

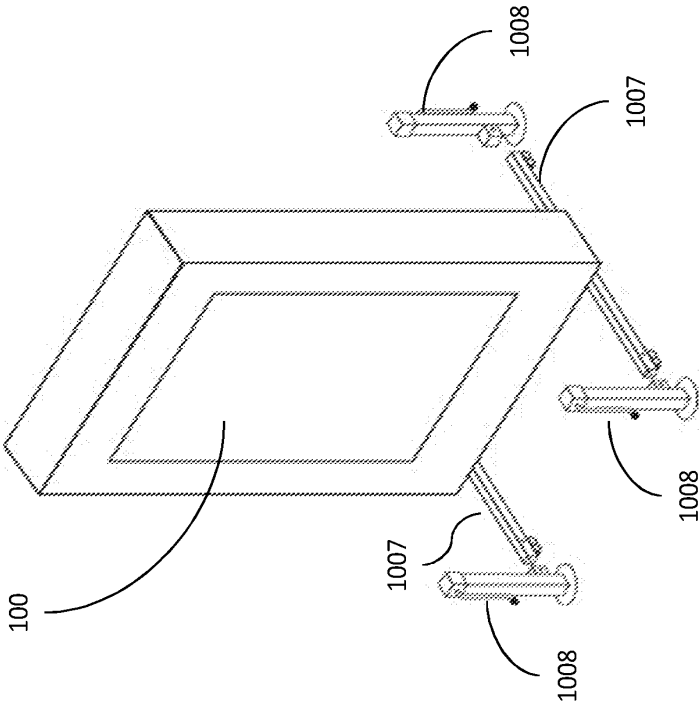


FIG. 37

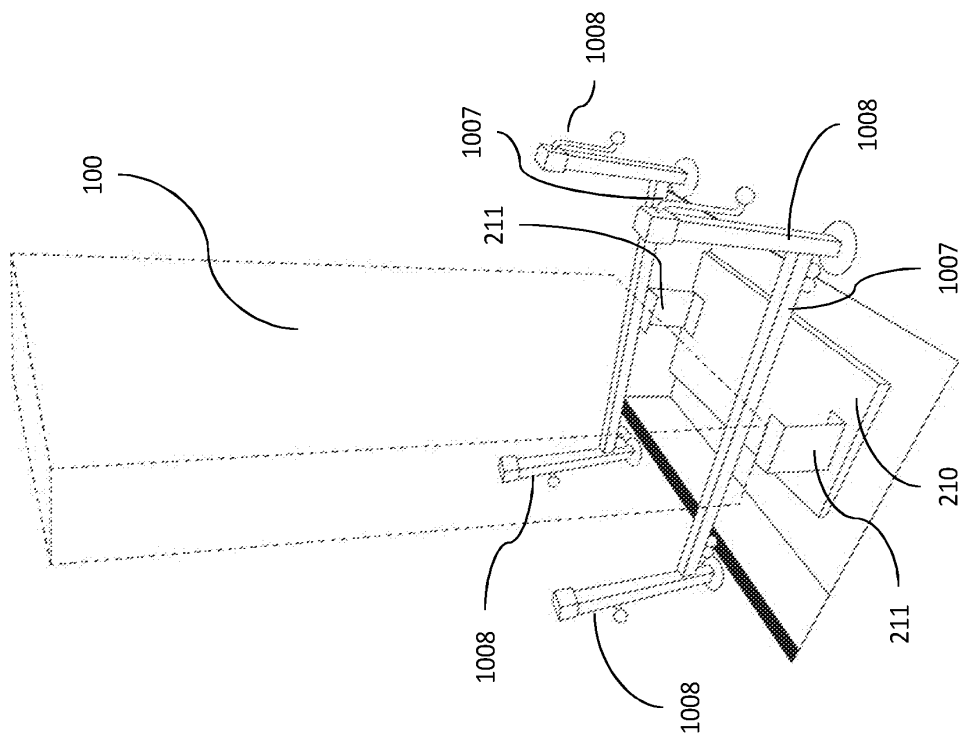


FIG. 38

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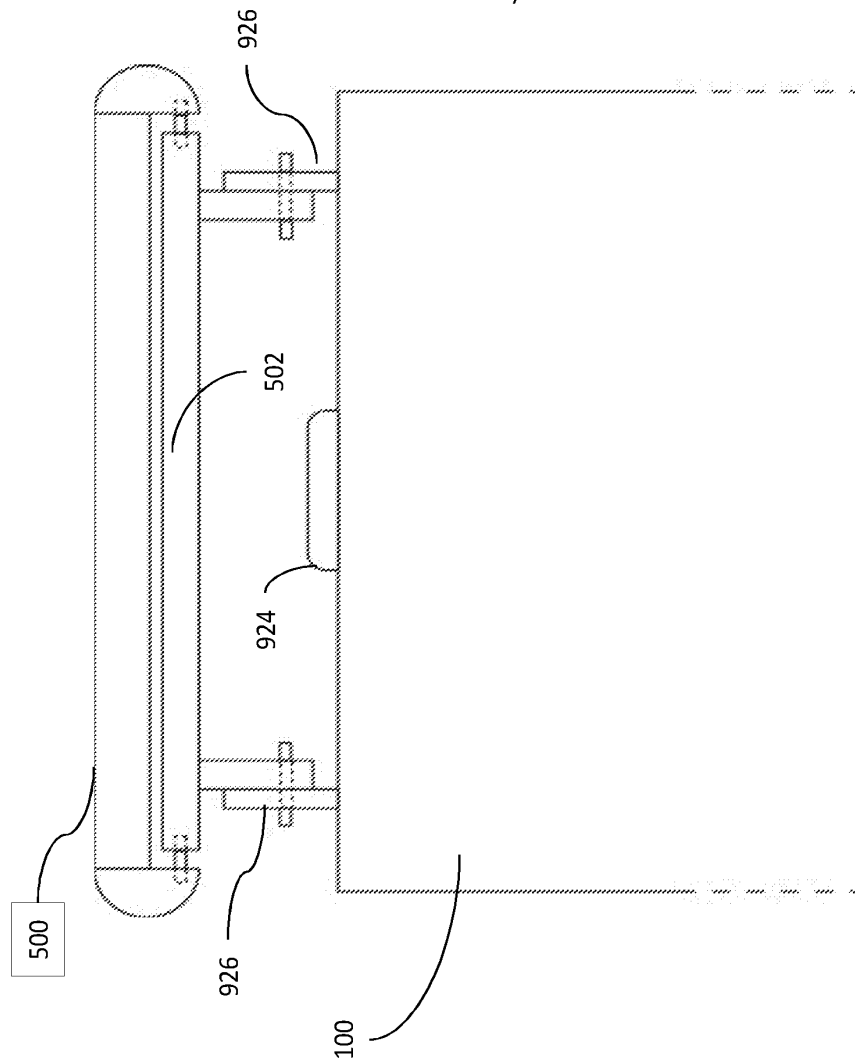


FIG. 39

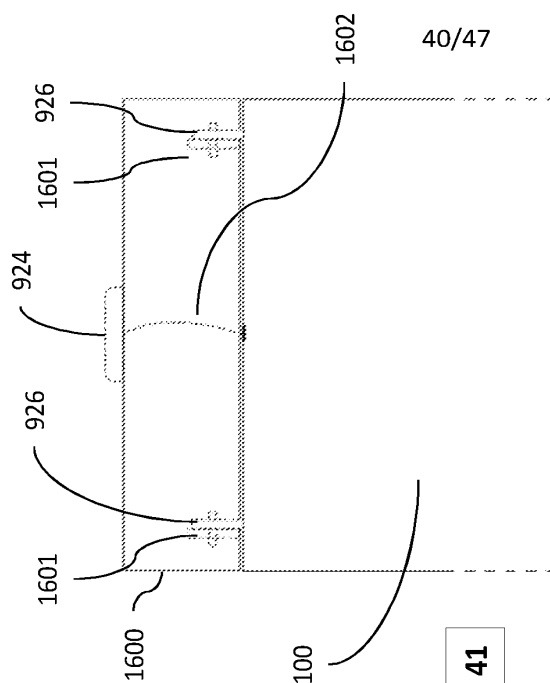


FIG. 41

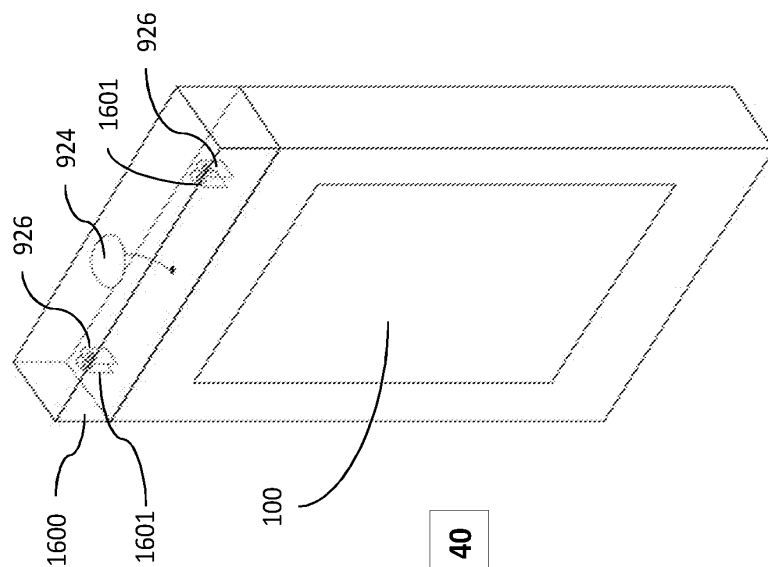


FIG. 40

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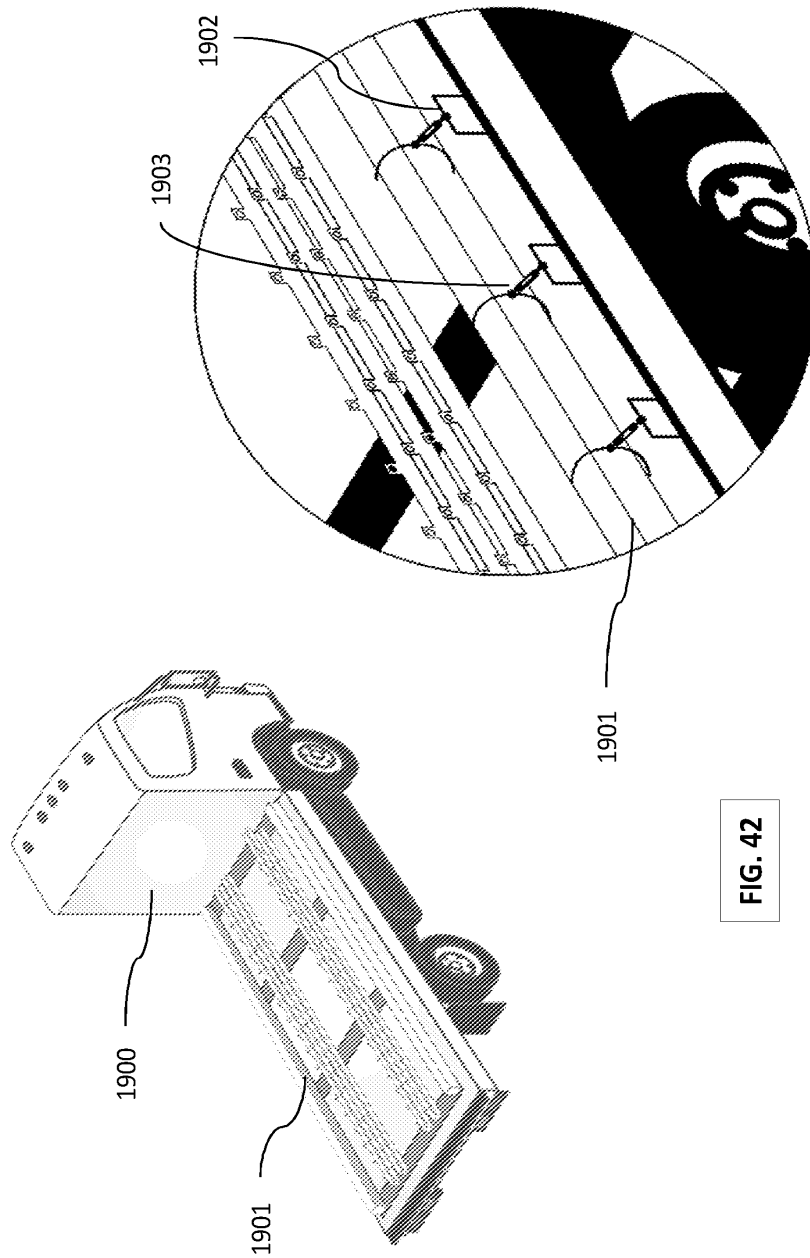
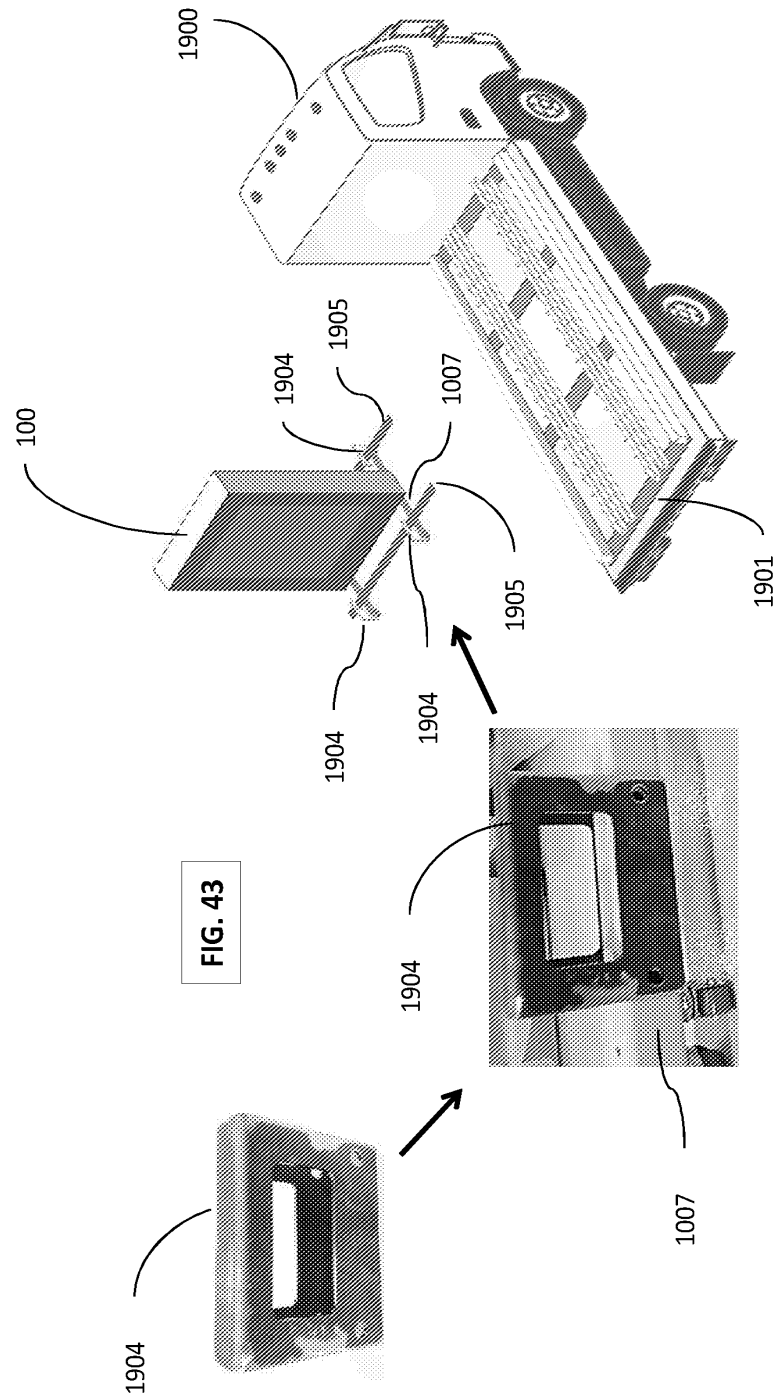
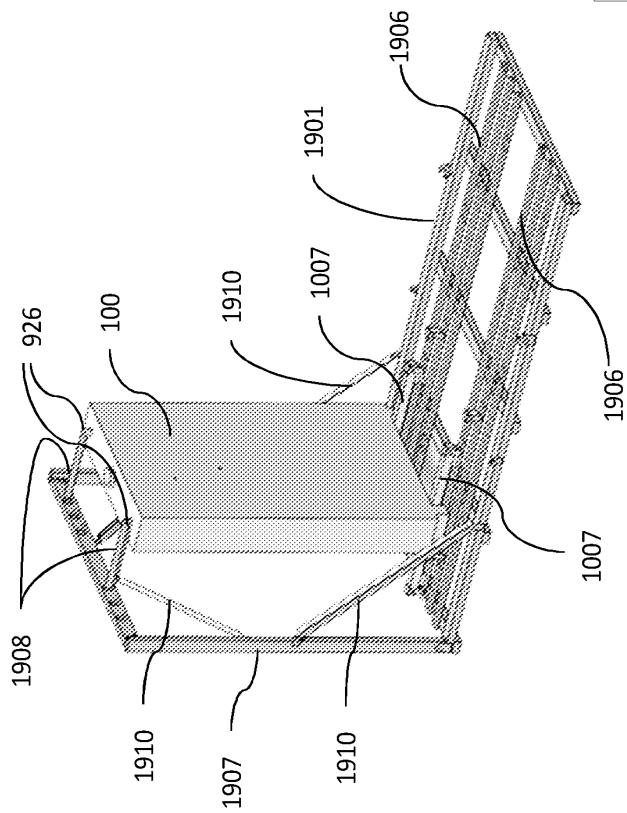
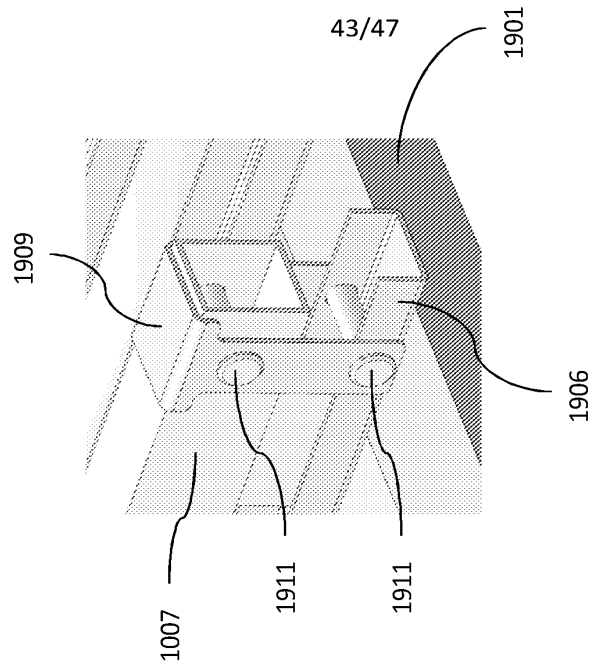


FIG. 42

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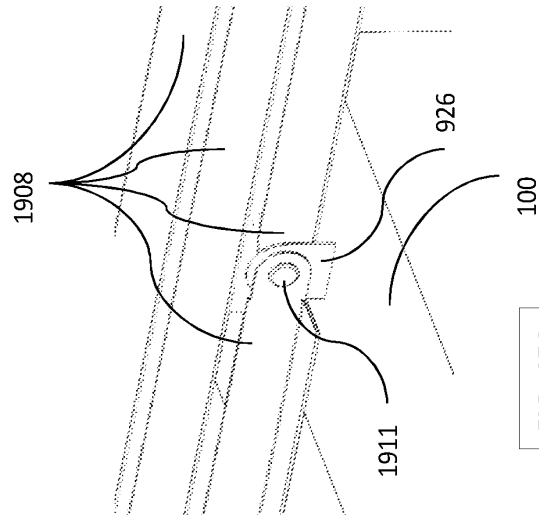


