat can easily be exchanged between the two paths of gas. A plurality of materials can be used to create the heat exchanger. Preferably, the material used should be corrosion resistant, rot resistant, light weight, and inexpensive. Metals are typically used for heat exchangers because of their high thermal conductivity. However, it has been discovered that plastics and composites can also satisfy the thermal conditions for electronic displays. An exemplary embodiment would utilize polypropylene as the material for constructing the plates for the heat exchanger. It has been found that although polypropylene may seem like a poor thermal conductor, the

large amount of surface area relative to the small material thickness, results in an overall thermal resistance that is low. Thus, an exemplary heat exchanger would be made of plastic and would thus produce a display assembly that is thin and lightweight. Specifically, corrugated or honeycomb plastic may be used for each plate layer.

[0049] As mentioned above, both inlet and exit fan assemblies are not required for the embodiments. Alternatively, only a single fan assembly may be used for each loop. Thus, only an inlet fan assembly may be used with the closed loop and only an exhaust fan assembly may be used with the open loop. Alternatively, one of the loops may have both inlet and exit fan assemblies while the other loop only has either an inlet or exit assembly.

[0050] The gas used in both loops can be any number of gaseous matters. In some embodiments, air may be used as the gas for both loops. Preferably, the gas which travels through the closed loop should be substantially clear, so that when it passes in front of the image assembly it will not affect the appearance of the image to a viewer. The gas which travels through the closed loop should also be substantially free of contaminants and/or particulate (ex. dust, dirt, pollen, water vapor, smoke, etc.) in order to prevent an adverse effect on the image quality and damage to the internal electronic components. It may also be preferable to keep the gas within the open loop from having contaminants. An optional filter (not shown) may be used to ensure that the air (either in the closed or open loop) stays free of contaminants. However, in an exemplary embodiment the open loop may be designed so that contaminants could possibly be present within the ambient gas but this will not harm the display. In these embodiments, the heat exchanger (and the optional path behind the image assembly or backlight or through the ribs) is properly sealed so that any contaminants in the ambient gas would not enter sensitive portions of the display. Thus, in these exemplary embodiments, ingesting ambient air for the ambient gas, even if the ambient air contains contaminants, will not harm the display. This can be particularly beneficial when the display is used in outdoor environments or indoor environments where contaminants are present in the ambient air.

[0051] **FIGURE 10A** shows a cross-section of another embodiment of a display 200. In this figure, the rear cover 250 and side covers 251 and 252 are shown to illustrate

one method for sealing the overall display 200. The image assembly 220 is shown near the front of the display 200. As discussed above, the image assembly 220 may comprise any form of electronic assembly for generating an image, including but not limited to: LCD, light emitting diode (LED), organic light emitting diode (OLED), field emitting displays (FED), light-emitting polymers (LEP), plasma displays, and any other flat/thin panel displays. The front display surface 221 is placed in front of the image assembly 220, defining a channel 290 through which the circulating gas may flow. The front display surface 221 may be any transparent material (glass, plastic, or composite) and may comprise several layers for polarizing light, reducing glare or reflections, and protecting the internal display components. In an exemplary embodiment, the front display surface 221 would comprise two panes of glass which are laminated together with optical adhesive (preferably index-matching). Further, a polarizing layer may be attached to one of the panes of glass in order to reduce the internal reflections and solar loading on the image assembly 220. It is most preferable that the polarizing layer be attached to the inner surface of the front display surface 221 (the one facing the closed loop channel 290) and also contain an anti-reflective (AR) coating.

[0052] For the embodiment shown in Figure 10A, the image assembly 220 may be an LCD stack with a backlight assembly 222. Some backlights may use cold cathode fluorescent lamps (CCFLs) to produce the illumination necessary for generating an image. In an exemplary embodiment, the backlight assembly 222 would comprise a printed circuit board (PCB) with a plurality of LEDs (light emitting diodes) on the front surface. As discussed above, an exemplary embodiment would have a low level of thermal resistance between the front surface of the backlight assembly 222 and the rear surface 223 of the backlight. A metallic PCB may be used for this purpose. The rear surface 223 of the backlight may contain a thermally conductive material, such as a metal. Aluminum may be an exemplary material for the rear surface 223. A second surface (or plate) 224 may be placed in close proximity behind the rear surface 223 of the backlight assembly 222. The space between the rear surface 223 of the backlight and the second surface 224 may define an additional optional open loop channel 225 through which ambient gas may travel in order to cool the backlight assembly 222. This

open loop channel 225 may be similar to the channel 15 shown above, except open loop channel 225 may be narrower.

[0053] FIGURE 10B shows the same cross section from Figure 10A with the rear cover 250 and side covers 251 and 252 removed and the closed and open loop air flows shown for explanatory purposes. The closed loop fan assembly 202 is used to propel the circulating gas 210 around the closed loop. A first open loop fan assembly 203 may be used to draw ambient gas 211 through the heat exchanger 201. Optionally, a second open loop fan assembly 204 may be used to draw ambient gas 212 through the optional channel 225 for cooling the backlight assembly 222. The optional second open loop fan assembly 204 can also be used to exhaust ambient gas which has traveled through the heat exchanger 201 and through the channel 225. If a second open loop fan assembly 204 is not used, the first open loop fan assembly 203 may be used to exhaust the ambient gas 211 that has traveled through the heat exchanger 201.

[0054] As noted above, in an exemplary embodiment the ambient gas does not mix with the circulating gas. It may be important for the image quality that the circulating gas remains free of particulate and contaminates as this gas travels in front of the image assembly 220. Since gas for the open loop may contain various contaminates, a preferable embodiment should be adequately sealed to prevent the gas from the two loops from mixing. This is not necessary however, as filters (either removable or permanent) may be used to minimize the effect of particulate for both the open and closed loops.

[0055] FIGURE 11 is a perspective section view of another embodiment of a display assembly 600 showing inlet 60 and exhaust 65 apertures for the ambient gas 20. The inlet aperture 60 may contain a screen or filter (removable or permanent) to remove any particulate (although this may not be necessary). One or more fans 50 may be used to draw the ambient gas 20 into the inlet aperture 60 and through the heat exchanger 201. In this embodiment, the ambient gas 20 is only drawn through the heat exchanger 201 and not through any additional optional channels or ribs. This embodiment may be used when the display assembly 80 (or backlight assembly) does not require the additional cooling of an additional channel. For example, and not by way of limitation,

this embodiment 600 may be used when an OLED is used as the image assembly 80. Further, this embodiment 600 may be used when the LCD backlight is not generating large amounts of heat because it is not required to be extremely bright (perhaps because it is not used in direct sunlight). Still further, this embodiment may be used when the ambient gas 20 contains particulate or contaminants which may damage the display. In these situations, it may be desirable to limit the exposure of the display to the ambient gas 20. Thus, in these situations it may be desirable to only ingest ambient gas 20 into the heat exchanger 201 and not through any additional cooling channels.

[0056] In some embodiments, the ambient gas 20 may be air conditioned (or otherwise cooled) before it is directed into the heat exchanger 201. A front display surface 221 may be used to create an anterior (front) wall of the channel 290 and/or protect the image assembly 80 from damage. An exemplary front display surface 221 may be glass. Another embodiment for the front display surface 221 may be two panes of glass which are laminated together using optical adhesive. Solar loading (radiative heat transfer from the sun through the front display surface 221 may result in a heat buildup on the image assembly 80 (ex. OLED or LCD assembly). This heat may be transferred to the circulating gas, where this heat may then be transferred to the ambient gas 20 and expelled from the display. The image assembly could be any one of the following: LCD, plasma display assembly, OLED, light emitting polymer (LEP) assembly, organic electro luminescence (OEL) assembly, or LED display assembly.

[0057] **FIGURE 12** shows an exemplary embodiment where a circulating gas 400 is forced between a front display surface 221 and an image assembly 80 and then through a heat exchanger 201 in order to remove at least a portion of the heat absorbed from the image assembly 80 and front display surface 221. The circulating gas 400 may be propelled by a closed loop fan assembly 410. The heat exchanger 201 may accept circulating gas 400 in one direction while accepting ambient gas 310 in a substantially perpendicular direction such that heat may transfer between the two gases.

[0058] In this embodiment, an optional additional flow of ambient gas 300 is accepted through the inlet aperture 350 and directed along channel 225 in order to cool the rear portion of the image assembly 80 (possibly a backlight). This embodiment uses a set of ribs 18, similar to the designs shown above in Figures 7 and 8. This embodiment also

uses a thermally-conductive plate 10, similar to the one shown in Figure 7. When this optional additional flow of ambient gas 300 is used, it is preferable that the anterior (front) surface 500 of the channel 225 be thermally conductive and preferably in thermal communication with at least a portion (preferably the rear portion) of the image assembly 80. Inlet aperture 350 may accept both ambient gas 310 and 300, or there may be separate inlet apertures for each flow of gas 310 and 300.

[0059] Similar to some of the previously described embodiments, the circulating gas 400 also passes over electronic assemblies in order to accept heat from these electronic assemblies. In this exemplary embodiment, the electronic assemblies have been separated by the heat exchanger 201 into two groups. The first group of electronic assemblies 900 may be considered the high power assemblies and may include but are not limited to: power modules, inductors, transformers, and other power-related devices. The second group of electronic assemblies 910 may be considered the low power assemblies and may include but are not limited to: timing and control boards, hard drives and other storage devices, video cards, software drivers, microprocessors, and other control devices. It is known to those skilled in the art that some high power electronic assemblies can cause electrical interference with other electronic assemblies that may be sensitive to electrical interference. Thus, in the exemplary embodiment shown, the heat exchanger 201 is used to separate the lower power electronic assemblies 910 from the high power electronic assemblies 900 to ensure a minimum amount of interference between the two. Further, some high power electronic assemblies 900 are known to also generate heat. This heat may be transferred to the circulating gas 400 prior to introducing this gas into the heat exchanger 201. In the exemplary embodiment shown, ambient air can be ingested as the ambient gas 310 and there is little risk of damage to the electrical assemblies 910 and 900 because the ambient gas 310 would preferably never contact these electrical assemblies. However, the electrical assemblies 910 and 900 will remain cool (as well as clean and dry) because of the cross-flow from the circulating gas 400.

[0060] The cooling system described herein may run continuously. However, if desired, temperature sensing devices (not shown) may be incorporated within the electronic display to detect when temperatures have reached a predetermined

threshold value. In such a case, the various cooling fans may be selectively engaged when the temperature in the display reaches a predetermined value. Predetermined thresholds may be selected and the system may be configured to advantageously keep the display within an acceptable temperature range. Typical thermostat assemblies can be used to accomplish this task. Thermocouples may be used as the temperature sensing devices. The speed of the various fan assemblies can also be varied depending on the temperature within the display.

[0061] It should be particularly noted that the spirit and scope of the disclosed embodiments provides for the cooling of any type of electronic display. By way of example and not by way of limitation, embodiments may be used in conjunction with any of the following: LCD (all types), light emitting diode (LED), organic light emitting diode (OLED), field emitting display (FED), light emitting polymer (LEP), organic electro luminescence (OEL), plasma displays, and any other type of thin/flat panel display. Furthermore, embodiments may be used with displays of other types including those not yet discovered. In particular, it is contemplated that the system may be well suited for use with large LED backlit, high definition (1080i or 1080p or greater) liquid crystal displays (LCD). While the embodiments described herein are well suited for outdoor environments, they may also be appropriate for indoor applications (e.g., factory/industrial environments, spas, locker rooms, kitchens, bathrooms) where thermal stability of the display may be at risk.

[0062] It should also be noted that the variety of cooling channels that are shown in the figures may be shown in a horizontal or vertical arrangement but it is clearly contemplated that this can be reversed or changed depending on the particular embodiment. Thus, the closed loop may run horizontally or vertically and in a clockwise or counter-clockwise direction. Further, the open loop may also be horizontal or vertical and can run left to right, right to left, and top to bottom, or bottom to top.

[0063] Having shown and described preferred embodiments, those skilled in the art will realize that many variations and modifications may be made to affect the described invention and still be within the scope of the claimed invention. Additionally, many of the elements indicated above may be altered or replaced by different elements which

will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

CLAIMS

1. A cooling system for an electronic image assembly having a front and back portion, the system comprising:

- a front display surface spaced apart from the front portion of the electronic image assembly;
- a channel defined by the space between the front display surface and the front portion of the electronic image assembly;
- a heat exchanger in gaseous communication with the channel, the heat exchanger having first and second gas pathways, where the first gas pathway is in gaseous communication with the channel;
- a first fan assembly positioned so as to force circulating gas through the channel and the first gas pathway; and
- a second fan assembly positioned so as to force ambient gas through the second gas pathway.

2. The cooling system of claim 1 wherein:

- the heat exchanger is a cross-flow heat exchanger.

3. The cooling system of claim 1 further comprising:

- a plate spaced apart from the rear portion of the electronic image assembly;
- a second channel defined by the space between the plate and the rear portion of the electronic image assembly; and
- wherein the second fan assembly is further positioned so as to force ambient gas through the second channel.

4. The cooling system of claim 3 further comprising:

a power module in electrical communication with the electronic image assembly;
and

a heat sink in thermal communication with the power module and placed within
the second channel.

5. The cooling system of any one of claims 3 or 4 further comprising:

a plurality of ribs placed within the second channel.

6. An electronic display assembly comprising:

an electronic image assembly;

an isolating structure space apart from the electronic image assembly;

a channel defined by the space between the isolating structure and the
electronic image assembly;

a power module having electronic components on a first side and a heat sink on
the second side, where the power module is attached to the isolating
structure so that the heat sink is within the channel and the electronic
components are outside the channel; and

a fan positioned so as to draw ambient gas through the channel.

7. The electronic display assembly of claim 6 further comprising:

a rib placed within the channel and in thermal communication with the isolating structure.

8. The electronic display assembly of claim 7 further comprising:

a surface placed within the channel and in thermal communication with the electronic image assembly and the rib;

9. The electronic display assembly of any one of claims 6, 7, or 8 wherein:

the electronic image assembly is a liquid crystal display.

10. The electronic display assembly of any one of claims 6, 7, or 8 wherein:

the electronic image assembly is an OLED display.

11. An electronic display assembly comprising:

an electronic image assembly having a front and rear portion;

a surface on the rear portion of the electronic image assembly and in thermal communication with the electronic image assembly;

a plate spaced apart from the surface;

a first channel defined by the space between the plate and the surface;

a power module in electrical communication with the electronic image assembly and in thermal communication with the plate; and

a first fan positioned so as to draw ambient gas through the first channel.

12. The electronic display assembly of claim 11 further comprising:
- a rib placed within the first channel and in thermal communication with the plate and the surface.
13. The electronic display assembly of claim 12 further comprising:
- a front display surface spaced apart from the front portion of the electronic image assembly;
 - a second channel defined by the space between the front display surface and the front portion of the electronic image assembly;
 - a heat exchanger in gaseous communication with the second channel, the heat exchanger having first and second gas pathways, where the first gas pathway is in gaseous communication with the second channel;
 - a second fan positioned so as to force ambient gas through the second gas pathway; and
 - a third fan positioned so as to force circulating gas through the second channel and the first gas pathway.
14. The electronic display assembly of any one of claims 11 through 13 wherein:
- the electronic image assembly is a LCD.
15. The electronic display assembly of any one of claims 11 through 13 wherein:
- the electronic image assembly is an OLED.

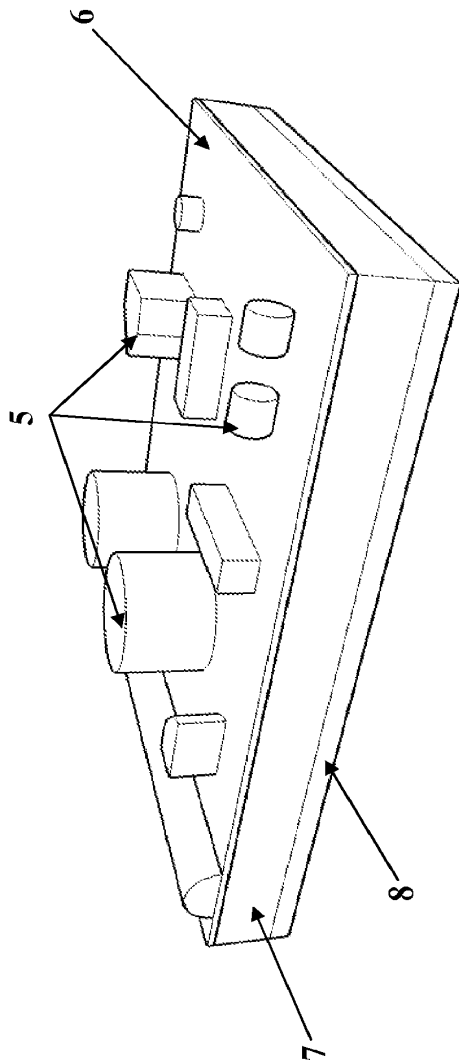


FIG - 1

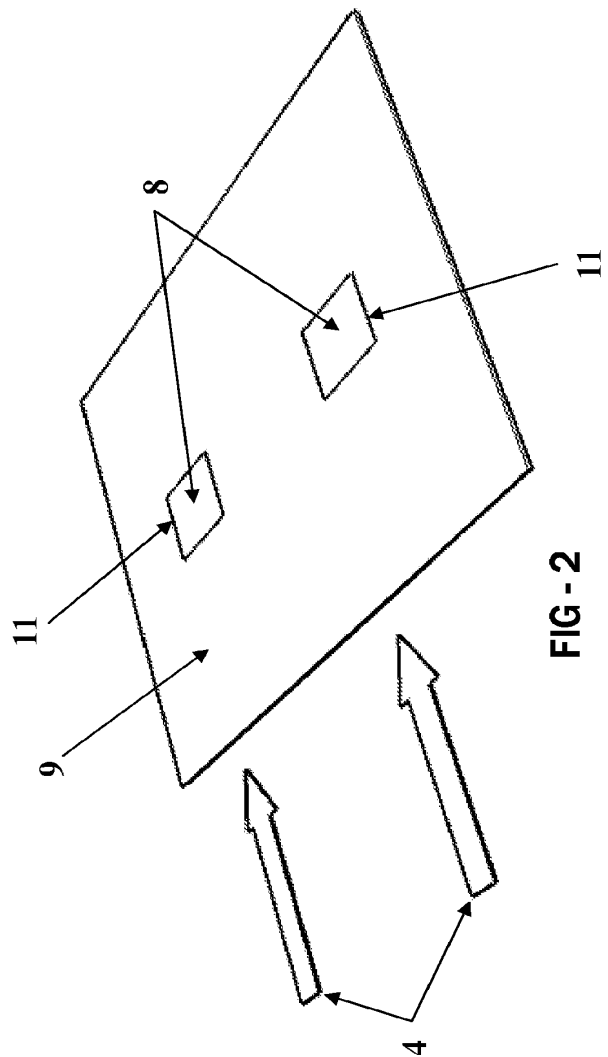


FIG - 2

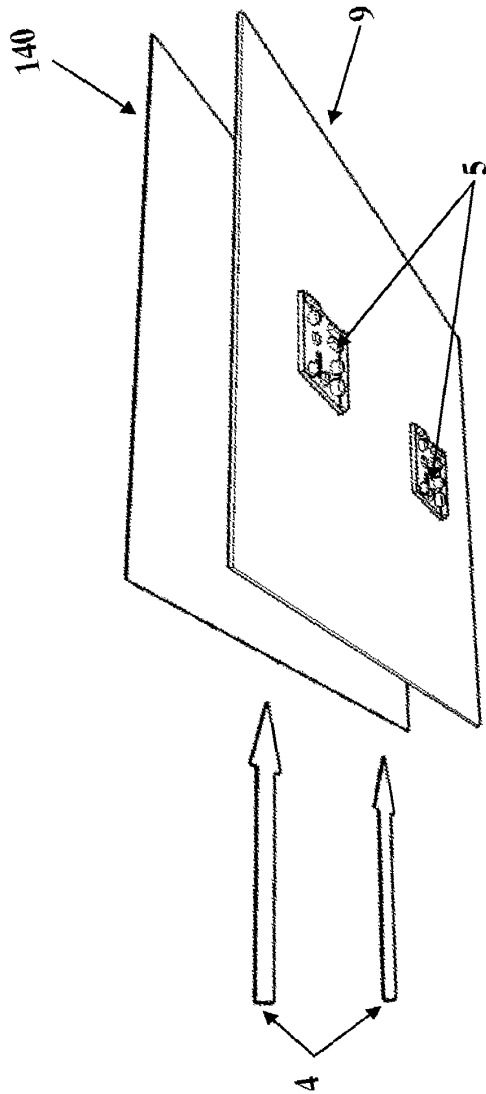


FIG - 3

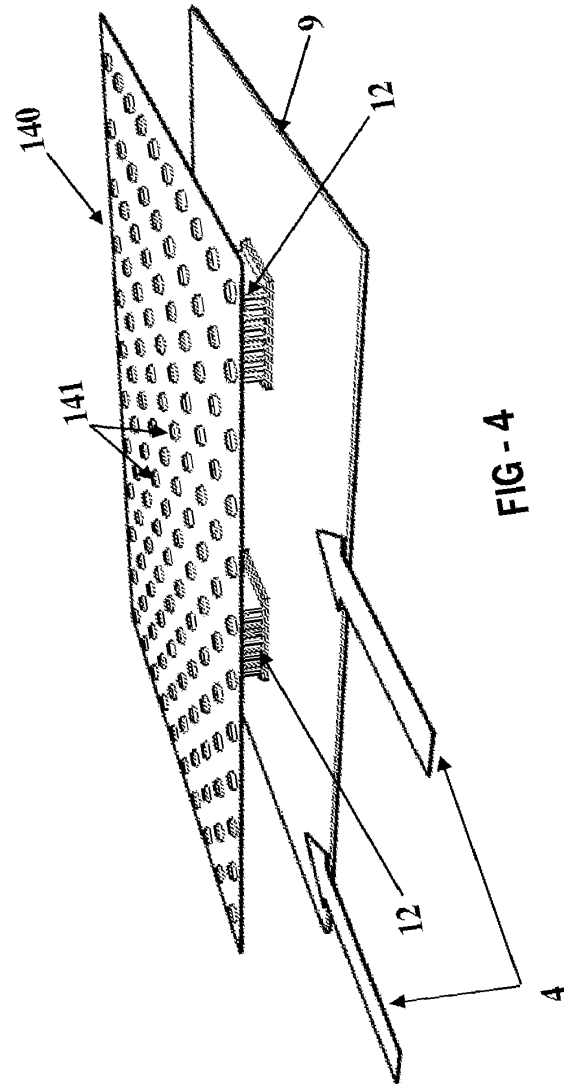
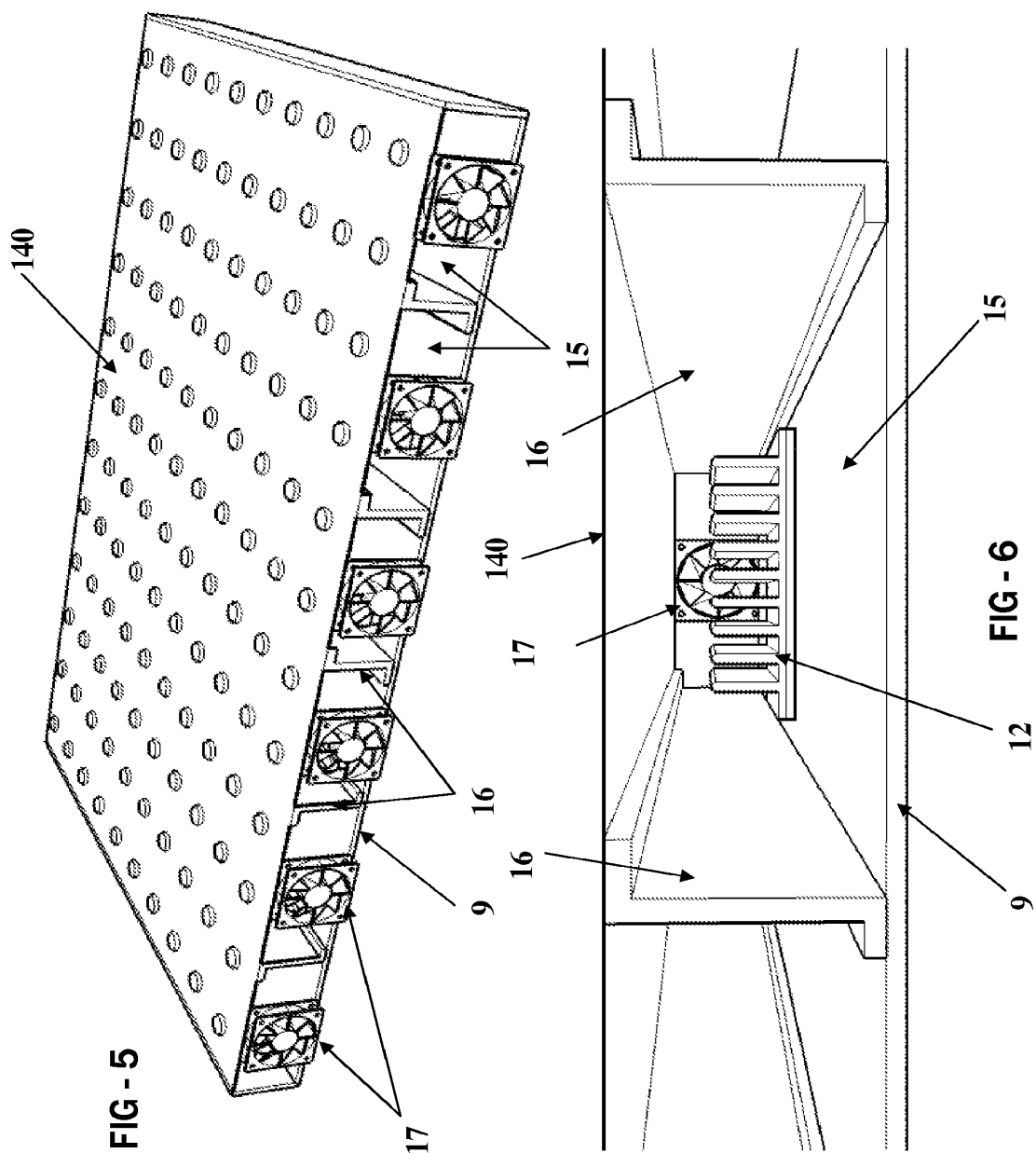
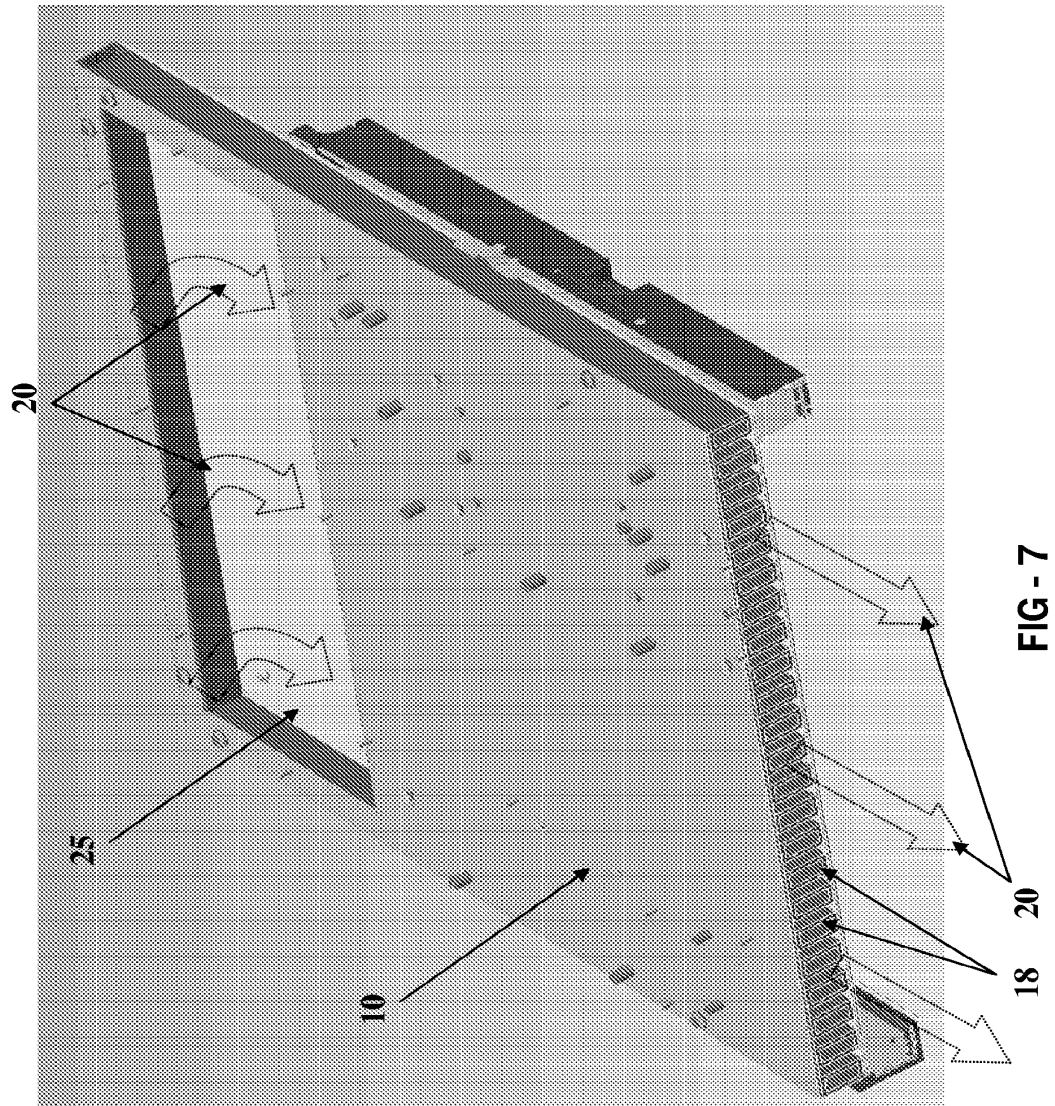
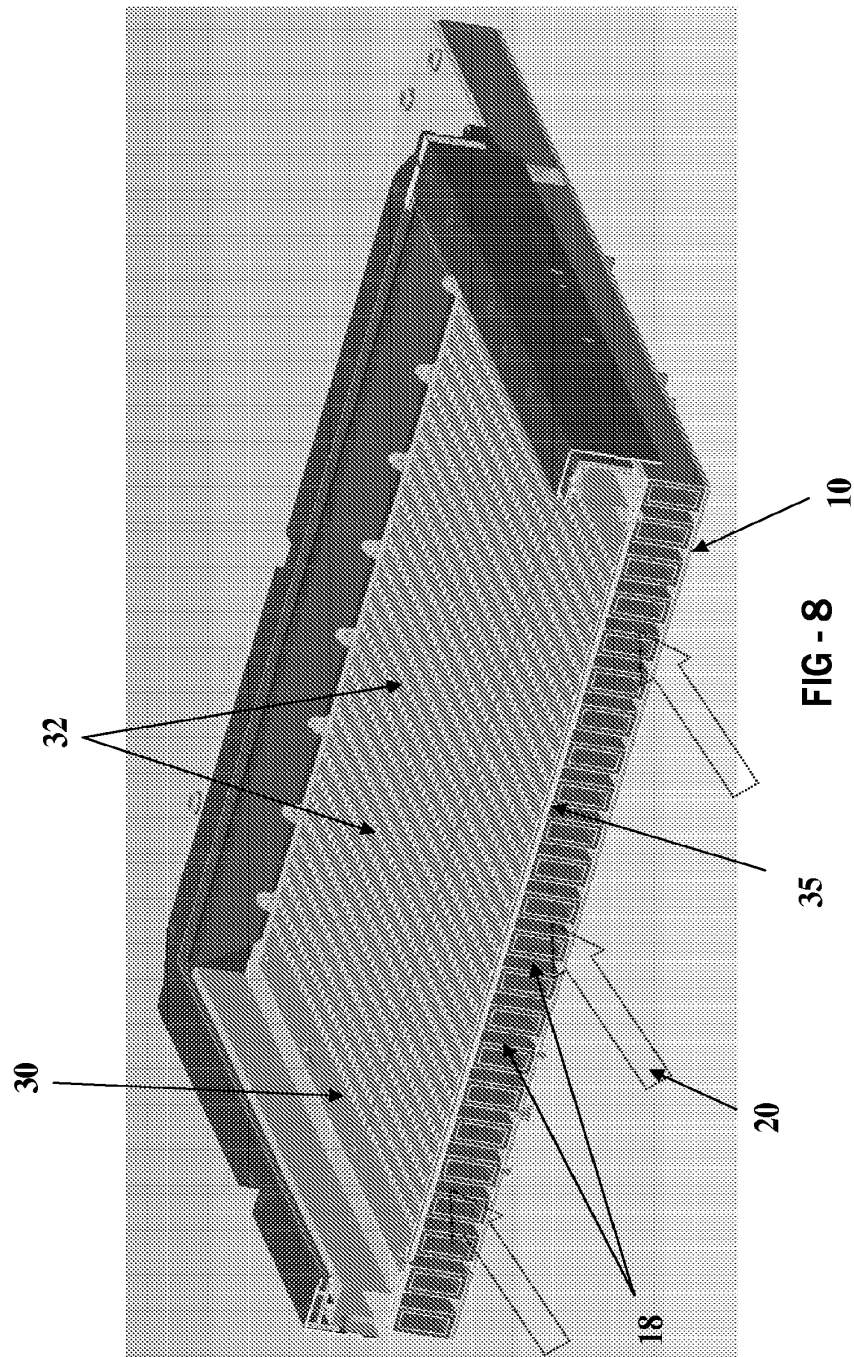


FIG - 4







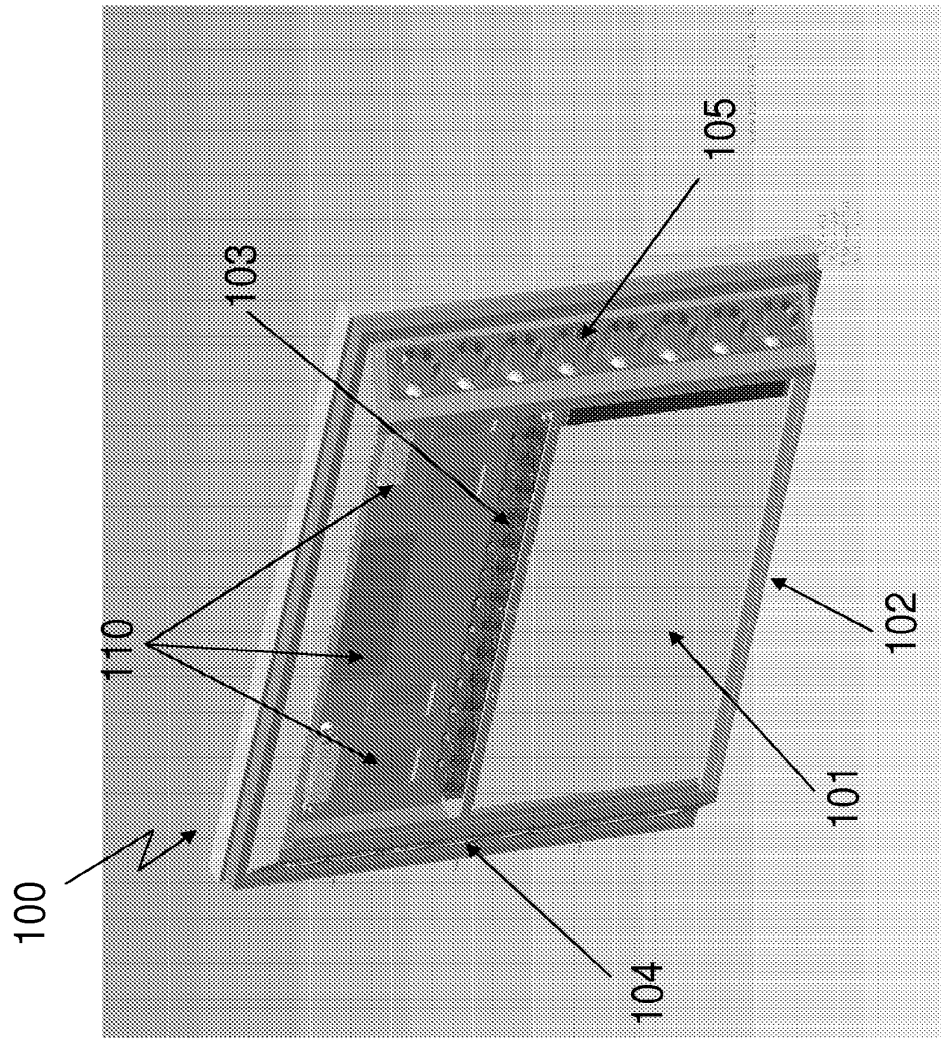
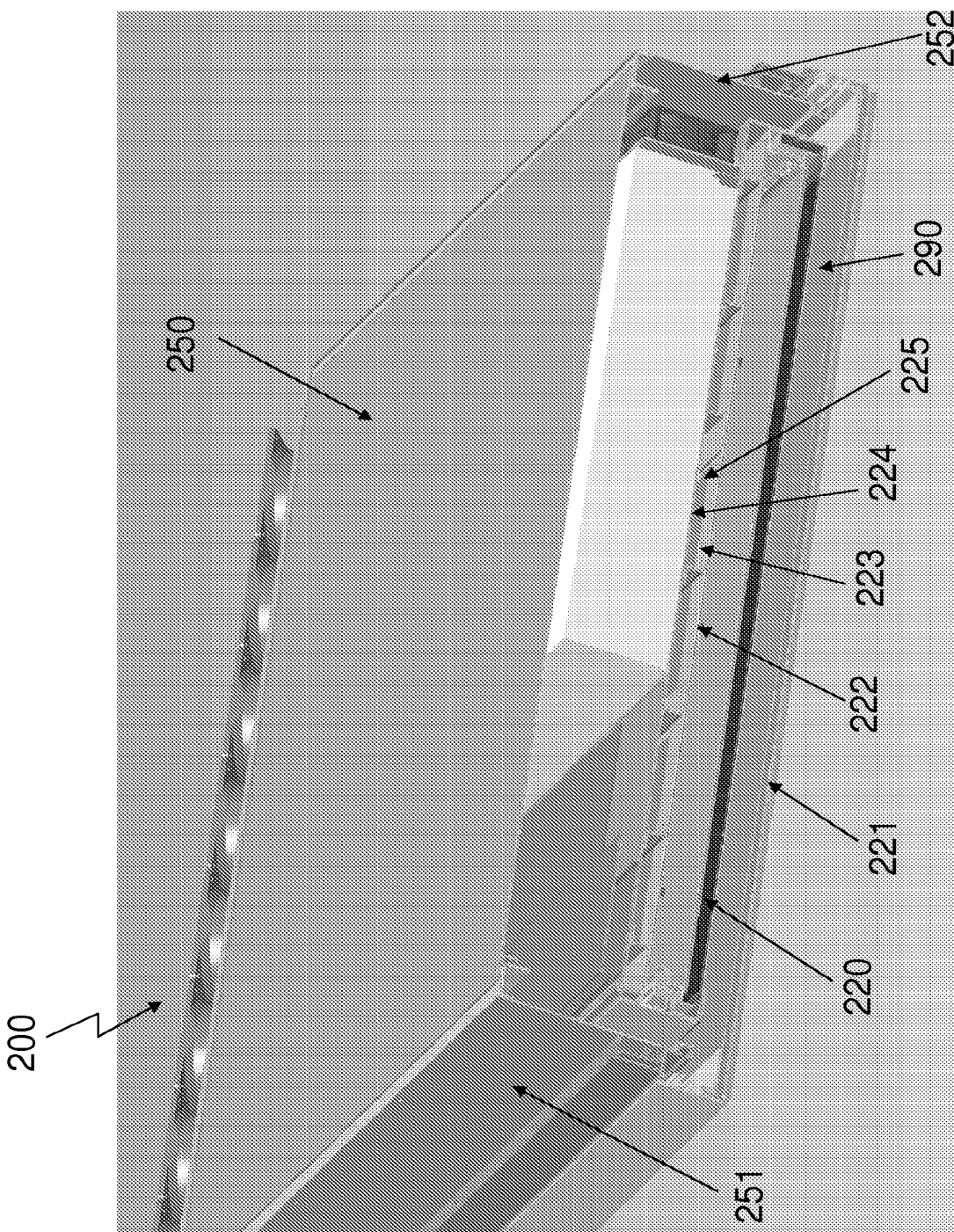


FIG - 9

**FIG - 10A**

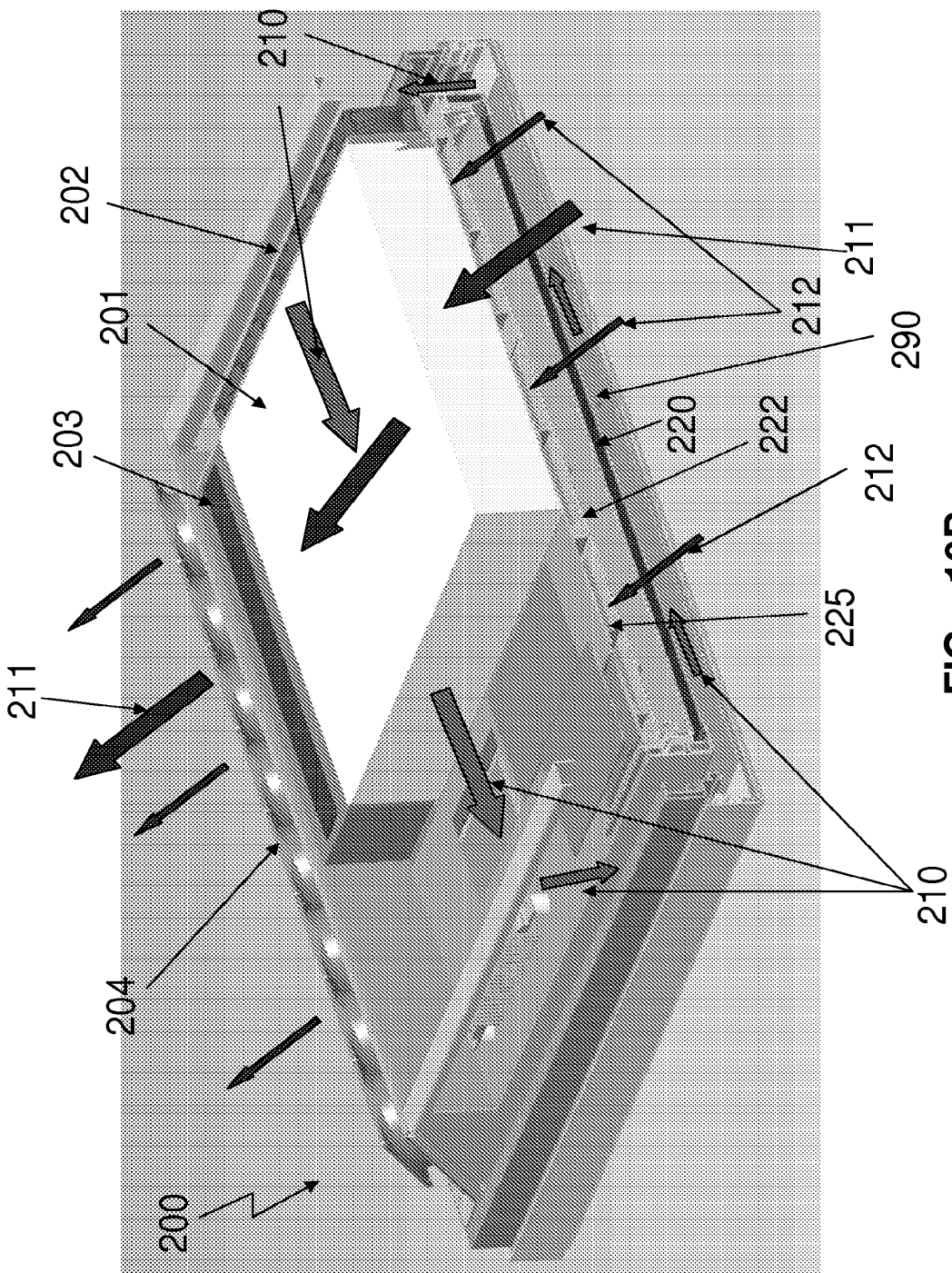
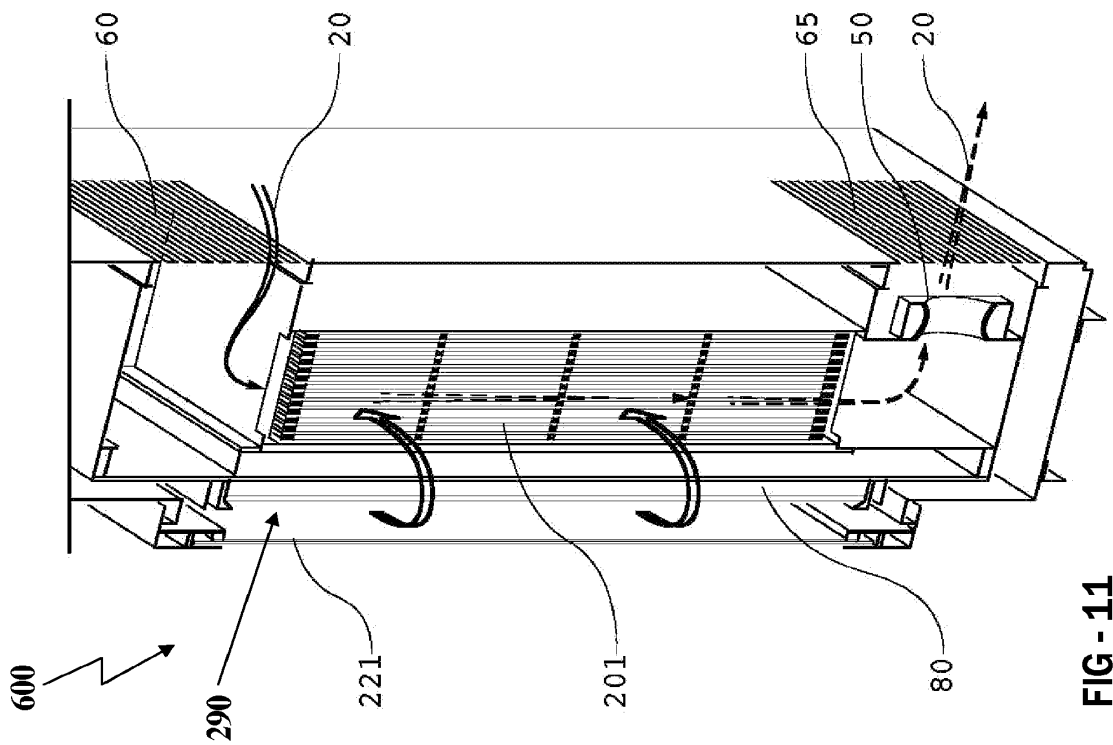
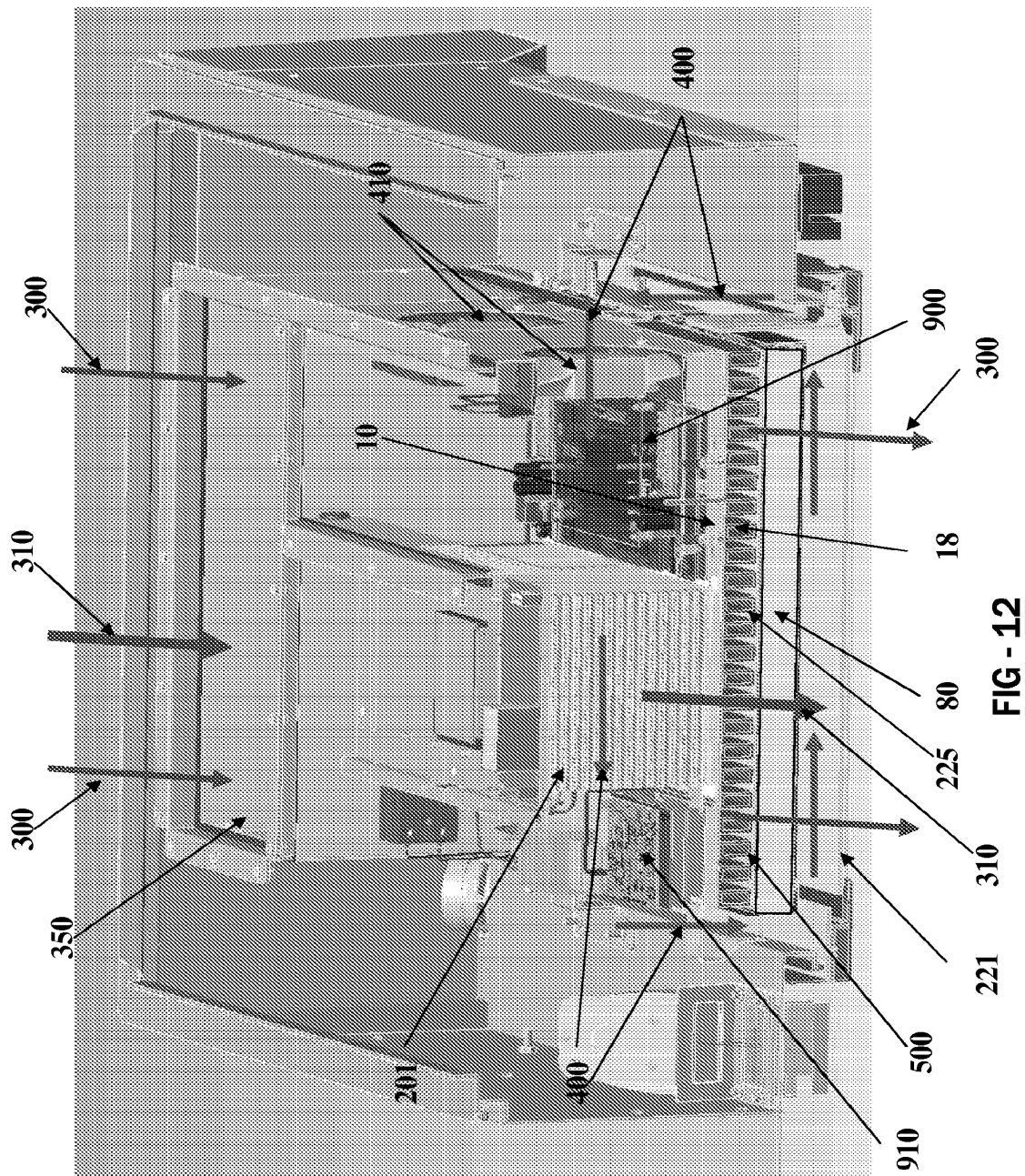


FIG - 10B





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[Continued on next page]

(54) Title: THERMAL PLATE WITH OPTIONAL COOLING LOOP IN ELECTRONIC DISPLAY

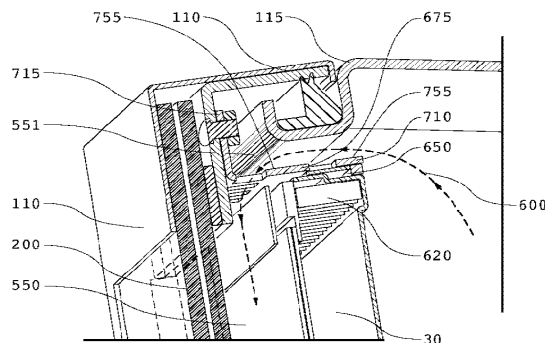


FIG. 3

(57) Abstract: An electronic display having one or more thermal plates in thermal communication with an image assembly and a thermally-conductive housing (and optional door frame). In some embodiments, the thermal plate is in thermal communication with the door frame which is in thermal communication with the housing. A channel may be defined between a transparent plate assembly and the image assembly where a fan may force cooling air through the channel. The cooling air may also pass through apertures in the thermal plate(s). An exemplary image assembly may provide an LED edge-lit LCD or an OLED display. In some embodiments, two displays may be provided in a back-to-back orientation within a single housing. The display may dissipate heat without the need to ingest ambient air.

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

cKOMPASS(KIPO internal) & Keywords: heat, "heat sink", "thermal plate", fan, LED, evacuat*

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2004-004581 A (SEIKO EPSON CORP.) 08 January 2004 See abstract, figs. 1-2, and paragraph [0068] - paragraph [0080].	1,2 3-20
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A	JP 06-082745 A (TOHOKU RICOH CO., LTD.) 25 March 1994 See abstract, figs 1-8, and their corresponding descriptions.	1-20
A	KR 10-1998-0020934 A (ORION ELECTRONICS CO., LTD.) 25 June 1998 See abstract, figs 1-3, and their corresponding descriptions.	1-20
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A	JP 2004-205599 A (VICTOR CO OF JAPAN LTD) 22 July 2004 See abstract, figs 1-6, and their corresponding descriptions.	1-20
A	KR 10-2004-0097466 A (LG.PHILIPS LCD CO., LTD.) 18 November 2004 See abstract, figs 1-3, and their corresponding descriptions.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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Korean Intellectual Property Office
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Authorized officer

SHIN, Yeong Kyo

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/US2010/058925

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KR 10-2004-0097466 A	18.11.2004	None	



Espacenet

Bibliographic data: KR20070048294 (A) — 2007-05-09**COOLING APPARATUS FOR USE IN FLAT DISPLAY DEVICE**

Inventor(s): KIM HONG KI [KR] ± (KIM, HONG KI)
Applicant(s): LG ELECTRONICS INC [KR] ± (LG ELECTRONICS INC)
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- **cooperative:** H01J11/34; H01J17/16; H01J17/28;
H05K7/20972 [more](#)
Application number: KR20050105172 20051104 [Global Dossier](#)
Priority number(s): KR20050105172 20051104
Also published as: [CN1960618 \(A\)](#) [CN1960618 \(B\)](#) [KR100747848 \(B1\)](#)

Abstract not available for KR20070048294 (A)
Abstract of corresponding document: CN1960618 (B)

There is provided a cooling apparatus for a flat display device. The cooling apparatus includes a flat display module, a front cover for protecting a front portion of the flat display module, a back cover for protecting a rear portion of the flat display module, an air inlet formed on a portion of the back cover to allow external air to be introduced into the back cover, an air outlet formed on another portion of the back cover and extending along a longitudinal length of the flat panel display module; a fan disposed inside the back cover and aligned with the air outlet formed on the back cover, and an air outlet channel formed in the back cover and aligned with the air outlet formed on the back cover, the air outlet having an effective exhaust area having a longitudinal length extending in a longitudinal direction of the flat display module.



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전체 청구항 수 : 총 11 항

(54) 평면 디스플레이 기기의 냉각 장치

(57) 요약

본 발명에 따른 평면 디스플레이 기기의 냉각장치는 평면 디스플레이 모듈; 상기 평면 디스플레이 모듈의 전방을 보호하는 프론트 커버; 상기 평면 디스플레이 모듈의 후방을 보호하는 백커버; 상기 백커버의 일측에 형성되어 외기가 흡입되는 흡입구; 상기 백커버의 타측에 형성되고, 상기 평면 디스플레이 모듈의 길이방향으로 길게 형성되는 백커버측 개구부; 상기 백커버측 개구부와 정렬되는 팬; 및 상기 백커버측 개구부와 정렬되는 상태에서, 그 형상이 상기 평면 디스플레이 모듈의 길이방향으로의 길이가 다른 방향의 길이보다 긴 상태로 유효토출면적을 제공하는 사각형상인 팬의 토출구가 포함된다.

