

15. A method for reducing the thermal inertia of an electronic display, the method comprising the steps of:

measuring a temperature within the display;

selecting a desired fan speed based on the temperature measurement;

measuring the ambient light contacting the display;

selecting a fan speed correction factor based on the ambient light measurement;

applying the fan speed correction factor to the desired fan speed to produce a corrected fan speed; and

driving the cooling fan at the corrected fan speed.

16. The method of claim 15 wherein:

the temperature measurement is performed near a power module which powers the electronic display.

17. The method of claim 15 wherein:

the temperature measurement is performed near a backlight component of the electronic display.

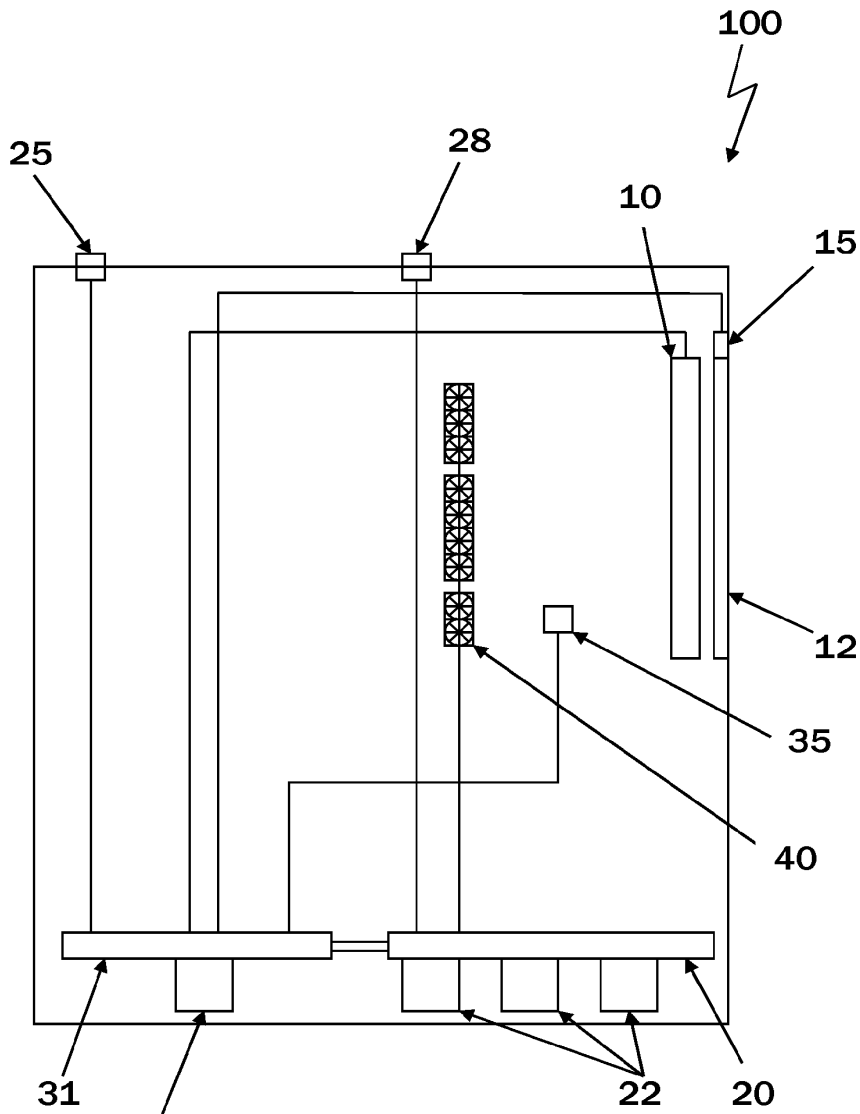


FIG - 1A

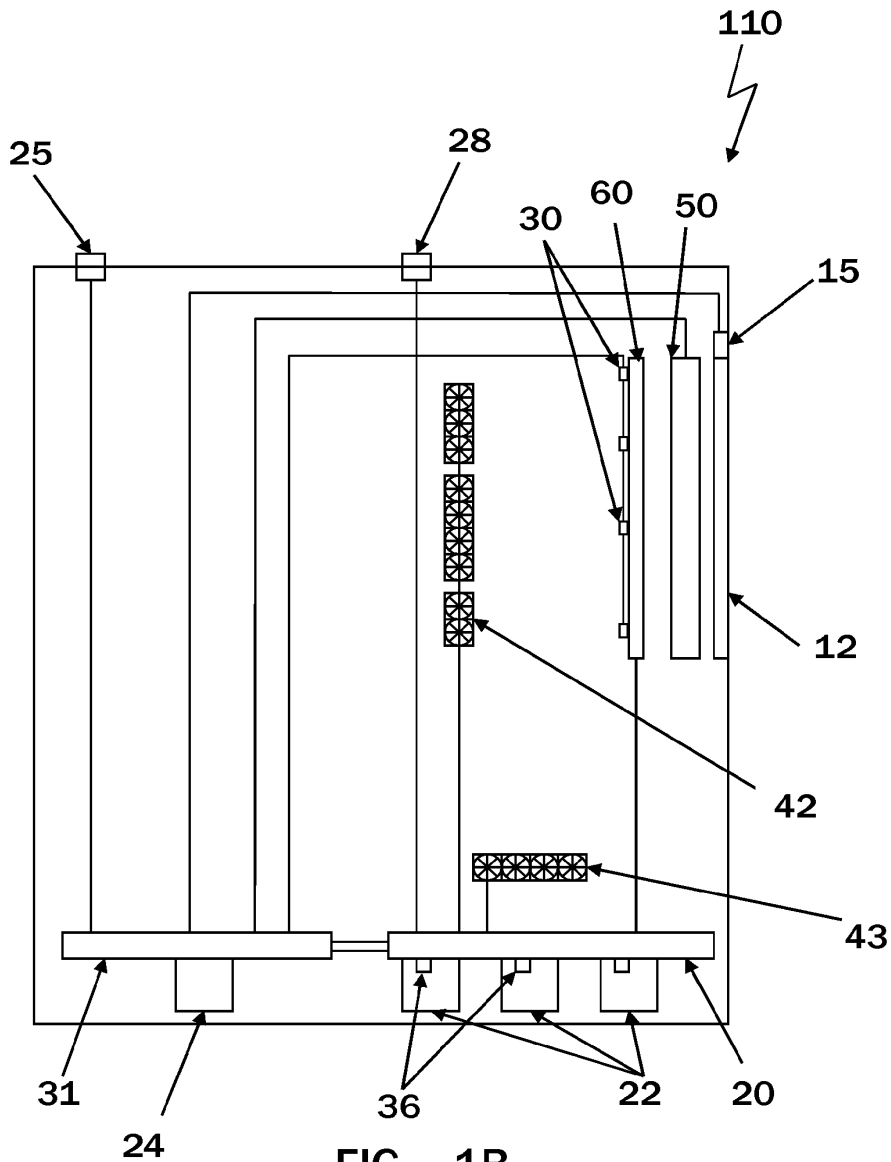


FIG - 1B

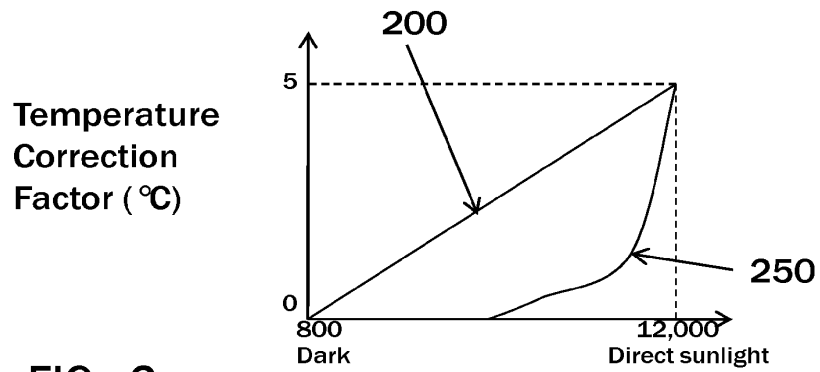


FIG - 2

Ambient Light Sensor Data

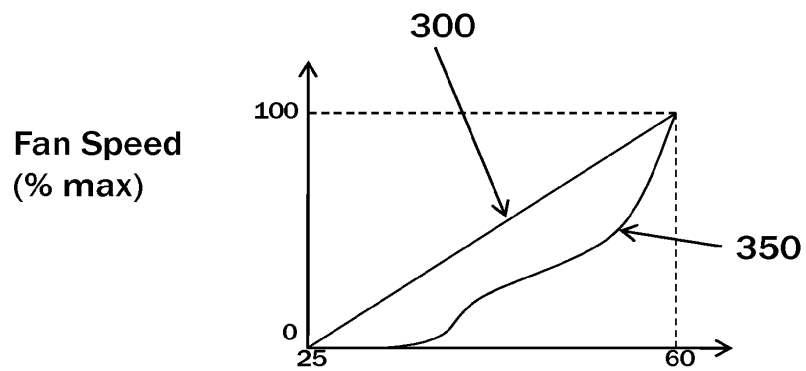
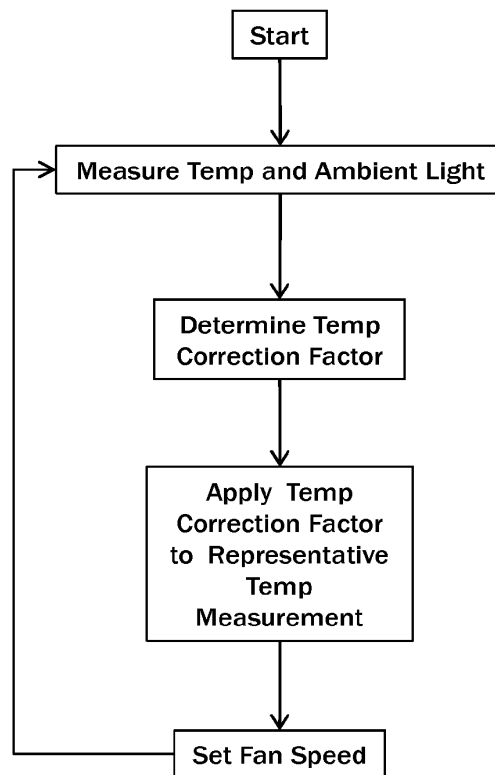
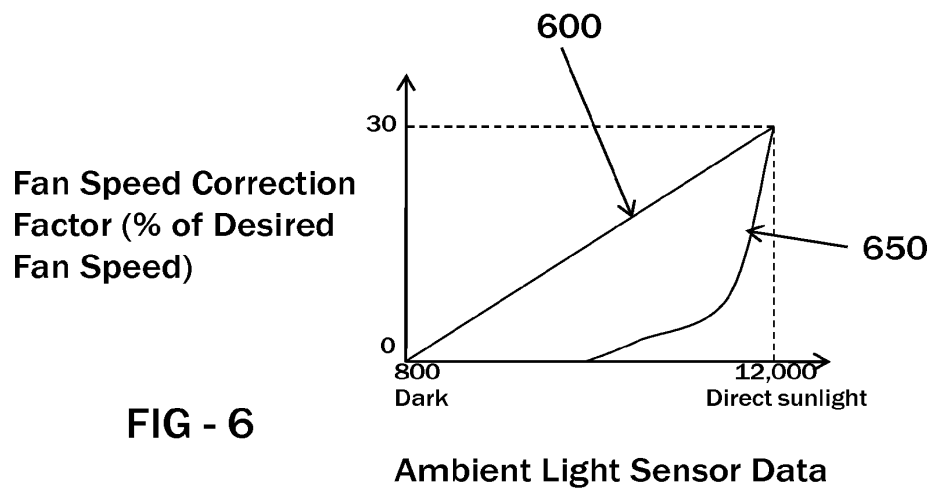
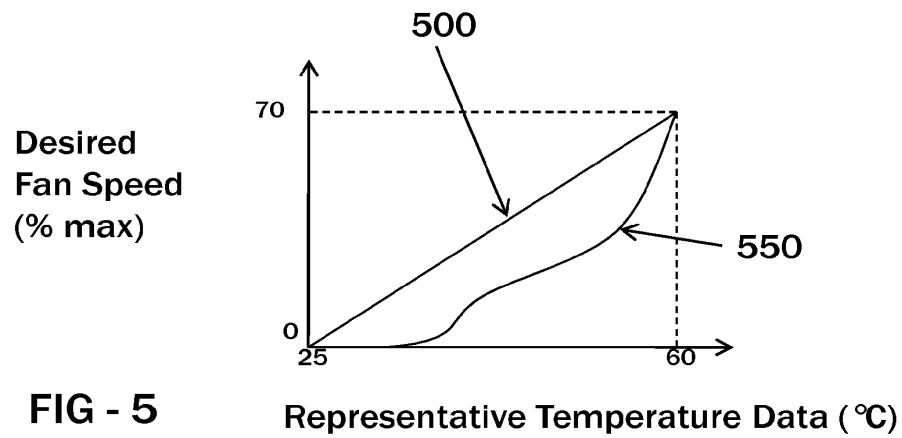


FIG - 3

Corrected Temperature Data (°C)

**FIG - 4**



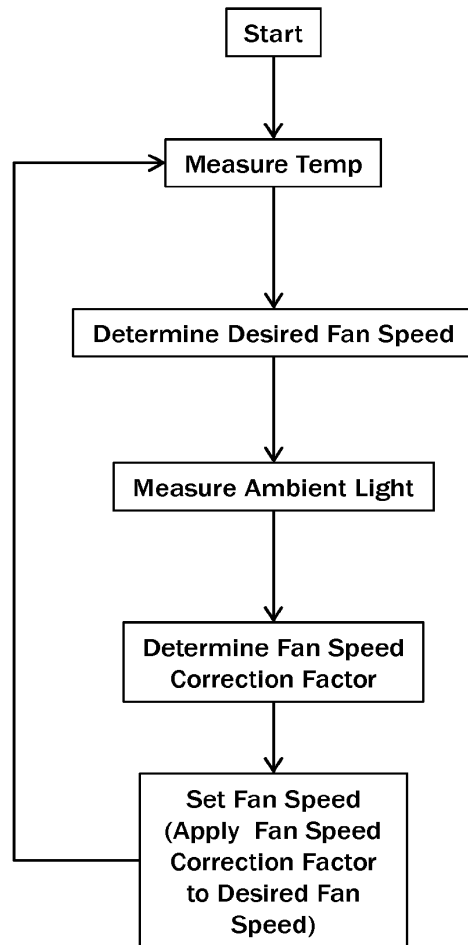


FIG - 7

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(71) Applicant (for all designated States except US): **MANUFACTURING RESOURCES INTERNATIONAL, INC.** [US/US]; 1600 Union Hill Road, Alpharetta, GA 30005 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **DUNN, William, R.** [US/US]; 1600 Union Hill Road, Alpharetta, GA 30005 (US). **HUBBARD, Tim** [US/US]; 1600 Union Hill Road, Alpharetta, GA 30005 (US). **BEDELL, Ware** [US/US]; 1600 Union Hill Road, Alpharetta, GA 30005 (US).

(74) Agents: **DUNHAM, Tyler** et al.; Standley Law Group LLP, 6300 Riverside Drive, Dublin, OH 43017 (US).

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(54) Title: SYSTEM AND METHOD FOR THERMALLY CONTROLLING AN ELECTRONIC DISPLAY WITH REDUCED NOISE EMISSIONS

(57) Abstract: An assembly for cooling an electronic image assembly having a rear channel placed behind the image assembly and a heat exchanger for accepting ambient air. The system contains a first fan placed within the heat exchanger to force ambient air through the heat exchanger and the rear channel. A second fan may be used to force circulating gas through an interior portion of the display housing and through the heat exchanger in order to transfer heat to the ingested ambient air.



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SYSTEM FOR THERMALLY CONTROLLING AN ELECTRONIC DISPLAY WITH REDUCED NOISE EMISSIONS

Inventors: William Dunn, Tim Hubbard, and Ware Bedell

Cross-Reference to Related Applications

[0001] This application claims priority to U.S. Application No. 13/211,887 filed on August 17, 2011, herein incorporated by reference in its entirety. This application claims priority to U.S. Application No. 61/375,470 filed on August 20, 2010, herein incorporated by reference in its entirety. This application is a continuation-in-part of U.S. Application No. 13/100,580 filed on May 4, 2011, herein incorporated by reference in its entirety. This application is also a continuation-in-part of U.S. Application No. 13/100,556 filed on May 4, 2011, herein incorporated by reference in its entirety. This application is also a continuation-in-part of U.S. Application No. 12/905,704 filed on October 15, 2010, 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] 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.

[0004] 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.

[0005] 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.

[0006] 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.

[0007] 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

[0008] Exemplary embodiments may 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. Circulating gas may also be used to remove heat from internal electronic assemblies. 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.

[0009] 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.

[0010] 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 (or between two separate heat exchangers), 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 electronic 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. In an exemplary embodiment, a single fan assembly can be used to drive the ambient gas through both the heat exchanger(s) and behind the electronic image assembly.

[0011] 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.

[0012] 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

[0013] 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:

[0014] FIGURE 1A provides a front perspective view of an exemplary embodiment of the electronic display.

[0015] FIGURE 1B provides a rear perspective view of an exemplary embodiment of the electronic display.

[0016] FIGURE 2 provides a rear perspective view similar to that shown in Figure 1B where the rear cover has been removed.

[0017] FIGURE 3 provides a perspective sectional view along the A-A section line shown in Figure 1B.

[0018] FIGURE 4 provides a perspective sectional view along the B-B section line shown in Figure 1B.

[0019] FIGURE 5 provides a perspective sectional view of insert C shown in Figure 4.

[0020] FIGURE 6 provides a perspective sectional view of one embodiment of the cross through plate.

[0021] FIGURE 7 provides an exploded perspective view of one embodiment of the heat exchanger.

[0022] 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).

[0023] 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.

[0024] FIGURE 10 provides a rear perspective view of an embodiment using a single fan assembly to control the flow of ambient gas, the embodiment shown with the rear cover removed.

[0025] FIGURE 11A provides a perspective sectional view of the embodiment from Figure 10 based on section line 11A-11A shown in Figure 10.

[0026] FIGURE 11B provides a perspective sectional view of insert B from Figure 11A.

Detailed Description

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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).

[0038] Optionally, ambient gas 210 may also be ingested into the display through inlet aperture 24. 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 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 and combines them into a single flow and exhausts it out of the exit aperture 25. 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. 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.

[0039] 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.

[0040] **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

contaminates 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.

[0041] An electronic image assembly 50 may be placed behind the front plate 10. A plurality of channels 60 may be placed behind (preferably immediately 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 immediately 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 on the rear portion of the electronic image assembly 50 so that heat can easily transfer to this plate and be removed by the ambient gas 210.

[0042] 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.

[0043] **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. 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.

[0044] Also shown in this sectional view is the path of the ambient gas 210 travelling down one of the channels 60 directly 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. As shown in this Figure, the paths of the ambient gas 210 and the circulating gas 250 will likely 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.

[0045] **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.

[0046] 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.

[0047] FIGURE 7 provides an exploded perspective view of one embodiment of the heat exchanger 45. In this view, the heat exchanger fan assembly 46 is shown removed from its mounted position within the heat exchanger 45. In this embodiment, the heat exchanger 45 is divided into two portions 47 and 48 where 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 drastically reduced because the surrounding portions 47 and 48 of

the heat exchanger 45 essentially act as a muffler for the fan assembly 46. 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). This design may be preferable when it is desirable to create the largest possible heat exchanger 45 (for maximum cooling abilities). 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).

[0048] 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). In other words,

an exemplary heat exchanger would have at least a first gas pathway for ambient gas and at least a second gas pathway for circulating gas, where the two pathways are substantially perpendicular and adjacent to each other and do not allow the ambient gas and circulating gas to mix.

[0049] 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).

[0050] 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.

[0051] 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).

[0052] 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 be placed between the LCD 300 and the backlight 320 in order to enclose the area and 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.

[0053] 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 between the LCD 300 and front plate 10. Circulating gas fan assembly 255 may be placed so that it can draw circulating gas 350 through the backlight cavity as well as circulating gas 250 between the LCD 300 and the front plate 10. 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).

[0054] Also shown in Figure 9 is the optional additional flow of ambient gas 210 which may travel immediately behind the 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.

[0055] 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 front 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.

[0056] **FIGURE 10** provides a rear perspective view of an embodiment 1000 using a single fan assembly 1050 to control the flow of ambient gas. The embodiment 1000 is shown here with the rear cover removed. In this figure, the main display assembly is still within the exterior display housing 1001. Similar to some of the embodiments describe above, a circulating gas fan assembly 1105 may be used to draw circulating gas 1106 into and through the heat exchanger 1100. Further, another circulating gas fan assembly 1205 may be used to draw circulating gas 1106 through heat exchanger 1200. The circulating gas 1106 may also be used to extract heat from various electrical components 1109.

[0057] An ambient gas fan assembly 1050 may be used to draw ambient gas into the inlet aperture 1009 and exhaust the ambient gas out of an exit aperture 1010. The ambient gas preferably travels through the heat exchangers 1200 and 1100 as well as the channel behind the electronic image assembly (if used). The section line 11A-11A is shown cutting horizontally through the display embodiment 1000.

[0058] **FIGURE 11A** provides a perspective sectional view of the embodiment from Figure 10 based on section line 11A-11A shown in Figure 10. For clarity, the exterior housing 1001 has been removed. Once the circulating gas 1106 has traveled through the heat exchangers 1200 and 1100, it may then be directed between the front transparent plate 1500 and the electronic image assembly 1600. After passing between the front transparent plate 1500 and the electronic image assembly 1600, the

circulating gas 1106 may then return to the heat exchangers 1200 and 1100. In this embodiment, fan assembly 1050 is used to control the flow of ambient gas 1055 and 1056. Ambient gas 1055 is directed through the heat exchangers 1200 and 1100 while ambient gas 1056 is directed behind the electronic image assembly 1600.

[0059] FIGURE 11B provides a perspective sectional view of insert B from Figure 11A. The channel 1700 may be defined by the space between the rear surface or portion of the electronic image assembly 1600 and a plate which is substantially parallel to the rear surface or portion of the electronic image assembly 1600. The channel 1700 may also contain ribs which are also thermally conductive and preferably in thermal communication with the electronic image assembly 1600. By placing the fan assembly 1050 so as to direct the ambient gas within the channel 1700 and the heat exchangers 1200 and 1100 simultaneously, several improvements can be achieved, including but not limited to: increased air flow, less fan noise, and a less expensive/lighter assembly. In this embodiment, the paths for ambient gas 1055 and ambient gas 1056 are substantially parallel to one another.

[0060] 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.

[0061] The circulating gases and ambient gases can be any number of gaseous matters. In some embodiments, air may be used as the gas for all. Preferably, because the circulating gases may travel in front of the image assembly and/or within the backlight cavity, they should be substantially clear, so that they will not affect the appearance of the image to a viewer. The circulating gases should also preferably 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/or damage to the internal electronic components. It may sometimes be preferable to keep ambient

gases from having contaminants as well. Filters may be used to help reduce the particulate within ambient gases. Filters could be placed near the inlet apertures so that ambient gases 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 but this will not harm the display. In these embodiments, the heat exchanger, manifolds, channels, 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, ingesting ambient air for the ambient gases, 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.

[0062] 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.

[0063] 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 electronic image assemblies: 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 thin 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 at risk.

[0064] 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. Although circulating gas may be shown traveling clockwise or counterclockwise, either orientation may be used with any of the embodiments herein. Similarly, although ambient gas may be shown travelling from top-bottom, bottom-top, left-right, or right-left, any arrangement can be used. Further, it should be understood that the figures herein are not necessarily drawn to scale, and some components may be enlarged for clarity and explanatory purposes.

[0065] 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;
 - a channel placed behind the electronic image assembly and in gaseous communication with the inlet and exit apertures;
 - an first fan positioned between the first and second portions which forces ambient gas through the first portion, second portion, and the channel;
 - and
 - a second fan which forces circulating gas through the internal cavity and at least one of the heat exchanger portions.
2. The cooling assembly of claim 1 wherein:
 - the first fan also draws ambient gas through the inlet aperture.
3. The cooling assembly of claim 2 wherein:
 - the first fan also pushes ambient gas through the exit aperture.
4. The cooling assembly of claim 1 further comprising:
 - an electronic component placed within the path of the circulating gas.
5. The cooling assembly of claim 4 wherein:
 - the electronic component is a power module.

6. The cooling assembly of claim 1 wherein:
the heat exchanger portions are comprised of corrugated layers.
7. The cooling assembly of claim 1 wherein:
the heat exchanger portions are cross-flow heat exchanger portions.
8. 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 front channel;
a rear plate placed behind the electronic image assembly, the space between the rear plate and the electronic image assembly defining a rear channel;
a heat exchanger in gaseous communication with the front 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;
an ambient gas fan assembly placed between the two portions of the heat exchanger to force ambient gas through the first gas pathways and through the rear channel; and
a circulating gas fan assembly positioned to force circulating gas through the front channel and the second gas pathways.
9. The electronic display assembly of claim 8 further comprising:
a power module placed within the path of the circulating gas.

10. The electronic display assembly of claim 8 wherein:
the electronic image assembly is a liquid crystal display.
11. The electronic display assembly of claim 8 wherein:
the electronic image assembly is an OLED display.
12. The electronic display assembly of claim 8 wherein:
the heat exchanger is a cross-flow heat exchanger comprised of corrugated layers.
13. The electronic display assembly of claim 8 further comprising:
a plurality of ribs placed within the channel and in thermal communication with the electronic image assembly.
14. The electronic display assembly of claim 13 wherein:
the ribs are metallic.
15. The electronic display assembly of claim 13 wherein:
the ribs are placed in conductive thermal communication with the electronic image assembly.

16. The electronic display assembly of claim 13 wherein:

the ribs have a rectangular cross-section.

17. A thermally-controlled liquid crystal display (LCD) assembly comprising:

a housing having an inlet aperture and exit aperture for ambient gas;
a LED backlight having a rear surface and placed within the housing;
a liquid crystal display (LCD) having a front surface and placed in front of the
LED backlight and within the housing;
a transparent front plate in front of the LCD, the space between the transparent
front plate and the LCD defining a front channel;
a rear plate placed behind the rear surface of the LED backlight;
a plurality of ribs placed between the rear plate and LED backlight, the space
between the rear plate, LED backlight, and ribs defining a plurality of rear
channels;
a heat exchanger having a first gas pathway in gaseous communication with the
front channel, and a second gas pathway in gaseous communication with
the inlet and exit apertures;
an ambient gas fan assembly placed within the heat exchanger to force ambient
gas into the inlet aperture, through the second gas pathway and the rear
channels, and out of the exit aperture; and
a circulating gas fan assembly positioned to force circulating gas through the
front channel and the first gas pathways.

18. The LCD assembly of claim 17 further comprising:

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

19. The LCD assembly of claim 17 wherein:

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

20. The LCD assembly of claim 17 wherein:

the ribs are metallic.