FIG. 45A

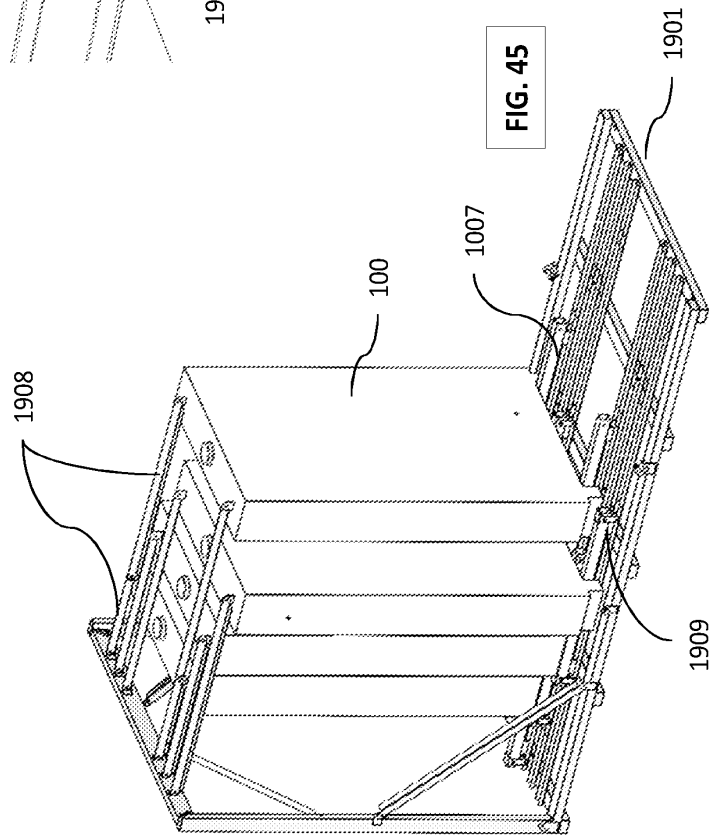
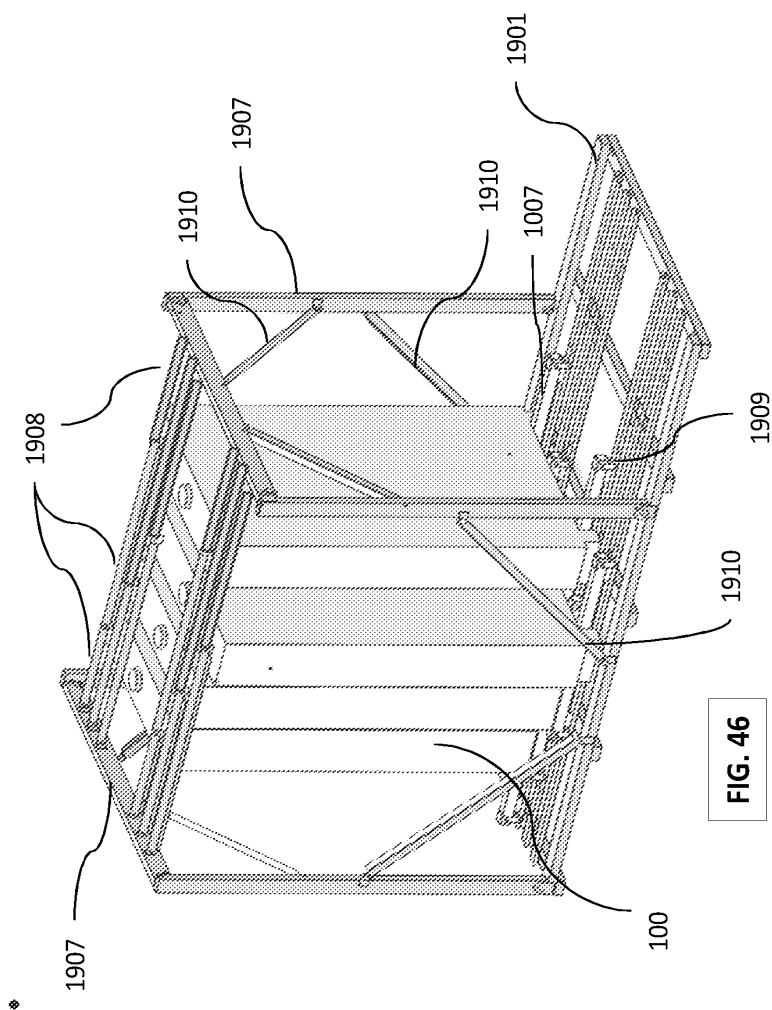
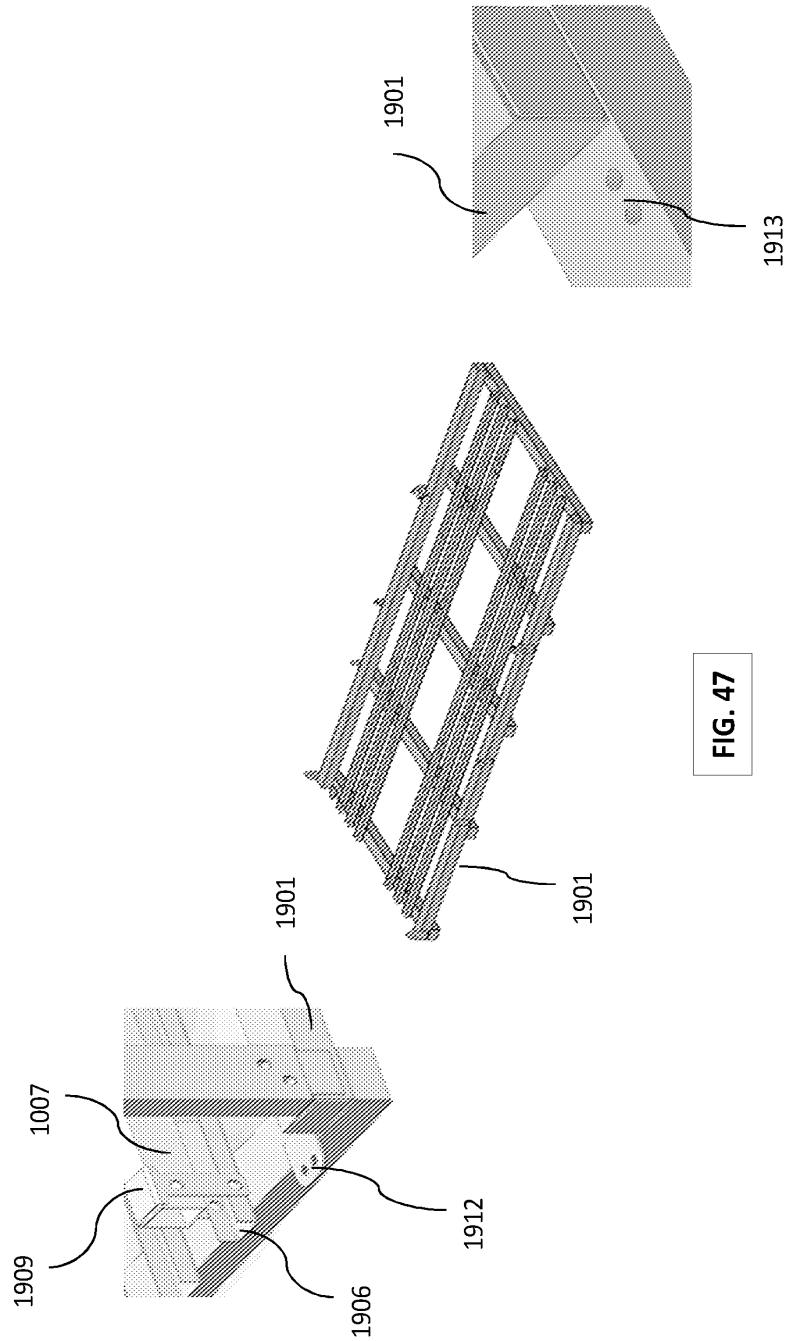


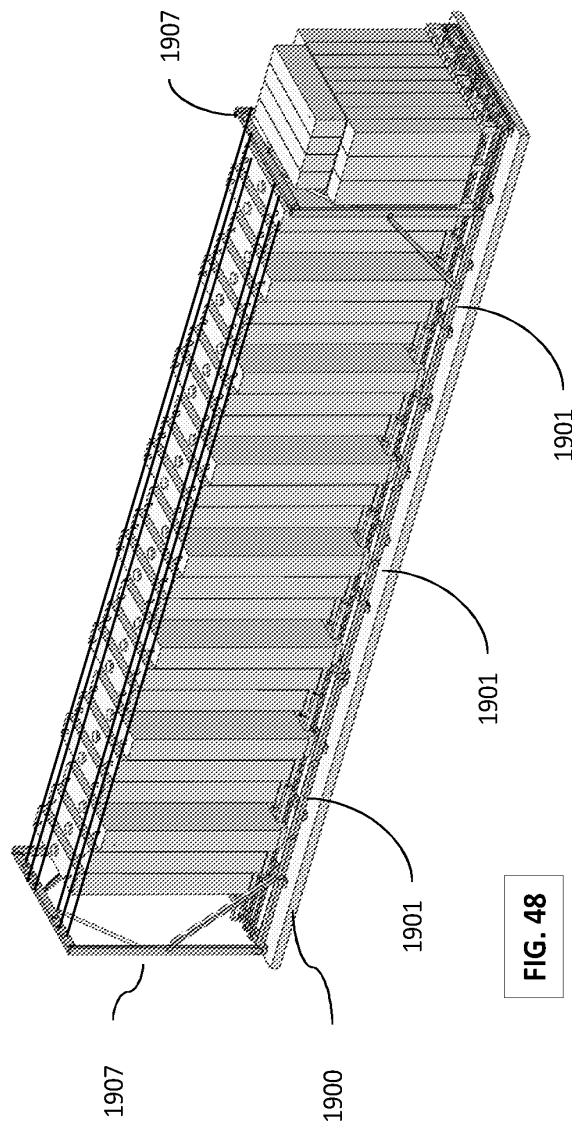
FIG. 45

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2015/054169

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N5/64
ADD.

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)

B01D G02F F21Y F21V H05K G09G G06F G09F A47B H04N

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2006/187140 A1 (BRASK KENNETH A [US]) 24 August 2006 (2006-08-24) abstract paragraphs [0019], [0029], [0030] figures 5,6	1-25
Y	US 2011/134356 A1 (SWATT BILL [US] ET AL) 9 June 2011 (2011-06-09) abstract paragraphs [0008], [0030] figure 3A	1,2,6-25
Y	US 2013/333340 A1 (WINKLER HEINZ [AT]) 19 December 2013 (2013-12-19) abstract paragraph [0026]	3
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"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

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

"&" document member of the same patent family

Date of the actual completion of the international search

15 April 2016

Date of mailing of the international search report

25/04/2016

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Lauri, Lauro

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2015/054169

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	----- US 2010/226091 A1 (DUNN WILLIAM [US]) 9 September 2010 (2010-09-09) the whole document	1-25
A	----- JP 2011 193196 A (PANASONIC CORP) 29 September 2011 (2011-09-29) abstract	1-25
A	----- EP 1 647 766 A2 (LG ELECTRONICS INC [KR]) 19 April 2006 (2006-04-19) the whole document -----	1-25

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2015/054169

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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(71) Applicant: MANUFACTURING RESOURCES INTERNATIONAL, INC. [US/US]; 6415 Shiloh Road East, Alpharetta, GA 30005 (US).

(72) Inventor: 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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Published:

— with international search report (Art. 21(3))

(54) Title: PERIMETER VENTILATION SYSTEM FOR ELECTRONIC DISPLAY

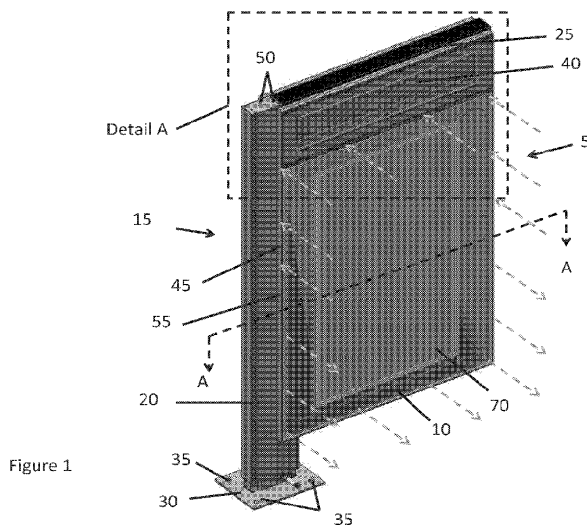


Figure 1

(57) Abstract: The exemplary embodiments herein provide an electronic display assembly having an electronic display surrounded by a front panel and a housing. An ingestion gap may be placed near a portion of the perimeter of the front panel while an exhaust gap may be placed near an opposing portion of the perimeter of the front panel. A buffer zone may be defined between the ingestion gap and the exhaust gap. A fan may be positioned to draw open loop fluid into the ingestion gap, through a channel behind the electronic display, and out of the exhaust gap. This fan may also draw open loop fluid through an optional heat exchanger. A circulating fan may force circulating air through an optional heat exchanger.

WO 2016/133852 A1

Perimeter Ventilation System for Electronic Display

Inventor(s): Ryan Demars

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to US Application No. 14/624,268 filed on February 17, 2015 which is herein incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] Embodiments of the present invention generally relate to mounting and cooling systems for electronic displays.

BACKGROUND

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

SUMMARY OF THE INVENTIVE CONCEPT

[0004] Exemplary embodiments may comprise a display assembly and a free standing display housing. The display assembly may be mounted within the free standing display housing. The display assembly may comprise an ingestion gap that is positioned along the perimeter of a front panel, as well as an exhaustion gap that is positioned along an opposing portion of the perimeter of the front panel. A fan may be positioned to force open loop fluid into the ingestion gap, through a channel behind the electronic display, and out of the exhaustion gap.

[0005] The same fan or an additional fan may be used to force open loop fluid through an optional heat exchanger as well. An additional circulating fan may be used to circulate a closed loop fluid through the heat exchanger as well.

[0006] A buffer zone may be placed between the ingestion gap and the exhaustion gap and preferably contains one or more septums which substantially limit or prohibit the vertical flow of open loop fluid once ingested into the housing. The septums are generally positioned horizontally and near the vertical center of the display assembly (although not required).

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] In addition to the features mentioned above, other aspects of the present invention will be readily apparent from the following descriptions of the drawings and exemplary embodiments, wherein like reference numerals across the several views refer to identical or equivalent features, and wherein:

[0008] **FIGURE 1** is a front perspective view of an exemplary embodiment of the electronic display assembly housed in a free standing housing, and indicating section line A-A and Detail A.

[0009] **FIGURE 2** is a front elevation view of the embodiment shown in FIG. 1 and indicating Detail N.

[0010] **FIGURE 3** is a detailed front elevation view of Detail N shown in FIG. 2.

[0011] **FIGURE 4** is a rear perspective view of the exemplary embodiment of FIG. 1, and indicating section line B-B as well as Detail C.

[0012] **FIGURE 5** is a front perspective view of Detail A shown in FIG. 1, shown with a front panel removed.

[0013] **FIGURE 6** is a rear perspective view of the exemplary embodiment shown in FIG. 1, where a rear panel has been removed, and indicating Detail D and Detail E.

[0014] **FIGURE 7** is a top perspective section view taken along section line A-A of FIG. 1, and indicating Detail F.

[0015] **FIGURE 8** is a top plan section view of Detail F shown in FIG. 7.

- [0016] **FIGURE 9** is bottom perspective section view taken along section line B-B of FIG. 4, and indicating Detail K.
- [0017] **FIGURE 10** is a bottom plan section view of Detail K shown in FIG. 9, and indicating Detail L.
- [0018] **FIGURE 11** is a front plan view of the exemplary embodiment shown in FIG. 1 and indicating section lines F-F, G-G, and H-H.
- [0019] **FIGURE 12A** is a top plan section view taken along section line F-F of FIG. 11, and indicating Detail O and Detail P.
- [0020] **FIGURE 12B** is a top plan section view taken along section line G-G of FIG. 11, and indicating Detail Q.
- [0021] **FIGURE 12C** is a top plan section view taken along section line H-H of FIG. 11, and indicating Detail R.
- [0022] **FIGURE 13A** is a top plan detailed section view of Detail O in FIG. 12A.
- [0023] **FIGURE 13B** is a top plan detailed section view of Detail Q in FIG. 12B.
- [0024] **FIGURE 13C** is a top plan detailed section view of Detail R in FIG. 12C.
- [0025] **FIGURE 14** is a top plan detailed section view of Detail P in FIG. 12A.
- [0026] **FIGURE 15** is a rear perspective view of Detail D shown in FIG. 6, shown with the free standing display housing removed.
- [0027] **FIGURE 16** is a front perspective view of Detail C shown in FIG. 4 of the rear panel, shown in isolation from the surrounding components.
- [0028] **FIGURE 17** is a bottom plan section view of Detail L shown in FIG. 10.
- [0029] **FIGURE 18** is a rear perspective view of Detail E shown in FIG. 6, shown with the free standing display housing removed.
- [0030] **FIGURE 19A** is a rear perspective view of the assembly of FIG. 1, shown with the free standing display housing removed, and indicating Detail S.
- [0031] **FIGURE 19B** is a front perspective view of the assembly of FIG. 1, shown with the free standing display housing and front panel removed, and indicating Detail T.
- [0032] **FIGURE 20** is a rear perspective detail view of Detail S shown in FIG. 19A.
- [0033] **FIGURE 21** is a front perspective detail view of Detail T shown in FIG. 19B.

[0034] **FIGURE 22** is bottom perspective section view taken along section line B-B of FIG. 4

[0035] **FIGURE 23** is a front perspective view of the assembly of FIG. 1 showing only the rear panel, free standing display housing, and a select portion of the display assembly in isolation from all other surrounding components.

[0036] **FIGURE 24** is a top view of the assembly of FIG. 1, showing only the rear panel and select portions of the display assembly in isolation from all other surrounding components, and indicating detail M.

[0037] **FIGURE 25** is a front perspective view of Detail M shown in FIG. 23.

[0038] **FIGURE 26A** is a front perspective view of a septum shown with only the free standing display housing and select portions of the display assembly in isolation from all other surrounding components.

[0039] **FIGURE 26B** is another front perspective view of the septum, again shown with only the free standing display housing and select portions of the display assembly in isolation from all other surrounding components.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENT(S)

[0040] 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.

[0041] 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.

[0042] Embodiments of the invention are described herein with reference to illustrations that are schematic illustrations of idealized embodiments (and intermediate structures) of the invention. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments of the invention should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing.

[0043] 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.

[0044] **FIGURE 1** is an exemplary embodiment of an electronic display assembly 5 (hereinafter also the “assembly”). The electronic display assembly 5 comprises a front panel 10 that may cover the majority of the front surface of the assembly 5. The front panel 10 may be transparent and positioned in front of an electronic display 70, which is preferably secured behind the front panel 10. In exemplary embodiments, the front panel 10 is a touch screen. A perimeter wall 55 may surround the front panel 10.

[0045] A free standing display housing 15 may surround the assembly 5 and may be configured to permit affixing the assembly 5 to the ground. In exemplary embodiments the free standing display housing 15 may be flag shaped. In still other embodiments, the free standing display housing 15 may be sized and configured to be integrated into a bus shelter.

[0046] The free standing display housing 15 may comprise a post 20, an upper beam 25, and a base 30. In exemplary embodiments, the base 30 may comprise select apertures 35, such as circular holes, that permit a fastener, such as a bolt, to pass through and thereby affix the base 30 to the ground. The number and location of the apertures 35 shown are merely an example. A bottom portion of post 20 may be buried to affix the free standing display to the ground. In some embodiments, this may be accomplished by burring said bottom portion of post 20 in concrete. The free standing display housing 15 and related components may be comprised of a metal, such as stainless steel or aluminum.