제안되는 바와 같은 본 발명에 의해서, 송풍팬의 설치를 위한 별도의 공간이 요구되지 않아서 평면 디스플레이 기기가 보다 얇아지고 간소하게 되면서도 충분한 방열효과를 얻을 수 있고, 재료가 절감되고, 설치가 편리해지는 장점을 얻을 수 있다.

대표도

도 6

특허청구의 범위

청구항 1.

평면 디스플레이 모듈;

상기 평면 디스플레이 모듈의 전방을 보호하는 프론트 커버;

상기 평면 디스플레이 모듈의 후방을 보호하는 백커버;

상기 백커버의 일측에 형성되어 외기가 돌입되는 돌입구;

상기 백커버의 타측에 형성되고, 상기 평면 디스플레이 모듈의 권이방향으로 권게 형성되는 백커버측 개구부;

상기 백커버측 개구부와 정렬되는 팬; 및

상기 백커버측 개구부와 정렬되는 상태에서, 그 형상이 상기 평면 디스플레이 모듈의 권이방향으로의 권이가 다른 방향의 권이보다 긴 상태로 유호돌출면적을 제공하는 직사각형상인 팬의 도출구가 포함되는 평면 디스플레이 기기의 내각장치.

청구항 2.

제 1 항에 있어서,

상기 팬은 횡류팬인 평면 디스플레이 기기의 내각장치.

청구항 3.

제 1 항에 있어서,

상기 팬은 시로코팬인 평면 디스플레이 기기의 내각장치.

청구항 4.

제 3 항에 있어서,

상기 팬은 양방향 돌입팬인 평면 디스플레이 기기의 내각장치.

청구항 5.

제 3 항에 있어서,

상기 시로코팬은 복수개가 일렬로 정렬되는 평면 디스플레이 기기의 내각장치.

청구항 6.

제 3 항에 있어서,

상기 시로코팬의 돌입측으로 공기의 유동방향을 가이드하는 유로가 포함되는 평면 디스플레이 기기의 내각장치.

청구항 7.

제 1 항에 있어서,

상기 백커버측 개구부는 상기 백커버의 테두리부에 형성되는 평면 디스플레이 기기의 냉각장치.

청구항 8.

제 1 항에 있어서,

상기 흡입구는 상기 백커버의 테두리부 및/또는 배면에 형성되는 평면 디스플레이 기기의 냉각장치.

청구항 9.

평면 디스플레이 모듈;

상기 평면 디스플레이 모듈을 내부에 보호하는 커버;

상기 커버의 일측에 형성되어 외기가 흡입되는 흡입구;

상기 백커버의 타측에 형성되는 백커버측 개구부; 및

상기 백커버측 개구부와 정렬된 상태에서 공기를 토출하고, 토출구의 유효토출면적이 실질적인 직사각형으로서 상기 평면 디스플레이 모듈의 길이방향인 제 1 방향이 상기 평면 디스플레이 모듈의 폭방향인 제 2 방향보다 긴 팬이 포함되는 평면 디스플레이 기기의 냉각장치.

청구항 10.

제 9 항에 있어서,

상기 팬은 횡류팬인 평면 디스플레이 기기의 냉각장치.

청구항 11.

제 9 항에 있어서,

상기 팬은 시로코팬인 평면 디스플레이 기기의 냉각장치.

명세서

발명의 상세한 설명

발명의 목적

발명이 속하는 기술 및 그 분야의 종래기술

본 발명은 평면 디스플레이 기기에 관한 것으로서, 상세하게는 평면 디스플레이 기기 내부의 고열이 신속하고 안정적으로 외부로 배출하도록 하는 평면 디스플레이 기기의 냉각장치에 관한 것이다.

평면 디스플레이 기기는 일반적인 음극선관과는 달리 매트릭스 형태로 배열되는 구동회로에 의해서, 각 화소의 발광상태가 서로 달리 구현되어 전체적으로 화상을 형성하는 장치이다. 이러한 평면 디스플레이 기기는 상기 음극선관과는 달리 부피가 작기 때문에, 협소한 실내공간에서 차지하는 공간이 작아서 소비자의 선호도가 높고 근래들어 그 사용이 현저하게 증

가하고 있다. 상기 평면 디스플레이 기기에 적용되는 평면 디스플레이 모듈은 그 구동방식에 따라서, 액정표시장치(Liquid Crystal Display : LCD), 전계 방출 표시장치(Field Emission Display : FED), 플라즈마 디스플레이 패널(Plasma Display Panel : PDP) 및 일렉트로 루미네센스(Electro-Luminescence : EL) 표시장치 등이 있다. 이들 디스플레이 모듈에 의해서 제작되는 평면 디스플레이 기기는 부피가 작아서 사용자의 편리함을 추구할 수는 있지만, 폭이 좁은 평면 형태의 내부 공간에 다수의 발열부품들이 집적되어 제작되기 때문에, 모듈의 구동 중에 발생하는 열이 방출되도록 하는 것은 중요한 해결 과제이다.

특히, PDP 장치는 방전가스의 방전현상에 의해서 화상이 형성되고 전장부품 등에 의해 고온의 열이 발생되기 때문에, 이와 같은 열이 신속하게 방출되지 아니하면 기기가 오작동되거나 고장을 일으키는 주된 요인으로 작용하는 것이 현실이다. 물론, 다른 방식으로 구동되는 평면 디스플레이 모듈도 방열성능이 기기의 성능을 제한하는 것은 물론이다.

상기되는 평면 디스플레이 기기의 냉각과 관련되는 문제를 해결하기 위하여 종래에 적용된 방법은, 열이 다량으로 발생되는 특정 발열부품의 뒷면에 비교적 크기의 히트싱크를 부착하여 특정 부품을 냉각하고, 전체적으로는 평면 디스플레이 기기의 커버에 다수의 홀을 뚫어서 공기가 평면 디스플레이 기기의 내외부로 연통할 수 있도록 하는 방법이 있다. 그러나, 이러한 방법은 고열이 발생하는 특정의 부품에 대한 냉각 효과는 기대할 수 있으나, 기기의 내부공간에 모이는 열이 외부로 방출되는 과정이 원활하게 수행되지 않기 때문에, 기기가 안정적으로 동작되지 못하는 문제점이 있다.

상기되는 방법을 개선하기 위하여 평면 디스플레이 기기의 형성방향에 직교되는 방향으로, 백커버의 중간부에서 후방을 향하여 축류팬이 설치되어 기기 내부의 고온공기가 디스플레이 기기의 후방으로 강제로 배출되는 방식이 적용된 바가 있다. 그러나, 이러한 방식은 비록 기기의 내부에 고이는 열기가 외부로 방출되는 효율은 높일 수가 있으나, 공기가 방출되는 동작 중에 많은 소음이 발생할 뿐만 아니라, 공기가 배출되기 위하여 기기의 배면과 벽면과의 사이에는 수십 센티미터 이상의 간격이 제공되어야 하는 문제점이 있다. 그리고, 축류팬이 설치되어 기기의 내부 공기를 빨아들이기 위하여 축류팬과 평면 디스플레이 모듈의 사이에 제공되어야 하는 간격과, 축류팬의 자체적인 간격으로 인하여 평면 디스플레이 모듈의 폭이 그만큼 두꺼워지는 문제점이 있다.

또한, 백커버의 면 상에 외부 공기가 흡입되거나 토출되도록 하기 위하여 다수의 개공이 형성됨으로서, 백커버의 강도를 떨어뜨리는 문제점이 있고, 이러한 강도상의 문제로 인하여 백커버의 재질을 보다 두껍게 형성해야 되기 때문에, 원가를 상승시키는 문제점이 있다.

발명이 이루고자 하는 기술적 과제

본 발명은 상기되는 문제점을 개선하기 위하여 제안되는 것으로서, 평면 디스플레이 기기가 보다 얇아지고 간소하게 되면서도 충분한 방열효과를 얻을 수 있는 평면 디스플레이 기기의 냉각장치를 제공하는 것을 목적으로 한다.

또한, 냉각장치의 제조비가 절감될 수 있을 뿐만 아니라, 유동 소음이 최소화될 수 있는 평면 디스플레이의 냉각장치를 제공하는 것을 목적으로 한다.

또한, 평면 디스플레이 기기 내부의 공기가 자연대류에 의해서도 외부로 방출되도록 함으로써, 방열 효율이 더욱 개선되고, 유동소음의 저감효과가 더욱 극대화되는 평면 디스플레이 기기의 냉각장치를 제안하는 것을 목적으로 한다.

또한, 평면 디스플레이 기기의 내부에서 공기의 유동방향이 개선되어 평면 디스플레이 기기의 설치에 대한 자유도가 개선될 수 있는 평면 디스플레이 기기의 냉각장치를 제안하는 것을 목적으로 한다.

또한, 평면 디스플레이 기기의 커버에 형성되는 통공의 형성 위치 및 구조를 개선하여 백커버의 강도를 증대시키는 평면 디스플레이 기기의 냉각장치를 제안하는 것을 목적으로 한다.

발명의 구성

상기되는 목적을 달성하기 위한 본 발명에 따른 평면 디스플레이 기기의 냉각장치는 평면 디스플레이 모듈; 상기 평면 디스플레이 모듈의 전방을 보호하는 프론트 커버; 상기 평면 디스플레이 모듈의 후방을 보호하는 백커버; 상기 백커버의 일측에 형성되어 외기가 흡입되는 흡입구; 상기 백커버의 타측에 형성되고, 상기 평면 디스플레이 모듈의 길이방향으로 길게 형성되는 백커버측 개구부; 상기 백커버측 개구부와 정렬되는 팬; 및 상기 백커버측 개구부와 정렬되는 상태에서, 그 형상이 상기 평면 디스플레이 모듈의 길이방향으로의 길이가 다른 방향의 길이보다 긴 상태로 유효토출면적을 제공하는 사각형상인 팬의 토출구가 포함된다.

다른 측면에 따른 본 발명의 평면 디스플레이 기기의 냉각장치는 평면 디스플레이 모듈; 상기 평면 디스플레이 모듈을 내부에 보호하는 커버; 상기 커버의 일측에 형성되어 외기가 흡입되는 흡입구; 상기 백커버의 타측에 형성되는 백커버측 개구부; 및 상기 백커버측 개구부와 정렬된 상태에서 공기를 토출하고, 토출구의 유효토출면적이 실질적인 직사각형으로서 상기 평면 디스플레이 모듈의 길이방향인 제 1 방향이 상기 평면 디스플레이 모듈의 폭방향인 제 2 방향보다 긴 팬이 포함된다.

제안되는 본 발명에 의해서 평면 디스플레이 기기에 대한 냉각효율이 개선되는 장점을 얻을 수 있고, 유동소음이 줄어들고, 평면 디스플레이 기기의 설치에 방해가 없이 보다 자유롭게 설치 가능하고, 팬의 동작에 있어서 동작 신뢰성이 향상되고, 원가가 절감되는 장점이 있다.

이하에서는 도면을 참조하여 본 발명의 바람직한 실시예를 상세하게 설명한다. 다만, 본 발명의 사상은 제시되는 실시예에 제한되지 아니하며, 본 발명의 사상을 이해하는 당업자는 동일한 사상의 범위 내에 포함되는 다른 실시예를 용이하게 제안할 수 있을 것이나, 이 또한 본 발명 사상의 범위 내에 포함된다고 할 것이다.

<제 1 실시예>

도 1은 본 발명에 따른 평면 디스플레이 기기의 사시도이다.

도 1을 참조하면, 본 발명의 평면 디스플레이 기기(1)는 평면 디스플레이 모듈(2)과, 상기 평면 디스플레이 모듈(2)의 전방을 지지하고 보호하는 프론트 커버(3)와, 평면 디스플레이 모듈(2)의 후방을 지지하고 보호하는 백 커버(4)가 포함된다. 그리고, 상기 백 커버(4)의 상측 테두리에는 평면 디스플레이 기기(1) 내부의 뜨거운 공기가 배출되는 백커버측 개구부(5)가 형성된다. 상기 백커버측 개구부(5)는 다수개의 슬릿이 집합되는 구조로 제공됨으로써, 백커버(4)의 강도저하가 발생되지 않도록 하는 것이 바람직하다. 다시 말하면, 상기 백커버측 개구부(5)는 전체적으로 평면 디스플레이 기기(1) 내부의 고온 공기가 토출되는 부분을 칭하는 것으로서, 그 내부 면적은 다수개의 슬릿이 집합되는 형태로 제공되어 있다.

상기 평면 디스플레이 모듈(2)은, 액정표시장치, 전계 방출 표시장치, 플라스마 디스플레이 패널, 및 일렉트로 루미네센스 표시장치등과 같이 매트릭스 형태로 화소가 배치되고 동작되는 모듈이 적용될 수가 있으나, 바람직하기로는 고열이 발생되는 PDP 모듈이 예시될 수 있다.

상기 프론트 커버(3)와 백커버(4)는 전체적으로 내부 공간에 평면 디스플레이 모듈(2)을 수용한 상태에서 외부와 내부를 구획하고 내부에 장착되는 부품을 보호하는 물품으로서, 본 실시예에서는 프론트 커버(3)와 백커버(4)가 별도의 물품으로 제공되어 양자가 결합되는 양상으로 설명이 되고 있으나, 어떠한 다른 형태로 제공되는 것도 가능하다. 예를 들면, 프론트 커버(3)와 백커버(4)가 단일의 물품으로 제공되는 것도 가능한 일이다. 다만, 프론트 커버(3)가 평면 디스플레이 기기의 전방을 보호하고, 백커버(4)가 평면 디스플레이 기기의 후방을 보호하는 용도로 사용되는 것은 당연하다. 그리고, 상기 백커버(4)의 내면과 평면 디스플레이 모듈(2)의 후면에 제공되는 다수의 발열부품과의 사이에는 소정의 간격이 제공되고, 상기 간격을 통해서 공기가 유동하여 상기 발열부품을 냉각시킨 뒤에, 상기 백커버측 개구부(5)를 통하여 배출되는 것도 당연하다.

상기되는 평면 디스플레이 기기의 사시도를 참조하여 본 발명 냉각장치의 동작을 설명한다.

상기 평면 디스플레이 기기(1)가 동작되면, 평면 디스플레이 모듈(2)에는 많은 열이 발생되는데, 특히, 평면 디스플레이 모듈(2)의 후면부의 발열부품에서 발생되는 열은 외부에서 유입된 공기에 의해서 냉각되고, 이후에 뜨거운 공기는 상방으로 이동한 뒤에 상기 백커버측 개구부(5)를 통하여 외부로 배출되는 과정을 거친다. 이와 같이 뜨거운 공기가 상방으로 이동되는 자연대류에 과정에 의해서 평면 디스플레이 기기의 내부의 공기가 배출될 수 있기 때문에 냉각효과가 더욱 증진되는 장점을 얻을 수 있다. 이와 같이 자연대류에 의한 냉각효과가 극대화되도록 하기 위하여, 상기 평면 디스플레이 기기(1)의 내부로 유입되는 공기는 평면 디스플레이 기기(1)의 하면부의 거의 전체 영역을 통하여 내부로 유입되도록 하여, 평면 디스플레이 모듈(2)의 후면부를 전체적으로 경유하도록 하여 냉각효율이 더욱 개선되도록 하는 것이 바람직하다.

또한, 상기 백커버측 개구부(5)는 백커버(4) 테두리의 경사진 부위에 제공되어 고온공기가 유동되는 방향(상측방향) 그대로 토출되도록 함으로써, 고온공기의 유동이 더욱 원활하게 이루어지는 장점이 있다.

물론, 평면 디스플레이 모듈(2)의 전면부는 외부로 노출되어 있기 때문에, 평면 디스플레이 모듈(2)의 전면부에서 발생하는 열은 외부 공기의 자연대류에 의해서 신속하게 방출될 수 있다.

도 2는 본 발명의 평면 디스플레이 기기에서 백커버 상면의 일부를 제거한 부분 절개 사시도이다.

도 2를 참조하면, 상기 백커버(4) 상면의 내측에는 횡류팬(7)이 디스플레이 기기의 길이방향으로 길게 설치된다. 이와 같이 횡류팬(7)이 설치됨으로써, 백커버(4) 상면부는 뜨거운 내부 공기가 외부로 방출되는 간격을 제공하게 된다. 이와 같이 좌우로 길이가 긴 백커버(4) 상면을 통하여 고온공기가 토출될 수 있기 때문에, 공기토출과정이 보다 용이해져서 공기의 유동저항 및 유동소음이 감소되고, 고온공기의 방열효율이 높아지는 장점을 얻을 수 있다.

상기 횡류팬(7)의 구성을 보다 상세하게 설명한다. 상기 횡류팬(7)은 백커버(4)의 좌우 길이 방향으로 길게 제공되는 횡류팬 임펠러(도 3의 10참조)와 상기 횡류팬 임펠러(10)의 일정 간격으로 횡류팬 임펠러(10)를 구획하고 횡류팬 임펠러(10)의 강도를 보강하는 원형의 플레이트(11)가 포함된다. 또한, 상기 횡류팬(7)의 일측으로는 구동축(15)과 상기 구동축(15)에 연결되는 모터(14)가 더 형성되어, 모터(14)의 회전력이 횡류팬(7)으로 전달되도록 한다.

또한, 상기 횡류팬 임펠러(10)의 회전시에 공기의 유동을 가이드하기 위하여 상기 횡류팬 임펠러(10)는 전체적으로 하우징(18)의 내부에 수용되는데, 상기 하우징(18)은 횡류팬 임펠러(10)의 전방으로 이격된 일측에 형성되는 스크롤(12)과, 이격된 타측에 형성되어 공기의 유동을 안정화시키는 스테빌라이저(13)가 포함된다. 상기 스크롤(12)은 횡류팬 임펠러(10)의 전방에 놓이고 상기 스테빌라이저(13)는 횡류팬 임펠러(10)의 후방에 놓여서, 상기 횡류팬 임펠러(10)는 도면을 기준으로 시계방향으로 회전하게 된다.

도 3에 제시되는 도 1의 I-I' 선의 단면도를 참조하여, 상기 횡류팬(7)에 의한 고온공기의 토출 작용을 상세하게 설명한다.

상기 횡류팬(7)은 이미 설명된 바와 같이 시계 방향으로 회전하는 동작에 의해서, 상기 백커버(4) 내부 공간의 공기가 상방으로 이동하여 스크롤(12)을 따라서 이동된 뒤에, 상기 백커버측 개구부(5)를 통하여 외부로 배출된다.

설명된 바와 같이 상기 횡류팬(7)은 상기 백커버(4) 상면의 길이방향으로 실질적으로 전체 길이에서 길게 제공되어 있기 때문에, 다량의 고온공기가 토출될 수 있다. 물론, 화면의 크기가 작아서 전체 길이에 대하여 횡류팬(7)이 제공될 필요가 없는 경우에는, 특정길이만큼만 백커버측 개구부(5) 및 횡류팬(7)이 설치될 수도 있을 것이다. 이와 같이 고온공기의 배출면적이 크게 제공됨으로써 공기의 배출에 있어서 방해가 줄어들 수 있고, 이로 인한 공기의 유동저항과 유동소음이 줄어드는 장점을 얻을 수 있다. 그리고, 고온 공기가 백커버(4)의 상면을 통하여 배출되기 때문에 백커버(4)의 배면과 벽면과의 간격부에는 공기의 원활한 배출을 위한 별도의 간격을 제공할 필요가 없다. 그러므로, 본 발명의 평면 디스플레이 기기는 벽면에 완전히 말착되어 장착될 수 있고, 그만큼 실내공간을 좁게 차지하게 되는 장점을 얻을 수 있다.

도 4는 도 2에서 횡류팬 임펠러와 모터등이 제거된 상태의 평면 디스플레이 기기의 사시도이고, 도 5는 도 4의 II-II'의 단면도이다.

도 4 및 도 5를 참조하여 본 발명에 따른 평면 디스플레이 기기의 냉각장치의 작용을 설명하면, 평면 디스플레이 기기의 상단부에는 스크롤(12)이 전방경계를 이루고, 스테빌라이저(13)가 후방경계를 이루는 직사각형 형태의 토출구(20)가 제공되는 것을 볼 수 있다. 물론, 상기 토출구(20)의 내부에는 상기 횡류팬(7)이 장착되고, 상기 토출구(20)는 상기 횡류팬(7)에 의해서 공기가 토출되는 면적을 제공하게 된다.

상기 토출구(20)는 실질적으로 평면 디스플레이 기기의 고온공기가 토출되는 면적으로서 유효토출면적(S)이라고 할 수 있는데, 본 발명에서는 상기 유효토출면적(S)은 백커버(4)의 상면에서 직사각형의 형태로 크게 제공됨으로써, 평면 디스플레이 기기 내부의 고온공기는 보다 신속하고 효율적으로 외부로 배출될 수 있는 것이다. 따라서, 상기 유효토출면적(S)이 크게 제공되면 크게 제공될 수록 고온공기의 배출이 보다 신속하게 이루어질 수 있고, 공기의 유동 중에 발생하는 소음이 줄어들고, 고온공기의 방열효율이 증가될 수 있는 것은 당연하게 짐작될 것이다.

또한, 유효토출면적(S)이 커지게 되면 디스플레이 기기의 내부를 통과하는 공기의 유량이 그만큼 늘어나게 되어서 냉각효율이 그만큼 높아지기 때문에, 백커버(4)의 배면에 별도로 설치되는 흡입공 및 토출공이 필요치 않게 된다. 그러므로, 다수의 공기 흡입구 및 토출구에 의해서 백커버(4)의 강도를 보강하기 위하여 백커버(4)의 재질을 고강도의 강판으로 할 필요가 없어지기 때문에 재료가 절감되는 장점을 얻을 수도 있다.

또한, 동일한 백커버(4) 상면의 전체면적 중에서 상기 유효토출면적(S)이 크게 제공되면 크게 제공될 수록, 평면 디스플레이 기기의 화면이 커져서 발열량이 많아지더라도 디스플레이 기기의 전후 두께는 얇아질 수 있는 장점을 얻을 수 있게 된다. 특히, 본 실시예와 같이 횡류팬(7)이 형성되는 경우에는, 횡류팬(7)은 다른 부품에 의한 방해가 없이 평면 디스플레이 기기(1)의 전후두께에 전체적으로 설치될 수 있기 때문에, 고온공기에 대한 방열효율이 더욱 개선될 수 있는 장점이 있다.

또한, 본 발명에 따른 평면 디스플레이 기기의 냉각장치는, 상기 유효토출면적(S)이 디스플레이 모듈의 형성방향, 다시 말하면 평면 디스플레이 기기 테두리부의 길이방향으로 길게 제공되는 제 1 모서리부와, 상기 디스플레이 기기 테두리의 길이방향과 수직되는 방향으로 상기 제 1 모서리부에 비하여 짧게 제공되는 제 2 모서리부로 이루어지는 직사각형으로 이루어져 있다. 물론, 상기 제 1 모서리부와 제 2 모서리부는 각각 평행 두개의 선을 가지고서 직사각형으로 이루어진다. 그러므로, 얇은 평면 형상으로 제공되는 평면 디스플레이 기기에 있어서 유효토출면적(S)이 그만큼 커질 수 있고, 유효토출면적(S)이 형성되는 평면 디스플레이 기기 일면의 형상과 유사한 형상으로서 해당되는 면의 실질적인 전체면적에 걸쳐서 제공되어 있기 때문에, 고온공기가 배출되는 면적이 그만큼 증가되는 장점을 얻을 수 있다.

도 6은 본 발명에 따른 평면 디스플레이 기기(1)의 냉각장치의 작용을 설명하기 위한 평면 디스플레이 기기의 배면도이다.

도 6을 참조하면, 상기 백커버(4)에는 백커버측 개구부(5)에 더하여 공기가 백커버(4)의 내부공간으로 유입되도록 하기 위한 측면 흡입구(16)와 배면 흡입구(17)가 더 형성된다.

상기 흡입구(16)(17)의 작용을 설명하면, 먼저 상기 측면 흡입구(16)는 백커버(4) 하단 테두리부의 경사진 부위에 형성되어 외부의 저온공기가 평면 디스플레이 기기의 내부 공간으로 상방으로 흡입되도록 한다. 물론, 상기 측면 흡입구(16)를 통하여 흡입되는 공기는 상기 백커버측 개구부(5)를 통하여 배출되는 공기를 보상하기 위하여 흡입되는 공기로서, 자연대류에 의해서 발생하는 음압과 상기 백커버측 개구부(5)를 통하여 배출되는 공기에 의한 음압을 보상하기 위하여 흡입되는 공기이다.

상기 측면 흡입구(16)를 통하여 흡입되는 공기는, 평면 디스플레이 모듈(2)의 배면에 제공되는 다수 부품의 고열이 전체적으로 냉각되도록 한 뒤에 상기 횡류팬(7)으로 흡입되고, 그 뒤에는 백커버측 개구부(5)를 통하여 배출되는 과정을 거치게 된다.

또한, 도면에 제시되는 바와 같이 상기 측면 흡입구(16)는 백커버(4) 하단 테두리부의 좌우방향을 가로질러 형성되도록 함으로써, 흡입되는 공기에 의해서 평면 디스플레이 모듈(2)의 부품이 좌우방향에 걸쳐서 그 전부가 냉각되도록 하는 것이 바람직하다. 도면에서 화살표는 공기의 유동방향을 설명하고 있다.

상기 백커버(4) 내부의 고온 공기가 토출되는 작용을 중심으로 설명하면, 상기 횡류팬(7)은 상기 백커버(4)의 상면에 좌우방향을 가로질러서 실질적으로 상면의 전체길이에 형성되고, 상기 유효토출면적(S)도 상기 횡류팬(7)과 대응되어 백커버(4) 상면의 좌우방향을 가로질러서 백커버(4) 상면의 전체면적에 형성되어 있다. 그러므로, 상기 백커버(4) 하면의 좌우방향의 전체길이부를 통하여 흡입된 저온공기는 수직방향으로 그대로 상승하면서 열을 식힌 뒤에 상면을 통하여 배출된다. 물론, 횡류팬(7)의 길이가 짧게 제공되는 경우에는 평면 디스플레이 기기의 코너부에 대한 방열효과는 어느 정도 줄어들 수 있으나, 그렇다 할지라도 직사각형상의 넓은 유효토출면적(S)에 의해서 방열효율이 개선되는 것은 당연하다.

한편, 상기 평면 디스플레이 모듈(2)의 각 부품 중에서도 특히 고열이 발생하는 부품(예를 들면 전원부), 저온조건이 필수적으로 요구되는 부품(예를 들면 TCP 칩(Tape Carrier Package Chip))이 있다.

이와 같은 부품별 동작조건을 만족시키기 위하여, 열적 안정성이 요구되는 부품은 상기 측면흡입구(16)의 인접위치에 형성되어 외부에서 유입되는 차가운 공기에 의해서 신속하게 냉각되도록 하는 것이 바람직하다. 또한, 다량의 열이 발생하는 부품의 경우에는 발생된 열이 다른 회로부에 영향을 주지 않으면서 신속하게 외부로 배출되도록 하기 위하여, 상기 횡류팬(7)의 인접위치에 형성되는 것이 바람직하다.

또한, 상기 배면 흡입구(17)는, 평면 디스플레이 모듈(2)의 회로배치로 인하여 부품의 위치를 변동시키지 못하고 특정 위치에 놓여야만 되는 경우에 사용될 수 있다. 다시 말하면, 상기 배면 흡입구(17)는 발열물품이 배치되는 평면 디스플레이 모듈(2)의 특정 위치에 대응되는 백커버(4)상의 위치에 형성되어, 외기가 배면 흡입구(17)를 통하여 직접 유입되면서 유입되는 저온 공기에 의해서 발열물품이 냉각되도록 하는 목적으로 사용될 수 있다. 다만, 상기 배면 흡입구(17)는 본원발명

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의 실시예 필수적인 구성요소가 없으며, 발원물품의 위치가 조정될 수 있는 경우에는 상기 측면 출입구(16)의 인접위치 또는 횡단(7)의 인접위치로 발원물품의 위치를 이동시켜 별도의 배면 출입구(17)가 요구되지 않도록 할 수도 있다.

설명된 바와 같이 본 발명에 따른 내각장치에 의해서 백커버(4)의 어느 일측 테두리부에 권개 펜이 놓일 수 있기 때문에, 백커버 내부의 고온공기의 방열성이 한층 더 개선되고, 내각 장치의 동작 상의 신뢰성이 좋아지는 장점을 얻을 수 있다.

<제 2 실시예>

본 발명의 제 2 실시예는 다른 부분에 있어서는 상기 제 1 실시예와 동일하고, 평면 디스플레이 기기 내부의 고온공기가 토출되도록 하는 송풍팬의 구조가 달라지는 것이 특징적으로 다르다. 그러므로, 이하의 설명에서는 본 실시예에 있어서 구성이 달라지는 부분에 대해서만 상세하게 설명하고, 설명이 되지 아니하는 부분에 대해서는 상기 제 1 실시예에 대하여 설명된 바가 인용되는 것으로 한다.

도 7은 본 발명의 제 2 실시예에 따른 평면 디스플레이 기기의 사시도이다.

도 7을 참조하면, 평면 디스플레이 모듈(32)과, 상기 평면 디스플레이 모듈(32)의 전방부를 보호하는 포워드 커버(33)과, 상기 평면 디스플레이 모듈(32)의 후방부를 보호하는 백커버(34)가 포함된다. 또한, 상기 백커버(34)의 상면에는 평면 디스플레이 기기 내부의 고온공기를 백커버를 개구부(51)(52)가 포함된다. 상기 백커버를 개구부(51)(52)는 백커버(34) 상면의 좌측에 형성되는 제 1 백커버를 개구부(51)와 우측에 형성되는 제 2 백커버를 개구부(52)가 포함된다.

이와 같이 상기 백커버를 개구부(51)(52)가 좌우로 나뉘어져 제공됨으로써, 평면 디스플레이 기기의 코너부에 대한 내각 고온공기는 시로코펜(41)(46)에 의해서 송풍되어 상기 백커버를 개구부(51)(52)를 통하여 배출된다.

도 8은 본 발명의 제 2 실시예에서 백커버의 상면부가 제거된 상태에서 그 내부를 도시한 평면 디스플레이 기기의 사시도이다.

도 8을 참조하면, 상기 제 1 백커버를 개구부(51)의 내부에는 제 1 시로코펜(41)이 정렬되어 놓이고, 상기 제 2 백커버를 개구부(52)의 내부에는 제 2 시로코펜(46)이 정렬되어 놓여있다. 이와 같은 배치에 의해서 평면 디스플레이 기기 내부의 고온공기는 시로코펜(41)(46)에 의해서 송풍되어 상기 백커버를 개구부(51)(52)를 통하여 배출된다. 또한, 상기 백커버를 개구부(51)(52)를 통하여 우측단을 통하여 출입되는 공기는, 상방으로 송풍되어 저사각형의 유호도출면적(S)를 가지는 제 1 토출구(45)를 통하여 토출되어 제 1 시로코펜(41)은 양방향 돌입 시로코펜으로서, 하우징(43)의 좌측단과 우측단이 모두 개구되어 있고, 시로코펜(42)은 하우징의 개구되는 좌측단과 우측단까지 연장되어 있다. 또한, 시로코펜의 구성의 간소화를 위하여 상기 평면 디스플레이 기기의 코너부에 위치한다. 또한, 상기 평면 디스플레이 기기의 코너부에 위치한다. 또한, 상기 평면 디스플레이 기기의 코너부에 위치한다.

한편, 상기 시로코펜(41)(46)의 돌입부를 통하여 유입되는 공기가 원활하게 가이드되도록 하기 위하여, 상기 하우징(43)의 좌측단 및 우측단에 형성되는 개구부와, 상기 토출구(45)를 서로 다른 공간으로 구획하는 유로 가이드(50)가 제공된다. 상기 유로 가이드(50)는 완만하게 하향 만곡되어 평면 디스플레이 기기의 내부 공간이 원활하게 시로코펜의 내부로 유입되도록 한다. 그리고, 상기 유로 가이드(50)는 시로코펜의 내부로 돌입되는 공기가 평면 디스플레이 기기의 내부의 고온공기로 제한되고 상기 토출구(45)를 통하여 이미 토출된 공기의 역유입을 방지하는 차단막으로서의 기능도 수행한다.

도 9는 본 발명의 제 2 실시예에 따른 내각장치의 작용을 설명하는 도면이다. 먼저, 평면 디스플레이 기기의 하단부를 통하여 돌입되는 공기는 평면 디스플레이 기기의 내부 공간을 전체적으로 냉각시킨 뒤에, 상기 시로코펜 양측단의 개구부를 향하여 이동한다. 이때, 상기 유로 가이드(50)는 제 1, 2, 3, 4 유로 가이드(51)(52)(53)(54)를 포함하고, 각각의 유로 가이드는 하우징(43)과 접하는 면을 정점으로 하여 하향으로 만곡되어 있다. 이와 같이 만곡되는 형상을 취함으로써 하측에서 유입되는 공기가 하우징(43)의 좌측단과 우측단을 통하여 원활하게 유입될 수 있도록 한다.

그리고, 상기 시로코펜(41)(46)의 좌우측단의 개구부를 통하여 돌입된 공기는 입펠러(42)에 의해서 그 토출방향에 전환되어 토출구(45) 및 백커버를 개구부(51)를 통하여 외부로 토출된다.

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또한, 본 실시예에서도 백커버의 유효도출면적(S)은 평면 디스플레이 기기의 연장방향 다시 말하면 길이방향으로 긴 직사각형의 형상으로 제공되어 있기 때문에, 비교적 넓은 고온공기 도출면적을 제공할 수 있는 장점이 있다. 나아가서, 넓은 장

환경, 도시되지는 아니하였으나, 상기 시프로펜(41)(46)의 물체가 설치되는 작은 하측부에는 공기의 유동이 작아서 내각 효과나 증발의 현이 나지 아니할 수 있는데, 이와 같이 방열이 부족한 부분에 대한 냉각이 원활하게 이루어질 수 있도록 하기 위하여 상기 시프로펜(41)(46)의 하측부와 대응되는 백커버(4)의 배면에는 배면출입구(도 6의 17참조)가 더 제공되도록 할 수도 있는 것이다.

또한, 상기 시프로펜(41)(46)은 두께가 형성되는 것으로 본 실시예에서는 열명이 되어 있지만 근래들어 대두되고 있는 화면의 대형화에 따라서는 100인치에 육박하는 대형화면에 대해서는 세게 이상의 시프로펜이 일렬로 제공되는 것도 가능한 일이다. 이와 같이 시프로펜이 배치되는 경우에는 상대적으로 백커버의 상면이 전체적으로 유효도출면적이 될 수 있기 때문에 방열효율이 더욱 개선될 것임은 용이하게 짐작될 것이다.

또한, 상기 시프로펜(41)(46)은 좌우 양측단부를 통하여 공기가 출입되는 양방향 출입편을 형성하고 있으나, 이에 제한되지 아니하고 모타가 입편의 어느 일단부에 설치된 상태에서 일방향을 통하여 공기가 출입되는 일방향 출입편을 사용할 수도 있다. 그러나, 이 경우에도 전체적으로 도출구는 직사각형의 유효도출면적을 가지는 구조로 제공됨으로써, 공기의 유동저항 및 유동소음이 줄어드는 것은 용이하게 예측가능할 것이다. 나아가서, 일방향 출입편이 사용되는 경우에는 두께 이 상 복수개의 시프로펜이 일렬로 사용되어 고온공기의 도출공간을 넓게 하는 것이 바람직한 것이다.

한편, 본 발명의 사상을 설명함에 있어서, 상기 유효도출면적은 직사각형인 것으로 설명을 하였으나, 펜의 도출구를 어떠한 형상으로 제공되는가에 따라서는, 길이가 긴 어느 한 쌍의 모서리 중에서 하나는 길고 다른 하나는 길이가 짧은 사다리꼴 형상으로 제공되더라도 이는 설명적으로 어느 일 방향의 길이가 다른 일방향으로의 길이에 비하여 길이가 긴 직사각형으로 볼 수 있을 것이다.

발명의 효과

제안되는 바와 같은 본 발명에 의해서, 종래의 설치를 위한 별도의 공간이 요구되지 않아서 평면 디스플레이 기기가 보다 많아지고 간소하게 되면서도 충분한 방열효과를 얻을 수 있는 장점이 있다.

또한, 평면 디스플레이 기기의 단면 형상과 유사한 형상으로서, 고온공기의 도출구를 제공하기 때문에 구조가 간단해지면 서도, 유동 소음이 최소화될 수 있는 장점이 있다.

또한, 평면 디스플레이 기기의 내부의 공기가 펜으로 부터 제공되는 음압뿐만 아니라 자연대류에 의해서 외부로 방출될 수 있기 때문에, 디스플레이 기기의 내부에서 공기의 순환이 원활하게 이루어지는 장점이 있다.

또한, 평면 디스플레이 기기의 내부에서 공기의 유동방향이 개선되어 평면 디스플레이 기기의 설치에 대한 자유도가 개선 될 수 있는 장점이 있다.

또한, 평면 디스플레이 기기의 내부를 흐르는 공기의 유속이 빨라지면서, 백 커버의 배면에 별도의 개공이 형성될 필요가 없 어지기 때문에, 백커버의 강도를 보강하기 위하여 백커버를 이루는 강판의 재질을 값비싼 고강도의 강판으로 할 필요가 없 어지기 때문에, 제조비가 절감되는 장점을 얻을 수도 있다.

도면의 간단한 설명

도 1은 본 발명에 따른 평면 디스플레이 기기의 사시도.

도 2는 본 발명의 평면 디스플레이 기기에서 백커버 상면의 일부를 제거한 부분 절개 사시도.

도 3은 도 1의 I-I' 선의 단면도.

도 4는 횡류팬 입셀러와 모터들이 제거된 상태의 평면 디스플레이 기기의 사시도.

도 5는 도 4의 II-II'의 단면도.

도 6은 본 발명에 따른 평면 디스플레이기 기기의 냉각장치의 작용을 설명하기 위한 평면 디스플레이 기기의 배면도.

도 7은 본 발명의 제 2 실시예에 따른 평면 디스플레이 기기의 사시도.

도 8은 본 발명의 제 2 실시예에서 백커버의 상면부가 제거된 상태에서 그 내부를 도시한 평면 디스플레이 기기의 사시도.

도 9는 본 발명의 제 2 실시예에 따른 냉각장치의 작용을 설명하는 도면.

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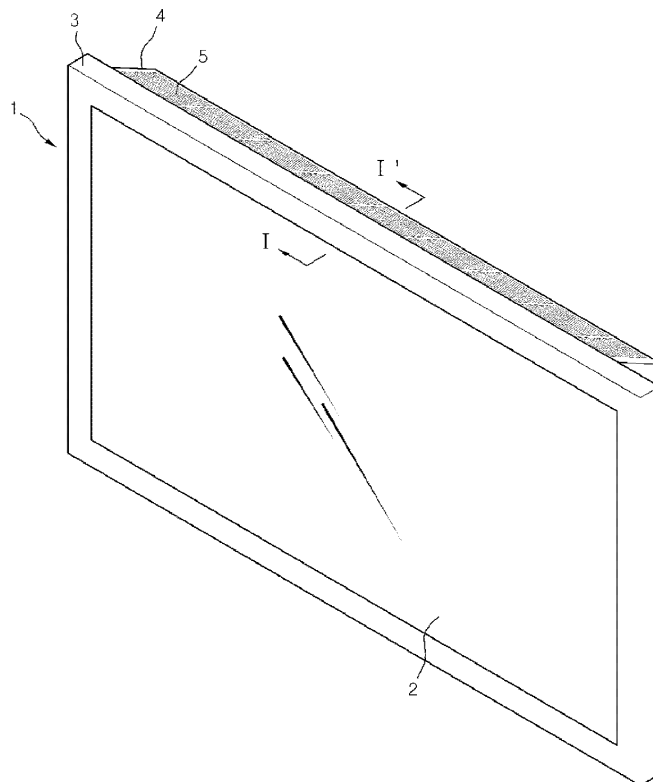
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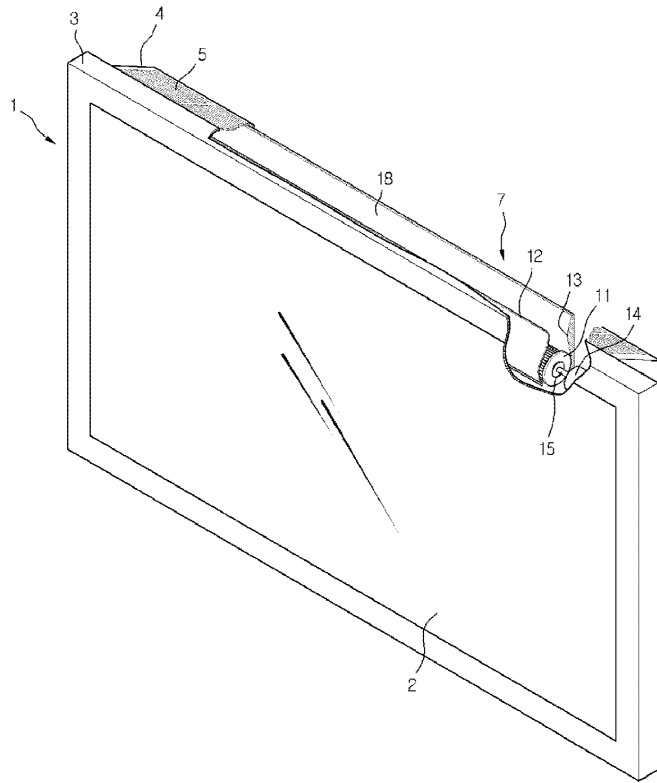
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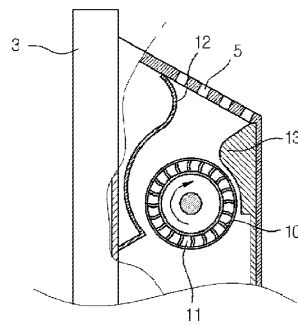
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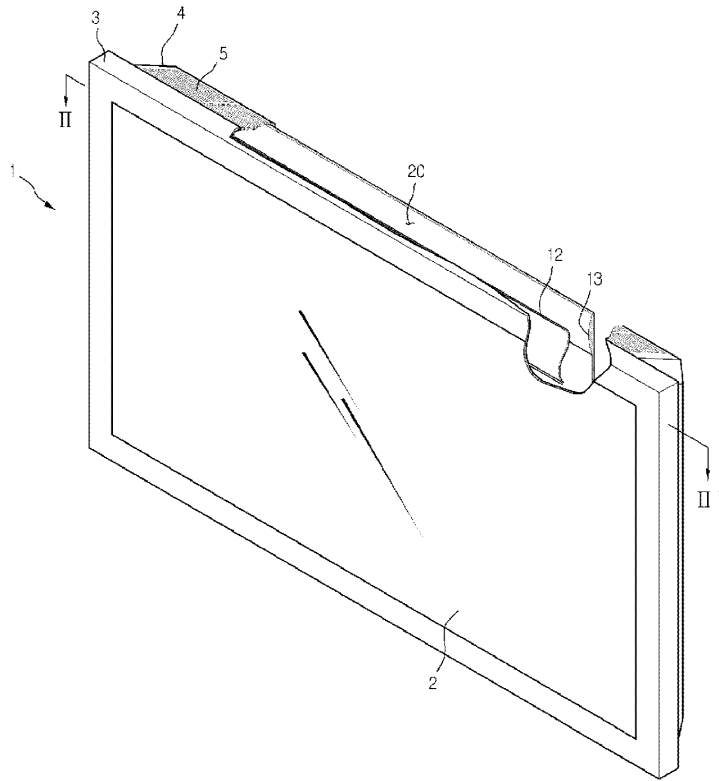
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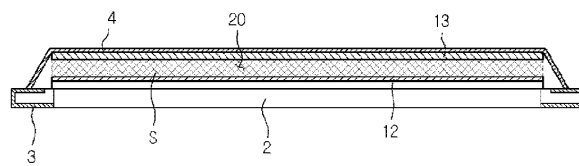
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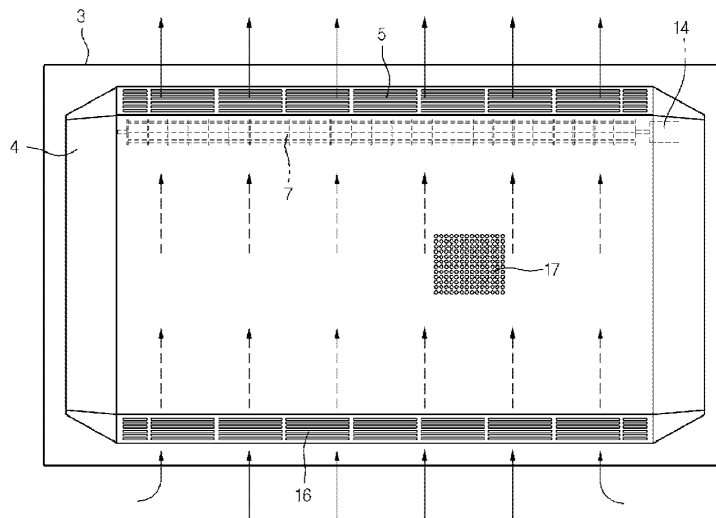
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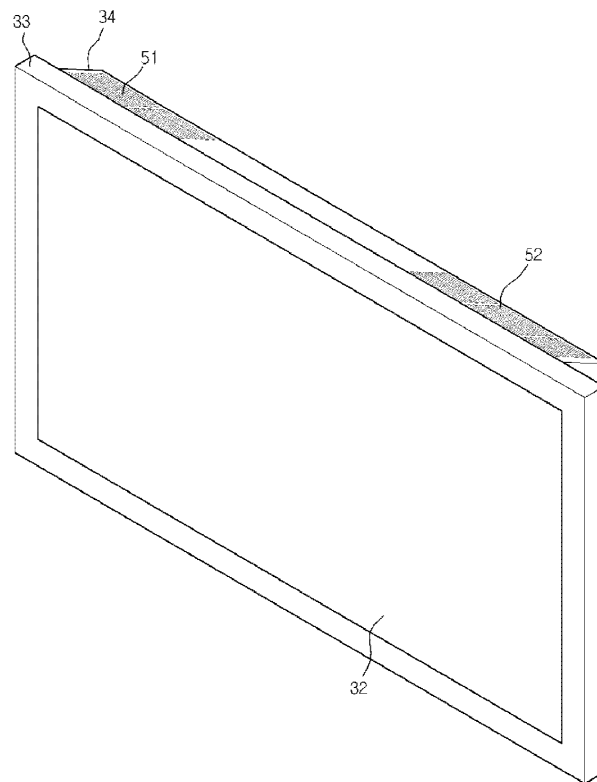
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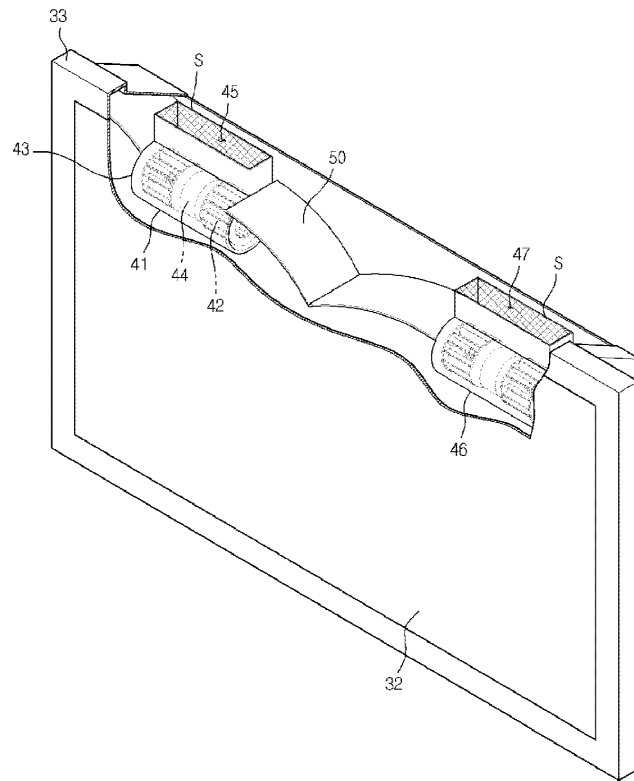
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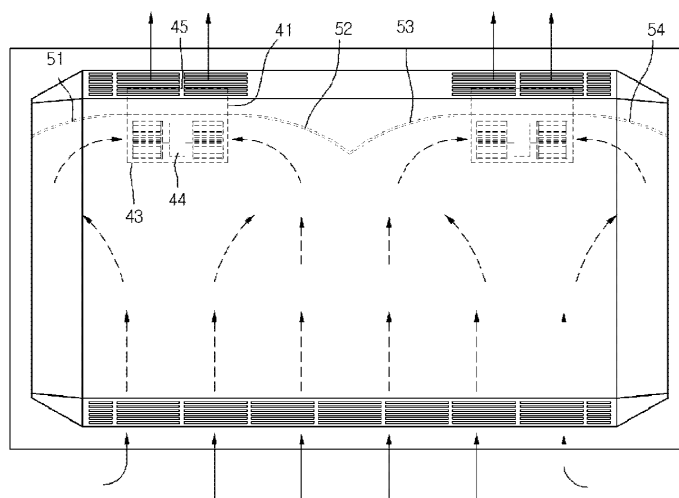
도면7



도면8



도면9





KOREAN PATENT ABSTRACTS

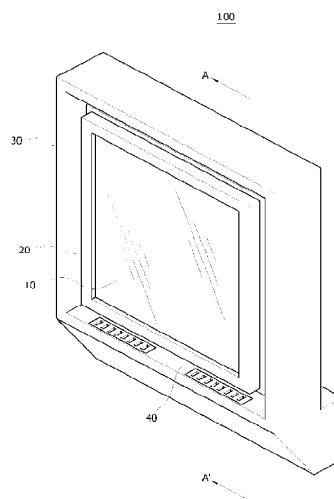
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LEE, CHEUL YONG**(51) Int. Cl: **G02F 1/13 (2006.01);**(54) **LCD COOLING MODULE AND AN AUTOMATIC TELLER MACHINE USING THE SAME, PARTICULARLY FOR PREVENTING DETERIORATION OF AN LCD**

(57) Abstract:

PURPOSE: An LCD cooling module, and an automatic teller machine using the same are provided to minimize a failure of an LCD by preventing deterioration of the LCD by cooling the LCD, thereby improving the management efficiency of the automatic teller machine.

CONSTITUTION: An LCD(10) displays image information. An LCD housing(30) is formed in a box shape with an open front for forming a containing space inside, wherein the LCD is embedded in the containing space with a front of the LCD exposed. An intake fan is installed at the LCD housing for cooling the LCD. The intake fan inhales air at a rear of the LCD housing and sends air to the containing space of the LCD housing.

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System for cooling an electronic image assembly

FIG. 4

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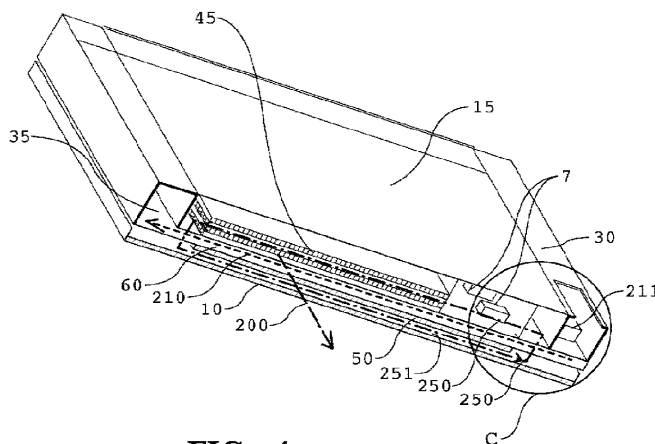


FIG - 4

(57) Abstract: A system for cooling an electronic image assembly. One embodiment of the system contains a plurality of channels placed behind the electronic image assembly and preferably in conductive thermal communication with the image assembly. Ambient gas is ingested into the display housing and directed to a manifold which distributes the ambient gas to the plurality of channels. Another embodiment of the system uses a heat exchanger with an internal fan assembly. Circulating gas may also be used to cool a front portion of the electronic image assembly or any other internal cavity of the electronic display housing. The circulating gas may be drawn through a heat exchanger so that heat may be transferred to an ambient gas. The heat exchanger may have an internal fan assembly for drawing ambient air through the heat exchanger and exhausting it out of the display housing.

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SYSTEM FOR COOLING AN ELECTRONIC IMAGE ASSEMBLY

Inventors: Tim Hubbard and William Dunn

Technical Field

[0001] Exemplary embodiments generally relate to cooling systems and in particular to cooling systems for electronic displays.

Background of the Art

[0002] Improvements to electronic displays now allow them to be used in outdoor environments for informational, advertising, or entertainment purposes. While displays of the past were primarily designed for operation near room temperature, it is now desirable to have displays which are capable of withstanding large surrounding environmental temperature variations. For example, some displays are capable of operating at temperatures as low as -22F and as high as 113 F or higher. When surrounding temperatures rise, the cooling of the internal display components can become even more difficult.

[0003] Additionally, modern displays have become extremely bright, with some backlights producing 1,000-2,000 nits or more. Sometimes, these illumination levels are necessary because the display is being used outdoors, or in other relatively bright areas where the display illumination must compete with other ambient light. In order to produce this level of brightness, illumination devices and electronic displays may produce a relatively large amount of heat.

[0004] Still further, in some situations radiative heat transfer from the sun through a front display surface can also become a source of heat. In some locations 800-1400 Watts/m² or more through such a front display surface is common. Furthermore, the market is demanding larger screen sizes for displays. With increased electronic display screen size and corresponding front display surfaces, more heat will be generated and more heat will be transmitted into the displays.

[0005] Exemplary modern displays have found some effective means for cooling the displays including circulating a closed loop of gas around the display and drawing ambient gas through the display so that the closed loop of gas may be cooled (as well

as portions of the electronic display). Various thermal communications have been discovered which can transfer heat away from the sensitive electronic components and out of the display. Heat exchangers were found to produce an excellent means for transferring heat between the closed loop of gas and the ambient gas. However, previous designs for moving the gas through the display have been found to generate an undesirable amount of noise emission from the display as well as thermal gradients where portions of the display were cooled but others remained warm.

[0006] When using LCD displays, it was found that backlights were often a source of heat and it was desirable to move gas across the rear surface of the backlight in order to cool it. While desirable, it was thought that the front surface of the backlight could not be cooled for fear that the backlight cavity would become contaminated with dust, dirt, or other particulate.

Summary of the Exemplary Embodiments

[0007] Exemplary embodiments use a combination of circulating gas and ambient gas in order to adequately cool an electronic display. Circulating gas may be used to remove heat from the front of the image assembly. When using a LCD as the electronic image assembly, circulating gas may also be used to remove heat from the backlight cavity of the LCD. Because the gas is only circulating within the display, it can remain free of particulate and contaminants and will not harm the display.