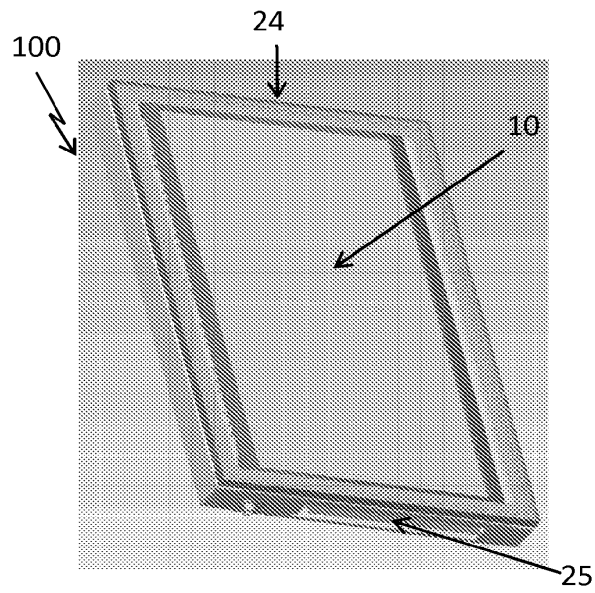


FIG - 1A

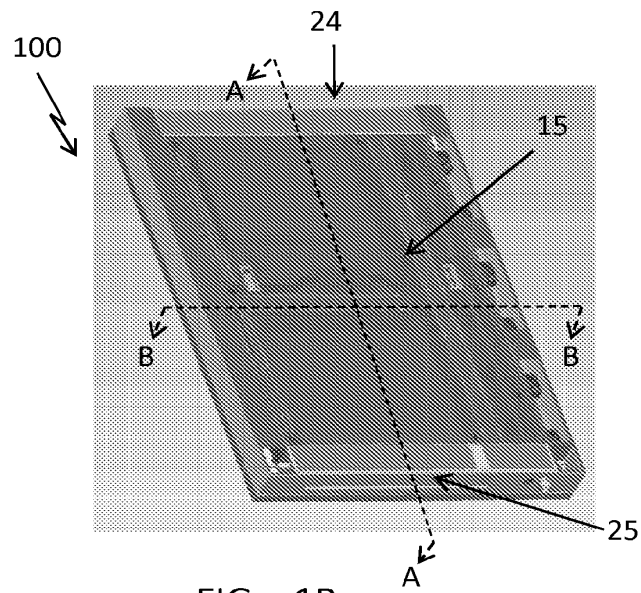


FIG - 1B

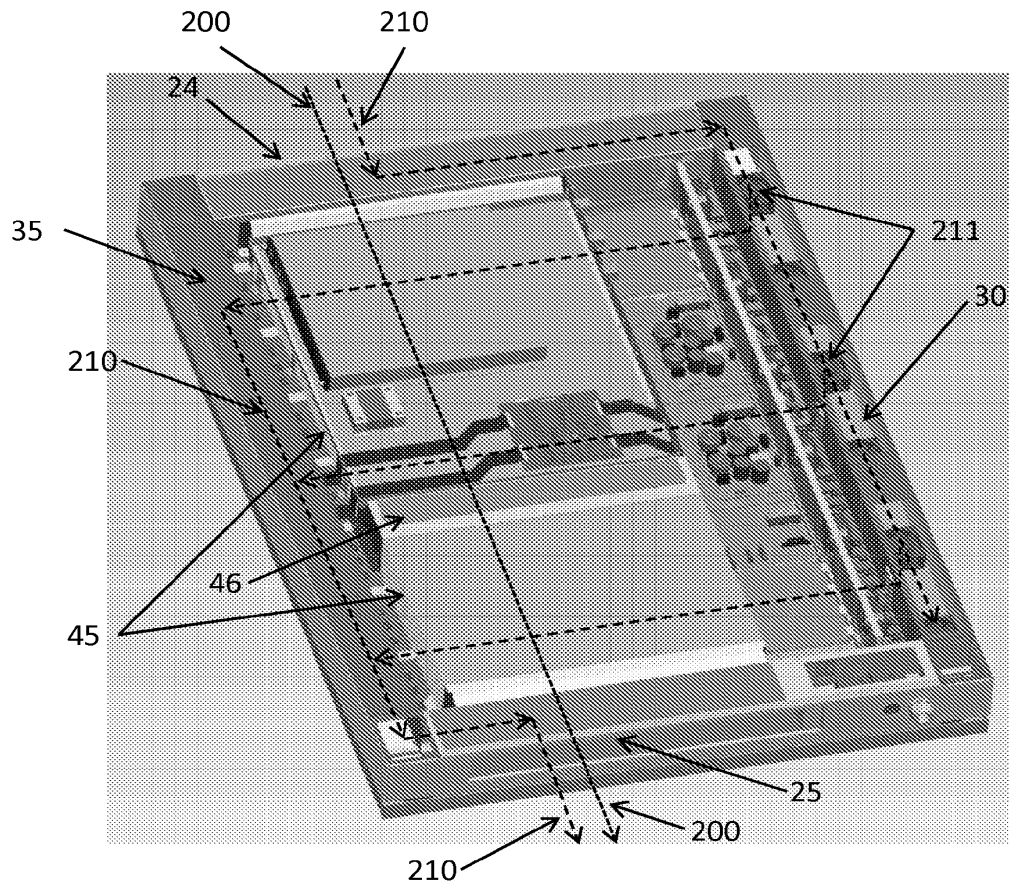


FIG - 2

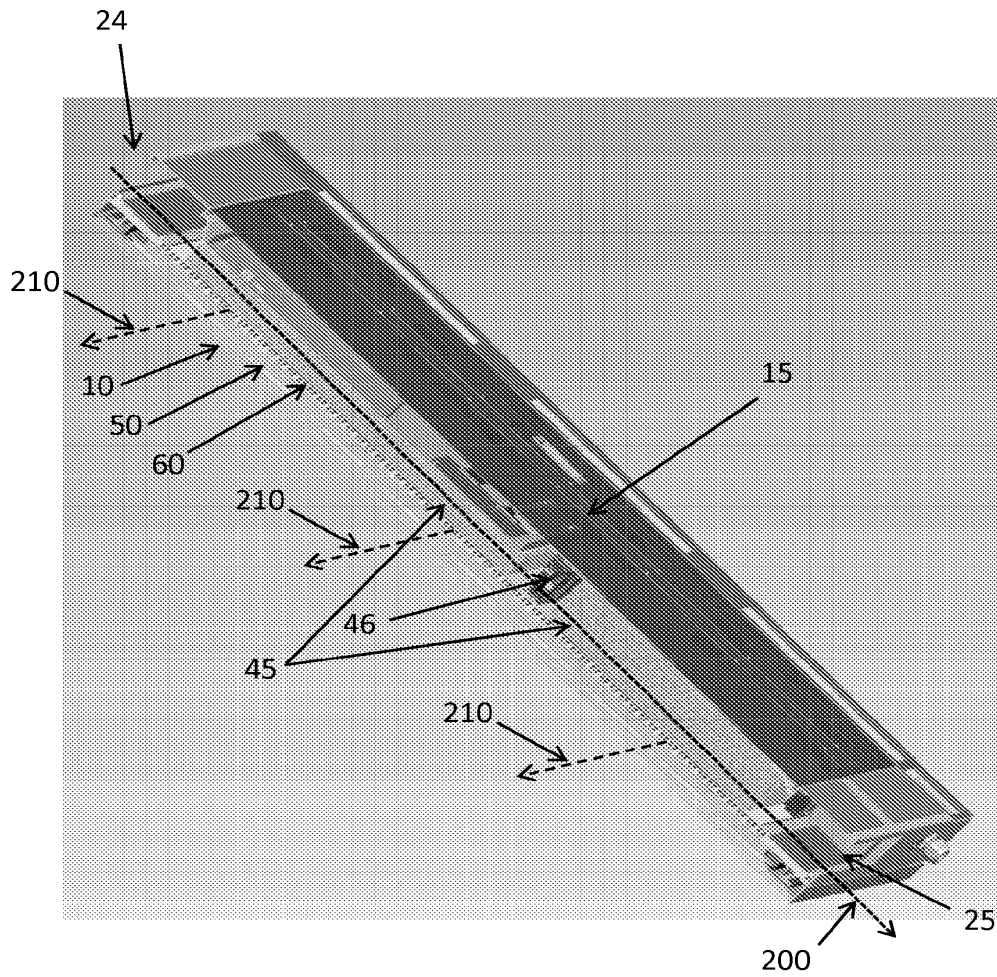


FIG - 3

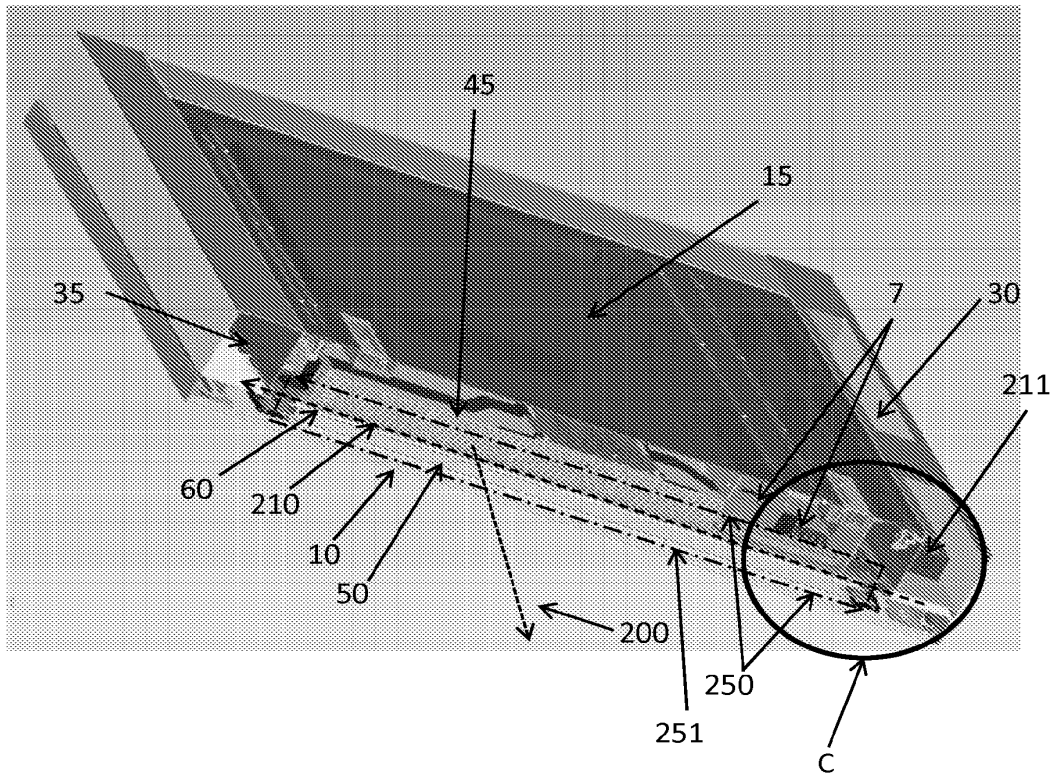


FIG - 4

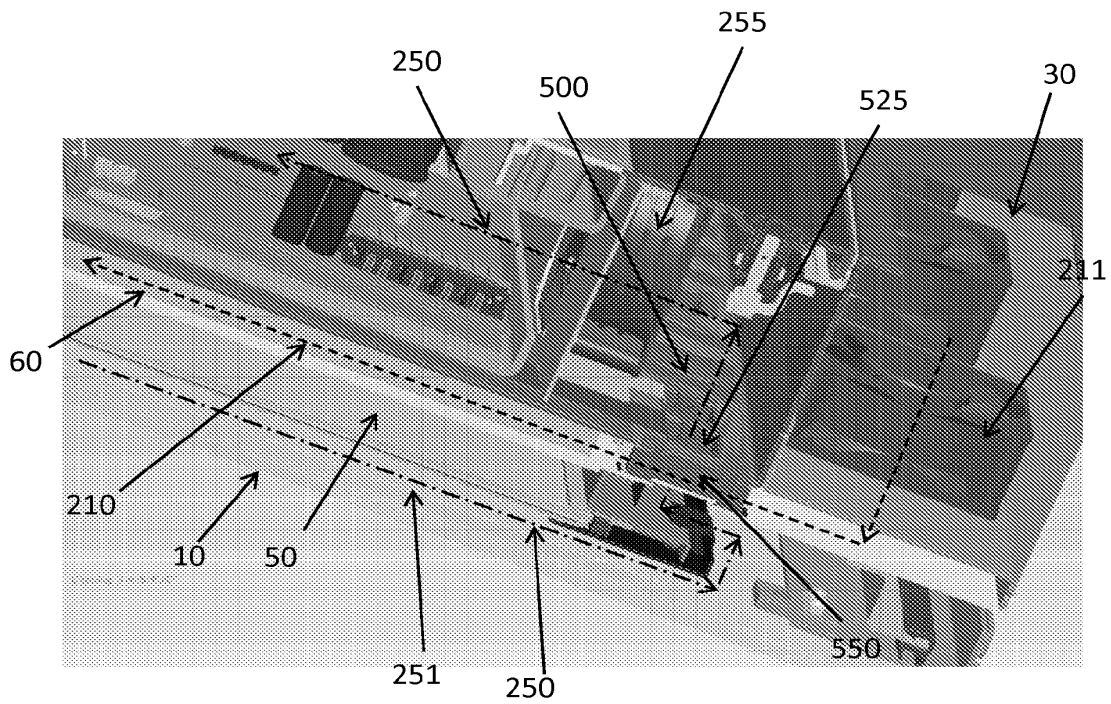


FIG - 5

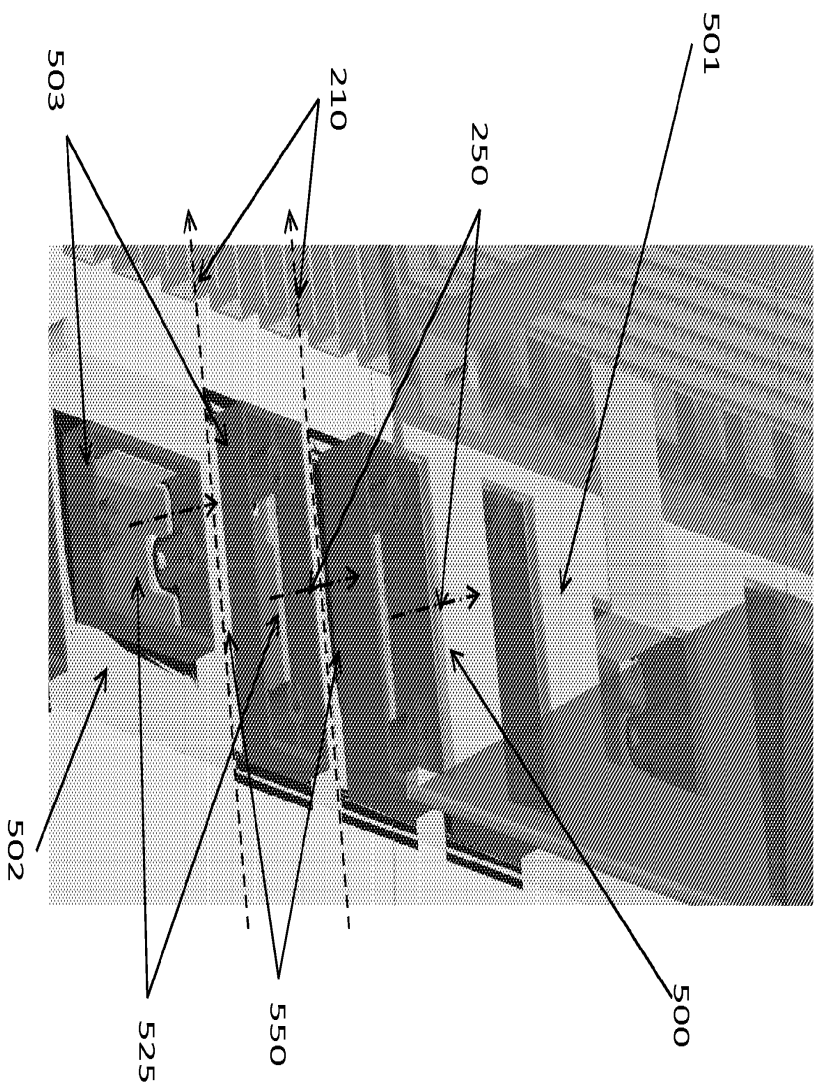


FIG - 6

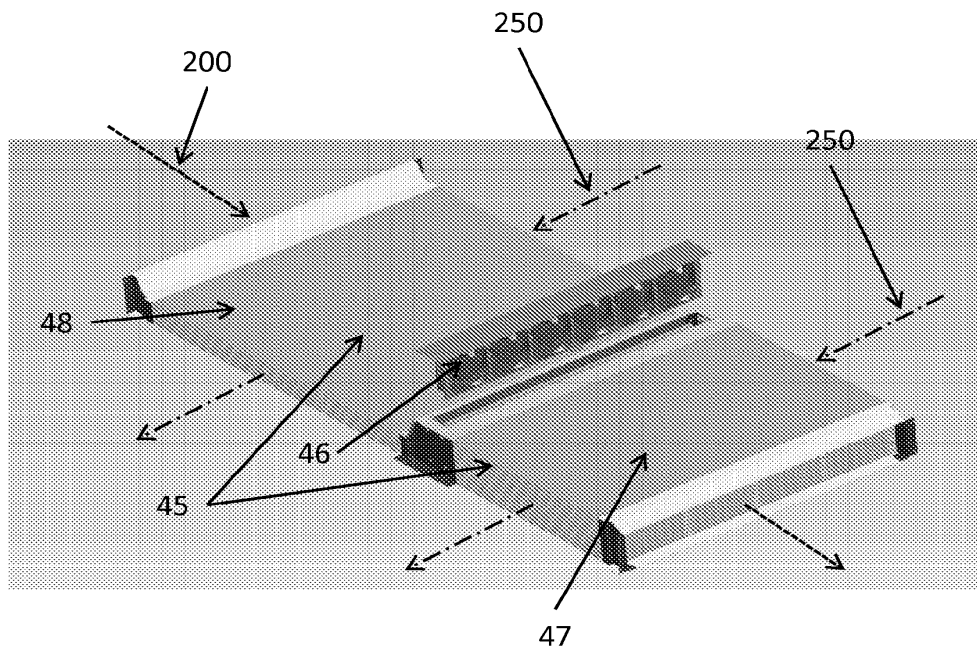


FIG - 7

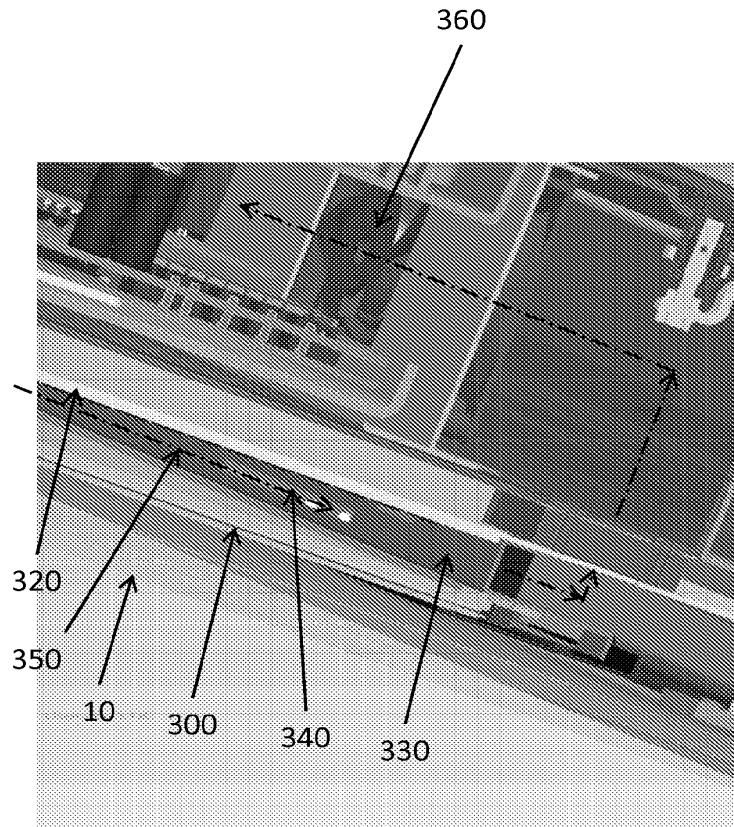


FIG - 8

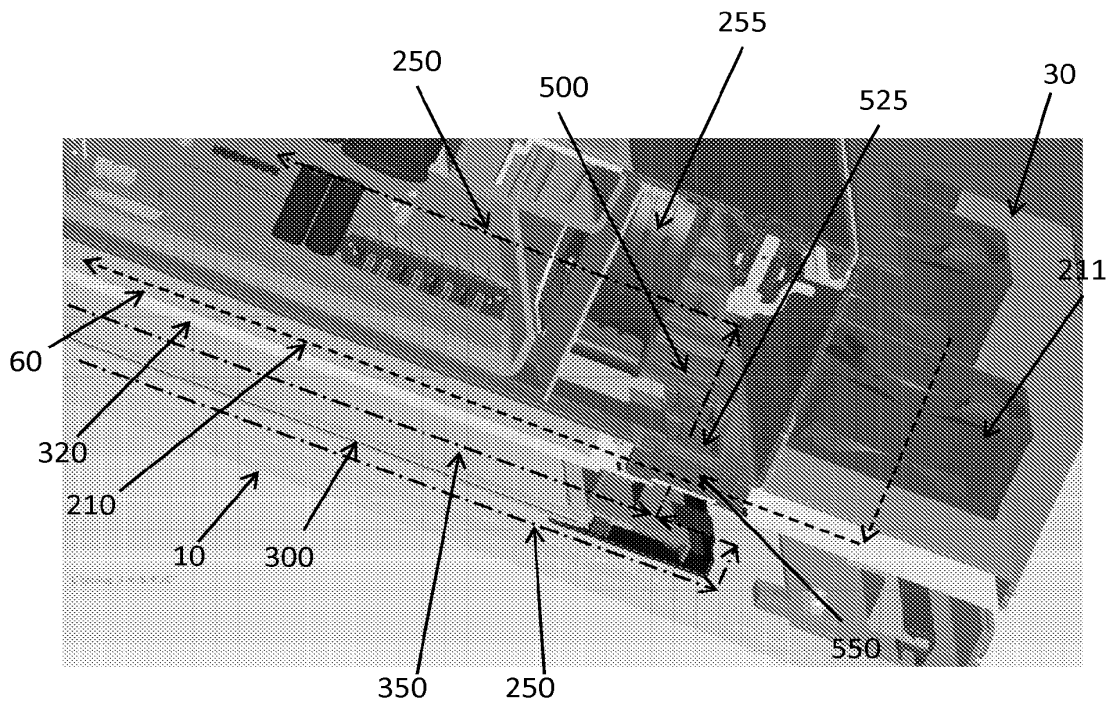
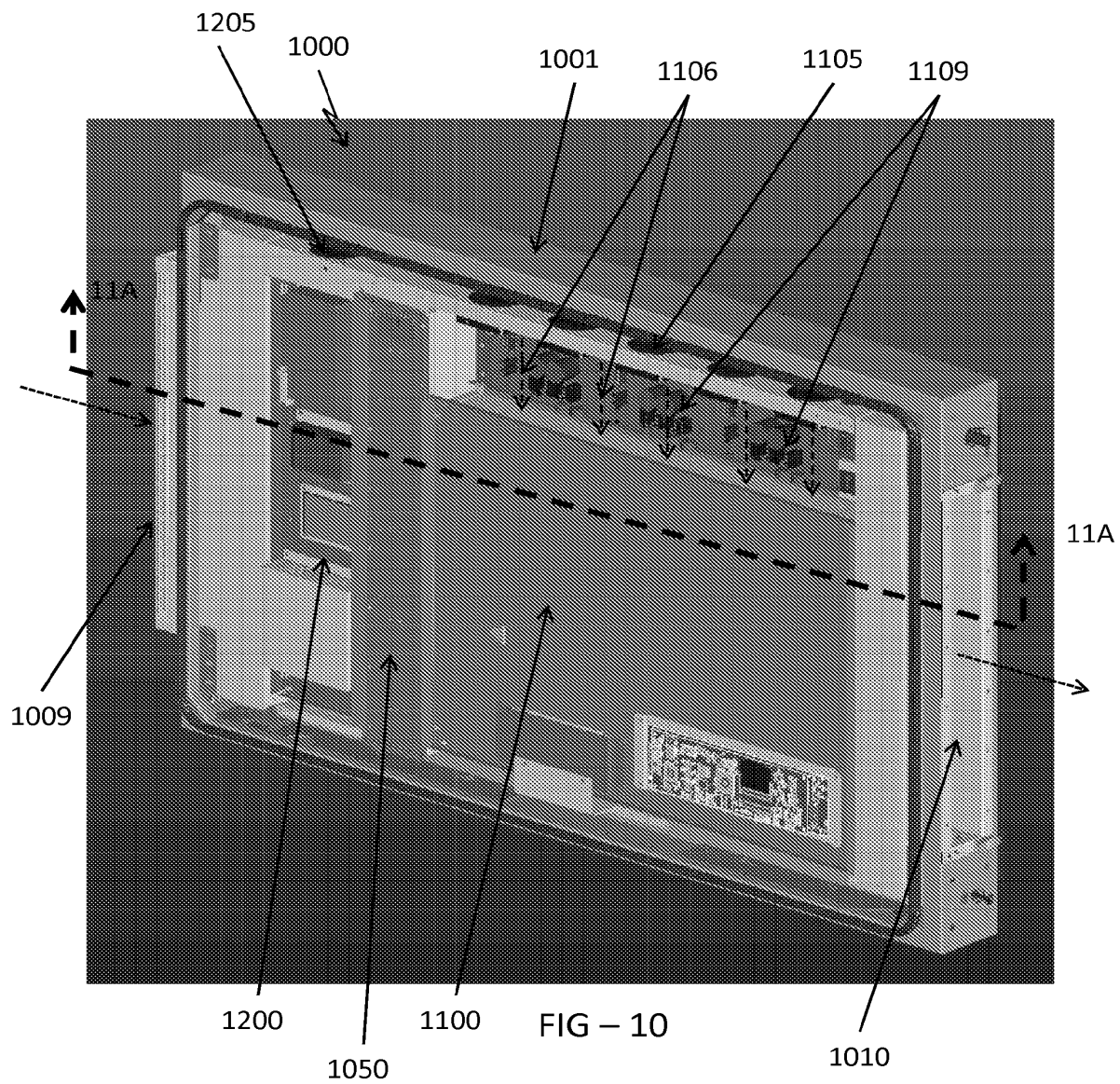
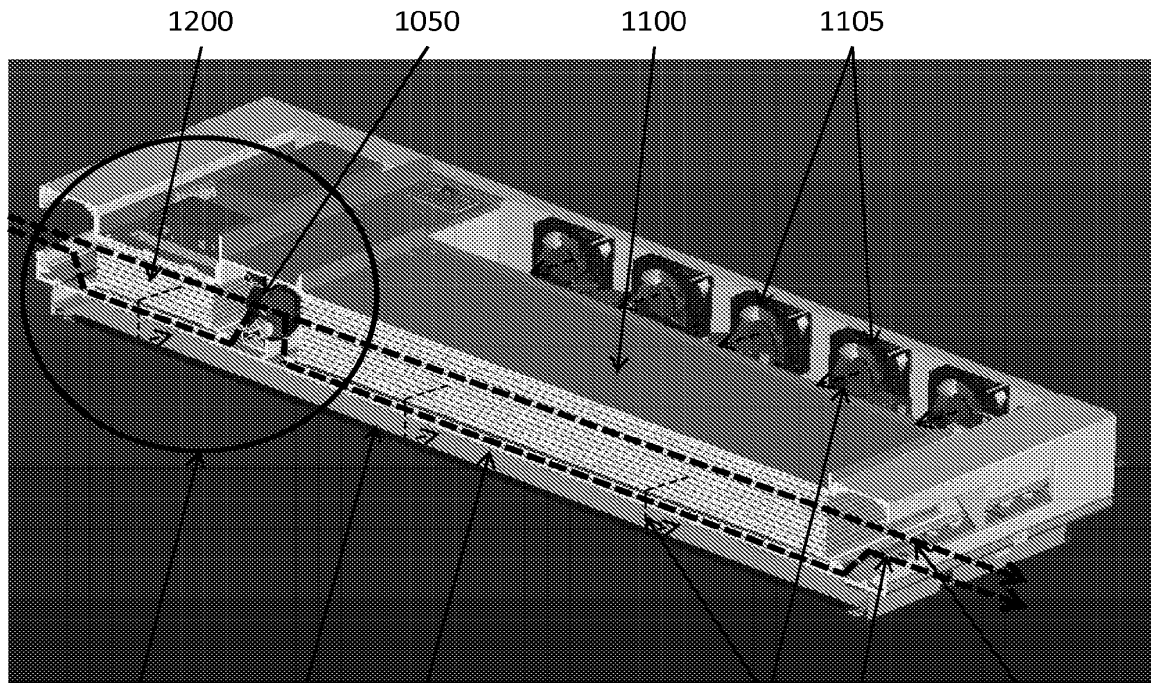
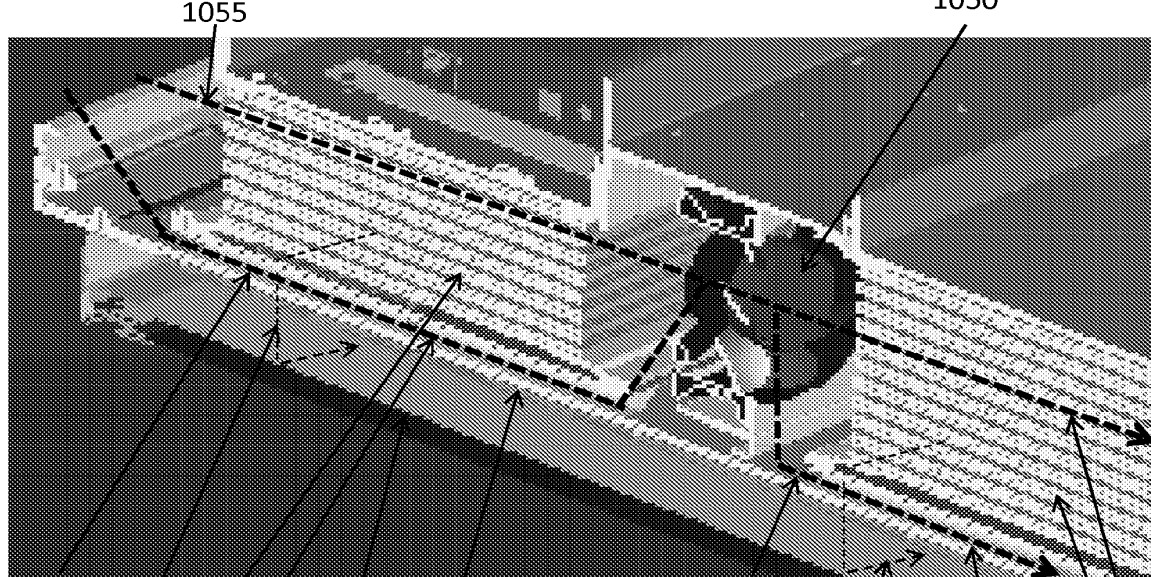


FIG - 9





B 1500 1600 FIG - 11A 1106 1056 1055



1055 1700 1106 1200 1500 1600 FIG - 11B 1056 1106 1700 1100 1055

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- (71) Applicant: **MANUFACTURING RESOURCES INTERNATIONAL, INC.** [US/US]; 6415 Shiloh Road East, Alpharetta, GA 30005 (US).
- (72) Inventors: **DUNN, William**; 6415 Shiloh Road East, Alpharetta, GA 30005 (US). **HUBBARD, Tim**; 6415 Shiloh Road East, Alpharetta, GA 30005 (US). **O'CONNOR, Kevin**; 6415 Shiloh Road East, Alpharetta, GA 30005 (US).
- (74) Agents: **DUNHAM, Tyler, S.** et al.; Standley Law Group LLP, 6300 Riverside Drive, Dublin, OH 43017 (US).
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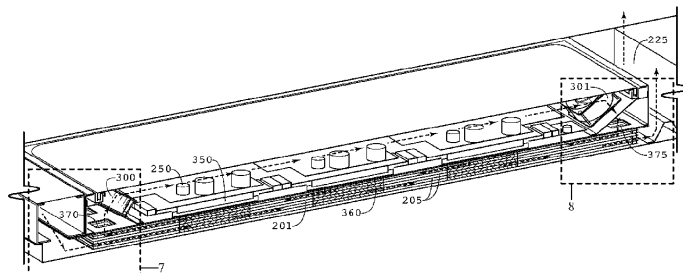


FIG. 6

(57) Abstract: The exemplary embodiments disclosed herein provide a heat exchanger assembly for cooling power module bricks, having a plurality of heat exchanger layers where a top layer is in conductive thermal communication with the power module brick. A series of metallic plates are preferably positioned within each heat exchanger layer and are preferably aligned with the power module brick. A circulating fan may be positioned to force circulating gas across the power module brick and through the heat exchanger. An external air fan may be positioned to force external air through the heat exchanger. Pass through junctions may be positioned near edges of the heat exchanger to permit the circulating gas to cross paths with the external air without allowing the two gas flows to mix with one another.

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HEAT EXCHANGE ASSEMBLY FOR AN ELECTRONIC DISPLAY

Cross-Reference to Related Applications

[0001] This application claims priority to co-pending US Provisional Application No. 61/791,421 filed on March 15, 2013 and herein incorporated by reference in its entirety.

Technical Field

[0002] The disclosed embodiments of the present invention relate to an assembly for removing the heat generated by an electronic display.

Background of the Art

[0003] Electronic displays are now being used in outdoor environments where high ambient temperatures and direct solar loading can cause the display to malfunction due to excess heat.

Summary of the Exemplary Embodiments of the Invention

[0004] The exemplary embodiments disclosed herein provide a heat exchanger assembly for cooling power module bricks, having a plurality of heat exchanger layers where a top layer is in conductive thermal communication with the power module brick. A series of metallic plates are preferably positioned within each heat exchanger layer and are preferably aligned with the power module brick. A circulating fan may be positioned to force circulating gas across the power module brick and through the heat exchanger. An external air fan may be positioned to force external air through the heat exchanger. Pass through junctions may be positioned near edges of the heat exchanger to permit the circulating gas to cross paths with the external air without allowing the two gas flows to mix with one another.

[0005] This and other unmet advantages are provided by the device and method described and shown in more detail below.

Brief Description of the Drawings

[0006] A better understanding of the disclosed embodiments will be obtained from a reading of the following detailed description and the set of accompanying drawings.

[0007] FIGURE 1 provides a perspective view of an exemplary electronic display assembly.

[0008] FIGURE 2 provides a perspective view of the electronic display subassembly after being removed from the assembly shown in Figure 1.

[0009] FIGURE 3 provides a perspective view of the electronics and power subassembly after being removed from the assembly shown in Figure 1 and illustrates the horizontal section line 6-6.

[0010] FIGURE 4 provides an exploded view of the electronics and power subassembly shown in Figure 3.

[0011] FIGURE 5 provides a perspective view of the electronics and power subassembly shown in Figure 3 after removing the cover doors.

[0012] FIGURE 6 provides a section view of the electronics and power subassembly shown in Figure 3, taken along the section line 6-6.

[0013] FIGURE 7 provides a detailed section view of DETAIL 7, shown in Figure 6 where a second section has been taken vertically through the center of the pass through junctions.

[0014] FIGURE 8 provides a detailed section view of DETAIL 8, shown in Figure 6 where a second section has been taken vertically through the center of the pass through junctions.

Detailed Description of a Preferred Embodiment

[0015] 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.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] FIGURE 1 provides a perspective view of an exemplary electronic display assembly having a housing containing an electronic display subassembly 100 and an electronics and power subassembly 150. In an exemplary embodiment, the housing would have two separate flows of external air flowing through the housing. The first is shown in this figure where external air is ingested at the apertures 50 and is exhausted from the aperture 75.

[0023] FIGURE 2 provides a perspective view of the electronic display subassembly 100 after being removed from the assembly shown in Figure 1. The electronic display 120 preferably has a pathway for external air running behind the display 120, this would provide the second flow of external air for an exemplary embodiment. In an exemplary embodiment, the inlet apertures 170 are positioned above the display and are in

gaseous communication with a gap 140 behind the display, which ultimately connects with an exhaust aperture 180 positioned below the display. The gap 140 may be created by placing a surface or plate 140 behind the rear surface of the electronic display 120. One or more fans 110 may be positioned to draw the external air through the inlet 170, gap 140, and exhaust 180.

[0024] The electronic display can be any variety of electronic display 120, including but not limited to liquid crystal display (LCD), LED, OLED, plasma, electroluminescent polymers, field emission display, and laser video displays. In an exemplary embodiment the electronic display 120 would comprise an LED backlit LCD where the rear surface of the electronic display 120 would be the rear surface of the LED backlight.

[0025] FIGURE 3 provides a perspective view of the electronics and power subassembly 150 after being removed from the assembly shown in Figure 1 and illustrates the horizontal section line 6-6. A pair of inlet apertures 220 are preferably in gaseous communication with the inlet apertures 50 in the housing to supply external air to the assembly. This ingested external air is preferably exhausted through the exhaust aperture 225, which aligns with the exhaust aperture 75 in the housing.

[0026] FIGURE 4 provides an exploded view of the electronics and power subassembly 150 shown in Figure 3. A first plenum enclosure is preferably created by the plenum walls 281, heat exchanger 201, and front cover 265. A second plenum enclosure is preferably created by the plenum walls 282, heat exchanger 202, and front cover 266. One or more power assemblies or power modules 250 may be placed within the first plenum enclosure. One or more electronic assemblies 260 may be placed within the second plenum enclosure. In an exemplary embodiment, the two plenum enclosures are substantially sealed, and do not accept external air, dust, or other contaminants other than the flow of external air described herein (which preferably would not enter the plenum enclosures, but would only flow through the heat exchangers 201 and 202 as described below).

[0027] Further, in an exemplary embodiment, the power modules 250 would be considered high voltage / high power electronics while the electronic assemblies 260 would be considered low voltage / low power electronics and these would be isolated

into their own respective plenums. Generally speaking, the electronic assemblies 260 would include, but would not be limited to: hard drives, video players, microprocessors, wireless/satellite antennas, and CPU's. A wiring conduit 275 may provide wiring access into the plenums but should be substantially sealed so as not to allow contaminants or external air to enter the plenum through the wiring conduit 275. The wiring conduit 275 may provide the electrical communication between the low power and high power electronics and also between the low/high power electronics and the electronic display 120.

[0028] FIGURE 5 provides a perspective view of the electronics and power subassembly shown in Figure 3 after removing the cover doors 265 and 266. A fan 310 may be placed in the inlet tube to draw the external air through the inlets, heat exchanger, and exhaust aperture 225. Alternatively, a fan 312 could be placed near the exhaust aperture 225. In some embodiments, both fans 310 and fan 312 may be used. In the first plenum, fans 300 and 301 are used to force a closed loop circulating gas through the plenum and heat exchanger 201. In the second plenum, fans 302 and 303 are used to force a closed loop circulating gas through the plenum and heat exchanger 202. Of course, in some embodiments only a single fan for each closed loop of circulating gas may be used rather than the pairing of fans shown herein.

[0029] FIGURE 6 provides a section view of the electronics and power subassembly 150 shown in Figure 3, taken along the section line 6-6. Each power module 250 is preferably placed in conductive thermal communication with the heat exchanger 201. In an exemplary embodiment, the power brick 350 is preferably in conductive thermal communication with the heat exchanger 201, which is comprised of a plurality of layers 205, where the space in between each layer defines a gaseous pathway. In an exemplary embodiment, a metallic plate 360 is preferably placed between each layer 205 of the heat exchanger 201, and is positioned adjacent to the areas containing a power brick 350. The layers 205 of the heat exchanger 201 may be metallic or plastic (sometimes corrugated plastic or corrugated metal as shown in the Figures) or any combination of these materials. The heat exchangers 201 and 202 are preferably counterflow heat exchangers.

[0030] In an exemplary embodiment, the length and width of the metallic plates 360 are substantially the same as the length and width of the power bricks 350, however this is not required. Ideally, a series of metallic plates 360 may be aligned with each brick 350, such that a layer 205 of the heat exchanger is placed between the brick 350 and the first plate 360, as well as between each subsequent plate 360. While it may not be necessary to place a metallic plate 360 between every heat exchanger layer 205, this may be done in an exemplary embodiment. Each metallic plate 360 may be sandwiched between the layers 205 and may be held in place with adhesive.

[0031] The external air is forced through the heat exchanger 201 and exhausted out of the exhaust aperture 225. In this way, heat from the power module 250 may be transferred to the brick 350 and eventually to the plates 360 and heat exchanger layers 205 through conductive heat transfer. The external air removes heat from these assemblies as it passes through the heat exchanger 201.

[0032] Additionally, closed loop circulating gas is also travelling through the pathways of the heat exchanger 201, where the gas pathways may be defined as the space between heat exchanger layers 205. The layers 205 may be spaced apart based on the thickness of the plates 360, and held with this spacing once assembled around the plates 360. In this embodiment, the closed loop of circulating gas is forced around the closed loop by the pair of fans 301 and 301. The loop may be described as beginning at fan 301, traversing the pass through junction 375, travelling through the heat exchanger 201, traversing the pass through junction 370, passing the fan 300, and travelling across the power modules 250 before returning to the fan 301. The gas pathways alternate, where a pathway accepting circulating gas would be adjacent to a pathway accepting external air which is in turn adjacent to another pathway accepting circulating gas. Preferably, the circulating gas and external air are not permitted to mix with one another. However, as the two gases travel through their pathways, heat from the circulating gas can be transferred to the external air and removed from the display housing through the exhaust.

[0033] The opposing heat exchanger 202 is setup in a similar fashion as the heat exchanger 201 described above. The only difference would be that heat exchanger 202 would not contain the bricks 350, which are generally not used for the low power/voltage

electronics 260. However, the metallic plates 360 may be used in the heat exchanger 202, in order to pull heat from the electronics 260 into the heat exchanger 202 for removal by the external air.

[0034] FIGURE 7 provides a detailed section view of DETAIL 7, shown in Figure 6, where a second section has been taken vertically through the center of the pass through junctions. Here, the details of an exemplary pass through junction 370 are shown. Generally, the pass through junction 370 is placed near the end of the heat exchanger 201. Initially, note the blocking elements 212 which are positioned within each pathway 206 which contains the closed loop circulating gas. These blocking elements 212 run the entire length of the heat exchanger 201, to prohibit external air from entering the circulating gas pathways. Also note the cutout opening 371 in the heat exchanger which preferably passes through several, if not every layer 205 of the heat exchanger. While a blocking element 212 may be placed adjacent to the opening 371 on the end of the heat exchanger, the opposing side of the opening 371 is preferably free of any blocking so that the pathways 215 which accept circulating gas can provide gaseous communication through the opening 371 to continue the circulating closed loop path.

[0035] A series of donut gaskets 210 may be placed within each pathway 206 which accepts external air, such that the donut gasket 210 substantially surrounds and seals off the pathway 206 from the opening 371. In this way, external air traveling through the heat exchanger is permitted to flow through the pathway 206, but is not permitted to enter the opening 371 or mix with the circulating gas. The donut gaskets 210 do not preferably run the entire length of the heat exchanger, but would only surround the openings 371, which could be any shape but are typically found as rectangles, squares, circles, ovals, or some combination of these. The interior dimensions of the donut gaskets 210 preferable match that of the cutout 371. However, the exterior dimensions of the donut gaskets 210 can vary.

[0036] Although not required, it is preferable that the donut gaskets 210 are comprised of a compressible material, preferably an elastomer or rubber of some type, but soft and compressible materials have been found to provide acceptable results. In some embodiments, the donut gaskets 210 can simply comprise a sheet of compressible

material having a void removed from the center, where that void can have any shape, including but not limited to any polygon, circle, or oval shape. Preferably, the donut gaskets 210 would have a continuous perimeter surrounding the void, which is preferably aligned with the opening 371, so that external air is not permitted to enter the opening 371, but can still travel through the pathway 206.