[0047] The upper beam 25 may further comprise a secondary display 40 that covers a majority of one side of the upper beam 25. In exemplary embodiments this secondary display 40 is a liquid crystal display (LCD). In other embodiments, the secondary display 40 may be a static display comprising an illumination device, such as a backlight, and a cavity to accommodate a static display, such as a poster.

[0048] A pair of elongate members 50 may extend from the top of the post 20. The elongate members 50 may be configured to further secure the free standing display housing 15, and thereby the assembly 5, in place. Any number and shape of elongate members 50 is contemplated. In exemplary embodiments, these elongate members 50 may be sized and configured to be integrated with a bus shelter.

[0049] As discussed in greater detail in the subsequent figures, the assembly 5 may further comprise a gap 45 between the perimeter wall 55 and the front panel 10 configured to permit the flow of a fluid, such as ambient air, in and out of the assembly 5. In exemplary embodiments, the assembly 5 may be configured such that the upper half of the assembly 5 permits the intake of a fluid, while the lower half of the assembly 5 permits the exhaust of said fluid, as illustrated by the flow lines. This is only an example as other embodiments may be configured such that the upper half of the assembly 5 permits the exhaust of a fluid, while the lower half of the assembly 5 permits the intake of said fluid.

[0050] **FIGURE 2** and **FIGURE 3** illustrates the gap 45, further indicated by the cross hatched area which has been enlarged in order to show the detail, extends along the perimeter of the assembly 5. The gap 45 may further comprise a buffer zone 46. The buffer zone 46 may be an area, preferably between the ingestion and exhaust portions of the gap 45 that does not permit the flow of external air. In other embodiments, the buffer zone 46 may substantially limit the flow of external air. In an exemplary embodiment, the gap 45 is positioned around the perimeter of the front panel 10 but is not found within the buffer zones 46. In an exemplary embodiment, the buffer zones 46 are located near the vertical centerline of the display assembly 5 and typically there is a first buffer zone on the right hand side of the assembly with a second buffer zone on the left hand side of the assembly.

[0051] In **FIGURE 4** the assembly 5 may further comprise a rear panel 60 that covers a majority of the rear surface of assembly 5. A rear perimeter wall 54 may surround the sides of rear panel 60. In exemplary embodiments, the rear perimeter wall 54 may be substantially the same as the perimeter wall 55. The upper beam 25 may further comprise a tertiary display 41 that may contain a backlight and graphic, similar to the secondary display 40. An illumination unit, such as a backlight, may be placed behind the rear panel 60. A cavity may be located behind the rear surface of rear panel 60 and may be configured to accommodate a static display, such as a poster, placed within or behind the rear panel 60. In alternate embodiments, an electronic display assembly (such as an LCD) may be placed behind the rear panel 60.

[0052] As discussed in greater detail in the subsequent figures, similarly to FIG. 1 the assembly 5 may further comprise a rear gap 44 between the rear perimeter wall 54 and the rear panel 60 configured to permit the flow of a fluid, such as ambient air, in and out of the assembly 5. In exemplary embodiments, the assembly 5 may be configured such that the upper half of the assembly 5 permits the intake of a fluid, while the lower half of the assembly 5 permits the exhaust of said fluid, as illustrated by the flow lines (but this could be reversed).

[0053] In exemplary embodiments of the present invention, ingestion and exhaustion of open loop fluid 400 may not take place along select portions of the rear gap 44, such as the upper and lower edges. In other embodiments, ingestion and exhaustion of open loop fluid 400 may take place along the entirety of rear gap 44, with the possible exception of the buffer zones 46.

[0054] **FIGURE 5** illustrates the front panel 10 removed, revealing that the electronic display 70 which may be affixed behind front panel 10 and within perimeter wall 55. The assembly 5 may further comprise a series of intake apertures 65 located above the electronic display 70, between the display 70 and the secondary display 40. The illustrated intake apertures 65 are merely exemplary, any number and shape of intake apertures 65 is contemplated. The intake apertures 65 may be configured to facilitate the ingestion of a fluid, such as ambient air, into an open loop that flows behind the electronic display 70. A pair of side interior channels 21 and 22 may run the majority of the length of each side of the electronic display 70.

[0055] **FIGURE 6** illustrates the rear panel 60 removed, revealing an interior rear panel 80 secured behind the rear panel 60. The interior rear panel 80 may cover a majority of the rear surface of the assembly 5. The assembly may contain a series of rear intake apertures 75 located above the interior rear panel 80 and sometimes within rear perimeter wall 54. The illustrated rear intake apertures 75 are merely exemplary, any number and shape of said apertures 75 is contemplated. As will be explained in greater detail in subsequent figures, the apertures 75 may be configured to facilitate the ingestion of the open loop fluid.

[0056] Similarly, the assembly 5 may further comprise a series of rear exhaust apertures 85 located below the interior rear panel 80 and sometimes within rear perimeter wall 54. The illustrated rear exhaust apertures 85 are merely exemplary, any number and shape of rear exhaust apertures 85 is contemplated. As will be explained in greater detail in subsequent figures, the rear exhaust apertures 85 may be configured to facilitate the exhaust of the open loop fluid. Optional fans 81 may be affixed behind interior rear panel 80 and above rear exhaust apertures

85. The fans 81 may be configured to control the flow of the open loop fluid. Any number of fans 81 is contemplated. In other embodiments, the fans 81 may be located at any number of locations along the open loop flow path, or any position between the intake 75 and exhaust apertures 85.

[0057] FIGURE 7 and FIGURE 8 illustrate the lower half of the assembly 5 and free standing display housing 15. A side beam 90 may be located on the opposite side of post 20 and may run a majority of the length of the assembly 5. The side beam 90 may be comprised of a metal and be configured to provide structural support and rigidity to the assembly 5. An electronics cavity 16 may be placed within the interior of the assembly 5. An optional heat exchanger 100 may be affixed within or near the electronics cavity 16. In exemplary embodiments the heat exchanger 100 may be a cross flow heat exchanger, but other types of heat exchangers can be used, especially counter flow heat exchangers and others. A series of electronic components 105 may also be affixed within the electronics cavity 16. As will be explained in greater detail in subsequent figures, open loop fluid 400, such as an external air, may circulate through the heat exchanger 100. Closed loop fluid, such as a circulating gas 700 may circulate through the electronics cavity, as well as over and through electronic components 105, and through heat exchanger 100.

[0058] As will be explained in greater detail in subsequent figures, in this embodiment open loop fluid 400 may exhaust the assembly 5 via gap 45 and optional rear gap 44. As indicated by the flow lines, open loop fluid may follow a zigzag path from a right side channel 19, out of the assembly 5. Alternatively, other route shapes may be utilized and are expressly contemplated.

[0059] When using a liquid crystal display as the electronic display 70, a backlight 106 may be placed behind the electronic display 70 and is preferably a direct lit LED backlight, but other illumination sources can be used with the exemplary embodiments. A plate 104 or other substantially planar object may be placed behind the backlight 106 in order to create a channel 102 for accepting open loop fluid 400. Preferably, the channel 102 is sealed to prevent open loop fluid 400

from entering other portions of the display assembly, specifically the electronics compartment 16.

[0060] **FIGURE 9** and **FIGURE 10** illustrate the upper half of assembly 5 and free standing display housing 15, which are similar to the lower half as shown in FIG. 7 and FIG. 8, respectively, with the exception of a pair of optional stiffeners 110. The optional stiffeners 110 will be explained in greater detail in subsequent figures. As will be explained in greater detail in subsequent figures, in this embodiment open loop fluid 400 may enter the assembly 5 via gap 45 and optional rear gap 44. As indicated by the flow lines, open loop fluid 400 may follow a zigzag path to the right side channel 19. Alternatively, other route shapes may be utilized and are expressly contemplated.

[0061] **FIGURE 11** is a front plan view of the assembly of FIG. 1 and indicates section lines F-F, G-G, and H-H.

[0062] **FIGURE 12A** and **FIGURE 12B** illustrates, as will be explained in greater detail in subsequent figures, a pair of channel septums 130 and a central septum 140 are preferably positioned substantially horizontally and near the vertical centerline of the assembly 5, although embodiments could also place them near the top or bottom of the assembly 5, away from the vertical centerline.

[0063] In this embodiment, Figure 12A shows the area of the gap 45 (and optional rear gap 44) that is designated as the intake of the open loop fluid 400.

[0064] Also shown in these figures, as well as Figure 12C is the fan 81, which is positioned to cause the flow of open loop fluid 400 into the portion of gap 45 (and optional rear gap 44) that is generally used as in intake for ambient air (filtered or unfiltered), down the left side interior channel 21 (intake channel), across/through channel 102, down the right side interior channel 22, and exhausting out of the portion of the gap 45 (and optional rear gap 44) that is used as an exhaust for the fluid 400. It should be noted that the left and right side interior channels 21 and 22 are optional as an alternative embodiment would include the following path for open loop fluid 400: into the portion of gap 45 (and optional rear gap 44) that is generally used as in intake for ambient air (filtered or unfiltered), across/through

channel 102, and exhausting out of the portion of the gap 45 (and optional rear gap 44) that is used as an exhaust for the fluid 400.

[0065] FIGURE 12C is a top sectional view taken along section line H-H of FIG. 11 and indicates Detail R. In this embodiment, this figure shows the area of the gap 45 (and optional rear gap 44) that is designated as the exhaust of the open loop fluid 400.

[0066] FIGURE 13A illustrates the ingestion of open loop fluid 400 via rear gap 44. The open loop fluid 400 may pass through an optional door stiffener 115 via aperture 122.

[0067] FIGURE 13B illustrates an exemplary embodiment of the assembly within the region of the optional buffer zone 46. In this embodiment, buffer zone 46 may comprise essentially an area at, near, or within the gap 45 (and optional rear gap 44) that contains one or more fluid-blocking plugs which are placed along the path of open loop fluid 400 so that it may not pass through in any substantial amount. In exemplary embodiments, the buffer zone 46 would contain the channel septums 130 along with the central septum 140, but some embodiments would utilize only the channel septum 130 (if the embodiment does not permit fluid 400 to flow through the door stiffeners). In some embodiments, rather than placing the channel septums 130 within the right and left side channels 18 and 19, the buffer zone 46 may contain a plug that is positioned near or at the end of the gap 44. Generally speaking, the buffer zone is horizontal and is placed near the vertical centerline of the assembly 5, although it could be placed near the top or bottom of the assembly 5.

[0068] It is notable that the buffer zone 46 should exist on both lateral sides of the assembly 5, as well as both on the front and rear of the assembly 5 (if using the rear gap 44) such that the buffer zone 46 blocks a portion of the front gap 45 (and the rear gap 44) on both the right and left sides of the assembly 5.

[0069] FIGURE 13C illustrates the exhaustion of open loop fluid 400 via rear gap 44. The open loop fluid 400 may pass through a door stiffener 115 via aperture 122.

[0070] It should be noted that although Figures 13A-13C illustrate the rear gap 44, in an exemplary embodiment the front gap 45 has a similar orientation as to the rear gap 44. It has not been shown here as it would be substantially duplicative.

[0071] **FIGURE 14** illustrates the combined areas of the gap 45 and the rear gap 44, as indicated by the cross hatched area. In exemplary embodiments, outside of the buffer zone 46, the cross hatched area allows the flow of open loop fluid 400 either into or out of the gap 45 (and the optional rear gap 44).

[0072] **FIGURE 15** illustrates the assembly 5 in isolation from the free standing display housing 15. A door stiffener 120 may be affixed immediately behind the front panel 10. In some embodiments, the door stiffener 120 may be affixed to a rear surface of the front panel 10. The door stiffener 120 may run substantially the perimeter of the front panel 10. The door stiffener 120 may be comprised of a metallic or other material suitably rigid to provide structural rigidity and strength to the assembly 5. The door stiffener 120 may comprise a series of apertures 125 that permit the flow of open loop fluid 400. The illustrated door stiffener apertures 125 are merely exemplary. Any number and shape of apertures 125 are contemplated.

[0073] **FIGURE 16** illustrates the rear panel 60 in isolation. In exemplary embodiments, rear door stiffeners 115 may be affixed around the perimeter edges of the rear panel 60, thereby framing rear panel 60. A door cavity 17 may be defined by the space between the rear panel 60, the interior surfaces of rear door stiffeners 115, and the interior rear panel 80 (not shown in the current figure). Open loop fluid 400 ingested via the rear gap 44 may be considered open loop fluid 400b once it travels through the rear door stiffeners 115 via apertures 122 into the door cavity 17. The illustrated apertures 122 are merely exemplary, any number and shape of apertures is contemplated. Optional stiffeners 110 in the form of elongate members may extend substantially the length of the rear panel 60. The optional stiffeners 110 may be comprised of a metal, a polymer, or other material suitably rigid to provide structural rigidity and strength to the rear panel 60. The optional stiffeners 110 may comprise a series of apertures 135 that

facilitate open loop fluid 400b to flow through the optional stiffeners 110. The illustrated optional stiffeners 110 and the apertures 135 are merely exemplary, any number and shape of the optional stiffeners 110 and the apertures 135 is contemplated.

[0074] The portion of the open loop fluid 400 traveling in the door cavity 17 is referred to as open loop fluid 400b. As shown, open loop fluid 400b may pass behind the interior panel 80 and be ingested via the intake apertures 75 in order to be directed towards the channel 102. In an exemplary embodiment, the fluid 400b would flow through intake apertures 75 and be directed into left side channel 18, which distributes the fluid 400b across the channel 102, and exhausted out of right side channel 19.

[0075] **FIGURE 17** illustrates, via flow lines, the circulation of open loop fluid 400a through the front and rear of assembly 5. Open loop fluid may be ingested via the gap 45, travel through the door stiffener 120 via the apertures 125 and travel vertically through the right side channel 19 sometimes defined in part by the right side interior channel 22 and side beam 90. Similarly, the open loop fluid 400a may be ingested via the rear gap 44, travel through the door stiffener 115 via the apertures 122, through optional stiffeners 110 via aperture 135, and enter the right side channel 19. On the opposite side of the assembly 5, a similar route may be taken whereby the open loop fluid ultimately enters a left side channel 18 sometimes defined in part by the left side interior channel 21 and post 20.

[0076] A substantially identical flow path in reverse may be taken for exhaustion of the open loop fluid at on the opposite end of the assembly 5. Again, in exemplary embodiments, ingestion takes place in the upper half of assembly 5 and exhaustion takes place in the lower half of assembly 5. In other embodiments, ingestion takes place in the lower half and exhaustion in the upper half of the assembly 5. In still other embodiments, ingestion may take place on the right side while exhaustion takes place on the left side with the buffer zone 46 placed at the top and bottom edges of the assembly to prevent cross inhalation of the two flow paths.

[0077] **FIGURE 18** illustrates an exemplary flow path for the open loop fluid 400 after being ingested via the gap 45 and the rear gap 44. The open loop fluid 400 which is ingested via the rear gap 44 may travel along the door cavity 17 between the optional door stiffeners 110 and can be referred to as the open loop fluid 400b. The open loop fluid 400b may then travel vertically along the rear interior panel 80 and be ingested via the rear intake apertures 75. Other portion of open loop fluid 400 may travel along the left side channel 18 and the right side channel 19 and be referred to as the open loop fluid 400a. After traveling vertically through the side channels 18 and 19, the open loop fluid 400a may travel over the top of said channels and be ingested via the intake apertures 75. Similarly, the open loop fluid 400 may be ingested via the gap 45, travel through the door stiffener apertures 125 below front panel 10, and be ingested via the intake apertures 65.

[0078] **FIGURE 19A** illustrates a rear perspective view of the assembly of FIG. 1 shown in isolation from the free standing display 15 and indicating Detail S.

[0079] **FIGURE 19B** illustrates a front perspective view of the assembly of FIG. 1 shown in isolation from the free standing display 15 and indicating Detail T.

[0080] **FIGURE 20** illustrates that the portion of open loop fluid 400 traveling in the right side channel 19 is referred to as open loop fluid 400a. The open loop fluid 400a may travel inside the right side channel 19, over the top of the right side interior channel 22, and into the intakes apertures 75.

[0081] **FIGURE 21**, similar to FIG. 20 but shown from a front perspective, illustrates that the portion of open loop fluid 400 traveling in the left side channel 18 is referred to as open loop fluid 400a. The open loop fluid 400a may travel inside the left side channel 18, over the top of the left side interior channel 21, and into the intakes apertures 65.

[0082] **FIGURE 22** is bottom perspective section view taken along section line B-B of FIG. 4. Once the open loop fluid 400a/400b is ingested via the various intake apertures 75 and 65, it is combined and then apportioned between a first portion of open loop fluid 400 which travels through the open loop gas pathways of the

heat exchanger 100, and a second portion of open loop fluid 400 which is directed through the channel 102.

[0083] One or more circulating fans 32 are used to force circulating gas 700 across the electronic components and through the closed loop gas pathways of the heat exchanger 100, as well as between the electronic display 70 and the front panel 10, forming a closed loop. In this embodiment, the circulating gas 700 passes through the opening within the pass through gasket 200 while the open loop fluid 400 travels around the pass through gasket, substantially ensuring that the open loop fluid 400 and circulating gas 700 do not mix. This design can be flipped however, where , the circulating gas 700 travels around the pass through gasket 200 while the external air 400 travels through the pass through gasket 200.

[0084] A portion of the flow of open loop fluid 400 is shown traversing the left side interior channel 21 and passing by the cross through gasket 200 in order to enter the channel 102 that runs behind the electronic display 70 (here behind the backlight 106). The channel 102 is preferably defined as the space between the rear surface of the electronic display 70 (here behind the backlight 106) and a plate 104. A preferably corrugated and preferably continuous heat sink is ideally placed within the channel in order to facilitate the conductive transfer of heat from the electronic display 101 to the continuous heat sink, to be removed by convection with the open loop fluid 400.

[0085] The heat exchanger 100 preferably contains a plurality of layers that define channels that contains either circulating gas 700 or open loop fluid 400. Preferably, the circulating gas 700 is not permitted to mix with the open loop fluid 400.

[0086] The flow of open loop fluid 400 travels through the channel 102 and again passes around the pass through gasket 200 to enter the left side interior channel 22, eventually being directed out of the portions of the gap 45 (and the optional rear gap 44) which have been designated for exhaustion of the fluid 400. In this embodiment, the circulating gas 700 is shown exiting the heat exchanger 100 and

passing through the opening within the pass through gasket 200 and then between the electronic display 70 and the front panel 10.

[0087] In a preferred embodiment, the heat exchanger 100 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 100 may be a cross-flow, parallel flow, or counter-flow heat exchanger. In an exemplary embodiment, the heat exchanger 100 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 open loop fluid 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).

[0088] 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).

[0089] 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.

[0090] 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).

[0091] In an exemplary embodiment, the electronic display 70 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 channel 102.

[0092] The circulating gas 700 and open loop fluid 400 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 70 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. Generally speaking, exemplary embodiments would utilize ambient air as the open loop fluid 400.

[0093] 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.

[0094] FIGURES 23 through 25 illustrate a central septum 140 which is preferably positioned substantially horizontally and near the vertical centerline of the assembly 5, although embodiments could also place them near the top or bottom of the assembly 5, away from the vertical centerline that extends along substantially the midline of the front surface of the rear panel 60. A right channel septum 130 extends substantially along the midline of the right side interior edge of the free standing display housing 15 such that it is generally aligned with the central septum 140. Similarly, a left channel septum 130 may be affixed on the left side interior edge of the assembly 5 such that it is aligned with the central septum 140.

[0095] The central septum 140, the right channel septum 130, and the left channel septum 130 (hereinafter collectively the “horizontal partition”) may be configured to substantially divide the door cavity 17 into an upper and lower half. The horizontal partition may be configured such that it creates a substantially air-tight seal between the upper and lower halves of the door cavity 17. Optionally, the horizontal partition may further comprise an expandable material, such as polyurethane foam, utilized in conjunction with the horizontal partition to provide

the airtight seal between the upper and lower halves. In exemplary embodiments the central septum 140 may be comprised of a sufficiently flexible material, such as a polymer, to create an airtight seal in the door cavity 17. In alternate embodiments, the central septum 140 may be comprised of a rigid material. In exemplary embodiments, the right channel septum 130 and the left channel septum 130 may be rigid.