[0008] Ambient gas may be ingested into the display in order to cool the circulating gas. The ambient gas and the circulating gas may be drawn through a heat exchanger which will allow the heat to transfer from the circulating gas to the ambient gas, preferably without letting the ambient and circulating gases mix with one another. An exemplary embodiment would use a cross-flow heat exchanger. An additional flow of ambient gas can be drawn across the rear surface of the image assembly to remove heat from the rear portion of the image assembly. When using a LCD as the electronic image assembly, this additional flow of ambient gas can be used to remove heat from the rear portion of the backlight for the LCD.

[0009] In order to reduce noise emissions, the fans which drive the ambient and/or circulating gas through the heat exchanger may be placed within the heat exchanger,

which can then act as a muffler and reduce the noise emitted by the fans. Further, if using the additional ambient gas pathway behind the image assembly, a manifold may be used to collect the ambient gas along an edge of the display and distribute this into a number of smaller flows. The fans for driving this additional ambient gas pathway can be placed within the manifold in order to reduce the noise emitted by the fans and provide an even distribution of ambient gas across the display.

[0010] It has been found that ingesting ambient gas from the top or bottom edge of the display is preferable as these edges are not typically observable to the viewer. However, when ingesting ambient gas from the top or bottom of a portrait-oriented display, it has been found that as the cool ambient gas travels across the rear portion of the electronic image assembly and accepts heat it increases in temperature. Once the cooling air reaches the opposite edge (either top or bottom), it may have increased in temperature substantially and may no longer provide adequate cooling to the opposing portion of the display. Thus, the manifolds herein allow for cool ambient air to adequately cool the entire electronic image assembly in an even manner and reduce any 'hot spots' within the electronic image assembly.

[0011] The foregoing and other features and advantages will be apparent from the following more detailed description of the particular embodiments of the invention, as illustrated in the accompanying drawings.

Brief Description of the Drawings

[0012] A better understanding of an exemplary embodiment will be obtained from a reading of the following detailed description and the accompanying drawings wherein identical reference characters refer to identical parts and in which:

[0013] **FIGURE 1A** provides a front perspective view of an exemplary embodiment of the electronic display.

[0014] **FIGURE 1B** provides a rear perspective view of an exemplary embodiment of the electronic display.

[0015] **FIGURE 2** provides a rear perspective view similar to that shown in Figure 1B where the rear cover has been removed.

[0016] FIGURE 3 provides a perspective sectional view along the A-A section line shown in Figure 1B.

[0017] FIGURE 4 provides a perspective sectional view along the B-B section line shown in Figure 1B.

[0018] FIGURE 5 provides a perspective sectional view of insert C shown in Figure 4.

[0019] FIGURE 6 provides a perspective sectional view of one embodiment of the cross through plate.

[0020] FIGURE 7 provides an exploded perspective view of one exemplary embodiment of the heat exchanger and fan assembly.

[0021] FIGURE 8 provides a perspective sectional view of another embodiment which uses a flow of circulating gas through the backlight cavity of a liquid crystal display (LCD).

[0022] FIGURE 9 provides a perspective sectional view of an exemplary embodiment which uses a flow of circulating gas through the backlight cavity in addition to the flow of circulating gas between the LCD and front plate.

Detailed Description

[0023] The invention is described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity.

[0024] It will be understood that when an element or layer is referred to as being "on" another element or layer, the element or layer can be directly on another element or layer or intervening elements or layers. In contrast, when an element is referred to as being "directly on" another element or layer, there are no intervening elements or layers present. Like numbers refer to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0025] It will be understood that, although the terms first, second, third, etc., may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

[0026] Spatially relative terms, such as "lower", "upper" and the like, may be used herein for ease of description to describe the relationship of one element or feature to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation, in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "lower" relative to other elements or features would then be oriented "upper" relative the other elements or features. Thus, the exemplary term "lower" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0027] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0028] Embodiments of the invention are described herein with reference to cross-section illustrations that are schematic illustrations of idealized embodiments (and intermediate structures) of the invention. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are

to be expected. Thus, embodiments of the invention should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing.

[0029] For example, an implanted region illustrated as a rectangle will, typically, have rounded or curved features and/or a gradient of implant concentration at its edges rather than a binary change from implanted to non-implanted region. Likewise, a buried region formed by implantation may result in some implantation in the region between the buried region and the surface through which the implantation takes place. Thus, the regions illustrated in the figures are schematic in nature and their shapes are not intended to illustrate the actual shape of a region of a device and are not intended to limit the scope of the invention.

[0030] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0031] **FIGURE 1A** provides a front perspective view of an exemplary embodiment of the electronic display 100. A transparent front plate 10 is placed on the front portion of the display to protect the internal components and allow the images produced by the display 100 to be seen. Some embodiments may use glass as the transparent front plate 10. Exemplary embodiments may use two pieces of glass laminated with index-matching optical adhesive. Some front plates 10 may provide other utility such as anti-reflection or polarizing functions. An inlet aperture 24 and exit aperture 25 may be provided in the housing so that the display 100 can accept ambient gas for cooling the display 100.

[0032] **FIGURE 1B** provides a rear perspective view of an exemplary embodiment of the electronic display 100. A rear cover 15 may be used to provide access to the internal components of the display 100.

[0033] **FIGURE 2** provides a rear perspective view similar to that shown in Figure 1B where the rear cover 15 has been removed. Ambient gas 200 may be ingested into the display through the inlet aperture 24 and pass through a heat exchanger 45 and exit the display through the exit aperture 25. The ambient gas 200 may be drawn into the display and forced through the heat exchanger 45 using heat exchanger fan assembly 46. An exemplary placement for the heat exchanger fan assembly 46 is discussed further below, but in many embodiments the fan assembly 46 can be placed near the inlet aperture 24 and/or exit aperture 25 and may or may not be placed within the heat exchanger 45 (as shown in Figure 2).

[0034] Optionally, ambient gas 210 may also be ingested into the display through inlet aperture 24 (or a separate inlet aperture). Ambient gas 210 may then be directed through a first manifold 30 which travels along the edge of the display. The first manifold 30 accepts the single larger inlet flow of ambient gas 210 and distributes it into a plurality of smaller flows (channels 60) across the display. A second manifold 35 may be placed along the opposite edge of the display as the first manifold 30. The second manifold 35 accepts the plurality of smaller flows (channels 60) and combines them into a single flow and exhausts it out of the exit aperture 25 (or a separate exit aperture). In this embodiment, a manifold fan assembly 211 is used to draw the ambient gas 210 into the inlet aperture 24 and force the ambient gas 210 across the display. For this particular embodiment, the manifold fan assembly 211 is placed within the first manifold 30 and is used to draw the ambient gas 210 into the display as well as distribute the single flow into a plurality of smaller flows (channels 60). This is not required however, as some embodiments may place the manifold fan assembly 211 in the second manifold 35, or within both the first and second manifolds 30 and 35.

[0035] The first and second manifolds 30 and 35 may be placed along any opposing edges of the display. However, it is preferable that the first and second manifolds 30 and 35 are placed along the vertical edges of the display with the channels 60 travelling horizontally. Other embodiments may place the first and second manifolds 30 and 35 along the horizontal edges of the display with the channels 60 travelling vertically.

[0036] While both flows of ambient gas may be used in an exemplary embodiment, there is no requirement that they are both used. Some embodiments may use only

ambient gas 200 or ambient gas 210. Also, if using both flows of ambient gas 200 and ambient gas 210 there is no requirement that they share the same inlet and exit apertures. Thus, there may be separate inlet and exit apertures for the two flows of ambient gas.

[0037] **FIGURE 3** provides a perspective sectional view along the A-A section line shown in Figure 1B. Again, ambient gas 200 may be ingested into the display through the inlet aperture 24 and pass through a heat exchanger 45 and exit the display through the exit aperture 25. The ambient gas 200 may be drawn into the display and forced through the heat exchanger 45 using heat exchanger fan assembly 46. Obviously, the inlet aperture 24 may contain a filter or other coverings so that contaminants, insects, garbage, and/or water/fluids cannot easily be ingested into the display. However, an exemplary embodiment would not be damaged if the ambient gas 200 contained contaminants as they would only pass through the heat exchanger 45 which may not be susceptible to damage from particulate or contaminants. Exit aperture 25 may also contain some type of covering to ensure that contaminants and/or insects could not enter the display.

[0038] An electronic image assembly 50 may be placed behind the front plate 10. A plurality of channels 60 may be placed behind the electronic image assembly 50. Ambient gas 210 may be forced through the channels 60 after travelling through the first manifold 30 (not shown here). The flow of ambient gas 210 behind the electronic image assembly 50 may be used to remove any buildup of heat from the rear portion of the electronic image assembly 50. It may be preferable to have a thermally conductive surface/plate on the rear portion of the electronic image assembly 50 so that heat can easily transfer to this surface/plate and be removed by the ambient gas 210.

[0039] The channels 60 can take on any number of forms. Although shown in this embodiment with a square cross-section this is not required. Other embodiments may contain channels 60 with I-beam cross-sections, hollow square cross-sections, hollow rectangular cross-section, solid rectangular or solid square cross-sections, 'T' cross-sections, 'Z' cross-sections, a honeycomb cross-section, or any combination or mixture of these. The channels 60 are preferably thermally conductive and also preferably in thermal communication with the electronic image assembly 50. Thus, in a preferred

embodiment, heat which accumulates on the rear portion of the electronic image assembly 50 may be transferred throughout the channels 60 and removed by ambient gas 210. Preferably, the channels 60 are metallic and even more preferably aluminum. Further, in an exemplary embodiment the channels 60 are in conductive thermal communication with the electronic image assembly 50.

[0040] **FIGURE 4** provides a perspective sectional view along the B-B section line shown in Figure 1B. In this view, the path of the circulating gas 250 can also be observed. The space between the front plate 10 and the electronic image assembly 50 may define a front channel 251, through which the circulating gas 250 may travel in order to remove any accumulation of heat on the front surface of the electronic image assembly 50. The circulating gas 250 is preferably then directed into the heat exchanger 45 where heat may be transferred from the circulating gas 250 to the ambient gas 200. Upon exiting the heat exchanger 45, the circulating gas 250 may be re-directed into the front channel 251. In this way, the heat exchanger 45 and the front channel 251 are placed in gaseous communication with each other.

[0041] The circulating gas 250 may also be directed over various electronic components 7 so that heat may be transferred from the electronic components 7 to the circulating gas 250. The electronic components 7 could be any one of the following but not limited to: power modules, heat sinks, capacitors, motors, microprocessors, hard drives, AC/DC converters, transformers, or printed circuit boards.

[0042] Also shown in this sectional view is the path of the ambient gas 210 travelling down one of the channels 60 behind the electronic image assembly 50. In this embodiment, the ambient gas 210 is forced out of the first manifold 30, across the channels 60, and into the second manifold 35 by manifold fan assembly 211. In other words, each channel 60 preferably has an inlet which is in gaseous communication with the first manifold 30 as well as an exit which is in gaseous communication with the second manifold 35. As shown in this Figure, the paths of the ambient gas 210 and the circulating gas 250 may cross, but it is preferable to keep the two gases from mixing (as the ambient gas 210 may contain particulate or contaminants while the circulating gas 250 can remain substantially free of particulate and contaminants). It may be preferable to keep the circulating gas 250 from having particulate or contaminants

because it travels in front of the electronic image assembly 50. Thus, to keep the image quality from being impaired, it may be desirable to keep the circulating gas 250 clean and prevent it from mixing with the ambient gas 210.

[0043] FIGURE 5 provides a perspective sectional view of insert C shown in Figure 4. As noted above, if practicing an embodiment which uses ambient gas 210 as well as the circulating gas 250, the pathways of the two gases may need to cross over one another and it may be desirable to prohibit them from mixing to prevent contamination of sensitive portions of the display. Here, cross through plate 500 allows the pathways of the two gases to cross over one another without letting them mix together. The cross through plate 500 in this embodiment contains a series of voids which pass through the plate. A first series of voids 550 passes through the cross through plate 500 and allows ambient gas 210 to travel from the first manifold 30 into the channels 60 which run behind the electronic image assembly 50. A second series of voids 525 pass through the cross through plate 500 in a direction substantially perpendicular to that of the first series of voids 550. The second series of voids 525 allows the circulating gas to exit the front channel 251, cross over the ambient gas 210, and continue towards the heat exchanger 45. In this embodiment, a circulating gas fan assembly 255 is used to draw the circulating gas 250 through the front channel 251 and through the heat exchanger 45. Much like the other fan assemblies shown and described here, the circulating gas fan assembly 255 could be placed anywhere within the display, including but not limited to the entrance/exit of the heat exchanger 45 or the entrance/exit of the front channel 251.

[0044] FIGURE 6 provides a perspective sectional view of one embodiment of the cross through plate 500. In this embodiment, the cross through plate 500 is comprised of a plurality of hollow blocks 503 sandwiched between a top plate 501 and bottom plate 502 with sections of the plates 501 and 502 removed to correspond with the hollow sections of the blocks 503. A portion of the top plate 501 has been removed to show the detail of the hollow blocks 503, first series of voids 550, and second series of voids 525. The cross through plate 500 could take on any number of forms and could be constructed in a number of ways. Some other embodiments may use a solid plate where the first and second series of voids 550 and 525 are cut out of the solid plate.

Other embodiments could use two sets of hollow blocks where the hollow sections are perpendicular to each other and the blocks are fastened together. Still other embodiments could use a design similar to those that are taught below for the heat exchanger 45, for example any type of cross-flow heat exchanger design could be used. Thus, an exemplary cross through plate 500 contains two gaseous pathways where the two pathways do not allow the gaseous matter to mix. Here, the first gas pathway would be 525 while the second gas pathway would be 550.

[0045] **FIGURE 7** provides an exploded perspective view of one exemplary embodiment of the heat exchanger 45 and fan assembly 46. In this view, the fan assembly 46 is shown removed from its mounted position within the fan housing 51. In this embodiment, the heat exchanger 45 is divided into two portions 47 and 48 where the fan housing 51 is used to provide a gaseous communication between the two portions 47 and 48. Here, the fan assembly 46 is placed between the two portions 47 and 48. While the fan assembly 46 can be placed anywhere so that it draws ambient gas 200 through the heat exchanger 45, it has been found that placing the fan assembly 46 between the two portions of the heat exchanger can provide a number of benefits. First, the volumetric flow rate of the ambient gas 200 through the heat exchanger is high, which results in better cooling capabilities for the heat exchanger 45. Second, the noise produced by the fan assembly 46 can be reduced because the surrounding portions 47 and 48 of the heat exchanger 45 essentially act as a muffler for the fan assembly 46.

[0046] In this embodiment, portion 48 is thinner and longer than portion 47. This was done in order to free up more space within the housing so that additional electronic components could fit within the housing (adjacent to portion 48). As shown, the fan housing 51 may be used to connect two portions of a heat exchanger which may be of different lengths. As shown, portion 48 of the heat exchanger is thinner than the fan housing 51. In an alternative embodiment, both portions 48 and 47 may be thinner than the fan assembly 46 such that a fan housing 51 may be used to provide a sealed gaseous communication between the two portions, even though they are both thinner than the fan assembly 51. This design may be preferable when it is desirable to create the largest possible heat exchanger 45 (for maximum cooling abilities) even though

space is limited. This is of course not required, and other embodiments may have portions which are of equal width and length. Also, although this embodiment uses the fan assembly 46 to drive the ambient gas 200, other embodiments could use a fan assembly placed within the heat exchanger to drive the circulating gas 250 instead and drive the ambient gas 200 with another fan assembly (possibly placed within the heat exchanger or located at the entrance/exit of the heat exchanger). Some exemplary embodiments may place fans within the heat exchanger 45 to drive both the ambient gas 200 and circulating gas 250.

[0047] The ambient gas 200 travels through a first pathway (or plurality of pathways) of the heat exchanger 45 while the circulating gas 250 travels through a second pathway (or plurality of pathways) of the heat exchanger 45. Although not required, it is preferable that the circulating gas 250 and ambient gas 200 do not mix. This may prevent any contaminants and/or particulate that is present within the ambient gas 200 from harming the interior of the display. In a preferred embodiment, the heat exchanger 45 would be a cross-flow heat exchanger. However, many types of heat exchangers are known and can be used with any of the embodiments herein. The heat exchanger 45 may be a cross-flow, parallel flow, or counter-flow heat exchanger. In an exemplary embodiment, the heat exchanger 45 would be comprised of a plurality of stacked layers of thin plates. The plates may have a corrugated, honeycomb, or tubular design, where a plurality of channels/pathways/tubes travel down the plate length-wise. The plates may be stacked such that the directions of the pathways are alternated with each adjacent plate, so that each plate's pathways are substantially perpendicular to the pathways of the adjacent plates. Thus, ambient gas or circulating gas may enter an exemplary heat exchanger only through plates whose channels or pathways travel parallel to the path of the gas. Because the plates are alternated, the circulating gas and ambient gas may travel in plates which are adjacent to one another and heat may be transferred between the two gases without mixing the gases themselves (if the heat exchanger is adequately sealed, which is preferable but not required).

[0048] In an alternative design for a heat exchanger, an open channel may be placed in between a pair of corrugated, honeycomb, or tubular plates. The open channel may travel in a direction which is perpendicular to the pathways of the adjacent plates. This

open channel may be created by running two strips of material or tape (esp. very high bond (VHB) tape) between two opposite edges of the plates in a direction that is perpendicular to the direction of the pathways in the adjacent plates. Thus, gas entering the heat exchanger in a first direction may travel through the open channel (parallel to the strips or tape). Gas which is entering in a second direction (substantially perpendicular to the first direction) would travel through the pathways of the adjacent plates).

[0049] Other types of cross-flow heat exchangers could include a plurality of tubes which contain the first gas and travel perpendicular to the path of the second gas. As the second gas flows over the tubes containing the first gas, heat is exchanged between the two gases. Obviously, there are many types of cross-flow heat exchangers and any type would work with the embodiments herein.

[0050] An exemplary heat exchanger may have plates where the sidewalls have a relatively low thermal resistance so that heat can easily be exchanged between the two gases. A number of materials can be used to create the heat exchanger. Preferably, the material used should be corrosion resistant, rot resistant, light weight, and inexpensive. Metals are typically used for heat exchangers because of their high thermal conductivity and would work with these embodiments. However, it has been discovered that plastics and composites can also satisfy the thermal conditions for electronic displays. An exemplary embodiment would utilize polypropylene as the material for constructing the plates for the heat exchanger. It has been found that although polypropylene may seem like a poor thermal conductor, the large amount of surface area relative to a small sidewall thickness, results in an overall thermal resistance that is low. Thus, an exemplary heat exchanger would be made of plastic and would thus produce a display assembly that is thin and lightweight. Specifically, corrugated plastic may be used for each plate layer where they are stacked together in alternating fashion (i.e. each adjacent plate has channels which travel in a direction perpendicular to the surrounding plates).

[0051] **FIGURE 8** provides a perspective sectional view of another embodiment which uses a flow of circulating gas 350 through the backlight cavity of a liquid crystal display (LCD) 300. In this embodiment, a LCD 300 and an associated backlight 320 are used

as the electronic image assembly. A backlight wall 330 may enclose the area between the LCD 300 and the backlight 320 in order to create a backlight cavity. Typically, the backlight cavity is closed to prevent contaminants/particulate from entering the backlight cavity and disrupting the optical/electrical functions of the backlight 320. However, as discussed above the exemplary embodiments may use a clean gaseous matter for the circulating gases which could now be used to ventilate the backlight cavity in order to cool the backlight 320 and even the rear portion of the LCD 300. An opening 340 can be placed in the backlight wall 330 to allow circulating gas 350 to flow through the backlight cavity. A fan assembly 360 may be used to draw the circulating gas 350 through the backlight cavity. In an exemplary embodiment there would be an opening on the opposing backlight wall (on the opposite side of the display as shown in this figure) so that circulating gas 350 could easily flow through the backlight cavity. In this way, the backlight cavity is placed in gaseous communication with the heat exchanger 45.

[0052] **FIGURE 9** provides a perspective sectional view of an exemplary embodiment which uses a flow of circulating gas 350 through the backlight cavity in addition to the flow of circulating gas 250 through the front channel 251 (the area defined between the LCD 300 and front plate 10). Circulating fan assembly 255 may be placed so that it can draw circulating gas 350 through the backlight cavity as well as circulating gas 250 through the front channel 251. As discussed above, the circulating gases 250 and 350 are preferably forced through the heat exchanger 45 (not shown in this figure) so that they may be cooled by the ambient gas 200 (also not shown in this figure). In this way, both the front channel 251 and the backlight cavity are placed in gaseous communication with the heat exchanger 45.

[0053] Also shown in Figure 9 is the optional additional flow of ambient gas 210 which may travel immediately behind the electronic image assembly (in this embodiment backlight 320). Once travelling through the first manifold 30, the ambient gas 210 may pass through the channels 60 in order to remove heat from the backlight 320 and even the channels 60 themselves (if they are thermally conductive). The manifold fan assembly 211 may be used to draw the ambient gas 210 into the first manifold 30 and through the channels 60. Again, the cross through plate 500 may be

used to allow the circulating gases 350 and 250 to cross paths with the ambient gas 210 without letting the two gases mix.

[0054] In an exemplary embodiment, the backlight 320 would contain a plurality of LEDs mounted on a thermally conductive substrate (preferably a metal core PCB). On the surface of the thermally conductive substrate which faces the channels 60 there may be a thermally conductive plate which may be in thermal communication with the channels 60. In an exemplary embodiment, the thermally conductive plate would be metallic and more preferably aluminum and the thermal communication between the channels 60 and the backlight 320 would be conductive thermal communication.

[0055] As noted above, many electronic image assemblies (especially LEDs, LCDs, and OLEDs) may have performance properties which vary depending on temperature. When 'hot spots' are present within an image assembly, these hot spots can result in irregularities in the resulting image which might be visible to the end user. Thus, with the embodiments described herein, the heat which may be generated by the image assembly (sometimes containing a backlight assembly) can be distributed (somewhat evenly) throughout the channels 60 and thermally-conductive surfaces to remove hot spots and cool the backlight and/or electronic image assembly.

[0056] The circulating gases 250 and 350, ambient gas 200, and optional ambient gas 210 can be any number of gaseous matters. In some embodiments, air may be used as the gas for all. As well known by those of ordinary skill in the art, air typically contains some amount of water vapor. It should be noted that the use of the term 'gas' herein does not designate pure gas and that it is specifically contemplated that any of the gaseous matters described herein may contain some amount of impurities including but not limited to water vapor. Preferably, because the circulating gases 250 and 350 may travel in front of the image assembly and backlight respectively, they should be substantially clear, so that they will not affect the appearance of the image to a viewer. The circulating gases 250 and 350 should also preferably be substantially free of contaminants and/or particulate in order to prevent an adverse effect on the image quality and/or damage to the internal electronic components. It may sometimes be preferable to keep ambient gases 200 and 210 from having contaminants as well. Filters may be used to help reduce the particulate within ambient gases 200 and 210.

Filters could be placed near the inlet aperture 24 so that ambient gases 200 and/or 210 could be drawn through the filter. However, in an exemplary embodiment the display may be designed so that contaminants could be present within the ambient gases 200 and 210 but this will not harm the display. In these embodiments, the heat exchanger 45, manifolds 30 and 35, channels 60, and any other pathway for ambient or circulating gas should be properly sealed so that any contaminants in the ambient gas would not enter sensitive portions of the display. Thus, in these exemplary embodiments, ambient air may be ingested for the ambient gases 200 and 210, even if the ambient air contains contaminants or particulate. This can be particularly beneficial when the display is used in outdoor environments or indoor environments where contaminants are present in the ambient air.

[0057] The cooling system may run continuously. However, if desired, temperature sensing devices (not shown) may be incorporated within the electronic display to detect when temperatures have reached a predetermined threshold value. In such a case, the various cooling fans may be selectively engaged when the temperature in the display reaches a predetermined value. Predetermined thresholds may be selected and the system may be configured to advantageously keep the display within an acceptable temperature range. Typical thermostat assemblies can be used to accomplish this task. Thermocouples may be used as the temperature sensing devices.

[0058] It is to be understood that the spirit and scope of the disclosed embodiments provides for the cooling of many types of electronic image assemblies. As used herein, the term 'electronic image assembly' is any electronic assembly for creating an image. At this time this, these are LCD (all types), light emitting diode (LED), organic light emitting diode (OLED), field emitting display (FED), light emitting polymer (LEP), organic electro luminescence (OEL), plasma displays, and any thin/flat panel electronic image assembly. Furthermore, embodiments may be used with displays of other types including those not yet discovered. In particular, it is contemplated that the system may be well suited for use with full color, flat panel OLED displays. Exemplary embodiments may also utilize large (55 inches or more) LED backlit, high definition liquid crystal displays (LCD). While the embodiments described herein are well suited for outdoor environments, they may also be appropriate for indoor

applications (e.g., factory/industrial environments, spas, locker rooms) where thermal stability of the display may be a concern.

[0059] As is well known in the art, electronic displays can be oriented in a portrait manner or landscape manner and either can be used with the embodiments herein.

[0060] Having shown and described preferred embodiments, those skilled in the art will realize that many variations and modifications may be made to affect the described embodiments and still be within the scope of the claimed invention. Additionally, many of the elements indicated above may be altered or replaced by different elements which will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

CLAIMS

1. An assembly for cooling an electronic image assembly within a housing having an inlet aperture for ambient gas, exit aperture for ambient gas, and internal cavity for circulating gas, the assembly comprising:
 - a first portion of a heat exchanger which accepts ambient gas from the inlet aperture;
 - a second portion of a heat exchanger which accepts ambient gas from the first portion;
 - an first fan positioned between the first and second portions which pulls ambient gas through the first portion and pushes ambient gas through the second portion;
 - a second fan which forces circulating gas through the internal cavity and at least one of the heat exchanger portions;
 - a plurality of channels placed behind the electronic image assembly, each channel having an inlet and exit;
 - a first manifold in gaseous communication with the inlet of each channel;
 - a second manifold in gaseous communication with the exit of each channel; and
 - a third fan positioned to force ambient gas through the channels.
2. A system for cooling an electronic image assembly with ambient gas, the system comprising:
 - a plurality of channels placed behind the electronic image assembly, each channel having an inlet and exit;
 - a first manifold in gaseous communication with the inlet of each channel;
 - a second manifold in gaseous communication with the exit of each channel; and
 - a fan positioned to force ambient gas through the channels.
3. The cooling system of claim 2 wherein:
 - the channels are in thermal communication with the electronic image assembly.
4. The cooling system of claim 2 wherein:

the first and second manifolds are placed along a pair of vertical edges of the electronic image assembly.

5. The cooling system of claim 2 wherein:
the fan is placed within either the first or second manifold.
6. The cooling system of claim 2 wherein:
the channels have a rectangular cross-section.
7. The cooling system of claim 2 wherein:
the channels are arranged in horizontal rows.
8. The cooling system of any one of claims 2-7 wherein:
the cooling channels are metallic.
9. The cooling system of claim 2 further comprising:
a front plate placed in front of the electronic image assembly, the space between the front plate and the electronic image assembly defining a front channel;
a circulating fan position to force circulating gas through the front channel; and
a pass through plate having a first pathway for ambient gas travelling through the plurality of channels behind the electronic image assembly and a second pathway for circulating gas travelling through the front channel.
10. The cooling system of claim 9 wherein:
the first and second gas pathways are substantially perpendicular.
11. The cooling system of claim 9 wherein:
the first and second gas pathways do not allow the ambient gas and circulating gas to mix.
12. The cooling system of claim 9 wherein:

the pass through plate is positioned adjacent to the first manifold.

13. An electronic display assembly comprising:
 - a housing;
 - an electronic image assembly contained within the housing and having a pair of opposing edges;
 - an inlet aperture in the housing for accepting ambient gas;
 - an exhaust aperture in the housing for exhausting ambient gas;
 - a plurality of channels placed behind the electronic image assembly;
 - a first manifold placed along one of the opposing edges which accepts ambient gas from the inlet aperture and distributes ambient gas to the plurality of channels;
 - a second manifold placed along the opposite edge as the first manifold which accepts ambient gas from the channels and directs it towards the exhaust aperture; and
 - a fan which forces the ambient gas through the channels.
14. The electronic display assembly of claim 13 wherein:
 - the fan is placed within the first manifold.
15. The electronic display assembly of claim 13 wherein:
 - the housing contains a top and bottom portion;
 - the inlet aperture is located at the top portion of the housing; and
 - the exhaust aperture is located at the bottom portion of the housing.
16. The electronic display assembly of claim 13 wherein:
 - the first and second manifolds are oriented vertically; and
 - the plurality of channels are oriented horizontally.
17. The electronic display assembly of any one of claims 13-16 wherein:

the channels are in conductive thermal communication with the electronic image assembly.

18. The electronic display assembly of claim 13 further comprising:

- a transparent front plate placed in front of the electronic image assembly, the space between the front plate and the electronic image assembly defining a front channel;
- a circulating fan position to force circulating gas through the front channel; and
- a first pass through plate adjacent to the first manifold and a second pass through plate adjacent to the second manifold, each pass through plate having a first pathway for ambient gas travelling through the plurality of channels behind the electronic image assembly and a second pathway for circulating gas travelling through the front channel.

19. The cooling system of claim 18 wherein:

- the first and second gas pathways are substantially perpendicular.

20. An electronic display assembly comprising:

- a housing having a top portion, bottom portion, and a pair of vertical edges;
- an electronic image assembly contained within the housing;
- an inlet aperture in the housing for accepting ambient gas;
- an exhaust aperture in the housing for exhausting ambient gas;
- a plurality of metallic channels placed behind and in conductive thermal communication with the electronic image assembly;
- a first manifold placed along one of the vertical edges which accepts ambient gas from the inlet aperture and distributes ambient gas to the plurality of channels;
- a second manifold placed along the opposite vertical edge as the first manifold which accepts ambient gas from the channels and directs it towards the exhaust aperture; and

a plurality of fans within the first manifold which draw the ambient gas into the inlet aperture and through the channels.

21. The electronic display assembly of claim 20 wherein:
the electronic image assembly is a liquid crystal display.
22. An assembly for cooling an electronic image assembly within a housing having an inlet aperture for ambient gas, exit aperture for ambient gas, and internal cavity for circulating gas, the assembly comprising:
a first portion of a heat exchanger which accepts ambient gas from the inlet aperture;
a second portion of a heat exchanger which accepts ambient gas from the first portion;
an first fan positioned between the first and second portions which pulls ambient gas through the first portion and pushes ambient gas through the second portion; and
a second fan which forces circulating gas through the internal cavity and at least one of the heat exchanger portions.
23. The cooling assembly of claim 22 wherein:
the first fan also draws ambient gas through the inlet aperture.
24. The cooling assembly of claim 23 wherein:
the first fan also pushes ambient gas through the exit aperture.
25. The cooling assembly of claim 22 further comprising:
an electronic component placed within the path of the circulating gas.
26. The cooling assembly of claim 25 wherein:
the electronic component is a power module.

27. The cooling assembly of claim 22 wherein:
the heat exchanger portions are comprised of corrugated layers.
28. The cooling assembly of claim 22 wherein:
the heat exchanger portions are cross-flow heat exchanger portions.
29. An assembly for cooling an electronic image assembly within a housing having an inlet aperture for ambient gas, exit aperture for ambient gas, and internal cavity for circulating gas, the assembly comprising:
a heat exchanger having first and second gas pathways;
an first fan placed within the heat exchanger to draw ambient gas through the inlet aperture and the first gas pathway of the heat exchanger; and
a second fan placed to draw circulating gas through the internal cavity and the second gas pathway of the heat exchanger.
30. The cooling assembly of claim 29 wherein:
the first fan comprises an inlet side and exhaust side such that a portion of the heat exchanger is adjacent to the inlet side and a further portion of the heat exchanger is adjacent to the exhaust side.
31. The cooling assembly of claim 29 wherein:
the internal cavity comprises a front channel defined by the space between the electronic image assembly and a transparent front plate.
32. The cooling assembly of claim 29 wherein:
the first fan also forces the ambient gas out the exit aperture.
33. The cooling assembly of claim 29 further comprising:
an electronic component placed within the path of the circulating gas.
34. The cooling assembly of claim 33 wherein:

the electronic component is a power module.

35. The cooling assembly of claim 29 wherein:

the heat exchanger is comprised of corrugated layers.

36. The cooling assembly of claim 29 wherein:

the heat exchanger is a cross-flow heat exchanger.

37. An electronic display assembly comprising:

a housing having an inlet aperture and exit aperture for ambient gas;

an electronic image assembly within the housing;

a transparent front plate in front of the electronic image assembly, the space between the transparent front plate and the electronic image assembly defining a channel;

a heat exchanger in gaseous communication with the channel, the heat exchanger comprising two portions, each portion having first and second gas pathways, where the first gas pathways are in gaseous communication with the inlet and exit apertures and the second gas pathways are in gaseous communication with the channel;

a first fan assembly placed between the two portions of the heat exchanger to force ambient gas through the first gas pathways; and

a second fan assembly positioned to force gas through the channel and the second gas pathways.

38. The electronic display assembly of claim 37 further comprising:

a power module placed within the path of the circulating gas.

39. The electronic display assembly of claim 37 wherein:

the electronic image assembly is a liquid crystal display.

40. The electronic display assembly of claim 37 wherein:

the electronic image assembly is an OLED display.

41. The electronic display assembly of claim 37 wherein:

the heat exchanger is a cross-flow heat exchanger comprised of corrugated layers.

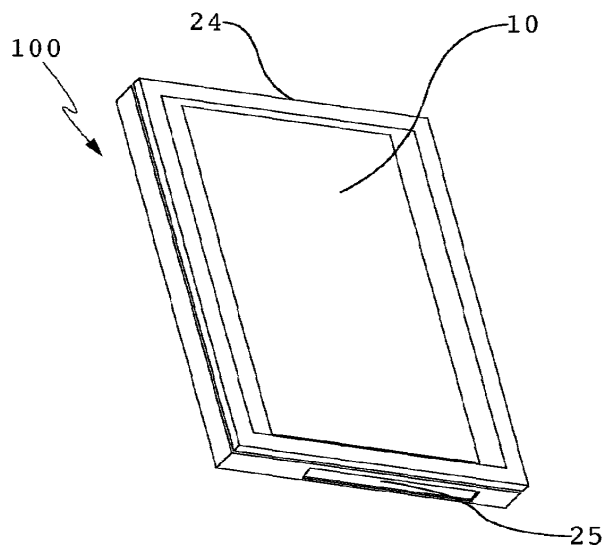


FIG - 1A

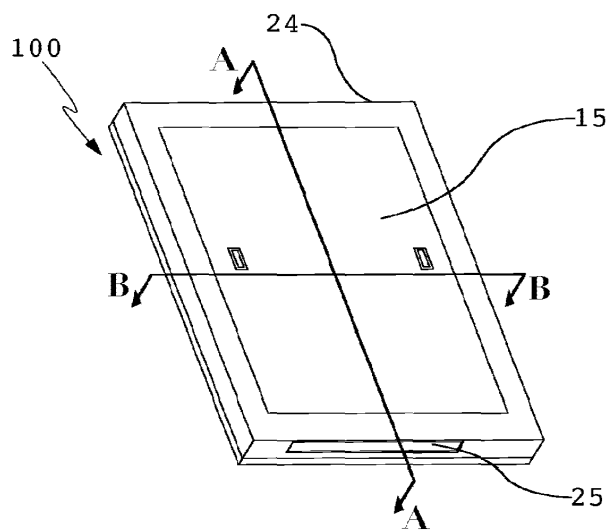


FIG - 1B

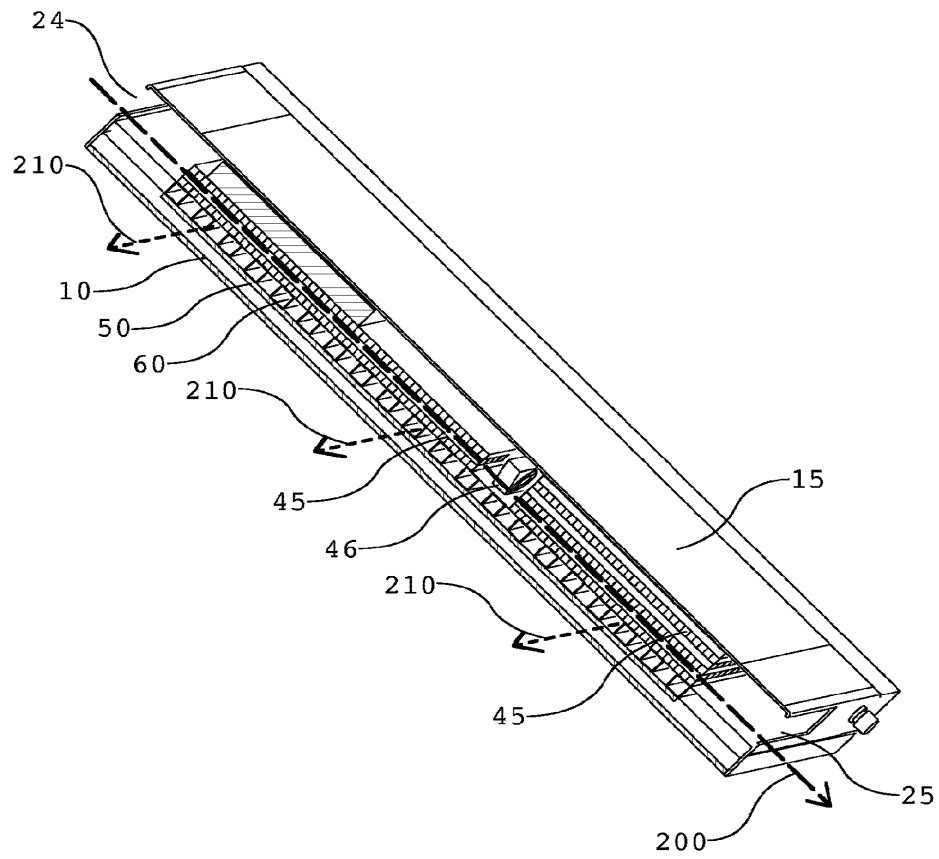


FIG - 3

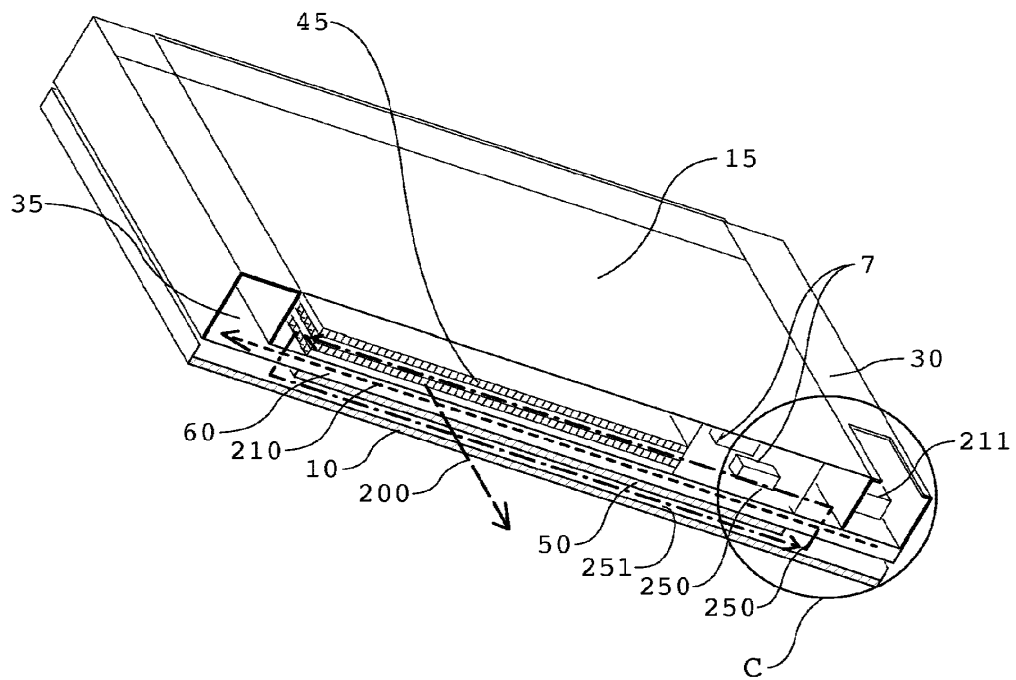


FIG - 4

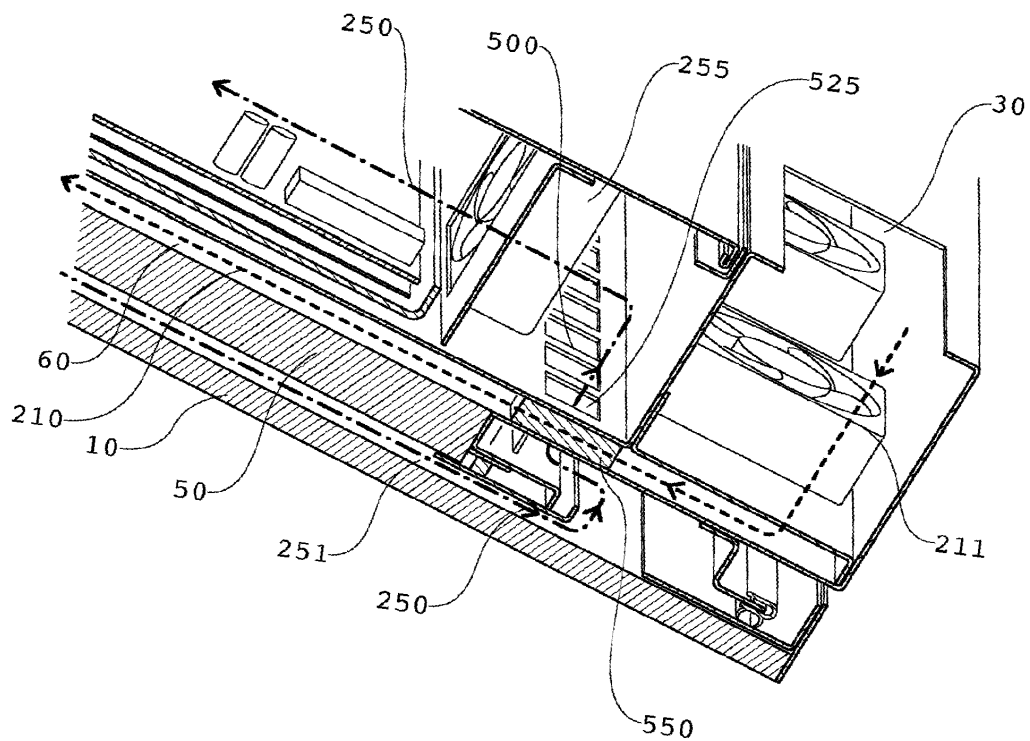


FIG - 5

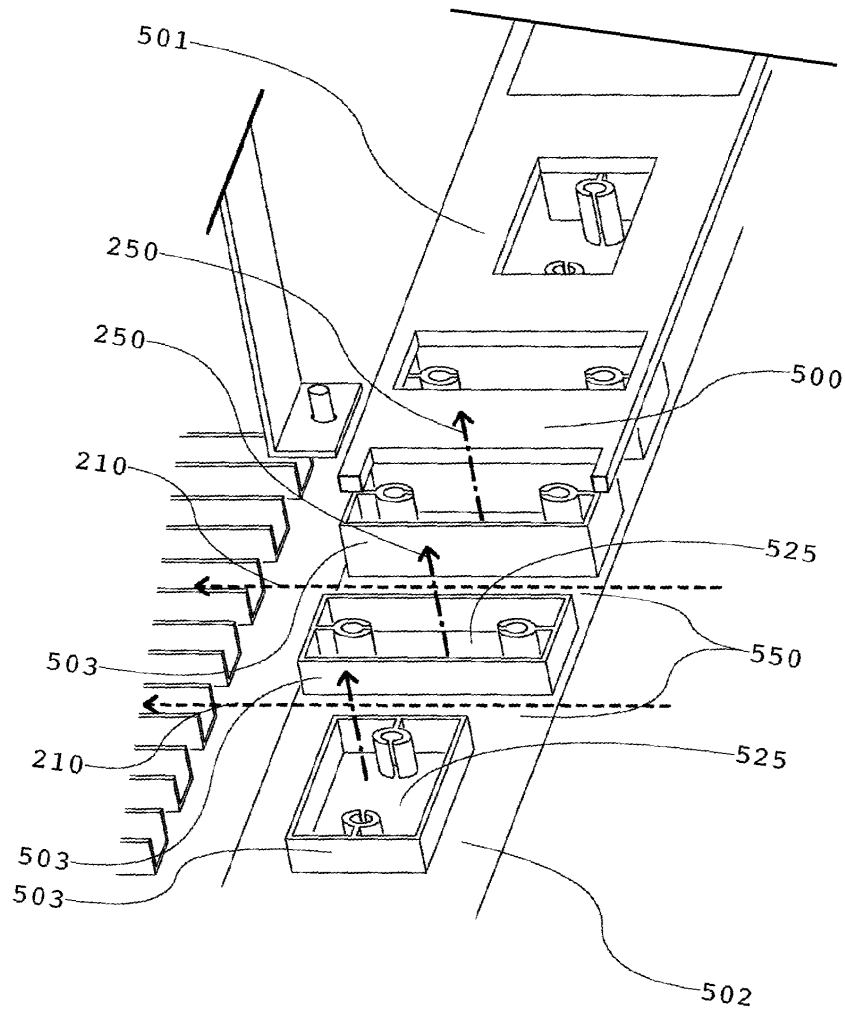


FIG - 6

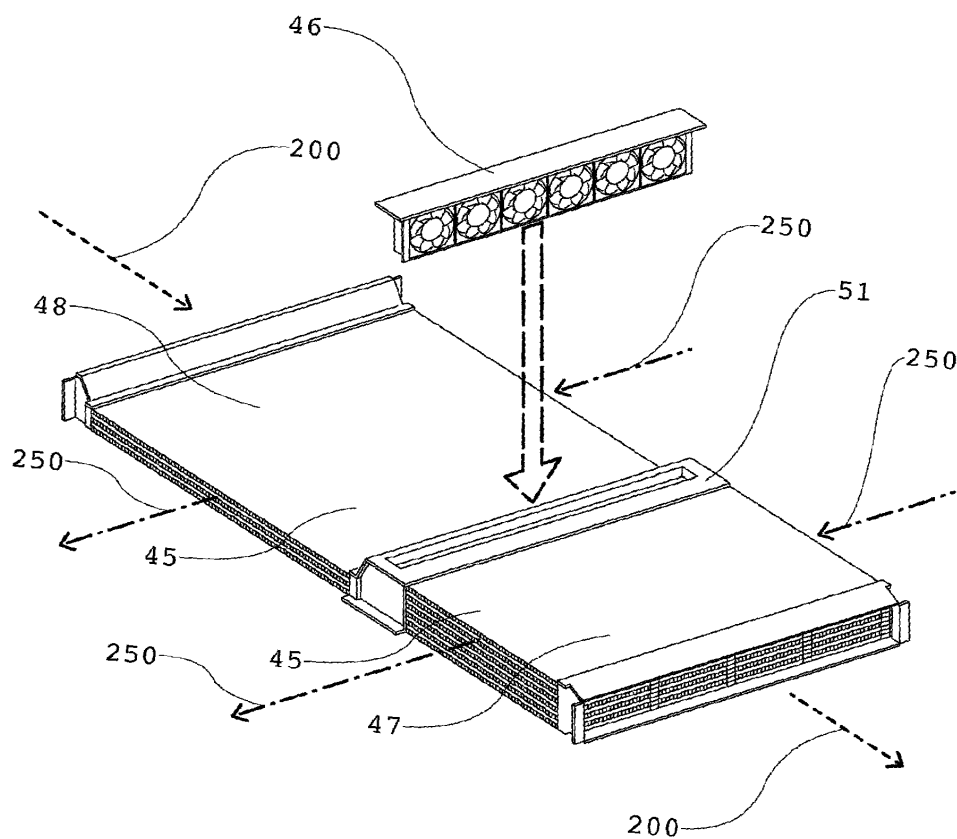


FIG - 7

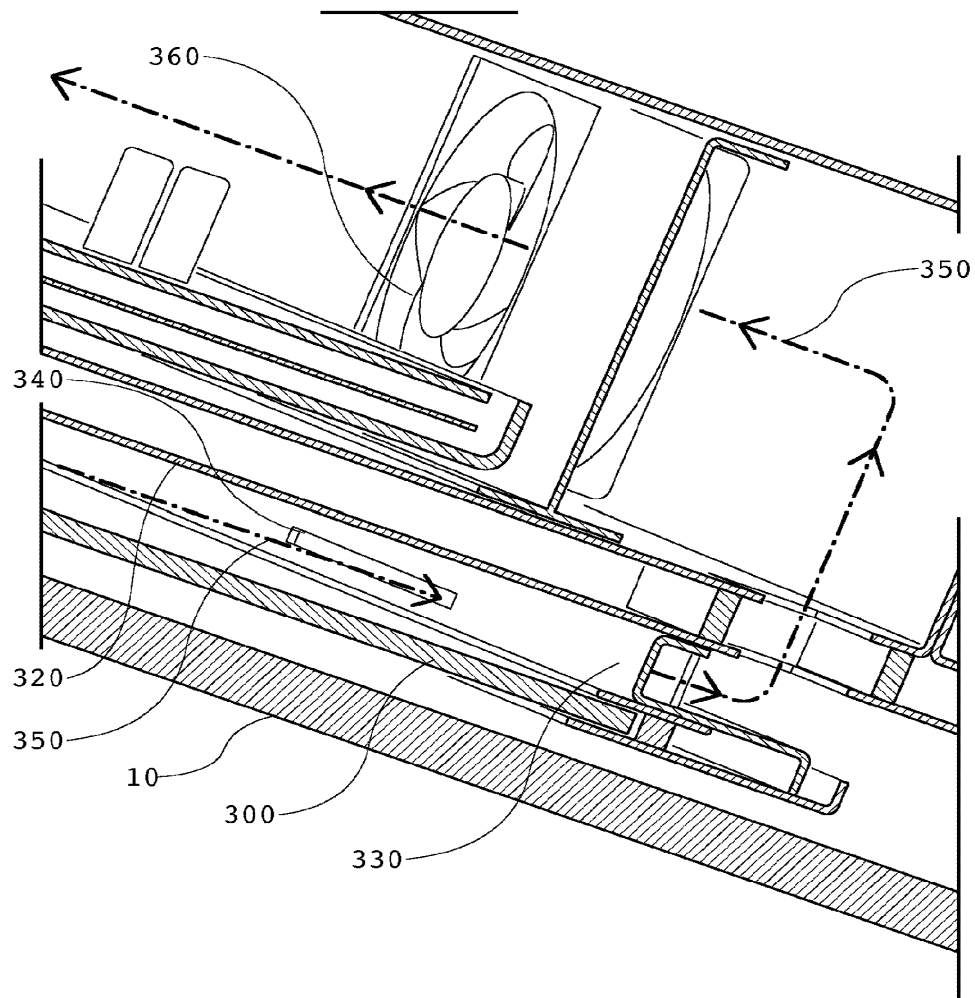


FIG - 8

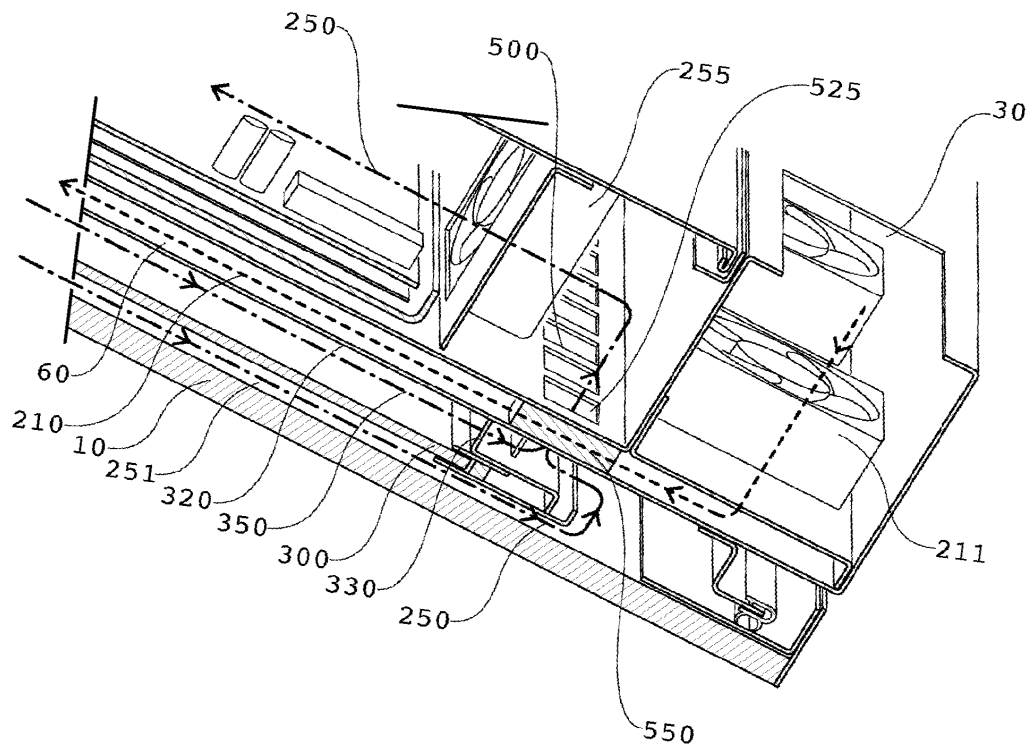


FIG - 9



Espacenet

Bibliographic data: CN2702363 (Y) — 2005-05-25

Heat radiation module for display card

Inventor(s): XIE XINMAO [CN] ± (XINMAO XIE)
Applicant(s): ADDA CORP [CN] ± (ADDA CORPORATION)
Classification: - **international:** **G06F1/20**; (IPC1-7): G06F1/20
- **cooperative:**
Application number: CN2004259817U 20040521
Priority number(s): CN2004259817U 20040521

Abstract of CN2702363 (Y)

The utility model relates to a heat radiation module for a display card which is a heat radiation module which can effectively decrease the operating temperature of the display card. A first heat radiation fin part and a second heat radiation fin part are arranged on the heat radiation module for a display card. A concave holding fan part is arranged between the first heat radiation fin part and the second heat radiation fin part. At least one radiation fan is vertically arranged in the holding fan part. The height of the heat radiation module can be effectively decreased because the radiation fan is deeply arranged in the heat radiation module. When the radiation fan rotates, the convection current between the thermal current in the first heat radiation fin part and the second heat radiation fin part and the outside air can be accelerated. The heat on the heat radiation module is quickly emitted. The radiation efficiency of the display card is raised.