[0037] FIGURE 8 provides a detailed section view of DETAIL 8, shown in Figure 6, where a second section has been taken vertically through the center of the pass through junctions. Here, the details of an exemplary opposing pass through junction 375 are shown. Again, the opposing pass through junction 375 is preferably placed near the end/edge of the heat exchanger 201. Also, again note the blocking elements 212 which are positioned within each pathway 206 which contains the closed loop circulating gas. These blocking elements 212 run the entire length of the heat exchanger 201, to prohibit external air from entering the circulating gas pathways. Also note the cutout opening 376 in the heat exchanger which preferably passes through several, if not every layer 205 of the heat exchanger. While a blocking element 212 may be placed adjacent to the opening 376 on the end of the heat exchanger, the opposing side of the opening 376 is preferably free of any blocking so that the pathways 206 which accept circulating gas can provide gaseous communication through the opening 376 to continue the circulating closed loop path.

[0038] A series of donut gaskets 210 may again be placed within each pathway 206 which accepts external air, such that the donut gasket 210 substantially surrounds and seals off the pathway 206 from the opening 376. In this way, external air traveling through the heat exchanger is permitted to flow through the pathway 206, but is not permitted to enter the opening 371 or mix with the circulating gas. Here, the external air would travel around the donut gasket 210, eventually exiting the heat exchanger and exhausting out of the exhaust aperture 225.

[0039] An angled redirection plate 400 is preferably placed after the heat exchanger and adjacent to the exhaust aperture 225 in order to change the direction of the external air approximately 90 degrees, or in other words to direct it towards the exhaust aperture 225.

[0040] Another pair of pass through junctions with their own gasket donuts and blocking elements are preferably used for the opposing side of the assembly, which houses the electronics 260. The design could be substantially the same, however in some embodiments it may be possible to use a smaller heat exchanger or perhaps one with fewer layers, as there may be less heat generated by the electronics 260 when compared to the power modules 250. There could also be fewer fans used on this side of the assembly as well.

[0041] It should be noted that the term circulating gas does not require a 'pure' gas but could be any gaseous matter (which could of course be a mixture of various types of gases and even small amounts of contaminate, but the circulating gas would preferably have only a minimal amount of contaminants, and most preferably would be free of particulate and contaminants).

[0042] 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. Thus, 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

What is claimed is:

1. A heat exchanger assembly for cooling power modules having bricks, the assembly comprising:
 - a plurality of heat exchanger layers where a top layer is placed in conductive thermal communication with the power module brick; and
 - a metallic plate positioned between each heat exchanger layer and adjacent to the power module brick.
2. The heat exchanger assembly of claim 1 further comprising:
 - an external air fan positioned to force external air through the heat exchanger layers.
3. The heat exchanger assembly of claim 1 wherein:
 - the power module brick is in conductive thermal communication with the top layer of the heat exchanger, and where the top layer of the heat exchanger is also in conductive thermal communication with the metallic plate.
4. The heat exchanger assembly of claim 2 further comprising:
 - blocking elements placed between alternating pairs of layers to define closed loop pathways where the blocking elements are placed along opposing edges of the heat exchanger;
 - a cutout placed near the edges of the heat exchanger which contain the blocking elements;
 - a donut gasket surrounding each cutout and placed only within pathways which are not closed loop pathways; and
 - a closed loop fan positioned to force a closed loop of circulating gas through the closed loop pathways, both cutouts, and along the power modules.
5. The heat exchanger assembly of claim 4 wherein:

the blocking elements run the entire length of the heat exchanger.

6. The heat exchanger of claim 4 wherein:
the external air is not permitted to mix with the circulating gas.
7. The heat exchanger of claim 1 wherein:
the heat exchanger layers are comprised of corrugated plastic.
8. The heat exchanger of claim 1 wherein:
the heat exchanger layers are comprised of metal.
9. A heat exchanger assembly for cooling power modules having bricks, the assembly comprising:
a plurality of heat exchanger layers placed within a plenum where an outer layer is placed in conductive thermal communication with the power module brick;
a plurality of gaseous pathways defined by the space between each layer where the pathways alternate between carrying air from outside of the plenum (external air pathway) and a closed loop gas (circulating gas pathway);
a metallic plate positioned within each pathway and adjacent to the power module brick;
an external air fan positioned to force external air through the external air pathways; and
a circulating fan positioned to force circulating gas through the circulating gas pathways.
10. The heat exchanger assembly of claim 9 wherein:
the circulating gas travels in a closed loop and does not mix with the external air.
11. The heat exchanger assembly of claim 9 wherein:

the power module brick is in conductive thermal communication with the outer layer of the heat exchanger, and where the outer layer of the heat exchanger is also in conductive thermal communication with the metallic plate.

12. The heat exchanger assembly of claim 9 further comprising:
blocking elements placed within entrances to the circulating gas pathways.
13. The heat exchanger assembly of claim 12 further comprising:
a cutout passing through several layers of the heat exchanger and placed adjacent to the blocking elements; and
a gasket sounding the cutout and placed only within external air pathways.
14. The heat exchanger assembly of claim 9 further comprising:
blocking elements placed along edges of the circulating gas pathways.
15. An assembly for cooling an electronic display having high power electrical assemblies and low power electrical assemblies, the cooling assembly comprising:
a first sealed plenum containing the high power electrical assemblies and a first heat exchanger;
a first circulating fan positioned for force circulating gas through the first heat exchanger and across the high power electrical assemblies;
a second sealed plenum containing the low power electrical assemblies and a second heat exchanger;
a second circulating fan positioned to force circulating gas through the second heat exchanger and across the low power electrical assemblies;
a first external fan positioned to draw external air through the first heat exchanger; and
a second external fan positioned to draw external air through the second heat exchanger.

16. The cooling assembly of claim 15 wherein the first heat exchanger comprises:
a plurality of heat exchanger layers where a top layer is placed in conductive thermal communication with the high power electrical assemblies.
17. The cooling assembly of claim 16 further comprising:
a metallic plate positioned between each heat exchanger layer and aligned with each of the high power electrical assemblies.
18. An assembly for cooling an electronic display having a power module brick and a video player, the cooling assembly comprising:
a housing containing the electronic display, power module brick, and a video player;
a first inlet aperture along an edge of the housing;
a second inlet aperture along an edge of the housing opposing the first inlet aperture;
an exhaust aperture placed near a center of the housing;
a portion of the housing which is placed behind the electronic display to define a gap;
a display fan positioned to force external air through the gap;
a first sealed plenum containing the power module brick and a first heat exchanger;
a first circulating fan positioned for force circulating gas through the first heat exchanger and across the power module brick;
a second sealed plenum containing the video player and a second heat exchanger;
a second circulating fan positioned to force circulating gas through the second heat exchanger and across the video player;
a first external fan positioned to draw external air through the first inlet aperture, first heat exchanger, and exhausted through the exhaust aperture;

a second external fan positioned to draw external air through the second inlet aperture, second heat exchanger, and exhausting out of the exhaust aperture; and
a series of metallic plates positioned within the first heat exchanger and substantially aligned with the power module brick.

19. The cooling assembly of claim 18 wherein the first heat exchanger comprises:
a plurality of heat exchanger layers where a top layer is placed in conductive thermal communication with the power module brick.
20. The cooling assembly of claim 19 further comprising:
a metallic plate positioned between each heat exchanger layer and adjacent to the power module brick.

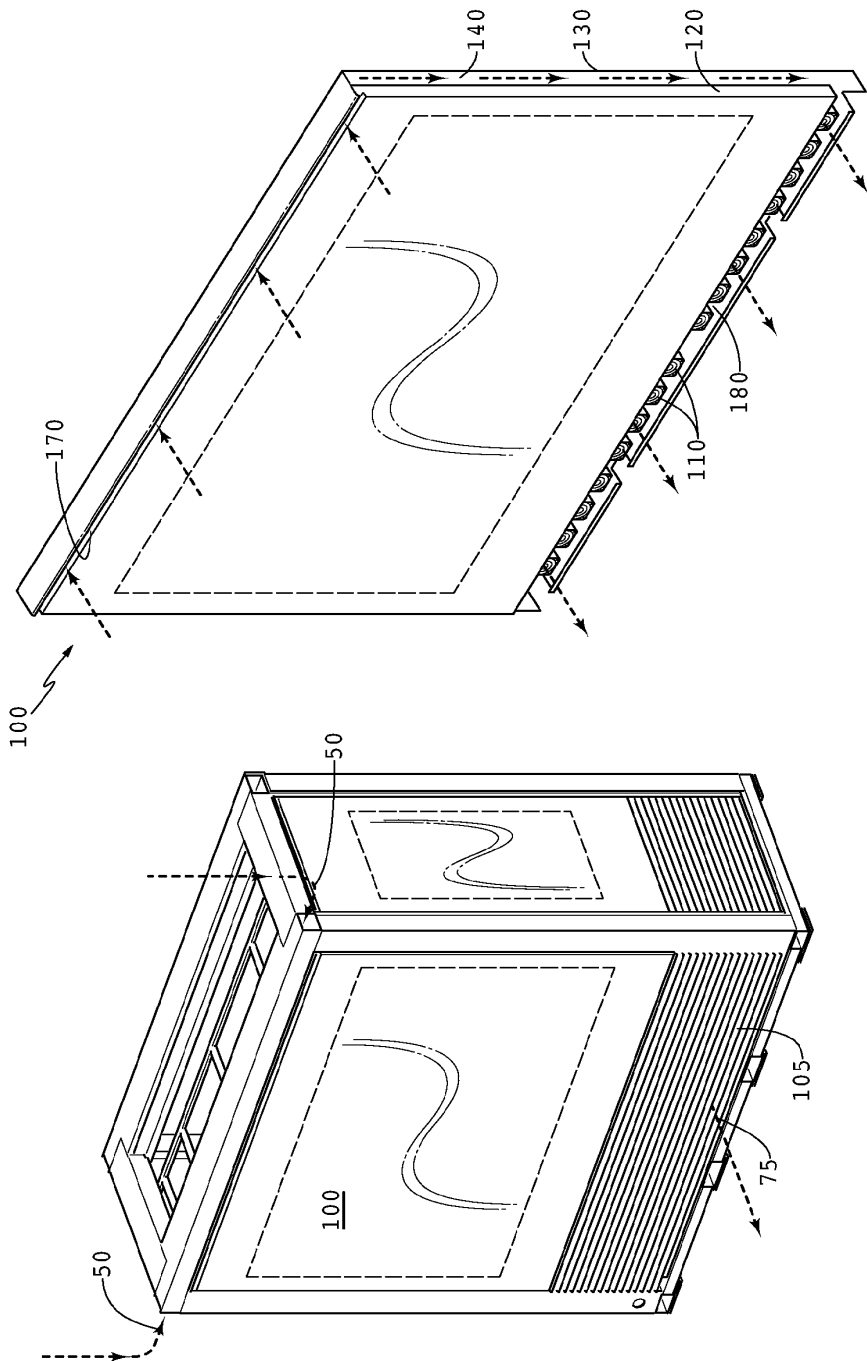
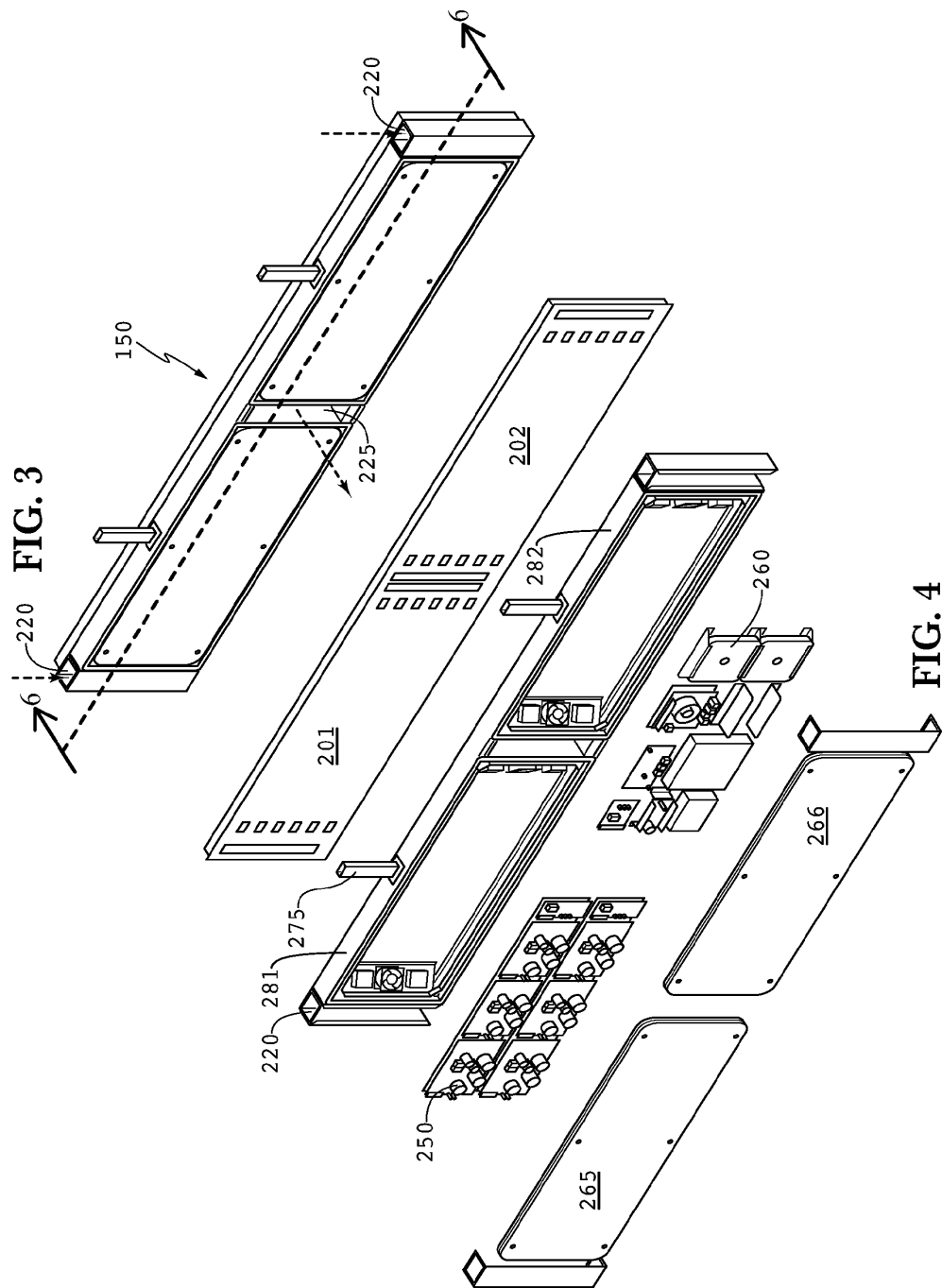


FIG. 2

FIG. 1



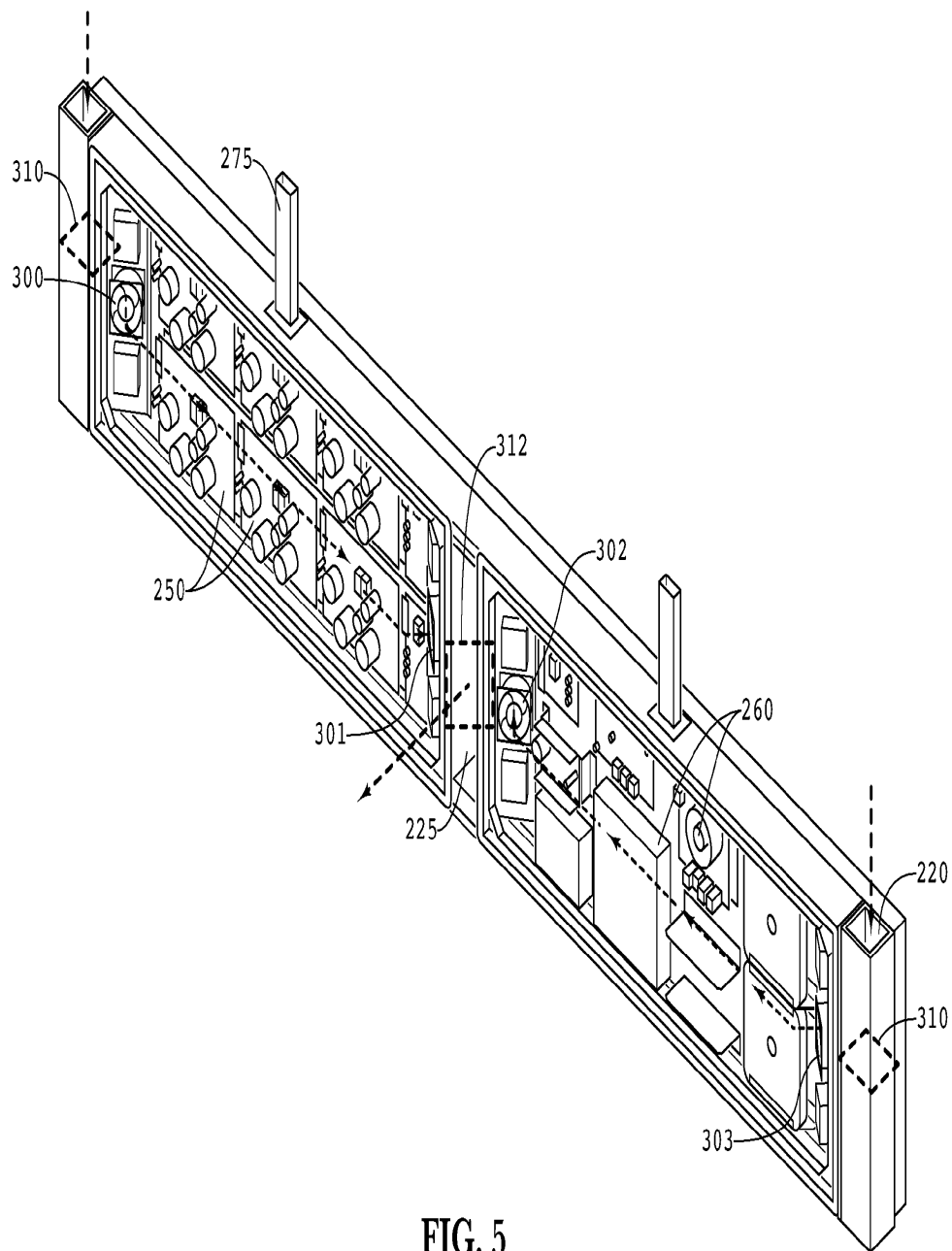


FIG. 5

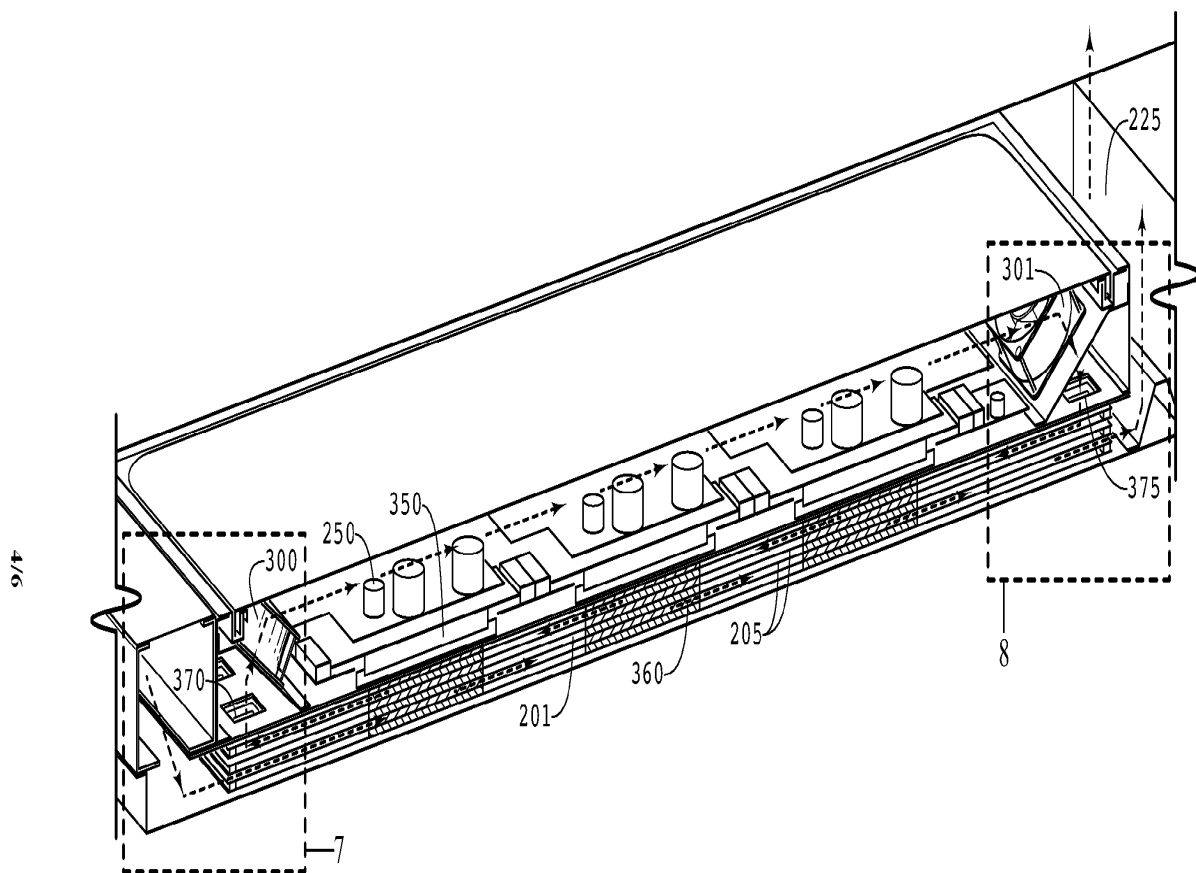


FIG. 6

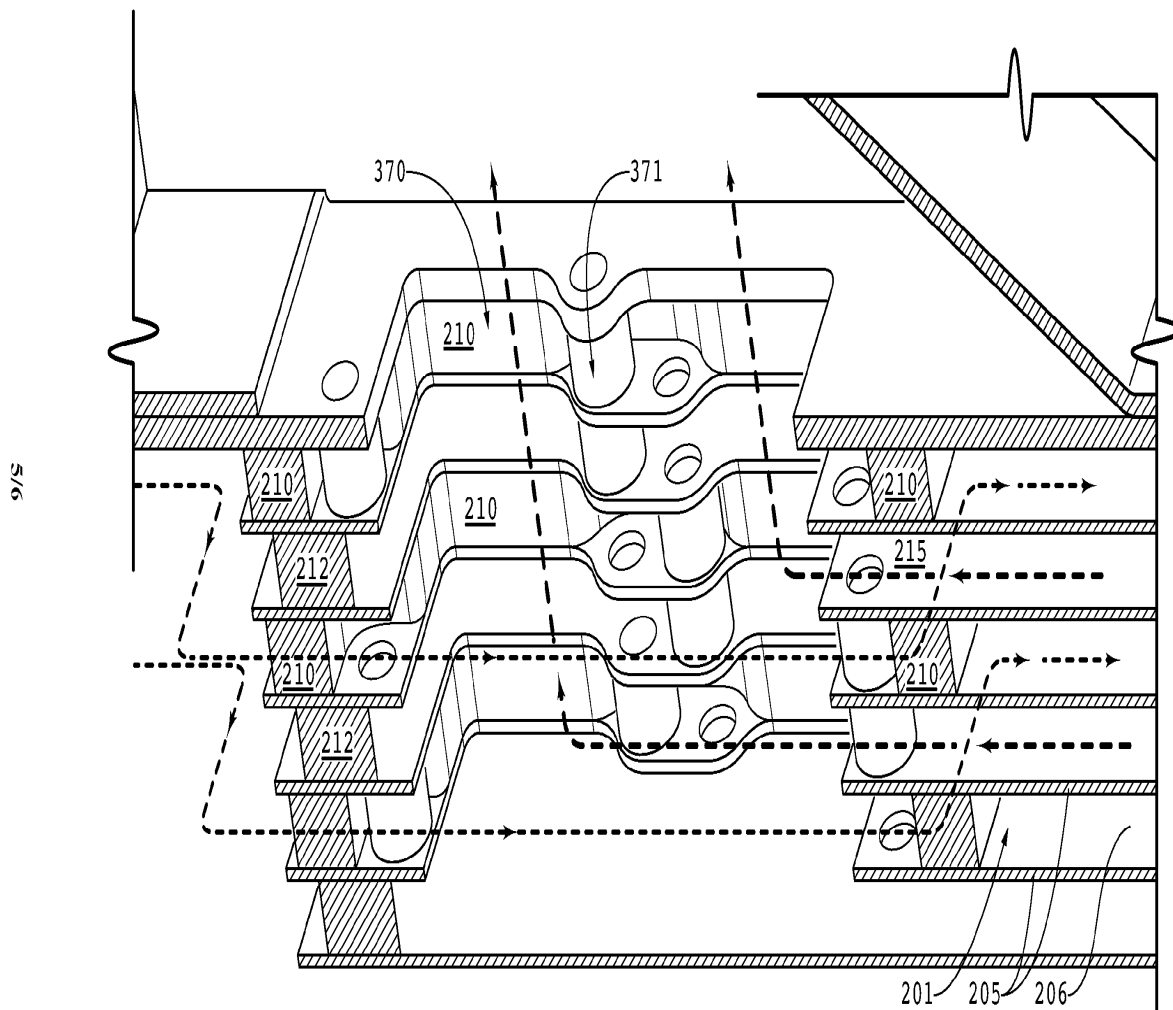


FIG. 7

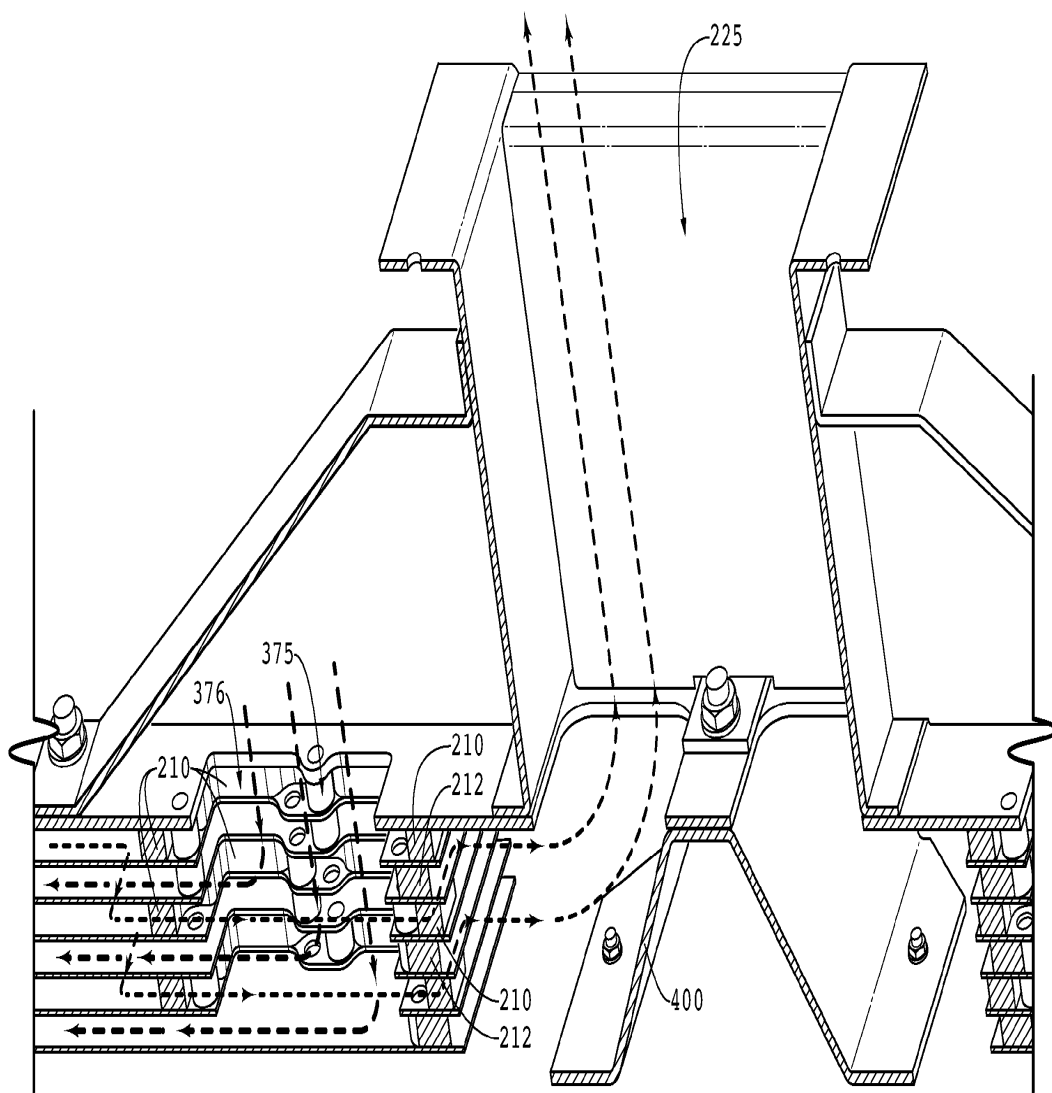


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 14/20850

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H05K 7/20 (2014.01)

USPC - 361/679.46, 704

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) - H05K 7/20 (2014.01)

USPC - 361/679.46, 704

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 349/161; 361/679.47, 679.48, 679.49, 679.5, 679.54, 688-691, 694-697, 701, 702, 707, 709, 710, 715

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

Patbase; Google (Patents; Scholar; Web); Espacenet; Search Terms: air, ambient, batter*, between, blow*, brick*, closed, communicat*, conduct*, cool*, cutout*, donut*, exchang*, external*, fan*, gasket*, heat*, hole*, intermediate*, layer*, loop*, metal*, mix*, multi*, opening*, o-ring*, path*, plate*, plural*, power*, seal*, stack*, thermal*, thro

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X		1-3, 7-12, 14
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Y	US 2011/0085301 A1 (Dunn) 14 April 2011 (14.04.2011), entire document, especially Figs. 3A-3C, para [0026], [0032]-[0034]	4-6, 13
Y	US 2002/0148600 A1 (Bosch et al.) 17 October 2002 (17.10.2002), para [0039]-[0040]	4-6
Y	US 2009/0120629 A1 (Ashe) 14 May 2009 (14.05.2009), Fig. 22, para [0200]	13
A	US 2011/0261523 A1 (Dunn et al.) 27 October 2011 (27.10.2011), Figs. 2-6, para [0023]-[0026]	1-14

☐ 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

"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

"G" document member of the same patent family

Date of the actual completion of the international search

23 July 2014 (23.07.2014)

Date of mailing of the international search report

25 AUG 2014

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents

P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 14/20850

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
--- See extra sheet ---

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-14

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 14/20850

Continuation of Box No. III - Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-14, directed to a heat exchanger assembly including a plurality of heat exchanger layers.

Group II: Claims 15-20, directed to an assembly for cooling an electronic display including first and second sealed plenums containing first and second heat exchangers.

The inventions listed as Groups I and II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special Technical Features

The inventions of Group I do not include the special technical feature of a first sealed plenum containing a first heat exchanger and a second sealed plenum containing a second heat exchanger as required by Group II.

The inventions of Group II do not include the special technical feature of a plurality of heat exchanger layers and a metallic plate positioned adjacent to the power module brick as required by Group I.

Common Technical Features

Groups I and II share the technical features of a heat exchanger within a plenum, an external fan, and a circulating fan, however these shared technical features do not represent a contribution over the prior art as being anticipated by US 2011/0085301 A1 (Dunn) which discloses a heat exchanger (para [0005], 'heat exchanger may be used to transfer heat from the circulating gas to the ambient gas') in a plenum (41, para [0024]), an external fan (60, Fig. 1; para [0018]) and a circulating fan (50, Fig. 1; para [0018]).

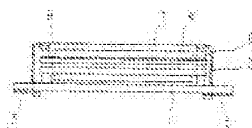
Therefore, Groups I-II lack unity under PCT Rule 13 because they do not share a same or corresponding technical feature.

LIQUID CRYSTAL DISPLAY DEVICE

Publication number: JP3153212 (A)
Publication date: 1991-07-01
Inventor(s): KOBAYASHI SHICHIRO; SEKI TERUO; AOYAMA NAOFUMI; SAKUMA TOSHIYUKI
Applicant(s): HITACHI LTD
Classification:
- **international:** **G02F1/1333; G02F1/1345; G02F1/13; G02F1/13;** (IPC1-7): G02F1/1333; G02F1/1345
- **European:**
Application number: JP19890291285 19891110
Priority number(s): JP19890291285 19891110

Abstract of JP 3153212 (A)

PURPOSE:To sufficiently take an EMI countermeasure by forming a transparent conductive film which is connected to a metallic shielding case and the earth pattern of a driving circuit board over the nearly entire surface of a transparent substrate on the side of the screen side of a liquid crystal display part(LCD). **CONSTITUTION:**The transparent conductive film 7 is formed on the nearly entire surface of the transparent substrate of an LCD 4 for compensation air ranged on the display side of a display LCD 1, and this transparent conductive film 7 is connected electrically in the path of conductive rubber 8, the metallic shielding case 2, the earth pattern 5 of PCB, and an external earth in order. The earth level is held on the screen of the LCD, so the entire screen of the LCD can be shielded. Namely, the flanks of the LCDs 1 and 4 are shielded by the metallic shield case 2 held at the earth level similarly and the screen of the LCD is shielded by the transparent conductive film 7. Consequently, the EMI countermeasure can be taken completely.