[0096] In an exemplary embodiment, the open loop fluid 400 may be ingested via the gap 45 (and optional rear gap 44) in the upper half of the assembly 5. Said open loop fluid 400a may travel along the right side channel 19 until a portion of said fluid reaches the right channel septum 130 and is prevented from traveling beyond. Similarly, the open loop fluid 400a may travel along the left side channel 18 until a portion of said fluid reaches the left side channel septum 130. Said portions of the open loop fluid may be forced to return vertically in the opposite direction and circulate through the upper half of right side channel 19 and the left side channel 18, respectively, until eventually being ingested via the intake apertures 65 and 75, as discussed in the previous figures.

[0097] In a similar fashion, open loop fluid 400b which travels along the door cavity 17 may travel vertically until a portion of said fluid 400b reaches central septum 140 and is prevented from traveling beyond. In this way, fluid 400b which has been ingested (but has not traveled through the heat exchanger 100 or the channel 102) cannot mix with the fluid 400b which has travelled through the heat exchanger 100 or the channel 102 and needs to be exhausted out of the gap 45 (and optional rear gap 44).

[0098] As also discussed in the previous figures, the open loop fluid 400 may circulate through the optional heat exchanger 100 until eventually being exhausted via the exhaust apertures 85. The open loop fluid 400 may then eventually return to the right side channel 19 or the left side channel 18 and travel vertically therein. The right channel septum 130 and the left channel septum 130, respectively, may prevent said open loop fluid from traveling beyond the midline of assembly 5 and thereby prevent the open loop fluid from each half of the

assembly 5 from becoming mixed. That is, open loop fluid not yet ingested via the intake apertures 65 and 75 may not be mixed with open loop fluid already ingested via said intake apertures 65 and 75. The open loop fluid encountering the right side septum 130 and the left side septum 130, respectively, may be forced to return vertically in the opposite direction until eventually being exhausted from the assembly 5 via the gap 45 (and optional rear gap 44).

[0099] FIGURE 26A and FIGURE 26B illustrate exemplary embodiments of the channel septums 130. In such embodiments, a portion of the channel septums 141 may be adjustable such that (if desired) a portion of the open loop fluid 400a may be permitted to pass by the channel septums 130, thereby permitting a limited amount of mixing between the ingestion and exhaustion open loop fluids. In such embodiments, a second portion of the channel septums 142 may be static, such that they may not be adjusted and provide a substantially air-tight seal such that ingestion and exhaustion open loop fluids may not be mixed. In other embodiments, the entirety of the channel septums 130 may be adjustable. In still other embodiments, the entirety of the channel septums 130 may be static.

[00100] 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.

[00101] 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.

[00102] It should also be noted that the variety of cooling loops that are shown in the figures may be shown in a horizontal or vertical arrangement but it is clearly contemplated that this can be reversed or changed depending on the particular embodiment. Thus, the open loop may run horizontally or vertically and in a clockwise or counter-clockwise direction. Further, the open loop may also be horizontal or vertical and can run left to right, right to left, and top to bottom, or bottom to top.

[00103] Having shown and described a preferred embodiment of the invention, those skilled in the art will realize that many variations and modifications may be made to affect the described invention and still be within the scope of the claimed invention. Additionally, many of the elements indicated above may be altered or replaced by different elements which will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

CLAIMS

We claim:

1. An electronic display assembly comprising:
 - an electronic display;
 - a housing and front panel which surround the electronic display;
 - an ingestion gap positioned along a portion of a perimeter of the front panel;
 - an exhaustion gap positioned along a portion of a perimeter of the front panel;
 - a channel positioned behind the electronic display;
 - a first gaseous pathway for open loop fluid to travel from the ingestion gap to the channel;
 - a second gaseous pathway for open loop fluid to travel from the channel to the exhaustion gap; and
 - a fan positioned to cause the flow of the open loop fluid.
2. The electronic display assembly of claim 1 further comprising:
 - a buffer zone positioned between the ingestion gap and the exhaustion gap.
3. The electronic display assembly of claim 1 wherein:
 - the ingestion gap permits the ingestion of ambient air into the housing
4. The electronic display assembly of claim 2 further comprising:
 - a central septum placed within the buffer zone.
5. The electronic display assembly of claim 1 further comprising:
 - a first side channel positioned vertically and forming at least a portion of the first gaseous pathway; and
 - a second side channel positioned vertically and forming at least a portion of the second gaseous pathway.

6. The electronic display assembly of claim 5 further comprising:
a channel septum placed within the first side channel.
7. The electronic display assembly of claim 6 wherein:
the channel septum substantially prevents the vertical flow of open loop fluid.
8. The electronic display assembly of claim 1 wherein:
the ingestion gap and the exhaustion gap face an intended observer of the electronic display.
9. An electronic display assembly comprising:
an electronic display;
a housing surrounding the electronic display;
an ingestion gap on the housing positioned to face an intended observer of the electronic display;
an exhaustion gap on the housing positioned to face an intended observer of the electronic display;
a channel positioned behind the electronic display;
a first side channel positioned vertically and permitting gaseous communication between the ingestion gap and the channel; and
a second side channel positioned vertically and permitting gaseous communication between the channel and the exhaustion gap; and
a fan positioned to cause open loop fluid to flow into the ingestion gap, through the first side channel, through the channel, through the second side channel, and exhausting out of the exhaustion gap.
10. The electronic display assembly of claim 9 further comprising:
a channel septum placed within the first side channel.

11. The electronic display assembly of claim 9 further comprising:
a buffer zone positioned between the ingestion gap and the exhaustion gap.
12. The electronic display assembly of claim 11 further comprising:
a central septum placed at the same vertical height as the buffer zone.
13. The electronic display assembly of claim 9 further comprising:
a heat exchanger having a first pathway for open loop fluid and a second
pathway for circulating gas; and
a circulating fan positioned to force circulating gas through the heat
exchanger.
14. The electronic display assembly of claim 9 wherein:
the channel is defined by the space between an LED backlight and a
plate.
15. The electronic display assembly of claim 9 wherein:
the ingestion gap is positioned on a first vertical half of the assembly,
while the exhaustion gap is positioned on the opposing vertical half
of the assembly.
16. The electronic display assembly of claim 9 further comprising:
a door cavity behind the electronic display which accepts open loop fluid
from the first side channel and directs it towards the channel behind
the electronic display.
17. An electronic display assembly comprising:
an electronic display;
a housing and front panel which surround the electronic display;
an ingestion gap positioned above the vertical center of the electronic

display and located between the front panel and the housing;
an exhaustion gap positioned below the vertical center of the electronic display and located between the front panel and the housing;
a heat exchanger having a first pathway for open loop fluid and a second pathway for circulating gas;
a circulating fan positioned to force circulating gas through the heat exchanger;
a central septum placed between the ingestion gap and the exhaustion gap and near the vertical center of the electronic display; and
a fan positioned to cause the flow of open loop fluid into the ingestion gap, through the heat exchanger, and out of the exhaustion gap.

18. The electronic display assembly of claim 17 further comprising:
a first side channel positioned vertically and permitting gaseous communication between the ingestion gap and the heat exchanger;
and
a second side channel positioned vertically and permitting gaseous communication between the heat exchanger and the exhaustion gap.
19. The electronic display assembly of claim 18 further comprising:
a first side channel septum placed within the first side channel; and
a second side channel septum placed within the second side channel
20. The electronic display assembly of claim 19 wherein:
the first and second side channel septums substantially block the vertical flow of open loop fluid.