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G06F 1/20



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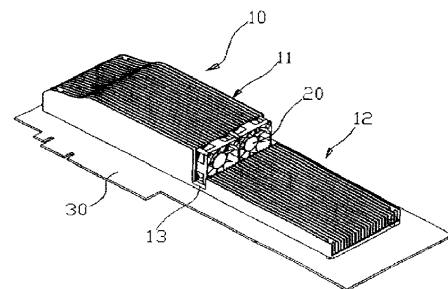
[74] 专利代理机构 北京三友知识产权代理有限公司
代理人 党晓林

权利要求书 1 页 说明书 5 页 附图 7 页

[54] 实用新型名称 显示卡散热模组

[57] 摘要

本实用新型涉及一种显示卡散热模组，其作为一种能有效降低显示卡作业时温度的散热模组，该显示卡散热模组上设有一第一散热鳍部与一第二散热鳍部，该第一散热鳍部与第二散热鳍部间设有一凹入的置扇部，该置扇部中立设有至少一散热风扇，如此一来，可因散热风扇深入安装在散热模组中，不但能有效减低散热模组的高度，且使散热风扇转动时，可加速第一、二散热鳍部中的热气流与外界的空气对流，而使散热模组上的热迅速散发出去，进而提升该显示卡的散热效率。



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SEC et al. v. MRI
SEC Exhibit 1022.2602
IPR2023-00221

1. 一种显示卡散热模组，包含一散热器及一散热风扇；其特征在于，该散热器，具有一第一散热鳍部与一第二散热鳍部，该第一散热鳍部与该第二散热鳍部由一凹入置扇部相区隔；该散热风扇，立设于该置扇部。
- 5 2. 根据权利要求 1 所述的显示卡散热模组，其特征在于，该第一散热鳍部由一片以上的散热鳍片所构成。
3. 根据权利要求 1 所述的显示卡散热模组，其特征在于，该第二散热鳍部由一片以上的散热鳍片所构成。
4. 根据权利要求 2 或 3 所述的显示卡散热模组，其特征在于，该散
- 10 热鳍片为由铝挤型制法所制得的鳍片结构。
5. 根据权利要求 2 或 3 所述的显示卡散热模组，其特征在于，该散热鳍片为由堆叠法所制得的鳍片结构。
6. 根据权利要求 2 或 3 所述的显示卡散热模组，其特征在于，该散热鳍片为以铝合金材质制成的鳍片结构。
- 15 7. 根据权利要求 2 或 3 所述的显示卡散热模组，其特征在于，该散热鳍片为由铜合金材质制成的鳍片结构。
8. 根据权利要求 1 所述的显示卡散热模组，其特征在于，该第一散热鳍部高于该第二散热鳍部。

显示卡散热模组

技术领域

- 本实用新型涉及一种显示卡散热模组，尤指一种应用于显示卡上的散热模组，其藉由将散热风扇立于相对的第一、二散热鳍部间，而使该散热风扇所产生的气流能有效带走显示卡上所产生的热源。

背景技术

- 在台湾成为举世闻名的电脑王国后，国内各企业无不克尽使命共同创造台湾奇迹，尤其，在电脑硬件的这个领域之中，国内企业也持续加强研发能力与产品竞争力，但是，随着CPU或显示卡的运算能力大增之下，电脑主机内部有关散热元件的提升是否跟得上目前的需求呢？实在难以令所有人百分之百的心服能跟得上，以致于让众多的使用者对电脑内部的散热效率打上一个大问号，其实，针对电脑的散热效率而言，是影响相关机件（如CPU、显示卡或其它适配卡等）的使用寿命、处理效能与稳定性的，因为，当这些相关机件的温度过高时，常会衍生出一些使用寿命降低、处理效能不佳与稳定性锐减的后果，所以，若要相关机件能够正常运作而达到一定的效能时，则对于这些机件的作业温度一定要严加控制，绝不能使作业温度过高而对使用者不利，以下举现有的技术来说明。

- 请参阅图1所示，为习知技术的示意图，如图所示的散热器100包含复数个散热鳍片110、一导热管120与一散热风扇130，其主要是将热源所产生的高温藉由该导热管120传导至不同之处的散热鳍片110，并且，利用该散热风扇130所产生的气流来使该局部的复数个散热鳍片110的温度得以降低。

- 请参阅图2、2a所示，为另一习知技术的示意图，该散热模组200，

其主要包含散热风扇 210 与复数的散热鳍片 220，且该散热鳍片 220 成环状而围绕于该散热风扇 210 的外围，利用该散热风扇 210 所产生的气流来降低散热鳍片 220 的温度。

经由所述先前技术的说明后应可得，设计人认为若是利用一导热管来传导热源至分布不同处的散热鳍片，则会因导热管再次加工使得导热管的品质稳定度降低及散热效率不佳且制作成本增加；或者，将多数的散热鳍片成环状而围绕于该散热风扇的外围时，则该散热风扇必须提供较大的风力，但该散热鳍片的有效散热表面积也相对会缩小，反而不利于整体的散热效率的提升。另外，运用导热管之后，虽能将热能传达至他处并因而增加散热面积，但是，该导热管的管内呈真空状，该导热管经过多次加工后，其导热效能将大为降低，并且，该导热管的制造费用较高。

发明内容

有鉴于此，设计人欲提供一种显示卡散热模组来有效降低显示卡的作业温度，并且达成先前技术所未提供的功效。

本实用新型的主要目的在于提供一种显示卡散热模组，其包含：一散热器，该散热器上设有一第一散热鳍部与一第二散热鳍部，且利用一置扇部将该第一散热鳍部与该第二散热鳍部加以区隔；以及至少一散热风扇，恰固设于该置扇部；藉由上述各元件的连结，令该散热风扇实施运转时，可因散热风扇立于第一、二散热鳍部间凹陷的置扇部中，不但能有效降低整个散热模组的高度，且在散热风扇两侧面对扇叶的第一、二散热鳍部，可藉由风力得到该散热风扇的吸风或排风的气流，进而提高散热效率，降低显示卡的温度。

本实用新型的另一目的，在于提供一种显示卡散热模组，其散热鳍部可藉由铝挤型制法与堆叠法制得，而该散热鳍部可为铜系合金或铝系合金，以提升热能的传导与热能的消散效率。

本实用新型的功效在于：显示卡的效能提升、显示卡的寿命增加以及使用者的总付出成本减少。以及，藉由本实用新型的功效而衍生的优点在于电脑的整体效率提升、显示卡的购置成本降低。

5 附图说明

图 1 为习知技术的示意图。

图 2 为另一习知技术的示意图。

图 2a 为另一习知技术的实施时的示意图。

图 3 为本实用新型的外观立体图。

10 图 4 为本实用新型的分解立体图。

图 5 为本实用新型的俯视图。

图 6 为本实用新型的右侧示意图。

图 7 为本实用新型的正视图。

图 8 为本实用新型实施状态的风力流向示意图。

15 图号说明：

10. . . 散热器

11. . . 第一散热鳍部

12. . . 第二散热鳍部

13. . . 置扇部

20 14. . . 散热鳍片

20. . . 散热风扇

30. . . 显示卡

D. . . 风向 (Direction of Air)

25 具体实施方式

本实用新型为一种显示卡散热模组，请参阅图 3、4 所示，本实用新

型为一种装置在显示卡 30 上的散热模组 10，该散热模组上设有一第一散热鳍部 11 与一第二散热鳍部 12，并且，利用一凹入的置扇部 13 将该第一散热鳍部 11 与该第二散热鳍部 12 加以区隔；以及至少一散热风扇 20，该散热风扇 20 恰立设于该置扇部 13，在将上述各元件连结之后，使得该散热风扇 20 实施运转时，可因散热风扇立于第一、二散热鳍部间凹陷的置扇部中，不但能有效降低整个散热模组的高度，且在散热风扇两侧面对扇叶的第一、二散热鳍部，可藉由风力得到该散热风扇的吸风或排风的气流，进而提高散热效率，降低显示卡的温度。

请参阅图 5、6 所示，前述本实用新型的散热器 10 是由一第一散热鳍部 11 与一第二散热鳍部 12 所组成的，而该第一散热鳍部 11 与该第二散热鳍部 12 皆是由一片以上的散热鳍片 14 所构成的，该散热鳍片 14 可由铝挤型制法或是堆叠法来制得，但设计人在此并不对铝挤型制法或是堆叠法来详加说明，因为，就同一行业熟习散热器的技术领域的专业人士应可轻易了解，故在此并未多作解释。

请参阅图 7、8 所示，本实用新型的散热鳍片 14 通常是使用高导热度的材质，例如铝系与铜系的金属材料，但并不以此为限，在本实用新型是以铝或铜系的合成金属材料（铝合金、铜合金）来作为实施本实用新型的示范。而在图 8 中说明了该散热风扇 20 运转时所产生的风向 D (Direction of Air) 是由该第二散热鳍部 12 吹向该第一散热鳍部 11，这是因为该第二散热鳍部 12 的高度低于该第一散热鳍部 11，这同时也是申请人考虑到散热效率所作的调整，但并不是要求一定得要如此才能实施本实用新型，因为，无论该第二散热鳍部 12 与该第一散热鳍部 11 之间孰高孰低，皆不影响本实用新型所达成的目的，以及该风向 D 也不限定其是由该第二散热鳍部 12 吹向该第一散热鳍部 11 或由该第一散热鳍部 11 吹向该第二散热鳍部 12。

综上所述，本实用新型的一种显示卡散热模组确实达成显示卡的效能

- 提升、显示卡的寿命增加、降低显示卡的作业温度以及使用者的总付出成本减少的目的，并且，进一步地使得电脑的整体效率提升、显示卡的购置成本降低以及使用者的时间成本降低，而基于本实用新型的原理也可实施于CPU等会产生热源的物品上，故可据以衍生的运用范围广泛，另外，
- 5 因为本实用新型的构造简单、方便使用，所以倍增生产效率也可同时兼顾生产成本，并在使用者的购买费用上可大幅降低，适于大量生产，实具产业利用价值，符合新型专利申请要件的产业利用性(Useful)，再者，本实用新型的一种显示卡散热模组又与最接近的先前技艺(The closest prior art)相较之下，明显具有相当大的进步跨距(Inventive Step)，
- 10 符合新型专利申请要件的进步性(Non-obviousness)，并且，经由本说明书的详细揭露下(如说明书与图式所揭露的技术内容)，足以致使同一行业的专业人士据以实施本实用新型，且其构成结构又未曾见于诸书刊或公开使用，诚符合新型专利申请要件的新颖性(Novelty)，恳请专利局早日核准本实用新型，以利申请人的商品化实施。
- 15 需陈明的，以上所述乃是本实用新型的具体实施例及所运用的技术原理，根据本文的揭露或教导可衍生推导出许多的非实质变更与修正，若依本实用新型的构想所作的等效改变，其所产生的功能作用仍未超出说明书及图式所涵盖的精神，均应属于本实用新型的保护范围。

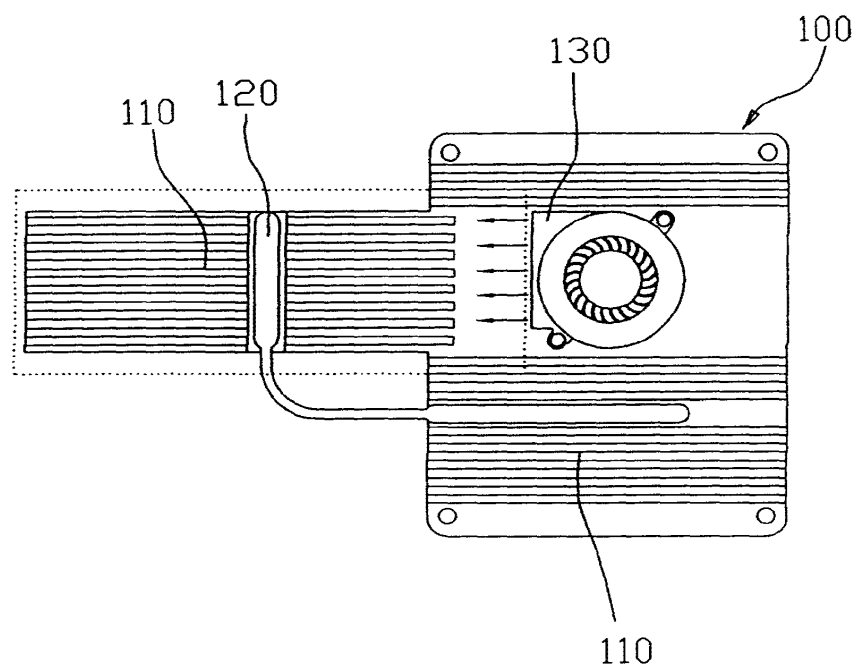


图 1

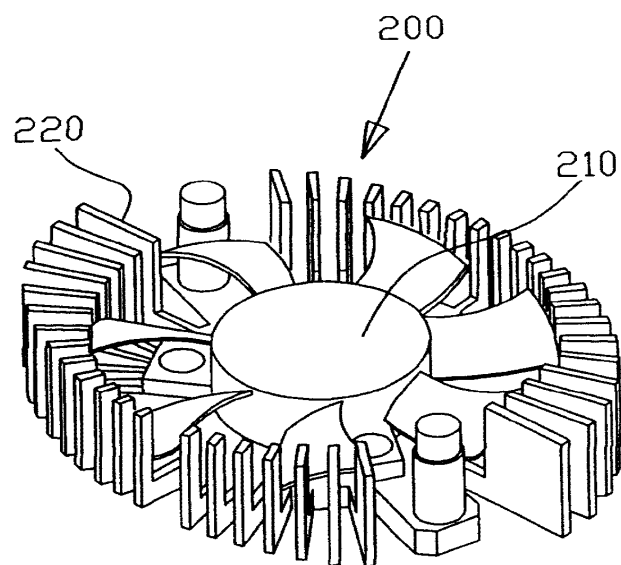


图 2

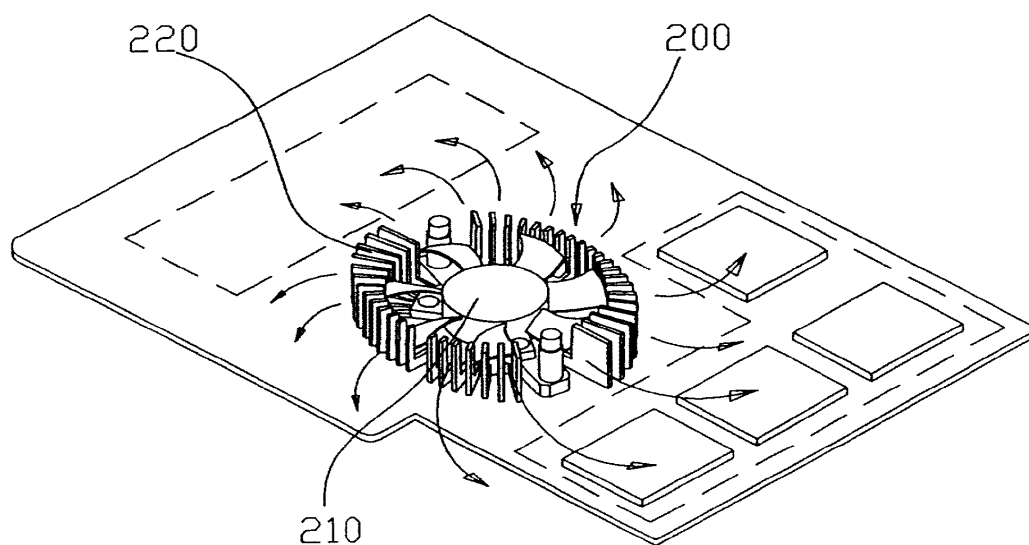


图 2a

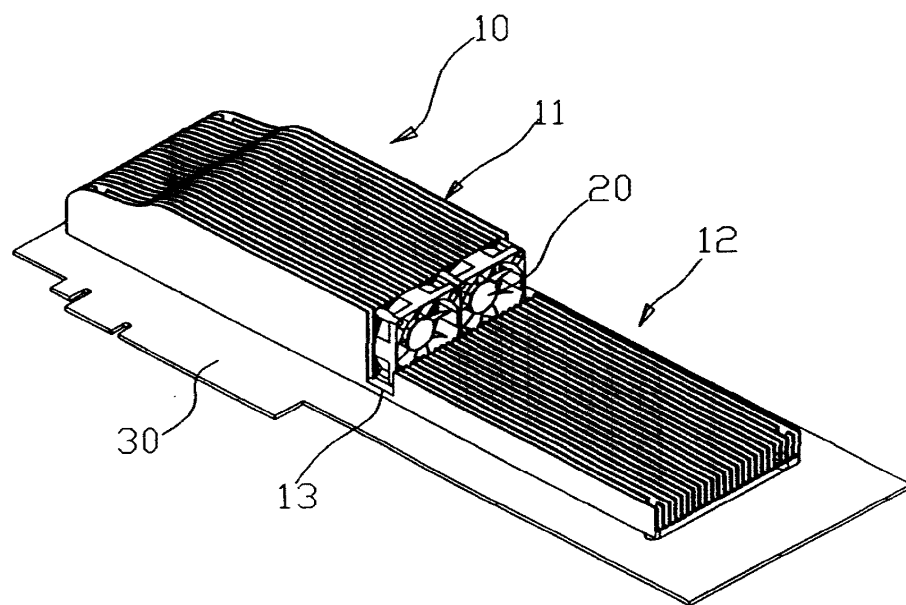


图 3

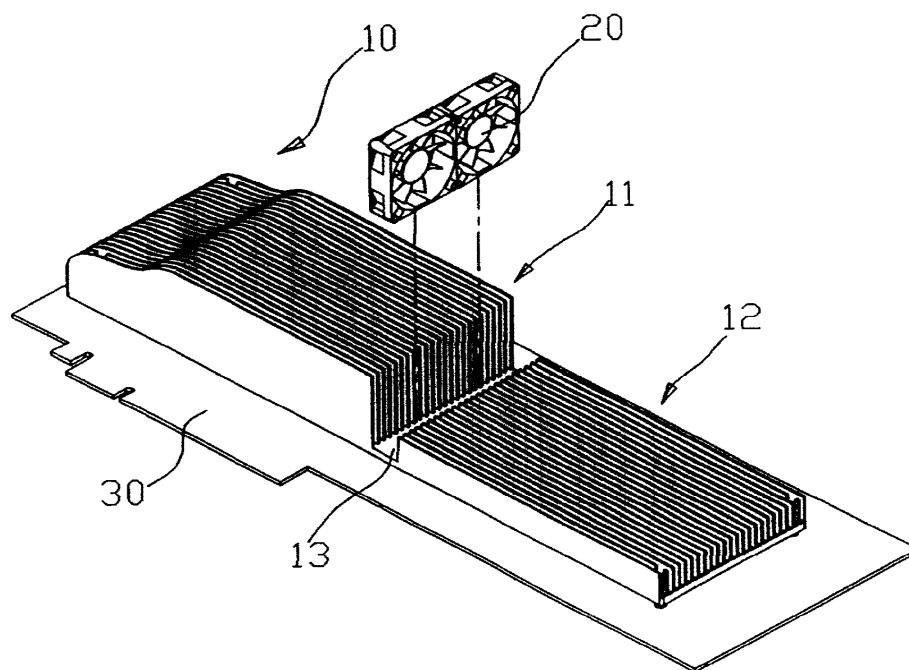


图 4

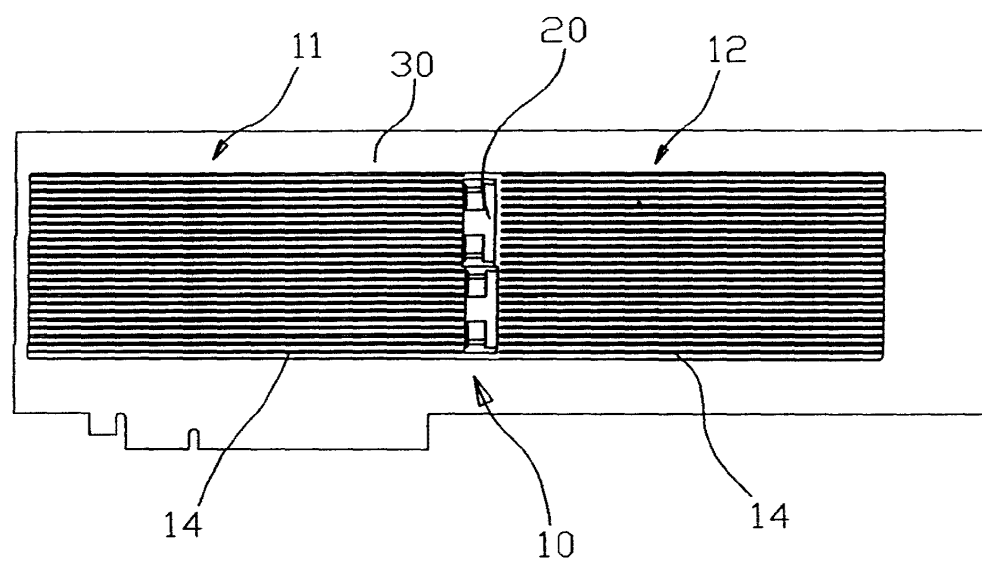


图 5

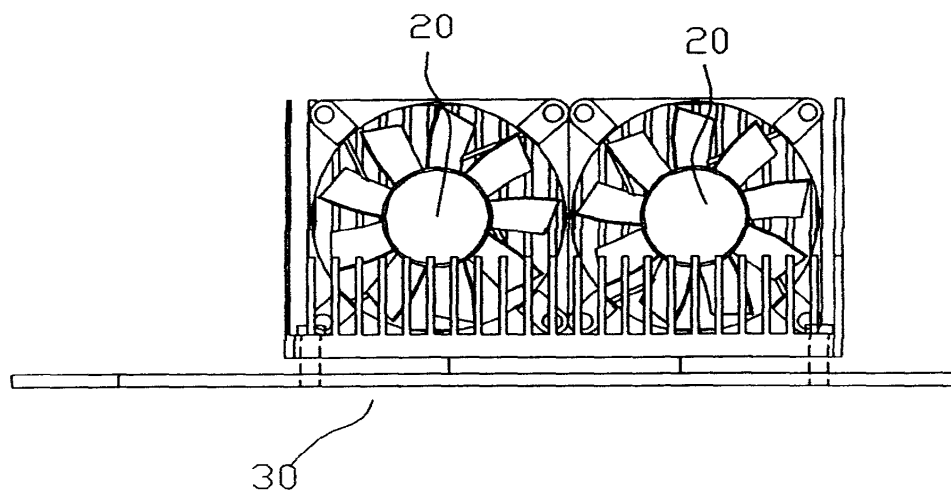


图 6

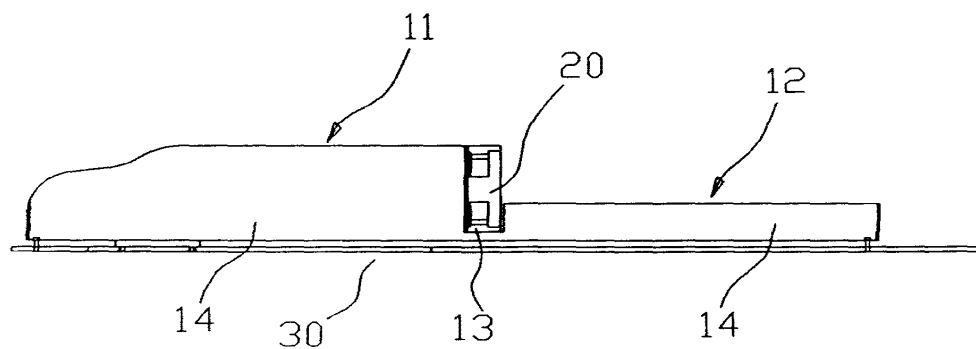


图 7

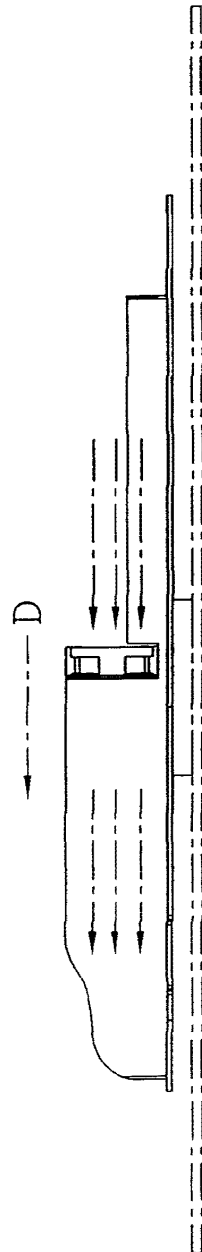


图 8



Espacenet

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THERMAL CONTROL SYSTEM FOR AN ELECTRONIC DISPLAY

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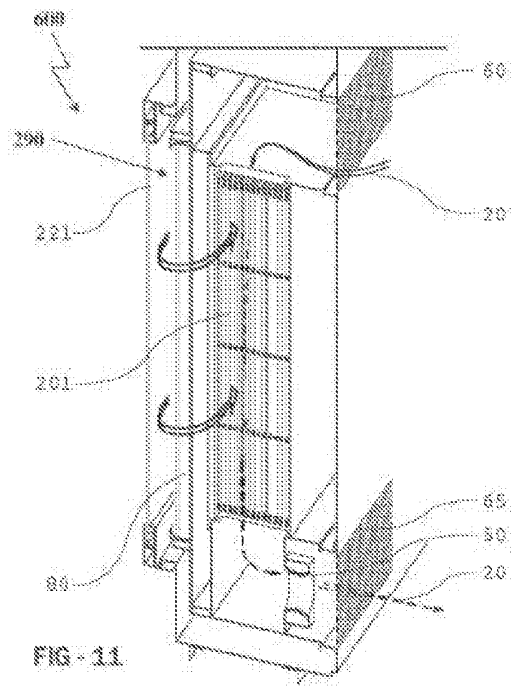
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A cooling assembly for an electronic image assembly and a display assembly containing the same. Some embodiments use ambient gas to cool power modules and/or an image assembly (sometimes backlight). Other embodiments use a closed loop of circulating gas which passes across the front surface of an image assembly and through a heat exchanger. An open loop passes through the heat exchanger and extracts heat from the circulating gas. Ambient air may be used as the ambient gas. An optional additional channel may be used to cool the back portion of the image assembly or backlight with ambient gas. Some embodiments also use thermally conductive plates and ribs to distribute the heat and avoid hot spots in the display. The cooling assembly can be used with any type of electronic assembly for producing an image.



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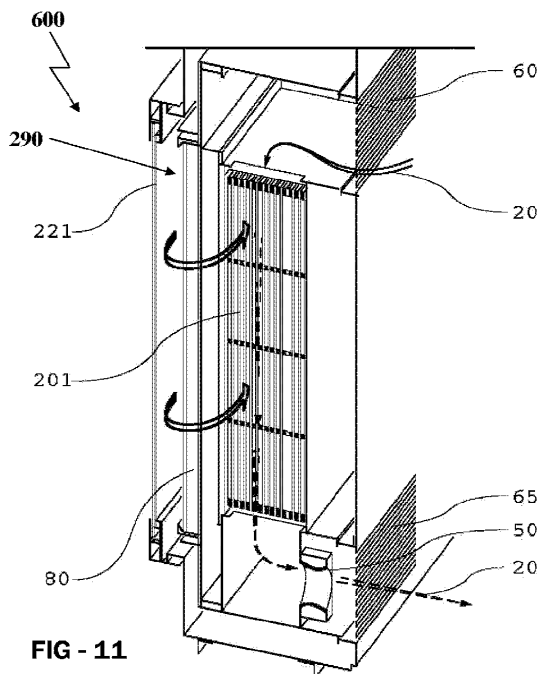
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[Continued on next page]

(54) Title: THERMAL CONTROL SYSTEM FOR AN ELECTRONIC DISPLAY



(57) Abstract: A cooling assembly for an electronic image assembly and a display assembly containing the same. Some embodiments use ambient gas to cool power modules and/or an image assembly (sometimes backlight). Other embodiments use a closed loop of circulating gas which passes across the front surface of an image assembly and through a heat exchanger. An open loop passes through the heat exchanger and extracts heat from the circulating gas. Ambient air may be used as the ambient gas. An optional additional channel may be used to cool the back portion of the image assembly or backlight with ambient gas. Some embodiments also use thermally conductive plates and ribs to distribute the heat and avoid hot spots in the display. The cooling assembly can be used with any type of electronic assembly for producing an image.

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Thermal Control System for an Electronic Display

Inventors: William Dunn, Tim Hubbard, Ware Bedell

Technical Field

[0001] The exemplary embodiments generally relate to cooling systems and in particular to cooling systems for electronic displays.

Background of the Art

[0002] Conductive and convective heat transfer systems for electronic displays generally attempt to remove heat from the electronic components in a display through as many sidewalls of the display as possible. In order to do this, the systems of the past have relied primarily on fans for moving internal air within the housing past the components to be cooled and out of the display. These components are typically power supplies. In some cases, the heated air is moved into convectively thermal communication with fins.

[0003] While such heat transfer systems have enjoyed a measure of success in the past, improvements to displays and new display applications require even greater cooling capabilities. In particular, cooling devices for electronic displays of the past have generally used convective heat dissipation systems that function to cool only the rear interior portion of the display. When used outdoors or in other warm environments, this is not adequate, especially when radiative heat transfer from the sun through a front display surface becomes a major factor. In many applications 200 Watts or more of power through a front display surface is common. Furthermore, the market is demanding larger screen sizes for displays. With increased electronic display screen size and corresponding front display surface size more heat will be generated and more heat will be transmitted into the displays. Also, when displays are used in outdoor environments the ambient air may contain contaminants (dust, dirt, pollen, water vapor, brake dust, sand, smoke, etc.) which, if ingested into the display for cooling the interior can cause damage to the interior components of the display.

[0004] Modern displays (especially those which are used outdoors) have become increasingly brighter, with some backlights producing 1,000-2,000 nits or more. In order to produce this level of brightness, illumination devices such as CCFL assemblies, LEDs, organic LEDs, and plasma assemblies may produce a relatively large amount of heat. Further, the illumination devices require a relatively large amount of power in order to generate the required brightness level. This large amount of power is typically supplied through one or more power supplies for the display. These power supplies may also become a significant source of heat for the display.

[0005] A large fluctuation in temperature is common when devices of the past are used in outdoor environments, direct sunlight, or other difficult thermal environments. Such temperature fluctuation adversely affects both the lifetime and the performance of the electronic components in these devices.

Summary of the Exemplary Embodiments

[0006] While the systems of the past have attempted to remove heat only through the non-display sides and rear components of an electronic display, a preferred embodiment may cause convective heat transfer from the front face of the image assembly as well (the side which faces an intended viewer). These preferred embodiments may comprise two separate flow paths for gas through an electronic display. A first flow path may be a closed loop and a second flow path may be an open loop. The closed loop path travels across the front surface of the image assembly, continues to the rear of the display where it may enter a heat exchanger, finally returning to the front surface of the image assembly. The open loop path draws gas (ex. ambient air) through the rear of the display (possibly through a heat exchanger) and then exhausts it out of the display housing. A heat exchanger may be used to transfer heat from the closed loop to the open loop and exhausted out of the display. Optionally, the open loop may also be forced behind the image assembly (sometimes a backlight other times an OLED or other type of image-producing assembly), in order to cool the image assembly and/or backlight assembly (if a backlight is necessary for the

particular type of display being used). A cross-flow heat exchanger may be used in an exemplary embodiment.

[0007] Other embodiments relate to a system for cooling the following portions of an electronic display, either alone or in combination: (1) power module(s), (2) backlight, and (3) front display surface. Power modules with heat dissipating assemblies (ex. cold plates and/or heat sinks) may be used with some embodiments where the side of the power module containing the heat dissipating assembly is placed in the path of ambient gas while the side of the power module containing sensitive electrical components remains in a separate environment. An isolating structure may provide the necessary gaseous (and sometimes particulate/contaminate) isolation between the two sides of the power modules. The closed loop may or may not be used when cooling the power modules with an open loop of ambient gas.

[0008] Backlights with a front and rear sides may be used with some embodiments for LCD displays where the front side contains the illumination devices and the rear side contains a thermally conductive surface for dissipating the heat from the illumination devices. Ideally, there should be a low level of thermal resistance between the front and rear sides of the backlights.

[0009] Other embodiments may place the power modules in thermal communication with a plurality of thermally conductive ribs where the ribs are placed in the path of cooling air (sometimes ambient gas). The heat from the power modules is distributed throughout the ribs and removed by the cooling air. It has been discovered that forcing air through the relatively narrow channels defined by the ribs improves the ability to remove heat from the power modules.

[0010] In another embodiment, both the power modules and the display backlight (or image assembly) are in thermal communication with the ribs. In this way, a single path of cooling air (sometimes ambient gas) can be used to cool two of the warmest components of a typical electronic display. For example, and not by way of limitation, LED arrays are commonly used as the illumination devices for LCD displays. It has been found that the optical properties of LEDs (and other illumination devices) can vary depending on temperature. Thus, when an LED is exposed to room temperatures, it may output light with a certain luminance, wavelength, and/or color temperature.

However, when the same LED is exposed to high temperatures, the luminance, wavelength, color temperature, and other properties can vary. Thus, when a temperature variation occurs across an LED backlight (some areas are at a higher temperature than others) there can be optical inconsistencies across the backlight which can be visible to the observer. By using the embodiments herein, heat buildup can be evenly distributed across the ribs and removed from the display. This can prevent any potential 'hot spots' in the backlight which may become visible to the observer because of a change in optical properties of the illumination devices (sometimes, but not always LEDs). In other embodiments, the image assembly (rather than a backlight) is in thermal communication with the ribs. The image assembly may comprise any form of electronic assembly for generating an image, including but not limited to: LCD, light emitting diode (LED), organic light emitting diode (OLED), field emitting displays (FED), light-emitting polymers (LEP), plasma displays, and any other flat/thin panel displays.

[0011] The ribs may provide an isolated chamber from the rest of the display so that ambient air can be ingested and used to cool the ribs. This is beneficial for situations where the display is being used in an outdoor environment and the ingested air may contain contaminants (pollen, dirt, dust, water, smoke, etc.) that would damage the sensitive electronic components of the display.

[0012] If a backlight is used with the particular display application, a backlight with front and rear sides may be used where the front side contains the illumination devices and the rear side contains a thermally conductive surface for dissipating the heat from the illumination devices. Ideally, there should be a low level of thermal resistance between the front and rear sides of the backlights. An exemplary embodiment contains a metal core PCB with LEDs on the front side and a metallic surface on the rear side.

[0013] By the aspects described below, the exemplary embodiments herein have made consistent cooling possible for large electronic displays, even in hot climates and placed in direct sunlight. The embodiments also do not require any form of air conditioner (although it may be used if desired), which reduces the space and energy requirements for the display.

[0014] The foregoing and other features and advantages of the exemplary embodiments will be apparent from the following more detailed description of the particular embodiments of the invention, as illustrated in the accompanying drawings.

Brief Description of the Drawings

[0015] A better understanding of an exemplary embodiment will be obtained from a reading of the following detailed description and the accompanying drawings wherein identical reference characters refer to identical parts and in which:

[0016] **FIGURE 1** is a perspective view of a typical power module;

[0017] **FIGURE 2** is a perspective view of two power modules installed within an isolating structure;

[0018] **FIGURE 3** is a perspective view of an embodiment where the cooling air may be used to cool the power modules and a backlight assembly;

[0019] **FIGURE 4** is a perspective view of an embodiment which is similar to that which was shown in Figure 3 with the exception that a heat sink is now being used with the power modules;

[0020] **FIGURE 5** shows a perspective view of an embodiment where a plurality of channels are created between the backlight assembly and the isolating structure;

[0021] **FIGURE 7** shows a perspective section view of another embodiment which uses a thermally-conductive plate and thermally-conductive ribs;

[0022] **FIGURE 8** shows a perspective section view of another embodiment where the ribs are used to distribute heat from and cool a backlight assembly;

[0023] **FIGURE 9** is a rear perspective view of an embodiment where the rear cover of the display has been removed;

[0024] **FIGURE 10A** is a perspective section view of another embodiment showing the closed loop and open loop channels;

[0025] **FIGURE 10B** is a perspective section view similar to the view shown in Figure 10A where the rear and side covers have been removed;

[0026] FIGURE 11 is a perspective section view of another embodiment showing inlet and exhaust apertures for the ambient gas which is used only within the heat exchanger and not within additional optional channels; and

[0027] FIGURE 12 is a perspective section view of an exemplary embodiment where a cross-flow heat exchanger is used to separate high power and low power electrical assemblies.

Detailed Description

[0028] FIGURE 1 shows one embodiment of a typical power module 7 which may be used with some of the embodiment described herein. A printed circuit board 6 may be attached to the power module 7 and may contain a plurality of electronic components 5 which may be necessary to operate and control the power module 7. These electronic components 5 may include, but are no means limited to resistors, capacitors, op-amps, wire harnesses, connectors, and inductors. A baseplate 8 may be attached to the power module 7 and may act as a heat dissipating assembly for the power module 7, such that heat which is generated by the power module 7 is transferred to the baseplate 8. In some embodiments there may be more components used, such as a conductive pad located between the power module and the baseplate 8. Also, as discussed further below, any type of heat sink or fin assembly may be used with the baseplate 8 to further enhance its thermodynamic properties. There may be conductive pads placed between the baseplate 8 and a heat sink assembly also.

[0029] FIGURE 2 shows two power modules installed within an isolating structure 9 which substantially prevents gaseous and contaminate communication between the two sides of the power module. The baseplates 8 of the power modules are shown on the side of the isolating structure 9 where surrounding-environment cooling air 4 is designed to pass over the baseplates 8. Gaskets 11 may be used to provide a gaseous (and/or contaminate) seal between the power modules and the isolating structure 9. Cooling air 4 is sometimes drawn from the environment surrounding the display. This environment may contain harmful contaminants which could damage various electrical components in the display. These harmful contaminants include, but

are not limited to: dust, smoke, pollen, water vapor, other harmful particulate and other harmful gases. Thus, one of the purposes for the isolating structure 9 is to prevent the surrounding-environment cooling air 4 from contacting some of the sensitive electronic components of the display, including but not limited to the electronic components 5 (shown in Figure 1) which are required to operate and control the power modules. By mounting the power modules within the isolating structure 9, surrounding-environment cooling air 4 can be drawn into the display housing and forced over the baseplates 8 (and optional heatsinks and fins) in order to cool the power modules. This can be accomplished without exposing sensitive electronic components to the potentially harmful surrounding-environment cooling air 4.

[0030] FIGURES 3 and 4 show embodiments where the cooling air 4 may be used to cool the power modules and a backlight assembly 140. These embodiments show a backlight assembly 140 which contains a plurality of illumination devices (ex. LEDs) 141 which are mounted to a printed circuit board (PCB). An exemplary embodiment would use a metal core PCB or any other mounting structure which would have a relatively low level of thermal resistance so that heat can transfer from the illumination devices 141 to the rear surface of the backlight assembly 140 where it can be removed by the cooling air 4. The illumination devices 141 could be LED, halogen, CCFL, or any other device which produces light. Further, a backlight assembly may not even be necessary for some embodiments such as plasma, OLED, LEP, or FED displays. However, these display types are also known to generate heat and where backlight cooling is described in this application these methods could also be applied to the cooling of rear surfaces of these electronic image assemblies. Thus, where backlight assemblies are shown, a plasma, OLED, FED, or LEP image assembly could be substituted. The electronic components 5 may be isolated from the cooling air 4 by using the isolating structure 9.

[0031] FIGURE 4 shows an embodiment which is similar to that which was shown in Figure 3 with the exception that a heat sink 12 is now in thermal communication with the power modules in order to further facilitate the transfer of heat away from the power modules. It should of course be noted that many types of heat sinks are available which are made of many different materials and have many different geometry types.

Any form of heat sink is particularly contemplated with various embodiments and may be used to satisfy different operating conditions.

[0032] **FIGURE 5** shows another embodiment where a plurality of channels 15 are created between the backlight assembly 140 and the isolating structure 9. Channel separators 16 may be used to separate each channel 15 and provide structural rigidity to the overall assembly. The channel separators 16 would preferably be fabricated out of thermally conductive material so that they may also transfer heat between the backlight assembly 140 and the isolating structure 9. A thermally conductive channel separator 16 can also extract heat from either the backlight assembly 140 or the isolating structure 9 and may dissipate the heat into the air moving through the channel 15. Thus, some channel separators 16 may contain fins or heat sinks in order to facilitate heat transfer to the air moving through the channel 15.

[0033] **FIGURE 6** shows a view down a single channel 15 which contains the heat sink 12 for a power module which is mounted within the isolating structure 9. Some channels 15 may contain power modules and others may not. A channel fan 17 may be used to draw air through the channel 15 in order to cool the heat sink 12 (if used) and the channel separators 16 (if thermally conductive) as well as the backlight 140 (or LED assembly for an LED display). Each channel 15 may contain one or more channel fans 17. Some channels may not contain a fan at all, but may rely solely on natural convection to allow heat to rise and exit the channel. As will be discussed at length below, the fans can be placed anywhere in the display assembly and may be used to draw air through the channels, push air through the channels, or a combination of both.

[0034] While the display is in operation, the channel fans 17 may run continuously. Alternatively, temperature sensing devices (not shown) may be placed in each channel and used to measure the temperature within the channel or any of the channel components (backlight or display assembly, isolating structure, or channel separators). Based on data received from these temperature sensing devices, the various fans may be selectively engaged depending on which channel requires cooling. Thus, fans 17 which draw air through channels 15 which contain power modules may run more often or at higher speeds due to the greater amount of heat coming from the power modules.

Also, channels which contain power modules may contain larger fans or a plurality of fans in order to cool the channel.

[0035] **FIGURE 7** shows another embodiment which uses a thermally-conductive plate 10 and ribs 18. In one embodiment, the baseplate 8 of the power module would be in thermal communication with the thermally-conductive plate 10. In other embodiments, a baseplate 8 may not be used and instead, the power module 7 would be in direct thermal communication with the thermally conductive plate 10. Due to the thermally-conductive nature of the plate 10 and ribs 18 and the thermal communication between them, heat which is produced by the power modules would be distributed throughout the plate 10 and ribs 18. In an exemplary embodiment, a path of cooling air 20 (ambient gas) is used to remove the heat which has accumulated on the plate 10 and ribs 18. Alternatively, a natural convection process could also be used to allow the heat to escape the plate 10 and ribs 18.

[0036] A plurality of mounting posts may be used to mount electronic assemblies such as PCBs, hard drives, timing and control boards, inductors, and even the power modules if desired. The mounting posts may also be thermally conductive so that the heat which is generated by these electronic assemblies can also be transferred to the plate 10 and the ribs 18 and removed by the cooling air 20.

[0037] In an exemplary embodiment, the plate 10 would provide a gaseous and contaminate barrier between the side containing the ribs 18 (and cooling air 20) and the side containing the mounting posts, power modules, and any other electronic assemblies. If the plate 10 provides an adequate barrier, ambient air may be ingested as cooling air 20 and the risk of contaminants entering the side of the plate 10 containing the sensitive electronic components may be reduced or eliminated. An inlet aperture 25 may be used to accept the cooling air 20 and direct it along the ribs 18.

[0038] The ribs 18 shown in this embodiment contain a hollow rectangular cross-section, but this is not required. Other embodiments may contain ribs with I-beam cross-sections, hollow square cross-sections, solid rectangular or solid square cross-sections, 'T' cross-sections, 'Z' cross-sections, corrugated or honeycomb cross-section, or any combination or mixture of these. It is preferable that the ribs 18 are thermally conductive. Metal may be used to produce the ribs 18 in some embodiments.

[0039] **FIGURE 8** shows another embodiment where the ribs 18 are used to distribute heat from and cool a backlight assembly. The backlight assembly in this embodiment includes a plurality of illumination devices 32 which are mounted on a thermally conductive substrate 30. In an exemplary embodiment, the illumination devices 32 would be LEDs and the thermally conductive substrate 30 would be a PCB and more preferably a metal core PCB. On the surface of the thermally conductive substrate 30 which faces the ribs 18 there may be a thermally conductive surface 35. In an exemplary embodiment, the thermally conductive surface 35 would be metallic and more preferably aluminum. It is preferred that the ribs 18 are in thermal communication with the rear surface 35 and that the rear surface 35 is in thermal communication with the thermally conductive substrate 30. In some embodiments however, the thermally conductive substrate 30 may comprise traditional PCB materials rather than a metal core PCB or any highly thermally conductive materials. It is most preferable that there is a low level of thermal resistance between the illumination devices 32 and the ribs 18. Cooling air 20 may again be forced along the ribs 18 in order to remove heat from the backlight assembly. Of course, this could also occur through natural convection, but more efficient cooling has been typically observed through forced convection. An image assembly (such as an OLED display which may not utilize a backlight) could also be used in place of the backlight assembly in order to cool the image assembly.

[0040] As noted above, many illumination devices (especially LEDs and OLEDs) may have performance properties which vary depending on temperature. When 'hot spots' are present within a backlight or illumination assembly, these hot spots can result in irregularities in the resulting image which might be visible to the end user. Thus, with the embodiments described herein, the heat which may be generated by the backlight assembly can be distributed throughout the various ribs and thermally-conductive surfaces to remove hot spots and cool the backlight.

[0041] In an exemplary embodiment, the ribs 18 may be used to cool both the backlight assembly and the power modules. In a further exemplary embodiment, the ribs 18 can also be used to cool any additional electronic assemblies by placing them in thermal communication with the thermally-conductive plate 10. Thus, with the ribs 18 in a central location, the 'front' would be towards an intended observer of the display while

the 'back' would be on the opposite side of an intended observer. Therefore, the front side of the ribs 18 would be in thermal communication with a backlight assembly (or other illumination or image-producing assembly) and the rear side of the ribs would be in thermal communication with a rear plate (i.e. thermally-conductive plate 10). A single path of cooling air can then be used to cool the interior of the display while the various hot spots can distribute heat throughout the ribs and other thermally conductive surfaces to provide the most efficient cooling. This can be accomplished without having to expose sensitive electrical components to the contaminants and/or particulate of ambient gas.

[0042] FIGURE 9 shows the rear of an exemplary electronic display 100, where the rear cover for the display housing has been removed in order to show the internal components. In this embodiment, fan assemblies 102 and 103 for a closed loop of circulating gas may be placed along two opposing edges of a heat exchanger 101. Preferably, fan assembly 102 is the inlet for the heat exchanger and fan assembly 103 is the exit for the heat exchanger 101. These assemblies can optionally be reversed however, where fan assembly 103 is the inlet and fan assembly 102 is the exit. Further, both assemblies 102 and 103 are not required. Some embodiments may use only one fan assembly for the closed loop of circulating gas. If only one fan assembly is used, it is preferable to place the fan assembly at the inlet of the heat exchanger 101, so that the circulating gas is 'pulled' across the front of the image assembly and pushed through the heat exchanger 101. This is not required however; other embodiments may pull the isolated gas through the heat exchanger 101. Other embodiments may push the isolated gas across the front of the image assembly. Fan assemblies 104 and 105 for an open loop of ambient gas may be placed along two opposing edges of the display housing. Again, both assemblies 104 and 105 are not required as some embodiments may use only one assembly and may use the open loop fan assemblies in a push or pull design. Therefore, when referring to the placement of the various fan assemblies, the terms 'push', 'pull', 'force', and 'draw' will be used interchangeably and any orientation may be used with the various embodiments herein.

[0043] The circulating gas which is being forced by the closed loop fan assemblies is primarily circulating around the display. For example, the circulating gas travels in a

loop where it contacts the front surface of the image assembly (see Figures 10A-10B) and transfers heat from the image assembly to the circulating gas. The circulating gas is then preferably directed (or forced, pulled, etc.) into the heat exchanger 101 in order to transfer heat from the circulating gas to the ambient gas. Afterwards, the circulating gas exits the heat exchanger 101 and may return to the front surface of the image assembly. The circulating gas may also pass over several electronic components 110 in order to extract heat from these devices as well. The electronic components 110 may be any components or assemblies used to operate the display including, but not limited to: transformers, circuit boards, resistors, capacitors, batteries, power modules, motors, inductors, illumination devices, wiring and wiring harnesses, lights, thermo-electric devices, and switches. In some embodiments, the electrical components 110 may also include heaters, when the display assembly might be used in cold-weather environments.

[0044] In order to cool the circulating gas (as well as optionally cooling a backlight assembly or image assembly as taught above) ambient gas is ingested into the display housing by the open loop fan assembly 104 and/or 105. The ambient gas may simply be ambient air which is surrounding the display 100. In some embodiments, the ambient gas may be air conditioned prior to being drawn into the display by one or more air conditioning assemblies (not shown). Once the ambient gas is ingested into the display, it may be directed (or forced) through the heat exchanger 101 and optionally also across the rear surface of the backlight assembly or image assembly (see Figures 10A-10B) or through ribs/channels as shown above or across power modules as shown above. By using the heat exchanger 101, heat is transferred from the circulating gas to the ambient gas. The heated ambient gas is then expelled out of the display housing.

[0045] Although not required, it is preferable that the circulating gas and ambient gas do not mix. In a preferred embodiment, the heat exchanger 101 would be a cross-flow heat exchanger. However, many types of heat exchangers are known and can be used with any of the embodiments herein. The heat exchanger 101 may be a cross-flow, parallel flow, or counter-flow (tube-within-a-tube or otherwise) heat exchanger. In an exemplary embodiment, the heat exchanger 101 would be a cross-flow and would be comprised of a plurality of stacked layers of thin plates. The plates may have a

corrugated or honeycomb design, where a plurality of channels or pathways travel down the plate length-wise. The plates may be stacked such that the directions of the pathways are alternated with each adjacent plate, so that each plate's pathways are substantially perpendicular to the pathways of the adjacent plates. Thus, gas may enter the heat exchanger only through plates whose channels or pathways travel parallel to the path of the gas. Because the plates are alternated, the closed loop and ambient gases may travel in plates which are adjacent to one another and heat may be transferred between the two gases without mixing the gases themselves (if the heat exchanger is adequately sealed, which is preferable but not required).

[0046] In an alternative design, an open gap may be placed in between pairs of channelized or honeycomb plates. The open gap may travel in a direction which is perpendicular to the channels of the plates. This open gap may be created by running two strips of material or tape (esp. very high bond (VHB) tape) between two opposite edges of the plates in a direction that is perpendicular to the direction of the channels in the adjacent plates. Thus, gas may travel through the open gap (parallel to the strips or tape) but would not pass through the open gap in a direction which is perpendicular to the strips or tape (parallel to the channels of the adjacent plates).

[0047] Other types of cross-flow heat exchangers could include a plurality of tubes which contain the first gas and travel perpendicular to the path of the second gas. As the second gas flows over the tubes containing the first gas, heat is exchanged between the two gases. Obviously, there are many types of cross-flow heat exchangers and any type would work with the embodiments herein.

[0048] An exemplary heat exchanger may have plates where the sidewalls are relatively thin so that heat can easily be exchanged between the two paths of gas. A plurality of materials can be used to create the heat exchanger. Preferably, the material used should be corrosion resistant, rot resistant, light weight, and inexpensive. Metals are typically used for heat exchangers because of their high thermal conductivity. However, it has been discovered that plastics and composites can also satisfy the thermal conditions for electronic displays. An exemplary embodiment would utilize polypropylene as the material for constructing the plates for the heat exchanger. It has been found that although polypropylene may seem like a poor thermal conductor, the

large amount of surface area relative to the small material thickness, results in an overall thermal resistance that is low. Thus, an exemplary heat exchanger would be made of plastic and would thus produce a display assembly that is thin and lightweight. Specifically, corrugated or honeycomb plastic may be used for each plate layer.

[0049] As mentioned above, both inlet and exit fan assemblies are not required for the embodiments. Alternatively, only a single fan assembly may be used for each loop. Thus, only an inlet fan assembly may be used with the closed loop and only an exhaust fan assembly may be used with the open loop. Alternatively, one of the loops may have both inlet and exit fan assemblies while the other loop only has either an inlet or exit assembly.

[0050] The gas used in both loops can be any number of gaseous matters. In some embodiments, air may be used as the gas for both loops. Preferably, the gas which travels through the closed loop should be substantially clear, so that when it passes in front of the image assembly it will not affect the appearance of the image to a viewer. The gas which travels through the closed loop should also be substantially free of contaminants and/or particulate (ex. dust, dirt, pollen, water vapor, smoke, etc.) in order to prevent an adverse effect on the image quality and damage to the internal electronic components. It may also be preferable to keep the gas within the open loop from having contaminants. An optional filter (not shown) may be used to ensure that the air (either in the closed or open loop) stays free of contaminants. However, in an exemplary embodiment the open loop may be designed so that contaminants could possibly be present within the ambient gas but this will not harm the display. In these embodiments, the heat exchanger (and the optional path behind the image assembly or backlight or through the ribs) is properly sealed so that any contaminants in the ambient gas would not enter sensitive portions of the display. Thus, in these exemplary embodiments, ingesting ambient air for the ambient gas, even if the ambient air contains contaminants, will not harm the display. This can be particularly beneficial when the display is used in outdoor environments or indoor environments where contaminants are present in the ambient air.

[0051] **FIGURE 10A** shows a cross-section of another embodiment of a display 200. In this figure, the rear cover 250 and side covers 251 and 252 are shown to illustrate

one method for sealing the overall display 200. The image assembly 220 is shown near the front of the display 200. As discussed above, the image assembly 220 may comprise any form of electronic assembly for generating an image, including but not limited to: LCD, light emitting diode (LED), organic light emitting diode (OLED), field emitting displays (FED), light-emitting polymers (LEP), plasma displays, and any other flat/thin panel displays. The front display surface 221 is placed in front of the image assembly 220, defining a channel 290 through which the circulating gas may flow. The front display surface 221 may be any transparent material (glass, plastic, or composite) and may comprise several layers for polarizing light, reducing glare or reflections, and protecting the internal display components. In an exemplary embodiment, the front display surface 221 would comprise two panes of glass which are laminated together with optical adhesive (preferably index-matching). Further, a polarizing layer may be attached to one of the panes of glass in order to reduce the internal reflections and solar loading on the image assembly 220. It is most preferable that the polarizing layer be attached to the inner surface of the front display surface 221 (the one facing the closed loop channel 290) and also contain an anti-reflective (AR) coating.

[0052] For the embodiment shown in Figure 10A, the image assembly 220 may be an LCD stack with a backlight assembly 222. Some backlights may use cold cathode fluorescent lamps (CCFLs) to produce the illumination necessary for generating an image. In an exemplary embodiment, the backlight assembly 222 would comprise a printed circuit board (PCB) with a plurality of LEDs (light emitting diodes) on the front surface. As discussed above, an exemplary embodiment would have a low level of thermal resistance between the front surface of the backlight assembly 222 and the rear surface 223 of the backlight. A metallic PCB may be used for this purpose. The rear surface 223 of the backlight may contain a thermally conductive material, such as a metal. Aluminum may be an exemplary material for the rear surface 223. A second surface (or plate) 224 may be placed in close proximity behind the rear surface 223 of the backlight assembly 222. The space between the rear surface 223 of the backlight and the second surface 224 may define an additional optional open loop channel 225 through which ambient gas may travel in order to cool the backlight assembly 222. This

open loop channel 225 may be similar to the channel 15 shown above, except open loop channel 225 may be narrower.