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⑨ 日本国特許庁(JP)

⑪ 特許出願公開

⑫ 公開特許公報(A) 平3-153212

⑤ Int. Cl.⁵

G 02 F 1/1333
1/1345

識別記号

庁内整理番号

8806-2H
9018-2H

⑬ 公開 平成3年(1991)7月1日

審査請求 未請求 請求項の数 1 (全3頁)

⑭ 発明の名称 液晶表示装置

⑰ 特 願 平1-291285

⑱ 出 願 平1(1989)11月10日

⑲ 発 明 者 小 林 七 朗 千葉県茂原市早野3300番地 株式会社日立製作所茂原工場
内
⑲ 発 明 者 関 輝 夫 千葉県茂原市早野3300番地 株式会社日立製作所茂原工場
内
⑲ 発 明 者 青 山 直 文 千葉県茂原市早野3300番地 株式会社日立製作所茂原工場
内
⑲ 発 明 者 佐 久 間 敏 幸 千葉県茂原市早野3300番地 株式会社日立製作所茂原工場
内
⑲ 出 願 人 株式会社日立製作所 東京都千代田区神田駿河台4丁目6番地
⑲ 代 理 人 弁理士 小川 勝男 外1名

明 細 書

1. 発明の名称

液晶表示装置

2. 特許請求の範囲

1. 表示用LCDと、少なくとも上記表示用LCDの側面周囲を覆う金属シールドケースと、上記表示用LCDの駆動回路基板とを具備する液晶表示装置において、上記LCDを構成する表示側の透明基板自体、または別の透明基板のほぼ全面に透明導電膜が設けられ、上記金属シールドケースが上記透明導電膜に電氣的に接続され、かつ該金属シールドケースが上記駆動回路基板のアースパターンに電氣的に接続されていることを特徴とする液晶表示装置。

3. 発明の詳細な説明

〔産業上の利用分野〕

本発明は、液晶表示装置に係り、特に、液晶表示装置におけるEMI(電磁波妨害:エレクトロマグネティックインタフィアレンス(Electro Magnetic Interference))対策に関する。

〔従来の技術〕

第2図は、従来の液晶表示装置を示す図で、(a)は平面図、(b)は正面図、(c)は(a)のII-II断面図である。

1は表示用LCD(液晶表示部)、2は金属シールドケース、3はPCB(プリント回路基板)、4は補償用LCD(LCD画面のバックを白くするためのもの)、5はPCB3に形成されたアースパターン、6は損傷防止用の絶縁膜である。LCD1、4はそれぞれ、寸法の違う上部透明ガラス基板と下部透明ガラス基板とが重ね合わせられ、その間に液晶が封止されている。

すなわち、従来の装置におけるEMI対策は、LCD1、4の側面の周囲に配置され、これらを覆う額縁状の金属シールドケース2をPCB3のアースパターン5に接続して行っている。アースパターン5は外部アースに接続されている。

従来の液晶表示装置は、例えば特開昭62-100736号公報、特開昭62-170940号公報等に記載されている。

〔発明が解決しようとする課題〕

従来の装置では、LCDの側面周辺に関しては、EMI対策がなされているが、LCD画面上に関してはなされていなかった。

本発明の目的は、EMI対策を十分施すことができる液晶表示装置を提供することにある。

〔課題を解決するための手段〕

上記の課題を解決するために、本発明は、表示用LCDと、少なくとも上記表示用LCDの側面周辺を覆う金属シールドケースと、上記表示用LCDの駆動回路基板とを具備する液晶表示装置において、上記LCDを構成する表示側の透明基板自体、または別の透明基板（例えば補償用LCD）のほぼ全面に透明導電膜が設けられ、上記金属シールドケースが上記透明導電膜に電氣的に接続され、かつ該金属シールドケースが上記駆動回路基板のアースパターンに電氣的に接続されていることを特徴とする。

上記全面に設けた透明導電膜と、金属シールドケースとは例えば導電性ゴムを介して接続する。

2→PCB3のアースパターン5→図示しない外部アースの経路で電氣的に接続されている。従って、LCD画面上をアースレベルに保つことができるので、LCDの画面全体をシールドすることができる。すなわち、LCD1、4の側面は、同様にアースレベルに保たれた金属シールドケース2により、また、LCD画面上は透明導電膜7によりシールドされ、EMI対策を完全に施すことができる。

なお、表示用LCD1の一方の透明ガラス基板には画素電極としてのパターン化された透明導電膜（図示せず）が、他方の透明ガラス基板には共通画素電極としての透明導電膜（図示せず）が全面に設けられている。本実施例の補償用LCD4は、この表示用LCD1の上記パターン化された透明画素電極をただ全面に設けるという変更により作製することができる。さらに、導電性ゴム8は補償用LCD4の透明ガラス基板の損傷防止にも役立つ。導電性ゴム8は金属シールドケース2で圧縮されている。

〔作用〕

本発明の液晶表示装置では、LCD画面側の透明基板のほぼ全面に、金属シールドケース・駆動回路基板のアースパターンに接続された透明導電膜が形成され、LCD画面上をアースレベルに保つことができるので、LCDの画面全体をシールドすることができ、EMI対策に有効である。

〔実施例〕

第1図は、本発明の一実施例の液晶表示装置を示す図で、(a)は平面図、(b)は正面図、(c)は(a)のI-I断面図である。

7は補償用LCDの透明ガラス基板の全面に設けたインジウム・チン・オキサイド（ITO膜：ネサ膜）等から成る透明導電膜、8は透明導電膜7と金属シールドケース2とを接続する導電性ゴムである。

本実施例の液晶表示装置では、表示用LCD1の表示側に配置された補償用LCD4の透明基板のほぼ全面に透明導電膜7が形成され、この透明導電膜7は、導電性ゴム8→金属シールドケース

以上、本発明の実施例を具体的に説明したが、本発明は上記実施例に限定されるものではなく、その要旨を逸脱しない範囲において種々変更可能であることは勿論である。例えば、上記実施例では、透明導電膜7を補償用LCD4の透明ガラス基板の全面に設けたが、表示側に配置した他の透明基板の全面に設けてもよく、さらに、補償用LCDを設けず、表示用LCDの透明ガラス基板の表示側に設けても本発明による効果を得ることができる。

また、第1図においては、表示用LCDを下側に、補償用LCDを上側に配置する構造になっているが、この配置を逆にして上側に表示用LCDを、下側に補償用LCDを配置した場合にも本発明を適用することができる。この場合は、上側に配置された表示用LCDの上側の基板の外側を透明導電膜で覆い、この透明導電膜をアースすればよい。

〔発明の効果〕

以上説明したように、本発明によれば、LCD

側面周囲のみならず、LCD画面上もアースレベルに保つことができるので、シールド効果が大きく、EMI対策を十分施すことができる。

4. 図面の簡単な説明

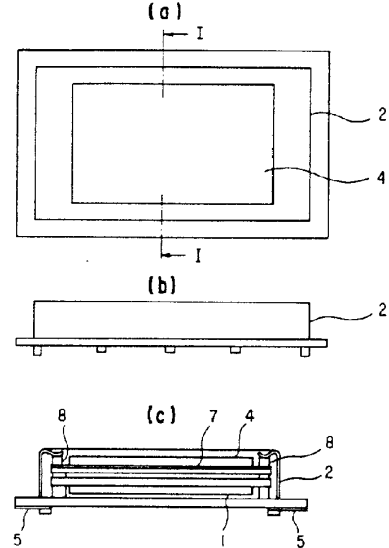
第1図(a)、(b)、(c)は、それぞれ本発明の一実施例の液晶表示装置を示す平面図、正面図、(a)のI-I断面図、第2図(a)、(b)、(c)は、それぞれ従来の液晶表示装置を示す平面図、正面図、(a)のII-II断面図である。

- 1…表示用LCD
- 2…金属シールドケース
- 3…PCB (プリント回路基板)
- 4…補償用LCD
- 5…PCBに形成されたアースパターン
- 6…損傷防止用の絶縁膜
- 7…透明導電膜
- 8…導電性ゴム

代理人弁理士 小川 勝 男

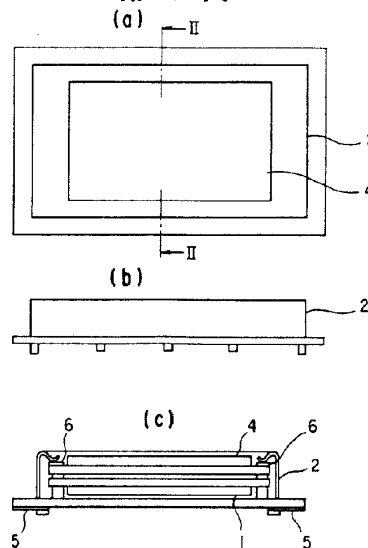


第1図



- 1…表示用LCD
- 2…金属シールドケース
- 3…PCB (プリント回路基板)
- 4…補償用LCD
- 5…PCBに形成されたアースパターン
- 7…透明導電膜
- 8…導電性ゴム

第2図



- 1…表示用LCD
- 2…金属シールドケース
- 3…PCB (プリント回路基板)
- 4…補償用LCD
- 5…PCBに形成されたアースパターン
- 6…損傷防止用の絶縁膜



Espacenet

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BACK LIGHT APPARATUS

Inventor(s): KIM TAE SOO [KR] ±
Applicant(s): PHICOM CORP [KR] ±
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- European:
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Abstract of KR100666961 (B1)

A backlight unit is provided to minimize the brightness variation of light applied to an object to be tested, thereby accurately identifying defects of the object to be tested, by partially controlling the reflective amount of light reflected from a reflective plate. A light source(110) emits a light to an object to be tested. A reflective plate(120) reflects the light emitted from the light source to the object to be tested. A brightness controlling member (130) is provided on the reflective plate. The brightness controlling member partially controls the amount of light reflected from the reflective plate, thereby making the brightness of light applied to the object to be tested uniform. The brightness controlling member corresponds to brightness holes, which are formed in the reflective plate.

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(65) 공개번호
(43) 공개일자

(73) 특허권자 주식회사 파이컴
서울 금천구 가산동 60-29번지

(72) 발명자 김태수
서울 금천구 독산1동 144-51 동만오피스텔 603호

(74) 대리인 장성구
김원준

심사관 : 장정태

전체 청구항 수 : 총 10 항

(54) 백 라이트 장치

(57) 요약

본 발명은 백 라이트 장치에 관한 것으로서, 피검사체를 조명하기 위한 백 라이트 장치에 있어서, 피검사체로 광을 발산하는 광원과, 광원으로부터 발산하는 광을 피검사체로 반사시키는 반사판과, 반사판에 마련되어 반사판의 광반사량을 부분적으로 보정함으로써 피검사체에 조사되는 광의 휘도가 균일하도록 하는 휘도보정수단을 포함한다. 따라서, 본 발명은 반사판의 광반사량을 용이하게 부분적으로 보정함으로써 광원의 특성이나 배열에 의해 필연적으로 발생하는 피검사체에 조사되는 광의 휘도 편차를 최소화하여 뛰어난 휘도 균일성을 가지도록 하고, 검사장비가 높은 휘도를 요구하더라도 이로 인해 광원으로부터 발생하는 열을 장치 내부에 정체됨이 없이 신속하고도 효과적으로 방출시킴으로써 피검사체가 온도로 인해 변형이 발생하는 것을 최소화함과 아울러 장비의 에러 발생을 방지하는 효과를 가지고 있다.

도 1

도 2

특허청구의 범위

청구항 1.

삭제

청구항 2.

피검사체를 검사를 위해 조명하는 백 라이트 장치에 있어서,

상기 피검사체로 광을 발산하는 광원과,

상기 광원으로부터 발산하는 광을 상기 피검사체로 반사시키는 반사판과,

상기 반사판에 마련되어 상기 반사판의 광반사량을 부분적으로 보정함으로써 상기 피검사체에 조사되는 광의 휘도가 균일하도록 하는 휘도보정수단을 포함하며,

상기 휘도보정수단은,

상기 반사판에 형성되어 광을 통과시키는 휘도보정홀인 것

을 특징으로 하는 백 라이트 장치.

청구항 3.

피검사체를 검사를 위해 조명하는 백 라이트 장치에 있어서,

상기 피검사체로 광을 발산하는 광원과,

상기 광원으로부터 발산하는 광을 상기 피검사체로 반사시키는 반사판과,

상기 반사판에 마련되어 상기 반사판의 광반사량을 부분적으로 보정함으로써 상기 피검사체에 조사되는 광의 휘도가 균일하도록 하는 휘도보정수단을 포함하며,

상기 휘도보정수단은,

상기 반사판에 부착되어 광을 흡수하는 휘도보정시트인 것

을 특징으로 하는 백 라이트 장치.

청구항 4.

제 2 항에 있어서,

상기 휘도보정홀은,

다수로 이루어지며, 상기 반사판의 가장자리로부터 중심으로 갈수록 조밀하게 분포되는 것

을 특징으로 하는 백 라이트 장치.

청구항 5.

제 2 항에 있어서,

상기 휘도보정홀은,

다수로 이루어지며, 상기 반사판의 가장자리로부터 중심으로 갈수록 직경 또는 폭이 증가하는 것

을 특징으로 하는 백 라이트 장치.

청구항 6.

제 2 항에 있어서,

상기 휘도보정홀은,

다수로 이루어지며, 상기 반사판의 가장자리로부터 중심으로 갈수록 간격이 작아지는 것

을 특징으로 하는 백 라이트 장치.

청구항 7.

제 2 항 또는 제 3 항에 있어서,

상기 광원 및 상기 반사판이 설치되며, 온도차이로 인해 발생하는 고온부분에 흡입구를, 저온부분에 방출구를 각각 형성하는 케이스와,

상기 흡입구 및 상기 방출구를 통해 공기를 각각 흡입 및 방출시키도록 상기 케이스에 설치되는 흡입팬 및 방출팬

을 더 포함하는 백 라이트 장치.

청구항 8.

제 2 항에 있어서,

상기 휘도보정홀을 통해 상기 광원에 냉각을 위한 공기를 송풍하도록 상기 휘도보정홀에 인접하도록 설치되는 냉각팬

을 더 포함하는 백 라이트 장치.

청구항 9.

제 3 항에 있어서,

상기 휘도보정시트는,

다수로 이루어지며, 상기 반사판의 가장자리로부터 중심으로 갈수록 조밀하게 분포되는 것

을 특징으로 하는 백 라이트 장치.

청구항 10.

제 3 항에 있어서,

상기 휘도보정시트는,

다수로 이루어지며, 상기 반사판의 가장자리로부터 중심으로 갈수록 직경 또는 폭이 증가하는 것을 특징으로 하는 백 라이트 장치.

청구항 11.

제 3 항에 있어서,

상기 휘도보정시트는,

다수로 이루어지며, 상기 반사판의 가장자리로부터 중심으로 갈수록 간격이 작아지는 것

을 특징으로 하는 백 라이트 장치.

명세서

발명의 상세한 설명

발명의 목적

발명이 속하는 기술 및 그 분야의 종래기술

본 발명은 백 라이트 장치에 관한 것으로서, 보다 상세하게는 피검사체에 대한 휘도의 균일성을 향상시킴으로써 피검사체에 대한 정확한 검사가 가능하도록 하며, 열을 신속하고도 효과적으로 배출시킴으로써 열로 인한 휘도의 편차 증가, 피검사체나 주변부품에 대한 손상을 방지하는 백 라이트 장치에 관한 것이다.

일반적으로, LCD(liquid crystal display) 패널 등과 같은 피검사체에 발생된 결함을 검사하는 장비는 피검사체에 광을 조사함으로써 피검사체 또는 피검사체에 존재하는 결함과 충돌한 광의 회절, 산란, 반사, 또는 투과에 의하여 LCD 패널과 같은 피검사체에서 결함을 찾아낼 수 있도록 하기 위해 중요한 요소인 백 라이트 장치가 마련된다.

이러한 종래의 LCD 패널 등과 같은 검사장비에 사용되는 백 라이트 장치를 첨부된 도면을 참조하여 설명하면 다음과 같다.

도 1은 종래의 기술에 따른 백 라이트 장치를 도시한 분해사시도이다. 도시된 바와 같이, 종래의 백 라이트 장치(10)는 케이스(11)와, 케이스(11)에 램프반침대(12)에 의해 병렬로 배열되도록 설치되어 피검사체를 향하여 광을 발산하는 다수의 램프(13)와, 램프(13)의 하측에 설치되어 램프(13)로부터 발산되는 광을 반사하는 반사판(14)과, 케이스(11)에 형성되는 개구(11a)를 통해 냉각을 위한 공기를 순환시키는 팬(15)을 포함한다. 또한, 케이스(11) 내측에 안정기(16)가 설치된다.

이와 같은 종래의 기술에 따른 백 라이트 장치(10)는 램프(13)에 의해 발산되는 광이 확산판(1)을 통해서 상판(2)을 통과하여 LCD 패널 등과 같은 피검사체로 조사된다. 이 때, 램프(13)로부터 발산되는 광은 반사판(14)에 의해 반사되어 피검사체로 조사된다.

이러한 종래의 백 라이트 장치(10)는 정확한 검사를 위하여 높은 휘도를 요구하고 있음에도 불구하고, 램프(13)의 특성 또는 배열에 따라 피검사체에 조사되는 광의 휘도 편차가 필연적으로 발생하게 되며, 이로 인해 피검사체에서 중심부분과 가장자리부분간의 휘도 편차가 25%를 상회하는 문제점을 가지고 있었다.

휘도 편차가 필연적으로 발생하는 이유를 보다 자세하게 설명하면 먼저, 종래의 백 라이트 장치(10)는 케이스(11)를 포함하여 구성부품들의 색상이 보통 흑색으로 이루어지는데, 광을 잘 흡수하는 흑색의 특성으로 인해 피검사체에 조사되는 광의 휘도는 중심부분보다 케이스(11)측인 가장자리부분이 낮게 된다.

그리고, 케이스(11) 내부에 마련된 고온인 램프(13)의 열을 배출하기 위하여 케이스(11) 측면에 팬(15)이 설치되어 있으나, 팬(15)이 케이스(11)내의 중심 부근에 대한 열을 외부로 제대로 배출시키지 못함으로써 케이스(11)내의 중심에 배치된 램프(13)의 온도가 케이스(11)내의 가장자리에 배치된 램프(13)의 온도보다 높아지게 된다. 따라서 온도가 높을수록 휘도가 높아지는 램프(13)의 특성으로 인해 케이스(11)내의 중심에 배치되는 램프(13)는 온도가 높아져서 높은 휘도를 가지고, 이와는 반대로 케이스(11)내의 가장자리에 배치되는 램프(13)는 온도가 낮아져서 낮은 휘도를 가지게 된다.

즉, 케이스(11)의 색상 및 케이스(11) 내부에 배치된 램프(13)의 온도 차이에 의한 원인에 의하여 피검사체로 제공되는 광의 휘도가 기준보다 가장자리 부근은 더 낮아지고, 중심 부근은 더 높아지게 되어 피검사체에 조사되는 광의 휘도 편차는 더욱 증가되는 문제점이 있었다.

이와 같이, 피검사체에 조사되는 광의 휘도 편차가 큰 값을 가지게 됨으로써 피검사체의 특정부분에 대한 검사가 제대로 이루어지지 않게 되며, 이로 인해 피검사체의 결점을 정확하게 판단하기 어려워 불량인 피검사체를 정상으로 판정하거나, 검사장비의 에리를 유발하여 정상적인 피검사체를 불량으로 판정하는 등 검사 작업에 많은 문제점을 발생시키고 있다.

특히, LCD 패널 검사장비는 암실에서 사용됨으로써 본체 대부분의 색상이 흑색이기 때문에 램프(13)로부터 발산되는 광을 잘 흡수하므로 피검사체에 대한 휘도 편차를 더욱 가중시키며, 이러한 장비 특성으로 인해 피검사체에서의 휘도 균일성이 한층 요구되고 있는 실정이다.

이러한 문제를 해결하기 위하여 다수의 램프(13)를 여러 영역으로 분할함으로써 각 영역에 대한 휘도를 조절하는 방법에 의해 원하는 휘도 균일성을 유지시키고 있으나, 각각의 영역 분할을 위해 길이가 짧은 램프를 사용하게 됨으로써 많은 개수의 램프(13)가 소요될 뿐만 아니라 안정기(16)의 개수도 늘어나서 장비의 크기, 사용 전력, 램프의 교체 회수 등이 크게 늘어날 뿐만 아니라 고열을 발생시키게 되며, 휘도 조절 작업이 번거롭다는 등 여러 가지 문제를 가지게 되었다.

또한, 종래의 백 라이트 장치(10)는 피검사체의 정확한 검사를 위해 피검사체와의 거리가 한정됨으로써 피검사체에 열이 쉽게 전달되어 휘게 됨으로써 변형에 따른 불량을 초래하며, 주변의 구성부품에 고온으로 인한 악영향을 초래함으로써 검사 작업의 정확성과 장비의 가동률을 저하시키고 있다. 이러한 문제점 해결을 위해 팬(15)을 구비하고 있으나, 케이스(11)내의 중심부분에 대한 열을 외부로 제대로 배출하지 못하며, 특히 반사판(14)이 내측 공기의 흐름에 장애가 됨으로써 열 배출을 더욱 어렵게 하였다.

이러한 문제점들을 해결함으로써 높은 휘도를 유지하면서도 고온에 의한 영향을 최소화할 수 있는 백 라이트 장치의 개발이 필요하게 되었다.

또한, 현재의 백 라이트 장치로는 대형화 장비에 대응할 때 휘도 편차가 더욱 증가하게 되는 문제점이 있었으나, 이러한 장비 특성으로 인해 피검사체에서의 휘도 균일성이 한층 요구되고 있는 실정이다.

발명이 이루고자 하는 기술적 과제

본 발명은 상술한 종래의 문제점을 해결하기 위한 것으로서, 본 발명의 목적은 피검사체에 대한 휘도의 균일성을 향상시킴으로써 피검사체에 대한 정확한 검사가 가능하도록 하며, 열을 신속하고도 효과적으로 배출시킴으로써 열로 인한 휘도의 편차 증가, 피검사체나 주변부품에 대한 손상을 방지하는 백 라이트 장치를 제공하는데 있다.

이와 같은 목적을 실현하기 위한 본 발명은, 피검사체를 조명하기 위한 백 라이트 장치에 있어서, 피검사체로 광을 발산하는 광원과, 광원으로부터 발산하는 광을 피검사체로 반사시키는 반사판과, 반사판에 마련되어 반사판의 광반사량을 부분적으로 보정함으로써 피검사체에 조사되는 광의 휘도가 균일하도록 하는 휘도보정수단을 포함하는 것을 특징으로 한다.

발명의 구성

이하, 본 발명의 가장 바람직한 실시예를 첨부한 도면을 참조하여 본 발명의 기술분야에서 통상의 지식을 가진 자가 용이하게 실시할 수 있도록 더욱 상세히 설명하기로 한다.

도 2는 본 발명의 제 1 실시예에 따른 백 라이트 장치를 도시한 분해 사시도이다. 도시된 바와 같이, 본 발명에 따른 백 라이트 장치(100)는 LCD 패널 등과 같은 피검사체에 존재하는 결함을 검사하는 검사장비에 설치되어 피검사체에 광을 조사함으로써 회전, 산란, 반사, 투과 등 광의 여러 가지 성질에 의해 피검사체에 존재하는 결함을 검출하도록 하는 장치로서, 광을 발산하는 광원(110)과, 광을 반사시키는 반사판(120)과, 반사판(120)에 마련되는 휘도보정수단(130)을 포함한다.

광원(110)은 장시간의 수명을 가지는 발광다이오드(Light Emitting Diode, "LED"라고도 함), 또는 노이즈와 열의 방출이 적은 냉음극형광램프(Cold Cathode Fluorescent Lamp, "CCFL"라고도 함), 또는 고휘도 구현이 가능한 열음극형광램프(Hot Cathode Fluorescent Lamp "HCFL"이라고도 함), 또는 고휘도 구현과 함께 높은 휘도 균일성을 가지는 외부전극형광램프(External Electrode Fluorescent Lamp, "EEFL"라고도 함) 등이 사용될 수 있는데, 본 실시예에서 직관형광램프를 사용하였다.

광원(110)은 양단에 마련되는 미도시된 단자가 커넥터(111)에 의해 접속됨으로써 나란하게 다수로 배열된다.

반사판(120)은 광원(110)으로부터 발산하는 광을 피검사체로 반사시키며, 광원(110)의 일측, 예컨대, 하측에 인접하도록 위치한다. 또한, 반사판(120)은 스테인레스틸 또는 알루미늄 재질로 제작되며, 광원(110)으로부터 발산되는 광을 효율적으로 반사하기 위하여 상면에 반사필름이 적층될 수 있다.

한편, 광원(110)과 반사판(120)의 설치를 위하여 케이스(150)가 마련된다.

케이스(150)는 광원(110)과 반사판(120)이 설치되기 위하여 케이스(150) 내측에 다수의 고정포스트(153)가 수직되게 형성되고, 이 고정포스트(153)에 반사판(120)과 광원(110)의 커넥터(111)가 미도시된 볼트나 스크루 등으로 고정된다. 또한, 반사판(120)과 커넥터(111)는 고정포스트(153)에 볼트나 스크루 등으로 고정되기 위하여 고정홀(121)과 고정부(112)가 각각 형성된다. 한편 케이스(110)는 내측에 다수의 안정기(154)가 설치된다.

휘도보정수단(130)은 반사판(120)에 마련되어 광원(110)으로부터 조사되어 반사판(120)으로부터 반사되는 광량을 부분적으로 보정함으로써 피검사체에 조사되는 광의 휘도가 균일하도록 한다.

휘도보정수단(130)은 도 2 및 도 3에 도시된 본 실시예에서 반사판(120)에 형성되어 광을 통과시키는 휘도보정홀이다.

휘도보정홀(130)은 피검사체에 도달하는 광의 휘도가 주변에 비해 높은 부분에 마주보도록 반사판(120)에 형성되며, 광원(110)의 광을 통과시킴으로써 반사판(120)의 부분적인 광 반사량을 줄인다.

휘도보정홀(130)은 효율적인 반사판(120)의 광반사량 부분 조절을 위하여 다수로 이루어지며, 광원(110)의 배열 등에 따른 구조적 특성으로 인해 중심부분이 가장자리에 비해 휘도가 높은 점을 감안하여 도 2 및 도 3에서 도시된 바와 같이, 반사판(120)의 가장자리로부터 중심으로 갈수록 조밀하게 분포되거나, 도 5에 도시된 바와 같이, 반사판(120)의 가장자리로부터 중심으로 갈수록 직경 또는 폭이 증가하거나, 도 6에 도시된 바와 같이, 반사판(120)의 가장자리로부터 중심으로 갈수록 간격이 작아지도록 형성된다.

한편, 케이스(150)는 광원(110)의 특성 및 배열 등에 따라 발생하는 온도차이로 인해 발생하는 고온부분에 흡입구(151)를 형성하고, 저온부분에 방출구(152)를 각각 형성하고 있다. 본 실시예에서는 케이스(150)에서 광원(110)의 측부와 마주보는 측면이 광원(110)을 전기적, 기계적으로 연결하는 커넥터(111)가 위치하는 측면에 비해 고온이므로, 케이스(150)는 광원(110)의 측부와 마주보는 측면에 다수의 흡입구(151)를, 커넥터(111)가 위치하는 측면에 다수의 방출구(152)를 각각 형성한다.

케이스(150)의 흡입구(151) 및 방출구(152)에는 공기를 흡입 및 방출시키기 위하여 흡입팬(160) 및 방출팬(170)이 각각 설치된다. 즉, 도 3에서 도시된 바와 같이, 흡입팬(160)은 외부의 공기를 흡입구(151)를 통해 흡입함으로써 케이스(150) 내의 고온부분을 통과하도록 하며, 방출팬(170)은 내부의 가열된 공기를 저온부분을 거쳐서 방출구(152)를 통해 외부로 방출시킨다.

한편, 광원(110)과 케이스(150)의 중심부분에 대한 직접적인 냉각을 통해 케이스(150)내의 온도를 효율적으로 낮추기 위한 냉각팬(180)을 더 포함할 수 있다.

냉각팬(180)은 휘도보정홀(130)을 통해 광원(110)에 냉각을 위한 공기를 송풍하도록 휘도보정홀(130)에 인접하도록 케이스(150)의 바닥면에 설치된다. 따라서, 도 4에 도시된 바와 같이, 냉각팬(180)에 의해 송풍되는 공기가 휘도보정홀(130)을 통해 광원(110)에 직접적으로 송풍됨으로써 광원(110)으로 인한 온도의 상승을 최대한 억제하며, 반사판(120)에 의한 공기의 흐름에 영향을 받지 않아 케이스(150)내, 특히 중심부분에 대한 냉각 효율을 향상시킨다.

휘도보정홀(130)을 통해 공기를 송풍할 수 있도록 냉각팬(180) 이외에도 펌핑력이나 압력에 의해 공기를 분사하는 에어 노즐 등과 같은 다양한 송풍수단이 이용될 수 있다.

이와 같은 구조로 이루어진 본 발명의 제 1 실시예에 따른 백 라이트 장치(100)의 작용을 설명하면 다음과 같다.

LCD 패널 등과 같은 피검사체 검사를 위해 광원(110)으로부터 발산되는 광과 반사판(120)으로부터 반사되는 광이 피검사체로 조사되며, 이 때, 피검사체에서의 휘도가 높은 부분에 상응하는 위치에 형성되는 휘도보정홀(130)을 통해 광원(110)으로부터 발산되는 광이 통과함으로써 반사판(120)의 반사량을 부분적으로 보정하게 되며, 이로 인해 피검사체에 조사되는 광의 휘도가 균일하도록 한다.

또한, 도 3에서 도시된 바와 같이, 흡입팬(160)에 의해 외부의 공기를 흡입구(151)를 통해 흡입하여 케이스(150)내의 고온부분, 즉 광원(110)에서 열의 방출이 심한 부분으로 직접적으로 통과하도록 함으로써 고온부분이 1차적으로 냉각되도록 하며, 방출팬(170)에 의해 내부의 가열된 공기를 저온부분, 즉 광원(110)에서 열의 방출이 적은 커넥터(111) 연결부위로 통과시켜서 방출구(152)를 통해 외부로 방출시킴으로써 저온부분을 2차적으로 냉각시킨다. 이로 인해 케이스(150)의 고온부분과 저온부분간의 온도 편차를 줄이게 되며, 이로 인해 온도의 불균일성으로 인해 유발되는 광원(110)의 휘도 편차를 최소화할 수 있다.

도 4에 도시된 바와 같이, 냉각팬(180)에 의해 송풍되는 공기는 휘도보정홀(130)을 통해 광원(110)에 직접적으로 송풍되며, 이로 인해 광원(110)으로 인한 온도상승을 신속하고도 효율적으로 억제하며, 반사판(120)이 공기의 흐름을 방해하지 않게 됨으로써 케이스(150)내, 특히 중심부분에 대한 냉각 효율이 뛰어나도록 한다.

또한, 휘도보정홀(130)은 반사판(120)의 가장자리로부터 중심으로 갈수록 조밀하게 분포되거나, 직경 또는 폭이 증가하거나, 간격이 작아지도록 형성됨으로써 광원(110)의 배열 등에 따른 구조적 특성으로 인한 중심부분의 고휘도 문제를 효과적으로 해결할 수 있다.

도 7은 본 발명의 제 2 실시예에 따른 백 라이트 장치를 도시한 분해 사시도이다. 도시된 바와 같이, 본 발명의 제 2 실시예에 따른 백 라이트 장치(200)는 제 1 실시예(100)와 마찬가지로 광원(110)과, 반사판(120)과, 휘도보정수단(140)을 포함하고 있을 뿐만 아니라 케이스(150), 흡입팬(160) 및 방출팬(170)을 더 포함하고 있다. 따라서, 제 1 실시예(100)와 동일한 부분은 그 설명을 생략하기로 하고, 차이점에 대해서 상세히 설명하기로 하겠다.

본 실시예에 따른 휘도보정수단(140)은 반사판(120)에 부착되어 광을 흡수하는 휘도보정시트이다.

휘도보정시트(140)는 광을 흡수하기 위해서 검은 색으로 제작됨이 바람직하며, 필름과 같은 얇은 형상뿐만 아니라 플레이트와 같은 비교적 두꺼운 형상으로 제작될 수 있으며, 평면 형상은 원형, 타원형, 다각형, 그 밖에 직선과 곡률이 혼합될 수 있다. 또한, 휘도보정시트(140)는 반사판(120)에 착탈이 가능하도록 부착되기 위하여 부착면에 접착층을 가질 수 있다.

휘도보정시트(140)는 이전 실시예의 휘도보정홀(130)(도 2 및 도 3 등에 도시)과 마찬가지로 반사판(120)의 광반사량을 효과적으로 부분 조절하기 위하여 다수로 이루어지며, 광원(110)의 배열 등에 따른 구조적 특성으로 인해 중심부분이 가장자리에 비해 휘도가 높기 때문에 이를 반영하기 위하여 반사판(120)의 가장자리로부터 중심으로 갈수록 조밀하게 분포되거나, 직경 또는 폭이 증가하거나, 간격이 작아지도록 형성된다.

한편, 본 발명의 제 2 실시예(200) 뿐만 아니라 이전의 실시예(100)에 따른 휘도보정수단(130, 140)을 피검사체에 요구되는 휘도 뿐만 아니라 정해진 편차이내의 휘도 균일성을 만족시키도록 형성 내지 부착시키기 위하여 반사판(120)에 마련되는 휘도보정수단(130, 140)의 규격, 개수, 위치 등은 휘도 및 휘도 편차를 시뮬레이션할 수 있는 컴퓨터 프로그램을 사용함으로써 반사판(120)에 마련되는 휘도보정수단(130, 140)의 적절한 규격, 개수, 위치 등을 1차적으로 구하게 되며, 이러한 데이터에 의한 휘도보정수단(130, 140)이 실제로 마련되는 반사판(120)을 검사상비에 사용하여 피검사체의 여러 부분에 대한 휘도의 실측값들에 따라 최종적으로 휘도보정수단(130, 140)의 규격, 개수, 반사판(120)에서의 위치를 구하게 된다.

이와 같은 구조를 가지는 본 발명의 제 2 실시예에 따른 백 라이트 장치(200)의 작용을 설명하면 다음과 같다.

광원(110)으로부터 발산되는 광은 도 8에서 도시된 바와 같이, 반사판(120)에 의해 반사되어 피검사체로 조사되나, 휘도 보정시트(140)에 도달하는 광은 흡수됨으로써 반사판(120)의 광반사량을 부분적으로 조정 내지 보정한다. 따라서, 이러한 휘도보정시트(140)가 피검사체에서 휘도가 비교적 높은 부분에 상응하는 위치에 마련됨으로써 피검사체에서 휘도가 비교적 높은 부분으로 조사되는 광의 양을 줄이게 됨으로써 피검사체에 조사된 광의 휘도를 전체적으로 균일하도록 한다.

발명의 효과

상술한 바와 같이, 본 발명에 따른 백 라이트 장치는 반사판의 광반사량을 용이하게 부분적으로 조정함으로써 광원의 특성이나 배열에 의해 필연적으로 발생하는 피검사체에 조사되는 광의 휘도 편차를 최소화하여 뛰어난 휘도 균일성을 가지도록 하고, 이로 인해 광원의 개수, 사용 전력, 유지 비용 등을 절감시키며, 검사장비가 피검사체의 결점을 정확하게 판별할 수 있도록 함으로써 피검사체의 불량여부를 제대로 판단하도록 하는 효과를 가지고 있다.

또한, 검사장비가 높은 휘도를 요구하더라도 이로 인해 광원으로부터 발생하는 열을 장치 내부에 정체가 없이 신속하고도 효과적으로 방출시킴으로써 피검사체가 온도로 인해 변형이 발생하는 것을 최소화하여 피검사체의 품질을 유지시키고, 주변부품이 열로 인해 손상되거나 에러를 유발시키는 방지하는 효과를 가지고 있다.

이상에서 설명한 것은 본 발명에 따른 백 라이트 장치를 실시하기 위한 하나의 실시예에 불과한 것으로서, 본 발명은 상기한 실시예에 한정되지 않고, 이하의 특허청구범위에서 청구하는 바와 같이 본 발명의 요지를 벗어남이 없이 당해 발명이 속하는 분야에서 통상의 지식을 가진 자라면 누구든지 다양한 변형 실시가 가능한 범위까지 본 발명의 기술적 정신이 있다고 할 것이다.

도면의 간단한 설명

도 1은 종래의 백 라이트 장치를 도시한 사시도이고,

도 2는 본 발명의 제 1 실시예에 따른 백 라이트 장치를 도시한 분해 사시도이고,

도 3은 본 발명의 제 1 실시예에 따른 백 라이트 장치를 도시한 평면도이고,

도 4는 도 3의 A-A'선에 따른 단면도이고,

도 5는 본 발명의 제 1 실시예에 따른 백 라이트 장치의 휘도보정홀의 다른 실시예를 도시한 평면도이고,

도 6은 본 발명의 제 1 실시예에 따른 백 라이트 장치의 휘도보정홀의 또 다른 실시예를 도시한 평면도이고,

도 7은 본 발명의 제 2 실시예에 따른 백 라이트 장치를 도시한 분해 사시도이고,

도 8은 본 발명의 제 2 실시예에 따른 백 라이트 장치의 작용을 도시한 요부확대도이다.