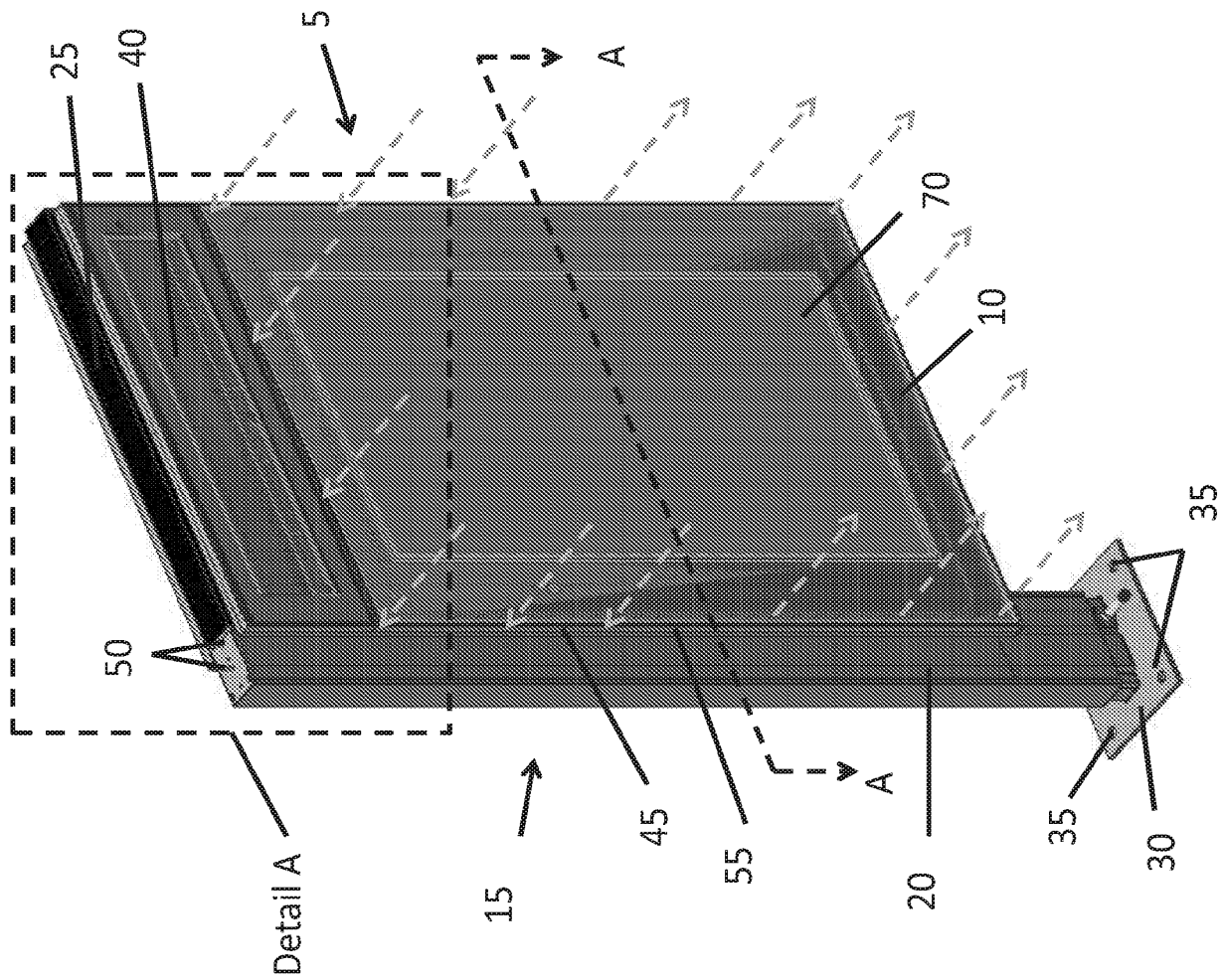


Figure 1

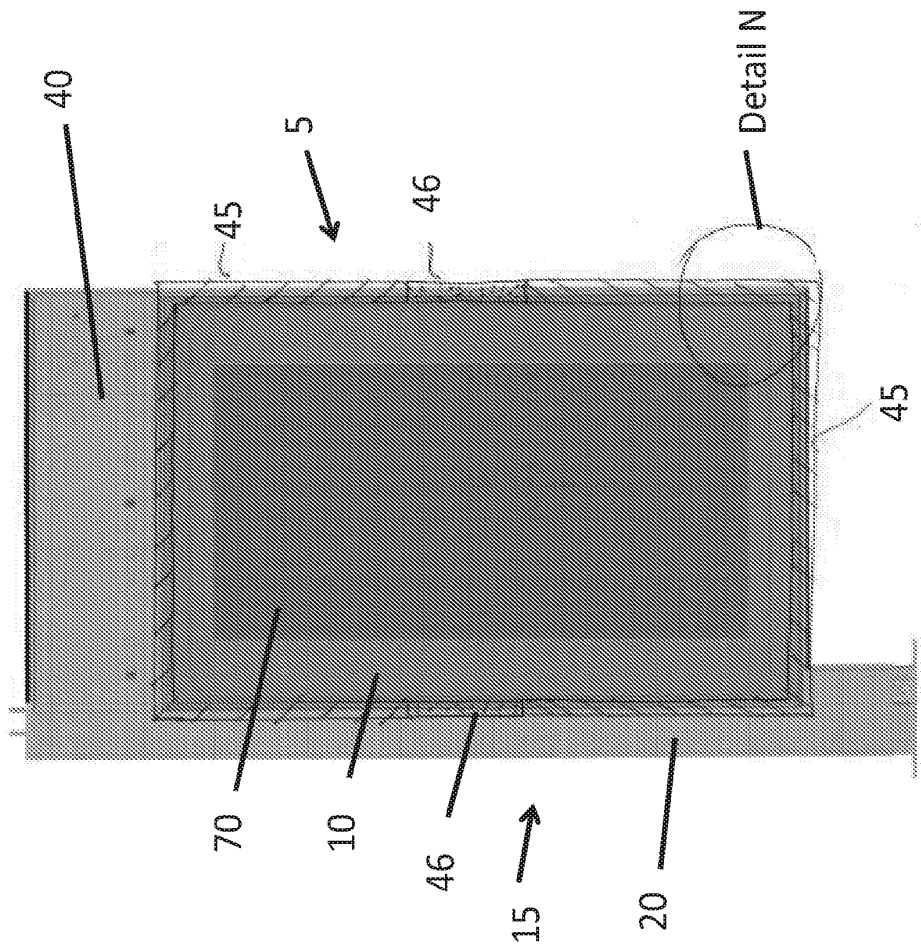


Figure 2

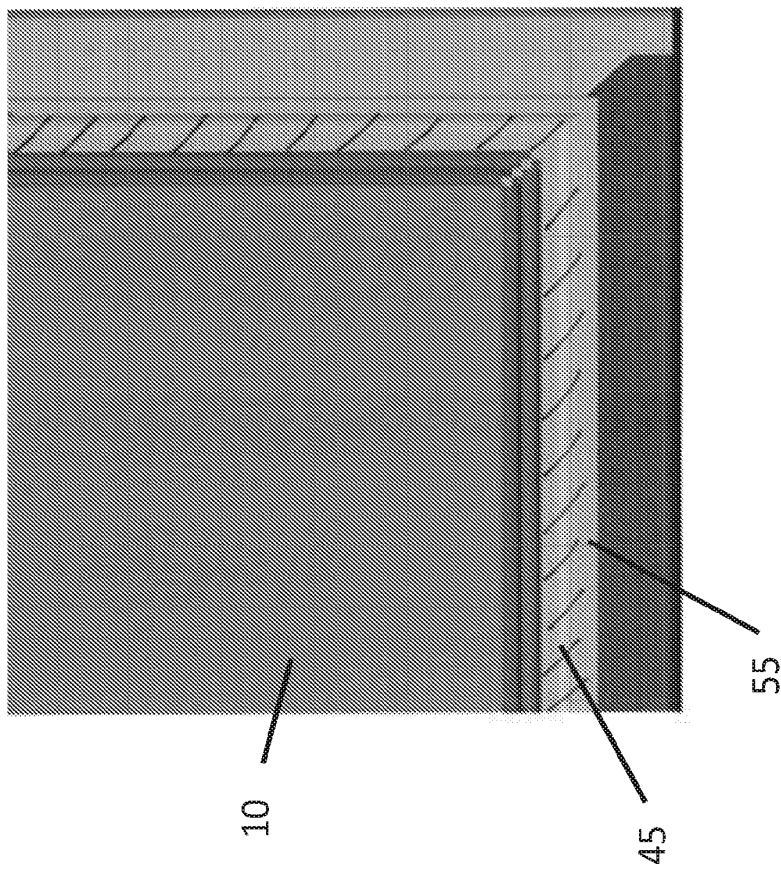


Figure 3

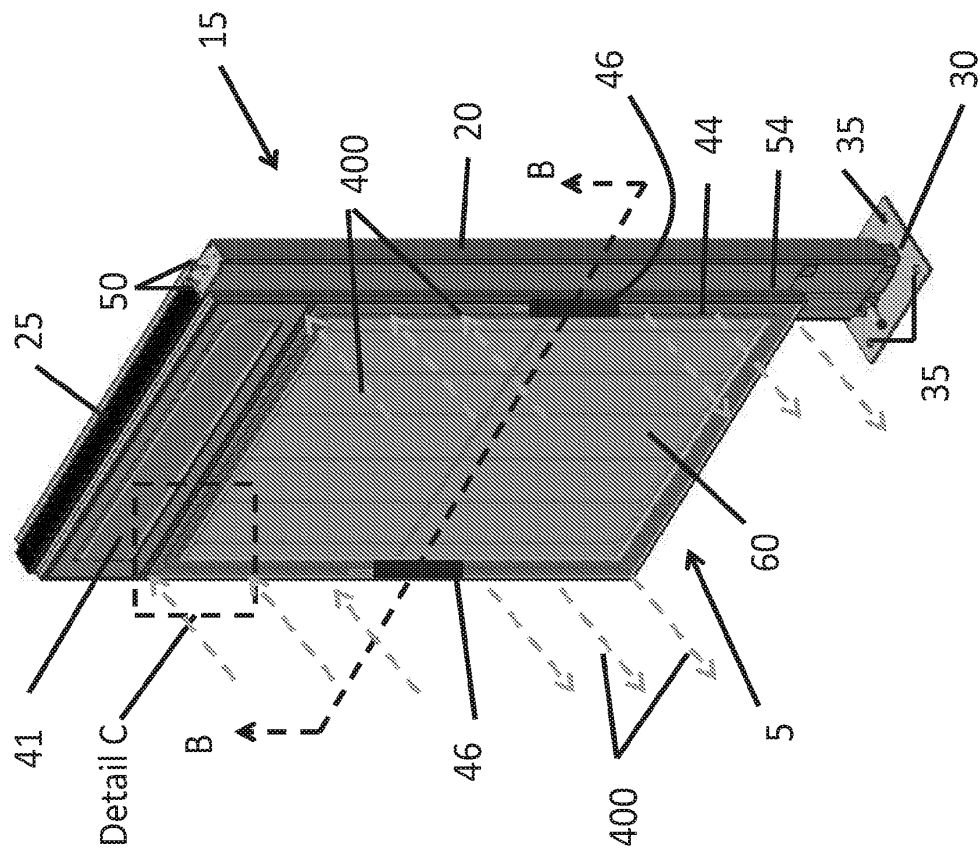


Figure 4

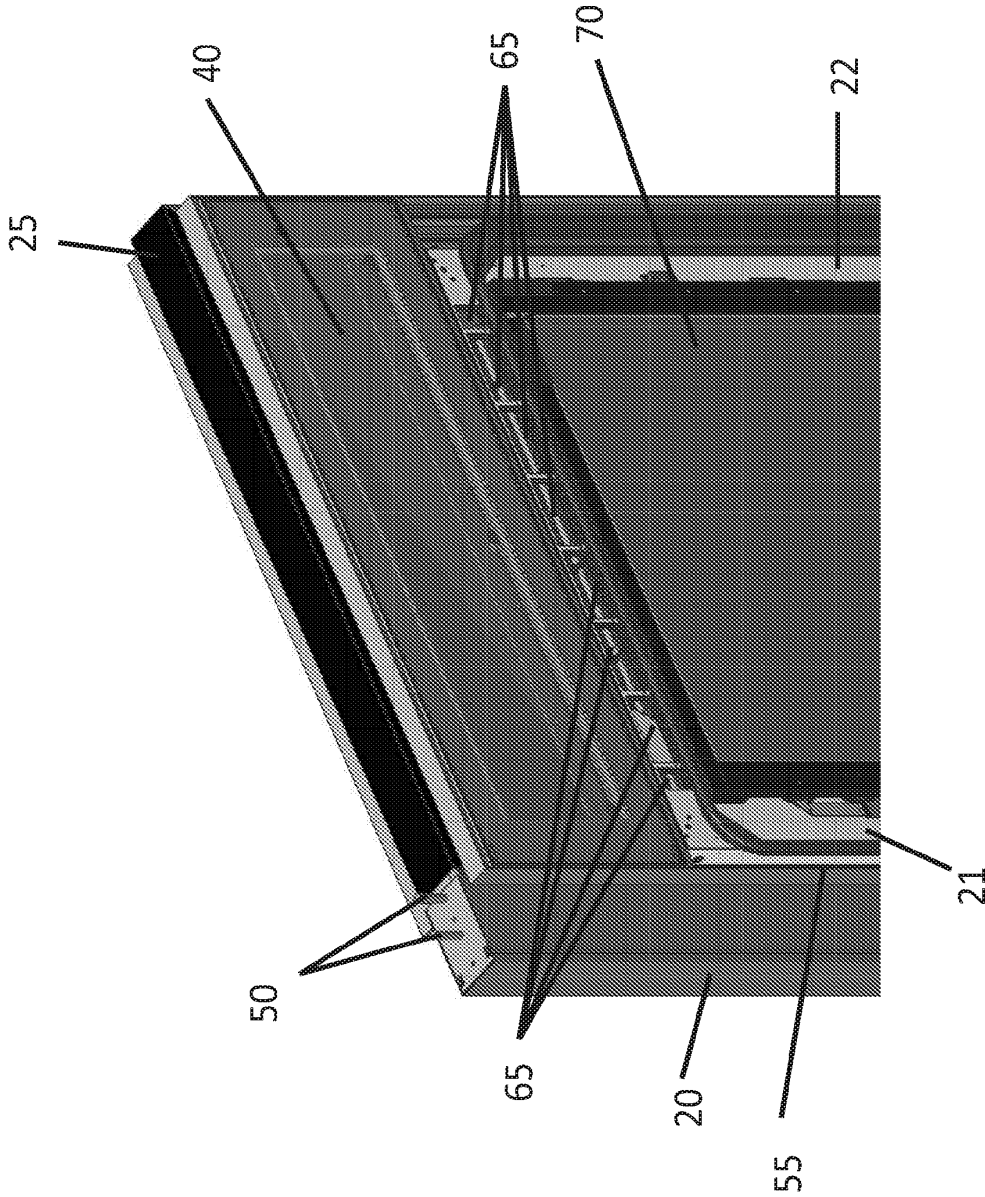


Figure 5

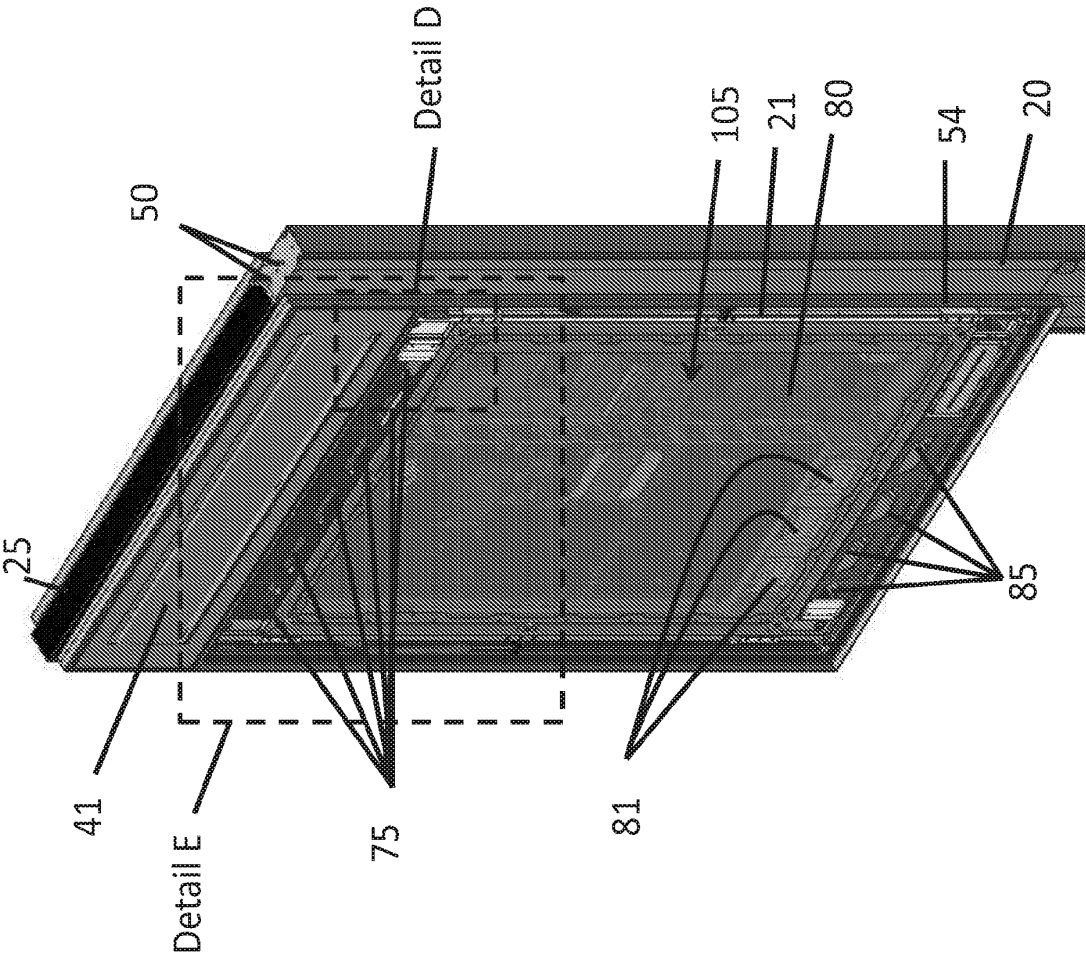