[0053] FIGURE 10B shows the same cross section from Figure 10A with the rear cover 250 and side covers 251 and 252 removed and the closed and open loop air flows shown for explanatory purposes. The closed loop fan assembly 202 is used to propel the circulating gas 210 around the closed loop. A first open loop fan assembly 203 may be used to draw ambient gas 211 through the heat exchanger 201. Optionally, a second open loop fan assembly 204 may be used to draw ambient gas 212 through the optional channel 225 for cooling the backlight assembly 222. The optional second open loop fan assembly 204 can also be used to exhaust ambient gas which has traveled through the heat exchanger 201 and through the channel 225. If a second open loop fan assembly 204 is not used, the first open loop fan assembly 203 may be used to exhaust the ambient gas 211 that has traveled through the heat exchanger 201.

[0054] As noted above, in an exemplary embodiment the ambient gas does not mix with the circulating gas. It may be important for the image quality that the circulating gas remains free of particulate and contaminates as this gas travels in front of the image assembly 220. Since gas for the open loop may contain various contaminates, a preferable embodiment should be adequately sealed to prevent the gas from the two loops from mixing. This is not necessary however, as filters (either removable or permanent) may be used to minimize the effect of particulate for both the open and closed loops.

[0055] FIGURE 11 is a perspective section view of another embodiment of a display assembly 600 showing inlet 60 and exhaust 65 apertures for the ambient gas 20. The inlet aperture 60 may contain a screen or filter (removable or permanent) to remove any particulate (although this may not be necessary). One or more fans 50 may be used to draw the ambient gas 20 into the inlet aperture 60 and through the heat exchanger 201. In this embodiment, the ambient gas 20 is only drawn through the heat exchanger 201 and not through any additional optional channels or ribs. This embodiment may be used when the display assembly 80 (or backlight assembly) does not require the additional cooling of an additional channel. For example, and not by way of limitation,

this embodiment 600 may be used when an OLED is used as the image assembly 80. Further, this embodiment 600 may be used when the LCD backlight is not generating large amounts of heat because it is not required to be extremely bright (perhaps because it is not used in direct sunlight). Still further, this embodiment may be used when the ambient gas 20 contains particulate or contaminants which may damage the display. In these situations, it may be desirable to limit the exposure of the display to the ambient gas 20. Thus, in these situations it may be desirable to only ingest ambient gas 20 into the heat exchanger 201 and not through any additional cooling channels.

[0056] In some embodiments, the ambient gas 20 may be air conditioned (or otherwise cooled) before it is directed into the heat exchanger 201. A front display surface 221 may be used to create an anterior (front) wall of the channel 290 and/or protect the image assembly 80 from damage. An exemplary front display surface 221 may be glass. Another embodiment for the front display surface 221 may be two panes of glass which are laminated together using optical adhesive. Solar loading (radiative heat transfer from the sun through the front display surface 221 may result in a heat buildup on the image assembly 80 (ex. OLED or LCD assembly). This heat may be transferred to the circulating gas, where this heat may then be transferred to the ambient gas 20 and expelled from the display. The image assembly could be any one of the following: LCD, plasma display assembly, OLED, light emitting polymer (LEP) assembly, organic electro luminescence (OEL) assembly, or LED display assembly.

[0057] FIGURE 12 shows an exemplary embodiment where a circulating gas 400 is forced between a front display surface 221 and an image assembly 80 and then through a heat exchanger 201 in order to remove at least a portion of the heat absorbed from the image assembly 80 and front display surface 221. The circulating gas 400 may be propelled by a closed loop fan assembly 410. The heat exchanger 201 may accept circulating gas 400 in one direction while accepting ambient gas 310 in a substantially perpendicular direction such that heat may transfer between the two gases.

[0058] In this embodiment, an optional additional flow of ambient gas 300 is accepted through the inlet aperture 350 and directed along channel 225 in order to cool the rear portion of the image assembly 80 (possibly a backlight). This embodiment uses a set of ribs 18, similar to the designs shown above in Figures 7 and 8. This embodiment also

uses a thermally-conductive plate 10, similar to the one shown in Figure 7. When this optional additional flow of ambient gas 300 is used, it is preferable that the anterior (front) surface 500 of the channel 225 be thermally conductive and preferably in thermal communication with at least a portion (preferably the rear portion) of the image assembly 80. Inlet aperture 350 may accept both ambient gas 310 and 300, or there may be separate inlet apertures for each flow of gas 310 and 300.

[0059] Similar to some of the previously described embodiments, the circulating gas 400 also passes over electronic assemblies in order to accept heat from these electronic assemblies. In this exemplary embodiment, the electronic assemblies have been separated by the heat exchanger 201 into two groups. The first group of electronic assemblies 900 may be considered the high power assemblies and may include but are not limited to: power modules, inductors, transformers, and other power-related devices. The second group of electronic assemblies 910 may be considered the low power assemblies and may include but are not limited to: timing and control boards, hard drives and other storage devices, video cards, software drivers, microprocessors, and other control devices. It is known to those skilled in the art that some high power electronic assemblies can cause electrical interference with other electronic assemblies that may be sensitive to electrical interference. Thus, in the exemplary embodiment shown, the heat exchanger 201 is used to separate the lower power electronic assemblies 910 from the high power electronic assemblies 900 to ensure a minimum amount of interference between the two. Further, some high power electronic assemblies 900 are known to also generate heat. This heat may be transferred to the circulating gas 400 prior to introducing this gas into the heat exchanger 201. In the exemplary embodiment shown, ambient air can be ingested as the ambient gas 310 and there is little risk of damage to the electrical assemblies 910 and 900 because the ambient gas 310 would preferably never contact these electrical assemblies. However, the electrical assemblies 910 and 900 will remain cool (as well as clean and dry) because of the cross-flow from the circulating gas 400.

[0060] The cooling system described herein may run continuously. However, if desired, temperature sensing devices (not shown) may be incorporated within the electronic display to detect when temperatures have reached a predetermined

threshold value. In such a case, the various cooling fans may be selectively engaged when the temperature in the display reaches a predetermined value. Predetermined thresholds may be selected and the system may be configured to advantageously keep the display within an acceptable temperature range. Typical thermostat assemblies can be used to accomplish this task. Thermocouples may be used as the temperature sensing devices. The speed of the various fan assemblies can also be varied depending on the temperature within the display.

[0061] It should be particularly noted that the spirit and scope of the disclosed embodiments provides for the cooling of any type of electronic display. By way of example and not by way of limitation, embodiments may be used in conjunction with any of the following: LCD (all types), light emitting diode (LED), organic light emitting diode (OLED), field emitting display (FED), light emitting polymer (LEP), organic electro luminescence (OEL), plasma displays, and any other type of thin/flat panel display. Furthermore, embodiments may be used with displays of other types including those not yet discovered. In particular, it is contemplated that the system may be well suited for use with large LED backlit, high definition (1080i or 1080p or greater) liquid crystal displays (LCD). While the embodiments described herein are well suited for outdoor environments, they may also be appropriate for indoor applications (e.g., factory/industrial environments, spas, locker rooms, kitchens, bathrooms) where thermal stability of the display may be at risk.

[0062] It should also be noted that the variety of cooling channels that are shown in the figures may be shown in a horizontal or vertical arrangement but it is clearly contemplated that this can be reversed or changed depending on the particular embodiment. Thus, the closed loop may run horizontally or vertically and in a clockwise or counter-clockwise direction. Further, the open loop may also be horizontal or vertical and can run left to right, right to left, and top to bottom, or bottom to top.

[0063] Having shown and described preferred embodiments, those skilled in the art will realize that many variations and modifications may be made to affect the described invention and still be within the scope of the claimed invention. Additionally, many of the elements indicated above may be altered or replaced by different elements which

will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

CLAIMS

1. A cooling system for an electronic image assembly having a front and back portion, the system comprising:

a front display surface spaced apart from the front portion of the electronic image assembly;

a channel defined by the space between the front display surface and the front portion of the electronic image assembly;

a heat exchanger in gaseous communication with the channel, the heat exchanger having first and second gas pathways, where the first gas pathway is in gaseous communication with the channel;

a first fan assembly positioned so as to force circulating gas through the channel and the first gas pathway; and

a second fan assembly positioned so as to force ambient gas through the second gas pathway.

2. The cooling system of claim 1 wherein:

the heat exchanger is a cross-flow heat exchanger.

3. The cooling system of claim 1 further comprising:

a plate spaced apart from the rear portion of the electronic image assembly;

a second channel defined by the space between the plate and the rear portion of the electronic image assembly; and

wherein the second fan assembly is further positioned so as to force ambient gas through the second channel.

4. The cooling system of claim 3 further comprising:
- a power module in electrical communication with the electronic image assembly;
 - and
 - a heat sink in thermal communication with the power module and placed within the second channel.
5. The cooling system of any one of claims 3 or 4 further comprising:
- a plurality of ribs placed within the second channel.
6. An electronic display assembly comprising:
- an electronic image assembly;
 - an isolating structure space apart from the electronic image assembly;
 - a channel defined by the space between the isolating structure and the electronic image assembly;
 - a power module having electronic components on a first side and a heat sink on the second side, where the power module is attached to the isolating structure so that the heat sink is within the channel and the electronic components are outside the channel; and
 - a fan positioned so as to draw ambient gas through the channel.
7. The electronic display assembly of claim 6 further comprising:

a rib placed within the channel and in thermal communication with the isolating structure.

8. The electronic display assembly of claim 7 further comprising:

a surface placed within the channel and in thermal communication with the electronic image assembly and the rib;

9. The electronic display assembly of any one of claims 6, 7, or 8 wherein:

the electronic image assembly is a liquid crystal display.

10. The electronic display assembly of any one of claims 6, 7, or 8 wherein:

the electronic image assembly is an OLED display.

11. An electronic display assembly comprising:

an electronic image assembly having a front and rear portion;

a surface on the rear portion of the electronic image assembly and in thermal communication with the electronic image assembly;

a plate spaced apart from the surface;

a first channel defined by the space between the plate and the surface;

a power module in electrical communication with the electronic image assembly and in thermal communication with the plate; and

a first fan positioned so as to draw ambient gas through the first channel.

12. The electronic display assembly of claim 11 further comprising:
- a rib placed within the first channel and in thermal communication with the plate and the surface.
13. The electronic display assembly of claim 12 further comprising:
- a front display surface spaced apart from the front portion of the electronic image assembly;
 - a second channel defined by the space between the front display surface and the front portion of the electronic image assembly;
 - a heat exchanger in gaseous communication with the second channel, the heat exchanger having first and second gas pathways, where the first gas pathway is in gaseous communication with the second channel;
 - a second fan positioned so as to force ambient gas through the second gas pathway; and
 - a third fan positioned so as to force circulating gas through the second channel and the first gas pathway.
14. The electronic display assembly of any one of claims 11 through 13 wherein:
- the electronic image assembly is a LCD.
15. The electronic display assembly of any one of claims 11 through 13 wherein:
- the electronic image assembly is an OLED.

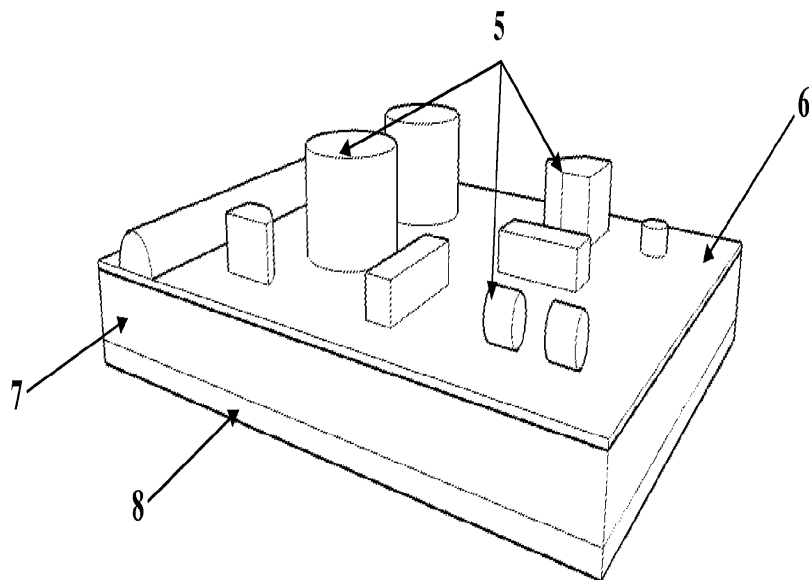


FIG-1

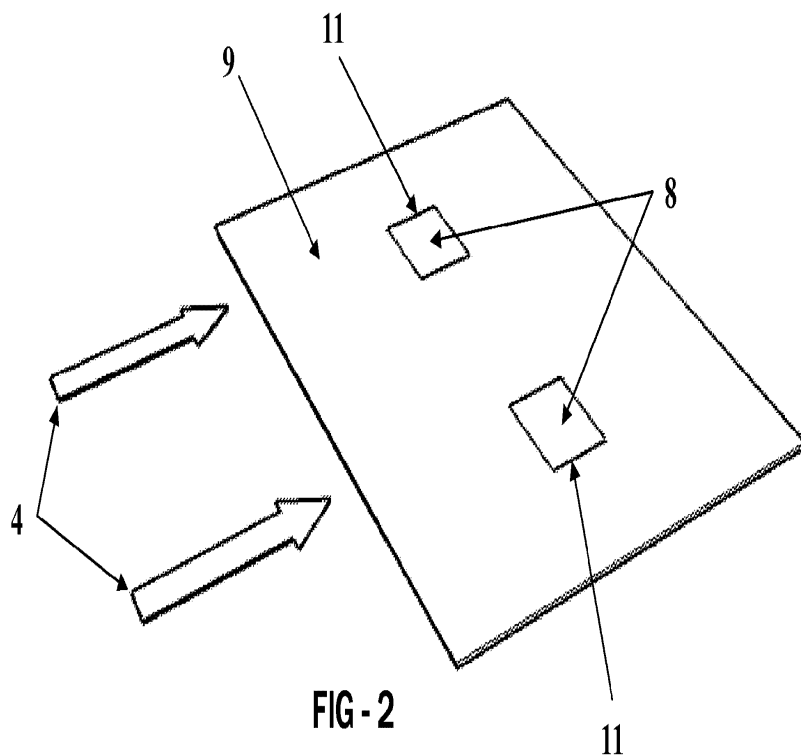


FIG-2

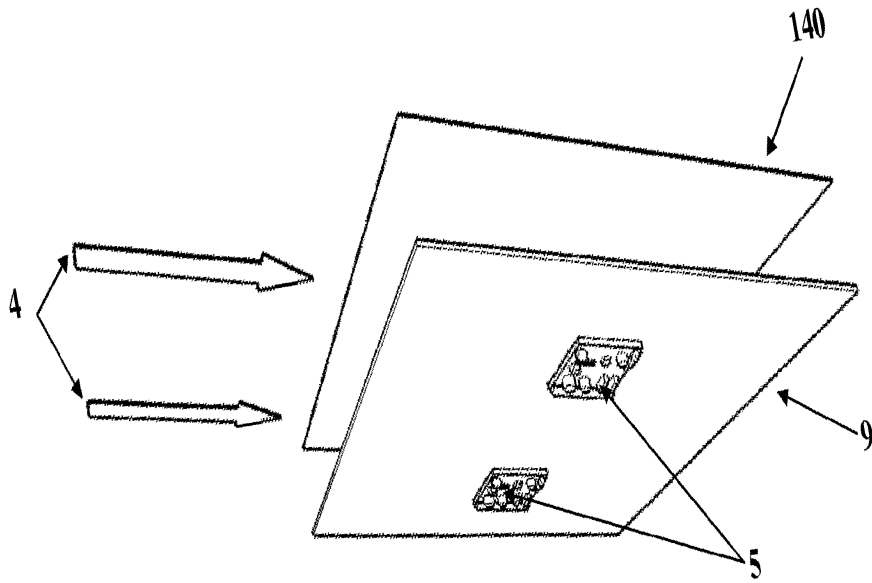


FIG - 3

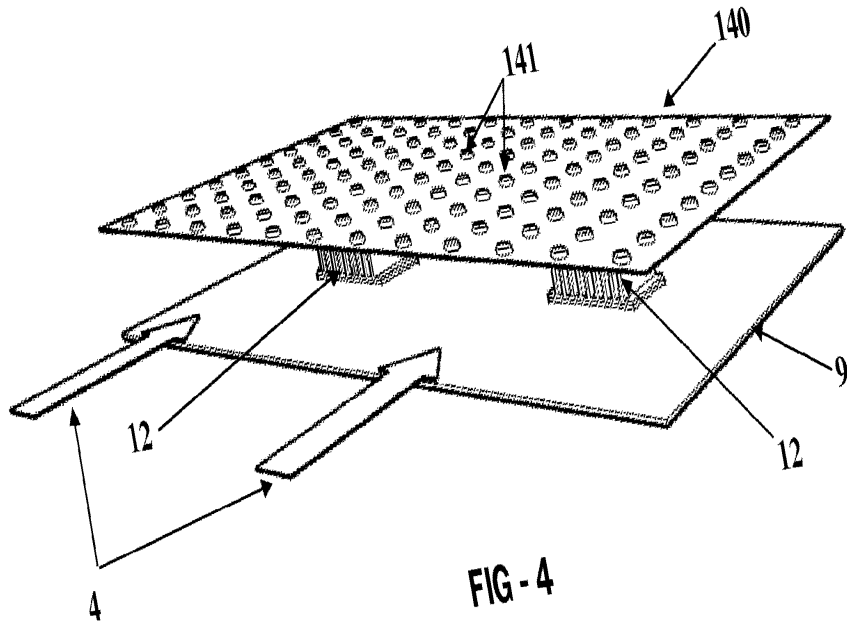
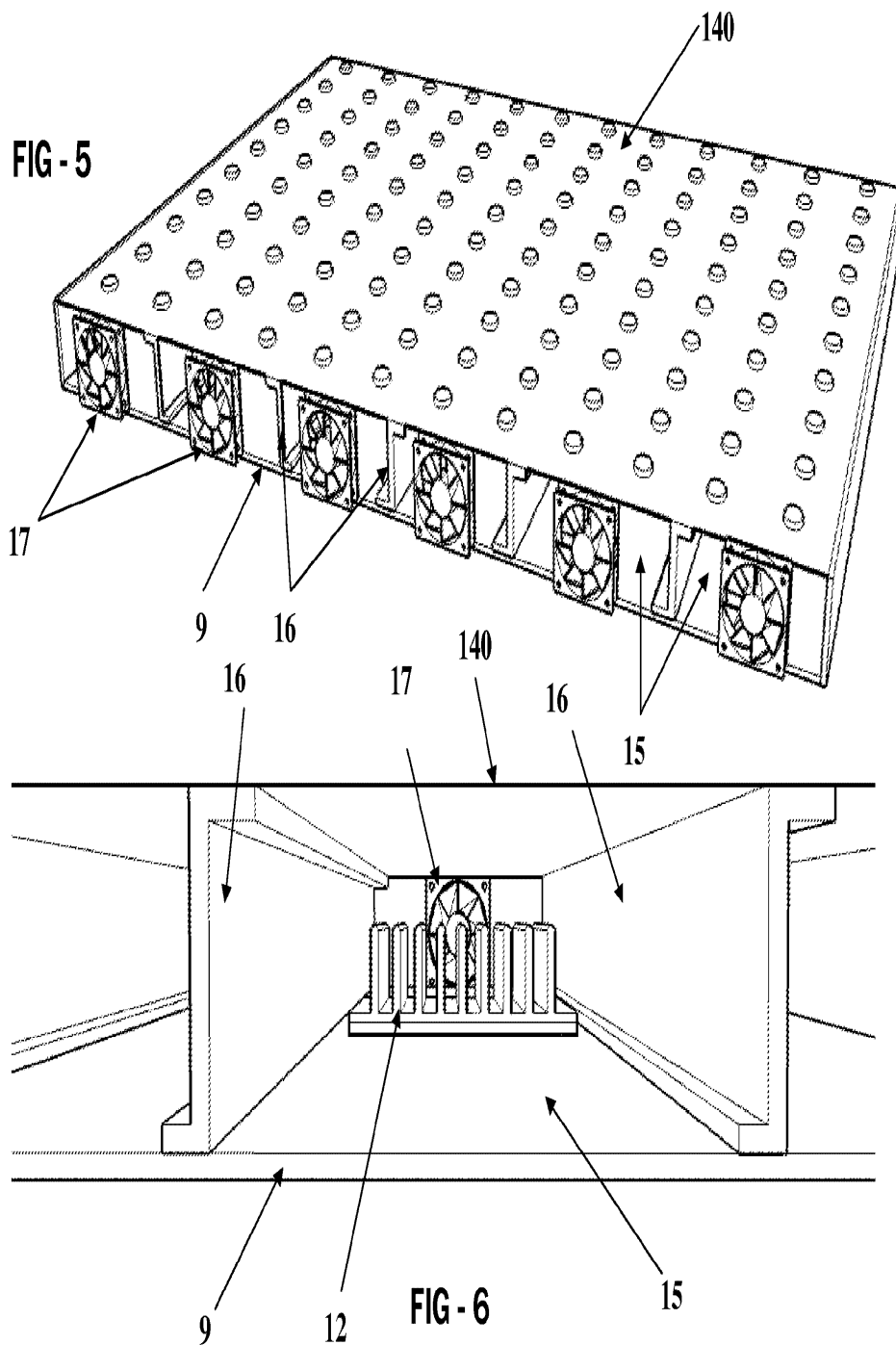
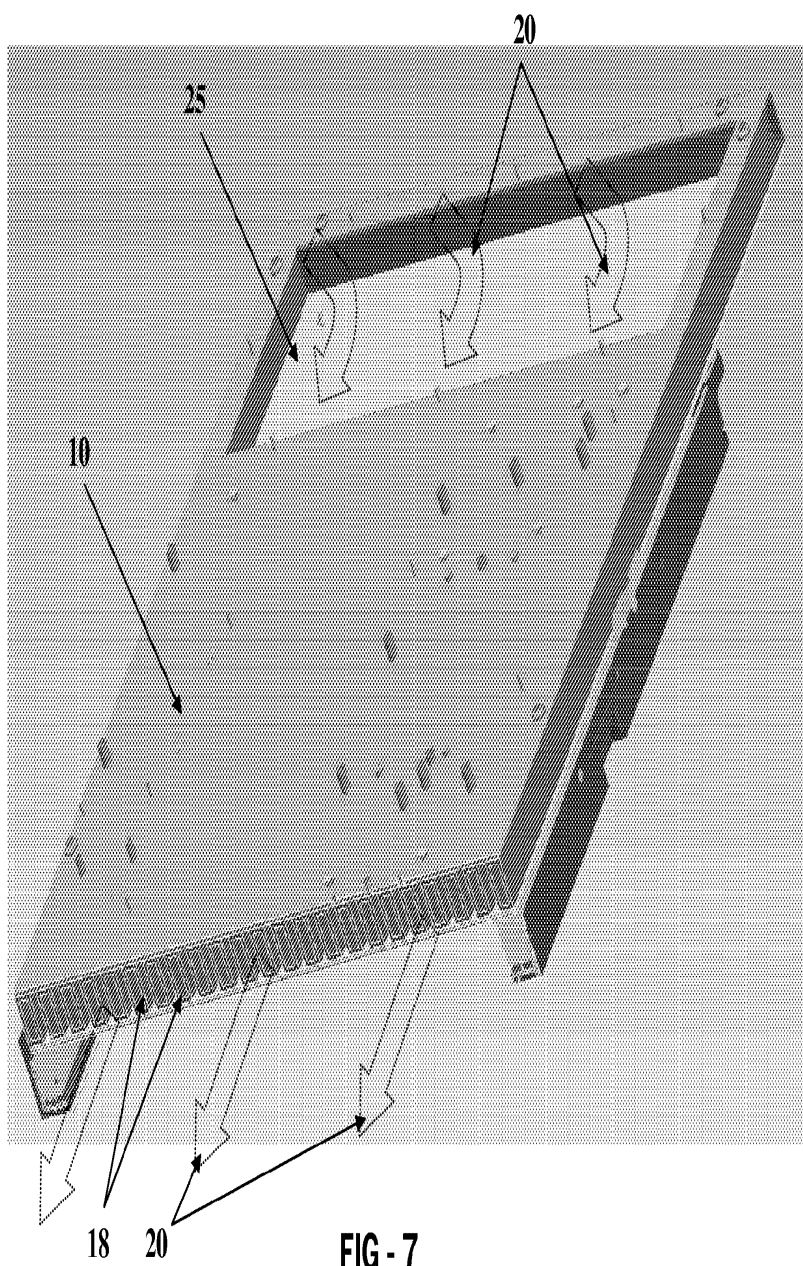
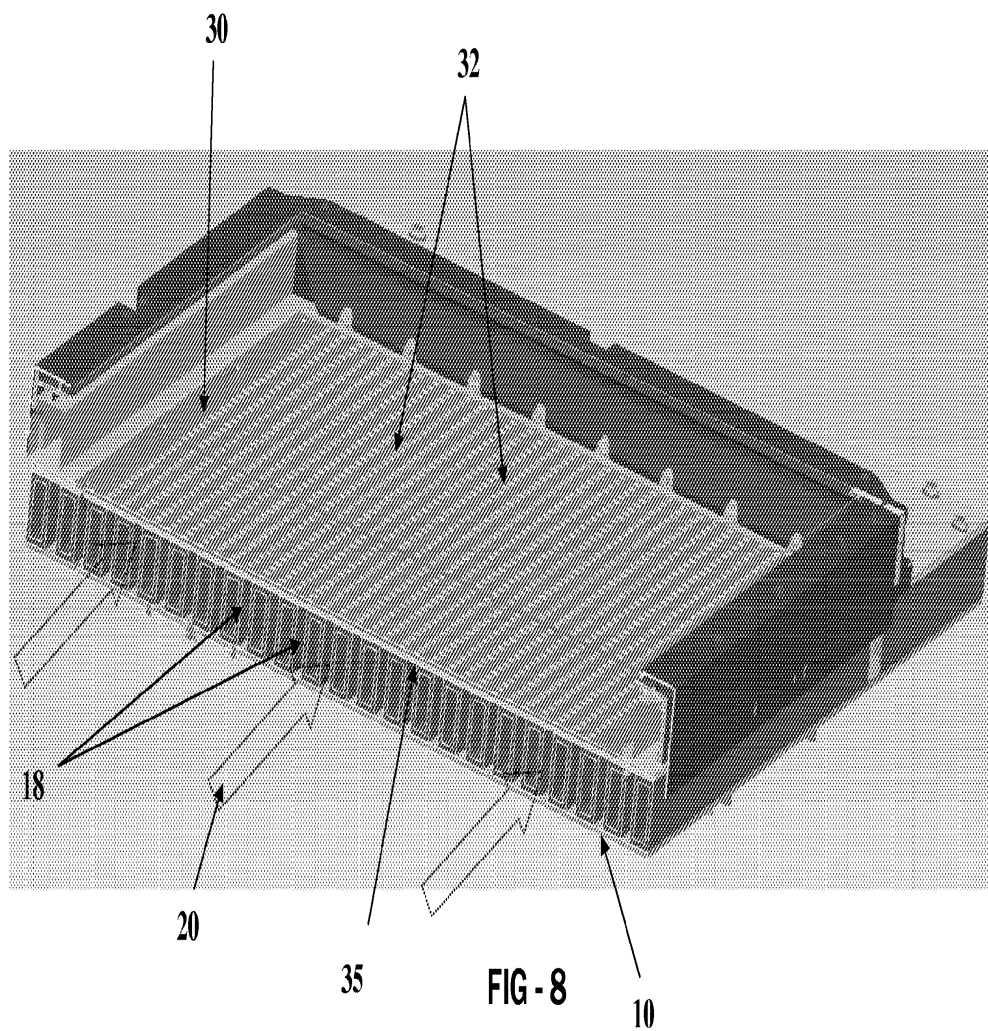


FIG - 4







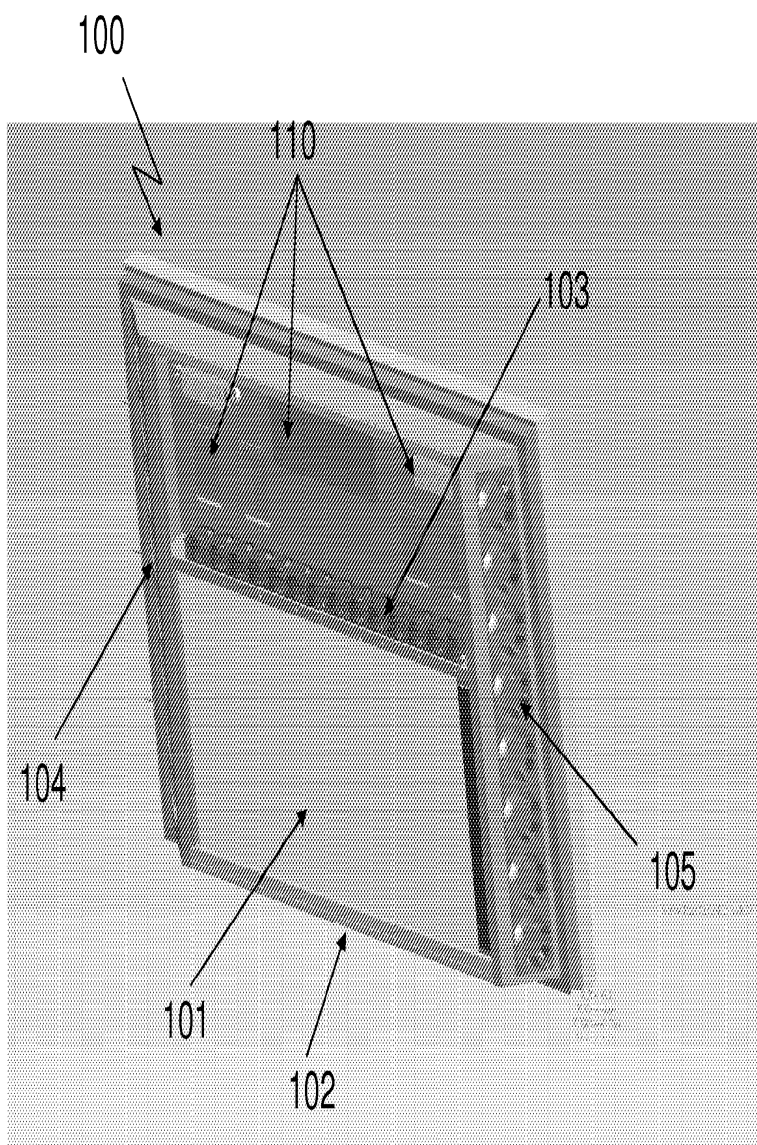


FIG - 9

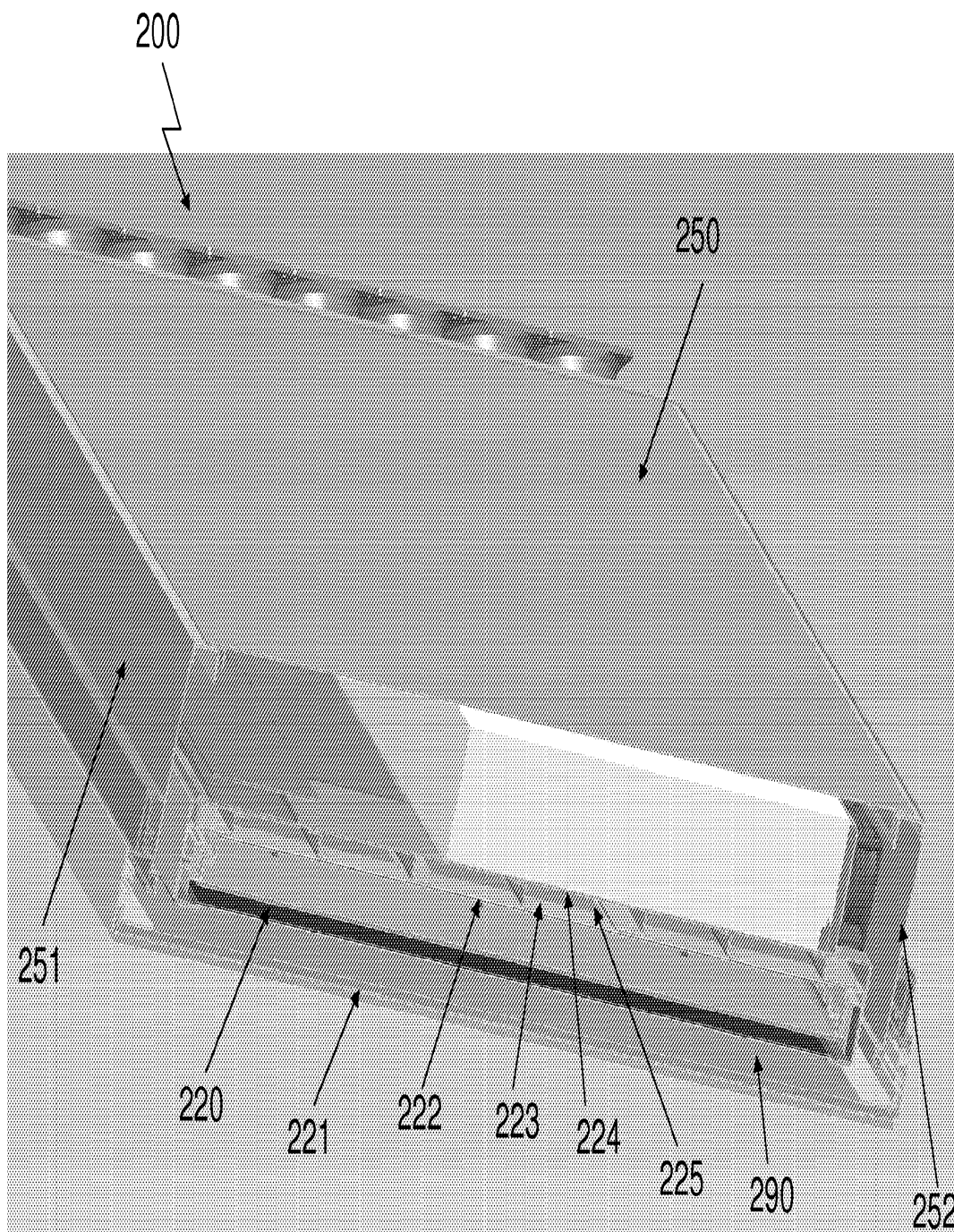


FIG - 10A

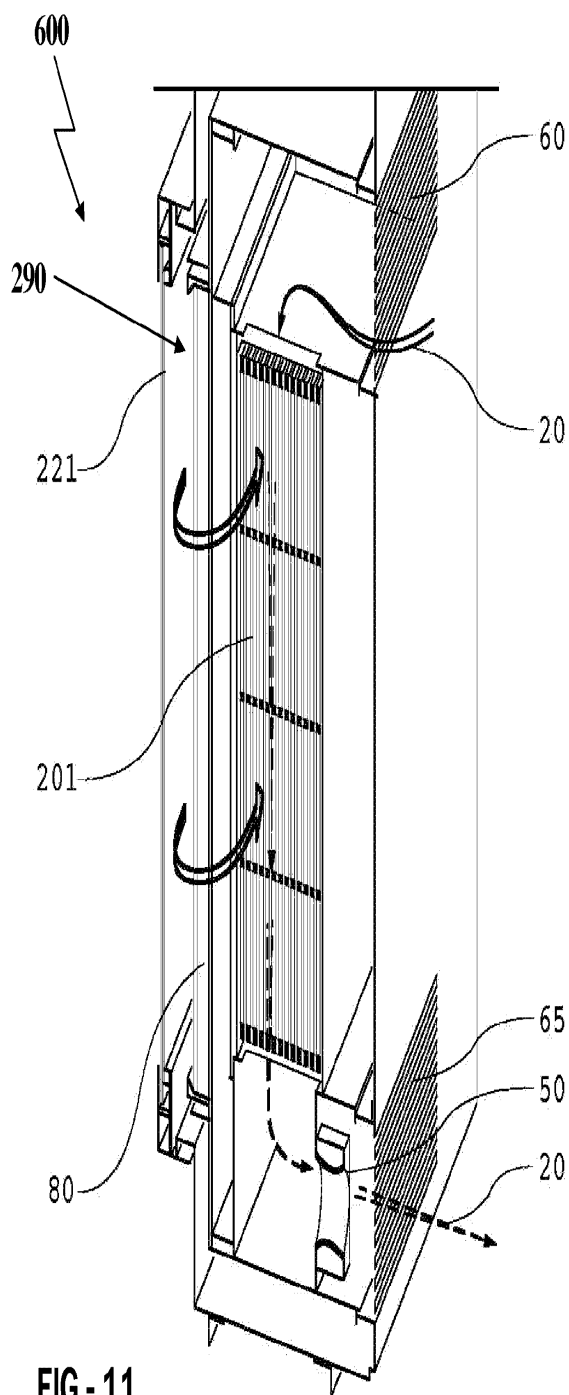
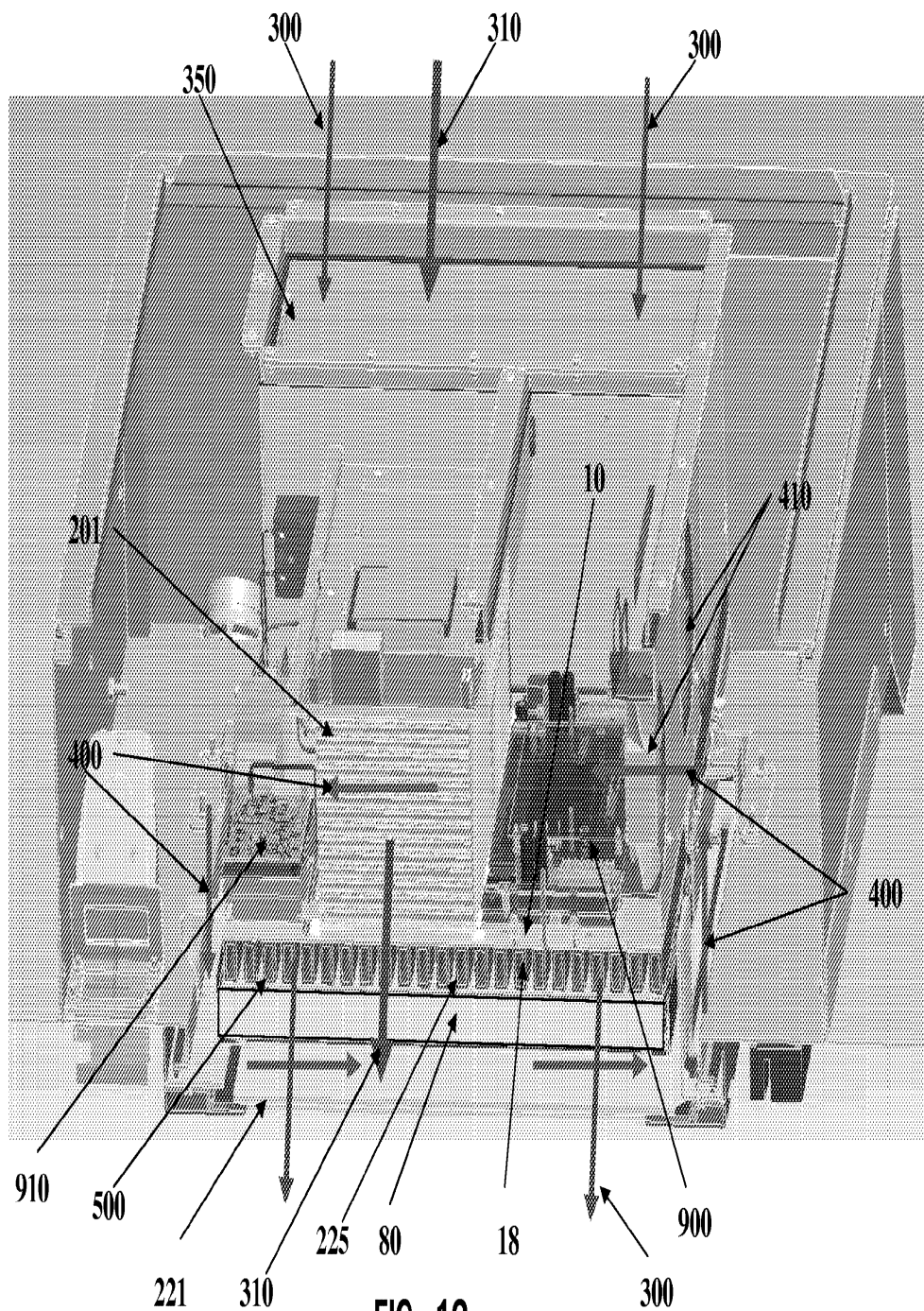


FIG - 11





Espacenet

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EXPANDED HEAT SINK FOR ELECTRONIC DISPLAYS AND METHOD OF PRODUCING THE SAME

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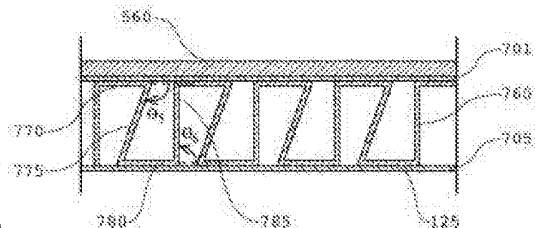
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Abstract of corresponding document: US2012038849 (A1)

An expanded heat sink for transferring heat from an electronic display component to a path of cooling air is disclosed. A continuous sheet may define a series of channels where the cooling air is blown through the channels and along the continuous sheet. When viewed along

the path of the cooling air and oriented horizontally, the continuous sheet may define a series of four-sided polygons having top, bottom, left side, and right side portions where either the top or bottom portions are absent from each polygon. The absent top portions may be supplied by a front plate or the rear portion of an electronic display. The absent bottom portions maybe supplied by a rear plate. One or more components of the electronic display may be placed in thermal communication with the sheet and/or front/rear plates to transfer heat from the components to the cooling air.



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[Continued on next page]

(54) Title: EXPANDED HEAT SINK FOR ELECTRONIC DISPLAYS AND METHOD OF PRODUCING THE SAME

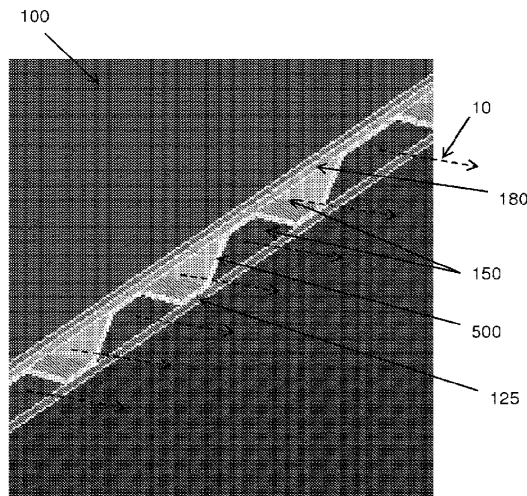


FIG - 1B

(57) Abstract: An expanded heat sink for transferring heat from an electronic display component to a path of cooling air is disclosed. A continuous sheet may define a series of channels where the cooling air is blown through the channels and along the continuous sheet. When viewed along the path of the cooling air and oriented horizontally, the continuous sheet may define a series of four-sided polygons having top, bottom, left side, and right side portions where either the top or bottom portions are absent from each polygon. The absent top portions may be supplied by a front plate or the rear portion of an electronic display. The absent bottom portions may be supplied by a rear plate. One or more components of the electronic display may be placed in thermal communication with the sheet and/or front/rear plates to transfer heat from the components to the cooling air.

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Expanded Heat Sink for Electronic Displays and Method of Producing the Same

Inventors: William Dunn, Bill Swatt, and Tim Hubbard

Cross-Reference to Related Applications

[0001] This application claims priority to U.S. Application No. 61/372,942, filed on August 12, 2010, herein incorporated by reference in its entirety. This application claims priority to U.S. Application No. 13/206,596 filed on August 10, 2011, herein incorporated by reference in its entirety.

Technical Field

[0002] Exemplary embodiments generally relate to cooling systems and in particular to cooling systems for electronic displays.

Background of the Art

[0003] Conductive and convective heat transfer systems for electronic displays generally attempt to remove heat from the electronic components in a display through the sidewalls of the display. Components such as power modules, which are known for producing a large amount of heat may have a 'heat sink' attached to the component which provides an expanded surface area so that heat may be transferred away from the component. These heat sinks have previously been limited to only the size of the power module itself.

[0004] Modern displays have become extremely bright, with some LCD backlights producing 1,000-2,000 nits or more. Sometimes, these illumination levels are necessary because the display is being used outdoors, or in other relatively bright areas where the display illumination must compete with other ambient light. In order to produce this level of brightness, illumination devices (ex. fluorescent lamps, LED, organic LED (OLED), light emitting polymer (LEP), organic electro luminescence (OEL), and plasma assemblies) may produce a relatively large amount of heat. Further, the illumination devices require a relatively large amount of power in order to generate the

required brightness level. This large amount of power is typically supplied through one or more power supplies for the display. These power supplies may also become a significant source of heat for the display.

[0005] Further, previous electronic displays were primarily designed for operation near room temperature. However, it is now desirable to have displays which are capable of withstanding large surrounding environmental temperature variations. For example, some displays are designed for operation at temperatures as low as -22F and as high as 113 F or higher. When surrounding temperatures rise, the cooling of the internal display components can become even more difficult.

[0006] Still further, in some situations radiative heat transfer from the sun through the front portion of the display can also become a source of heat. Furthermore, the market is demanding larger screen sizes for displays. With increased electronic display screen size and corresponding front display surfaces, more heat will be generated and more heat will be transmitted into the displays.

Summary of the Exemplary Embodiments

[0007] Exemplary embodiments relate to a system for cooling various components of an electronic display. The exemplary embodiments may be used to cool the power module(s) or power transformer(s), backlight (if used in the particular display), and other internal components of an electronic display, either alone or in combination. The component(s) may be placed in thermal communication with a continuous conductive sheet which may be placed in the path of cooling air. The heat from the components are distributed throughout the continuous conductive sheet and removed by the cooling air. Some embodiments may place the continuous conductive sheet between a pair of substantially parallel plates (which may also be conductive and may be in thermal communication with the continuous conductive sheet and one or more components).

[0008] In one embodiment where the electronic display is a liquid crystal display, power modules and the display backlight may be placed in thermal communication with the continuous conductive sheet. In this way, a single path of cooling air can be used to cool two of the most heat-producing components of a typical LCD. For example, and not by way of limitation, LED arrays are commonly used as the illumination devices for LCD backlights. It has been found that the optical properties of LEDs (and other illumination devices) can vary depending on temperature. Thus, when an LED is exposed to room temperatures, it may output light with a certain luminance, wavelength, and/or color temperature. However, when the same LED is exposed to high temperatures, the luminance, wavelength, color temperature, and other properties can vary. Thus, when a temperature variation occurs across an LED backlight (some areas are at a higher temperature than others) there can be optical inconsistencies across the backlight which can be visible to the observer. By using the exemplary embodiments herein, heat buildup can be evenly distributed across the continuous conductive sheet and removed from the display. This can prevent any potential 'hot spots' in the backlight which may become visible to the observer because of a change in optical properties of the LEDs.

[0009] The continuous conductive sheet may provide an isolated chamber from the rest of the display so that ambient air can be ingested and used to cool the continuous conductive sheet. This is beneficial for situations where the display is being used in an

outdoor environment and the ingested air may contain contaminants (pollen, dirt, dust, water, smoke, etc.) that would damage the sensitive electronic components of the display.

[0010] The foregoing and other features and advantages will be apparent from the following more detailed description of the particular embodiments of the invention, as illustrated in the accompanying drawings.

Brief Description of the Drawings

[0011] A better understanding of an exemplary embodiment will be obtained from a reading of the following detailed description and the accompanying drawings wherein identical reference characters refer to identical parts and in which:

[0012] FIGURE 1A is a front perspective section view of an exemplary embodiment used to cool an LED backlight;

[0013] FIGURE 1B is a detailed front perspective section view of insert B from Figure 1A;

[0014] FIGURE 2 is a rear perspective view of an embodiment using fans to draw cooling air through the channels;

[0015] FIGURE 3A is a rear perspective section view of an embodiment where the cooling fans are placed within the continuous conductive sheet and several components are placed within thermal communication with the continuous conductive sheet;

[0016] FIGURE 3B is a rear perspective section view of insert B from Figure 3A;

[0017] FIGURE 4 is a perspective view of one embodiment for the continuous conductive sheet;

[0018] FIGURE 5A is a side view of one embodiment for the continuous conductive sheet used within an LED-backlit liquid crystal display;

[0019] FIGURE 5B is a side view of another embodiment for the continuous conductive sheet used to cool a backlight as well as other electrical components; and

[0020] FIGURE 5C is a side view of another embodiment for the continuous conductive sheet used within an electronic display.

Detailed Description

[0021] The invention is described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity.

[0022] It will be understood that when an element or layer is referred to as being "on" another element or layer, the element or layer can be directly on another element or layer or intervening elements or layers. In contrast, when an element is referred to as being "directly on" another element or layer, there are no intervening elements or layers present. Like numbers refer to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0023] It will be understood that, although the terms first, second, third, etc., may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

[0024] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0025] Embodiments of the invention are described herein with reference to cross-section illustrations that are schematic illustrations of idealized embodiments (and intermediate structures) of the invention. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments of the invention should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing.

[0026] For example, an implanted region illustrated as a rectangle will, typically, have rounded or curved features and/or a gradient of implant concentration at its edges rather than a binary change from implanted to non-implanted region. Likewise, a buried region formed by implantation may result in some implantation in the region between the buried region and the surface through which the implantation takes place. Thus, the regions illustrated in the figures are schematic in nature and their shapes are not intended to illustrate the actual shape of a region of a device and are not intended to limit the scope of the invention.

[0027] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0029] Herein the terms 'front' and 'rear' may be used to describe the relationship between the various elements shown in the various embodiments. The term 'front' is used herein to denote a direction towards the intended observer of the electronic display. The term 'rear' is used herein to denote a direction away from the intended observer of the electronic display.

[0030] **FIGURE 1A** is a front perspective section view of an exemplary embodiment used to cool an LED backlight 100 (or an LED display). In this embodiment, the continuous conductive sheet 500 is placed adjacent to the LED backlight 100 and used to create a plurality of channels 150. Preferably, the LED backlight 100 is in thermal

communication with the continuous conductive sheet 500. Thus, heat which is generated by the LED backlight 100 is transferred to the continuous conductive sheet 500 and removed by cooling air 10.

[0031] FIGURE 1B is a detailed front perspective section view of insert B from Figure 1A. In this embodiment, the continuous conductive sheet 500 is placed between a front plate 180 and a rear plate 125 in order to create the channels 150. The front plate 180 is preferably in thermal communication with the LED backlight 100 and the continuous conductive sheet 500. The rear plate 125 may also be in thermal communication with the continuous conductive sheet 500. The thermal communication may be conductive, convective, radiative, or any combination of these. Preferably, the thermal communication is at least conductive.

[0032] The LED backlight 100 and front plate 180, front plate 180 and continuous conductive sheet 500, and the continuous conductive sheet 500 and rear plate 125 may be fastened to one another using any number of different techniques, including but not limited to: mechanical fasteners, adhesives, double-sided tape, welding, or other similar techniques. Each component may be attached to one another using similar or different methods. It is preferable that the chosen technique permits thermal communication between the components (if desired). In some embodiments the thermal communication between components may be accomplished by simply placing the components in contact with one-another or in close proximity to one another. Some embodiments may use a combination of the fastening techniques above. Thus, an exemplary embodiment may use both mechanical fasteners as well as an adhesive (preferably a thermally conductive adhesive) or double-sided tape. An exemplary type of double-sided tape would be Very High Bond (VHB™) tape commercially available from 3M™ Saint Paul, MN. www.3M.com An exemplary form of mechanical fasteners would be rivets or screws/bolts.

[0033] FIGURE 2 is a rear perspective view of an embodiment using fans 225 to draw cooling air 10 through the channels 150. Inlet apertures 200 allow the fans 225 to draw cooling air 10 in between the rear plate 125 and front plate 180 and along the channels 150. The cooling air 10 can then be exhausted out of the exit apertures 210. A single fan may be used in some embodiments, while several fans (even more than shown in

Figure 2) could be used in other embodiments. Of course, the fans 225 could instead be placed at the inlet apertures 200 and used to 'push' the cooling air 10 through the channels 150 rather than 'pull' (as shown in Figure 2). Further, fans could be placed at both the inlet apertures 200 and exit apertures 210 to both push and pull the cooling air 10 through the system.

[0034] FIGURE 3A is a rear perspective section view of an embodiment where the cooling fans 300 are placed within the continuous conductive sheet 500 and electronic components 800 are placed in thermal communication with the continuous conductive sheet 500. In this embodiment, cooling air 10 is drawn into the inlet apertures 310 by fans 300 which are placed along the length of the continuous conductive sheet 500. Thus, in this embodiment the fans 300 perform both a 'pull' and 'push' of the cooling air 10 through the channels 150. Electronic components 800 may be placed in thermal communication with the continuous conductive sheet 500 by establishing thermal communication between the electronic components 800 and the rear plate 125 (which is preferably in thermal communication with the continuous conductive sheet 500 in this embodiment).

[0035] The electronic components 800 may be any electronic component used in an electronic display which generates heat. The electronic components 800 are preferably in electrical communication with the electronic display assembly. Some embodiments may use power supplies/modules or power transformers as the electronic components 800.

[0036] FIGURE 3B is a rear perspective section view of insert B from Figure 3A. In this embodiment, the continuous conductive sheet 500 is placed between a front plate 180 and a rear plate 125 in order to create the channels 150. As discussed further below, a front plate 180 may not be necessary in some embodiments. Thus, in some embodiments the continuous conductive sheet 500 may be directly fastened to the rear portion of the LED backlight 100 (or another rear portion of an electronic display, especially an OLED assembly).

[0037] In this embodiment, a portion of the front plate 180 overlaps a portion of the rear plate 125 to create an overlap section 350. Here, heat is permitted to transfer directly between the edges of the rear plate 125 and front plate 180 and allows the

thermal energy to quickly and evenly spread throughout the plates and the continuous conductive sheet 500.

[0038] FIGURE 4 is a perspective view of one embodiment for the continuous conductive sheet 500.

[0039] FIGURE 5A is a side view of one embodiment for the continuous conductive sheet 500 used within an LED-backlit liquid crystal display. In this embodiment, the LED backlight 100 is attached to and in thermal communication with the front plate 180; which is attached to and in thermal communication with the continuous conductive sheet 500. A liquid crystal assembly 550 is placed in front of the LED backlight 100. The liquid crystal assembly 550 may contain several layers and is well known in the art. Typically, the liquid crystal assembly 550 contains two transparent plates with liquid crystal material sandwiched in between the two plates. An electrode of some type is typically used to orient the liquid crystal material. Additional layers may also be used to orient/polarize light, color filter the light, and provide anti-reflective or protective properties. These layers have not been shown as they are well-known in the art and are not critical to these embodiments of the invention.

[0040] Here, the rear plate 125 may not be in thermal communication with the continuous conductive sheet 500 but may only provide structure for the channels and/or structural support to the assembly. Of course, it is preferable that the rear plate 125 and the continuous conductive sheet 500 are in thermal communication so that heat can be more effectively and evenly distributed and removed. Ideally, there should be a low level of thermal resistance between the front and rear sides of the backlight 100. An exemplary embodiment may utilize a metal core PCB with LEDs on the front side and a metallic surface (or otherwise thermally conductive surface) on the rear side.