< 도면의 주요 부분에 대한 부호의 설명 >

110 : 광원 111 : 커넥터

112 : 고정부 120 : 반사판

130,140 : 휘도보정수단 (130 : 휘도보정홀, 140 : 휘도보정시트)

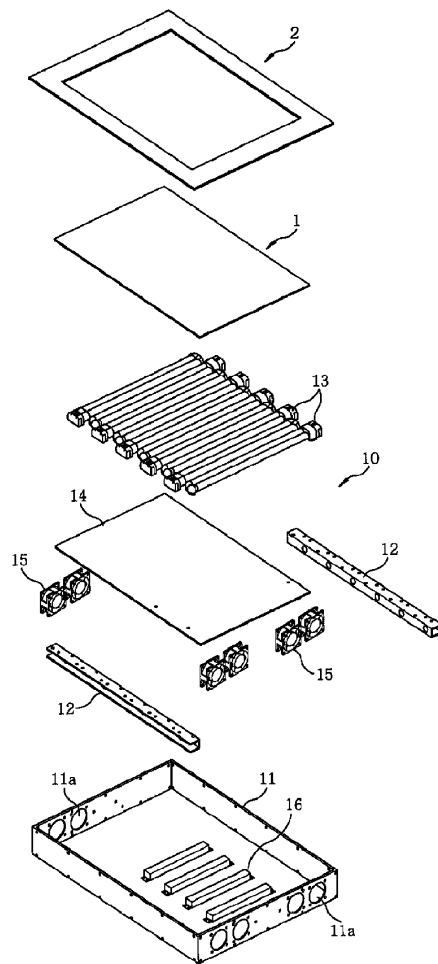
150 : 케이스 151 : 흡입구

152 : 방출구 160 : 흡입팬

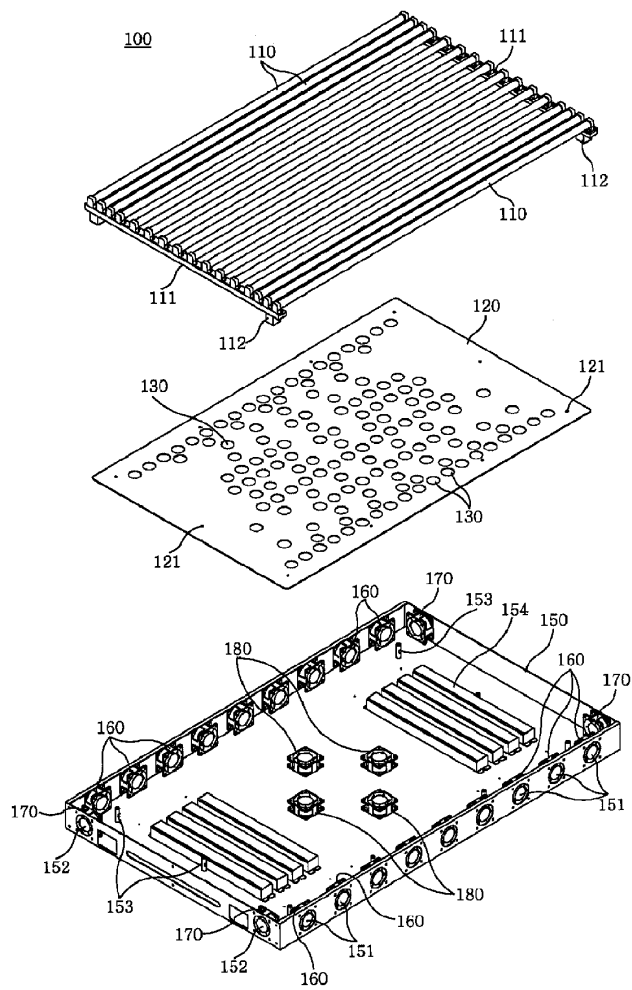
170 : 방출팬 180 : 냉각팬

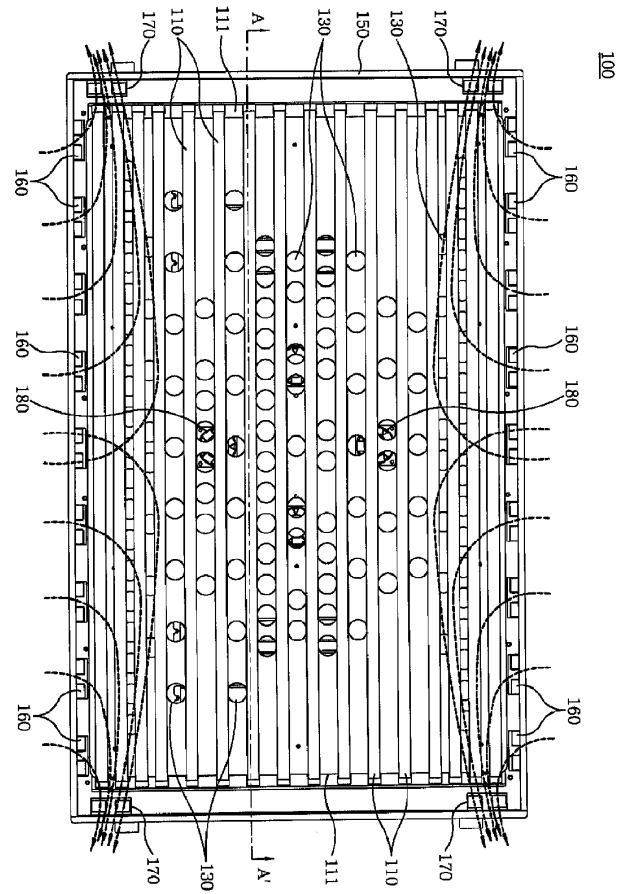
도면

도면1



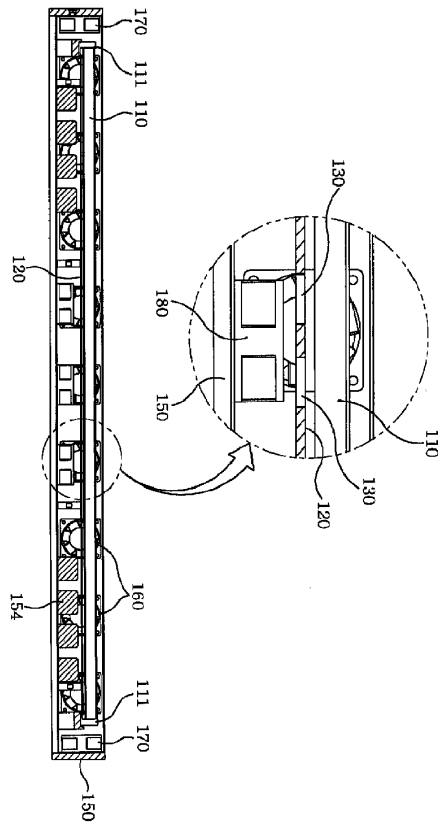
도면2



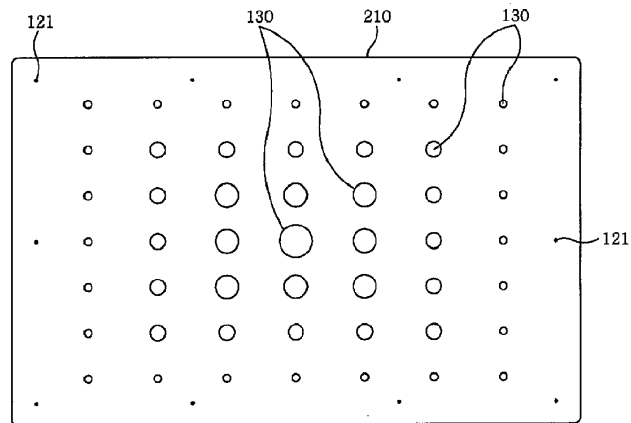


도 1

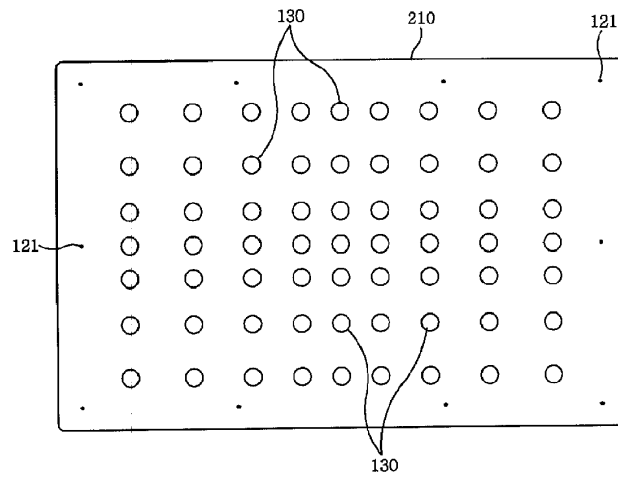
도면 4



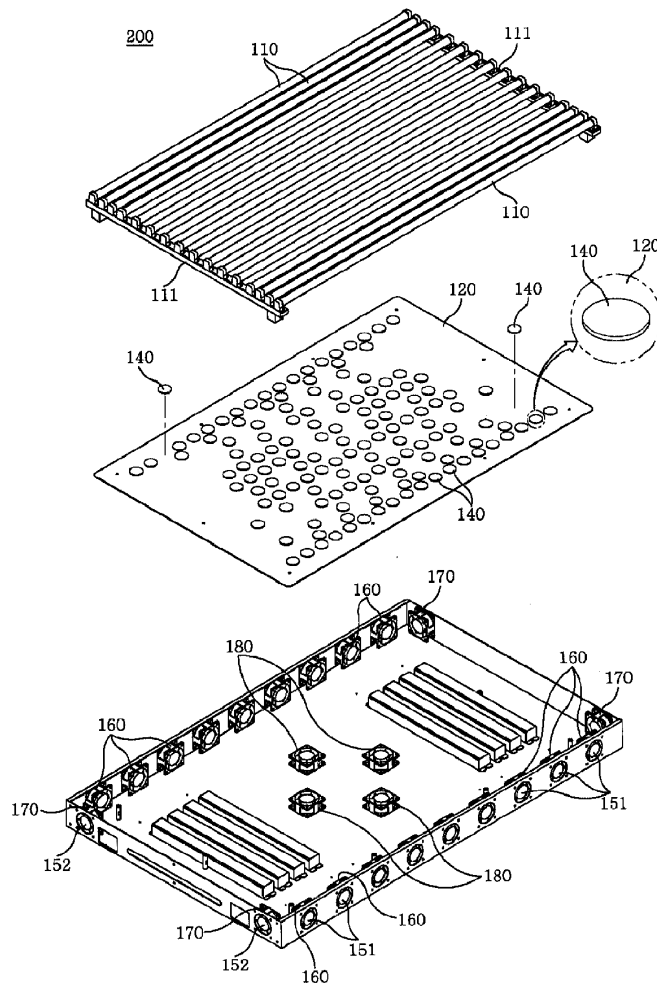
도면 5



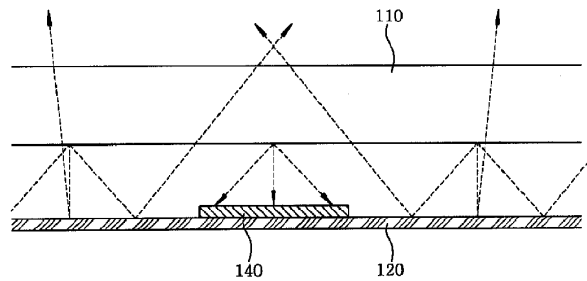
도면6



도면7



도면8



(51)Int.Cl.⁶ 識別記号 F I
G 0 2 F 1/136 5 0 0 C 0 2 F 1/136 5 0 0

審査請求 未請求 請求項の数8 ○L (全 10 頁)

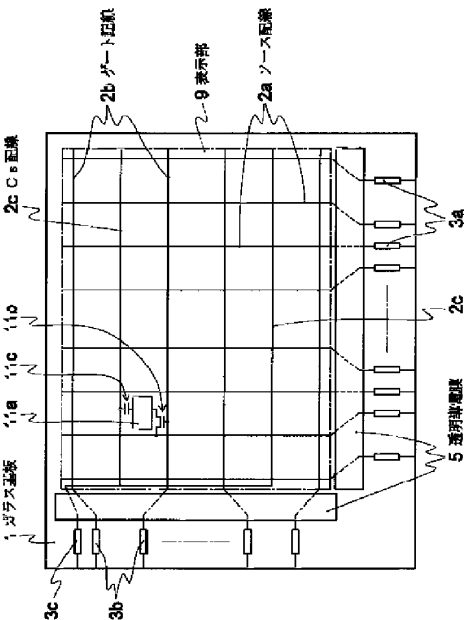
(21)出願番号	特願平9-330174	(71)出願人	595059056 株式会社アドバンスト・ディスプレイ 熊本県菊池郡西合志町御代志997番地
(22)出願日	平成9年(1997)12月1日	(72)発明者	中橋 輝久 熊本県菊池郡西合志町御代志997番地 株 式会社アドバンスト・ディスプレイ内
		(72)発明者	中山 明男 熊本県菊池郡西合志町御代志997番地 株 式会社アドバンスト・ディスプレイ内
		(74)代理人	弁理士 朝日奈 宗太 (外1名)

(54)【発明の名称】 液晶表示装置

(57)【要約】

【課題】 周辺回路やバックライトなどから液晶表示パネルへの電磁波を大幅に低減でき、かつ、E M I 対策のためにLCDの構造を複雑化することがない液晶表示装置を提供する。

【解決手段】 第1の透明基板、該第1の透明基板に対向する第2の透明基板、および前記第1の透明基板と第2の透明基板とのあいだに挟持される液晶材料を含んでなる液晶表示パネルと、該液晶表示パネル表面に配置され、液晶表示パネルに光を放射するバックライトとを含んでなり、前記第1の透明基板表面のうち液晶材料に接する側の面上に、スイッチング素子がマトリクス状に形成され、かつ、該スイッチング素子に電気信号を供給する2種類の配線が互いに直交するように設けられてなる液晶表示装置であって、前記2種類の配線のうち第1の透明基板の表示部の外周部に設けられる部分の上方に透明導電膜が形成されてなる。



【特許請求の範囲】

【請求項1】 第1の透明基板、該第1の透明基板に対向する第2の透明基板、および前記第1の透明基板と第2の透明基板とのあいだに挟持される液晶材料を含んでなる液晶表示パネルと、該液晶表示パネル表面に配置され、液晶表示パネルに光を放射するバックライトとを含んでなり、前記第1の透明基板表面のうち液晶材料に接する側の面上に、スイッチング素子がマトリクス状に形成され、かつ、該スイッチング素子に電気信号を供給する2種類の配線が互いに直交するように設けられてなる液晶表示装置であって、前記2種類の配線のうち第1の透明基板の表示部の外周部に設けられる部分の上方に透明導電膜が形成されてなる液晶表示装置。

【請求項2】 前記透明導電膜の材料がITOである請求項1記載の液晶表示装置。

【請求項3】 前記透明導電膜が前記2種類の配線の一端部に接続されることにより外部接続端子として機能する請求項1記載の液晶表示装置。

【請求項4】 第1の透明基板、該第1の透明基板に対向する第2の透明基板、および前記第1の透明基板と第2の透明基板とのあいだに挟持される液晶材料を含んでなる液晶表示パネルと、該液晶表示パネル表面に配置され、液晶表示パネルに光を放射するバックライトとを含んでなる液晶表示装置であって、前記第1の透明基板表面のうち液晶材料に接する側の面上に透明導電膜が形成され、該透明導電膜の上方にスイッチング素子がマトリクス状に形成され、かつ、該スイッチング素子に電気信号を供給する2種類の配線が互いに直交するように設けられてなる液晶表示装置。

【請求項5】 前記透明導電膜の材料がITOである請求項4記載の液晶表示装置。

【請求項6】 第1の透明基板、該第1の透明基板に対向する第2の透明基板、および前記第1の透明基板と第2の透明基板とのあいだに挟持される液晶材料を含んでなる液晶表示パネルと、該液晶表示パネル表面に配置され、液晶表示パネルに光を放射するバックライトとを含んでなる液晶表示装置であって、前記第1の透明基板表面のうち液晶材料に接する側の面上に第1の透明導電膜が形成され、該第1の透明導電膜の上方にスイッチング素子がマトリクス状に形成され、かつ、該スイッチング素子に電気信号を供給する2種類の配線が互いに直交するように設けられ、さらに前記2種類の配線のうち第1の透明基板の表示部の外周部に設けられる部分の上方に第2の透明導電膜が形成されてなる液晶表示装置。

【請求項7】 前記第1の透明導電膜および第2の透明導電膜の材料がITOである請求項6記載の液晶表示装置。

【請求項8】 前記第1の透明導電膜が前記2種類の配線の一端部に接続されることにより外部接続端子として機能する請求項6記載の液晶表示装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、液晶表示装置などの平面型表示装置用のアクティブマトリクス型装置の駆動回路やバックライトなどで発生した電磁波により生じるEMI (electro magnetic interference) に対する対策を施した液晶表示装置に関する。

【0002】

【従来の技術】従来の液晶表示装置（以下、「LCD」ともいう）は、液晶表示パネルと、該液晶表示パネルを挟持する2枚の偏光板と、該偏光板を介して液晶表示パネルに光を放射するバックライトと、前記液晶表示パネルに電気信号を供給する駆動回路とからなる。

【0003】前記液晶表示パネルは、第1の透明基板と第2の透明基板と液晶材料とを含んでなる。前記液晶表示パネルは、第1の透明基板を第2の透明基板に一定の間隙を保持しつつ対向させた状態にし、第1の透明基板の周縁部を第2の透明基板の周縁部に貼着したのち、前記間隙に液晶材料に注入することにより形成される。従来のLCDの一例であるアクティブマトリクス型LCDの液晶表示パネルの表示部はマトリクス状に形成された画素からなる。各画素には、液晶材料を駆動するための電界を発生するための透明電極と、薄膜トランジスタ（以下、「TFT」という）などのスイッチング素子とが設けられる。駆動回路から出力された電気信号は、スイッチング素子を介して各画素の透明電極に印加される。前記駆動回路は、走査信号を出力する駆動回路（以下、「走査駆動回路」という）とデータ信号を出力する駆動回路（以下、「データ駆動回路」という）とからなる。走査信号およびデータ信号は、それぞれゲート配線およびソース配線を介してスイッチング素子に印加される。

【0004】一般に、アクティブマトリクス型LCDは、高視野角および高コントラストなどの特徴を有し、AV (audio-visual) およびOA (office automation) 用のLCDに広く用いられている。

【0005】前記アクティブマトリクス型LCDの構造や製法は、特開平8-6069号公報に開示されている。この種のアクティブマトリクス型LCDにおける電磁干渉 (electro magnetic interference (EMI)) 対策としては、駆動回路から出力される電気信号の立ち上がり部分または立ち下がり部分を鈍らせるようにし、高調波の発生を抑制したり、最近では、液晶表示パネルの表示面に透光性の電磁波シールド板などを設け、表示面から射出される電磁波が前記シールド板にて遮断されるようにしたりして、電磁波を低減している。なお、シールド板による遮断を行ったLCDの一例は、特開昭62-229179号公報に開示されている。

【0006】前述のように、従来のEMI対策が施されたLCDでは、シールド板を固定するための構成を液晶

表示パネルに設けることが必要で、しかも、この構成が複雑になったり、シールド板の固定取り付け作業が、煩雑になったり、シールド板による干渉縞で画面が見づらくなるという問題があった。

【0007】また、第1の透明基板表面にTFT、透明電極、ゲート配線およびソース配線などが設けられてなる基板（以下、「アクティブマトリクス基板」という）自体には、これといったEMI対策は施されていない。

【0008】図11は、従来のアクティブマトリクス基板の一例を示す説明図である。図11において、1は、第1の透明基板であるガラス基板、2aはソース配線、2bは、ゲート絶縁膜（図示せず）を介してソース配線に直交するゲート配線、2cは、ゲート絶縁膜を介してソース配線2aに直交し、かつ、補助容量を形成するためのコモン信号が印加されるCs配線、3aはソース配線2aに接続された外部接続端子（以下、「ソース外部接続端子」という）、3bはゲート配線2bに接続された外部接続端子（以下、「ゲート外部接続端子」という）、3cはCs配線2cに接続された外部接続端子（以下、「Cs外部接続端子」という）、4はテーパー配線部、9は、ガラス基板1の表示部、11aは透明電極、11bは、走査信号が所定の電圧値になっているときのみデータ信号を透明電極11aに印加するTFT（等価的に示されている）、11cは、光リーク電流やフィールドスルーによる影響を防止する補助容量、12は周辺端子部を示す。前記ソース外部接続端子3a、ゲート外部接続端子3bは、データ駆動回路および走査駆動回路の出力端子をソース配線2aおよびゲート配線2bに接続するための端子であり、前記周辺端子部12とはガラス基板1の表示部9の外周部のうち、ソース配線2a、ゲート配線2bおよびCs配線2cの一端部と、前記ソース外部接続端子3a、ゲート外部接続端子3bおよびCs外部接続端子3cとが形成される部分をいう。なお、Cs配線2cのうちゲート配線2bと交差する箇所は、絶縁膜を介してゲート配線2bと交差する。したがって、コモン信号はCs外部接続端子3cを介してCs配線2cのみに印加される。また、テーパー配線部4は、ソース配線2aおよびゲート配線2bのうち、データ駆動回路および走査駆動回路を形成する際にパッケージとしてTCP（tape carrier package）を使用していることに対応してテーパー状に形成されている部分である。なお、図11には、ソース配線2aが8本のみ、ゲート配線2bが4本のみ、Cs配線2cが2本のみ示されており、透明電極11a、TFT11bおよび補助容量11cは画素分のみ示されているが、それぞれ数はこれに限られない。また、2本のソース配線2aおよび2本のゲート配線2bによって区切られる1つの領域が1つの画素である。

【0009】従来のアクティブマトリクス基板の周辺端子部に設けられたゲート配線およびソース配線の上層に

はゲート絶縁膜やDC（直流電流）カット用の絶縁膜（以下、単に「DCカット絶縁膜」という）が形成されているだけであり、駆動回路などの周辺回路やバックライトなどからの電磁波により生じるEMIへの影響が大きい。

【0010】

【発明が解決しようとする課題】前述のように、従来のLCDによれば、周辺回路やバックライトからの電磁波によりEMIが悪化したり、EMIを低減するためにLCDの構造が複雑化するという問題が生じる本発明はかかる問題を解決するためになされたもので、周辺回路やバックライトなどから液晶表示パネルへの電磁波を大幅に低減し、EMI対策のためにLCDの構造を複雑化することがなく、容易に電磁波を低減し、EMIを改善することができるアクティブマトリクス基板を用いた液晶表示装置を提供することを目的とする。

【0011】

【課題を解決するための手段】本発明の液晶表示装置は、第1の透明基板、該第1の透明基板に対向する第2の透明基板、および前記第1の透明基板と第2の透明基板とのあいだに挟持される液晶材料を含んでなる液晶表示パネルと、該液晶表示パネル表面に配置され、液晶表示パネルに光を放射するバックライトとを含んでなり、前記第1の透明基板表面のうち液晶材料に接する側の面上に、スイッチング素子がマトリクス状に形成され、かつ、該スイッチング素子に電気信号を供給する2種類の配線が互いに直交するように設けられてなる液晶表示装置であって、前記2種類の配線のうち第1の透明基板の表示部の外周部に設けられる部分の上方に透明導電膜が形成されてなるものである。

【0012】また、前記透明導電膜の材料がITOである。

【0013】また、前記透明導電膜が前記2種類の配線の一端部に接続されることにより外部接続端子として機能するものである。

【0014】本発明の液晶表示装置は、第1の透明基板、該第1の透明基板に対向する第2の透明基板、および前記第1の透明基板と第2の透明基板とのあいだに挟持される液晶材料を含んでなる液晶表示パネルと、該液晶表示パネル表面に配置され、液晶表示パネルに光を放射するバックライトとを含んでなる液晶表示装置であって、前記第1の透明基板表面のうち液晶材料に接する側の面上に透明導電膜が形成され、該透明導電膜の上方にスイッチング素子がマトリクス状に形成され、かつ、該スイッチング素子に電気信号を供給する2種類の配線が互いに直交するように設けられてなるものである。

【0015】また、前記透明導電膜の材料がITOである。

【0016】本発明の液晶表示装置は、第1の透明基板、該第1の透明基板に対向する第2の透明基板、およ

び前記第1の透明基板と第2の透明基板とのあいだに挟持される液晶材料を含んでなる液晶表示パネルと、該液晶表示パネル表面に配置され、液晶表示パネルに光を放射するバックライトとを含んでなる液晶表示装置であって、前記第1の透明基板表面のうち液晶材料に接する側の面上に第1の透明導電膜が形成され、該第1の透明導電膜の上方にスイッチング素子がマトリクス状に形成され、かつ、該スイッチング素子に電気信号を供給する2種類の配線が互いに直交するように設けられ、さらに前記2種類の配線のうち第1の透明基板の表示部の外周部に設けられる部分の上方に第2の透明導電膜が形成されてなるものである。

【0017】また、前記第1の透明導電膜および第2の透明導電膜の材料がITOである。

【0018】また、前記第1の透明導電膜が前記2種類の配線の一端部に接続されることにより外部接続端子として機能するものである。

【0019】

【発明の実施の形態】つぎに、本発明の液晶表示装置の実施の形態について説明する。

【0020】本発明の液晶表示装置の実施の形態においては、アクティブマトリクス基板が、ゲート配線およびソース配線のうち第1の透明基板の表示部の外周部に設けられる部分（すなわち、テーパー配線部）の上方に形成される透明導電膜、および／または第1の透明基板表面のうち液晶材料に接する側の面上に形成される透明導電膜を含んでなる。2つの透明導電膜は、いずれも液晶表示パネルから電磁波を遮断するために設けられる。

【0021】透明導電膜をテーパー配線部の上方に形成するばあい、透明導電膜とゲート配線およびソース配線とのあいだには絶縁膜が形成される。なお、該絶縁膜は、透明導電膜と、絶縁膜の下方に形成されるものとのあいだで導通をとる箇所を除いて透明導電膜の全表面に形成される。このばあい、前記絶縁膜を形成したのち、透明導電膜となる膜をガラス基板の上方全体に成膜し、当該膜を従来からのパターンエッチング法を用いてエッチングし、テーパー配線部の上方に透明導電膜を形成する。なお、前記エッチングの際に、透明導電膜となる膜をゲート配線の端部、ソース配線の端部およびCs配線の端部の上方にも残すことにより、ゲート外部接続端子、ソース外部接続端子およびCs外部接続端子が形成される。該ゲート外部接続端子、ソース外部接続端子およびCs外部接続端子が形成される箇所の絶縁膜はあらかじめ除去されている。

【0022】また、透明導電膜を第1の透明基板表面に形成するばあい、当該透明導電膜表面に絶縁膜が形成されたのちTFT、ゲート配線およびソース配線などからなるTFTアレイが形成される。なお、前記透明導電膜表面に形成される絶縁膜は透明導電膜の全表面に形成される。

【0023】さらに、5枚マスク構造のアクティブマトリクス基板を形成するばあい、表示用の透明電極をパターンニングする際、同時に電磁波遮断用の透明導電膜をテーパー配線部の上方にパターンニングする。なお、前記5枚マスク構造のアクティブマトリクス基板は、ガラス基板上に、ゲート配線と、ゲート絶縁膜と、TFTの一部を構成するシリコンと、ソース配線およびドレイン配線と、保護絶縁膜と、該保護絶縁膜に形成されたコンタクトホールを介して前記ソース配線およびドレイン配線に電気的に接続される外部接続端子としてのITO膜とを順次設けることにより形成される。さらに、アクティブマトリクス基板の他の例としては、6枚マスク構造のアクティブマトリクス基板がある。該6枚マスク構造のアクティブマトリクス基板は、ガラス基板上に、ゲート配線と、ゲート絶縁膜と、TFTの一部を構成するシリコンと、前記ソース配線およびドレイン配線に電気的に接続される外部接続端子としてのITO膜と、保護絶縁膜と、該保護絶縁膜に形成されたコンタクトホールを介して外部接続端子に電気的に接続されるソース配線およびドレイン配線と、DCカット絶縁膜とを設けることにより形成される。LCDおよび該LCDの基本的な製法などについては、特開平8-6069号公報に開示されている。

【0024】

【実施例】つぎに、本発明の液晶表示装置の実施例について図面を参照しつつ説明する。

【0025】実施例1．図面を参照しつつ、本発明の液晶表示装置の実施例1について説明する。

【0026】図1は、本発明の液晶表示装置の実施例1にかかわるアクティブマトリクス基板の一例を示す説明図である。図1において、図11と同一の箇所は同じ符号を用いて示す。さらに、5は、ITO(indium tin oxide)などからなる透明導電膜を示す。

【0027】透明導電膜5は電磁波を遮断するために形成される。さらに、透明導電膜5は、ソース配線2aおよびゲート配線2bのテーパー配線部の上方に形成される。図示されていないが、ソース配線2aおよびゲート配線2bと透明導電膜5とのあいだには、ゲート絶縁膜などの絶縁膜が形成されている。該絶縁膜は、透明導電膜5と、絶縁膜下部に形成されるものとのあいだで導通をとる箇所を除いて、ガラス基板1の全面に形成される。なお、前記導通をとる箇所の例としては、透明導電膜5のうちソース外部接続端子、ゲート外部接続端子またはCs外部接続端子として利用される部分の下部に位置する箇所がある。

【0028】図2は、図1のアクティブマトリクス基板のうちテーパー配線部および該テーパー配線部の周辺部を示す拡大断面説明図である。図2において、図1と同一の箇所は同じ符号を用いて示す。さらに、6は、ゲート絶縁膜などの絶縁膜を示す。なお、図2には、ソース配線

2aのテーパ配線部および該テーパ配線部の周辺部が示されている。

【0029】図2に示されるように、テーパ配線部の上方には、ITO、 In_2O_3 または SnO_2 などの透明導電材料を用いて電磁波遮断用の透明導電膜5が形成される。前記透明導電膜5により、バックライトや周辺回路から送出される方形波などが原因となって、LCDを構成するあらゆる回路および配線などから放出される電磁波が透明導電膜5により遮断される。したがって、バックライトや周辺回路から液晶表示パネルへの電磁波を低減することができる。

【0030】また、電磁波を透明導電膜5を介してグラウンド（接地面）へ落としてもよい。図3は、本発明の液晶表示装置の実施例1にかかわる液晶表示パネルおよび該液晶表示パネルの周辺部の一例を示す説明図である。図3において、図1および図2と同一の箇所は同じ符号を用いて示す。さらに、10は、液晶表示パネルを支持する金属フレーム、11は金属製導線、21はアクティブマトリクス基板、22は第2の透明基板、23は液晶材料、24は、第1の透明基板の周縁部を第2の透明基板の周縁部に貼着する際に使用されるシール材を示す。金属製導線11は、透明導電膜5と金属フレーム10とを電気的に接続するために設けられる。なお、実際は液晶表示パネルを挟持するように2枚の偏光板が設けられるが、図3では省略されており図示されていない。

【0031】図3に示される構造においては、バックライトや周辺回路から発生している電磁波は、透明導電膜5から、金属製導線11および金属フレーム10を経てグラウンドへ落とされる。したがって、バックライトや周辺回路から液晶表示パネルへの電磁波を大幅に低減し、EMIを改善することができる。さらに、図3に示される構造を採用することで、EMI対策のためにLCDの構造が複雑化することを抑制できる。

【0032】実施例2、つぎに、本発明の液晶表示装置の実施例2について図面を参照しつつ説明する。

【0033】図4は、本発明の液晶表示装置の実施例2にかかわるアクティブマトリクス基板の一例を示す説明図である。図4において、図1と同一の箇所は同じ符号を用いて示す。図4に示されるように、ガラス基板の全面に透明導電膜5が設けられる。図示されていないが、ソース配線2aおよびゲート配線2bと透明導電膜5とのあいだには、ゲート絶縁膜などの絶縁膜が形成されている。該絶縁膜は透明導電膜5の全面に形成される。

【0034】図5は、図4のアクティブマトリクス基板のうちテーパ配線部および該テーパ配線部の周辺部を示す拡大断面説明図である。図5において、図4と同一の箇所は同じ符号を用いて示す。さらに、6は、ゲート絶縁膜などの絶縁膜、7は、ゲート配線、ソース配線、TFTおよび透明電極を含んでなるTFTアレイを示す。なお、図5には、ガラス基板のうちゲート配線およびソ

ース配線が形成されていない箇所が示されている。

【0035】本実施例においては、透明導電膜5は、LCDを製造する工程のうち、アクティブマトリクス基板のTFTアレイを形成する工程（以下、「アレイ工程」という）の第1番目の工程において形成される。

【0036】また、電磁波を透明導電膜5を介してグラウンド（接地面）へ落としてもよい。図6は、本発明の液晶表示装置の実施例2にかかわる液晶表示パネルおよび該液晶表示パネルの周辺部の一例を示す説明図である。図6において、図4および図5と同一の箇所は同じ符号を用いて示す。さらに、10は、液晶表示パネルを支持する金属フレーム、11は金属製導線、22は第2の透明基板、23は液晶材料、24は、第1の透明基板の周縁部を第2の透明基板の周縁部に貼着する際に使用されるシール材を示す。金属製導線11は、透明導電膜5と金属フレーム10とを電気的に接続するために設けられる。なお、実際は液晶表示パネルを挟持するように2枚の偏光板が設けられるが、図6では省略されており図示されていない。

【0037】図6に示される構造においては、透明導電膜5と金属製導線11とを電気的に接続するために、絶縁膜6に少なくとも1つの開口部を設ける。その結果、バックライトや周辺回路から発生している電磁波は、透明導電膜5から、金属製導線11および金属フレーム10を経てグラウンドへ落とされる。したがって、バックライトや周辺回路から液晶表示パネルへの電磁波を大幅に低減し、EMIを改善することができる。さらに、図6に示される構造を採用することで、EMI対策のためにLCDの構造が複雑化することを抑制できる。

【0038】実施例3、つぎに、本発明の液晶表示装置の実施例3について図面を参照しつつ説明する。

【0039】図7は、本発明の液晶表示装置の実施例3にかかわるアクティブマトリクス基板の一例を示す説明図である。図8は、図7のアクティブマトリクス基板のうち周辺端子部を示す部分拡大説明図である。図8(a)は周辺端子部を示す平面説明図であり、図8(b)は図8(a)のA-A線断面説明図である。図7および図8において、図1および図2と同一の箇所は同じ符号を用いて示す。さらに、13は、絶縁膜6（図8(b)にのみ示される）に設けられた開口部である。図8には、周辺端子部のうちソース配線が形成される部分が示されている。なお、図8(a)に示される電位 $V_{\times}$ は、ソース外部接続端子として形成された透明導電膜5に所定の電位 $V_{\times}$ が印加できることを示し、電位 $V_{\times}$ は、通常、ソース外部接続端子に印加される電位を示す。さらに、矢印Bで示される方向には表示部があり、矢印Cで示される方向には、液晶表示パネルを製造するあいだ、ソース外部接続端子とゲート外部接続端子とのあいだの電位差をなくし、静電気によるTFT素子などの破壊を防ぐために設けられたショートリングがある。

【0040】図7および図8に示されるように、透明導電膜5は、テーパー配線部の上部に設けられるとともに、さらにソース外部接続端子を形成する箇所にも形成され、ソース外部接続端子として機能する。図8に示されるように、透明導電膜5は開口部13においてソース配線2aと電氣的に接続される。開口部13は、絶縁膜6の所定の箇所をたとえばドライエッチング法によりエッチングすることにより形成される。