Figure 6

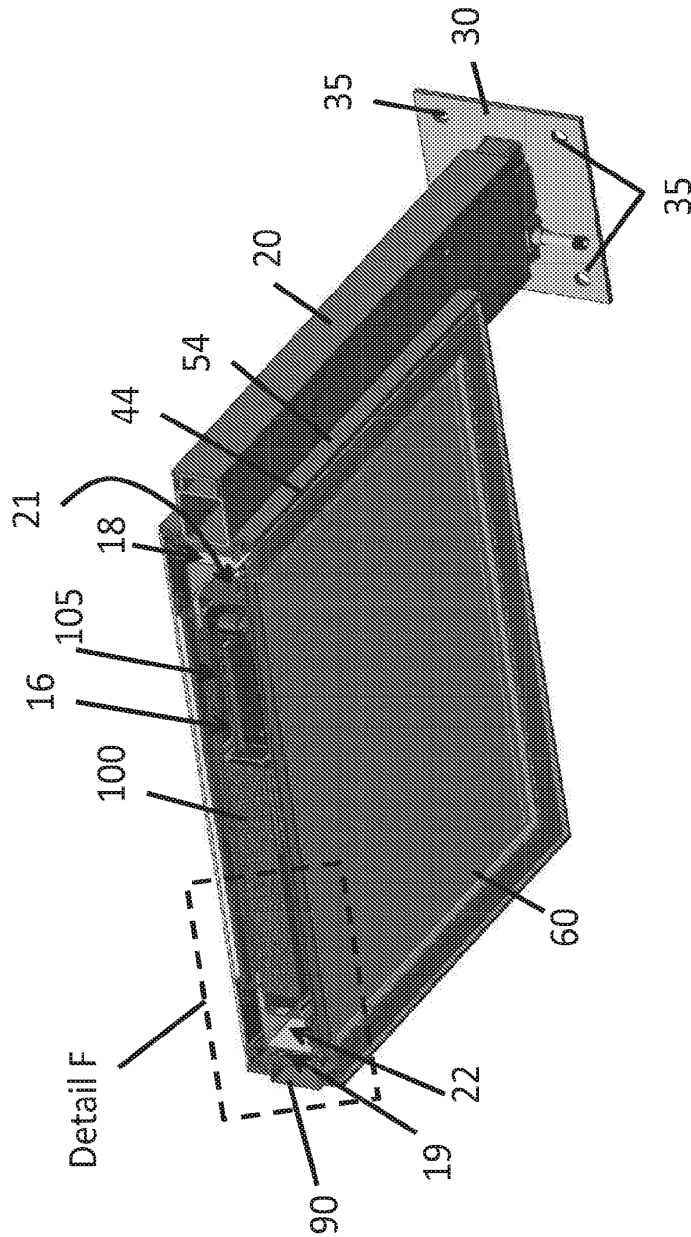


Figure 7

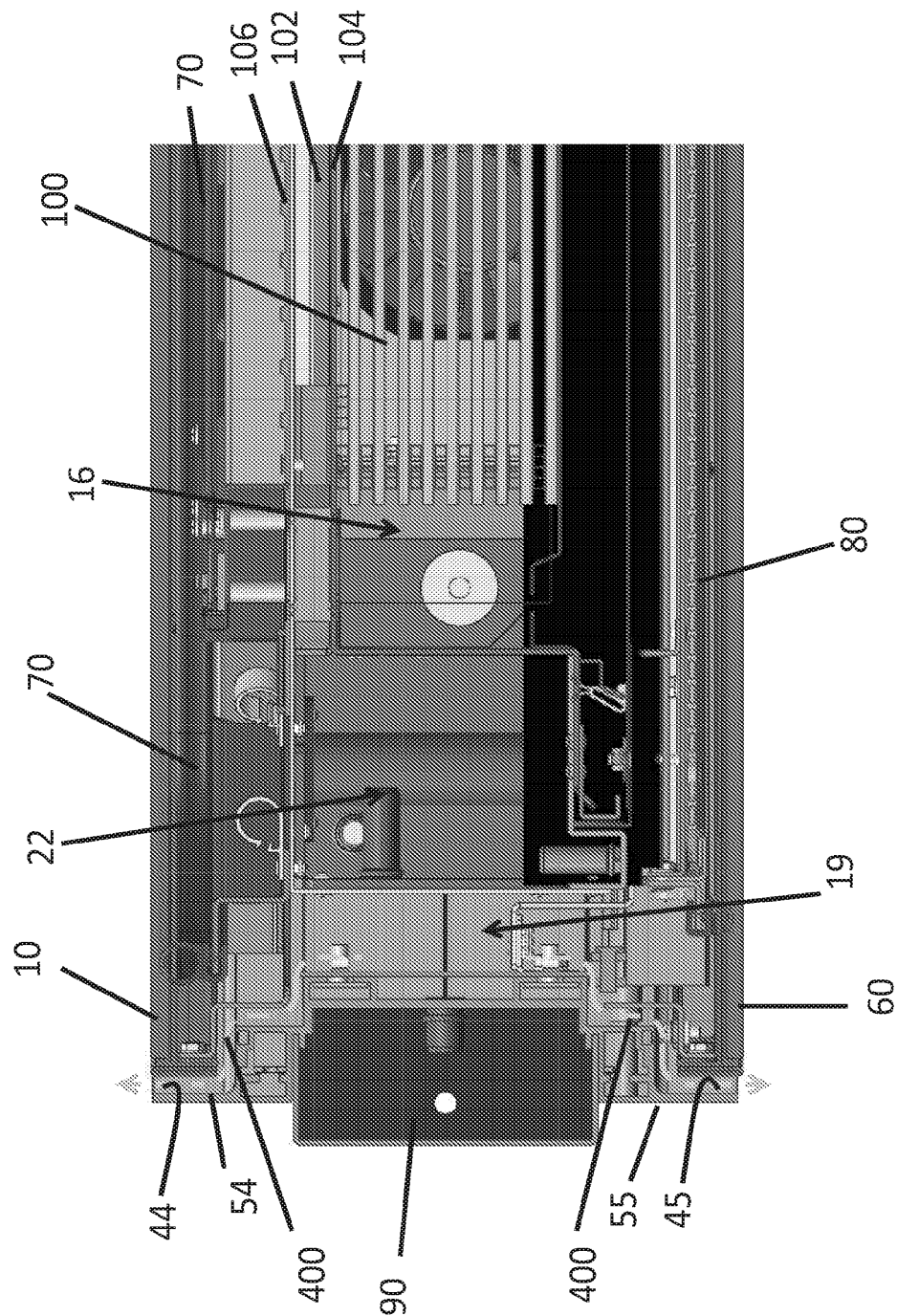


Figure 8

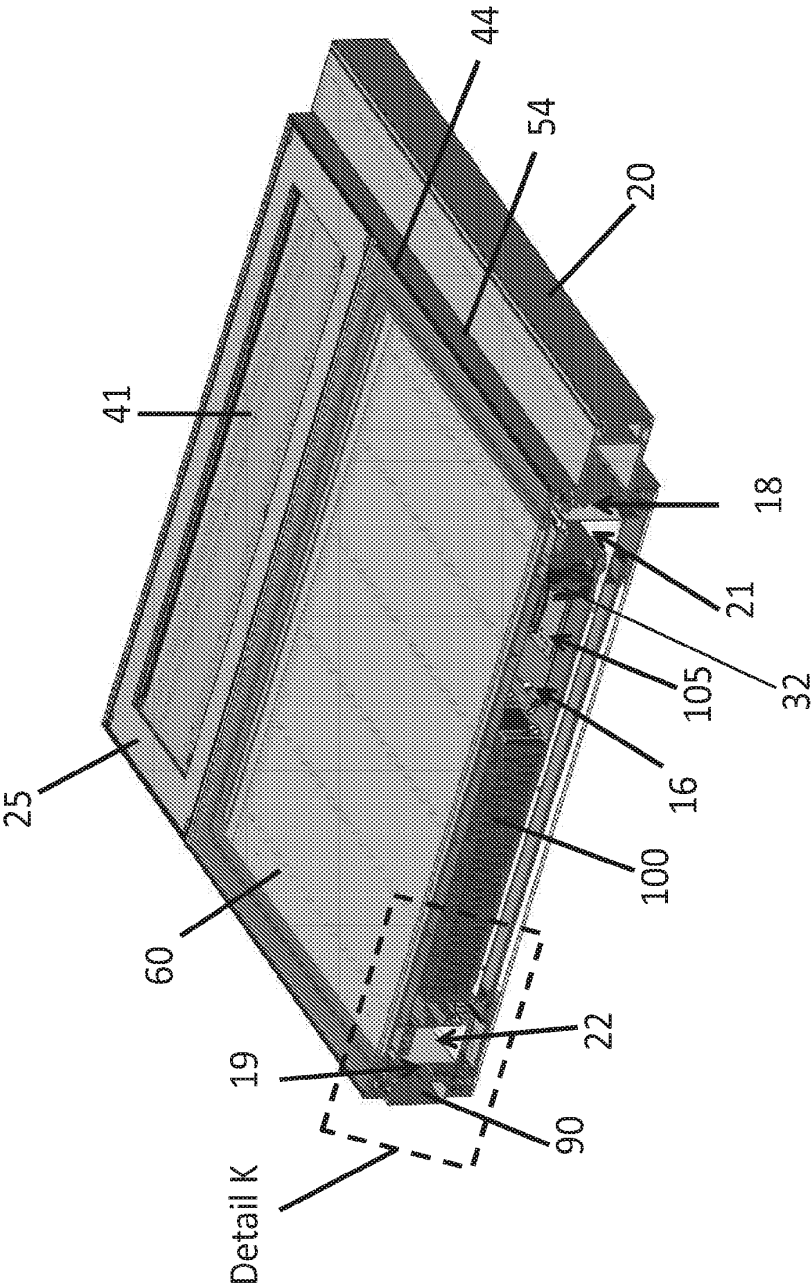


Figure 9

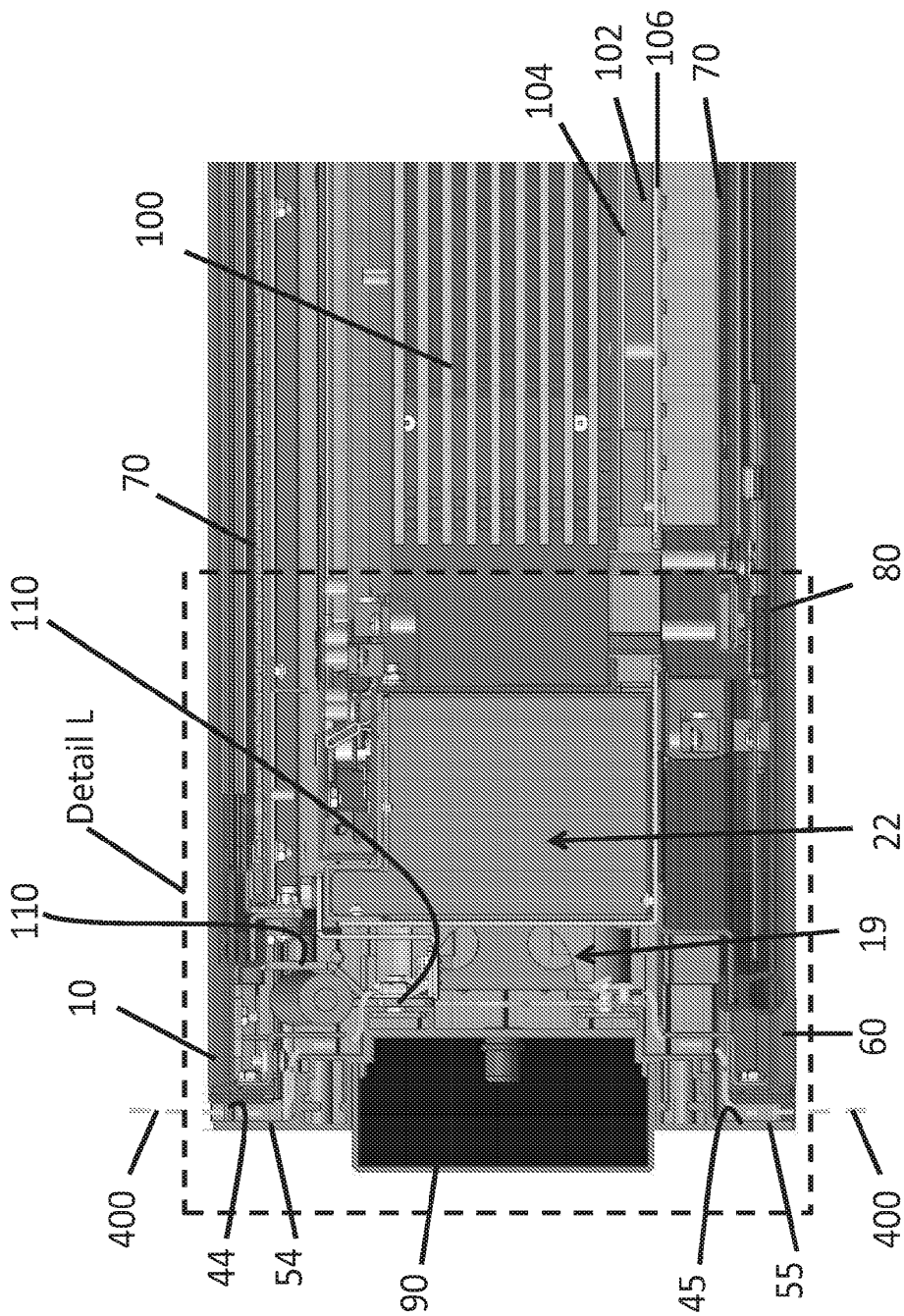


Figure 10

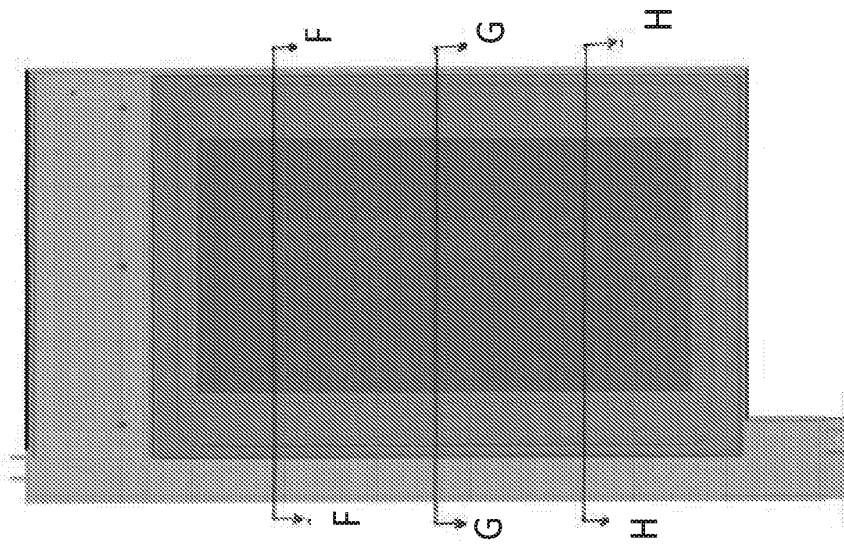
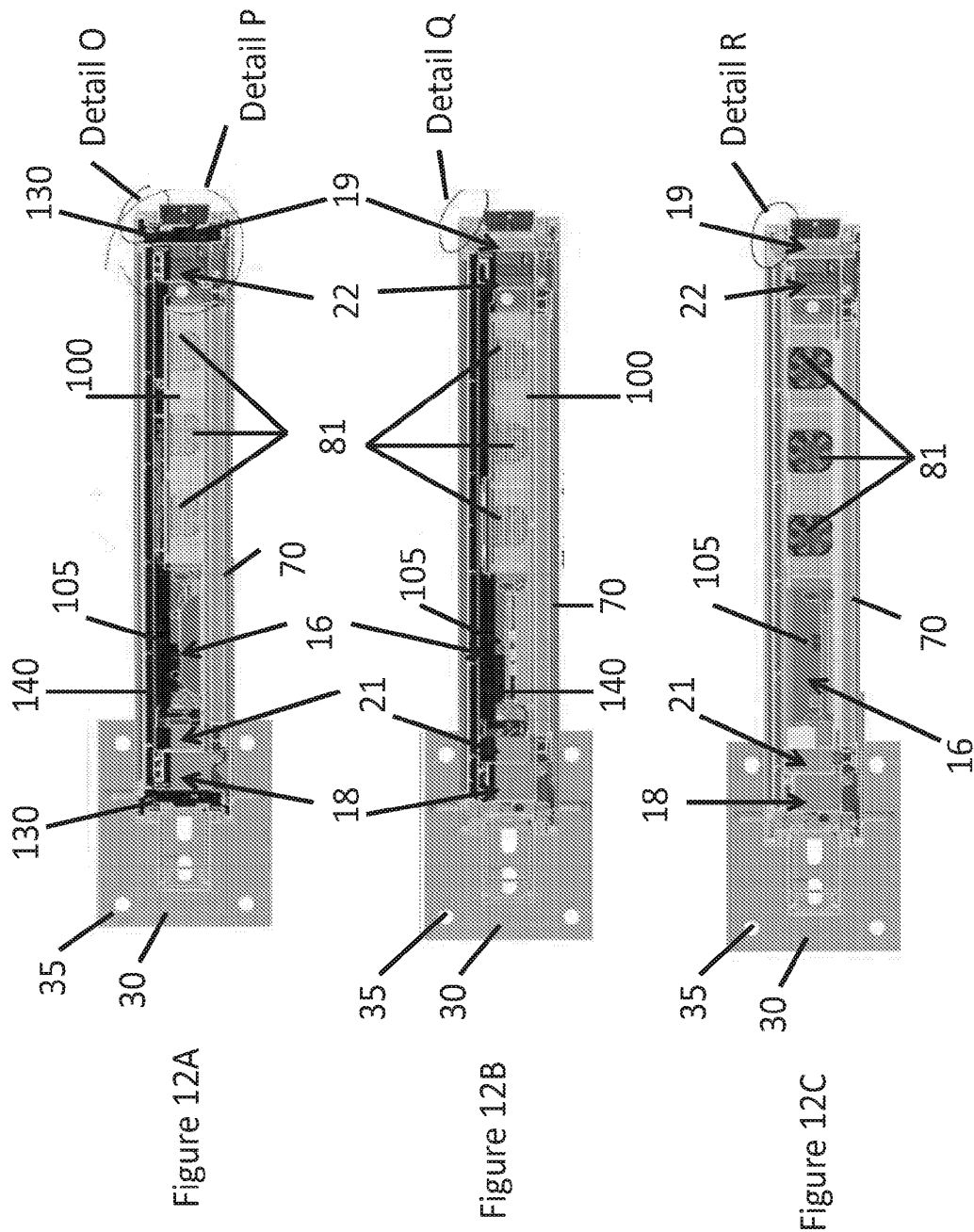