[0041] Generally, the continuous conductive sheet 500 may be described as four continuous portions, which are generally repeated to create the overall structure. For this embodiment, the first portion 600 runs parallel to and adjacent with the front plate 180. The second portion 610 extends from the first portion 600 at angle Θ_1 towards the rear plate 125. The third portion 620 extends from the second portion 610 and runs parallel to and adjacent with the rear plate 125. The fourth portion 630 extends from the third portion 620 at angle Θ_2 towards the front plate 180. The four portions may

then be repeated to create the continuous conductive sheet 500. Thus, the fourth portion 630 may continue to a second series of portions, starting with another portion similar to the previous first portion 600. In some embodiments, angle Θ_1 may be substantially equal to angle Θ_2 . While in other embodiments, angle Θ_1 may be different than angle Θ_2 .

[0042] In other words, when oriented horizontally and viewed along the direction of the cooling air (the side view shown in Figure 5A) the continuous conductive sheet 500 may be formed to create a series of four-sided polygons, each one having a bottom side (portion 620), left side (portion 610), right side (portion 630), and a top side (in this polygon supplied by front plate 180) where either the top or bottom side is absent from each polygon. For the embodiment shown in Figure 5A, the absent side of the polygon alternates between the top side and bottom side for each adjacent polygon. An exemplary version of the embodiment shown in this figure may be formed of stamped or bent sheet metal.

[0043] FIGURE 5B is a side view of another embodiment for the continuous conductive sheet 750 used to cool a backlight 700 as well as other electrical components 800. In this embodiment, the continuous conductive sheet 750 is attached to and in thermal communication directly with the backlight 700 (thus, there is no separate front plate used). A liquid crystal assembly 550 is placed in front of the backlight 700, which may be LED driven or may be any other means for illuminating the rear portion of the liquid crystal assembly 550. An additional electrical component 800 is placed in electrical communication with the backlight 700 and/or liquid crystal assembly 550 and is in thermal communication with the rear plate 705. Here, heat which is produced by the electrical component 800 may be transferred to the rear surface 704 of the rear plate 705, where it may then be transferred to the front surface 706 of the rear plate 705. The cooling air can remove the heat from the front surface 706 of the rear plate 705. Additionally, the heat may be transferred from the front surface 706 of the rear plate 705 to the continuous conductive sheet 750 where it may spread throughout the continuous conductive sheet 750 and ultimately removed by the cooling air.

[0044] Again, this embodiment of the continuous conductive sheet 750 may be described as four continuous portions, which are generally repeated to create the overall structure. For this embodiment, the first portion 710 runs parallel to and adjacent with the backlight 700. The second portion 715 extends from the first portion 710 at angle Θ_3 towards the rear plate 705. The third portion 720 extends from the second portion 715 and runs parallel to and adjacent with the rear plate 705. The fourth portion 725 extends from the third portion 720 at angle Θ_4 towards the backlight 700. The four portions may then be repeated to create the continuous conductive sheet 750. Thus, the fourth portion 725 may continue to a second series of portions, starting with another portion similar to the previous first portion 710. In some embodiments, angle Θ_3 may be substantially equal to angle Θ_4 . While in other embodiments, angle Θ_3 may be different than angle Θ_4 . In this particular embodiment, both angles Θ_3 and Θ_4 are near 90 degrees, or perpendicular to the backlight 700 and rear plate 705 and/or first portion 710 and third portion 720.

[0045] In other words, when oriented horizontally and viewed along the direction of the cooling air (the side view shown in Figure 5B) the continuous conductive sheet 750 may be formed to create a series of four-sided polygons, each one having a bottom side (portion 720), left side (portion 715), right side (portion 725), and a top side (in this polygon supplied by backlight 700) where either the top or bottom side is absent from each polygon. For the embodiment shown in Figure 5B, the absent side of the polygon alternates between the top side and bottom side for each adjacent polygon. An exemplary version of the embodiment shown in this figure may be formed of stamped or bent sheet metal.

[0046] **FIGURE 5C** is a side view of another embodiment for the continuous conductive sheet 760 used within an electronic display. Here, the continuous conductive sheet 760 is attached to and in thermal communication with the front plate 701 which is attached to and in thermal communication with an electronic display assembly 560. In this embodiment, the continuous conductive sheet 760 may be used to cool a type of electronic display that does not require a backlight device. Thus, the electronic display assembly 560 could be, but is not limited to any one of the following types of displays: OLED, LED, light emitting polymer (LEP), organic electro

luminescence (OEL), and plasma. The heat which is generated by the electronic display assembly 560 can be transferred to the front plate 701 where it can be transferred to the continuous conductive sheet 760 and removed by the cooling air. Additionally, radiative heat transfer from sunlight can also cause a heat buildup upon the electronic display assembly 560. This heat can also be transferred to the continuous conductive sheet 760 and removed by the cooling air. Here, the rear plate 705 may not be in thermal communication with the continuous conductive sheet 760 but may only provide structure for the channels and/or structural support to the assembly. Of course, it is preferable that the rear plate 705 and the continuous conductive sheet 760 are in thermal communication so that heat can be more effectively and evenly distributed and removed.

[0047] Again, this embodiment of the continuous conductive sheet 760 may be described as four continuous portions, which are generally repeated to create the overall structure. For this embodiment, the first portion 770 runs parallel to and adjacent with the front plate 701. The second portion 775 extends from the first portion 770 at angle Θ_5 towards the rear plate 705. The third portion 780 extends from the second portion 775 and runs parallel to and adjacent with the rear plate 705. The fourth portion 785 extends from the third portion 780 at angle Θ_6 towards the front plate 701. The four portions may then be repeated to create the continuous conductive sheet 760. Thus, the fourth portion 785 may continue to a second series of portions, starting with another portion similar to the previous first portion 770. In some embodiments, angle Θ_5 may be substantially equal to angle Θ_6 . While in other embodiments, angle Θ_5 may be different than angle Θ_6 .

[0048] In other words, when oriented horizontally and viewed along the direction of the cooling air (the side view shown in Figure 5C) the continuous conductive sheet 760 may be formed to create a series of four-sided polygons, each one having a bottom side (portion 780), left side (portion 775), right side (portion 785), and a top side (in this polygon supplied by front plate 701) where either the top or bottom side is absent from each polygon. For the embodiment shown in Figure 5C, the absent side of the polygon alternates between the top side and bottom side for each adjacent polygon. An

exemplary version of the embodiment shown in this figure may be formed of bent sheet metal.

[0049] Electronic displays are produced in a variety of sizes and orientations, including but not limited to both landscape and portrait orientations. Any of the embodiments herein can be used to cool the various types, sizes, and orientations of electronic displays. Further, the channels may be oriented in a vertical manner, and the cooling air may travel from top to bottom or from bottom to top. Still further, the channels may be oriented in a horizontal manner, and the cooling air can travel left to right or right to left.

[0050] While the embodiments of the continuous conductive sheet have been generally described as containing four portions which repeat themselves, other embodiments could use a mixture of different designs. Thus, some embodiments may not repeat the same four portions over and over. Some embodiments could use four portions from the continuous conductive sheet 750 of Figure 5B, followed by four portions from the continuous conductive sheet 500 of Figure 5A. Of course, any number of different combinations could be used, depending on the materials and manufacturing process used to construct the particular continuous conductive sheet.

[0051] It should be noted that the embodiments herein do not require that a singular continuous conductive sheet is used to cool the entire electronic display. A plurality of smaller continuous conductive sheets may be used in order to cool the display. The smaller continuous conductive sheets may be connected to each other and in thermal communication with one another or they may be spaced apart from one another. Thus, as used herein the term 'continuous' does not require that the entire display is cooled with a single conductive sheet. The term 'continuous' as used herein defines a single element that can be placed between two substantially planar objects to create at least two channels.

[0052] Further, the term 'thermal communication' as used herein does not require direct thermal communication, i.e. there may be intermediate devices or layers in-between the two components which are still considered to be in 'thermal communication.' Conductive heat transfer is one type of thermal communication and is preferable with the exemplary embodiments herein. Convective thermal communication

is one type of thermal communication which is preferable between the continuous conductive sheet and the cooling air.

[0053] The continuous conductive sheets have been shown herein with relatively constant cross-sectional thicknesses but this is also not required. Some portions of the continuous conductive sheets may be thicker or thinner than other portions and some may even contain fins or additional extended surface areas for removing the absorbed heat.

[0054] It is preferable that the front plate, rear plate, and continuous conductive sheet are comprised of materials which are thermally conductive. Metals have been found to be exemplary materials for these components. More specifically, sheet metals and even more specifically aluminum sheet metals are preferable. However, many thermally conductive plastics and composite materials can also perform adequately. Specifically, polypropylene sheets would be within the scope of the various embodiments.

[0055] In an exemplary embodiment, the front and rear plates would provide a gaseous and contaminate barrier between the space between them (containing the continuous conductive sheet) and the rest of the display. If the plates provide an adequate barrier, ambient air may be ingested as cooling air 10 and the risk of contaminants entering the portions of the display containing the sensitive electronic components may be reduced or eliminated.

[0056] As noted above, many illumination devices (especially LEDs and OLEDs) may have performance properties which vary depending on temperature. When 'hot spots' are present within a backlight or illumination assembly, these hot spots can result in irregularities in the resulting image which might be visible to the end user. Thus, with the embodiments described herein, the heat which may be generated by the backlight assembly can be distributed (somewhat evenly) throughout the various ribs and thermally-conductive surfaces to remove hot spots and cool the backlight.

[0057] The cooling system may run continuously. However, if desired, temperature sensing devices (not shown) may be incorporated within the electronic display to detect when temperatures have reached a predetermined threshold value. In such a case, the various cooling fans may be selectively engaged when the temperature in the display

reaches a predetermined value. Predetermined thresholds may be selected and the system may be configured to advantageously keep the display within an acceptable temperature range. Typical thermostat assemblies can be used to accomplish this task. Thermocouples may be used as the temperature sensing devices.

[0058] It is to be understood that the spirit and scope of the disclosed embodiments provides for the cooling of many types of displays. By way of example and not by way of limitation, embodiments may be used in conjunction with any of the following: LCD (all types), light emitting diode (LED), organic light emitting diode (OLED), field emitting display (FED), light emitting polymer (LEP), organic electro luminescence (OEL), plasma displays, and any other type of flat panel electronic display. Furthermore, embodiments may be used with displays of other types including those not yet discovered. In particular, it is contemplated that the system may be well suited for use with full color, flat panel OLED displays. Exemplary embodiments may also utilize large (55 inches or more) LED backlit, high definition (1080i or 1080p or greater) liquid crystal displays (LCD). While the embodiments described herein are well suited for outdoor environments, they may also be appropriate for indoor applications (e.g., factory/industrial environments, spas, locker rooms) where thermal stability of the display may be at risk.

[0059] Although fans are shown with some of the embodiments herein, they are not required for all embodiments. While forced convection (using fans) is preferable, natural or un-forced convection (no fans) may also produce acceptable results and is within the scope of the invention.

[0060] The relative sizing of each component shown in the figures is not to be interpreted as a requirement of the invention or that they are accurately drawn to scale. Some components have been enlarged for clarity. Other components have been simplified for clarity.

[0061] Having shown and described preferred embodiments, those skilled in the art will realize that many variations and modifications may be made to affect the described embodiments and still be within the scope of the claimed invention. Additionally, many of the elements indicated above may be altered or replaced by different elements which

will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

CLAIMS

1. An expanded heat sink for transferring heat from an electronic display component to a path of cooling air, the expanded heat sink comprising:

a continuous sheet when viewed along the path of the cooling air and oriented horizontally, defines a series of four-sided polygons having top, bottom, left side, and right side portions where either the top or bottom portions are absent from each polygon.

2. The heat sink of claim 1 wherein:

the absent portion of the polygon alternates between the top and bottom portion for each adjacent polygon.

3. The heat sink of claim 1 wherein:

the four-sided polygons are trapezoids.

4. The heat sink of any one of claims 1-3 wherein:

the top and bottom portions are substantially parallel.

5. The heat sink of claim 1 wherein:

the four-sided polygons are rectangles.

6. The heat sink of any claim 1 further comprising:

a front plate placed above the continuous sheet; and

a rear plate placed below the continuous sheet.

7. The heat sink of claim 6 wherein:

the front plate is placed so as to supply the missing top portion of the polygons;
and

the rear plate is placed so as to supply the missing bottom portion of the
polygons.

8. A liquid crystal display (LCD) comprising:

the heat sink of claim 6;

an LED backlight placed above and in thermal communication with the front
plate; and

a liquid crystal assembly placed above the LED backlight.

9. The LCD of claim 8 further comprising:

a fan positioned to draw cooling air between the front plate and rear plate and
along the continuous sheet.

10. The LCD of any one of claims 8-9 wherein:

the LED backlight is placed in conductive thermal communication with the front
plate.

11. An expanded heat sink for transferring heat from an electronic display component to a path of cooling air, the expanded heat sink comprising:

- a substantially planar front plate;
- a substantially planar rear plate placed parallel to the front plate; and
- a continuous sheet placed between the front and rear plates to define a series of channels for accepting the cooling air.

12. The heat sink of claim 11 wherein:

- the continuous sheet contains a series of four portions:
 - the first portion running substantially parallel to the front plate,
 - the second portion extending from the first portion and towards the rear plate at a first angle,
 - the third portion extending from the second portion and substantially parallel to the rear plate, and
 - the fourth portion extending from the third portion and towards the front plate at a second angle.

13. The heat sink of claim 12 wherein:

- the first portions are in contact with the front plate, and
- the third portions are in contact with the rear plate.

14. The heat sink of claim 12 wherein:

- the first and second angles are substantially equal.

15. The heat sink of claim 12 wherein:

the first and second angles are each less than ninety degrees.

16. An electronic display comprising:

the heat sink of claim 11;

an electronic display assembly placed in front of and in thermal communication with the front plate; and

a fan positioned to draw cooling air through the channels.

17. The electronic display of claim 16 further comprising:

an electrical component in conductive thermal communication with the rear plate.

18. The electronic display of claim 17 wherein:

the electrical component is any one of the following: power module, power supply, and power transformer.

19. A liquid crystal display (LCD) comprising:

the heat sink of claim 1;

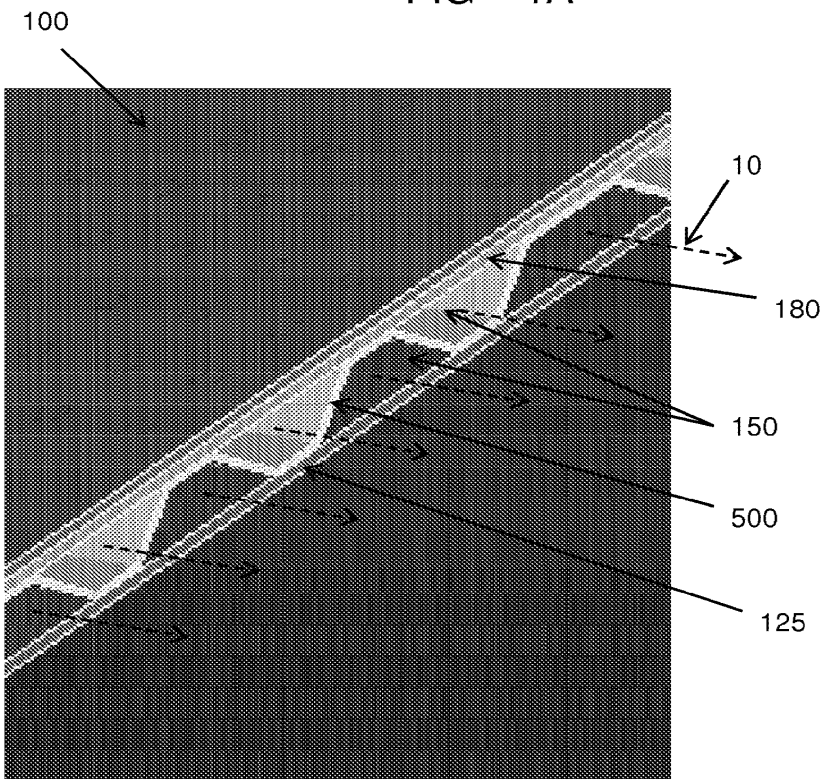
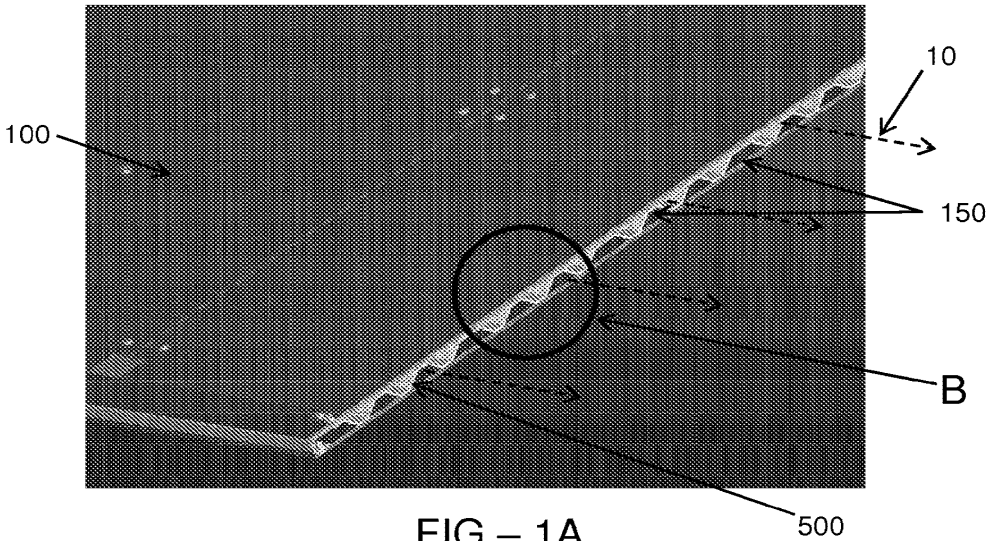
an LED backlight placed above and in thermal communication with the continuous sheet;

a liquid crystal assembly placed above the LED backlight;

a rear plate placed behind and in thermal communication with the continuous sheet; and

a fan positioned to draw cooling air between the LED backlight and rear plate and along the continuous sheet.

20. The LCD of claim 19 further comprising:
an electrical component in conductive thermal communication with the rear plate.



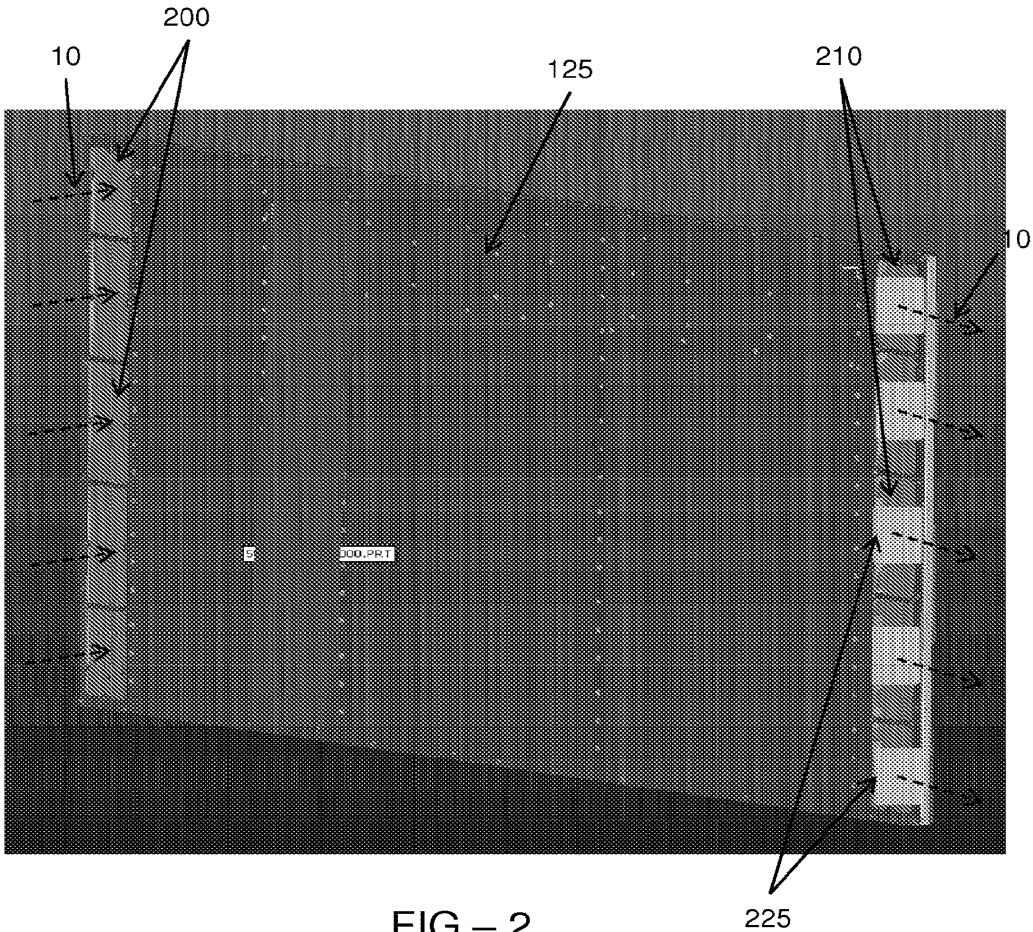
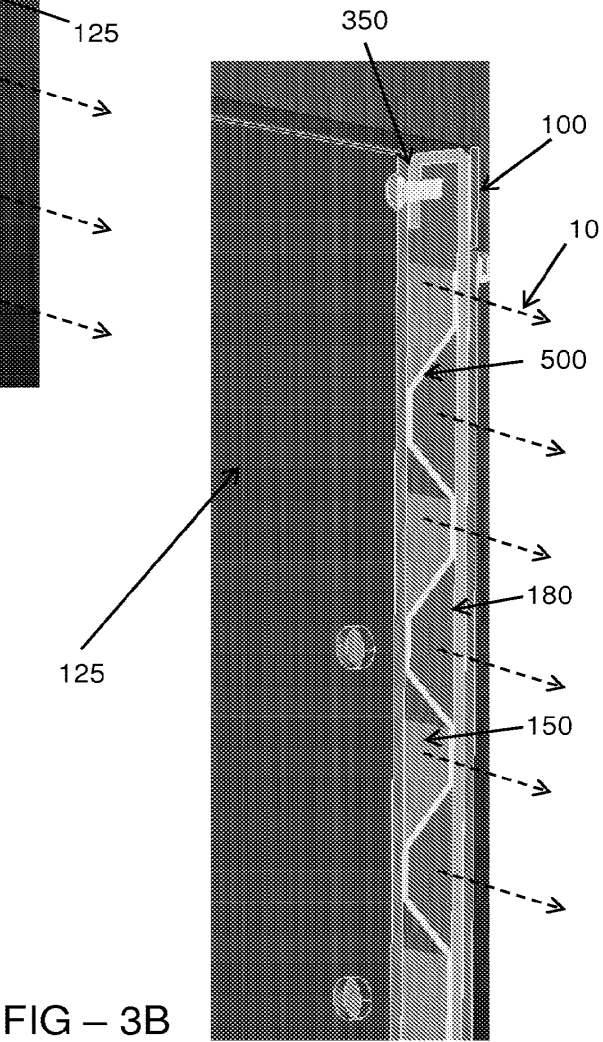
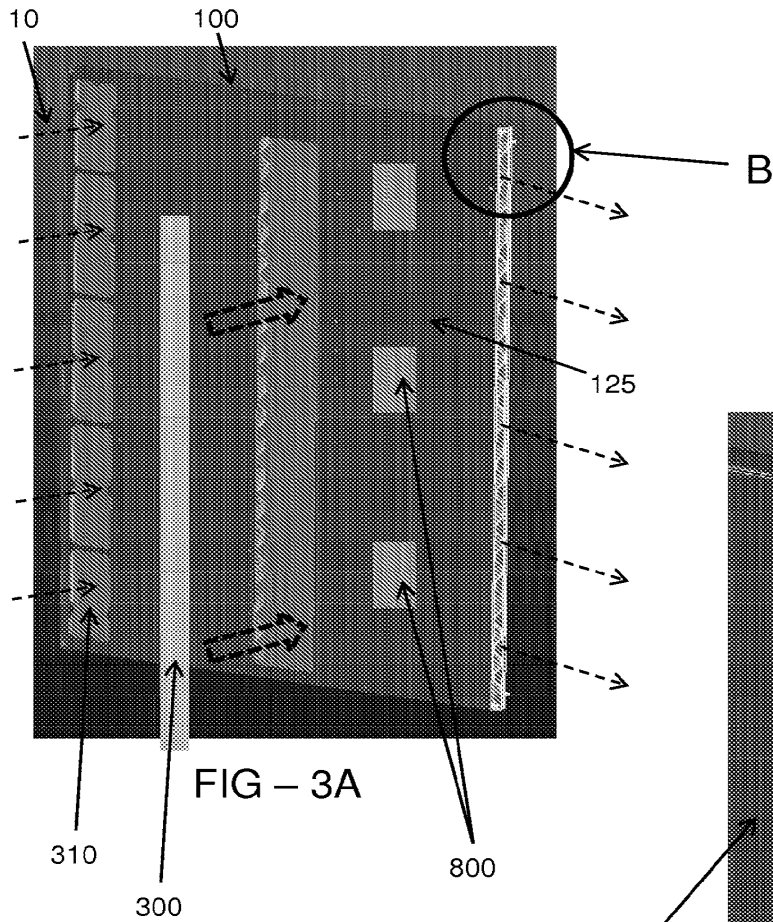


FIG - 2



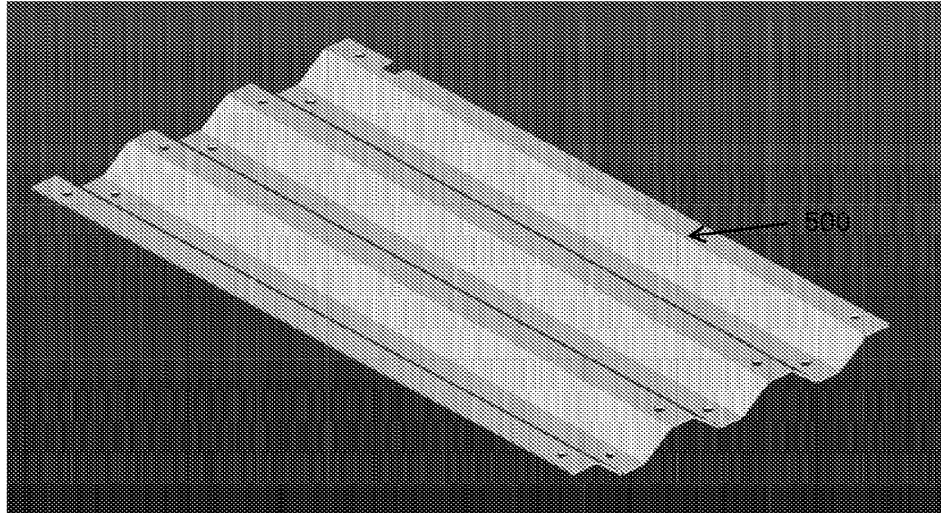


FIG - 4

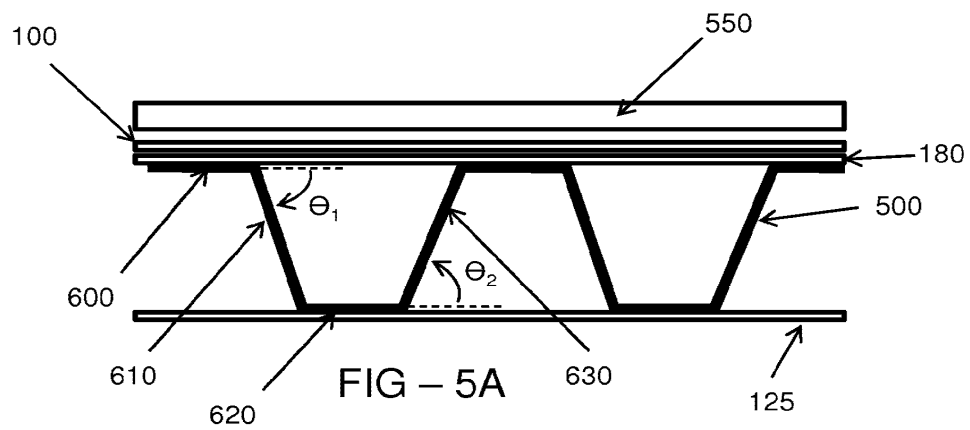
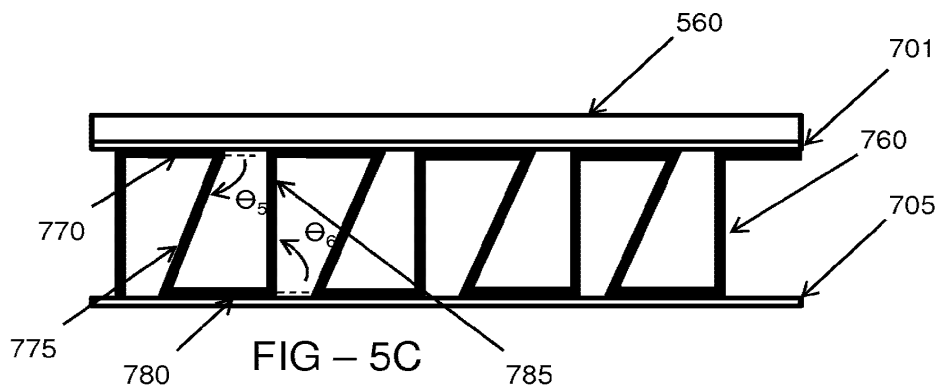
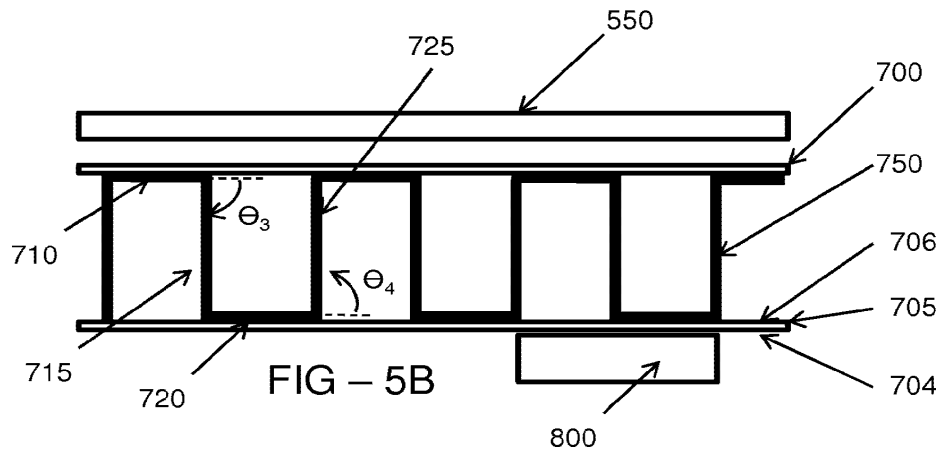


FIG - 5A





Espacenet

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BACK PAN COOLING ASSEMBLY FOR ELECTRIC DISPLAY

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Exemplary embodiments disclosed herein provide a back pan cooling assembly for an electronic display having a rear pan. A cooling back pan is preferably positioned behind the rear pan, the space between the cooling back pan and the rear pan defining a gap. A fan is positioned to cause a flow of ambient air through the gap. An electronic component for driving the electronic display may be placed in conductive thermal communication with the cooling back pan. A rear cover can be placed against the cooling back pan to define a sealed compartment which does not permit ambient air to enter. A port can be provided within the rear cover which allows ambient air to travel between the surroundings, the fan, and the gap.

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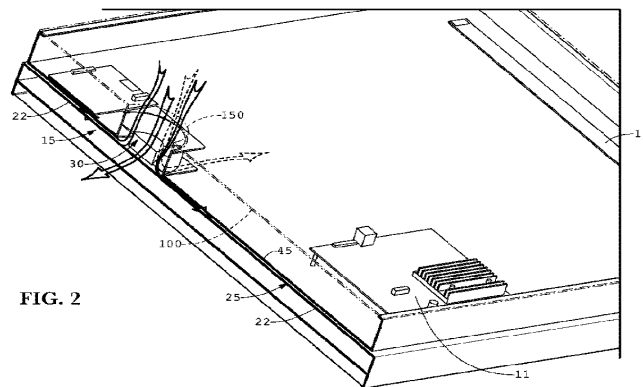


FIG. 2

(57) Abstract: Exemplary embodiments disclosed herein provide a back pan cooling assembly for an electronic display having a rear pan. A cooling back pan is preferably positioned behind the rear pan, the space between the cooling back pan and the rear pan defining a gap. A fan is positioned to cause a flow of ambient air through the gap. An electronic component for driving the electronic display may be placed in conductive thermal communication with the cooling back pan. A rear cover can be placed against the cooling back pan to define a sealed compartment which does not permit ambient air to enter. A port can be provided within the rear cover which allows ambient air to travel between the surroundings, the fan, and the gap.

WO 2014/062815 A1

Back Pan Cooling Assembly for Electronic Display

Cross-Reference to Related Applications

[0001] This application claims priority to US Application No. 61/714,381 filed on October 16, 2012 and is herein incorporated by reference in its entirety.

Technical Field

[0002] Embodiments generally relate to a cooling assembly for the back pan of an electronic display.

Background of the Art

[0003] Electronic displays are now being used for a variety of applications, in addition to the traditional in-home viewing applications. It is now desirable for electronic displays to be used as restaurant menu boards, advertising, and general informational purposes. Each application may require a different set of electronic assemblies, in order to drive the electronic display and provide any ancillary services related to the electronic display and its purpose. Electronic displays are typically manufactured in standard sizes, shapes, and with standard electronic components.

Summary of the Exemplary Embodiments

[0004] One exemplary embodiment provides a cooling back pan that is positioned behind the rear pan of an electronic display, where the space between the cooling back pan and the rear pan defines a gap. A fan is preferably positioned so as to cause a flow of ambient air through the gap, cooling the rear pan and the cooling back pan. Electronic components for operating the electronic display can be mounted to the cooling back pan and preferably are placed in conductive thermal communication with the cooling back pan.

[0005] The foregoing and other features and advantages of the present invention will be apparent from the following more detailed description of the particular embodiments, as illustrated in the accompanying drawings.

Brief Description of the Drawings

[0006] A better understanding of an exemplary embodiment will be obtained from a reading of the following detailed description and the accompanying drawings wherein identical reference characters refer to identical parts and in which:

[0007] FIGURE 1 is a rear perspective view of an exemplary back pan cooling assembly.

[0008] FIGURE 2 is a sectional view of the embodiment shown in Figure 1.

Detailed Description

[0009] The invention is described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity.

[0010] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0011] Embodiments of the invention are described herein with reference to illustrations that are schematic illustrations of idealized embodiments (and intermediate

structures) of the invention. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments of the invention should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing.

[0012] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0013] FIGURE 1 is a rear perspective view of an exemplary back pan cooling assembly where the rear cover 100 has been removed. An electronic display 15 is provided on the bottom with an exemplary cooling back pan 45 positioned on the top. The electronic display 15 contains a rear pan 22 on the rear surface of the electronic display 15 (i.e. on the side opposing an intended observer). The rear pan 22 is often a component in mass-manufactured electronic displays and typically provides mounts for electronic subassemblies or housings to go with the electronic display. In some embodiments, the rear pan 22 is metallic. As used herein, the term 'rear pan' does not require that the pan is actually the one that came with the originally mass-manufactured display, as this component may be upgraded from its originally mass-manufactured form by downstream manufacturers.

[0014] Here, electronic components 10 and 11 for driving the electronic display 15 are fastened to the cooling back pan 45. In an exemplary embodiment, the electronic components 10 and 11 may be placed in conductive thermal communication with the cooling back pan 22. The electronic components 10 and 11 may contain any one of the following: timing and control boards (TCON), power supplies, video cards/drivers/players, input/output interfaces, antennas, wireless receivers, modems, local electronic storage, and CPU/microprocessors.

[0015] The space between the rear pan 22 and the exemplary cooling back pan 45 defines an air gap 25. The fan 30 is positioned so as to cause a flow of ambient cooling air through the gap 25, in order to cool both the rear pan 22 and the cooling back pan 45. The fan 30 preferably draws ambient air from around the display housing, without letting the air enter other portions of the display housing, especially the portions of the cooling back pan 45 which contain the electronic components 10 and 11 (i.e. the portions sealed off between the cooling back pan 45 and the rear cover 100). In other words, the fan 30 is preferably placed in sealed gaseous communication with the surrounding ambient air and the gap 25 such that ambient air can pass through the fan 30 and gap 25 without entering the area sealed by the cooling back pan 45 and rear cover 100.

[0016] In at least one embodiment, a port 150 is provided which provides sealed gaseous communication between the ambient air surrounding the display housing and the fan 30. Once forced through the gap 25, the cooling air can exit any portion of the perimeter of the rear pan 22 and cooling back pan 45 assemblies, and eventually is exhausted out of the edges of the display housing. In other words, the gap 25 preferably extends to all four edges of the display housing and allows ambient air to enter/exit the gap 25 along all four edges of the rear pan 22 and cooling back pan 45.

[0017] **FIGURE 2** is a sectional view of the embodiment shown in Figure 1.

[0018] As can be observed, the cooling back pan 45 can be used to mount any number of specialized electrical components 10 and 11 which may be required for the end-use of any electronic display. At the same time, the cooling back pan 45 can help remove heat from the electronic components 10 and 11 as well as the rear pan 22, without exposing the sensitive components to ambient air (which may contain dirt, dust, or contaminants).

[0019] It should be noted that although a single fan 30 is shown, this is not required by any embodiment as there can be multiple fans positioned on the cooling back pan 45 in other embodiments. Also, although an exemplary embodiment uses the fan 30 to push the cooling air into the gap 25, alternative embodiments could also be used to draw air from the edges of the display housing, through the gap 25, and exhaust the air through the port 150. It should also be noted that additional fans may be positioned

within the cooling back pan 45 in order to circulate air around the interior of the cooling back pan 45, without mixing with the ambient air.

[0020] It should also be noted that it is preferable to place the fan 30 near the center of the cooling back pan 45, although this is not required. It may be preferable in some instances to place the fan 30 closer to the horizontal top edge of the cooling back pan 45 (as shown in Figure 2), as the heat generated by the display assembly tends to rise where additional flow rates of cooling air would be beneficial in this area. In most cases, if using only one fan 30, it may be preferable to place the fan near the vertically-drawn centerline of the cooling back pan 45.

[0021] As used herein, the term 'electronic display' is any electronic assembly for generating an image to a viewer. The term specifically includes, but is not limited to: liquid crystal displays (all types), OLED, light emitting diode (LED), field emitting display (FED), light emitting polymer (LEP), organic electro luminescence (OEL), plasma displays, and any other type of thin/flat panel display. In an exemplary embodiment, the electronic display 15 comprises an LED edge lit LCD display where the LED backlight is placed in conductive thermal communication with the rear pan 22. In another exemplary embodiment, the electronic display 15 comprises an LED direct backlit LCD display where the rear pan 22 is provided as the rear surface of the direct LED backlight.

[0022] Having shown and described a preferred embodiment of the invention, those skilled in the art will realize that many variations and modifications may be made to affect the described invention and still be within the scope of the claimed invention. Additionally, many of the elements indicated above may be altered or replaced by different elements which will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

CLAIMS

We claim:

1. A back pan cooling assembly for an electronic display having a rear pan, the assembly comprising:
 - a cooling back pan positioned behind the rear pan, the space between the cooling back pan and the rear pan defining a gap;
 - a fan positioned to cause a flow of ambient air through the gap; and
 - an electronic component for driving the electronic display, placed in conductive thermal communication with the cooling back pan.
2. The cooling assembly of claim 1 wherein:
 - the fan is sealed within the cooling back pan such that ambient air is not permitted to contact the electronic component.
3. The cooling assembly of claim 1 wherein:
 - the electronic display is in conductive thermal communication with the rear pan.
4. The cooling assembly of claim 1 further comprising:
 - an LED backlight within the electronic display and placed in thermal communication with the rear pan.
5. The cooling assembly of claim 1 wherein:
 - the rear pan and cooling back pan each contain four perimeter edges which are substantially aligned with one another.
6. The cooling assembly of claim 5 wherein:
 - the gap extends to all four perimeter edges of the rear pan and cooling back pan.
7. The cooling assembly of claim 5 wherein:
 - ambient air is permitted to enter the gap along all four perimeter edges.

8. The cooling assembly of claim 1 wherein:
the rear pan comprises the rear surface of a direct-lit LED backlight.
9. The cooling assembly of claim 1 further comprising:
a port in gaseous communication with the fan such that ambient air is drawn through the port and exhausted out of the gap.
10. The cooling assembly of claim 1 further comprising:
a port in gaseous communication with the fan such that ambient air is drawn through the gap and exhausted out of the port.
11. A back pan cooling assembly for an electronic display having a rear pan, the assembly comprising:
a cooling back pan positioned behind the rear pan, the space between the cooling back pan and the rear pan defining a gap;
a rear cover positioned on the cooling back pan to define a rear compartment which is sealed to prevent ambient air from entering the rear compartment;
a port which accepts ambient gas;
an open loop gaseous pathway defined by gaseous communication between the port, fan, and gap; and
a fan positioned to cause a flow of ambient air through the open loop gaseous pathway.
12. The cooling assembly of claim 11 further comprising:
an electronic component for operating the electronic display, placed within the compartment and mounted to the cooling back pan.
13. The cooling assembly of claim 11 wherein:

the rear pan and cooling back pan each contain four perimeter edges which are substantially aligned with one another.

14. The cooling assembly of claim 13 wherein:
the gap extends to all four perimeter edges of the rear pan and cooling back pan.
15. The cooling assembly of claim 11 wherein:
the fan is oriented such that ambient air is drawn through the port and exhausted out of the gap.
16. The cooling assembly of claim 11 wherein:
the fan is oriented such that ambient air is drawn through the gap and exhausted out of the port.
17. A back pan cooling assembly for an electronic display having a rear pan with a pair of vertical edges and a pair of horizontal edges, the assembly comprising:
a cooling back pan having a pair of vertical edges substantially aligned with the vertical edges of the rear pan and a pair of horizontal edges which are substantially aligned with the horizontal edges of the rear pan;
a gap defined between the cooling back pan and rear pan which extends to each horizontal edge to define a pair of horizontal edge gaps and to each vertical edge to define a pair of vertical edge gaps; and
a fan positioned to cause ambient air to flow through the vertical edge gaps and the horizontal edge gaps.
18. The cooling assembly of claim 17 wherein:
the fan is positioned near a center of the cooling back pan.
19. The cooling assembly of claim 17 further comprising:
an LED backlight within the electronic display which is placed in conductive thermal communication with the rear pan.

20. The cooling assembly of claim 17 further comprising:
- a rear cover positioned on the cooling back pan to define a rear compartment which is sealed to prevent ambient air from entering the rear compartment;
 - a port within the rear cover; and
 - an open loop gaseous pathway defined by gaseous communication between the port, fan, and the edge gaps.

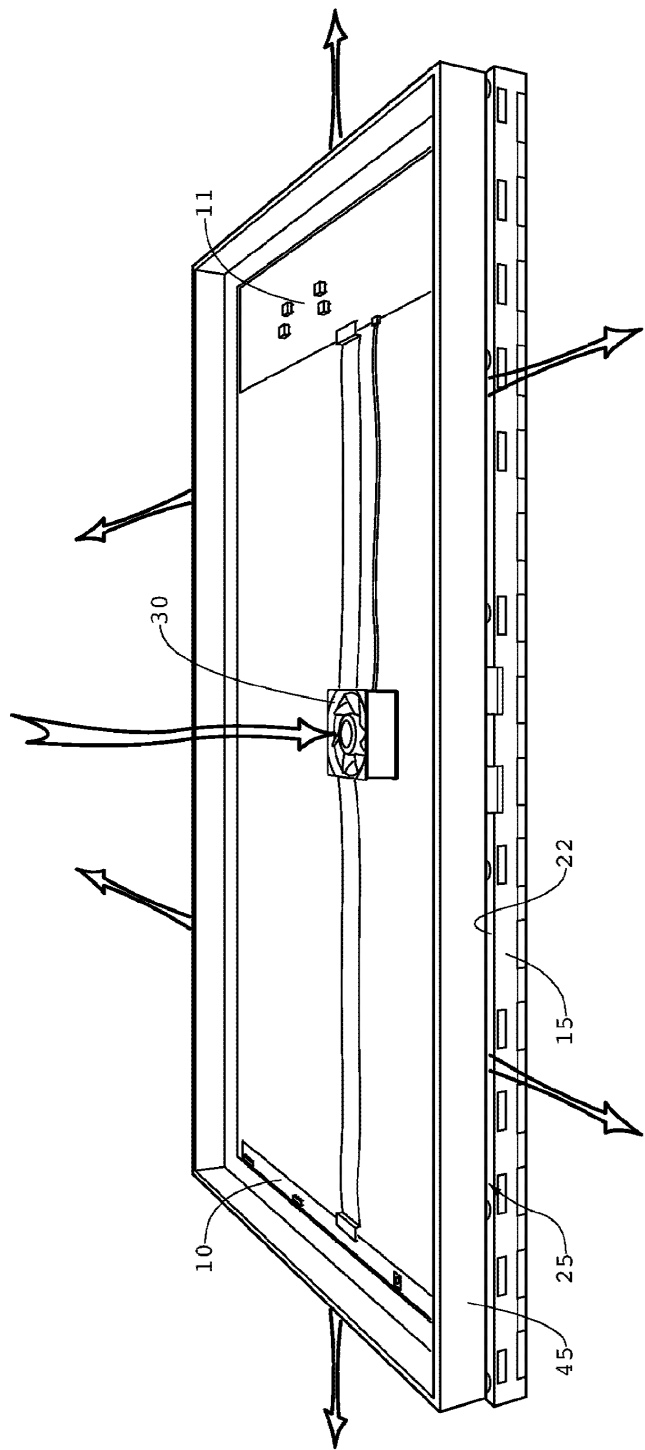


FIG. 1

1/2

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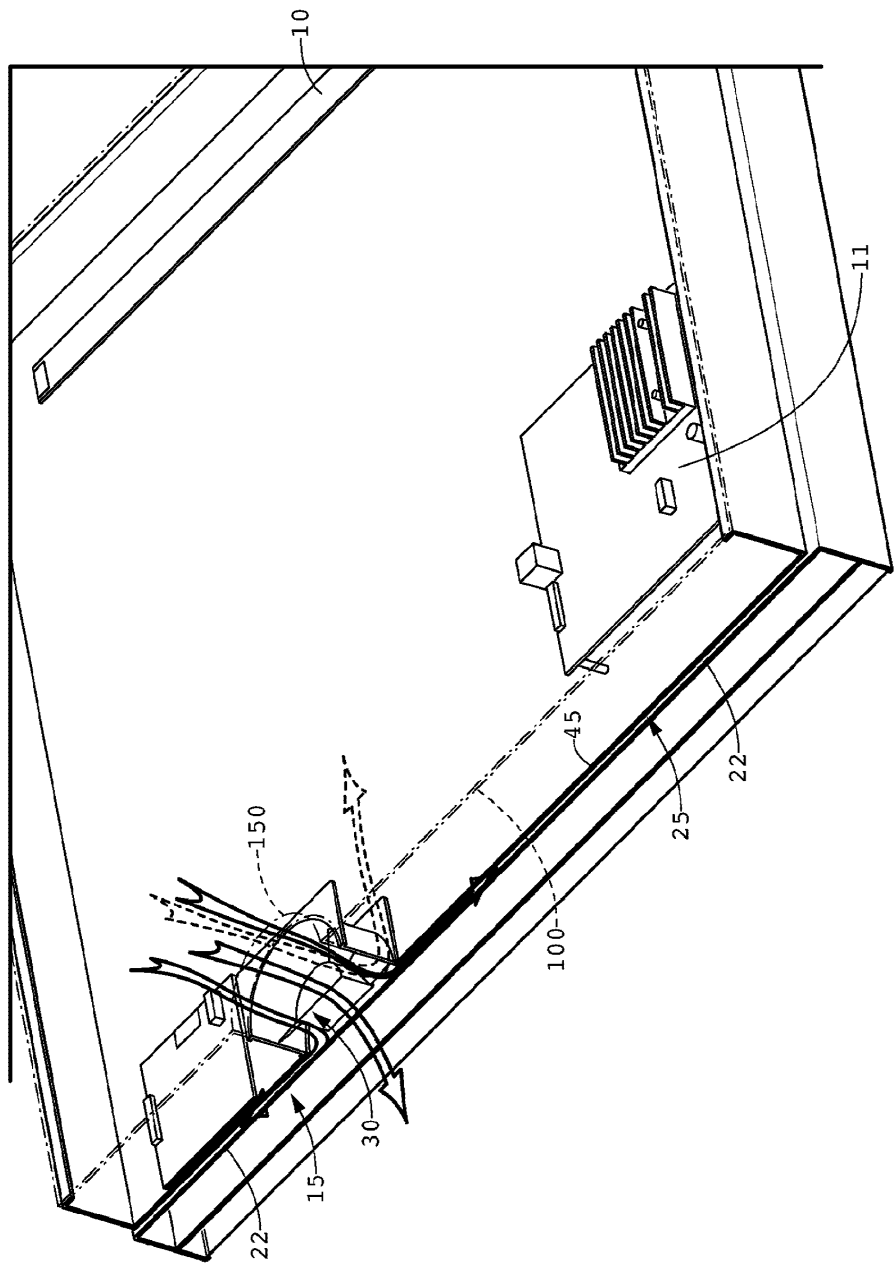


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/065264

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G09F 9/00 (2014.01)

USPC - 362/612

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - F21V 29/00; G09F 9/00; G09G 3/20, 5/00, 5/10; H01J 17/28; H05K 7/20 (2014.01)

USPC - 174/547; 345/55, 87, 204; 361/692, 695, 697; 362/97.3, 612

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

CPC - F21V 29/00; G09F 9/00; G09G 3/20, 5/00, 5/10; H01J 17/28; H05K 7/20 (2014.01)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Orbit, Google Patents, Google, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 11296094 A (IRIE et al) 29 October 1999 (29.10.1999) entire document	1, 3, 5-7, 9, 10, 17, 18
Y		2, 4, 8, 11-16, 19, 20
Y	US 2012/0020114 A1 (MIYAMOTO et al) 26 January 2012 (26.12.2012) entire document	2, 4, 8, 11-16, 19, 20
A	US 2012/0044217 A1 (OKADA et al) 23 February 2012 (23.02.2012) entire document	1-20

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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Date of mailing of the international search report

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FIGURE EIGHT CLOSED LOOP COOLING SYSTEM FOR ELECTRONIC DISPLAY

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Abstract of corresponding document: US2015009627 (A1)

The exemplary embodiments herein provide a figure eight closed loop of circulating gas pathways wrapping around an electronic display. One or more open loop ambient air pathways may pass through the figure eight but do not allow the circulating gas and the ambient air to mix. In some embodiments, the open loop ambient air pathway travels along a rear surface of the electronic display. In some embodiments, the circulating gas pathways contain a front channel placed in front of the electronic display, a rear channel placed behind the electronic display, and a center channel placed between the front and rear channels. Pass-through apertures may be placed within the path of the circulating gas and/or the ambient air to allow the paths of the two gaseous matters to cross without allowing them to mix with one another.

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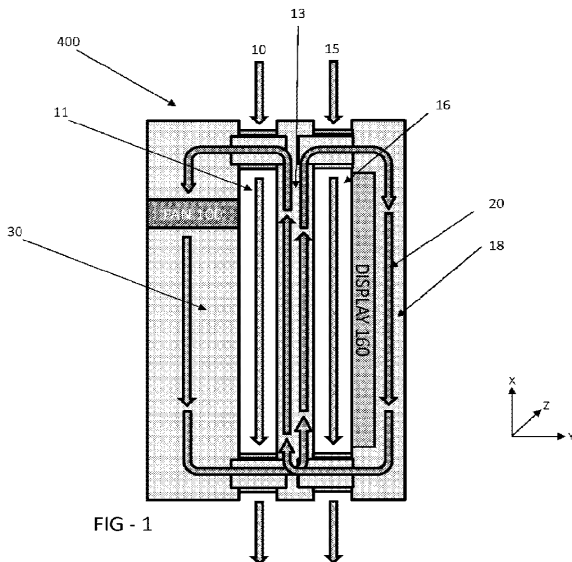
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[Continued on next page]

(54) Title: FIGURE EIGHT CLOSED LOOP COOLING SYSTEM FOR ELECTRONIC DISPLAY



(57) Abstract: The exemplary embodiments herein provide a figure eight closed loop of circulating gas pathways wrapping around an electronic display. One or more open loop ambient air pathways may pass through the figure eight but do not allow the circulating gas and the ambient air to mix. In some embodiments, the open loop ambient air pathway travels along a rear surface of the electronic display. In some embodiments, the circulating gas pathways contain a front channel placed in front of the electronic display, a rear channel placed behind the electronic display, and a center channel placed between the front and rear channels. Pass-through apertures may be placed within the path of the circulating gas and/or the ambient air to allow the paths of the two gaseous matters to cross without allowing them to mix with one another.

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FIGURE EIGHT CLOSED LOOP COOLING SYSTEM FOR ELECTRONIC DISPLAY

Inventors: William Dunn and Kevin O'Conner

Cross-Reference to Related Applications

[0001] This application claims priority to US Provisional Application No. 61/843,706 filed on July 8, 2013 which is herein incorporated by reference in its entirety.

Technical Field

[0002] Embodiments generally relate to cooling systems for electronic displays.

Background of the Art

[0003] Electronic displays are sometimes used in outdoor environments or other areas where the surrounding temperatures may be high or there may be other sources of heat such as solar loading causing the temperatures within the display to rise. However, some portions of the display can be difficult to cool as simply ingesting ambient air into some portions of the display can introduce dust and contaminants into sensitive portions of the display, which can lead to premature failures.

Summary of the Exemplary Embodiments

[0004] Exemplary embodiments provide a figure eight closed loop circulating gas path which defines a center channel for the closed loop of circulating gas. A pair of open loop ambient air channels may be placed on opposite sides of the center channel, in order to remove heat from at least the center channel and the closed loop circulating

gas. One or more open loop ambient air pathways may pass through the figure eight but do not allow the circulating gas and the ambient air to mix. In some embodiments, the open loop ambient air pathway travels along a rear surface of the electronic display. In some embodiments, the circulating gas pathways contain a front channel placed in front of the electronic display, a rear channel placed behind the electronic display, and a center channel placed between the front and rear channels. Pass-through apertures may be placed within the path of the circulating gas and/or the ambient air to allow the paths of the two gaseous matters to cross without allowing them to mix with one another.

[0005] The foregoing and other features and advantages of the present invention will be apparent from the following more detailed description of the particular embodiments, as illustrated in the accompanying drawings.