【0041】実施例3によれば、電磁波を透明導電膜5により遮断してバックライトや周辺回路から液晶表示パネルへの電磁波を低減することができる。

【0042】実施例4、つぎに、本発明の液晶表示装置の実施例4について図面を参照しつつ説明する。

【0043】図9は、本発明の液晶表示装置の実施例4にかかわるアクティブマトリクス基板の一例を示す説明図である。図10は、図9のアクティブマトリクス基板のうちソース配線が形成されるテーパー配線部および該テーパー配線部の周辺部を示す拡大断面説明図である。図9および図10において、図1および図2と同一の箇所は同じ符号を用いて示す。さらに、図9および図10において、5aは、ガラス基板1全面に形成される第1の透明導電膜、5bは、ソース配線2aおよびゲート配線2bの上方に形成される第2の透明導電膜、6aは、第1の透明導電膜5a上に形成される第1の絶縁膜、6bは、第2の透明導電膜5bとソース配線2aおよびゲート配線2bとのあいだに形成される第2の絶縁膜、13は、第2の絶縁膜6bに設けられた開口部を示す。第1の絶縁膜6aは、図5に示される絶縁膜6と同一のものであり、第2の絶縁膜6bは、図2に示される絶縁膜6と同一のものである。

【0044】実施例4においては、実施例2と同様に、ガラス基板1の全面に第1の透明導電膜5a（図9には図示されていない）が設けられる。さらに、実施例1と同様に、テーパー配線部の上方に第2の透明導電膜5bが設けられる。なお、実施例3と同様に、第2の透明導電膜5bがソース外部接続端子を形成する箇所にも形成され、ソース外部接続端子として機能する。

【0045】図9および図10に示される構造においては、2層の透明導電膜（第1の透明導電膜5aおよび第2の透明導電膜5b）を設けることにより、実施例1および実施例2と比較してさらに電磁波を遮断することができる。

【0046】また、図示されていないが、実施例1と同様に、金属製導線11（図3参照）を設けてもよい。金属製導線を設けることにより、バックライトや周辺回路から発生している電磁波を、第2の透明導電膜5aから、金属製導線11および金属フレーム10（図3参照）を経てグラウンドへ落とすことができる。したがって、バックライトや周辺回路から液晶表示パネルへの電磁波を大幅に低減し、EMIを改善することができる。そ

の結果、EMI対策のためにLCDの構造が複雑化することを抑制できる。

【0047】

【発明の効果】本発明によれば、透明導電膜を設けて電磁波を遮断することにより、周辺回路やバックライトなどから液晶表示パネルへの電磁波を大幅に低減することができる。さらに、透明導電膜を金属製導線に電氣的に接続することにより電磁波を除去することができるので、EMI対策のためにLCDの構造を複雑化することなく、容易に電磁波を低減することができる。

【図面の簡単な説明】

【図1】本発明の液晶表示装置の実施例1にかかわるアクティブマトリクス基板の一例を示す説明図である。

【図2】図1のアクティブマトリクス基板のうちテーパー配線部および該テーパー配線部の周辺部を示す拡大断面説明図である。

【図3】本発明の液晶表示装置の実施例1にかかわる液晶表示パネルおよび該液晶表示パネルの周辺部の一例を示す説明図である。

【図4】本発明の液晶表示装置の実施例2にかかわるアクティブマトリクス基板の一例を示す説明図である。

【図5】図4のアクティブマトリクス基板のうちテーパー配線部および該テーパー配線部の周辺部を示す拡大断面説明図である。

【図6】本発明の液晶表示装置の実施例2にかかわる液晶表示パネルおよび該液晶表示パネルの周辺部の一例を示す説明図である。図6において、図4および図5と同一の箇所は同じ符号を用いて示す。

【図7】本発明の液晶表示装置の実施例3にかかわるアクティブマトリクス基板の一例を示す説明図である。

【図8】図7のアクティブマトリクス基板のうち周辺端子部を示す部分拡大説明図である。

【図9】本発明の液晶表示装置の実施例4にかかわるアクティブマトリクス基板の一例を示す説明図である。

【図10】図9のアクティブマトリクス基板のうちテーパー配線部および該テーパー配線部の周辺部を示す拡大断面説明図である。

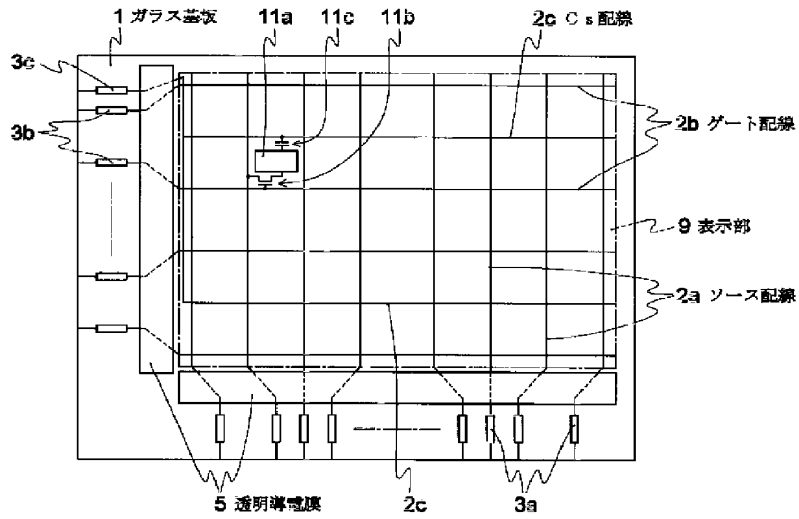
【図11】従来のアクティブマトリクス基板の一例を示す説明図である。

【符号の説明】

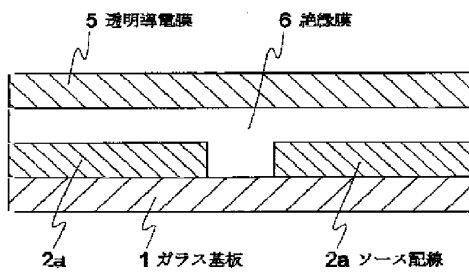
- 1 ガラス基板
- 2a ソース配線
- 2b ゲート配線
- 2c Cs配線
- 3a ソース外部接続端子
- 3b ゲート外部接続端子
- 3c Cs外部接続端子
- 4 テーパー配線部
- 5 透明導電膜
- 9 表示部

12 周辺端子部

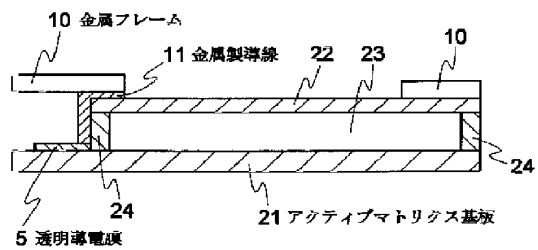
【図1】



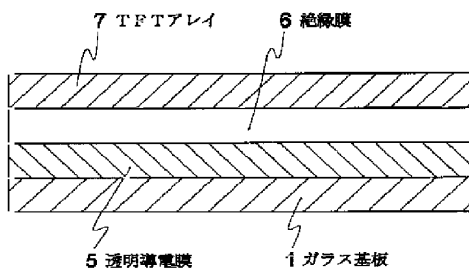
【図2】



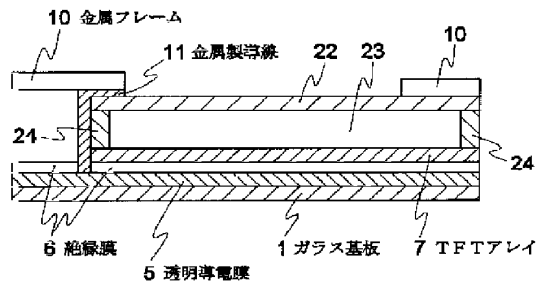
【図3】



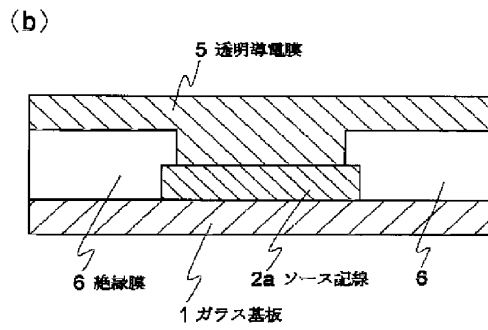
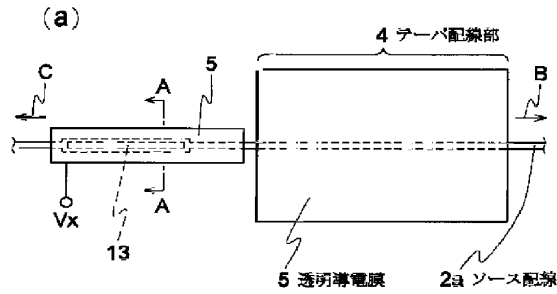
【図5】



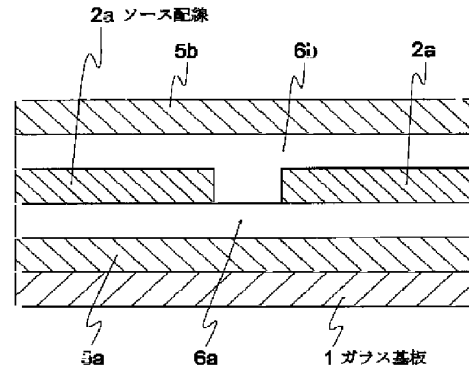
【図6】



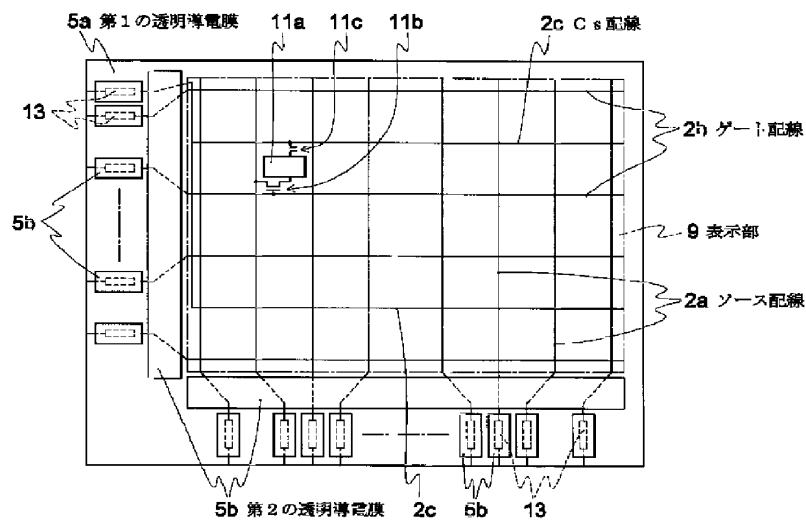
【図8】



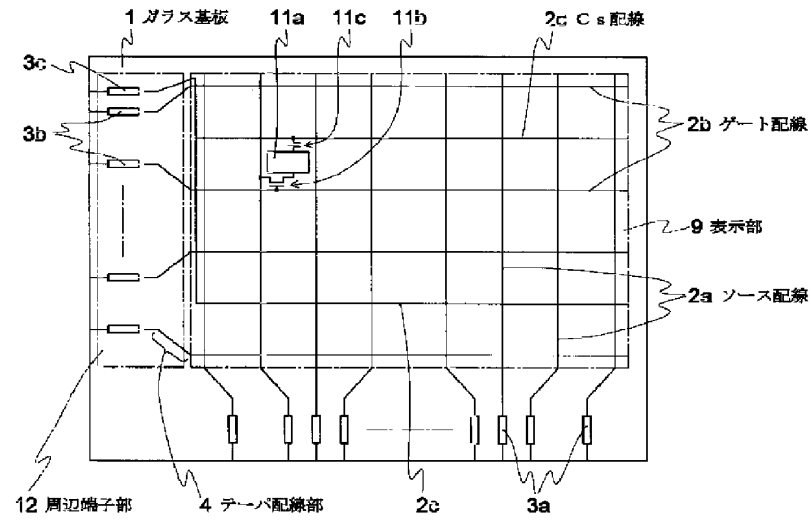
【図10】



【例9】



【図11】





Espacenet

Bibliographic data: JP2000131682 (A) — 2000-05-12

DISPLAY DEVICE

Inventor(s): NAKASHIZU KATSUMI; YAMAZOE TAKASHI ± (NAKASHIZU KATSUMI, ; YAMAZOE TAKASHI)

Applicant(s): NIPPON SEIKI CO LTD ± (NIPPON SEIKI CO LTD)

Classification: - **international:** **G02F1/13; G02F1/1335; G02F1/13357; G09F9/00;**
(IPC1-7): G02F1/13; G02F1/1335; G09F9/00
- **cooperative:**

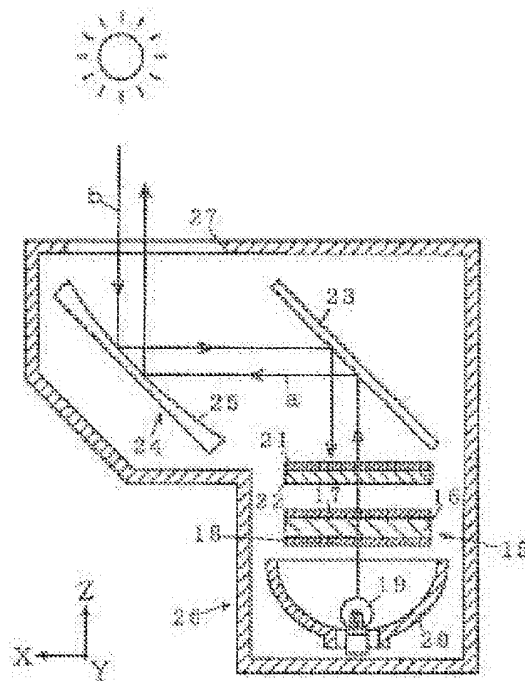
Application number: JP19980308014 19981029 Global Dossier

Priority number (s): JP19980308014 19981029

Also published as: JP4114194 (B2)

Abstract of JP2000131682 (A)

PROBLEM TO BE SOLVED: To provide a liquid crystal display device suppressing a temp. rise of a liquid crystal cell and obtaining a proper contrast ratio. SOLUTION: A liquid crystal display element 15 is provided with a liquid crystal cell 16, a first front side polarizing member 17 arranged on the front of the liquid crystal 16 and a rear side polarizing member 18 arranged on the back of the liquid crystal cell 16. A second front side polarizing member 21 having a polarization direction of a nearly equal direction to the first front side polarizing member 17 and arranged on the front of the liquid crystal display element 15 is provided.



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審査請求 未請求 請求項の数 8 O L (全 6 頁) 最終頁に続く			

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(71) 出願人 000231512

日本精機株式会社
新潟県長岡市東藤橋 2 丁目 2 番 34 号

(72) 発明者 中 静 勝 己

新潟県長岡市藤橋 1 丁目 190 番地 1 日本
精機株式会社アールアンドデイセンター内

(72) 発明者 山 添 尚

新潟県長岡市藤橋 1 丁目 190 番地 1 日本
精機株式会社アールアンドデイセンター内

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5G435 AA02 AA12 BB12 BB15 BB19

DD12 FF03 FF05 GC02 GC08

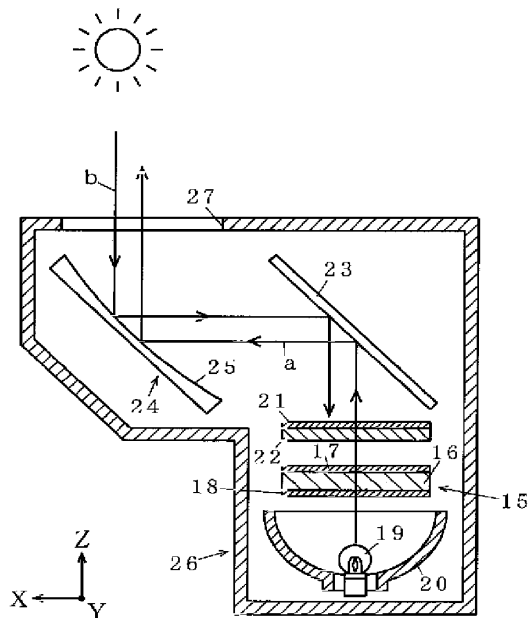
GG23 HH02

(54) 【発明の名称】 表示装置

(57) 【要約】

【課題】 液晶セルの温度上昇を抑制し適正なコントラスト比が得られる液晶表示装置を提供する。

【解決手段】 液晶表示素子 15 は、液晶セル 16 と、液晶セル 16 の前面に配設される第一の前側偏光部材 17 と、液晶セル 16 の後面に配設される後側偏光部材 18 とを有する。第一の前側偏光部材 17 と略同じ方向の偏光方向を有し液晶表示素子 15 の前方に配設される第二の前側偏光部材 21 を設ける。



【特許請求の範囲】

【請求項1】 一対の透光性基板に液晶を封入した液晶セルと前記液晶セルの前面に配設される第一の前側偏光部材と前記液晶セルの後面に配設される後側偏光部材とを有する液晶表示素子と、前記第一の前側偏光部材と略同じ方向の偏光方向を有し前記液晶表示素子の前方に配設される第二の前側偏光部材と、を有することを特徴とする表示装置。

【請求項2】 請求項1に記載の表示装置において、前記第二の前側偏光部材は反射型偏光フィルムであることを特徴とする表示装置。

【請求項3】 一対の透光性基板に液晶を封入した液晶セルと前記液晶セルの前面に配設される前側偏光部材と前記液晶セルの後面に配設される後側偏光部材とを有する液晶表示素子を有する表示装置であって、前記前側偏光部材は反射型偏光フィルムであることを特徴とする表示装置。

【請求項4】 一対の透光性基板に液晶を封入した液晶セルと前記液晶セルの前方に設けられる前側偏光部材と前記液晶セルの後方に設けられる後側偏光部材とを有する液晶表示素子を有する表示装置であって、前記前側偏光部材は前記液晶セルから所定間隔をあけて配置されることを特徴とする表示装置。

【請求項5】 請求項4に記載の表示装置において、前記前側偏光部材は反射型偏光フィルムであることを特徴とする表示装置。

【請求項6】 請求項4または請求項5に記載の表示装置において、前記液晶表示素子の後方に配設され前記液晶表示素子を照明する光源を有し、前記後側偏光部材は前記液晶セルから所定間隔をあけて配置されることを特徴とする表示装置。

【請求項7】 請求項1乃至請求項6の何れかに記載の表示装置において、前記液晶表示素子の表示像を拡大する光学部材を有することを特徴とする表示装置。

【請求項8】 請求項1乃至請求項7の何れかに記載の表示装置において、前記液晶表示素子は、赤（R）または緑（G）の画素よりも多数の青（B）の画素を有することを特徴とする表示装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、液晶表示素子を有する表示装置に関するものである。

【0002】

【従来の技術】従来より、図6及び図7に示すような車両用表示装置1がある。斯かる車両用表示装置1は、液晶表示素子2、光源3及びリフレクタ4をケース5に収容したものであり、車両のダッシュボード6に埋設されている。この車両用表示装置1はフロントガラス7に表示像aを投影し運転者8に虚像9を視認させるものであり、一般にヘッドアップディスプレイと称されている。

液晶表示素子2は透明電極膜を付けた一対の透光性基板に液晶を封入した液晶セル10の前後面に前側偏光板11、後側偏光板12を貼り合わせたものである。前側偏光板11の偏光方向（Y軸方向）と後側偏光板12の偏光方向（X軸方向）とは垂直になっている。液晶表示素子2は受光型表示素子であり、液晶表示素子2の後方に光源3及びこの光源3の光を反射させるリフレクタ4を設け液晶表示素子2を後方から照明し、良好な視認性を得るようにしている。

【0003】

【発明が解決しようとする課題】液晶セル10内の液晶の粘性は温度によって変化するため、適正なコントラスト比が得られるように駆動電圧を調整している。例えば、ケース5内に温度センサを取付けて、この温度センサの出力に基いて、液晶セル10の温度が高いときは駆動電圧を下げ、温度が低いときは駆動電圧を上げるように構成している。しかし、液晶セル10の温度が著しく上昇すると駆動電圧を調整しても所望のコントラスト比が得られない。ところが、ケース5の開口13から太陽光bが入射する場合があります。前側偏光板11が太陽光bを吸収して発熱しこの熱が液晶セル10に伝わり、液晶セル10の温度が過度に上昇してしまう虞があった。特に、表示像aを拡大する凸レンズ等の光学部材14が設けられた表示装置では、光学部材14により太陽光bが前側偏光板11の狭い範囲に集められるため温度上昇が著しい。本発明は、液晶セルの温度上昇を抑制し適正なコントラスト比が得られる表示装置を提供するものである。

【0004】

【課題を解決するための手段】本発明は、前記課題を解決するため、一対の透光性基板に液晶を封入した液晶セルと前記液晶セルの前面に配設される第一の前側偏光部材と前記液晶セルの後面に配設される後側偏光部材とを有する液晶表示素子と、前記第一の前側偏光部材と略同じ方向の偏光方向を有し前記液晶表示素子の前方に配設される第二の前側偏光部材と、を有するものである。

【0005】また、本発明は、前記第二の前側偏光部材は反射型偏光フィルムであるものである。

【0006】また、本発明は、一対の透光性基板に液晶を封入した液晶セルと前記液晶セルの前面に配設される前側偏光部材と前記液晶セルの後面に配設される後側偏光部材とを有する液晶表示素子を有する表示装置であって、前記前側偏光部材は反射型偏光フィルムであるものである。

【0007】また、本発明は、一対の透光性基板に液晶を封入した液晶セルと前記液晶セルの前方に設けられる前側偏光部材と前記液晶セルの後方に設けられる後側偏光部材とを有する液晶表示素子を有する表示装置であって、前記前側偏光部材は前記液晶セルから所定間隔をあけて配置されるものである。

【0008】また、本発明は、前記前側偏光部材は反射型偏光フィルムであるものである。

【0009】また、本発明は、前記液晶表示素子の後方に配設され前記液晶表示素子を照明する光源を有し、前記後側偏光部材は前記液晶セルから所定間隔をあけて配置されるものである。

【0010】また、本発明は、前記液晶表示素子の表示像を拡大する光学部材を有するものである。

【0011】また、本発明は、前記液晶表示素子は、赤（R）または緑（G）の画素よりも多数の青（B）の画素を有するものである。

【0012】

【発明の実施の形態】以下、本発明をヘッドアップディスプレイに適用した一実施の形態を添付の図面に基いて説明する。なお、図1、図3及び図4においては紙面と垂直な方向をY軸方向、紙面の横方向をX軸方向、紙面の縦方向をZ軸方向として説明する。図1及び図2は第一の実施の形態を示す図であり、この第一の実施の形態は請求項1、請求項2及び請求項7に対応する。

【0013】15は液晶表示素子であり、この液晶表示素子15は一对の透光性基板に液晶が封入された液晶セル16、前側偏光板17（第一の前側偏光部材）及び後側偏光板18（後側偏光部材）からなるものである。前側偏光板17の偏光方向はY軸方向となっており、後側偏光板18の偏光方向はX軸方向となっている。19はランプ（光源）であり、このランプ19は液晶表示素子15の後方に配設され液晶表示素子15を照明する。20はリフレクタであり、このリフレクタ20はランプ19が発する光を液晶表示素子15に反射させる。リフレクタ20はおわん形となっている。

【0014】21は反射型偏光フィルム（第二の前側偏光部材）である。この反射型偏光フィルム21は例えば商品名「HMF（Heat Management Filter）」（住友スリーエム株式会社製）からなるものである。反射型偏光フィルム21の偏光方向は前側偏光板17の偏光方向と同じ方向（Y軸方向）となっている。反射型偏光フィルム21はガラス基板22に貼着され、液晶表示素子15の前方に配設されている。

【0015】23は平面反射鏡であり、この平面反射鏡23は液晶表示素子15に対して略45度の角度で配置されており表示像aを後述する凹面反射鏡に反射させる。24は凹面反射鏡（光学部材）であり、この凹面反射鏡24は表示像aを車面のフロントガラス（図示しない）に向けて反射させる。凹面反射鏡24の反射面25は凹面となっており、表示像aを拡大することができる。26はケースであり、このケース26には表示像aを出射する開口27が形成されている。液晶表示素子15、ランプ19、リフレクタ20、反射型偏光フィルム21、平面反射鏡23及び凹面反射鏡24はケース26に収容される。

【0016】次に、図2を用いて反射型偏光フィルム21の作用を説明する。反射型偏光フィルム21はY軸方向の光を通過させ、X軸方向の光を反射させる。つまり、通常の偏光板は偏光方向（Y軸方向）と直交する方向（X軸方向）の光を吸収するが、反射型偏光フィルム21はX軸方向の光を反射することができる。従って、太陽が略真上にある時は太陽光bがケース26の開口27から入射し凹面反射鏡25及び平面反射鏡23に反射されて液晶表示素子15に照射されるが、太陽光bは反射型偏光フィルム21に吸収されることがない。反射型偏光フィルム21に反射された光は、平面反射鏡23及び凹面反射鏡25に反射され、開口27からケース26に射出される。

【0017】そして、反射型偏光フィルム21を通過した太陽光bは、Y軸方向の偏光であるので、前側偏光板17を通過し液晶セル16内で90度振じられてX軸方向の偏光となり、後側偏光板18も通過する。従って、太陽光bは各偏光板17、18に吸収されることがなく、液晶セル16の温度は上昇しない。一方、液晶表示素子15の前側偏光板17の偏光方向と反射型偏光フィルム21の偏光方向とは同じ方向（Y軸方向）となっているため、表示像aは反射型偏光フィルム21を通過できる。

【0018】なお、第二の前側偏光部材は通常の偏光板であっても良いが、X軸方向の光を吸収し発熱するため、この熱によりケース26内の空気が暖められて液晶セル16の温度が上がるので、第二の前側偏光部材は反射型偏光フィルム21が望ましい。

【0019】図3は第二の実施の形態を示す図であり、この第二の実施の形態は請求項3及び請求項7に対応する。第一の実施の形態と同一の箇所には同一の符号を付しその詳細な説明を省略する。

【0020】液晶表示素子28は、液晶セル16の後面に後側偏光板18を貼着し前面に反射型偏光フィルム21を貼着したものである。29は凸レンズ（光学部材）であり、この凸レンズ29は表示像aを拡大させることができる。太陽が略真上にある時は太陽光bがケース26の開口27から入射し、液晶表示素子28に照射されるが、第一の実施の形態と同様に反射型偏光フィルム21の作用により、太陽光bは各偏光板17、18に吸収されることがなく、液晶セル16の温度は上昇しない。反射型偏光フィルム21に反射された光は、開口27からケース26に射出される。

【0021】図4は第三の実施の形態を示す図であり、この第三の実施の形態は請求項4、請求項5、請求項6及び請求項7に対応する。第一、第二の実施の形態と同一の箇所には同一の符号を付しその詳細な説明を省略する。

【0022】液晶表示素子30は、反射型偏光フィルム21、ガラス基板22、液晶セル16、後側偏光板18

及びガラス基板31からなるものである。後側偏光板18はガラス基板30に貼着され、液晶セル16から所定間隔d1をあけて配置されている。反射型偏光フィルム21はガラス基板22に貼着され、液晶セル16から所定間隔d2をあけて配置されている。太陽が略真上にある時は太陽光bがケース26の開口27から入射し、液晶表示素子30に照射されるが、第一の実施の形態と同様に反射型偏光フィルム21の作用により、太陽光bは反射型偏光フィルム21、後側偏光板18に吸収されることがなく、液晶セル16の温度は上昇しない。

【0023】後側偏光板18の偏光方向はX軸方向であり、X軸方向の光を通過させY軸方向の光を吸収する。ランプ19の光はX軸及びY軸方向の光を含んでいるため、後側偏光板18はY軸方向の光を吸収し発熱するため、この熱によりケース26内の空気が暖められるが、後側偏光板18は液晶セル16から所定間隔d1をあけて配置されており液晶セル16に接していないため、液晶セル16の温度上昇は僅かである。

【0024】なお、前側偏光部材は通常の偏光板であっても良いが、X軸方向の光を吸収し発熱するため、この熱によりケース26内の空気が暖められて液晶セル16の温度が上がるので、前側偏光部材は反射型偏光フィルム21が望ましい。

【0025】以上述べた各実施の形態によれば、太陽光bに因る液晶セル16の温度上昇を緩和することができ、液晶表示素子15、28、30の適正なコントラストを得ることができる。特に、表示像aを拡大するため凹面反射鏡24または凸レンズ29等の光学部材を設けた表示装置において、太陽光bが光学部材により集光されるため、本発明を適用することが効果的である。なお、本明細書において、「前方」とは表示像aが進む向きを意味する。前側偏光部材は液晶表示素子15の前方に配置すれば良く、例えば第一の実施の形態において、反射型偏光フィルム21（第二の前側偏光部材）を平面反射鏡23と凹面反射鏡24との間に配置しても良い。

【0026】また、一般にランプ19の光は青色の光が弱いため、図5に示すように、液晶表示素子15、28、30には、赤（R）または緑（G）の画素よりも2倍の青（B）の画素を設けることが望ましい。

【0027】

【発明の効果】本発明は、一対の透光性基板に液晶を封

入した液晶セルと前記液晶セルの前面に配設される第一の前側偏光部材と前記液晶セルの後面に配設される後側偏光部材とを有する液晶表示素子と、前記第一の前側偏光部材と略同じ方向の偏光方向を有し前記液晶表示素子の前方に配設される第二の前側偏光部材と、を有するものであり、液晶セルの温度上昇を抑制し適正なコントラスト比を得ることができる。

【0028】また、本発明は、一対の透光性基板に液晶を封入した液晶セルと前記液晶セルの前面に配設される前側偏光部材と前記液晶セルの後面に配設される後側偏光部材とを有する液晶表示素子を有する表示装置であって、前記前側偏光部材は反射型偏光フィルムであるものであり、液晶セルの温度上昇を抑制し適正なコントラスト比を得ることができる。

【0029】また、本発明は、一対の透光性基板に液晶を封入した液晶セルと前記液晶セルの前方に設けられる前側偏光部材と前記液晶セルの後方に設けられる後側偏光部材とを有する液晶表示素子を有する表示装置であって、前記前側偏光部材は前記液晶セルから所定間隔をあけて配置されるものであり、液晶セルの温度上昇を抑制し適正なコントラスト比を得ることができる。

【図面の簡単な説明】

【図1】本発明の第一の実施の形態を示す断面図。

【図2】同上第一の実施の形態を示す要部斜視図。

【図3】本発明の第二の実施の形態を示す断面図。

【図4】本発明の第三の実施の形態を示す断面図。

【図5】本発明の液晶表示素子の画素の説明図。

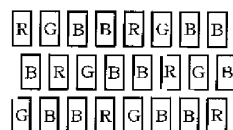
【図6】従来例を示す側面図。

【図7】同上従来例を示す断面図。

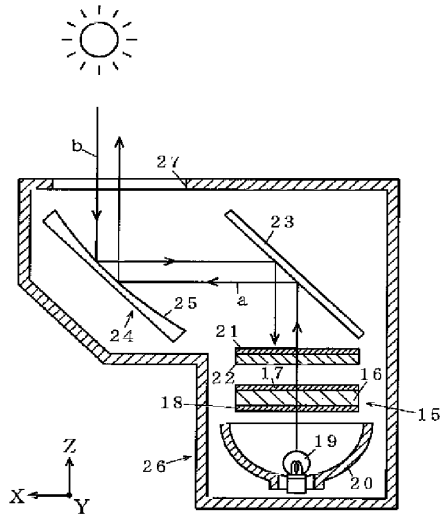
【符号の説明】

- 15 液晶表示素子
- 16 液晶セル
- 17 前側偏光板（第一の前側偏光部材）
- 18 後側偏光板（後側偏光部材）
- 19 ランプ（光源）
- 21 反射型偏光フィルム（第二の前側偏光部材）
- 24 凹面反射鏡（光学部材）
- 28 液晶表示素子
- 29 凸レンズ（光学部材）
- a 表示像

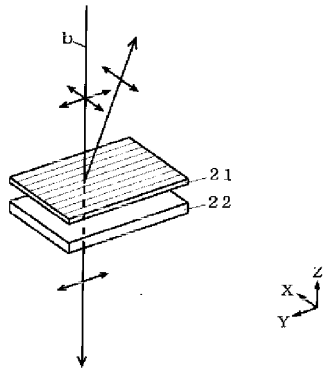
【図5】



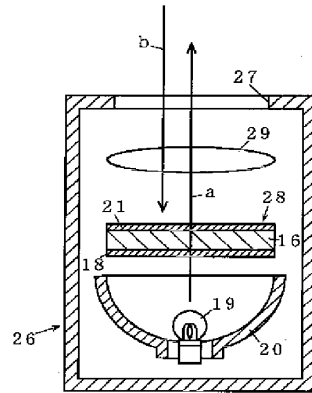
【図1】



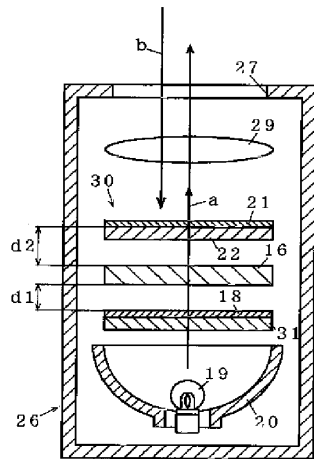
【図2】



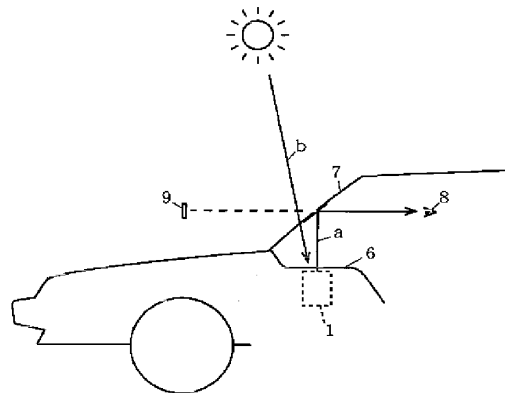
【図3】



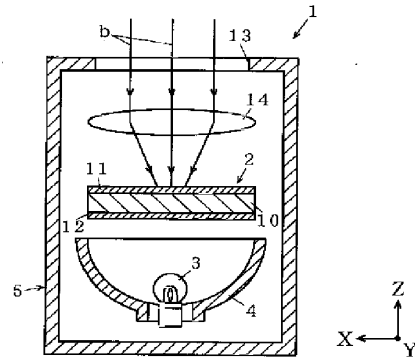
【図4】



【図6】



【図7】



フロントページの続き

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Espacenet

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IMAGE DISPLAY DEVICE

Inventor(s): NOTO ATSUSHI ± (NOTO ATSUSHI)

Applicant(s): FUJITSU GENERAL LTD ± (FUJITSU GENERAL LTD)

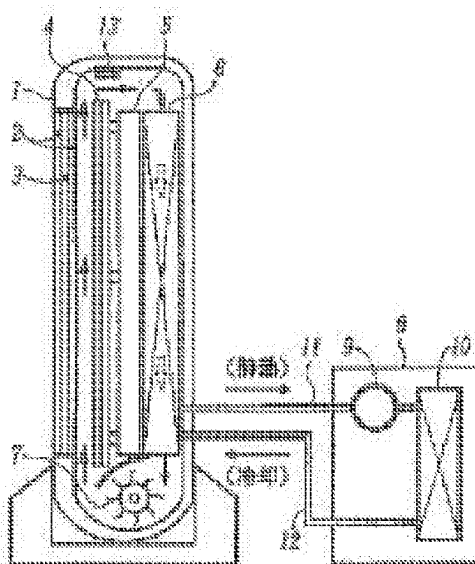
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Abstract of JPH09307257 (A)

PROBLEM TO BE SOLVED: To prevent the leaking of an unusual sound caused by the plasma discharge of a PDP at low voltage to the outside of a housing, to suppress temperature rise by cooling the PDP, and to exhibit full performance. **SOLUTION:** A housing 1 is formed in required film thickness of synthetic resin, etc., the front of the housing 1 is formed by double reinforced glass 2, a void 3 is provided, and the dew concentration generated by the cooling of the housing is prevented. Ventilating space is provided on the front side of the PDP 4, refrigeration cycle cooling unit 6 is provided behind a circuit board, and a ventilating fan 7 is provided on the lower part. The cooling unit is connected to a heat dissipating unit 8 by two refrigerant pipes 11 and 12, the heated refrigerant is compressed by a compressor 9, heat is radiated by a heat radiator 10, and cooled refrigerant is sent to the cooler by a refrigerant pipe 12. The air cooled by the cooling unit is circulated in the housing by an air blasting fan as shown by the arrows, and the PDP and the circuit board are cooled.