Figure 11



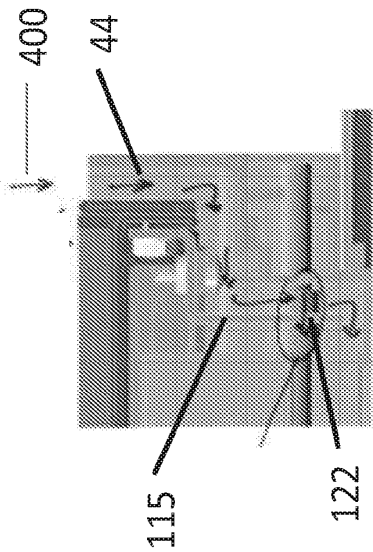


Figure 13A

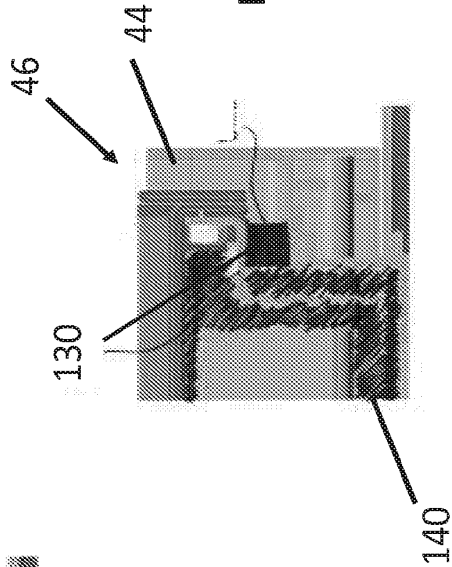


Figure 13B

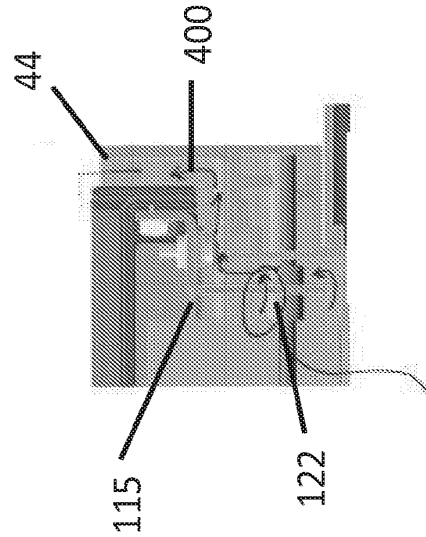


Figure 13C

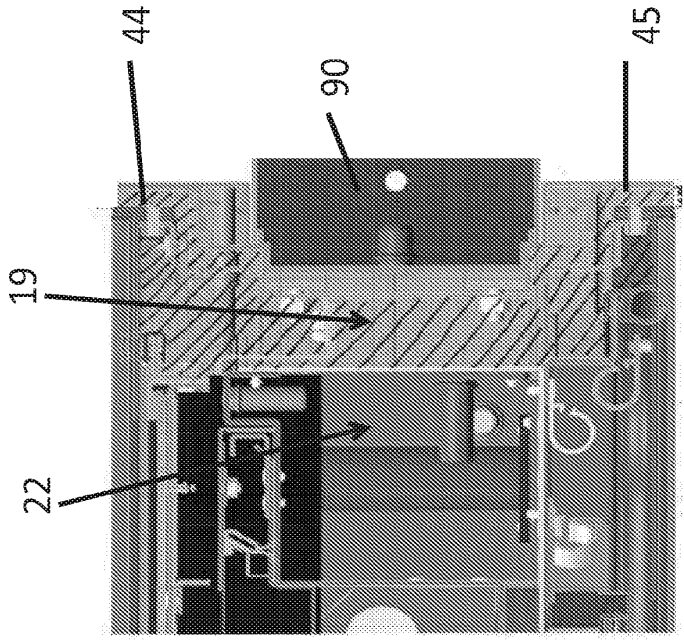


Figure 14

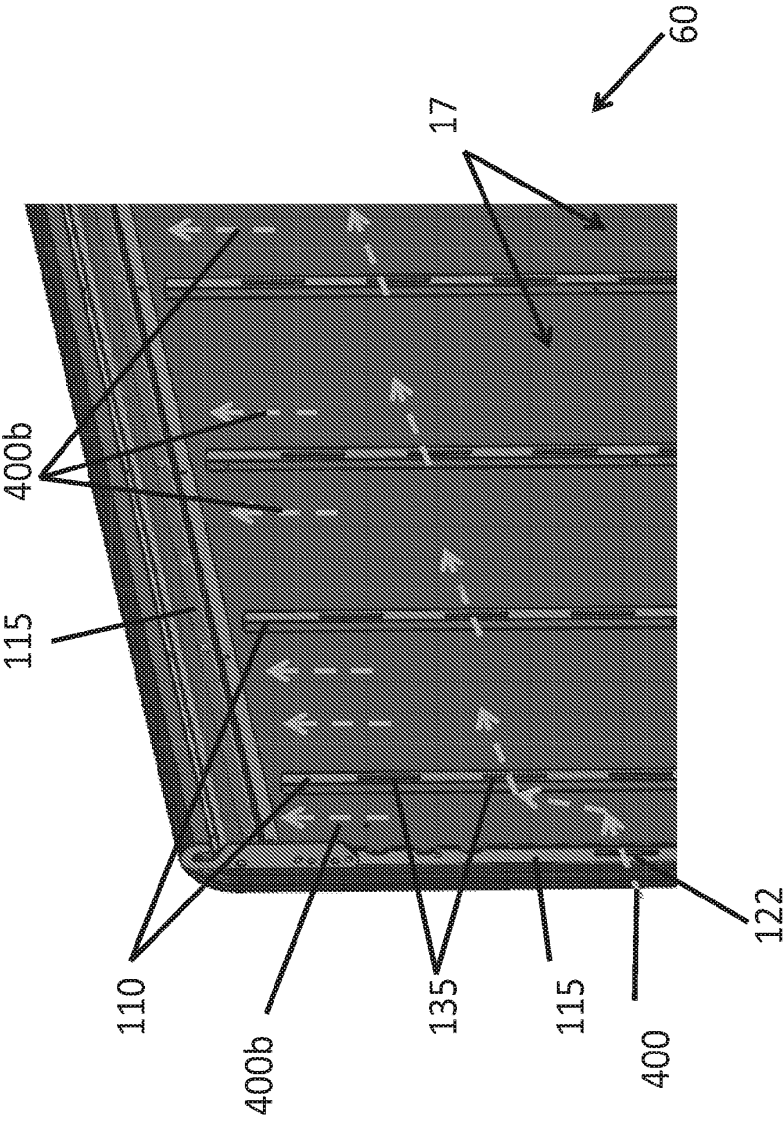


Figure 16

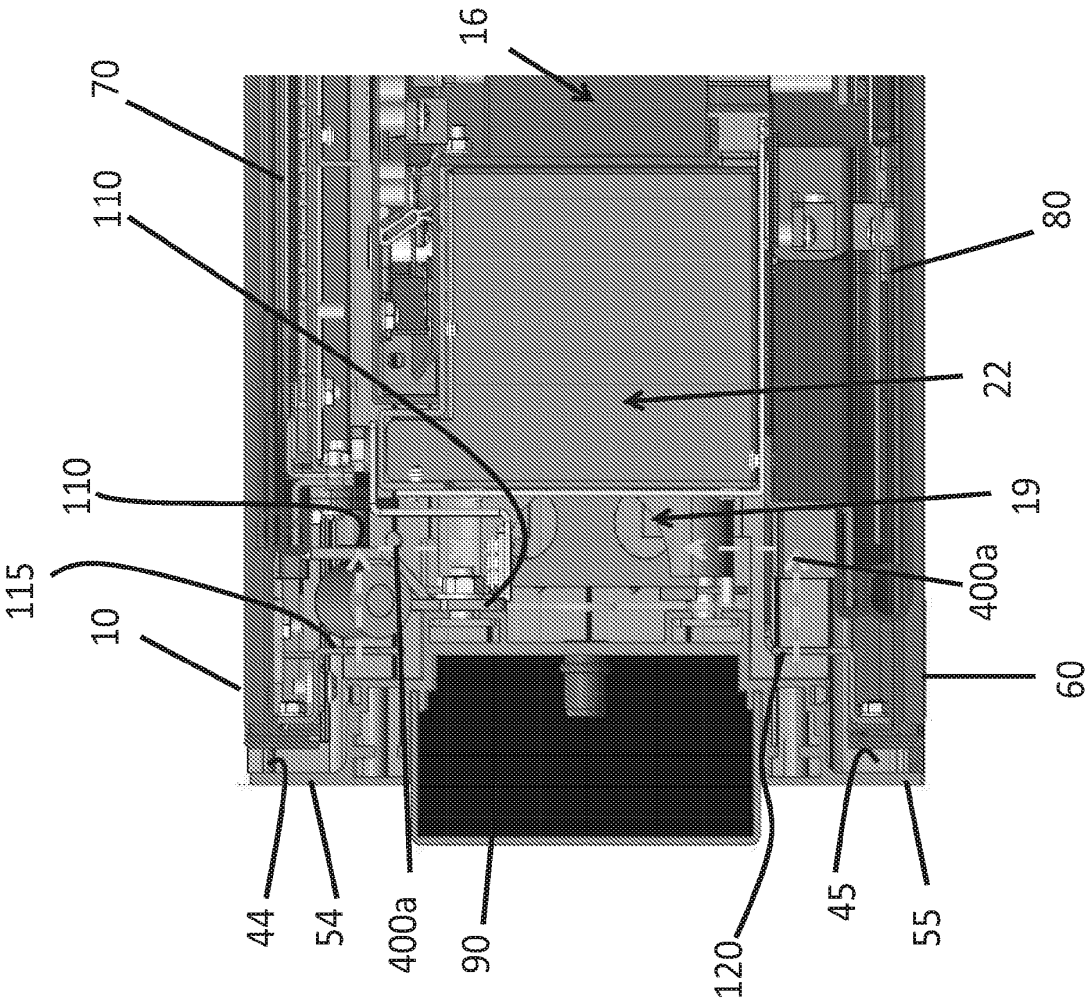


Figure 17

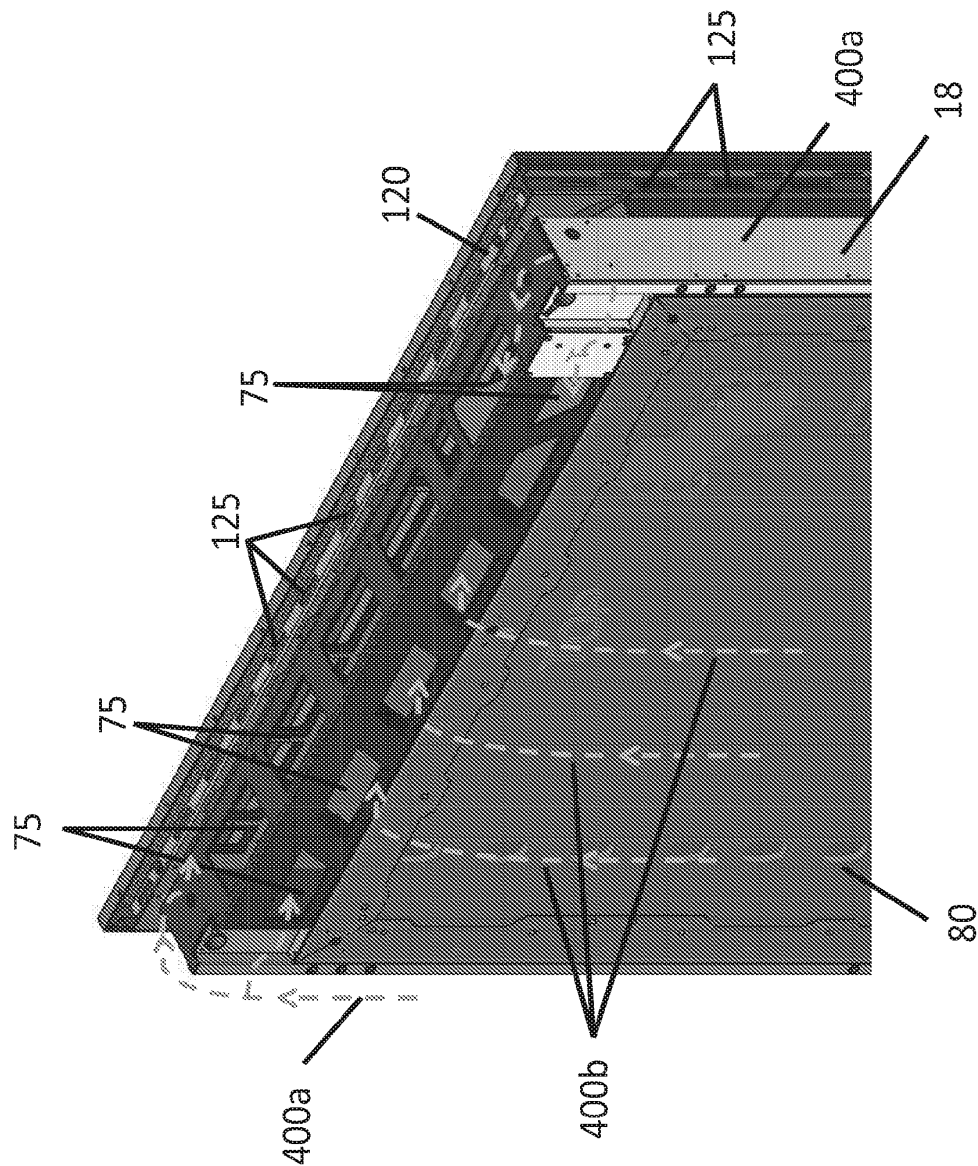


Figure 18

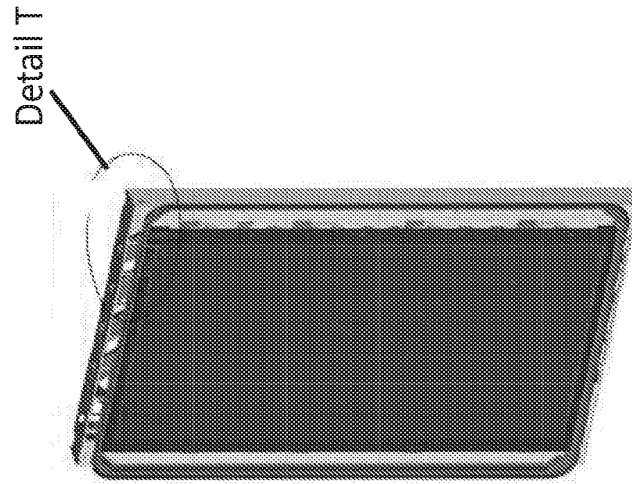


Figure 19B

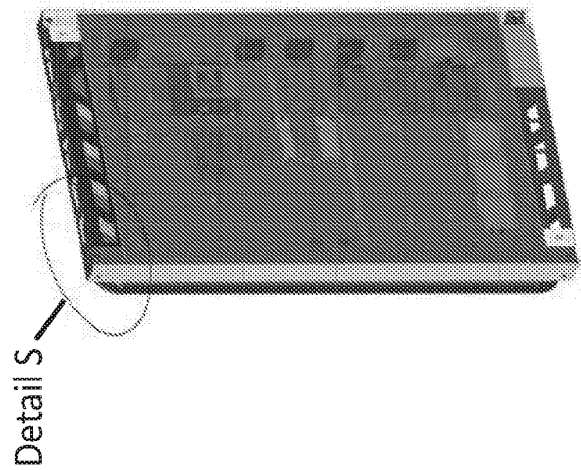


Figure 19A

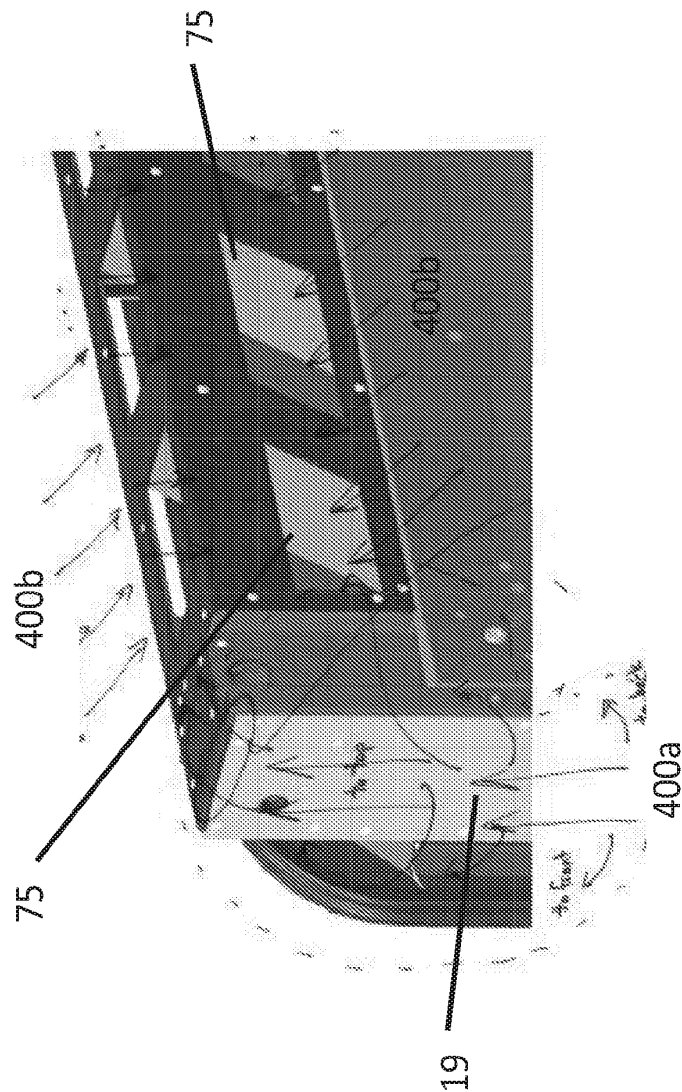


Figure 20

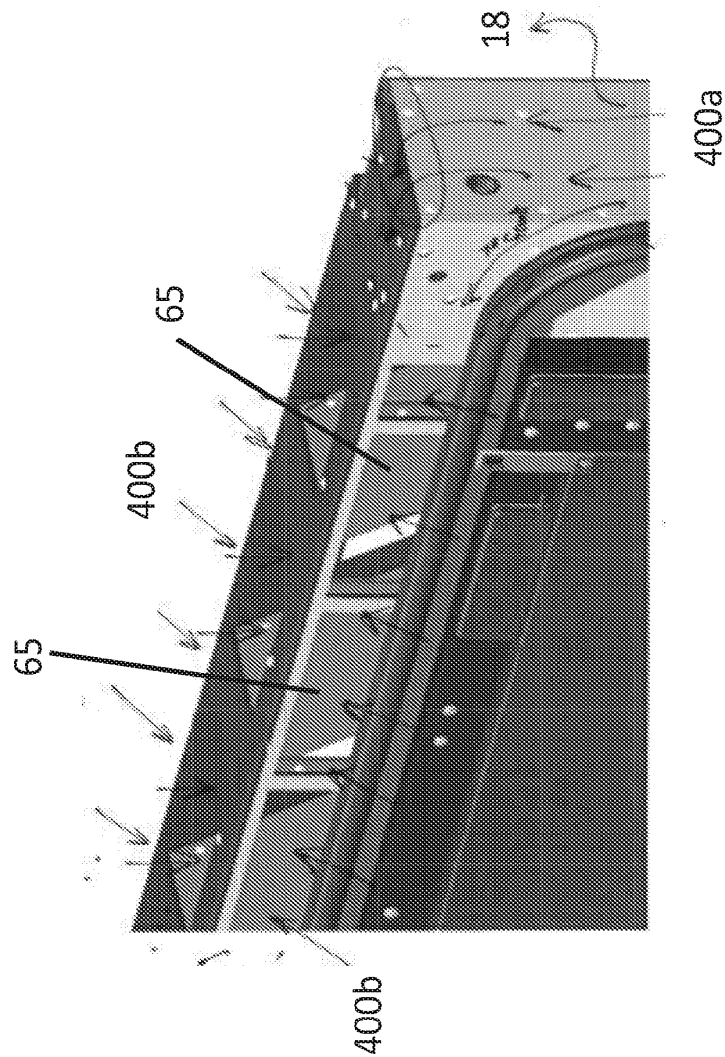


Figure 21

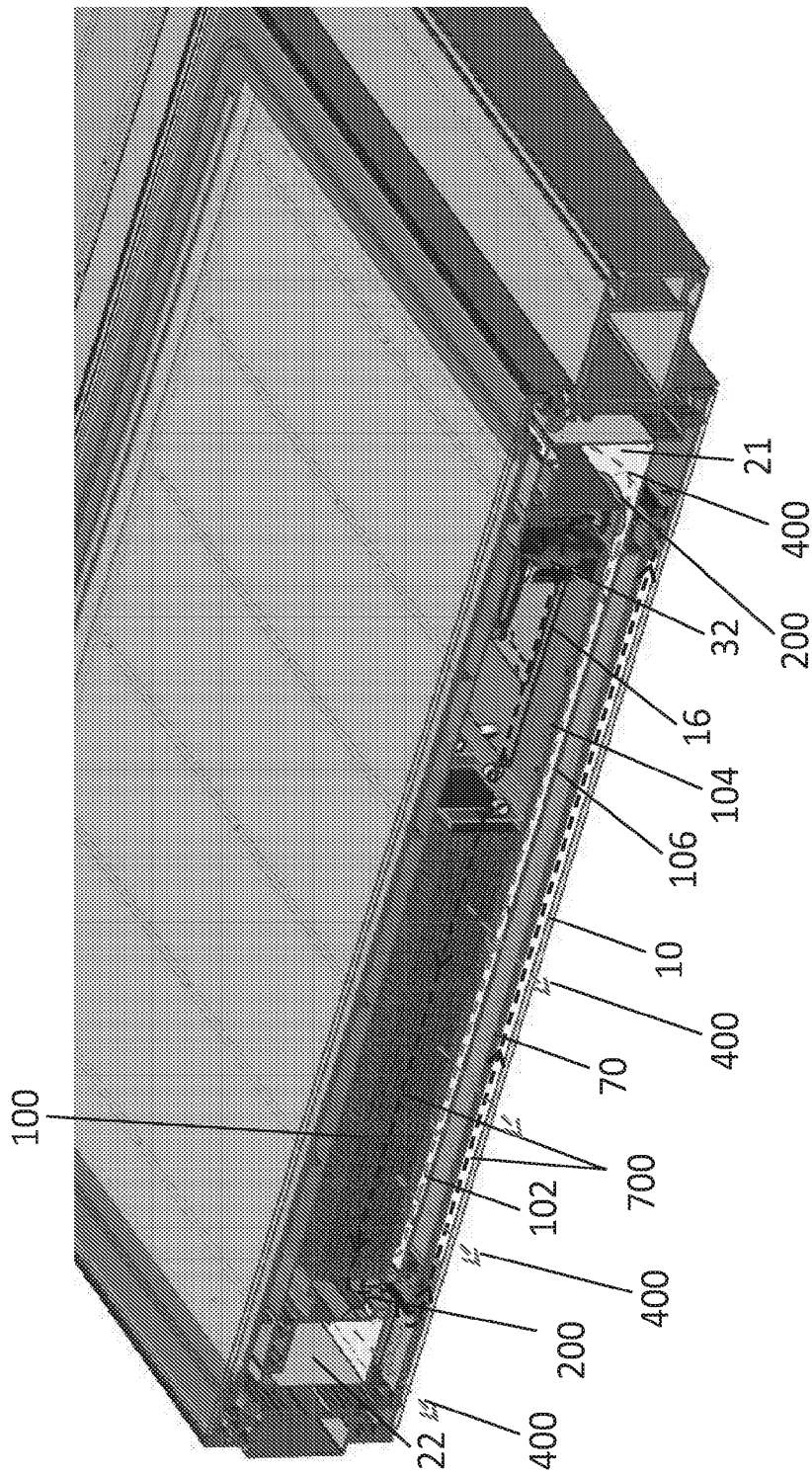


Figure 22

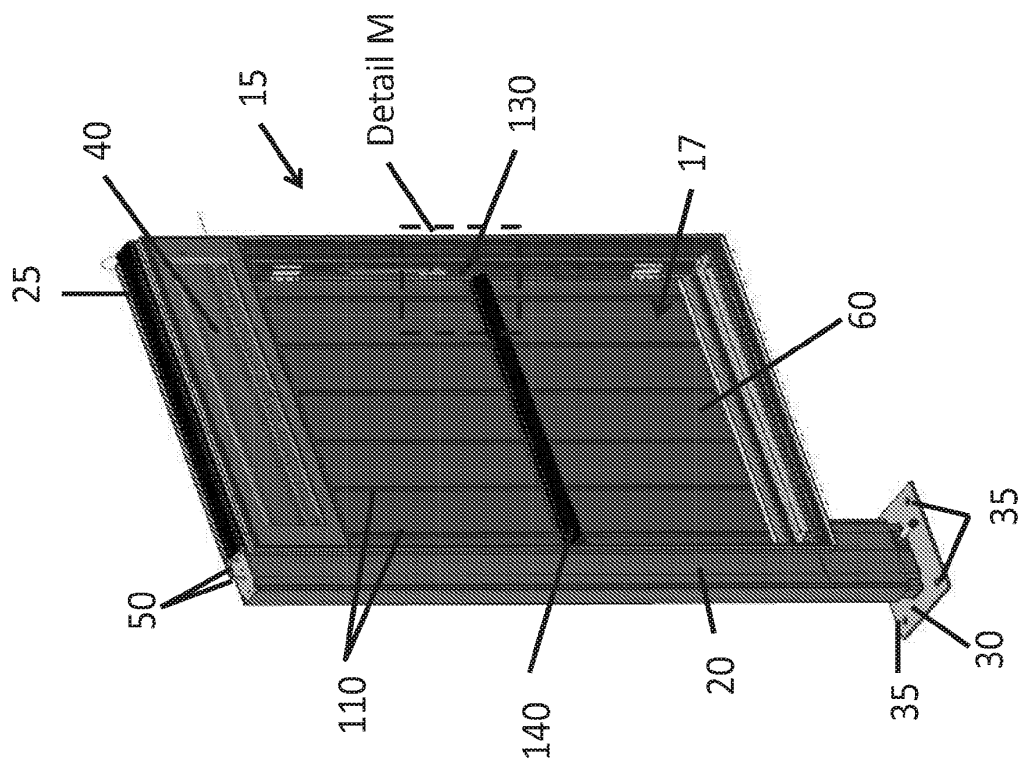


Figure 23

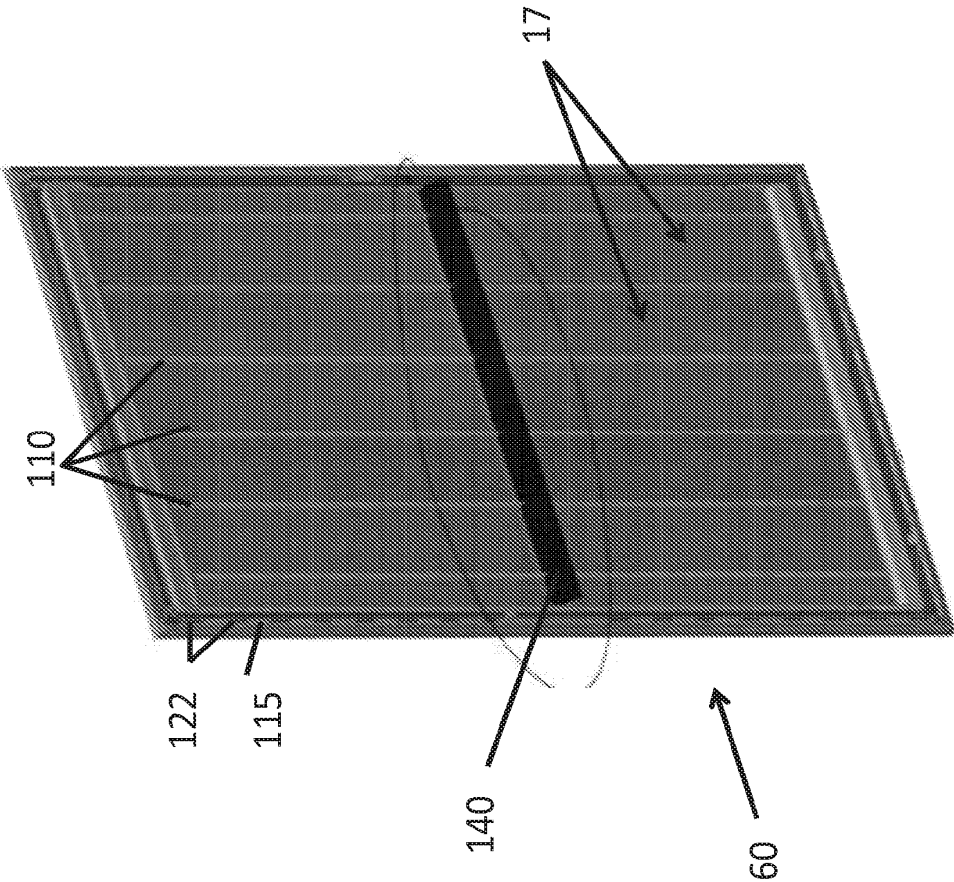


Figure 24

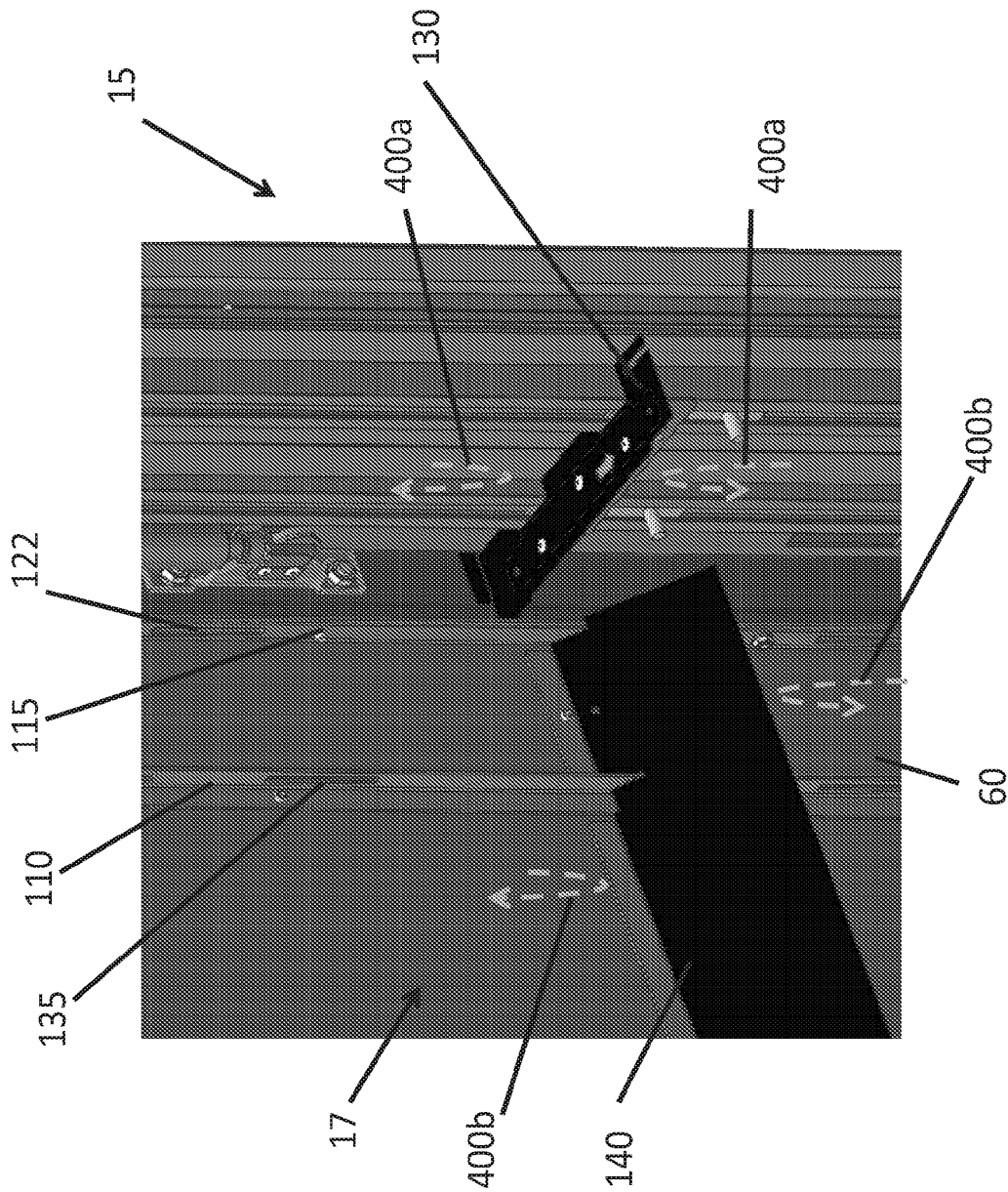


Figure 25

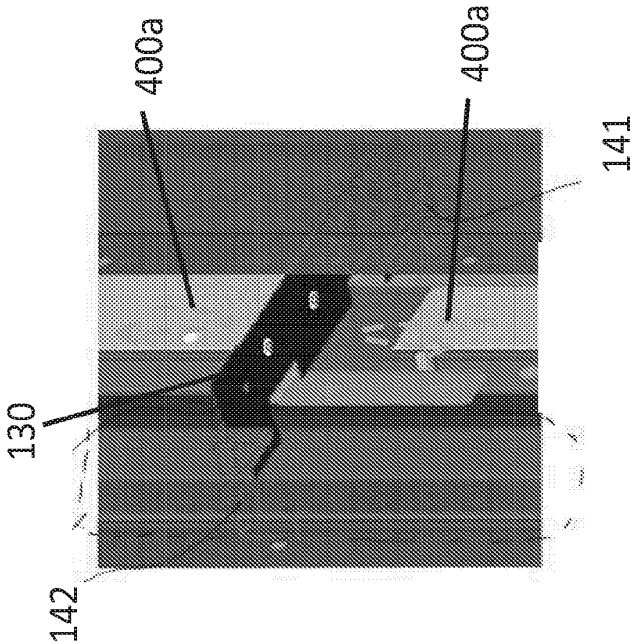


Figure 26B

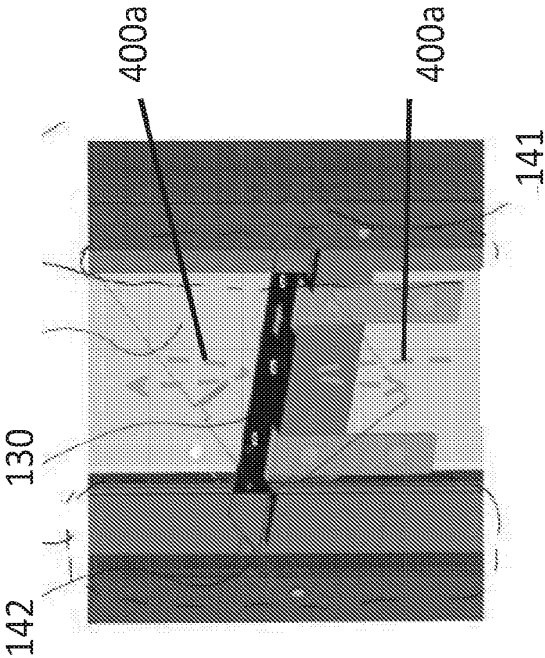


Figure 26A

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US16/17973

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - H05K 7/20; G02F 1/1335; F21V 29/60 (2016.01) CPC - G02F 1/133385; H05K 7/20954, 7/20972 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) Classifications: H05K 7/20; G02F 1/1335; F21V 29/60; H01L 23/467 (2016.01) CPC Classifications: G02F 1/133385; H05K 7/20954, 7/20972 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google Scholar; IEEE; EBSCO Keywords used: electronic display; cooling system; ingestion gap; exhaustion gap; fan; buffer zone; central septum		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- A	US 2011/0058326 A1 (IDEMS, R et al.) March 10, 2011; abstract; figures 6-7, 14-15, 18-19; paragraphs [0005-0007]; [0041]	1, 3, 5-6, 8-10, 13-16 --- 2, 4, 7, 11-12, 17-20
A	US 2008/0209934 A1 (RICHARDS, J) September 04, 2008; figures 8-9; paragraphs [0034-0035]	2, 4, 7, 11-12
A	US 2014/0111758 A1 (MANUFACTURING RESOURCES INTERNATIONAL, INC.) April 24, 2014; figures 2a-2b; paragraphs [0016]; [0018]; [0025]	2, 11, 17-20
A	US 2009/0126906 A1 (DUNN, W) May 21, 2009; figures 2-3; paragraphs [0029]; [0033]	7, 17-20
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 04 April 2016 (04.04.2016)		Date of mailing of the international search report 22 APR 2016
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300		Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)



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SYSTEM AND METHOD FOR THERMALLY CONTROLLING AN ELECTRONIC DISPLAY

Inventor(s): 던 윌리엄 알.