Brief Description of the Drawings

[0006] A better understanding of an exemplary embodiment will be obtained from a reading of the following detailed description and the accompanying drawings wherein identical reference characters refer to identical parts and in which:

[0007] **FIGURE 1** is a simplified illustration of an exemplary embodiment of the figure eight closed loop cooling system.

[0008] **FIGURE 2** is a side rear perspective view showing the overall assembly of the display with the rear cover removed and indicating the section line 3-3.

[0009] **FIGURE 3** is a perspective section view taken from the section line 3-3 and indicating the locations for Detail 4 and Detail 5.

- [0010] **FIGURE 4** is a detailed perspective section view of Detail 4.
- [0011] **FIGURE 5** is a detailed perspective section view of Detail 5.
- [0012] **FIGURE 6** is a bottom rear perspective view showing the overall assembly of the display and indicating the section line 7-7.
- [0013] **FIGURE 7** is a perspective section view taken from the section line 7-7.

Detailed Description

[0014] The invention is described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity.

[0015] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0016] Embodiments of the invention are described herein with reference to illustrations that are schematic illustrations of idealized embodiments (and intermediate structures) of the invention. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments of the invention should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing.

[0017] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0018] **FIGURE 1** is a simplified illustration of an exemplary embodiment of the figure eight closed loop cooling system 400. This exemplary embodiment contains a plurality of channels in the assembly. The front channel 18 is placed in front of the display 160 and preferably allows closed loop circulating gas 20 to remove heat from the front of the display 160. The front open loop channel 16 is positioned behind the display 160 and preferably allows open loop air 15 to pass behind the display 160, removing heat at least from the rear portion of the display 160 and the center channel 13. The center channel 13 is preferably positioned between the front open loop channel 16 and the rear open loop channel 11 and allows closed loop circulating gas 20 to cross paths with itself

(creating the figure eight) and to cross paths with the open loop air 10 and 15 without allowing the closed loop circulating gas and open loop air to mix.

[0019] The rear open loop channel 11 is preferably positioned immediately adjacent to the center channel 13, and allows open loop air 10 to flow through, thereby removing heat from the center channel 13 (and/or the closed loop circulating gas 13 contained within) and the rear channel 30. The rear channel 30 is positioned near the rear of the display and may contain various electronic components 35 for operating the overall display assembly, fans, or the display 160 itself.

[0020] In an exemplary embodiment, the front channel 18, center channel 13, and rear channel 30 are in sealed gaseous communication with each other. In other words, these channels do not permit closed loop circulating gas 20 to substantially escape or to allow ambient air or open loop air to enter these channels. Also in an exemplary embodiment, open loop air 10 and 15 is simply ambient air surrounding the display assembly. However, in some embodiments the open loop air 10 and 15 may be treated in some way (ex. filtered, air conditioned, or pre-cooled in some way) prior to being ingested into the display assembly. In this particular embodiment, the closed loop fan 100 is positioned within the rear channel 30, although this is not required. All that is required is that the closed loop fan 100 is positioned to force the closed loop circulating gas 20 through the front channel 18, center channel 13, and rear channel 30. The closed loop circulating gas 20 can be any gaseous matter that preferably does not contain large amounts of particulate. However, it does not have to be pure gas of any type; simple clean air works fine with the exemplary embodiments.

[0021] FIGURE 2 is a side rear perspective view showing the overall assembly of the display with the rear cover removed and indicating the section line 3-3. In this particular embodiment, the display assembly is designed for a portrait orientation with the closed loop fans 100 positioned at the top of the assembly and the open loop fans 200 positioned at the bottom of the assembly. This is of course not required however, as the embodiments herein can be flipped or oriented for a landscape orientation if desired. Further, the open loop fans 200 do not have to be placed at the bottom of the assembly, but could be positioned anywhere so that the open loop air travels in the paths specified in these exemplary embodiments. It of course goes without saying that additional fans could also be used to increase flow rates and/or pressure.

[0022] FIGURE 3 is a perspective section view taken from the section line 3-3 and indicating the locations for Detail 4 and Detail 5. Here, the front channel 18 is defined between the front transparent plate 150 and the electronic display 160. In an exemplary embodiment the electronic display 160 may be an LED backlit liquid crystal display (LCD), but this is not required. Alternative embodiments may utilize any type of flat panel electronic display, including but not limited to plasma, OLED, electroluminescent polymers, or similar. In some embodiments, the various electrical components 35 (power supplies, printed circuit boards, microprocessors, electronic storage, etc.) may be attached and in thermal communication with a plate 31 which may form the rear portion of channel 11 for open loop air 10. In this way, heat that is generated by the electrical components 35 may be transferred to the plate 31, where it can be removed by open loop air 10.

[0023] FIGURE 4 is a detailed perspective section view of Detail 4. Closed loop circulating gas 20 is permitted to pass through the rear open loop channel 11 without mixing with the open loop air 10 by use of pass-through apertures 200, which provide sealed gaseous communication between the rear channel 30 and the center channel 13, without permitting open loop air 10 to enter the channels 30 and 13. In an exemplary embodiment, rear open loop channel 11 may also contain cooling fins 400 for distributing heat from the adjacent channels (30 and 13) and/or electronic components 35 in order to be efficiently removed by the open loop air 10. Similarly, front open loop channel 16 may also contain cooling fins 450 for distributing heat from the adjacent channels (30 and 18) and/or the rear surface of the display 160 in order to be efficiently removed by the open loop air 15. In an exemplary embodiment, the display 160 contains a direct lit LED backlight where the cooling fins 450 are placed in thermal communication with the LED backlight. The cooling fins 450 and 400 may be comprised of any thermally conductive material, but would preferably be comprised of metal and in an exemplary embodiment would be a thin sheet (or multiple thin sheets) of metal.

[0024] FIGURE 5 is a detailed perspective section view of Detail 5. Closed loop circulating gas 20 is permitted to pass through the front open loop channel 16 without mixing with the open loop air 15 by use of pass-through apertures 205, which provide sealed gaseous communication between the front channel 18 and the center channel 13, without permitting open loop air 15 to enter the channels 18 and 13.

[0025] FIGURE 6 is a bottom rear perspective view showing the overall assembly of the display and indicating the section line 7-7.

[0026] **FIGURE 7** is a perspective section view taken from the section line 7-7. The center channel 13 is preferably divided into a plurality of subchannels 300 and 305. On this end of the overall assembly, subchannels 300 are in gaseous communication with the pass-through apertures 200 (which connects the subchannel 300 with the rear channel 30) while subchannels 305 are in gaseous communication with the pass-through apertures 205 (which connects the subchannel 305 with the front channel 18). However, on the opposite end of the assembly (see Figure 3) subchannels 300 are in gaseous communication with the pass-through apertures 205 (which connects the subchannel 300 with the front channel 18) while subchannels 305 are in gaseous communication with the pass-through apertures 200 (which connects the subchannel 305 with the rear channel 30). In this way, the closed loop of circulating gas 20 travels through the front channel 18, through a pass-through aperture to travel along subchannel 305, through another pass-through aperture to travel along the rear channel 30, through another pass-through aperture to travel along the subchannel 300, and finally through another pass-through aperture to return to the front channel 18. In this way, the closed loop of circulating gas 20 performs the 'figure eight' through the assembly, as it weaves its way across the front channel 18, through the center channel 13, across the rear channel 30, again through the center channel 13, and returning to the front channel 18.

[0027] It should be noted that subchannels 300 and 305 may not be required in some embodiments as the center channel 13 could be completely open. It should also be noted that other embodiments may use the subchannels 300 and 305 but would not allow a single subchannel to communicate gaseously with both the front channel 18 and

the rear channel 30. In other words, when viewing the end of the assembly as shown in Figure 7, the opposing end of the assembly would be substantially similar. Thus, subchannels 300 would only communicate with pass-through apertures 200 and the rear channel 30, while the subchannels 305 would only communicate with pass-through apertures 205 and front channel 18. Thus, in this embodiment there would be two separate closed loops.

[0028] Although there is preferably gaseous communication throughout the figure eight, subchannel 300 directs the flow of closed loop circulating gas 20 through rear channel 30 and center channel 13 while subchannel 305 directs the flow of closed loop circulating gas 20 through the center channel 13 and front channel 18. In this preferred embodiment, the subchannels 300 and 305 allow separate flow paths for closed loop circulating gas 20 within the center channel 13, without requiring additional fans. These separate flow paths which cross through the center and loop around the display in a single continuous flow, define the figure eight path for the closed loop circulating gas 20 (seen also in Figure 1). Further, in this preferred embodiment, the flow direction of closed loop circulating gas 20 through the center channel 13 is opposite the flow direction of open loop air 15 and 10, creating a counter-flow heat exchanger between the center channel 13 and the front/rear open loop channels 11 and 16. However, this is not required, as a parallel flow or a cross flow design would work as well.

[0029] In an exemplary embodiment, the rear channel 30 would share a plate with the rear open loop channel 11, such that one side of the plate would be within the rear channel 30 while the opposing side of the plate would be within the rear open loop channel 11. This arrangement is illustrated in Figure 3 with the rear plate 31. Similarly,

it may be preferable for the center channel 13 and the rear open loop 11 to share a plate, such that one side of the plate is within the center channel 13 while the other side of the plate is within the rear open loop 11. Similarly, it may be preferable for the center channel 13 and the front open loop 16 to share a plate. Finally, it may also be preferable for the rear surface of the display 160 to form the front wall of the front open loop 16, such that open loop ambient air 15 can remove heat from the electronic display 160. In some embodiments the rear surface of the display 160 would be the rear surface of a metallic PCB holding a plurality of LEDs for the backlight.

[0030] Having shown and described a preferred embodiment of the invention, those skilled in the art will realize that many variations and modifications may be made to affect the described invention and still be within the scope of the claimed invention. Additionally, many of the elements indicated above may be altered or replaced by different elements which will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

CLAIMS

We claim:

1. A cooling assembly for an electronic display comprising:
 - a figure eight closed loop of circulating gas pathways wrapping around the electronic display; and
 - an open loop ambient air pathway passing through the figure eight which does not allow circulating gas to mix with ambient gas.
2. The cooling assembly of claim 1 further comprising:
 - a front channel defined between a front surface of the electronic display and a transparent plate;
 - wherein the figure eight closed loop of circulating gas pathways includes the front channel.
3. The cooling assembly of claim 2 further comprising:
 - a rear channel containing electronic components which are mounted to a rear plate;
 - wherein the figure eight closed loop of circulating gas pathways includes the rear channel.
4. The cooling assembly of claim 3 further comprising:
 - a center channel placed between the front channel and rear channel;

wherein the figure eight closed loop of circulating gas pathways includes the center channel.

5. The cooling assembly of claim 1 wherein:

the open loop ambient air pathway travels along a rear surface of the electronic display.

6. The cooling assembly of claim 3 wherein:

the open loop ambient air pathway travels along a side of the rear plate which is opposite the side containing the electronic components.

7. The cooling assembly of claim 1 further comprising:

a plurality of pass-through apertures placed within the figure eight closed loop of circulating gas pathways.

8. The cooling assembly of claim 7 wherein:

the pass-through apertures are arranged such that the circulating gas travels through the center of the aperture while the open loop ambient air passes around the aperture.

9. The cooling assembly of claim 7 wherein:

the pass-through apertures are arranged to prevent the circulating gas from mixing with the open loop ambient air.

10. A cooling assembly for an electronic display comprising:
- a closed loop of gas pathways for circulating gas comprising
 - a front channel placed in front of the electronic display,
 - a rear channel placed behind the electronic display, and
 - a center channel placed between the front and rear channels;
 - a first open loop pathway for ambient air positioned between the electronic display and the center channel; and
 - a second open loop pathway for ambient air positioned between the center channel and the rear channel.
11. The cooling assembly of claim 10 further comprising:
- a closed loop fan positioned to force circulating gas through the closed loop of gas pathways; and
 - an open loop fan positioned to force ambient air through the first and second open loop pathways.
12. The cooling assembly of claim 10 further comprising:
- a rear plate having a posterior and anterior side and placed within the rear channel;
 - a plurality of electronic components attached to the posterior side of the rear plate; and
 - wherein the anterior side of the rear plate forms a portion of the second open loop pathway.

13. The cooling assembly of claim 10 further comprising:
a plurality of pass-through apertures positioned within the first open loop pathway.
14. The cooling assembly of claim 13 wherein:
the pass-through apertures contain a hole in the center and are arranged such that the circulating gas travels through the hole in the center while the ambient air travels around the pass-through aperture.
15. The cooling assembly of claim 10 wherein:
the second open loop pathway and the rear channel share a plate such that a side of the plate is within the rear channel while an opposing side of the plate is within the second open loop pathway.
16. The cooling assembly of claim 10 wherein:
the center channel is placed between the first and second open loop pathways.
17. A cooling assembly for an electronic display comprising:
a front channel defined by the space between a front surface of the electronic display and a transparent plate;
a first open loop pathway defined by the space between a rear surface of the electronic display and a front plate;

a rear plate positioned behind the electronic display and having a first side forming part of a rear channel and an opposing side forming part of a second open loop pathway;

a center channel placed between the first and second open loop pathways;

a closed loop fan positioned to force circulating gas through the front channel, rear channel, and center channel; and

an open loop fan positioned to force ambient air through the first and second open loop pathways.

18. The cooling assembly of claim 17 further comprising:

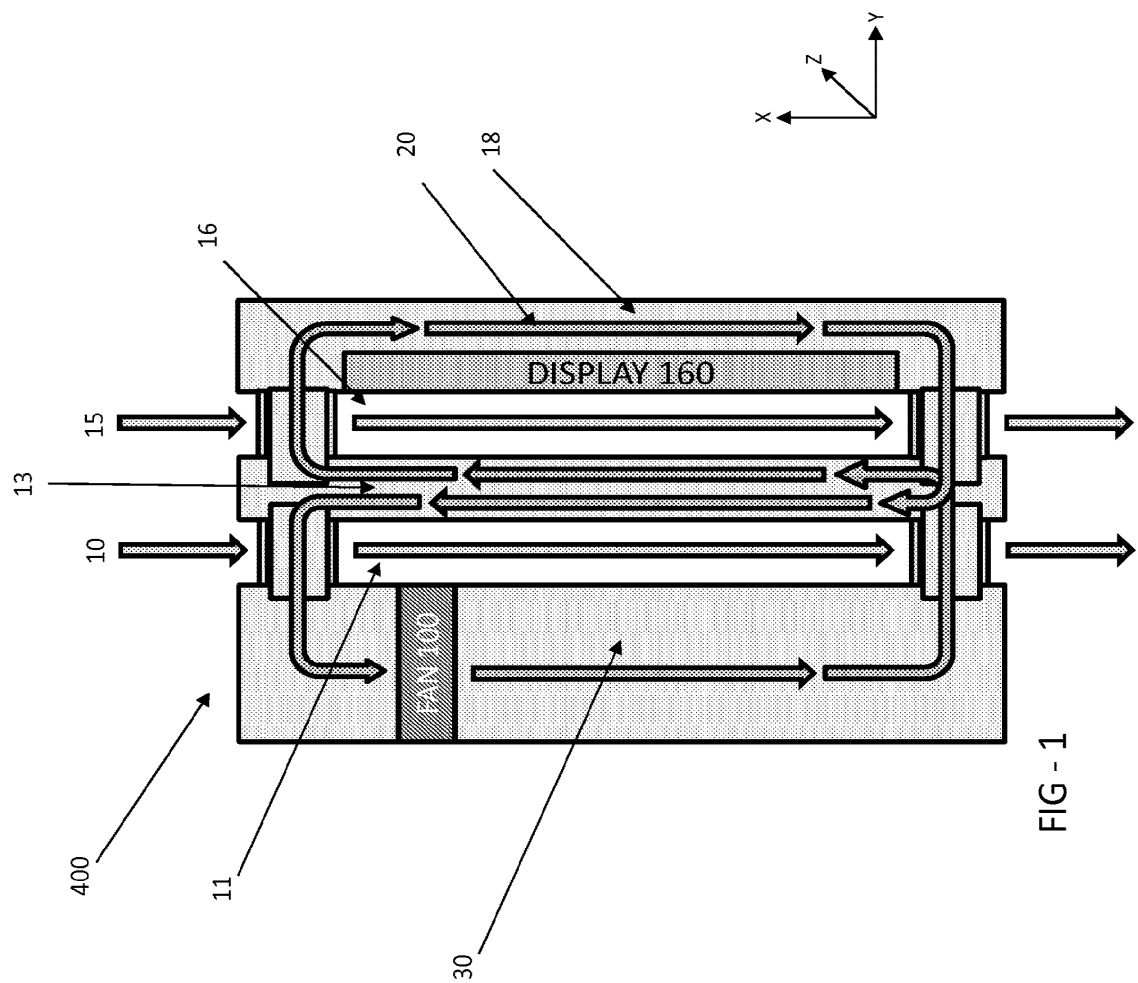
a plurality of pass-through apertures placed within the path of the circulating gas.

19. The cooling assembly of claim 17 further comprising:

a plurality of electronic components attached to the side of the rear plate forming part of the rear channel.

20. The cooling assembly of claim 17 further comprising:

a plurality of cooling fins placed within the first and second open loop pathways.



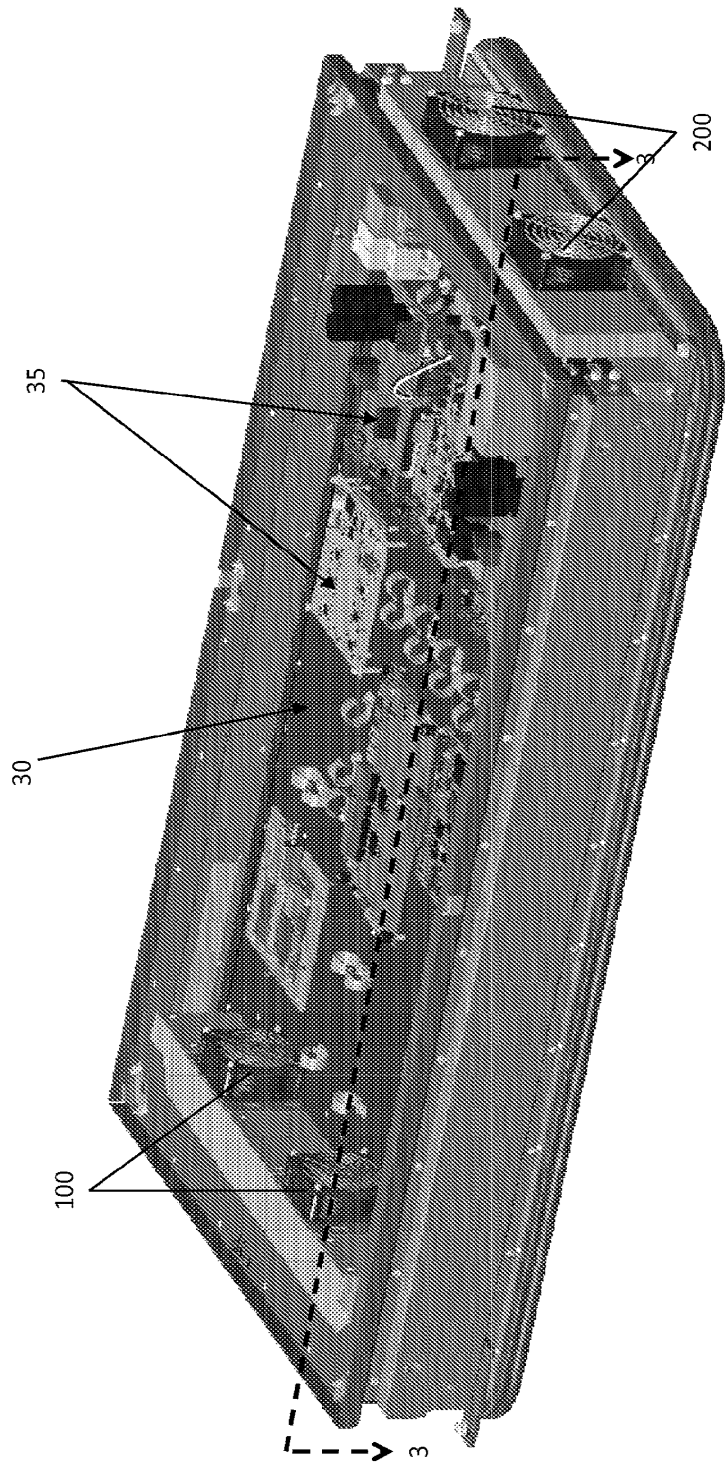


FIG - 2

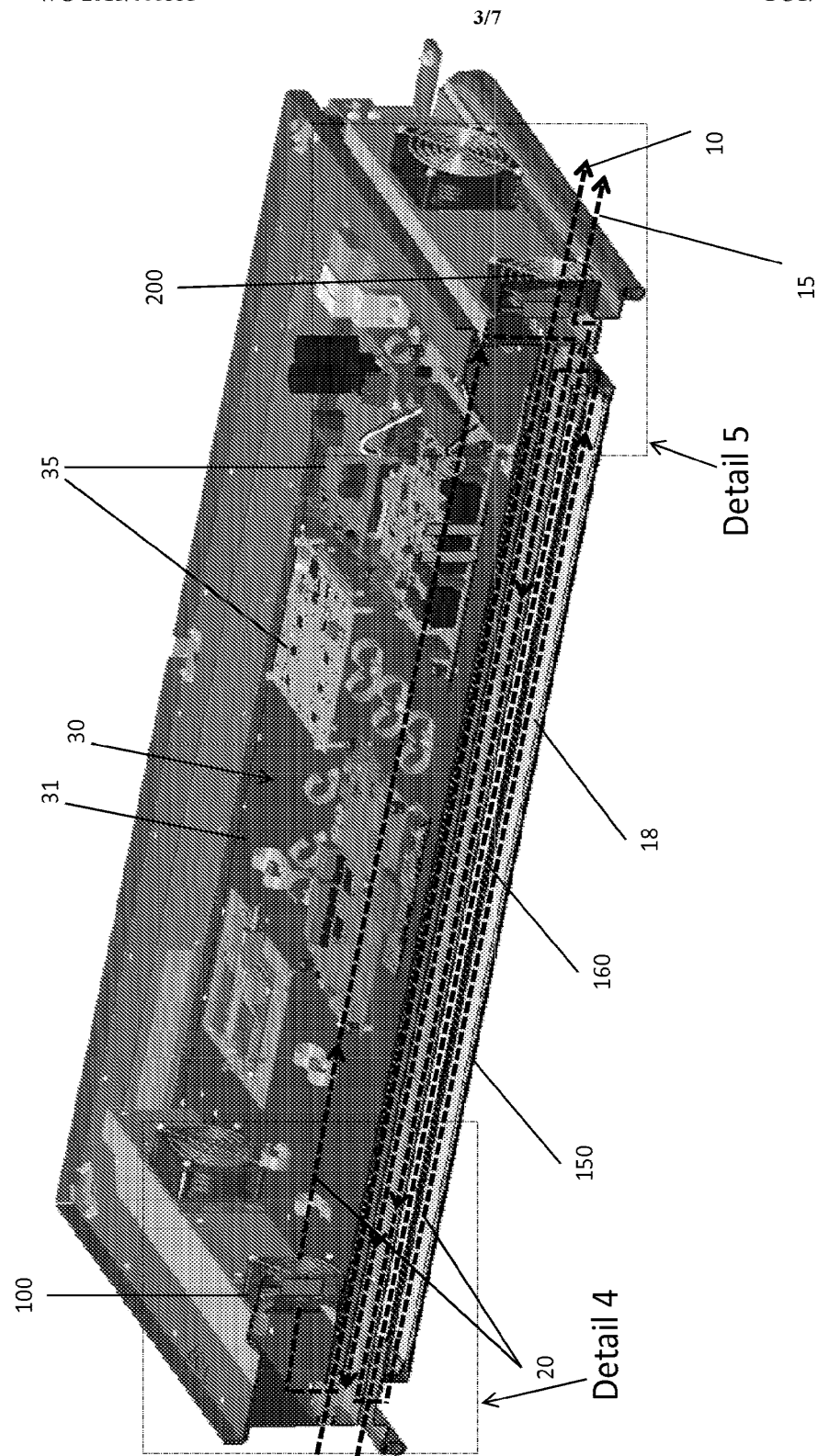


FIG - 3

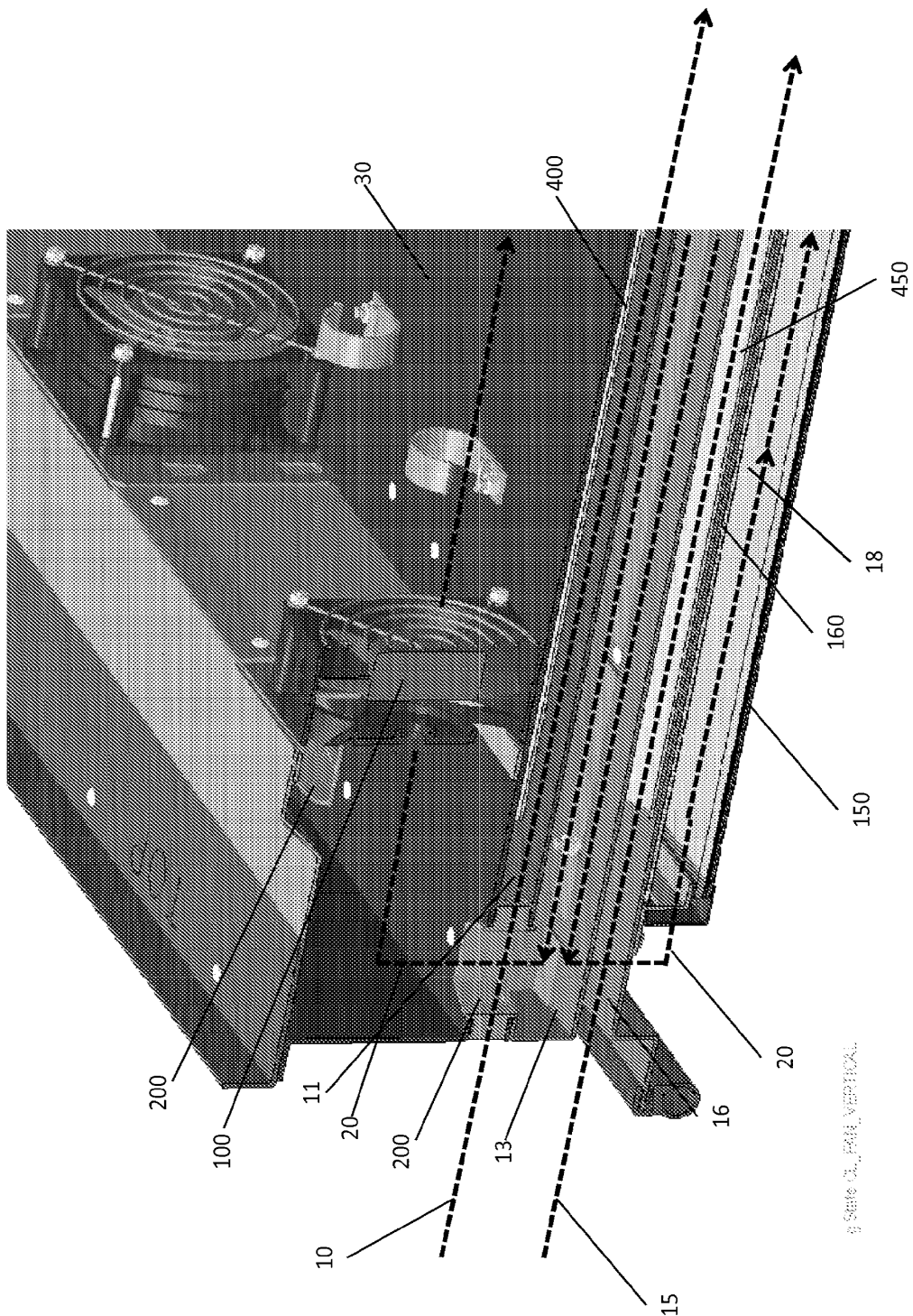


FIG - 4

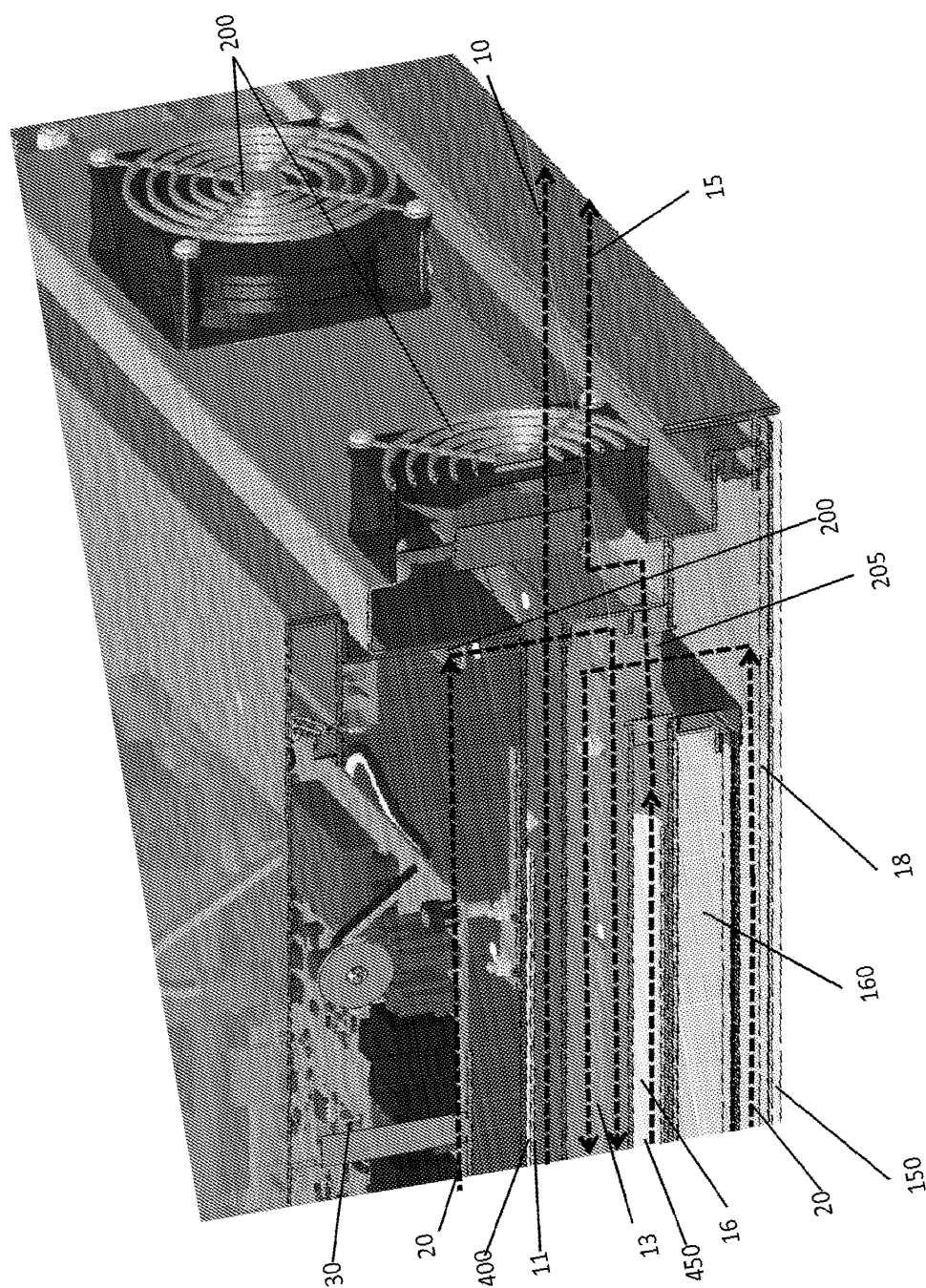


FIG - 5

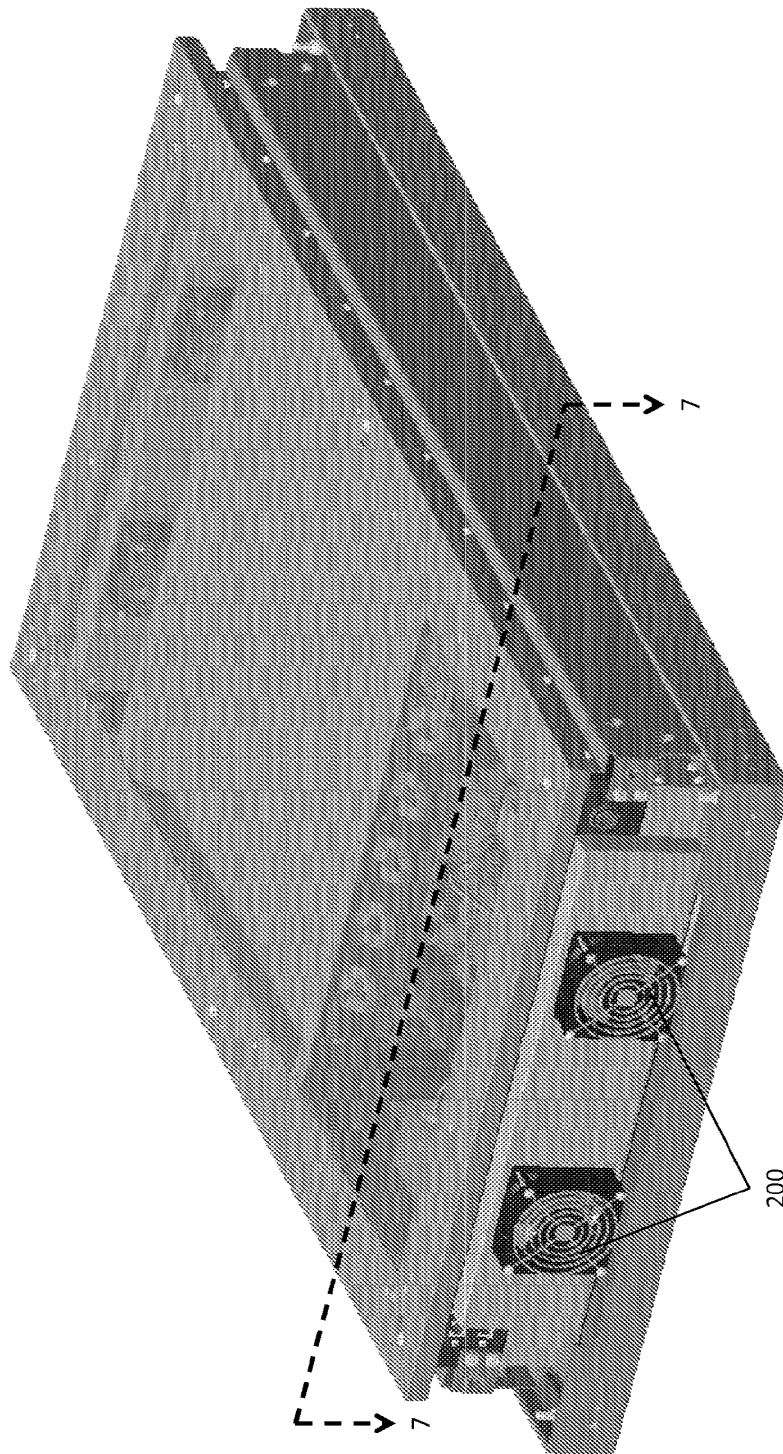


FIG - 6

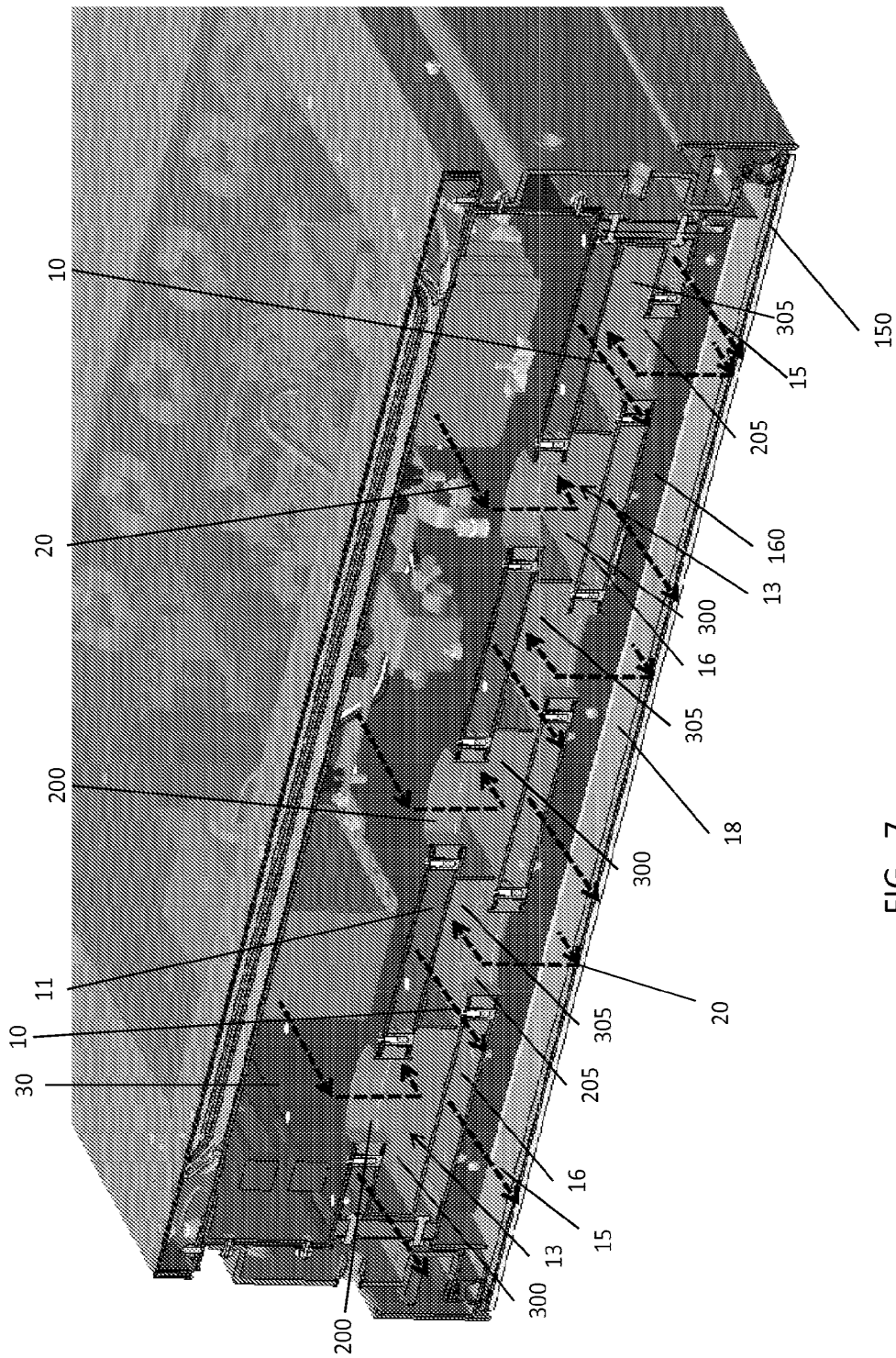


FIG - 7



Espacenet

Bibliographic data: EP3117693 (A2) — 2017-01-18

HYBRID REAR COVER AND MOUNTING BRACKET FOR ELETRONIC DISPLAY

Inventor(s): DUNN WILLIAM [US]; DIAZ MARCOS [US]; AZEVEDO KYLE [US] ± (DUNN, William, ; DIAZ, Marcos, ; AZEVEDO, Kyle)

Applicant(s): MFG RESOURCES INT INC [US] ± (Manufacturing Resources International, INC)

Classification: - international: *H05K5/00; H05K7/14; H05K7/20*
- cooperative: G02F1/133308; H04N5/64; H05K7/20972;
G02F1/133603; G02F2001/133314;
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US2015264826 (A1) US2017231112 (A1) more

Abstract not available for EP3117693 (A2)

Abstract of corresponding document: US2015264826 (A1)

A system and method for mounting an electronic display is disclosed herein. A rear cover mounting bracket may contain a rear plate and a sidewall which surrounds a perimeter of the plate. A plurality of mounting holes may be placed within the plate to allow fastening the rear plate to a vertical surface. An electronic display assembly module may contain a thermal plate where the attachment of the rear cover mounting bracket to the module creates a plenum which can house one or more electronic components. In a preferred embodiment, the rear plate contains a pair of hooks and the module contains a pair of corresponding cylinders which can be engaged with the hooks so that the module can hang from the hooks.

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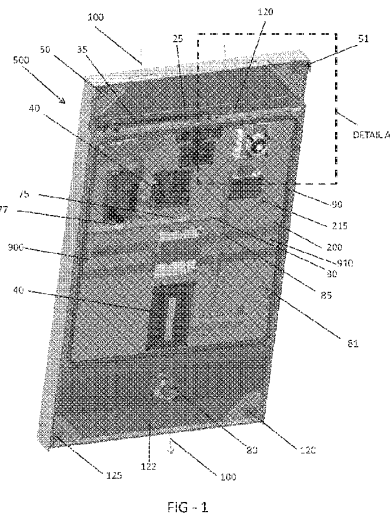
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(57) Abstract: A system and method for mounting an electronic display is disclosed herein. A rear cover mounting bracket may contain a rear plate and a sidewall which surrounds a perimeter of the plate. A plurality of mounting holes may be placed within the plate to allow fastening the rear plate to a vertical surface. An electronic display assembly module may contain a thermal plate where the attachment of the rear cover mounting bracket to the module creates a plenum which can house one or more electronic components. In a preferred embodiment, the rear plate contains a pair of hooks and the module contains a pair of corresponding cylinders which can be engaged with the hooks so that the module can hang from the hooks.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US15/19975

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B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC(8): H05K 5/00, 7/14, 7/16, 7/18, 7/20; G06F 1/20 (2015.01); CPC: H05K 7/20136, 7/20145, 7/20154, 7/20172, 7/202, 7/20954, 7/20972; G02F 1/1333, 1/133385; F28D 9/00, 9/0062; F28F 3/02; F21V 29/02 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched. Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google; Google Scholar; EBSCO; SEARCH STRINGS: ((mount* W4 bracket) OR (mount* W4 support) OR (mount* W4 plate) OR (mount* W4 frame) OR bracket OR support OR plate OR frame) AND ((electronic W4 display W4 assembly) OR monitor OR tv OR television OR (video W4 screen)) AND (thermal W4		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 5,748,269 A (HARRIS, D. et al.) May 05, 1998; figures 1-3, 4B, 5 and 6; column 3, lines 14-18, 37-38, 53-59; column 4, lines 33-37; column 5, lines 15-40; column 6, lines 21-31	1-6 — 7-9, 11, 14, 15
X — Y	US 2013/0270975 A1 (MANUFACTURING RESOURCES INTERNATIONAL, INC.) October 17, 2013; figures 1-4; paragraphs [0016], [0018], [0020] and [0023]	10, 12, 13, 16-20 — 7-9, 11, 14, 15
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 24 May 2015 (24.05.2015)		Date of mailing of the international search report 02 SEP 2015
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300		Authorized officer: Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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SEC et al. v. MRI
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DISPLAY APPARATUS

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Classification: - international: **F21S2/00; F21V29/00; G02F1/13; G02F1/133;
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G09G3/34; G09G3/36**

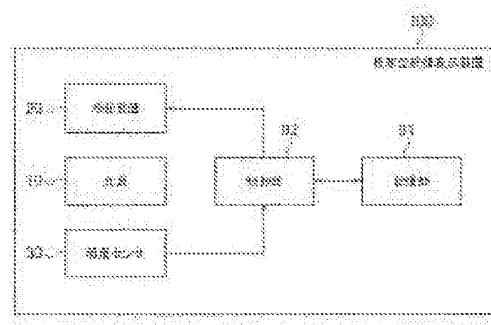
- cooperative:

Application number: JP20060152475 20060531 Global Dossier

Priority number (s): JP20060152475 20060531

Abstract of JP2007322718 (A)

PROBLEM TO BE SOLVED: To provide a display device capable of optimizing the environment temperature of each light source while saving power of the display device. ;SOLUTION: The projection type display apparatus 100 having a plurality of LEDs 10 includes: a plurality of cooling devices 20 provided for the corresponding LEDs 10 and used for adjusting the environment temperatures of the LEDs 10; an illuminance sensor 30 for detecting the state of each LED 10; and a control section 92 used for comparing the state of each LED 10 detected by the illuminance sensor 30 with a target state determined for each LED 10 and then controlling each of the cooling devices 20 based on the result of the comparison between the state of the corresponding LED 10 and its target state. The control section 92 controls the cooling devices 20 while maintaining the total consumption power of the cooling devices 20 at the maximum power consumption level for an adjustment section or below. ;COPYRIGHT: (C) 2008,JPO&INPIT

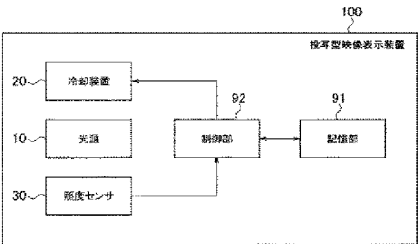


(51) Int. Cl.	F 1	テーマコード (参考)
G03B 21/16 (2006.01)	G03B 21/16	2H088
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審査請求 有 請求項の数 6 O L (全 15 頁) 最終頁に続く		

(21) 出願番号 (22) 出願日	特願2006-152475 (P2006-152475) 平成18年5月31日 (2006. 5. 31)	(71) 出願人 000001889 三洋電機株式会社 大阪府守口市京阪本通2丁目5番5号 (74) 代理人 100133514 弁理士 寺山 啓進 (74) 代理人 100122910 弁理士 三好 広之 (72) 発明者 井上 益孝 大阪府守口市京阪本通2丁目5番5号 三洋電機株式会社内 (72) 発明者 近藤 信幸 大阪府守口市京阪本通2丁目5番5号 三洋電機株式会社内
		最終頁に続く

(54) 【発明の名称】 表示装置

(57) 【要約】
【課題】表示装置の省電力化を図りながら、各光源の環境温度を最適化することを可能とする表示装置を提供する。
【解決手段】複数のLED10を有する投写型表示装置100が、LED10毎に設けられており、LED10の環境温度を調節する複数の冷却装置20と、LED10の状態をLED10毎に検出する照度センサ30と、照度センサ30によって検出されたLED10の状態とLED10毎に定められた目標状態とを比較して、LED10の状態と目標状態とを比較した結果に基づいて、複数の冷却装置20をそれぞれ制御する制御部92とを備え、制御部92が、複数の冷却装置20の消費電力の合計を調節部最大消費電力以下に保ちながら冷却装置20を制御する。
【選択図】 図3



【特許請求の範囲】

【請求項1】

複数の光源を有する表示装置であって、
前記光源毎に設けられており、前記光源の環境温度を調節する複数の温度調節部と、
前記光源の状態を前記光源毎に検出する状態検出部と、
前記状態検出部によって検出された前記光源の状態と前記光源毎に定められた目標状態とを比較して、前記光源の状態と前記目標状態とを比較した結果に基づいて、前記複数の温度調節部をそれぞれ制御する制御部とを備え、
前記制御部は、前記複数の温度調節部の消費電力の合計を調節部最大消費電力以下に保ちながら、前記温度調節部を制御することを特徴とする表示装置。

【請求項2】

前記制御部は、前記複数の光源の照度の比率を一定比率に保ちながら、前記温度調節部を制御することを特徴とする請求項1に記載の表示装置。

【請求項3】

前記制御部は、前記光源の状態が前記目標状態に達せずに、前記複数の温度調節部の消費電力の合計が前記調節部最大消費電力を超えた場合に、前記複数の光源の照度の比率を一定比率に保ちながら、前記温度調節部を制御することを特徴とする請求項1に記載の表示装置。

【請求項4】

前記制御部は、
前記温度調節部に加えて、前記複数の光源をそれぞれ制御しており、
前記複数の温度調節部の消費電力及び前記複数の光源の消費電力の合計を最大消費電力以下に保ちながら、前記温度調節部及び前記光源を制御することを特徴とする請求項1に記載の表示装置。

【請求項5】

前記温度調節部は、前記光源の環境温度を液体の流量によって調節しており、
前記制御部は、前記液体の流量を制御することを特徴とする請求項1に記載の表示装置。

【請求項6】

前記光源の状態は、前記光源の照度又は前記光源の環境温度であることを特徴とする請求項1に記載の表示装置。

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、複数の光源を有する表示装置に関する。

【背景技術】

【0002】

従来、複数の光源（例えば、赤色、緑色及び青色の光源）を有する表示装置が一般的に広く知られている。なお、表示装置とは、LCDディスプレイ、リアプロジェクションテレビ、プロジェクタなどである。

【0003】

また、光源の環境温度が高くなると、光源の照度や寿命が劣化するため、このような表示装置には、光源を冷却する冷却装置が設けられている（例えば、特許文献1）。

【0004】

表示装置に設けられる冷却装置としては、各光源に対する冷却能力が一律に同じである冷却装置が挙げられる。このような冷却装置によれば、冷却能力の制御を一元化することができるため、冷却能力の制御が容易である。一方で、各光源の照度や寿命に対して環境温度が与える影響は光源の種類（色など）によって異なるため、各光源の環境温度を個別に最適化することが好ましい。

【0005】

また、各光源の照度や寿命などを光源毎に考慮して、各光源に対する冷却能力が個別に制御される冷却装置も提案されている。このような冷却装置によれば、各光源に対する冷却能力が個別に制御されるため、各光源の環境温度を個別に最適化することができる。

【特許文献1】特開2005-149943号公報（請求項1、図1など）

【発明の開示】

【発明が解決しようとする課題】

【0006】

ところで、近年では、地球温暖化などの問題に対応するために、装置の省電力化が叫ばれている。これに伴って、上述した表示装置でも省電力化を図りたいという要望が高まっている。

【0007】

ここで、各光源に対する冷却能力が個別に制御される冷却装置では、冷却装置の全体に係る冷却能力は、光源毎に個別に制御される冷却能力の合計である。従って、冷却装置を有する表示装置の設置場所が高温となれば、各光源に対応する冷却能力がそれぞれ強化されるため、冷却装置の全体に係る冷却能力も強化される。すなわち、冷却装置を有する表示装置の設置場所が高温となった場合には、冷却装置の全体に係る消費電力が増加する。

【0008】

このように、各光源に対する冷却能力を個別に最適化しようとすると、表示装置（冷却装置）の全体に係る消費電力が増加してしまう場合があった。すなわち、各光源の環境温度の最適化のみを考慮すると、表示装置の省電力化を図ることができない場合があった。

【0009】

そこで、本発明は、上述した課題を解決するためになされたものであり、表示装置の省電力化を図りながら、各光源の環境温度を最適化することを可能とする表示装置を提供することを目的とする。

【課題を解決するための手段】

【0010】

本発明の一の特徴は、複数の光源（LED10）を有する表示装置（投写型表示装置100）が、前記光源毎に設けられており、前記光源の環境温度を調節する複数の温度調節部（冷却装置20）と、前記光源の状態を前記光源毎に検出する状態検出部（照度センサ30）と、前記状態検出部によって検出された前記光源の状態と前記光源毎に定められた目標状態とを比較して、前記光源の状態と前記目標状態とを比較した結果に基づいて、前記複数の温度調節部をそれぞれ制御する制御部（制御部92）とを備え、前記制御部が、前記複数の温度調節部の消費電力の合計を調節部最大消費電力以下に保ちながら、前記温度調節部を制御することを要旨とする。

【0011】

かかる特徴によれば、制御部が、複数の温度調節部の消費電力の合計を調節部最大消費電力以下に保ちながら温度調節部を制御することによって、表示装置の設置場所が高温となった場合などに、表示装置の消費電力が無制限に増加することを抑制することができる。また、制御部が複数の温度調節部を個別に制御することによって、光源の環境温度を個別に最適化することができる。

【0012】

本発明の一の特徴は、本発明の上述した特徴において、前記制御部が、前記複数の光源の照度の比率（ホワイトバランス）を一定比率に保ちながら、前記温度調節部を制御することを要旨とする。

【0013】

本発明の一の特徴は、本発明の上述した特徴において、前記制御部が、前記光源の状態が前記目標状態に達せずに、前記複数の温度調節部の消費電力の合計が前記調節部最大消費電力を超えた場合に、前記複数の光源の照度の比率（ホワイトバランス）を一定比率に保ちながら、前記温度調節部を制御することを要旨とする。

【0014】

本発明の一の特徴は、本発明の上述した特徴において、前記制御部が、前記温度調節部に加えて、前記複数の光源をそれぞれ制御しており、前記複数の温度調節部の消費電力及び前記複数の光源の消費電力の合計を最大消費電力以下に保ちながら、前記温度調節部及び前記光源を制御することを要旨とする。

【0015】

本発明の一の特徴は、本発明の上述した特徴において、前記温度調節部が、前記光源の環境温度を液体の流量によって調節しており、前記制御部が、前記液体の流量を制御することを要旨とする。

【0016】

本発明の一の特徴は、本発明の上述した特徴において、前記光源の状態が、前記光源の照度又は前記光源の環境温度であることを要旨とする。

【発明の効果】

【0017】

本発明によれば、表示装置の省電力化を図りながら、各光源の環境温度を最適化することを可能とする表示装置を提供することができる。

【発明を実施するための最良の形態】

【0018】

以下において、本発明の実施形態について図面を参照しながら説明する。なお、以下の図面の記載において、同一又は類似の部分には、同一又は類似の符号を付している。ただし、図面は模式的なものであることに留意すべきである。

【0019】

ただし、図面は模式的なものであり、各寸法の比率などは現実のものとは異なることに留意すべきである。従って、具体的な寸法などは以下の説明を参酌して判断すべきである。また、図面相互間においても互いの寸法の関係や比率が異なる部分が含まれていることは勿論である。

【0020】

〔第1実施形態〕

（投写型表示装置の構成）

以下において、本発明の第1実施形態に係る投写型表示装置の構成について、図面を参照しながら説明する。図1及び図2は、本発明の第1実施形態に係る投写型表示装置100を示す図である。図1に示すように、投写型表示装置100は、投写レンズ80を有しており、投写レンズ80によって拡大された像をスクリーン200上に投写する。

【0021】

図2に示すように、投写型表示装置100は、複数のLED10と、複数の冷却装置20と、複数の照度センサ30と、複数のテーパロッド40と、複数の導光部材50と、複数の液晶パネル60と、ダイクロイックプリズム70と、投写レンズ80とを有する。

【0022】

LED10は、各色の光を発する光源（LED10r、LED10g及びLED10b）である。なお、LED10の照度（輝度）は、LED10の環境温度に依存する。

【0023】

冷却装置20は、LED10毎に設けられており、各LED10の環境温度を個別に調節する冷却装置（冷却装置20r、冷却装置20g及び冷却装置20b）である。具体的には、冷却装置20は、液冷や空冷などの方法で各LED10の環境温度を下げる装置であり、制御部（図2では、不図示）によって個別に制御される。また、各冷却装置20の冷却能力を上げようとすると、冷却装置20が消費する消費電力が大きくなる。