A temperature sensor 13 is provided in the housing, and the refrigerant cycle and the air blasting fan are operated when air is in the temperature higher than required.

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(71) 出願人 000006611

株式会社富士通ゼネラル

神奈川県川崎市高津区末長1116番地

(72) 発明者 能戸 敦志

川崎市高津区末長1116番地 株式会社富士

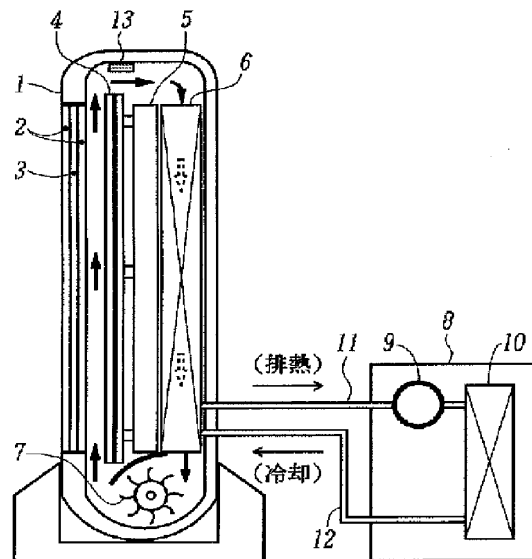
通ゼネラル内

(54) 【発明の名称】 映像表示装置

(57) 【要約】

【課題】 低圧下でのPDPのプラズマ放電に起因する異音の筐体外への漏出を防止し、PDPを冷却し温度上昇を抑え、性能をフルに発揮させる。

【解決手段】 筐体1は合成樹脂等で所要の肉厚に形成し、前面は二重の強化ガラス2で構成し、空隙3を設け、筐体内の冷却に伴う結露を防止する。PDP4の前面側に通風空間を設け、背面の回路基板5の背後に冷凍サイクルの冷却器6を配設し、下方に送風ファン7を設ける。冷却器は2本の冷媒配管11、12で排熱ユニット8に接続し、コンプレッサ9で冷却器よりの暖められた冷媒を圧縮し、放熱器10で放熱させ、冷えた冷媒を冷媒配管12で冷却器に送る。冷却器で冷却された空気を送風ファンで筐体内を矢印のように循環させ、PDPおよび回路基板等を冷却する。筐体内に温度センサ13を設け、所要温度以上の場合に冷凍サイクルおよび送風ファンを運転する。



【特許請求の範囲】

【請求項1】 密閉された筐体内に、プラズマディスプレイパネルと、冷却器と放熱器とで構成される冷凍サイクルの冷却器と、送風ファンとを配設し、前記冷凍サイクルの放熱器を筐体外に配設し、前記冷却器による冷気にてプラズマディスプレイパネルを冷却するようにした映像表示装置。

【請求項2】 前記冷却器をプラズマディスプレイパネルの背面側に配設し、前記送風ファンを冷却器の下方に配設し、前記筐体とプラズマディスプレイパネルの前面との間に通風空間を設け、送風ファンの回転により、冷却器で冷却された空気が前記通風空間の下端に向けて送風され、通風空間を通った空気が通風空間の上端より冷却器に向かう循環経路を形成するようにした請求項1記載の映像表示装置。

【請求項3】 前記筐体は、断熱性を有する合成樹脂材で形成すると共に、プラズマディスプレイパネルの映像表示面に対向する部分を強化ガラスの二重構造とし、強化ガラス間に空隙を設け、筐体内の冷却によるガラス面への結露を防止するようにした請求項1または請求項2記載の映像表示装置。

【請求項4】 前記筐体内に温度センサを配設し、筐体内の温度が所要温度以上の場合に前記冷凍サイクルおよび送風ファンの運転を行うようにした請求項1、請求項2または請求項3記載の映像表示装置。

【請求項5】 密閉された筐体内にプラズマディスプレイパネルおよび送風ファンを配設すると共に、筐体外に冷凍装置を付設し、筐体および冷凍装置の間を二本の通風管で連結し、一方の通風管で冷凍装置より冷却された空気を筐体内に送り、前記送風ファンにより筐体内を循環させ、他方の通風管で筐体内で温められた空気が冷却装置に戻されるようにし、プラズマディスプレイパネルを冷却するようにした映像表示装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明はプラズマディスプレイパネル（PDP）を用いた映像表示装置に係り、冷却装置を付設して筐体内を冷却し、PDPの性能低下を抑制し、輝度・コントラストを改善するものに関する。

【0002】

【従来の技術】PDPは同一画面サイズの陰極線管に比べて奥行きが薄いので、駆動回路等を搭載した回路基板をPDPの背面に取付けることにより筐体の奥行きを大幅に短縮できる。しかし、PDPはプラズマ放電で発熱し、この熱でPDP自体の温度が上昇し、同時に回路基板が暖められる。PDPは、温度上昇により蛍光体の発光効率が下り、輝度が低下し、温度上昇を抑えるべく点灯時間を制限すればさらに輝度が低下するという問題があり、また、回路基板の温度上昇で駆動回路部品の信頼性が低下するため、温度定格の余裕のある部品を使用し

なければならぬという問題がある。

【0003】このため、PDPを用いた映像表示装置ではPDPの放熱に重きを置き、例えば、図2に示す如く、PDP4の背面の回路基板5の背後に軸流ファン21等を設け、筐体22の底部等から外気を吸入し、PDP4と回路基板5との間、あるいは回路基板5の背後を通し、筐体背面の通風孔23から筐体外に排出し、PDP4および回路基板5を冷却するようにしている。なお、PDP4の前面には外光の反射防止等のため光学フィルタ24を配設するので、この光学フィルタ24を熱伝導のよい材料を使用すれば有効な放熱手段となるが、人の手等が触れた場合に熱く感じないようにする必要があり、このような理由もあって光学フィルタ24を熱伝導のよくないプラスチック材で構成しているのが現状であり、光学フィルタ24による放熱効果は期待できない。

【0004】PDP4は、2枚のガラス基板で密閉された空間にキセノンガス等を封入し、電極間の放電でキセノンガス等の分子を励起し、紫外線を発生させ、この紫外線で内部に塗布されている蛍光物質を励起し、可視光領域の光を発光するものであるが、この放電（プラズマ放電）によりキセノンガス等の体積が膨張し、ガラス基板が振動し、異音を発生する。ガラス基板間の密閉空間の気圧は略数十分の1気圧程度であり、低地では2枚のガラス基板が大気圧により押圧されるので振動が抑えられ、異音はさほど気にならないレベルであるが、PDPを気圧の低い状態、例えば、飛行中の航空機内あるいは高地等で動作させた場合、ガラス基板外からの押圧力が相対的に低下するためガラス基板は振動しやすい状態となり、異音のレベルが高くなる。

【0005】

【発明が解決しようとする課題】本発明はこのように点に鑑み、映像表示装置の筐体を密閉式とし、異音の漏出レベルを低減させ、筐体内に冷凍サイクルの冷却器および送風ファンを設け、冷凍サイクルの放熱器を筐体外に配設し、冷却器で冷却された空気を送風ファンにより筐体内を循環させ、PDPを冷却し、PDPの性能をフルに発揮させるようにすることにある。

【0006】

【課題を解決するための手段】本発明は上述の課題を解決するため、密閉された筐体内に、PDPと、冷却器と放熱器とで構成される冷凍サイクルの冷却器と、送風ファンとを配設し、前記冷凍サイクルの放熱器を筐体外に配設し、前記冷却器による冷気にてPDPを冷却するようにした映像表示装置を提供するものである。

【0007】

【発明の実施の形態】本発明による映像表示装置では、筐体を断熱性を有する合成樹脂材で密閉構造に形成し、内部にPDPと冷却器と送風ファンとを配設し、この冷却器とで冷凍サイクルを構成する放熱器を筐体外に配設し、冷却器はPDPの背面側に配置し、送風ファンを冷

却器の下方に配置し、筐体前面のPDPの映像表示面に対向する部分を強化ガラスの二重構造とし、ガラス部分を含む筐体前部とPDPとの間に通風空間を設け、送風ファンの回転により、冷却器で冷却された空気が前記通風空間の下端に向けて送風され、通風空間を通った空気が通風空間の上端より冷却器に向かう循環経路を形成するようにし、筐体内に温度センサを設け、筐体内の温度が所要温度以上に上昇した場合、冷凍サイクルおよび送風ファンを運転し、PDPの温度を下げ、PDPを最良の状態で作動させるようにする。

【0008】

【実施例】以下、図面に基づいて本発明による映像表示装置の実施例を詳細に説明する。図1は本発明による映像表示装置の一実施例の要部側断面図である。図において1は筐体で、合成樹脂材等で形成する。2は強化ガラスで、二重構造とし、中間に空隙3を設ける。4はPDP、5はPDP4の駆動回路等を配設した回路基板で、PDP4の背面に取付けられる。6は冷却器、7は送風ファン、8は排熱ユニット、排熱ユニット8内の9はコンプレッサ、10は放熱器、11および12は冷媒配管で、これら冷却器6、コンプレッサ9、放熱器10、冷媒配管11および12により冷凍サイクルを構成する。13は温度センサで、筐体1内の温度を検出する。

【0009】次に、本発明による映像表示装置の動作を説明する。PDP4は映像信号に基づく回路基板5からの信号で駆動され、プラズマ放電によりガラス基板内に封入されたキセノンガス等の分子を励起し、紫外線を発生させ、内部に塗布されている蛍光物質を励起し、可視光領域の光を発光し、映像を表示する。筐体1は合成樹脂材により所要の肉厚に形成し、前面部に強化ガラス2（二重構造）を用いて密閉構造とし、PDP4等の保持に必要な強度を得ると同時に断熱性を持たせるようにする。強化ガラス2を用いるのは、外部から強い衝撃が加わった場合にガラスが破損し破片が飛散しないようにするためであり、この部分（強化ガラス）にプラスチック等を用いないのは、例えば、航空機の機内、あるいは標高の高い場所等に設置する場合に外気圧と筐体内の気圧の差で変形する（膨らむ）ことがないようにするためである。なお、強化ガラス2を2枚用いて空隙3を作るのは、筐体1内の冷却により外気との温度差でガラスに結露を生じないようにするためである。

【0010】PDP4は、筐体1および強化ガラス2との間に適宜の幅の通風空間を設けて取付ける。冷却器6は回路基板5の背後に配設し、冷媒配管11および12で排熱ユニット8と接続する。そして、排熱ユニット8内のコンプレッサ9で冷媒を高圧高圧に圧縮し、放熱器10に送り、外気との熱交換（排熱）により凝縮液化させ、冷媒配管12で筐体1内に送り、図示しないキャピラリチューブ等で減圧した後、冷却器6により筐体1内の空気と接交換（吸熱）を行い、筐体1内の空気を冷却する。熱

交換により低圧ガスとなった冷媒は冷媒配管11によりコンプレッサ9に戻る。冷却器6で冷却された空気は送風ファン7により矢印の向きに送風され、PDP4の前面の通風空間を通り、PDP4の発熱で暖められ（PDP4の温度を下げ）、PDP4の上端を通り冷却器6に入る。そして、再び冷却器6で冷却され、送風ファン7により送風されるという循環経路を形成する。なお、送風ファン7は、例えば、クロスフローファンを使用し、PDP4の全幅に満遍なく冷風を送るようにする。

【0011】筐体1内の天井部等に温度センサ13を取付け、筐体1内の温度を検出し、所要の温度以上になった場合に前記冷凍サイクルおよび送風ファン7を運転するようにする。なお、上記では、冷凍サイクルは冷却器6、コンプレッサ9および放熱器10等で構成する冷媒圧縮式の例で説明したが、液体アンモニア等を高圧下で加熱し、冷却器に送り蒸発させ、この蒸発熱で筐体1内の空気を冷却する吸収式冷凍サイクルで構成してもよい。この方式はコンプレッサ9を用いないのでコンプレッサの運転による騒音対策を要しない利点がある。

【0012】上記では、冷凍サイクルの冷却器を筐体内に配設する例で説明したが、コンプレッサ、放熱器と共に冷却器も筐体外に設置し、この冷却装置と筐体との間を2本の通風管で接続し、一方の通風管で冷却装置より筐体内に冷気を送り、この冷気を送風ファンにより筐体内で循環させ、暖められた空気を他方の通風管で冷却装置に戻すようにしてもよい。

【0013】上述のように、また、冷凍サイクルを設けて筐体内を冷却することによりPDP4の温度上昇が抑制され、蛍光体の発光効率が低下しないので高輝度の映像を表示でき、回路基板の温度上昇が抑制されるので駆動回路等の部品の信頼性が向上する。また、筐体1を密閉構造とすることにより、PDP4のプラズマ放電に伴って発生する異音の筐体外への漏出レベルが低減され、平地に比べて気圧の低い状態、例えば、飛行中の航空機の中あるいは高地に設置した場合でもPDPの異音は殆ど気にならないものとなる。

【0014】

【発明の効果】以上に説明したように、本発明による映像表示装置によれば、冷凍サイクルを設けて筐体内を冷却するので、PDPの温度上昇が抑制され、蛍光体の発光効率が低下しないので高輝度の映像を表示でき、回路基板の温度上昇が抑制されるので駆動回路等の部品の信頼性が向上する。また、筐体を密閉構造にしたのでPDPのプラズマ放電に起因する異音の筐体外への漏出レベルが低減され、平地に比べて気圧の低い状態、例えば、飛行中の航空機の中あるいは高地に設置した場合でもPDPの異音は殆ど気にならないものとなる。

【図面の簡単な説明】

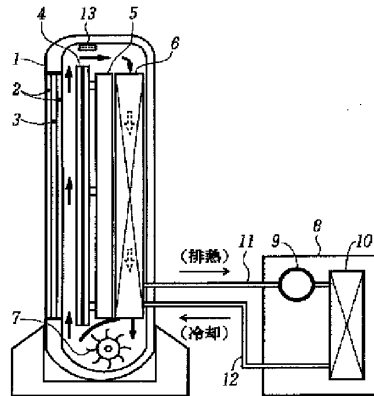
【図1】本発明による映像表示装置の一実施例の要部側断面図である。

【図2】従来の映像表示装置の一例の要部側断面図である。

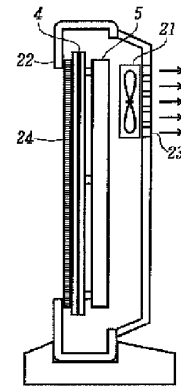
【符号の説明】

- | | |
|----------------------|--------------------|
| 1 筐体 | 5 回路基板 |
| 2 強化二重ガラス | 6 冷却器 |
| 4 プラズマディスプレイパネル（PDP） | 7 送風ファン（クロスフローファン） |
| | 9 コンプレッサ |
| | 10 放熱器 |

【図1】



【図2】



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Notes:

1. Untranslatable words are replaced with asterisks ("***").

2. Texts in the figures are not translated and shown as it is.

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Examiner: Last updated 01/13/2012 / Priority: 1. Mechanical engineering

CLAIM + DETAILED DESCRIPTION

[Claim(s)]

[Claim 1]A condensator of a refrigerating cycle which comprises a plasma display panel, and a condensator and a radiator in a sealed housing, A display unit which allocates a blower fan, allocates a radiator of the aforementioned refrigerating cycle out of a housing, and cooled a plasma display panel in cold by the aforementioned condensator.

[Claim 2]Allocate the aforementioned condensator in the tooth-back side of a plasma display panel, allocate the aforementioned blower fan under the condensator, provide ventilation space between the aforementioned housing and a front face of a plasma display panel, and with rotation of a blower fan, The display unit according to claim 1 with which air for which air cooled with a condensator was ventilated towards a lower end of the aforementioned ventilation space, and which passed along ventilation space formed a circulating route which faces to a condensator from an upper bed of ventilation space.

[Claim 3]Form the aforementioned housing with a synthetic resin material which has adiathermancy, and it makes a portion which counters a graphic display side of a plasma display panel dual structure of tempered glass, The display unit according to claim 1 or 2 which provides a cavity between tempered glass and prevented dew condensation to a glass surface by cooling in a housing.

[Claim 4]Claim 1 which allocated a temperature sensor in the aforementioned housing, and was made to perform operation of the aforementioned refrigerating cycle and a blower fan when temperature in a housing was more than required temperature, the display unit according to claim 2 or 3.

[Claim 5]Allocate a plasma display panel and a blower fan in a sealed housing, and. Attach a refrigerating plant out of a housing and between a housing and refrigerating plants is connected with two ventilation pipes, A display unit which air cooled from a refrigerating plant with one ventilation pipe is sent in a housing, inside of a housing is circulated with the aforementioned blower fan, and air which was able to be warmed within a housing with a ventilation pipe of another side is returned to a cooling system, and cooled a plasma display panel.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the display unit which used the plasma display panel (PDP), attaches a cooling system, cools the inside of a case, controls the degradation of PDP, and relates to what improves brightness contrast.

[0002]

[Description of the Prior Art]Since depth is thin compared with the cathode-ray tube of the same screen size, PDP can shorten the depth of a case substantially by attaching to the tooth back of PDP the circuit board in which the drive circuit etc. were carried. However, PDP generates heat by plasma discharge, the temperature of the PDP itself rises with this heat, and a circuit board is warmed simultaneously. Since the luminous efficacy of a fluorescent substance gets down by a rise in heat, luminosity falls, PDP has the problem that luminosity falls further if lighting times are restricted in order to suppress a rise in heat, and the reliability of a driving circuit part article falls by the rise in heat of a circuit board, There is a problem that the generous parts of temperature rating must be used.

[0003]For this reason, in the display unit using PDP, weight is put on heat dissipation of PDP, For example, as shown in drawing 2, axial fan 21 grade is provided behind the circuit board 5 of the tooth back of PDP4, The open air is inhaled from the pars basilaris ossis occipitalis of the case 22, etc., and he discharges between PDP4 and the circuit boards 5 or the back of the circuit board 5 from the ventilating hole 23 on through and the tooth back of a housing out of a housing, and is trying to cool PDP4 and the circuit board 5. If a good material of heat conduction is used, will become an effective radiation means, but since the light filter 24 is allocated in the front face of PDP4 for the antireflection of outdoor daylight, etc. [this light filter 24] The actual condition is it being necessary to make it not feel hotly, when people's hand etc. touch, and there being such a Reason, and constituting the light filter 24 from a plastic material which is not good as for heat conduction, and the radiating effect by the light filter 24 cannot be expected.

[0004]Although PDP4 encloses xenon gas etc. with space sealed with two glass substrates, molecules, such as xenon gas, are excited by inter-electrode electric discharge, ultraviolet rays are generated, the fluorescent substance applied to the inside by these ultraviolet rays is excited and light is emitted in the light of a light range, Volume, such as xenon gas, expands by this electric discharge (plasma discharge), a glass substrate vibrates, and an allophone is generated. The atmospheric pressure of a closed space between glass substrates is about 1 atmosphere of abbreviated several 10 minutes, since two glass substrates are pressed by the atmospheric pressure, vibration is suppressed and an allophone is a level which is not worried so much in lowlands, but. When operating PDP at the high ground within the state, for example, the airplane under flight, where an atmospheric pressure is low, etc., since the thrust from the outside of a glass substrate declines relatively, a glass substrate will be in the state of being easy to vibrate, and the level of an allophone will become high.

[0005]

[Problem to be solved by the invention]This invention makes the housing of a display unit a direct vent type in view of such a point, and the break-through level of an allophone is reduced, The condensator and blower fan of a refrigerating cycle are provided in a housing, the radiator of a refrigerating cycle is allocated out of a housing, the inside of a housing is circulated for the air cooled with the condensator with a blower fan, PDP is cooled, and it is in making it make full demonstrate the engine performance of PDP.

[0006]

[Means for solving problem]In order that this invention may solve above-mentioned problem, in the sealed housing PDP, The condensator of the refrigerating cycle which comprises a condensator and a radiator, and a blower fan are allocated, the radiator of the aforementioned refrigerating cycle is allocated out of a housing, and the display unit which cooled PDP in the cold by the aforementioned condensator is provided.

[0007]

[Mode for carrying out the invention]In the display unit by this invention, a housing is formed in sealed structure with the synthetic resin material which has adithermancy, Allocate PDP, a condensator, and a blower fan in an inside, and the radiator which constitutes a refrigerating cycle from this condensator is allocated out of a housing, Arrange a condensator to the tooth-back side of PDP, and it arranges a blower fan under the condensator, Make into the dual structure of tempered glass the portion which counters the graphic display side of PDP of the front face of a housing, provide ventilation space between the housing anterior part and PDP containing a square, and with rotation of a blower fan, The air cooled with the condensator is ventilated towards the lower end of the aforementioned ventilation space, and air passing through ventilation space forms the circulating route which faces to a condensator from the upper bed of ventilation space, When a temperature sensor is formed in a housing and the temperature in a housing rises more than required temperature, a refrigerating cycle and a blower fan are operated, the temperature of PDP is lowered, and it is made to operate PDP in the best state.

[0008]

[Working example]Hereafter, based on Drawings, the working example of the display unit by this invention is described in detail. Drawing 1 is an important section sectional side elevation of one working example of the display unit by this invention. In a figure, 1 is a housing and is formed with a synthetic resin material etc. 2 is tempered glass, considers it as dual structure and forms the cavity 3 in the middle. It is the circuit board in which 4 allocated PDP in and five allocated the drive circuit of PDP4, etc., and is attached to the tooth back of PDP4. A condensator and 7, nine in an exhaust heat unit and the exhaust heat unit 8, 6 is refrigerant piping and, as for a compressor and 10, a blower fan and 8 constitute [a radiator, and 11 and 12] a refrigerating cycle by these condensators 6, the compressor 9, the radiator 10, and the refrigerant piping 11 and 12. 13 is a temperature sensor and detects the temperature in the housing 1.

[0009]Next, operation of the display unit by this invention is explained. PDP4 is driven by the signal from the circuit board 5 based on a video signal, it excites molecules, such as xenon gas enclosed by plasma discharge in the glass substrate, generates ultraviolet rays, excites the fluorescent substance applied to the inside, emits light in the light of a light range, and displays an image. The housing 1 is formed in necessary wall thickness with a synthetic resin material, uses the tempered glass 2 (dual structure) for the front part, makes it sealed structure, and it gives adithermancy at the same time it obtains intensity required for maintenance of PDP4 grade. The tempered glass 2 is used in order to damage glass and to keep a fragment from dispersing, when a strong shock is added from the outside.

A plastic etc. are not used for this portion (tempered glass) in order to make it there be nothing that is transformed with a difference of outdoor air pressure and an atmospheric pressure in a housing (it swells), when installing in the inside of a plane of an airplane, or a place where altitude is high for example. The cavity 3 is made using the tempered glass 2 two sheets in order not to produce dew condensation on glass in a temperature gradient with the open air by cooling in the housing 1.

[0010]PDP4 provides and attaches the ventilation space of proper width between the housing 1 and the tempered glass 2. The condensator 6 is allocated behind the circuit board 5, and is connected with the exhaust heat unit 8 by the refrigerant piping 11 and 12. And a refrigerant is compressed into high temperature high pressure by the compressor 9 in the exhaust heat unit 8, After sending to the radiator 10, making it condensate-ize by heat exchange (exhaust heat) with the open air, sending in the housing 1 by the refrigerant piping 12 and decompressing with the capillary tube etc. which are not illustrated, the condensator 6 performs air and ***** (endoergic) in the housing 1, and air in the housing 1 is cooled. The refrigerant which became low pressure gas by heat exchange returns to the compressor 9 by the refrigerant piping 11. The air cooled with the condensator 6 is ventilated by direction of an arrow head with the blower fan 7, passes along the ventilation space of the front face of PDP4, is warmed by generation of heat of PDP4 (it is lowering about the temperature of PDP4), and goes into the condensator 6 through the upper bed of PDP4. And it is again cooled with the condensator 6 and the circulating route of being ventilated with the blower fan 7 is formed. A cross flow fan is used for the blower fan 7, and it sends a cold blast to the overall width of PDP4 uniformly, for example.

[0011]The temperature sensor 13 is attached to the ceiling part in the housing 1, etc., the temperature in the housing 1 is detected, and when it becomes more than a necessary temperature, the aforementioned refrigerating cycle and the blower fan 7 are operated. Above, although the example of the refrigerant compression equation constituted from the condensator 6, the compressor 9, and radiator 10 grade explained the refrigerating cycle, it heats liquid ammonia etc. under high voltage, is sent to a condensator, evaporates it, and may consist of absorption type refrigeration cycles which cool air in the housing 1 with this evaporation heat. Since this system does not use the compressor 9, it has an advantage which does not require the measure against noise by operation of a compressor.

[0012]Although the example allocated in a housing explained the condensator of the refrigerating cycle above, Also install a condensator out of a housing with a compressor and a radiator, and between this cooling system and housing is connected with two ventilation pipes, Cold is sent in a housing from a cooling system with one ventilation pipe, this cold is circulated within a housing with a blower fan, and it may be made to return the warmed air to a cooling system with the ventilation pipe of another side.

[0013]As mentioned above, since the rise in heat of PDP4 is controlled and the luminous efficacy of a fluorescent substance does not fall by providing a refrigerating cycle and cooling the inside of a housing, a high-intensity image can be displayed, and since the rise in heat of a circuit board is controlled, the reliability of parts, such as a drive circuit, improves. By making the housing 1 into sealed structure, the break-through level to the outside of the housing of an allophone by which it is generated in connection with the plasma discharge of PDP4 is reduced, and even when it installs in the inside of the state, for example, the airplane under flight, where an atmospheric pressure is low, or high ground, compared with the flat ground, the allophone of PDP is hardly worried.

[0014]

[Effect of the Invention]Since according to the display unit by this invention a refrigerating cycle is provided and the inside of a housing is cooled as explained above, The rise in heat of PDP is controlled, since the luminous efficacy of a fluorescent substance does not fall, a high-intensity image can be displayed, and since the rise in heat of a circuit board is controlled, the reliability of parts, such as a drive circuit, improves. Since the housing was made into sealed structure, even when the break-through level to the outside of the housing of the allophone resulting from the plasma discharge of PDP is reduced and it installs in the inside of the state, for example, the airplane under flight, where an atmospheric pressure is low, or high ground, compared with the flat ground, the allophone of PDP is hardly worried.

[Translation done.]

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- (71) **Applicant:** MANUFACTURING RESOURCES INTERNATIONAL, INC. [US/US]; 6415 Shiloh Road East, Alpharetta, GA 30005 (US).
- (72) **Inventors:** DUNN, William; 6415 Shiloh Road East, Alpharetta, GA 30005 (US). HUBBARD, Tim; 6415 Shiloh Road East, Alpharetta, GA 30005 (US). DEMARS, Ryan; 6415 Shiloh Road East, Alpharetta, GA 30005 (US).
- (74) **Agents:** DUNHAM, Tyler S. et al.; Standley Law Group LLP, 6300 Riverside Drive, Dublin, OH 43017 (US).
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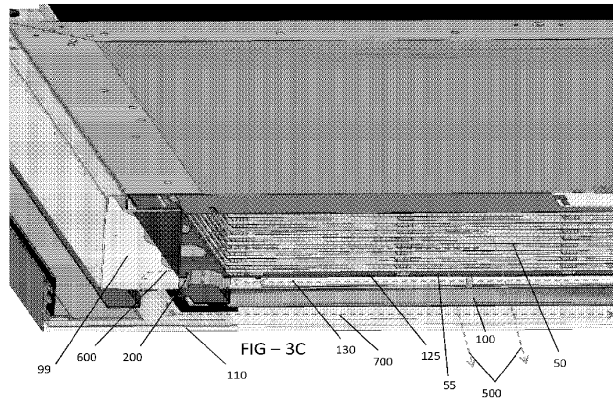
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(54) **Title:** COOLING SYSTEM FOR AN ELECTRONIC DISPLAY



(57) **Abstract:** The exemplary embodiments herein provide a system for cooling an electronic display where a plate is positioned behind the electronic display, the space between the plate and the electronic display defining a first channel. A first fan is preferably positioned to force a first flow of external air through the first channel. A heat exchanger is preferably positioned adjacent to the plate where the space between the heat exchanger and the plate defines a second channel; and a second fan is preferably positioned to force a second flow of external air through the second channel and through the heat exchanger. A continuous heat sink may be placed within the first channel. Pass through gaskets may be used to ensure the external air may cross paths with the circulating gas without permitted the external air and circulating gas to mix.

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COOLING SYSTEM FOR AN ELECTRONIC DISPLAY

Inventors: William Dunn, Tim Hubbard, Ryan DeMars

Cross-Reference to Related Applications

[0001] This application claims priority to U.S. Application No. 61/791,390 filed on March 15, 2013, which is 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] 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.

[0004] 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.

[0005] 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.

Summary of the Exemplary Embodiments

[0006] Exemplary embodiments use a combination of circulating gas and external air in order to adequately cool an electronic display. Circulating gas may be used to remove heat from the front of the image assembly. Because the gas is only circulating within the display, it can remain free of particulate and contaminants and will not harm the display.

[0007] External air may be ingested into the display in order to cool the circulating gas. The external air and the circulating gas may be drawn through a heat exchanger which will allow the heat to transfer from the circulating gas to the external air, preferably without letting the external air and circulating gases mix with one another. An exemplary embodiment would use a cross-flow or counter-flow heat exchanger. An additional flow of external air can be drawn across the rear surface of the electronic display to remove heat from the rear portion of the electronic display. When using a

LCD as the electronic image assembly, this additional flow of external air can be used to remove heat from the rear portion of the backlight for the LCD.

[0008] If using the additional external air pathway behind the electronic display, a manifold may be used to collect the external air along an edge of the display and distribute this into a number of smaller flows. The fans for driving this additional external air pathway can be placed within the manifold in order to reduce the noise emitted by the fans and provide an even distribution of external air across the display.

[0009] 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

[0010] 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:

[0011] **FIGURE 1** provides a rear perspective view of an exemplary electronic display assembly and illustrating the horizontal section line 3-3 and vertical section line 5-5.

[0012] **FIGURE 2** provides a rear perspective view of the embodiment shown in Figure 1 where the rear cover has been removed.

[0013] **FIGURE 3A** provides a perspective section view taken along the section line 3-3 of Figure 1 and showing Details 3B and 3C.

[0014] **FIGURE 3B** provides a detailed section view of Detail 3B shown in Figure 3A.

[0015] **FIGURE 3C** provides a detailed section view of Detail 3C shown in Figure 3A.

[0016] **FIGURE 4** provides a top planar view of an exemplary pass through gasket.

[0017] **FIGURE 5** provides a planar section view taken along the vertical section line 5-5 shown in Figure 1 and indicates Detail 6.

[0018] **FIGURE 6** provides a detailed planar section view of Detail 6 shown in Figure 5 and indicates Detail 7 as well as section line 8-8.

[0019] **FIGURE 7** provides a detailed planar section view of Detail 7 shown in Figure 6.

[0020] **FIGURE 8** provides a perspective section view taken along section line 8-8 shown in Figure 6.

[0021] **FIGURE 9** provides a perspective view of an exemplary embodiment for a corrugated heat sink.

Detailed Description

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] 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.

[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.

[0028] **FIGURE 1** provides a rear perspective view of an exemplary electronic display assembly and illustrating the horizontal section line 3-3 and vertical section line 5-5. A housing 7 is preferably used to contain the assembly and may utilize a rear cover 5 to provide access to the display assembly when removed.

[0030] **FIGURE 2** provides a rear perspective view of the embodiment shown in Figure 1 where the rear cover 5 has been removed. A first flow of external air 500 is

shown passing through a heat exchanger 500, driven by fans 40. Although fans 40 are shown drawing external air 500 through the heat exchanger, fans 40 could also be positioned to push external air 500 through the heat exchanger. Other embodiments could of course use fans to both push and pull through the heat exchanger, or fans in addition to the ones shown here. A second flow of external air is shown being forced by fans 25 and 20 to flow into a first manifold 98 across the rear portion of the electronic display assembly, down a second manifold 99, and eventually exhausted out of an exhaust aperture at the bottom of the display. A plurality of electronic assemblies 51 for controlling and powering the electronic display is shown within the housing 7 cavity. The electronic assemblies 51 could be any one of the following but not limited to: power modules, video players, wireless/satellite receivers, hard drives, microprocessors, capacitors, motors, microprocessors, hard drives, AC/DC converters, transformers, or printed circuit boards.

[0031] FIGURE 3A provides a perspective section view taken along the section line 3-3 of Figure 1 and showing Details 3B and 3C.

[0032] FIGURE 3B provides a detailed section view of Detail 3B shown in Figure 3A. A plurality of circulating fans 30 are used to force circulating gas 700 across the electronic assemblies 51 and through the heat exchanger 50, as well as between the front transparent plate 110 and the electronic display 100, forming a closed loop. The circulating gas 700 passes through the opening within the pass through gasket 200 while the external air 600 travels around the pass through gasket, substantially ensuring that the external air 600 and circulating gas 700 do not mix.

[0033] The flow of external air 600 is shown traversing the first manifold 98 and passing by the cross through gasket 200 in order to enter a channel which runs behind the electronic display 100. The channel is preferably defined as the space between the rear surface of the electronic display 100 and a plate 125. A preferably corrugated and preferably continuous heat sink 130 is ideally placed within the channel in order to facilitate the conductive transfer of heat from the electronic display 100 to the continuous heat sink 130, to be removed by convection with the external air 600.

[0034] The heat exchanger 50 preferably contains a plurality of layers which define channels which contain either circulating gas 700 or external air 500. Preferably, the circulating gas 700 is not permitted to mix with the external air 500 or the external air 600. In an exemplary embodiment, another channel 55 is defined by the space between the plate 125 and the heat exchanger 50 and would contain the external air 500. Preferably, the flow of external air 500 through channel 55 is perpendicular to the flow of external air 600 passing through the gap between the rear surface of the electronic display 100 and the plate 125.

[0035] **FIGURE 3C** provides a detailed section view of Detail 3C shown in Figure 3A. The flow of external air 600 travels through the channel and again passes around the pass through gasket 200 to enter the second manifold 99, eventually being directed out of an exhaust aperture. The circulating gas 700 is shown exiting the heat exchanger 50 and passing through the opening within the pass through gasket 200 and then between the front transparent plate 110 and the electronic display 100.