【0024】

例えば、液冷に係る冷却装置20で冷却能力を上げるためには、液体の流量を増やす必要がある。また、液体の流量を増やすためにポンプの駆動力を上げる必要があるため、冷却装置20の消費電力が大きくなる。一方、空冷に係る冷却装置20で冷却能力を上げるためには、空気の流量を増やす必要がある。また、空気の流量を増やすためにファンの駆

動力を上げる必要があるため、冷却装置 20 の消費電力が大きくなる。

【0025】

なお、冷却装置 20 は、液冷や空冷に係る装置だけではなくて、ベルチェ素子などであってもよい。

【0026】

照度センサ 30 は、LED 10 が発する光の照度（輝度）を LED 10 毎に検出するセンサ（照度センサ 30 r、照度センサ 30 g 及び照度センサ 30 b）である。なお、照度センサ 30 が配置される位置は、LED 10 が発する光の照度が検出可能であれば、どこに配置されてもよいことは勿論である。

【0027】

テーパーロッド 40 は、各 LED 10 が発する光を導光部材 50 側に導くロッド（テーパーロッド 40 r、テーパーロッド 40 g 及びテーパーロッド 40 b）であり、テーパー形状を有している。

【0028】

導光部材 50 は、各 LED 10 が発する光を液晶パネル 60 側に導く部材（導光部材 50 r、導光部材 50 g 及び導光部材 50 b）であり、角柱状の形状を有している。

【0029】

液晶パネル 60 は、各 LED 10 が発する光を変調する光変調素子（液晶パネル 60 r、液晶パネル 60 g 及び液晶パネル 60 b）である。

【0030】

ダイクロイックプリズム 70 は、各液晶パネル 60 から出射された光を合成して、合成された光を投写レンズ 80 側に射出する。

【0031】

投写レンズ 80 は、ダイクロイックプリズム 70 から出射された光を拡大して、スクリーン 200 上に映像を投写する。

【0032】

（投写型表示装置の機能ブロック）

以下において、本発明の第 1 実施形態に係る投写型表示装置の機能ブロックについて、図面を参照しながら説明する。図 3 は、本発明の第 1 実施形態に係る投写型表示装置 100 の機能ブロックを示す図である。なお、図 3 では、本発明について明確に説明するために、投写型表示装置 100 の構成の一部が省略されている点に留意すべきである。

【0033】

図 3 に示すように、投写型表示装置 100 は、上述した構成に加えて、記憶部 91 と、制御部 92 とを有する。

【0034】

記憶部 91 は、LED 10 毎に定められた各 LED 10 の照度の目標照度を記憶している。ここで、目標照度は、LED 10 毎に定められた照度の絶対値である。また、記憶部 91 は、各 LED 10 の照度の比率に係る目標比率（ホワイトバランス）を記憶する。なお、ホワイトバランスは、LED 10 毎に定められた目標照度の比率によって算出されてもよい。

【0035】

さらに、記憶部 91 は、各冷却装置 20 の消費電力の合計に対して許容可能な最大消費電力を記憶している。なお、記憶部 91 は、最大消費電力に代えて、各冷却装置 20 の冷却能力の合計に対して許容可能な最大冷却能力を記憶していてもよい。

【0036】

制御部 92 は、各冷却装置 20（冷却装置 20 r、冷却装置 20 g、冷却装置 20 b）、各照度センサ 30（照度センサ 30 r、照度センサ 30 g 及び照度センサ 30 b）及び記憶部 91 に接続されている。また、制御部 92 は、各冷却装置 20 に供給される電流を制御することによって、各冷却装置 20 の冷却能力を制御する。

【0037】

具体的には、制御部92は、各照度センサ30から取得する検出照度と記憶部91に記憶された目標照度とを比較して、検出照度が目標照度に達していないLED10に対応する冷却装置20の冷却能力を強化する。

【0038】

また、制御部92は、各冷却装置20の消費電力の合計を記憶部91に記憶された最大消費電力以下に保ちながら、各冷却装置20に供給する電流（冷却能力）を制御する。

【0039】

例えば、制御部92は、LED10の照度を目標照度に近づけるために、各冷却装置20の冷却能力を強化しようとする。各冷却装置20の消費電力の合計が最大消費電力を超えてしまう場合には、記憶部91に記憶されたホワイトバランスを保ちながら、冷却装置20に供給する電流（冷却能力）を最適化する。すなわち、制御部92は、LED10の照度が目標照度となるまで冷却装置20の冷却能力を強化せずに、最大消費電力を超えない範囲内でホワイトバランスを保ちながら冷却装置20を最適に制御する。

【0040】

（照度制御の一例）

以下において、本発明の第1実施形態に係る照度制御の一例について、図面を参照しながら説明する。図4及び図5は、本発明の第1実施形態に係る照度制御の一例について説明するための図である。

【0041】

最初に、LED10の環境温度に応じて、LED10の照度が変化する例について、図4を参照しながら説明する。なお、図4において、縦軸はLED10の照度であり、横軸はLED10に供給される電流である。

【0042】

図4に示すように、電流－照度特性は、LED10の環境温度が低くなること（冷却能力を強化すること）によって向上し、LED10の環境温度が高くなること（冷却能力を緩和すること）によって低下する。例えば、LED10に供給される電流が I_0 であり、目標照度が L_0 である場合を例に挙げると、検出照度が L_1 である場合には、冷却能力を強化することによってLED10の照度を目標照度（ L_0 ）とすることができる。一方、検出照度が L_2 である場合には、冷却能力を緩和することによってLED10の照度を目標照度（ L_0 ）とすることができる。

【0043】

次に、検出照度と目標照度とを比較して、冷却装置20の冷却能力を制御する例について、図5を参照しながら説明する。なお、図5（a）は、記憶部91に記憶された目標照度の一例を示しており、図5（b）は、照度センサ30によって検出された検出照度の一例を示している。

【0044】

このような場合には、制御部92は、検出照度と目標照度との差分比率に応じて、各冷却装置20の冷却能力を以下のように割り当てる。具体的には、LED10rの差分比率（ R_w ）は、 $R_w = (30 - 20) / 30 = 0.33$ である。同様に、LED10gの差分比率（ G_w ）は、 $G_w = (60 - 50) / 60 = 0.17$ であり、LED10bの差分比率（ B_w ）は、 $B_w = (10 - 10) / 10 = 0$ である。

【0045】

続いて、冷却装置20rに割り当てられる冷却能力の割合（ R ）は、 $R = R_w / (R_w + G_w + B_w) = 0.33 / (0.33 + 0.17 + 0) = 0.66$ となる。同様に、冷却装置20gに割り当てられる冷却能力の割合（ G ）は、 $G = G_w / (R_w + G_w + B_w) = 0.17 / (0.33 + 0.17 + 0) = 0.34$ となり、冷却装置20bに割り当てられる冷却能力の割合（ B ）は、 $B = B_w / (R_w + G_w + B_w) = 0 / (0.33 + 0.17 + 0) = 0$ となる。

【0046】

なお、制御部92は、算出された割合（割合（ R ）、割合（ G ）及び割合（ B ））に応

じて、複数の冷却装置20の全体に許容される最大冷却能力を各冷却装置20に割り当てる。

【0047】

このように、制御部92が、検出照度と目標照度との差分比率に応じて各冷却装置20に冷却能力を割り当てることによって、各冷却装置20の冷却能力（消費電力）の合計が最大冷却能力（最大消費電力）を超えずに、ホワイトバランスを維持することができる。

【0048】

（投写型表示装置の動作）

以下において、本発明の第1実施形態に係る投写型表示装置の動作について、図面を参照しながら説明する。図6は、本発明の第1実施形態に係る投写型表示装置100の動作を示すフロー図である。

【0049】

図6に示すように、ステップ10において、投写型表示装置100は、LED10毎にLED10の照度を検出する。

【0050】

ステップ20において、投写型表示装置100は、ステップ10で検出された検出照度と記憶部91に記憶された目標照度と比較する。

【0051】

ステップ30において、投写型表示装置100は、検出照度が目標照度と一致するか否かをLED10毎に判定する。また、投写型表示装置100は、全てのLED10について検出照度が目標照度と一致する場合には、一連の処理を終了する。一方、投写型表示装置100は、検出照度が目標照度と一致しないLED10がある場合には、ステップ40の処理に移る。

【0052】

ステップ40において、投写型表示装置100は、各LED10の照度を目標照度と一致させるために必要な各冷却装置20の消費電力を見積もる。

【0053】

ステップ50において、投写型表示装置100は、ステップ40で見積もられた消費電力の合計（消費電力見積）が最大消費電力を超えるか否かを判定する。また、投写型表示装置100は、消費電力見積が最大消費電力を超える場合には、ステップ70の処理に移り、消費電力見積が最大消費電力以下である場合には、ステップ60の処理に移る。

【0054】

ステップ60において、投写型表示装置100は、各LED10の照度を目標照度と一致させるために、各冷却装置20に供給すべき電流を個別に決定する。具体的には、投写型表示装置100は、検出照度と目標照度との差分比率に応じて、低下させる必要がある温度を算出し、算出した温度だけLED10の環境温度を低下させるために必要な電流を決定する。

【0055】

ステップ70において、投写型表示装置100は、ホワイトバランスを維持しながら、各冷却装置20に供給すべき電流（各冷却装置20に割り当てるべき冷却能力）を決定する。具体的には、投写型表示装置100は、検出照度と目標照度との差分比率に応じて、冷却装置20に供給すべき電流（冷却装置20に割り当てるべき冷却能力）を決定する。

【0056】

ステップ80において、投写型表示装置100は、ステップ60又はステップ70で決定された電流（冷却能力）に従って冷却装置20を個別に制御する。

【0057】

なお、投写型表示装置100は、ステップ80の処理が終了すると、再びステップ10の処理に戻って、ステップ10～ステップ80をループ処理することによって、LED10の環境温度を最適化する。

【0058】

(作用及び効果)

本発明の第1実施形態に係る投写型表示装置100によれば、制御部92が、複数の冷却装置20の消費電力の合計を最大消費電力以下に保ちながら冷却装置20を制御することによって、投写型表示装置100の設置場所が高温となった場合などに、投写型表示装置100の消費電力が無制限に増加することを抑制することができる。また、制御部92が複数の冷却装置20を個別に制御することによって、LED10の環境温度を個別に最適化することができる。

【0059】

また、本発明の第1実施形態に係る投写型表示装置100によれば、制御部92は、LED10の照度を目標照度と一致させようとする、各冷却装置20の消費電力の合計が最大消費電力を超えてしまう場合に、LED10の照度が目標照度と一致するまで冷却装置20の冷却能力を強化せずに、ホワイトバランスを保ちながら冷却装置20を制御する。従って、投写型表示装置100の消費電力が無制限に増加することなく、LED10の照度を最適化することができる。

【0060】

〔第2実施形態〕

以下において、本発明の第2実施形態について説明する。なお、以下においては、上述した第1実施形態と第2実施形態との相違点について主として説明する。

【0061】

具体的には、上述した第1実施形態では、投写型表示装置100は、冷却装置20に供給される電流（冷却能力）のみについて制御する。これに対して、第2実施形態では、投写型表示装置100は、冷却装置20に供給される電流（冷却能力）に加えて、LED10に供給される電流を制御する。

【0062】

(投写型表示装置の機能ブロック)

以下において、本発明の第2実施形態に係る投写型表示装置の機能ブロックについて、図面を参照しながら説明する。図7は、本発明の第2実施形態に係る投写型表示装置100の機能ブロックを示す図である。なお、図7では、上述した図3と同一の構成については同一の符号を付している。また、図7では、上述した図3と同様に、投写型表示装置100の構成の一部が省略されている点に留意すべきである。

【0063】

図7に示すように、投写型表示装置100は、LED10と、冷却装置20と、照度センサ30と、記憶部91と、制御部92とを有する。

【0064】

記憶部91は、各冷却装置20の消費電力及び各LED10の消費電力の合計に対する最大消費電力（冷却装置＋光源）を記憶している。また、記憶部91は、LED10に供給することが許容される電流の最大定格をLED10毎に記憶している。

【0065】

制御部92は、冷却装置20、照度センサ30及び記憶部91に加えて、LED10にも接続されており、各冷却装置20に供給する電流（冷却能力）に加えて、各LED10に供給する電流を制御する。また、制御部92は、各冷却装置20の消費電力及び各LED10の消費電力の合計を記憶部91に記憶された最大消費電力（冷却装置＋光源）以下に保つとともに、各LED10に供給される電流を記憶部91に記憶された最大定格以下に保ちながら、各冷却装置20に供給する電流及び各LED10に供給する電流を制御する。

【0066】

具体的には、制御部92は、冷却装置20に供給する電流を増やすことによってLED10の照度が向上する割合（以下、冷却装置電流制御効率）と、LED10に供給する電流を増やすことによってLED10の照度が向上する割合（以下、光源電流制御効率）とを比較する。

【0067】

また、制御部92は、光源電流制御効率が冷却装置電流制御効率よりも高い場合には、各LED10に供給する電流を各冷却装置20に供給する電流よりも優先して制御する。一方、制御部92は、光源電流制御効率が冷却装置電流制御効率以下である場合には、各冷却装置20に供給する電流を各LED10に供給する電流よりも優先して制御する。

【0068】

(照度制御の一例)

以下において、本発明の第2実施形態に係る照度制御の一例について、図面を参照しながら説明する。図8及び図9は、本発明の第2実施形態に係る照度制御の一例について説明するための図である。

【0069】

最初に、冷却装置電流制御効率について図8(a)及び図8(b)を参照しながら説明する。なお、図8(a)において、縦軸はLED10の照度であり、横軸はLED10の環境温度である。また、図8(b)において、縦軸はLED10の環境温度あり、横軸は冷却装置20に供給される電流であり、 T_a は投写型表示装置100の外気温である。

【0070】

図8(a)に示すように、LED10の照度は、LED10の環境温度が上がるに従って低下する。例えば、LED10の環境温度が T_2 である場合には、LED10の照度は L_2 であり、LED10の環境温度が T_1 である場合には、LED10の照度は L_1 である。

【0071】

なお、目標照度が L_0 である場合を例に挙げると、LED10の照度が L_2 である場合には、LED10の環境温度を上げることによってLED10の照度を下げることが可能である。一方、LED10の照度が L_1 である場合には、LED10の環境温度を下げることによってLED10の照度を上げることが可能である。

【0072】

一方、図8(b)に示すように、冷却装置20に供給される電流(冷却装置20の消費電力)を増やすことによってLED10の環境温度が低下する割合(以下、環境温度低下割合)は、LED10の環境温度が外気温(T_a)に近づくに従って小さくなる。例えば、環境温度が T_3 である場合には環境温度低下割合が高いが、環境温度が T_4 である場合には環境温度低下割合が非常に低い。

【0073】

図8(a)及び図8(b)に示したように、LED10の環境温度が外気温(T_a)に近づくに従って環境温度低下割合が小さくなるため、冷却装置20に供給される電流(冷却装置20の消費電力)を増やしても、LED10の照度を上げることが難しくなる。すなわち、冷却装置電流制御効率は、LED10の環境温度が外気温(T_a)に近づくに従って小さくなる。

【0074】

次に、光源電流制御効率について図9を参照しながら説明する。なお、図9において、縦軸はLED10の照度であり、横軸はLED10に供給される電流である。

【0075】

図9に示すように、LED10の照度は、LED10に供給される電流(LED10の消費電力)が増えるに従って上昇する。例えば、LED10の照度が目標照度(L_0)である場合を例に挙げると、LED10に供給される電流は I_0 であるが、LED10に供給される電流を最大定格(I_{MAX})まで上げると、LED10の照度は L_{MAX} まで上昇する。

このように、LED10の消費電力が最大定格(I_{MAX})を超えない範囲内であれば、LED10の照度を上げることが可能である。

【0076】

図8及び図9を参照しながら説明したように、冷却装置電流制御効率は、外気温(T_a)

) と L E D 1 0 の環境温度との温度差によって制約を受け、光源電流制御効率、各 L E D 1 0 の最大定格によって制約を受ける。

【0077】

(投写型表示装置の動作)

以下において、本発明の第2実施形態に係る投写型表示装置の動作について、図面を参照しながら説明する。図10は、本発明の第2実施形態に係る投写型表示装置100の動作を示すフロー図である。なお、図10において、ステップ10～ステップ70の処理は、上述した図6と同様であるため、その説明については省略する。

【0078】

図10に示すように、ステップ110において、投写型表示装置100は、光源電流制御効率が冷却装置電流制御効率よりも高いか否かを判定する。また、投写型表示装置100は、光源電流制御効率が冷却装置電流制御効率よりも高い場合には、ステップ120の処理に移り、光源電流制御効率が冷却装置電流制御効率以下である場合には、ステップ40の処理に移る。

【0079】

なお、ステップ110は、ステップ30で検出照度が目標照度と一致しない L E D 1 0 があると判定された場合に行われる処理である。

【0080】

ステップ120において、投写型表示装置100は、 L E D 1 0 の照度を目標照度と一致させるために、 L E D 1 0 に供給すべき電流を見積もる。具体的には、投写型表示装置100は、照度センサ30によって検出された検出照度と記憶部91に記憶された目標照度との差分に基づいて、 L E D 1 0 に供給すべき電流を見積もる。

【0081】

ステップ130において、投写型表示装置100は、ステップ120で見積もられた電流（供給電流見積）が最大定格を超えるか否かを L E D 1 0 毎に判定する。また、投写型表示装置100は、供給電流見積が最大定格を超える L E D 1 0 がある場合には、ステップ40の処理に移り、供給電流見積が最大定格を超える L E D 1 0 がいない場合には、ステップ140の処理に移る。

【0082】

ステップ140において、投写型表示装置100は、各 L E D 1 0 の照度を目標照度と一致させるために、各 L E D 1 0 に供給すべき電流を個別に決定する。具体的には、投写型表示装置100は、検出温度と目標温度との差分に応じて、 L E D 1 0 に供給すべき電流を決定する。

【0083】

ステップ80aにおいて、投写型表示装置100は、ステップ60、ステップ70又はステップ130で決定された供給電流に従って、 L E D 1 0 又は冷却装置20を個別に制御する。

【0084】

なお、投写型表示装置100は、ステップ80の処理が終了すると、再びステップ10の処理に戻って、ステップ10～ステップ80をループ処理することによって、 L E D 1 0 の環境温度を最適化する。

【0085】

このように、投写型表示装置100がステップ10～ステップ80をループ処理することによって、 L E D 1 0 に供給する電流を増やすことに起因して L E D 1 0 の環境温度が増加しても、 L E D 1 0 の環境温度が最適化される。

【0086】

(作用及び効果)

本発明の第2実施形態に係る投写型表示装置100によれば、制御部92は、各冷却装置20に供給される電流だけでなく、 L E D 1 0 に供給される電流を制御する。また、制御部92は、複数の L E D 1 0 及び複数の冷却装置20の消費電力の合計が最大消費電

力（光源＋冷却装置）を超えない範囲内で、LED 10及び冷却装置20を制御する。従って、LED 10の環境温度が外気温（ T_a ）に近づいて冷却装置電流制御効率が低下する場合であっても、LED 10の照度を効率的に高めることができる。その結果、投写型表示装置100の消費電力の増加を抑制することができる。

【0087】

〔その他の実施形態〕

本発明は上述した実施形態によって説明したが、この開示の一部をなす論述及び図面は、この発明を限定するものであると理解すべきではない。この開示から当業者には様々な代替実施形態、実施例及び運用技術が明らかとなろう。

【0088】

例えば、上述した第1実施形態及び第2実施形態では、表示装置が投写型表示装置100であるものとして説明したが、これに限定されるものではない。具体的には、表示装置は、複数の光源を有する表示装置であればよく、LCDディスプレイ、プロジェクタ、リアプロジェクションテレビなどであってもよい。

【0089】

また、上述した第1実施形態及び第2実施形態では、光源の状態を検出する状態検出部が照度センサ30であるものとして説明したが、これに限定されるものではない。具体的には、状態検出部は、光源の環境温度を検出する温度センサであってもよい。

【0090】

なお、状態検出部が温度センサである場合には、制御部92は、光源の照度ではなくて、光源の環境温度を用いて、冷却装置20やLED 10に供給される電流を制御する。

【0091】

さらに、上述した第1実施形態及び第2実施形態では、光源がLED 10であるものとして説明したが、これに限定されるものではない。具体的には、光源が温度依存性を有していれば、本発明を適用可能であり、光源は、レーザダイオードなどであってもよい。

【0092】

また、上述した第1実施形態及び第2実施形態では、温度調節部がLED 10の環境温度を下げる冷却装置20であるものとして説明したが、これに限定されるものではない。例えば、温度調節部は、LED 10の環境温度を下げるとともに、LED 10の環境温度を上げることも可能な装置であってもよい。

【0093】

さらに、上述した第1実施形態及び第2実施形態では特に触れていないが、制御部92は、LED 10の経時劣化を考慮して、冷却装置20やLED 10に供給される電流を制御してもよい。

【0094】

また、上述した第2実施形態では、制御部92は、LED 10に供給される電流の見積（供給電流見積）が最大定格を超える場合には、LED 10に供給される電流を制御せずに、冷却装置20に供給される電流を制御するが、これに限定されるものではない。具体的には、制御部92は、供給電流見積が最大定格を超える場合であっても、最大定格内でLED 10に供給される電流を制御するとともに、冷却装置20に供給される電流を制御することによって、各LED 10の照度の向上を図ってもよい。

【図面の簡単な説明】

【0095】

【図1】本発明の第1実施形態に係る投写型表示装置100を示す図である（その1）。

【図2】本発明の第1実施形態に係る投写型表示装置100を示す図である（その2）。

【図3】本発明の第1実施形態に係る投写型表示装置100の機能ブロックを示す図である。

【図4】本発明の第1実施形態に係る照度制御の一例について説明するための図である（その1）。

【図5】本発明の第1実施形態に係る照度制御の一例について説明するための図である（

その２）。

【図6】本発明の第１実施形態に係る投写型表示装置１００の動作を示すフロー図である。

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【図7】本発明の第２実施形態に係る投写型表示装置１００の機能ブロックを示す図である。

【図8】本発明の第２実施形態に係る照度制御の一例について説明するための図である（その１）。

【図9】本発明の第２実施形態に係る照度制御の一例について説明するための図である（その２）。

【図10】本発明の第２実施形態に係る投写型表示装置１００の動作を示すフロー図である。

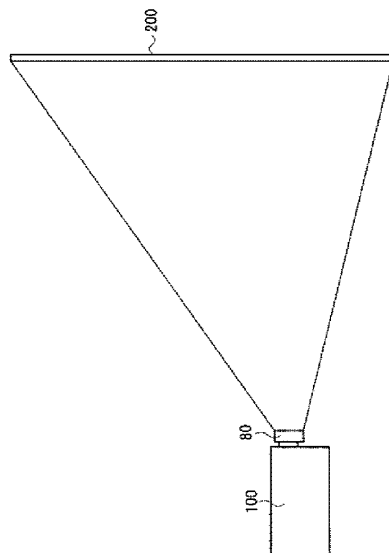
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【符号の説明】

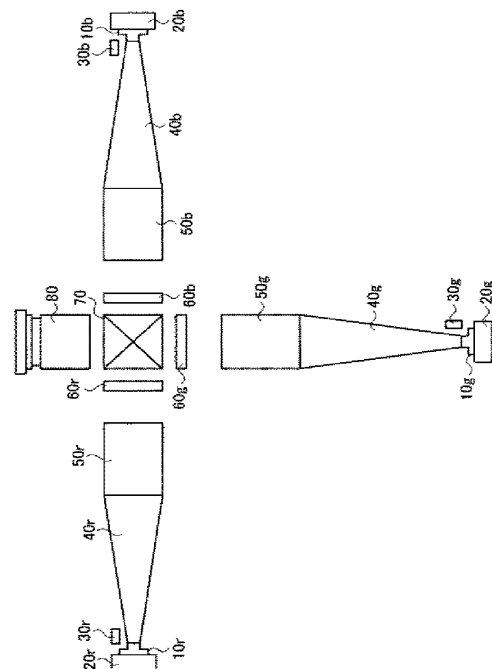
【0096】

LED 10、冷却装置 20、照度センサ 30、テーパロッド 40、導光部材 50、液晶パネル 60、ダイクロイックプリズム 70、投写レンズ 80、記憶部 91、制御部 92、投写型表示装置 100、スクリーン 200

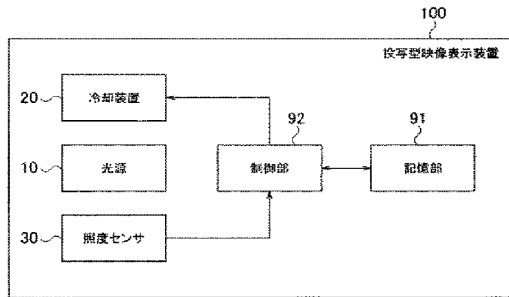
【図1】



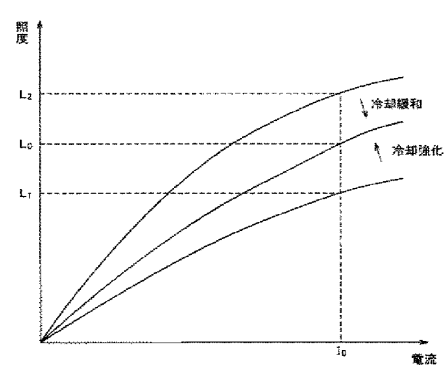
【図2】



【図3】



【図4】



【図5】

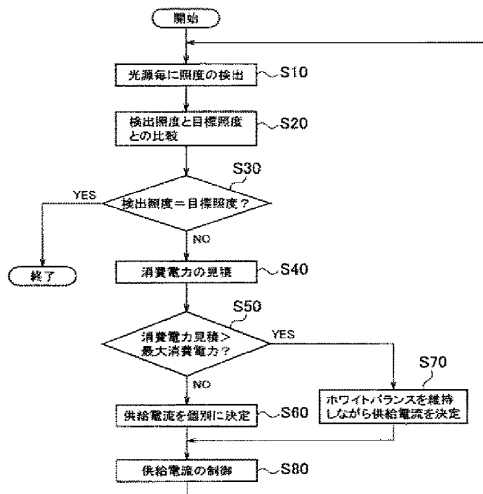
(a)

R	G	B
30	60	10

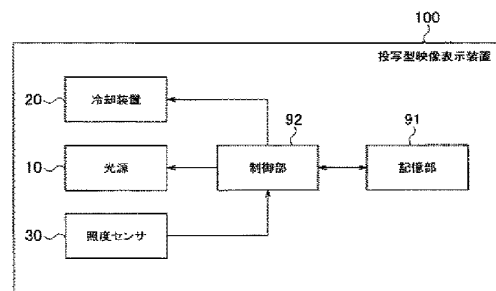
(b)

R	G	B
20	50	10

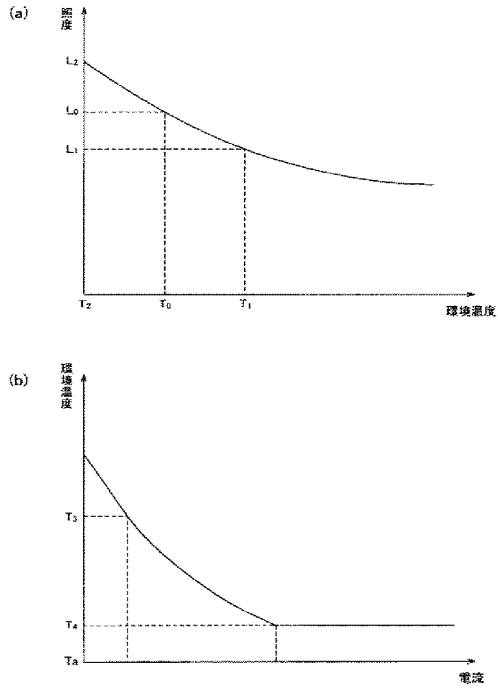
【図6】



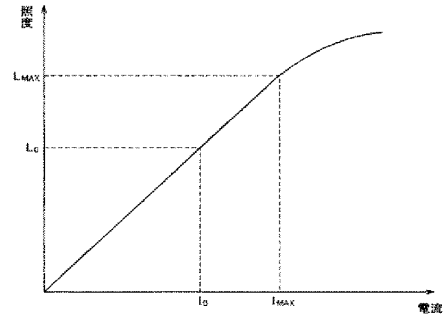
【図7】



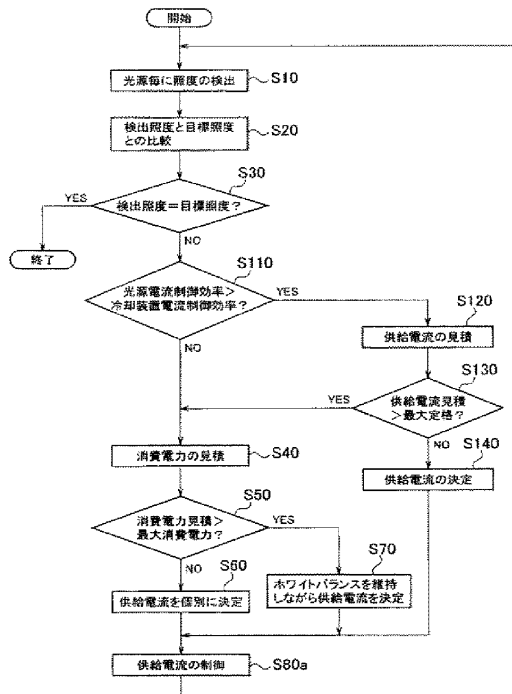
【図8】



【図9】



【図10】



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 5C006 AA22 AF13 AF52 AF62 AF63 AF69 AF78 BF14 BF36 BF38
 BF39 EA01 EC11 FA19 FA33 FA47 FA54
 5C080 AA07 AA10 BB05 CC03 DD04 DD20 DD26 DD29 EE28 GG12
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COOLING DEVICE OF HYBRID-TYPE

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Applicant(s):

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 - cooperative: F28D15/0233; F28D15/0266; F28D15/046; H01L23/427; F28F2210/02; F28F2245/02; H01L2924/0002 more

Application number: JP20040567181 20031028 [Global Dossier](#)

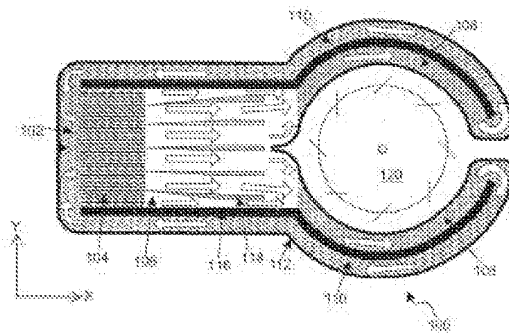
Priority number (s): [KR20030004932 20030124](#) ; [WO2003KR02282 20031028](#)

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F 2 8 D 15/02 1 0 1 L

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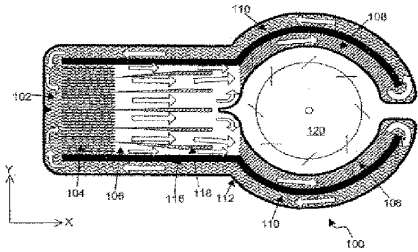
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(54) 【発明の名称】 ハイブリッド型の冷却装置

(57) 【要約】

【課題】 ハイブリッド型の冷却装置を提供する。

【解決手段】 相変化による冷却と、送風及び対流による冷却とが何れも可能なハイブリッド型の冷却装置である。



【特許請求の範囲】

【請求項1】

外部の熱源からの熱を冷却させるためのハイブリッド型の冷却装置において、
内部に相変化する冷媒の循環ループが形成されるが、その一側に分岐部を備える相変化冷却器と、

前記相変化冷却器の分岐部に設置されたファンと、を備えるが、

前記相変化冷却器は、

その内部の一端に形成されるが、前記液状の冷媒が毛細管現象によって少なくとも一部に充填され、充填された液状の冷媒が外部の熱源から伝えられた熱によって気化される蒸発部と、

前記蒸発部と隣接して形成されるが、気化された冷媒が前記分岐部に向って移動する気状冷媒移動部と、

前記分岐部の少なくとも一部の領域であって、前記気状冷媒移動部と隣接した領域に形成されるが、少なくとも二段に分岐され、前記気状の冷媒が液状に凝縮される凝縮部と、

前記分岐部の少なくとも一部の領域であって、前記凝縮部に隣接した領域に形成されるが、前記蒸発部と断熱され、液状に凝縮された冷媒が前記蒸発部に向って移動する液状冷媒移動部と、

前記蒸発部と前記液状冷媒移動部の少なくとも一部を断熱させる断熱部と、を備えることを特徴とするハイブリッド型の冷却装置。

【請求項2】

前記液状冷媒移動部の少なくとも一部は、前記液状の冷媒が保存される冷媒保存部であることを特徴とする請求項1に記載のハイブリッド型の冷却装置。

【請求項3】

前記気状冷媒移動部と前記液状冷媒移動部は、前記断熱部により互いに分離されたことを特徴とする請求項1に記載のハイブリッド型の冷却装置。

【請求項4】

前記液状冷媒移動部は、液状の冷媒と前記液状冷媒移動部の内壁との間の表面張力が重力より大きく設定された少なくとも一つの微細チャンネルを備えることを特徴とする請求項1に記載のハイブリッド型の冷却装置。

【請求項5】

前記気状冷媒移動部には、気状の冷媒を前記凝縮部に移動させるための複数のガイドを備えることを特徴とする請求項1に記載のハイブリッド型の冷却装置。

【請求項6】

前記相変化冷却器の外側において、前記凝縮部に対応する領域に形成された複数のフィンをも更に備えることを特徴とする請求項1に記載のハイブリッド型の冷却装置。

【請求項7】

前記複数のフィンのうち、少なくとも一部は、X-Y平面での断面が曲線状に形成されたことを特徴とする請求項6に記載のハイブリッド型の冷却装置。

【請求項8】

少なくとも一つの前記相変化冷却器をも更に備えるが、前記相変化冷却器の相互間に少なくとも前記蒸発部を共有することを特徴とする請求項1に記載のハイブリッド型の冷却装置。

【請求項9】

前記蒸発部の所定位置から上下に分岐が形成され、前記共有された蒸発部で気化された気体が、前記複数の相変化冷却器のそれぞれに分岐されて移動できる冷媒流路をも更に備えることを特徴とする請求項8に記載のハイブリッド型の冷却装置。

【請求項10】

前記気状冷媒移動部の所定位置から上下に分岐が形成され、前記共有された蒸発部で気化された気体が、前記複数の相変化冷却器のそれぞれに分岐されて移動できる冷媒流路を

更に備えることを特徴とする請求項8に記載のハイブリッド型の冷却装置。

【請求項11】

少なくとも一つの前記相変化冷却器を更に備えるが、前記相変化冷却器のそれぞれの蒸発部が熱的に接触したことを特徴とする請求項1に記載のハイブリッド型の冷却装置。

【請求項12】

前記分岐部の終端は、相互間に連結されて一つの閉環を形成することを特徴とする請求項1に記載のハイブリッド型の冷却装置。

【請求項13】

外部の熱源からの熱を冷却させるためのハイブリッド型の冷却装置において、
内部に相変化する冷媒の循環ループが形成されるが、その一側に少なくとも二段の分岐部が形成された相変化冷却器と、
前記相変化冷却器の分岐部に設置されたファンと、を備えるが、
前記相変化冷却器は、
その内部の前記分岐部に隣接した領域に形成されるが、前記液状の冷媒が毛細管現象によって少なくとも一部に充填され、充填された液状の冷媒が外部の熱源から伝えられた熱によって気化される蒸発部と、
前記蒸発部と隣接して形成されるが、気化された冷媒が前記分岐部の逆方向に向かって移動する気状冷媒移動部と、
前記分岐部に形成されるが、前記気状の冷媒が流入されて液状に凝縮される凝縮部と、
前記凝縮部に隣接して形成されるが、前記液状に凝縮された冷媒が前記蒸発部に向かって移動する液状冷媒移動部と、を備えることを特徴とするハイブリッド型の冷却装置。

【請求項14】

前記液状冷媒移動部の少なくとも一部は、前記液状の冷媒が保存される冷媒保存部であることを特徴とする請求項13に記載のハイブリッド型の冷却装置。

【請求項15】

前記液状冷媒移動部は、液状の冷媒と前記液状冷媒移動部の内壁との間の表面張力が重力より大きく設定された少なくとも一つの微細チャンネルを備えることを特徴とする請求項13に記載のハイブリッド型の冷却装置。

【請求項16】

前記気状冷媒移動部には、気状の冷媒を前記凝縮部に移動させるための複数のガイドを備えることを特徴とする請求項13に記載のハイブリッド型の冷却装置。

【請求項17】

前記相変化冷却器の外側において、前記凝縮部に対応する領域に形成された複数のフィンを更に備えることを特徴とする請求項13に記載のハイブリッド型の冷却装置。

【請求項18】

前記複数のフィンのうち、少なくとも一部は、X-Y平面での断面が曲線状に形成されたことを特徴とする請求項17に記載のハイブリッド型の冷却装置。

【請求項19】

少なくとも一つの前記相変化冷却器を更に備えるが、前記相変化冷却器の相互間に少なくとも前記蒸発部を共有することを特徴とする請求項13に記載のハイブリッド型の冷却装置。

【請求項20】

前記蒸発部の所定位置から上下に分岐が形成され、前記共有された蒸発部で気化された気体が、前記複数の相変化冷却器のそれぞれに分岐されて移動できる冷媒流路を更に備えることを特徴とする請求項19に記載のハイブリッド型の冷却装置。

【請求項21】

前記気状冷媒移動部の所定位置から上下に分岐が形成され、前記共有された蒸発部で気化された気体が、前記複数の相変化冷却器のそれぞれに分岐されて移動できる冷媒流路を更に備えることを特徴とする請求項19に記載のハイブリッド型の冷却装置。

【請求項22】

少なくとも一つの前記相変化冷却器を更に備えるが、前記相変化冷却器のそれぞれの蒸発部が熱的に接触したことを特徴とする請求項13に記載のハイブリッド型の冷却装置。

【請求項23】

前記分岐部の終端は、相互間に連結されて一つの閉環を形成することを特徴とする請求項13に記載のハイブリッド型の冷却装置。

【請求項24】

外部の熱源からの熱を冷却させるためのハイブリッド型の冷却装置において、

(イ) 内部に相変化する冷媒の循環ループが形成されるが、

(イ-1) その内部の一端に形成されるが、前記液状の冷媒が毛細管現象によって少なくとも一部に充填され、充填された液状の冷媒が外部の熱源から伝えられた熱によって気化される蒸発部と、

(イ-2) 前記蒸発部と隣接して形成されるが、気化された冷媒がその圧力差によって所定方向に移動する気状冷媒移動部と、

(イ-3) 少なくとも前記気状冷媒移動部と隣接した領域であって、前記蒸発部の反対側に形成されるが、前記気状の冷媒が一側に流入されて凝縮され、凝縮された液状の冷媒が所定方向に移動して他端に流出され、中央に空間を有するように成形された分岐部と、

(イ-4) 前記分岐部の他端と隣接して形成されるが、前記液状の冷媒が前記蒸発部に向って移動する液状冷媒移動部と、

(イ-5) 前記蒸発部と前記液状冷媒移動部の少なくとも一部を断熱させる断熱部と、を備える相変化冷却器と、

(ロ) 前記相変化冷却器の前記分岐部の中央空間に設置されたファンを備えることを特徴とするハイブリッド型の冷却装置。

【請求項25】

外部の熱源からの熱を冷却させるためのハイブリッド型の冷却装置において、

(イ) 内部に相変化する冷媒の循環ループが形成されるが、

(イ-1) その内部の一端に形成されるが、前記液状の冷媒が毛細管現象によって少なくとも一部に充填され、充填された液状の冷媒が外部の熱源から伝えられた熱によって気化される蒸発部と、

(イ-2) 前記蒸発部と隣接して形成されるが、気化された冷媒がその圧力差によって所定方向に移動する気状冷媒移動部と、

(イ-3) 前記蒸発部と隣接した領域であって、前記気状冷媒移動部の反対側に形成されるが、前記気状の冷媒が一側に流入されて凝縮され、凝縮された液状の冷媒が所定方向に移動して、前記蒸発部に流出されて中央に空間を有する分岐部と、を備える相変化冷却器と、

(ロ) 前記相変化冷却器の前記分岐部の中空に設置されたファンを備えることを特徴とするハイブリッド型の冷却装置。

【請求項26】

外部の熱源からの熱を冷却させるためのハイブリッド型の冷却装置において、

それぞれの一端が所定角度に曲がるように成形されて、設置時に中央に空間を有する分岐部を構成する一対のヒートパイプと、

前記一対のヒートパイプの曲がった部分が形成する分岐部の中央空間に設置されたファンと、を備えることを特徴とするハイブリッド型の冷却装置。

【請求項27】

外部の熱源からの熱を冷却させるためのハイブリッド型の冷却装置において、

それぞれの一端が所定角度に曲がるように成形されて、設置時に中央に空間を有する分岐部を構成する一対の相変化冷却器と、

前記一対の相変化冷却器が構成する分岐部の中央空間に設置されたファンと、を備えるが、

前記一対の相変化冷却器のそれぞれは、

その内部に相変化する冷媒の循環ループが形成されるが、

(イー１) その内部の一端に形成されるが、前記液状の冷媒が毛細管現象によって少なくとも一部に充填され、充填された液状の冷媒が外部の熱源から伝えられた熱によって気化される蒸発部と、

(イー２) 前記蒸発部と隣接して形成されるが、気化された冷媒が前記分岐部に向って移動する気状冷媒移動部と、

(イー３) 少なくとも前記気状冷媒移動部と隣接して形成されるが、前記分岐部の少なくとも一部を形成するように成形され、前記気状の冷媒が一侧に流入されて凝縮される凝縮部と、

(イー４) 前記凝縮部と隣接して形成されるが、前記分岐部の少なくとも一部を形成するように成形され、前記液状の冷媒が前記蒸発部に向って移動する液状冷媒移動部と、

(イー５) 前記蒸発部と前記液状冷媒移動部の少なくとも一部を断熱させる断熱部と、を備えることを特徴とするハイブリッド型の冷却装置。

【請求項28】

外部の熱源からの熱を冷却させるためのハイブリッド型の冷却装置において、

それぞれの一端が所定角度に曲がるように成形され、設置時に中央に空間を有する分岐部を構成する一対の相変化冷却器と、

前記一対の相変化冷却器が構成する分岐部の中央空間に設置されたファンと、を備えるが、

前記一対の相変化冷却器のそれぞれは、

その内部に相変化する冷媒の循環ループが形成されるが、

(イー１) その内部の一端に形成されるが、前記液状の冷媒が毛細管現象によって少なくとも一部に充填され、充填された液状の冷媒が外部の熱源から伝えられた熱によって気化される蒸発部と、

(イー２) 前記蒸発部と隣接して形成されるが、気化された冷媒が前記分岐部の逆方向に向って移動する気状冷媒移動部と、

(イー３) 前記分岐部に隣接した領域に形成されるが、前記分岐部の少なくとも一部を形成するように成形され、前記気状の冷媒が一侧に流入されて凝縮される凝縮部と、

(イー４) 前記凝縮部と隣接して形成されるが、前記分岐部の少なくとも一部を形成するように成形され、前記液状の冷媒が前記蒸発部に向って移動する液状冷媒移動部と、を備えることを特徴とするハイブリッド型の冷却装置。

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、半導体集積回路装置などの熱を冷却するための冷却装置に係り、特に、作動流体の相変化による冷却方式とフィン及び／またはファンによる冷却方式を併用するハイブリッド型（または、混合型）の冷却装置に関する。

【背景技術】

【0002】

半導体素子の高集積化の傾向により、デザインルールが減少し、それにより、半導体素子を構成する電子回路の線幅が狭くなることにより、単位面積当りのトランジスタ数が増加して、電子装備の小型化、高性能化を達成したが、それに伴って半導体素子の単位面積当りの熱発散率が更に上昇した。このような熱発散率の増加は、半導体素子の性能の低下及び寿命の短縮をもたらす。窮極的には、半導体素子を採用したシステムの信頼度を低下させる。特に、半導体素子においては、その動作温度によって各種パラメータ値が鋭敏に変化して、集積回路の特性を更に劣化させる。

【0003】

このような熱発散率の上昇に対応して、これを冷却するための冷却技術も発展してきたが、公知の通常的な冷却技術としては、フィンファン冷却方式、熱電素子冷却方式、液体噴射冷却方式、浸水冷却方式、ヒートパイプ冷却方式などがある。

【0004】

前記フィンファン冷却方式は、フィン及び／またはファンを利用して強制冷却させる

方法であり、数十年間多く利用されてきたが、ノイズ、振動及び大きい体積に比べて冷却効率が低いという問題点がある。また、前記熱電素子冷却方式は、ノイズ、振動はないが、大きい駆動電源が要求されて、エネルギー保存法則により高熱側で必要以上の過多の熱消散装置が要求されるという問題点がある。また、前記液体噴射冷却方式は、効率性に優れており、冷却器の研究の主流になっているが、外部電源を利用する薄膜ポンプなどを使用して、その構造が複雑であり、重力の影響を多く受け、個人携帯電子装置に適用する場合、ロバスト設計が難しいという問題がある。

【0005】

前記のような問題点により、最近では、ヒートパイプ冷却方式は、構造が簡単であり、製作が容易であるという長所があり、前記フィンファン冷却装置と共に小型冷却装置として多様な形状で広く適用されている。すなわち、図1に示すように、通常のヒートパイプとフィンファンとを結合した冷却装置10は、その一端が熱源20と接触したヒートパイプ12と、前記ヒートパイプ12の他端に設置された複数のフィン14と、前記フィン14の近傍に設置されたファン16とを備えて、熱源20から吸収された熱を前記フィン14によって放出する構造を有する。

【0006】

しかし、前記のようなヒートパイプを使用する冷却装置10では、気体及び液体の流動方向が互いに逆であるため、高熱量がヒートパイプに印加される場合、発生する気体の速い流速により、凝縮部から蒸発部に帰還する液体が気体移動部に再び吸い込まれて、結局、蒸発部まで帰還できず、これによりドライアウトが発生する。また、パイプの内部で気化された冷媒は、浮力と圧力との差に依存して移動し、ヒートパイプの内部では、液化された冷媒が帰還部の媒質の構造及びサイズによって重力に依存するため、設置可能な位置に多くの制限があるという問題点がある。

【0007】

更に、最近の中央処理処置のような高集積化された半導体素子は、その発熱量が、従来の冷却装置では処理しがたい程度の多量であり、前記ヒートパイプとフィンファンとを結合した構造の冷却装置10においても、三つまたは四つに達するヒートパイプ12と、二つまたはそれ以上のファン16とを備えねば冷却が不可能な実情である。このように、構成要素の個数が増加すれば、そのサイズが非常に大きくなり、また、いくつかのファン16によるノイズ及び電力消費も飛躍的に増加して、結局、実用性を失うという問題点がある。このような既存のヒートパイプ冷却モジュールの短所は、流体の相変化を利用するとしても、結局は、広い面積のフィンを通じて熱を伝導させねばならないため、フィン自体での熱伝達損失が、ヒートパイプの相変化媒質での熱伝達に比べて急減するためである。

【発明の開示】

【発明が解決しようとする課題】

【0008】

本発明は、前記の問題点を解決するためになされたものであって、本発明の目的は、相変化時の潜熱による冷却と、送風及び対流による冷却とを併行する小型のハイブリッド型の冷却装置を提供するところにある。

【0009】

また、本発明の他の目的は、フィンとフィンとの間にハイブリッド型の冷却装置を配置して、フィンを介した熱伝導の損失を最小化し、冷却性能を向上させた小型のハイブリッド冷却装置を提供するところにある。

【0010】

また、本発明の更に他の目的は、重力の影響に関係なく冷却性能を発揮できる小型のハイブリッド型の冷却装置を提供するところにある。

【0011】

また、本発明の更に他の目的は、設置位置や場所に実質的な制限がない小型のハイブリッド型の冷却装置を提供するところにある。

【課題を解決するための手段】

【0012】

前記目的を達成するために、本発明は、外部の熱源からの熱を冷却させるためのハイブリッド型の冷却装置において、内部に相変化する冷媒の循環ループが形成されるが、その一側に分岐部を備える相変化冷却器と、前記相変化冷却器の分岐部に設置されたファンとを備えるが、前記相変化冷却器は、その内部の一端に形成されるが、前記液状の冷媒が毛細管現象によって少なくとも一部に充填され、充填された液状の冷媒が外部の熱源から伝えられた熱によって気化される蒸発部と、前記蒸発部と隣接して形成されるが、気化された冷媒が前記分岐部に向って移動する気状冷媒移動部と、前記分岐部の少なくとも一部の領域であって、前記気状冷媒移動部と隣接した領域に形成されるが、少なくとも二段に分岐され、前記気状の冷媒が液状に凝縮される凝縮部と、前記分岐部の少なくとも一部の領域であって、前記凝縮部に隣接した領域に形成されるが、前記蒸発部と断熱され、液状に凝縮された冷媒が前記蒸発部に向って移動する液状冷媒移動部と、前記蒸発部と前記液状冷媒移動部の少なくとも一部を断熱させる断熱部と、を備えるハイブリッド型の冷却装置を提供する。

【発明を実施するための最良の形態】

【0013】

以下、添付図面を参照して本発明の好ましい実施形態について詳細に説明する。

【0014】

まず、図2を参照すれば、図2は、本発明の第1実施形態によるハイブリッド型の冷却装置の平断面図である。図示するように、本実施形態によるハイブリッド型の冷却装置100は、その内部に相変化する冷媒の循環ループが形成されるが、その循環ループの少なくとも一部は、中空の環状に分岐された部分（以下、“分岐部”）より構成される相変化冷却器112と、前記相変化冷却器の分岐部の中空に設置されたファン120と、を備える。

【0015】

前記相変化冷却器112のハウジングは、シリコンやガリウムのような半導体物質、自己結集単層膜（Self Assembled Monolayer；SAM）のような新素材積層物質、熱伝導率に優れた銅またはアルミニウムのような金属物質及び／またはそれらの合金物質、セラミック物質、プラスチックのような高分子物質や、ダイヤモンドのような結晶質材料などの多様な素材で製造されうる。特に、外部熱源が半導体チップである場合、外部熱源の表面物質と同じ物質より形成して、接触熱抵抗を最小化できる。また、前記相変化冷却器112が半導体物質で製造される場合には、半導体チップの製造工程で、前記外部熱源の表面物質と一体になるように形成することも可能である。

【0016】

次いで、前記相変化冷却器112内に注入される冷媒は、外部の熱により液状と気状との相変化を発生させ得るものから選択されうる。本実施形態によれば、前記冷媒として、潜熱及び表面張力の大きい水を使用することが好ましいが、これは、環境汚染を考慮して、フロン（CFC）系列の冷媒を使用しないことが好ましいためである。

【0017】

また、前記相変化冷却器112の材質により、その内壁と冷媒との間の表面張力のサイズが変わるため、本発明の実施においては、これに適した冷媒を選択せねばならない。例えば、水以外にも、メタノールまたはエタノールなどのアルコール系の冷媒を使用することも可能である。前記のような水やアルコール系の冷媒の場合、熱容量が大きく、半導体物質の内壁との間の表面張力による接触角が小さいため、冷媒の流速が大きくなって、多量の熱を伝達するのに有利であるという長所を有する。また、水またはアルコール系の冷媒の場合には、フロン系の冷媒と違って、ある理由によって前記相変化冷却器112から漏れても、環境汚染の問題が発生しない。

【0018】

このような冷媒の選択は、本発明の実施のための単純な設計的な選択事項に過ぎないた

め、本発明の技術的範囲を限定するものではない。

【0019】

図示するように、前記相変化冷却器112は、その内部の一端に形成されるが、前記液状の冷媒が毛細管現象によって少なくとも一部に充填され、充填された液状の冷媒が外部の熱源（図示せず）から伝えられた熱によって気化される蒸発部104と、前記蒸発部104と隣接して形成されるが、気化された冷媒が、その圧力差によって所定方向に移動する気状冷媒移動部106と、前記気状冷媒移動部106と隣接して形成されるが、二段に分岐され、前記気状の冷媒が液状に凝縮される凝縮部108と、前記凝縮部108に隣接して形成されるが、前記蒸発部104と断熱され、液状に凝縮された冷媒が前記蒸発部104に向って移動する液状冷媒移動部102、110と、を備える。本実施形態では、前記凝縮部108及び液状冷媒移動部110が前記分岐部を構成する。

【0020】

前記相変化冷却器112内で、前記冷媒は、図面の矢印方向に沿って循環ループを形成する。すなわち、前記蒸発部104、前記気状冷媒移動部106、前記凝縮部108、前記凝縮部側の液状冷媒移動部110及び前記蒸発部側の液状冷媒移動部102を順に通って循環されるように構成されている。

【0021】

本発明の実施形態によっては、前記液状冷媒移動部102、110の所定領域に一定量の液状の冷媒が保存されるように、適当な体積を有する冷媒保存部（図示せず）を更に備える。例えば、前記蒸発部側の液状冷媒移動部102の領域が冷媒保存部として形成されて使用される。

【0022】

前記蒸発部側の液状冷媒移動部102の一端（“出口側”）には前記蒸発部104が隣接して形成され、前記蒸発部104は、複数の微細チャンネルが形成されて、毛細管現象によって前記微細チャンネルの少なくとも一部または全部に、前記蒸発部側の液状冷媒移動部102に保存された冷媒が充填される。また、前記蒸発部104は、外部の熱源（図示せず）に隣接するように設置されるが、それにより、前記熱源から伝えられた熱により、前記微細チャンネルに充填された液状の冷媒が気化されて、気状の冷媒に相変化される。従って、前記熱源からの熱は、前記冷媒の相変化による潜熱ほど前記冷媒に吸収され、後述するように、気状の冷媒を再び凝縮させることにより前記熱源の熱を除去する。

【0023】

前記微細チャンネル内での表面張力は、重力より大きく形成されることが好ましい。前記微細チャンネルに充填された液状である冷媒のメニスカスの接触角は小さいほど好ましいが、このためには、前記微細チャンネルの内壁を親水性を有する物質より形成するか、または親水性の処理を実施することが好ましい。このような親水性処理としては、例えば、メッキ処理、塗装処理、コーティング処理、着色処理、アノダイジング処理、プラズマ処理、レーザー処理などがある。また、その熱伝達率を向上させるために前記微細チャンネルの内壁の表面粗度を調節できるが、約1Åないし約100Å程度の表面粗度を有することが好ましい。

【0024】

更に、前記微細チャンネルの断面は、四角形以外にも、円形、楕円形、直方形、正方形、多角形などの多様な形態を有するように形成することもできる。特に、前記微細チャンネルの長手方向（すなわち、X軸方向）に沿って断面積を増加または減少させることにより、冷媒との間の表面張力のサイズを制御でき、その内壁に複数のグルーブまたはノードを設置して、冷媒の移動方向を決定するか、または冷媒の移動速度を制御することも可能である。

【0025】

次いで、前記蒸発部104で気化された冷媒は、前記蒸発部側の液状冷媒移動部102の逆方向に移動するが、このように、気状の冷媒が移動できる通路の役割を行う気状冷媒移動部106を前記蒸発部104に隣接して形成する。図示するように、前記気状冷媒移