[0036] **FIGURE 4** provides a top planar view of an exemplary pass through gasket 200. As shown the opening within the gasket 200 is defined by a pair of sides 210

which are substantially planar and parallel to the flow of the circulating gas 700. The opening also contains a pair of sides 220 which are curved outwardly from a common centerline passing through the sides 210. Generally, the cross sectional thickness of the gasket 200 is relatively constant. Also, preferably the gasket 200 is a continuous element surrounding the opening. The external air 600 impacts the curved sidewall (having a similar shape and offset from the curved sides 220) and travels around the curved sidewall until it passes parallel to the sidewall 210 and curves around the opposing curved sidewall until resuming a more laminar flow. Preferably, the circulating gas 700 curves around the curved sides 220 when entering/exiting the gasket 200.

[0037] FIGURE 5 provides a planar section view taken along the vertical section line 5-5 shown in Figure 1 and indicates Detail 6. This figure illustrates the flow of external air 500 which enters the housing through an inlet aperture, passes through the heat exchanger 50 and channel 55, eventually exiting the housing through an exhaust aperture.

[0038] FIGURE 6 provides a detailed planar section view of Detail 6 shown in Figure 5 and indicates Detail 7 as well as section line 8-8. Here, the section line 8-8 cuts directly through the corrugated heat sink 130.

[0039] FIGURE 7 provides a detailed planar section view of Detail 7 shown in Figure 6. Here, the corrugated heat sink 130 preferably alternates between contacting the rear surface of the electronic display 100 and the plate 125, defining a series of alternating channels (one channel defined by the heat sink 130 and the rear surface of the electronic display 100, and the second channel defined by the heat sink 130 and the plate 125).

[0040] **FIGURE 8** provides a perspective section view taken along section line 8-8 shown in Figure 6. As shown, the external air 600 is forced by the fans 25 and 20 to enter the housing and travel down the first manifold until passing by a pass through gasket 200 and across the corrugated heat sink 130 until passing by another pass through gasket 200 and entering the second manifold to be exhausted out of the housing. Of course, some embodiments may not utilize both fans 25 and 20 but may only utilize one or the other. Some embodiments may use more fans in addition to fans 25 and 20.

[0041] **FIGURE 9** provides a perspective view of an exemplary embodiment for a corrugated heat sink.

[0042] Some embodiments may use glass as the transparent front plate 110. Exemplary embodiments may use two pieces of glass laminated with index-matching optical adhesive. Some front plates 110 may provide other utility such as anti-reflection or polarizing functions.

[0043] In a preferred embodiment, the heat exchanger 50 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 50 may be a cross-flow, parallel flow, or counter-flow heat exchanger. In an exemplary embodiment, the heat exchanger 50 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, external air 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 external air 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).

[0044] 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).

[0045] 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.

[0046] 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).

[0047] In an exemplary embodiment, the electronic display 100 would be a direct LED backlit LCD where the LED backlight would contain a plurality of LEDs mounted on a thermally conductive substrate (preferably a metal core PCB). The rear surface of the LED backlight would preferably contain a thermally conductive plate which may be in conductive thermal communication with the heat sink 130. In an exemplary embodiment, the heat sink 130 would be metallic and more preferably aluminum.

[0048] The circulating gas 700, external air 500, and external air 600 can be any number of gaseous matters. In some embodiments, air may be used as the gas for all. Preferably, because the circulating gas 700 travels in front of the electronic display 100

it should be substantially clear, so that it will not affect the appearance of the image to a viewer. The circulating gas 700 should also preferably 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/or damage to the internal electronic components.

[0049] The cooling system may run continuously. However, if desired, temperature sensing devices 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.

[0050] 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 electronic image assemblies: 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 thin 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 at risk.

[0051] 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.

[0052] 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

We claim:

1. A system for cooling an electronic display having a rear surface comprising:
 - a plate positioned adjacent to the rear surface of the electronic display, the space between the plate and the rear surface of the electronic display defining a first channel;
 - a first fan positioned to force a first flow of external air through the first channel;
 - a second channel placed adjacent to the first channel and sharing the plate; and
 - a second fan positioned to force a second flow of external air through the second channel.
2. The system of claim 1 wherein:
 - the first flow of external air is perpendicular to the second flow of external air.
3. The system of claim 1 wherein:
 - the plate is metallic.
4. The system of claim 1 further comprising:
 - a first and second manifold in gaseous communication with the first channel.
5. The system of claim 1 wherein:
 - the rear surface of the electronic display is the rear surface of an LED backlight.

6. The system of claim 1 further comprising:
a continuous heat sink placed within the first channel.
7. The system of claim 6 wherein:
the continuous heat sink is in conductive thermal communication with the rear
surface of the electronic display.
8. The system of claim 6 wherein:
the continuous heat sink is in conductive thermal communication with the plate.
9. The system of claim 1 further comprising:
a heat exchanger having a first plurality of pathways for accepting the second
flow of external air and a second plurality of pathways for accepting
circulating gas;
a transparent plate positioned in front of the electronic display to produce a third
channel between the plate and the electronic display; and
a circulating fan positioned to force circulating gas through the second plurality of
pathways of the heat exchanger and through the third channel.
10. The system of claim 9 further comprising:
a pass through gasket having an opening for accepting circular gas.
11. The system of claim 9 further comprising:

a pass through gasket positioned within the first channel such that circulating gas travels through the gasket while the first flow of external air travels around the gasket.

12. The system of claim 9 further comprising:

a pair of pass through gaskets positioned within the path of the circulating gas such that a closed loop of the circulating gas would pass through both gaskets.

13. The system of claim 9 wherein:

the second channel is defined by the space between the plate and the heat exchanger.

14. The system of claim 10 wherein:

the opening of the gasket is defined by a first pair of sides which are parallel to the flow of the circulating gas and a second pair of sides which connect to the first pair of sides and curve away from a center of the opening.

15. A system for cooling an electronic display comprising:

a plate positioned behind the electronic display, the space between the plate and the electronic display defining a first channel;
a first fan positioned for force a first flow of external air through the first channel;

a heat exchanger positioned adjacent to the plate where the space between the heat exchanger and the plate defines a second channel; and
a second fan positioned to force a second flow of external air through the second channel and through the heat exchanger.

16. The system of claim 15 further comprising:

a corrugated metallic heat sink positioned within the first channel.

17. The system of claim 15 wherein:

the heat sink contacts the electronic display and the plate in an alternating fashion.

18. The system of claim 15 further comprising:

a transparent plate positioned in front of the electronic display to produce a third channel between the plate and the electronic display; and
a circulating fan positioned to force circulating gas through the heat exchanger and through the third channel.

19. A system for cooling an electronic display comprising:

a plate positioned behind the electronic display, the space between the plate and the electronic display defining a first channel;
a first fan positioned for force a first flow of external air through the first channel;

a heat exchanger positioned adjacent to the plate where the space between the heat exchanger and the plate defines a second channel;

a second fan positioned to force a second flow of external air through the second channel and through the heat exchanger;

a first plurality of pathways within the heat exchanger for accepting the second flow of external air;

a second plurality of pathways within the heat exchanger for accepting circulating gas; and

a plurality of pass through gaskets placed within the first channel such that circulating gas travels through the gaskets while the first flow of external air travels around the gaskets.

20. The system of claim 19 further comprising:

an opening within the pass through gaskets defined by a pair of opposing sides which are substantially planar and connect with another pair of opposing sides which are curved outwardly.

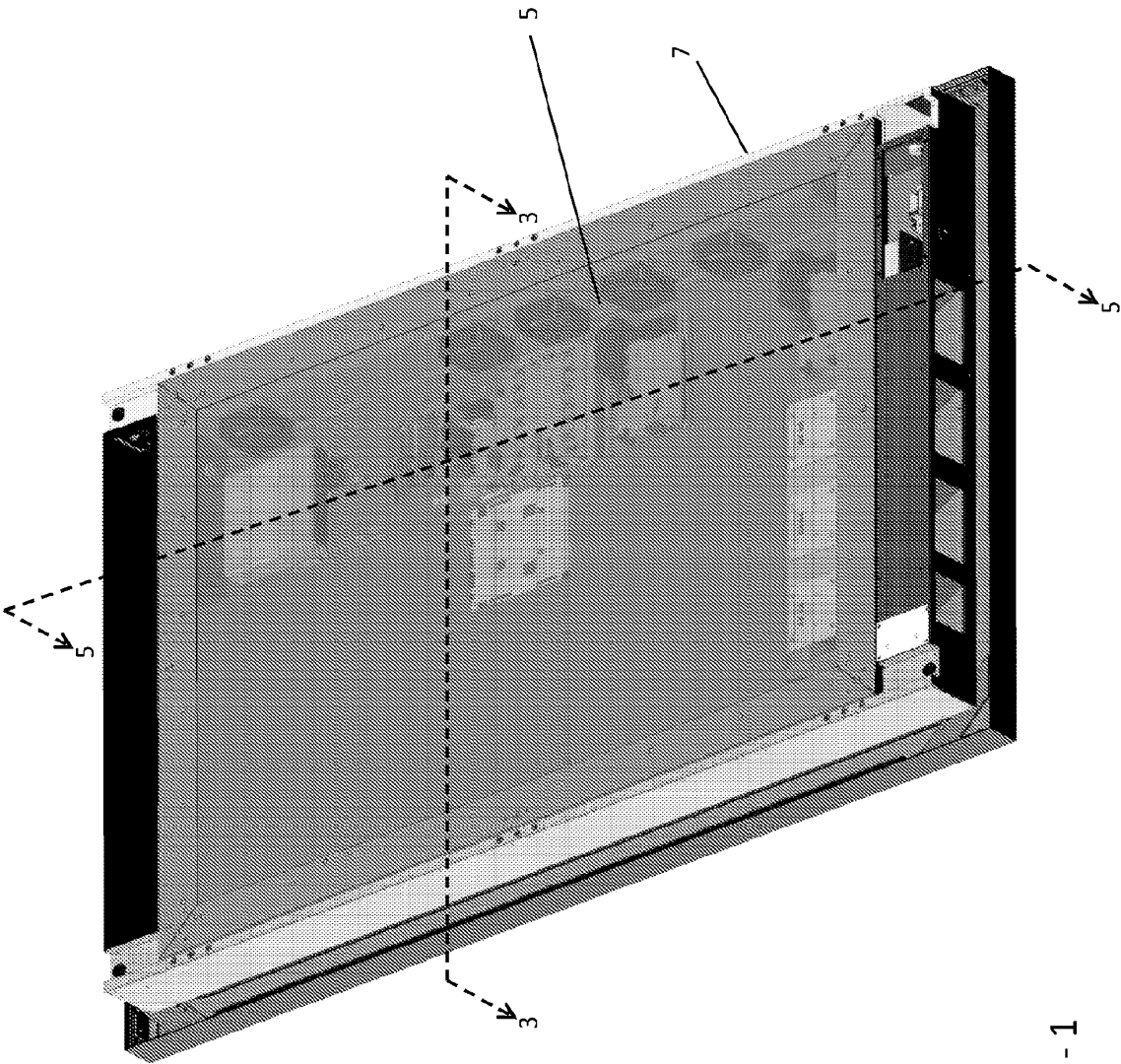
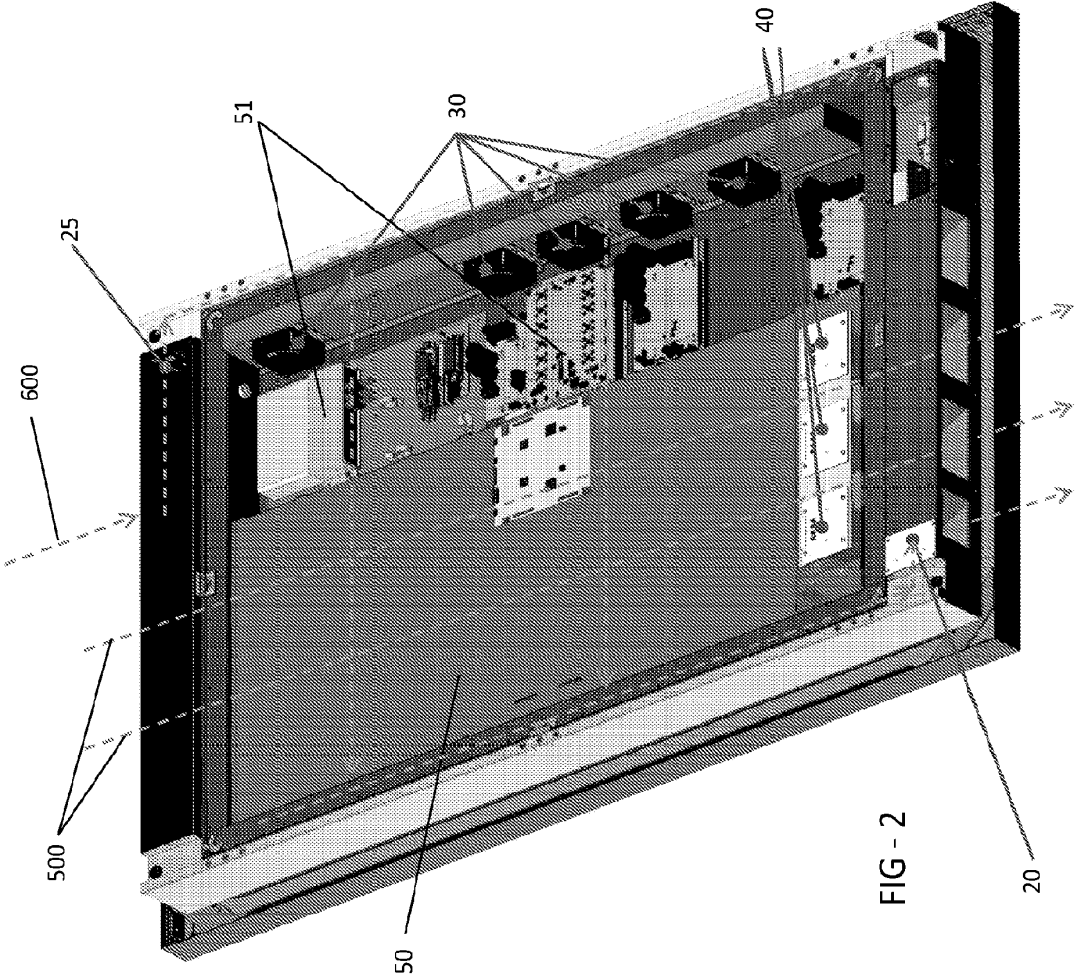


FIG - 1



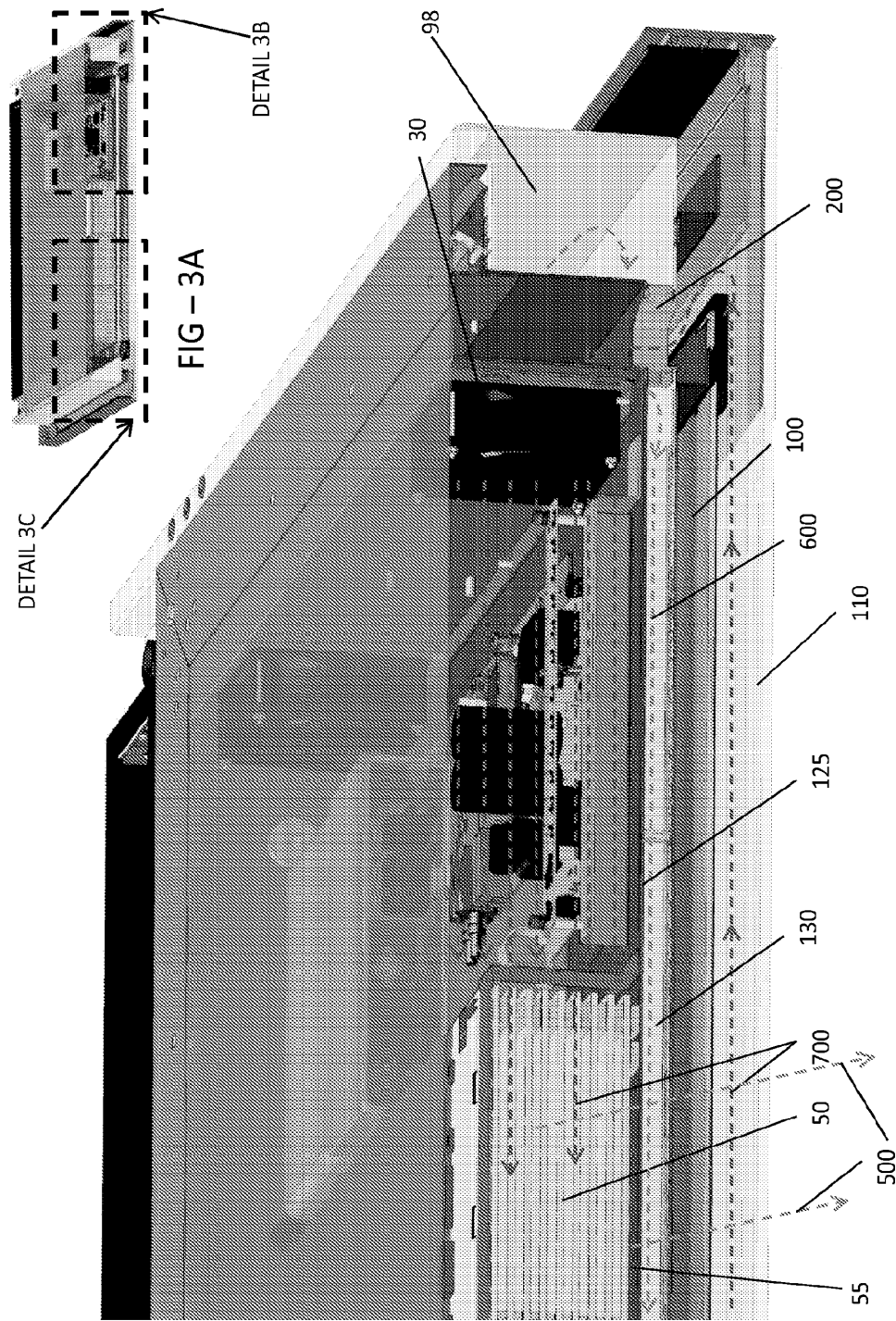
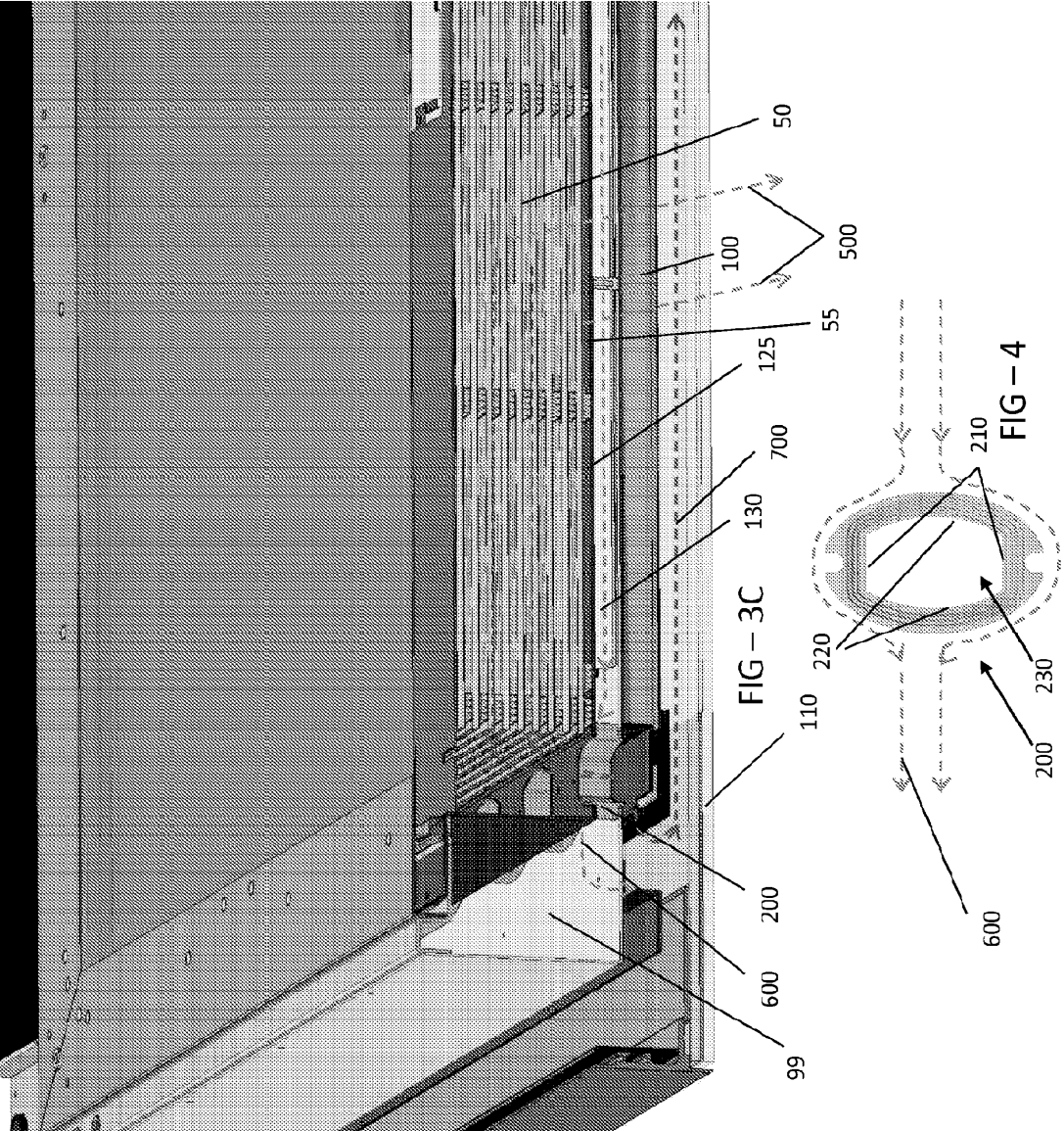
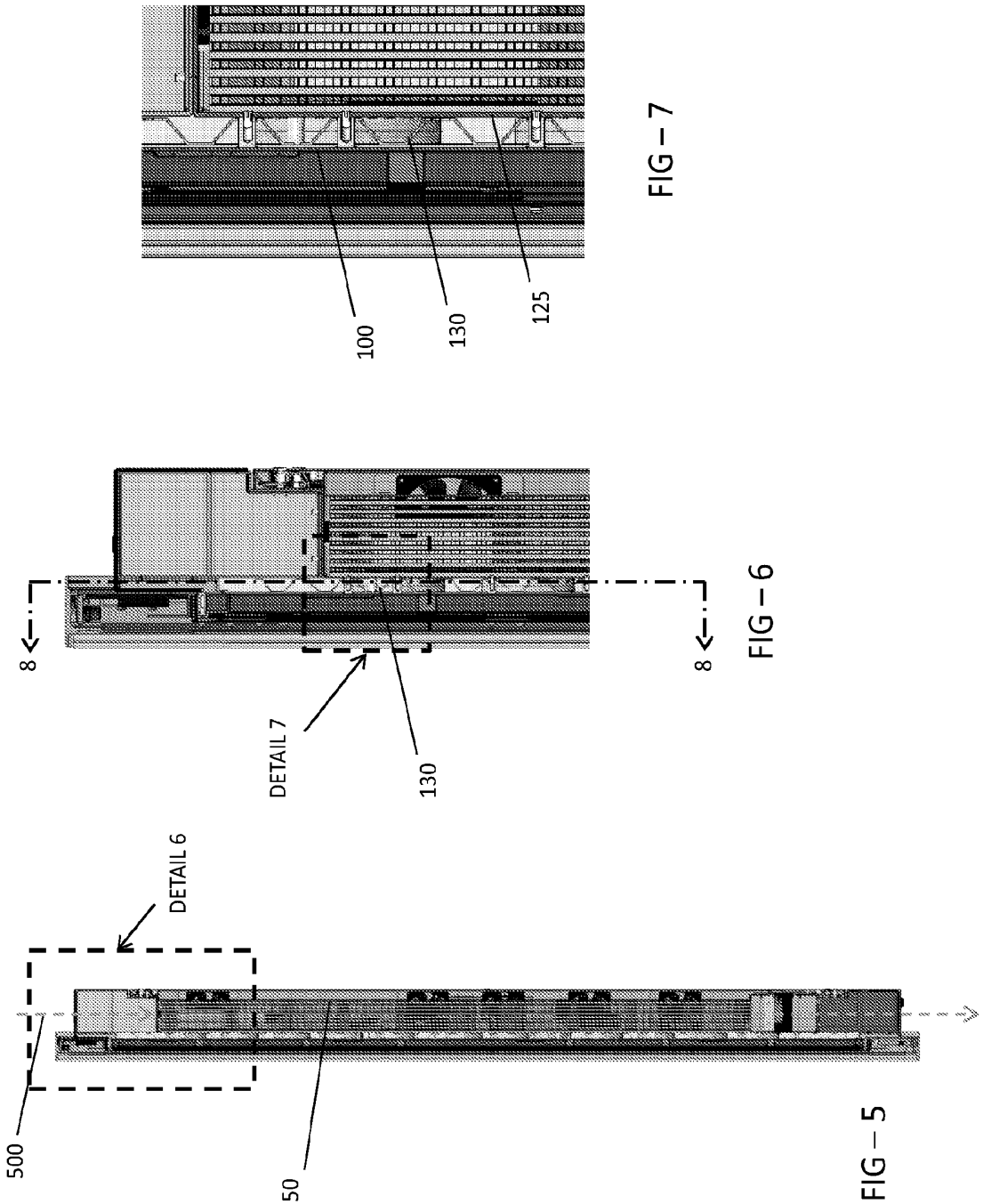


FIG - 3B





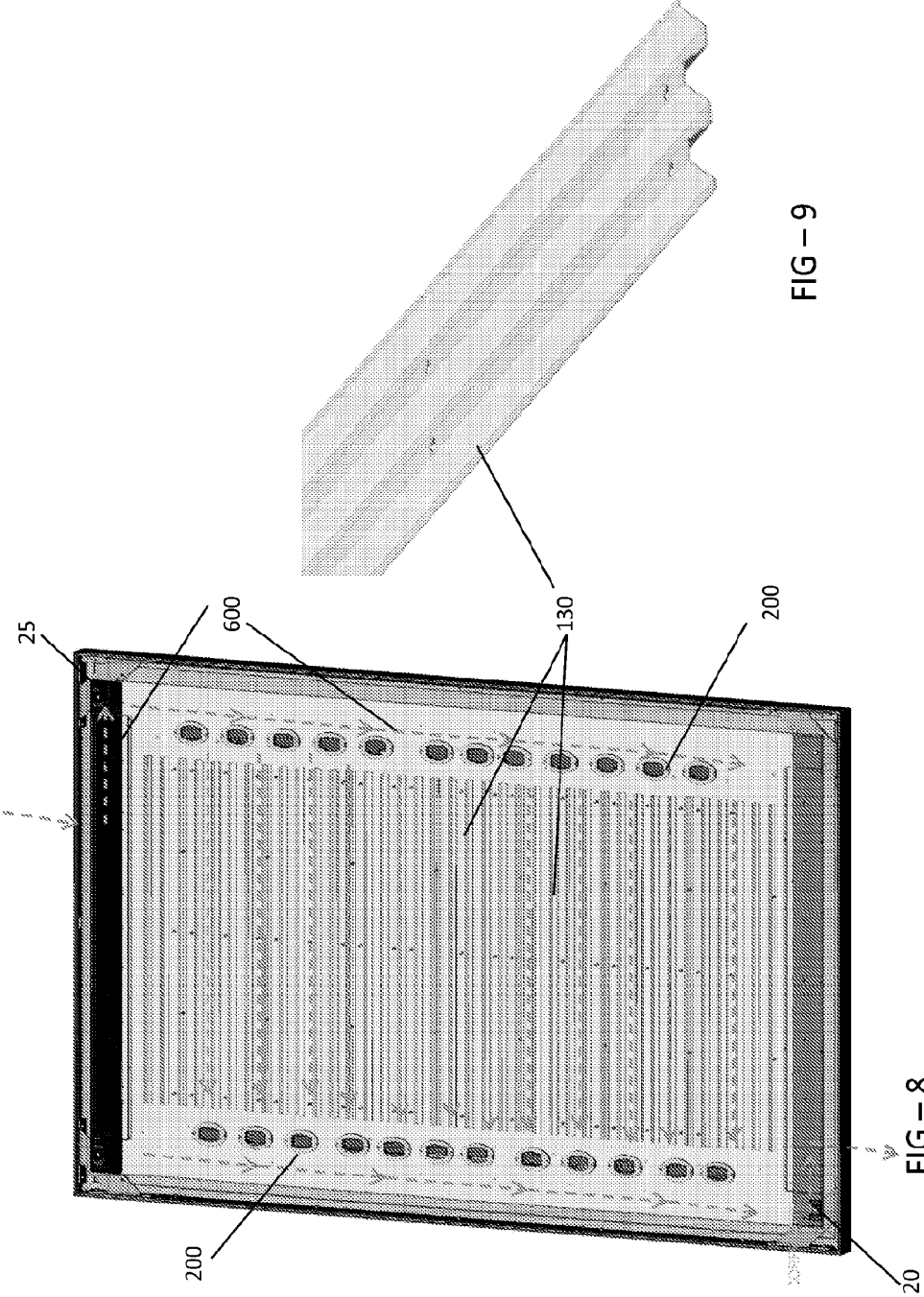


FIG - 9

FIG - 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/21945

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - H05K 5/00, 7/20 (2014.01) USPC - 361/679.47, 696 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) - F28F 13/00; G02F 13/33; G06F 1/16; G09F 9/00; H05K 7/20 (2014.01) USPC - 165/121; 349/161; 361/695, 696, 697, 679.47 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) MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); Google/Google Scholar; Proquest; IP.com; electron*, display, device, panel, cool*, plate*, pan*, filrst NEAR3 (channel OR duct), second NEAR3 (channel OR duct), first ADJ Fan*, second ADJ fan, heat ADJ exchanger*, standoff*, space, gap, HUBBARD NEAR2 TIM, DUNN NEAR2 WILLIAM																																			
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>US 8,369,083 B2 (DUNN, W et al.) February 05, 2013; abstract; figure 1B, 2, 4, 8; claim 8;</td> <td>1-2, 4-5, 9-11</td> </tr> <tr> <td>--</td> <td>column 2, lines 37-39, 44-45; column 3, lines 53-54, 65; column 4, lines 3-5, 13-15, 16-20,</td> <td></td> </tr> <tr> <td>Y</td> <td>43-45; column 5, lines 16-18, 54-56, 66-67; column 6, lines 1-2, column 7, lines 64-65; column 11, 27-30</td> <td>3, 6-8</td> </tr> <tr> <td>Y</td> <td>US 2012/0038849 A1 (DUNN, W et al.) February 16, 2012; abstract; figure 1A; paragraphs [0010], [0029], [0030], [0053]</td> <td>3, 6-8</td> </tr> <tr> <td>A</td> <td>US 2012/0255704 A1 (NAKAMICHI, M) October 11, 2012; entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 2012/0106081 A1 (HUBBARD, T et al.) May 03, 2012; entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 2011/0013114 A1 (DUNN, W et al.) January 20, 2011; entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 8,035,968 B2 (KWON, OK et al.) October 11, 2011; entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 2006/0132699 A1 (CHO, JW et al.) June 22, 2006; entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 2012/0274876 A1 (CAPPAERT, B et al.) November 01, 2012; entire document</td> <td>1-20</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	US 8,369,083 B2 (DUNN, W et al.) February 05, 2013; abstract; figure 1B, 2, 4, 8; claim 8;	1-2, 4-5, 9-11	--	column 2, lines 37-39, 44-45; column 3, lines 53-54, 65; column 4, lines 3-5, 13-15, 16-20,		Y	43-45; column 5, lines 16-18, 54-56, 66-67; column 6, lines 1-2, column 7, lines 64-65; column 11, 27-30	3, 6-8	Y	US 2012/0038849 A1 (DUNN, W et al.) February 16, 2012; abstract; figure 1A; paragraphs [0010], [0029], [0030], [0053]	3, 6-8	A	US 2012/0255704 A1 (NAKAMICHI, M) October 11, 2012; entire document	1-20	A	US 2012/0106081 A1 (HUBBARD, T et al.) May 03, 2012; entire document	1-20	A	US 2011/0013114 A1 (DUNN, W et al.) January 20, 2011; entire document	1-20	A	US 8,035,968 B2 (KWON, OK et al.) October 11, 2011; entire document	1-20	A	US 2006/0132699 A1 (CHO, JW et al.) June 22, 2006; entire document	1-20	A	US 2012/0274876 A1 (CAPPAERT, B et al.) November 01, 2012; entire document	1-20
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☐ Further documents are listed in the continuation of Box C. ☐																																			
<table border="1"> <thead> <tr> <th>* Special categories of cited documents:</th> <th></th> </tr> </thead> <tbody> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"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</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"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</td> </tr> <tr> <td>"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)</td> <td>"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</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td>"&" document member of the same patent family</td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </tbody> </table>			* Special categories of cited documents:		"A" document defining the general state of the art which is not considered to be of particular relevance	"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	"E" earlier application or patent but published on or after the international filing date	"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	"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)	"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	"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	"P" document published prior to the international filing date but later than the priority date claimed																						
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Date of the actual completion of the international search 22 June 2014 (22.06.2014)		Date of mailing of the international search report 30 JUL 2014																																	
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201		Authorized officer: Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774																																	

Form PCT/ISA/210 (second sheet) (July 2009)

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EFS ID:	31490241
Application Number:	15789331
International Application Number:	
Confirmation Number:	2408
Title of Invention:	ELECTRONIC DISPLAY WITH COOLING
First Named Inventor/Applicant Name:	William Dunn
Customer Number:	8698
Filer:	Eric Michael Gayan/Brianna Lacy
Filer Authorized By:	Eric Michael Gayan
Attorney Docket Number:	MAN2241-045P
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Filing Date:	20-OCT-2017
Time Stamp:	15:39:43
Application Type:	Utility under 35 USC 111(a)

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Submitted with Payment	no
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47	Foreign Reference	WO2011072217A2.pdf	653455	no	19
			9fa9e570f995f5e51df42f4b10f2d7cc67398f44		
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48	Foreign Reference	WO2011150078A2.pdf	693132	no	24
			50fd2d2d1bc7ba1d91c4b483a7ed3bf081b0a464		
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49	Foreign Reference	WO2012024426A2.pdf	3416521	no	35
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50	Foreign Reference	WO2014149773A1.pdf	1024006	no	25
			782349d03230842bae2af31cd12f7c21a95d83c9		
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51	Non Patent Literature	SunBriteTV_Model4610HD.pdf	651096	no	1
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52	Non Patent Literature	SunBriteTV_SunBriteTVIntroducesTwoNewAll-WeatherOutdoorTelevisionsInfoComm2008_2008.pdf	3334774	no	7
			b4f4581054a4d9c7a57c43639aff5b7c93fa510a09		
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54	Non Patent Literature	Zeeff_EMAnalysisofLCDmonitor.pdf	32280	no	1
			7b0bd09845fb84e162687874b519e3bae5309b71		
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55	Foreign Reference	JP3153212.pdf	163069	no	4
			6680dd691639afefa075b86da8c219186c72c820		
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56	Foreign Reference	KR100666961.pdf	572715	no	15
			a08ec127ab31dc07a08bb4d2df6e3c68354d6ba2		
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57	Foreign Reference	JP11160727.pdf	1054811	no	11
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