Applicant(s): 매뉴팩처링 리소시스 인터내셔널 인코포레이티드

Classification: - international: G02F1/1333; G02F1/1335
 - cooperative: G02F1/133382; G02F1/133385; H05K7/20972;
G02F2001/133628; G02F2201/36

Application number: KR20157033690 20081117 Global Dossier

Priority number(s): US20070941728 20071116 ; US20080033058P 20080303 ;
US20080033064P 20080303 ; US20080039454P 20080326 ;
US20080053713P 20080516 ; US20080057599P 20080530 ;
US20080076126P 20080626 ; US20080191834 20080814 ;
US20080234307 20080919 ; US20080234360 20080919 ;
US20080235200 20080922 ; US20080237365 20080924 ;
US20080115333P 20081117 ; WO2008US83792 20081117

Also published as: BRPI0820231 (A2) CA2705814 (A1) EP2225603 (A2)
EP2225603 (A4) EP2225603 (B1) more

Abstract not available for KR101764381 (B1)

Abstract of corresponding document: WO2009065125 (A2)

Embodiments relate generally to various thermal control features for electronic displays. One feature comprises a closed loop isolated gas chamber, where a first chamber is in contact with the display surface and transfers heat between the isolated gas and the display surface. A second chamber is in gaseous communication with the first chamber and is adapted to heat or cool the isolated gas and reintroduce the isolated gas into the first chamber. Another feature uses constricted convection to facilitate the cooling of the backlight assembly for the electronic display. Another feature uses

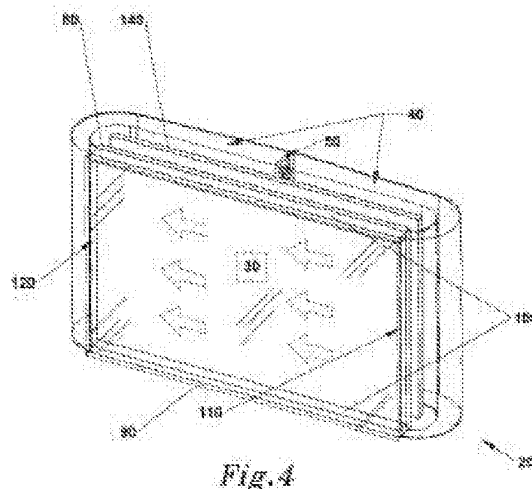
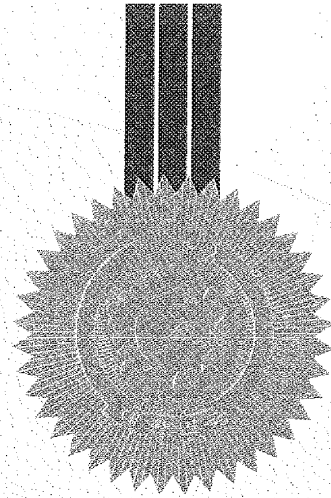


Fig. 4

an air curtain to further heat or cool the exterior viewing surface of the display. Another feature uses a linear polarizer with an insulating gap to reduce the solar loading of the display stack and provide insulation from the ambient air temperature. Another feature uses a fluid system to contact fluid coolant with the display surface in order to cool the display. Each of the features may be used alone, or in combination to provide the proper operating temperature for the display depending on its desired operating environment.

특허증

CERTIFICATE OF PATENT



특허

Patent Number

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전자 디스플레이 장치의 열 제어 방법 및 시스템

특허권자 Patentee

매뉴팩처링 리소시스 인터내셔널 인코포레이티드
미국 조지아 30005 알파레타 실로 로드 이스트 6415

발명자 Inventor

던 윌리엄 알.

미국 조지아 30005 알파레타 유니온 힐 로드 1600

위의 발명은 「특허법」에 따라 특허등록원부에 등록되었음을 증명합니다.

This is to certify that, in accordance with the Patent Act, a patent for the invention has been registered at the Korean Intellectual Property Office.



특허청

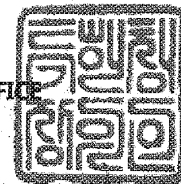
Korean Intellectual
Property Office

2017년 07월 27일

특허청장

COMMISSIONER,

KOREAN INTELLECTUAL PROPERTY OFFICE



[translation]

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(73) Patentee: MANUFACTURING RESOURCES
INTERNATIONAL, INC.

(52) CPC Cl.
G02F 1/133385 (2013. 01)
G02F 2001/133628 (2013. 01)

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(72) Inventor(s): DUNN, William, R.

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(74) Attorney: Jang Won Park

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(87) Int'l Laid-Open No.: WO 2009/065125

Int'l Laid-Open Date: May 22, 2009

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Number of Claims as allowed: 19 claims in total

Examiner: YOO, Chang Hoon

(54) Title of Invention: SYSTEM AND METHOD FOR THERMALLY CONTROLLING AN
ELECTRONIC DISPLAY

Abstract, Specification and Claims are not translated.



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심사청구일자 2015년11월25일
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- (43) 공개일자 2015년12월11일
- (62) 원출원 특허 10-2010-7013306
원출원일자(국제) 2008년11월17일
심사청구일자 2013년11월12일
- (86) 국제출원번호 PCT/US2008/083792
- (87) 국제공개번호 WO 2009/065125
국제공개일자 2009년05월22일
- (30) 우선권주장
11/941,728 2007년11월16일 미국(US)
(뒷면에 계속)
- (56) 선행기술조사문헌
JP2006513577 A*
KR1020070048294 A*
US05991153 A*
*는 심사관에 의하여 인용된 문헌
- (73) 특허권자
매뉴팩처링 리소시스 인터내셔널 인코포레이티드
미국 조지아 30005 알파레타 실로 로드 이스트 6415
- (72) 발명자
던 윌리엄 알.
미국 조지아 30005 알파레타 유니온 힐 로드 1600
- (74) 대리인
박장원

전체 청구항 수 : 총 19 항

심사관 : 유창훈

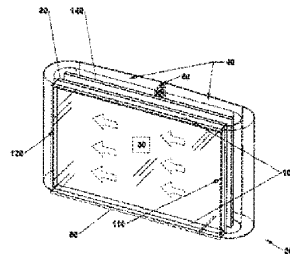
(54) 발명의 명칭 전자 디스플레이 장치의 열 제어 방법 및 시스템

(57) 요약

실시형태들은 일반적으로 전자 디스플레이 장치용의 여러 열 제어 피치들에 관한 것이다. 하나의 피치는 페루프 고립 가스 챔버를 포함하며, 여기서 제1 챔버는 상기 디스플레이 표면과 접촉하고, 고립 가스와 디스플레이 표면 사이에서 열을 전달한다. 제2 챔버는 상기 제1 챔버와 가스 연통하며, 상기 고립 가스를 가열하거나 냉각하며,

(뒷면에 계속)

배표도 - 도4



고압 가스를 제1 챔버로 재도입한다. 다른 피쳐는 전자 디스플레이 장치용 백라이트 어셈블리를 냉각하기 위해 수축 대류를 사용한다. 다른 피쳐는 디스플레이 장치의 외부 가시면을 추가로 가열 또는 냉각하기 위해 에어 커튼을 사용한다. 다른 피쳐는 상기 디스플레이 스택의 태양광 부하를 줄이고 주위 공기 온도와 절연하기 위한 절연 캡을 구비하는 선형 편광판을 사용한다. 다른 피쳐는 디스플레이 장치를 냉각하기 위해 디스플레이 표면과 유체 냉각제가 접촉하는 유체 시스템을 사용한다. 소망하는 작동 환경에 따라 디스플레이 장치에 적당한 작동 온도를 제공하기 위해 각 피쳐들은 단독으로 사용될 수 있고, 서로 조합되어 사용될 수도 있다.

(30) 우선권주장

61/033,058	2008년03월03일	미국(US)
61/033,064	2008년03월03일	미국(US)
61/039,454	2008년03월26일	미국(US)
61/053,713	2008년05월16일	미국(US)
61/057,599	2008년05월30일	미국(US)
61/076,126	2008년06월26일	미국(US)
12/191,834	2008년08월14일	미국(US)
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12/235,200	2008년09월22일	미국(US)
12/237,365	2008년09월24일	미국(US)
61/115,333	2008년11월17일	미국(US)

명세서

청구범위

청구항 1

디스플레이 표면과 후방면을 구비하는 전자 디스플레이용 가스 냉각 시스템으로,

순환 가스를 포함하며, 상기 전자 디스플레이를 둘러싸는 폐쇄형 루프 가스 순환 경로; 및

상기 폐쇄형 루프 가스 순환 경로의 개방된 중앙부를 관통하며, 주위 공기 유동을 받아들이고 그 주위 공기 유동이 전자 디스플레이의 후방면을 따라 이동하도록 구성되는 주위 공기 채널을 포함하고,

상기 폐쇄형 루프 가스 순환 경로 내의 순환 가스가 주위 공기 채널을 관통하여 유동하는 주위 공기와 격리되어 있는 것을 특징으로 하는, 전자 디스플레이용 가스 냉각 시스템.

청구항 2

제1항에 있어서,

팬을 획정하기 위해 디스플레이 표면의 전방에 위치하는 투명 전광판; 및

상기 순환 가스가 상기 팬을 통해 유동하도록 순환 가스를 강제 송풍하게 위치하는 팬을 추가로 포함하는 것을 특징으로 하는, 전자 디스플레이용 가스 냉각 시스템.

청구항 3

삭제

청구항 4

제1항에 있어서,

전자 디스플레이의 후방면을 따라 주위 공기가 유동하도록 주위 공기를 강제 송풍하게 위치하는 팬을 추가로 포함하는 것을 특징으로 하는, 전자 디스플레이용 가스 냉각 시스템.

청구항 5

제1항에 있어서,

주위 공기 채널은, 상기 채널을 관통하는 주위 공기의 유동 방향이 폐쇄형 루프 가스 순환 경로 내에서의 순환 가스의 유동 방향과 적교하도록 배향되어 있는 것을 특징으로 하는, 전자 디스플레이용 가스 냉각 시스템.

청구항 6

열 제어 전자 디스플레이로,

인입구와 배출구를 구비하는 하우징;

디스플레이 표면을 구비하는 액정 스택;

상기 액정 스택의 전방에 위치하는 열전도성 후방면을 구비하는 LED 백라이트;

순환 가스를 포함하며, 상기 액정 스택과 LED 백라이트 주위 둘레에 위치하는 연속된 순환 가스 경로; 및

주위 공기의 유동이 하우징 인입구를 통해 인입되어 LED 백라이트의 후방면을 따라 이동한 후 하우징 배출구를 통해 빠져나가도록 위치하는 팬을 포함하는 것을 특징으로 하는 열 제어 전자 디스플레이.

청구항 7

제6항에 있어서,

상기 팬이, 주위 공기의 유동 방향이 폐쇄형 루프 내의 순환 가스의 유동 방향과 적교하도록 배향되어 있는 것

을 특징으로 하는 열 제어 전자 디스플레이.

청구항 8

열 제어 액정 디스플레이 어셈블리로,

디스플레이 표면을 구비하는 액정 스택;

상기 액정 스택의 전방에 위치하는 열전도성 후방면을 구비하는 LED 백라이트;

디스플레이 표면의 전방에 위치하여, 디스플레이 표면과의 사이에 채널을 형성하는 공간이 형성되도록 하는 유리판;

순환 가스가 상기 채널을 관통하며 흐르도록, 상기 액정 스택과 LED 백라이트를 둘러싸도록 위치하는 순환 가스의 폐쇄형 루프; 및

주위 공기 유동이 LED 백라이트의 후방면과 접촉하도록 하는 수단을 포함하는 것을 특징으로 하는 열 제어 액정 디스플레이 어셈블리.

청구항 9

제8항에 있어서,

상기 수단은, 주위 공기의 유동 방향이 폐쇄형 루프 내의 순환 가스의 유동 방향과 직교하도록 하는 것을 특징으로 하는 열 제어 액정 디스플레이 어셈블리.

청구항 10

제8항에 있어서,

내부 표면과 외부 표면을 구비하는 플레임으로, 순환 가스가 내부 표면과 접촉하게 되고, 주위 공기가 외부 표면과 접촉하도록 구성되는 플레임을 추가로 포함하는 것을 특징으로 하는 열 제어 액정 디스플레이 어셈블리.

청구항 11

후방면을 구비하는 전자 디스플레이를 냉각하는 방법으로,

전자 디스플레이와 수축 대류관 사이에 갭이 형성되도록, 전자 디스플레이의 후방면에 인접하게 수축 대류관을 위치시키는 단계;

전자 디스플레이 주위로 가스가 순환하기 위한 폐쇄형 루프 경로를 위치시키는 단계;

폐쇄형 루프 주위에 순환 가스를 강제 송풍하는 단계; 및

상기 갭을 통해 찬 공기를 강제 송풍하는 단계를 포함하는 것을 특징으로 하는 전자 디스플레이 냉각 방법.

청구항 12

제11항에 있어서,

상기 수축 대류관이 냉각 챔버의 벽으로 재공되는 것을 특징으로 하는 전자 디스플레이 냉각 방법.

청구항 13

제11항에 있어서,

갭을 통해 찬 공기를 강제 송풍하는 단계는 갭을 통해 주위 공기를 빨아들이는 팬에 의해 수행되는 것을 특징으로 하는 전자 디스플레이 냉각 방법.

청구항 14

제11항에 있어서,

갭을 통해 찬 공기를 강제 송풍하는 단계는 갭을 통해 주위 공기를 밀어내는 팬에 의해 수행되는 것을 특징으로 하는 전자 디스플레이 냉각 방법.

청구항 15

제11항에 있어서,

갭을 통해 찬 공기를 강제 송풍하기 전에 여과하는 단계를 추가로 포함하는 것을 특징으로 하는 전자 디스플레이 냉각 방법.

청구항 16

전방면과, 전자 디스플레이의 후방면과 제2의 전방면 사이에 형성되는 갭을 구비하는 전자 디스플레이를 냉각하는 방법으로,

전자 디스플레이 주위로 폐쇄형 루프로 가스를 순환시키는 단계;

상기 가스가 전자 디스플레이의 전방면과 접촉하도록 하는 단계; 및

상기 갭을 통해 찬 공기를 강제 송풍하는 단계를 포함하며,

상기 찬 공기가 상기 순환 가스와 격리되어 있는 것을 특징으로 하는 전자 디스플레이 냉각 방법.

청구항 17

제16항에 있어서,

폐쇄형 루프 내에서 전자 디스플레이 주위로 가스를 순환시키는 단계가,

전자 디스플레이의 전방면의 앞에 위치하는 제1 가스 챔버;

전자 디스플레이의 후방면의 뒤쪽에 위치하며, 상기 제1 가스 챔버와 가스 연통하는 제2 가스 챔버; 및

상기 제2 가스 챔버 내에 위치하여, 상기 제1 가스 챔버와 제2 가스 챔버 주위로 가스를 송풍하는 데에 사용되는 냉각 챔버 팬에 의해 수행되는 것을 특징으로 하는 전자 디스플레이 냉각 방법.

청구항 18

제16항에 있어서,

갭을 통해 찬 공기를 강제 송풍하는 단계가 팬에 의해 수행되는 것을 특징으로 하는 전자 디스플레이 냉각 방법.

청구항 19

LED 백라이트가 후방면을 구비하고, 액정 디스플레이는 전방 가시면과, LED 백라이트의 후방면과 이격 배치되어 갭을 형성하는 후방면을 포함하는 LED 백라이트 액정 디스플레이를 냉각하는 방법으로,

액정 디스플레이와 백라이트 주위를 폐쇄형 루프로 가스를 순환시키는 단계;

갭을 통해 찬 공기를 강제 송풍하는 단계; 및

상기 순환 가스와 찬 공기가 혼합되지 않도록 하는 단계를 포함하는 것을 특징으로 하는 LED 백라이트 액정 디스플레이 냉각 방법.

청구항 20

제19항에 있어서,

액정 디스플레이와 백라이트 주위를 폐쇄형 루프로 가스를 순환시키는 단계가,

액정 디스플레이의 전방 가시 면의 앞에 위치하는 제1 가스 챔버;

LED 백라이트의 후방면의 뒤쪽에 위치하며, 상기 제1 가스 챔버와 가스 연통하는 제2 가스 챔버; 및

상기 제2 가스 챔버 내에 위치하여, 상기 제1 가스 챔버와 제2 가스 챔버 주위로 가스를 송풍하는 데에 사용되는 냉각 챔버 팬에 의해 수행되는 것을 특징으로 하는 LED 백라이트 액정 디스플레이 냉각 방법.

발명의 설명

기술 분야

[0001] 예시적 실시형태들은 일반적으로 전자 디스플레이 장치를 가열/냉각하는 시스템에 관한 것이다.

배경 기술

[0002] 전자 디스플레이 장치는 온도가 조절되는 실내에서 사용되는 것이 일반적이다. 디스플레이 장치 주위의 온도는 비교적 안정적(실내 온도 근방)이기는 하지만, 디스플레이 장치의 부품들은 다양한 열을 발생시킬 수 있다. 이러한 열이 적절하게 배출되지 않으면, 디스플레이 장치에 손상을 입히거나, 수명을 단축시키게 된다. 통상적으로 디스플레이 장치 내의 전자부품들에서 발생한 열을 디스플레이 장치의 측면을 통해 방출하기 위해, 전도 및 대류 열전달 시스템이 사용되고 있다. 이러한 열전달 시스템이 과거에는 성공적으로 사용되었지만, 오늘날 전자 디스플레이 장치는 더 큰 냉각 능력(일부 경우에는 가열 능력)을 필요로 한다.

[0003] 현대의 전자 디스플레이 장치는 실외 환경과 주변 온도가 실내 온도보다 높거나 낮은 상황에서도 사용되고 있다. 주위 공기로부터 열이 전달되는 외에도, 디스플레이 장치 표면을 통한 태양으로부터의 복사 열전달도 주요 요인이 될 수 있다. 일부 응용분야 및 사용 위치에서, 그러한 디스플레이 장치 표면을 통해 200 와트 또는 그 이상의 전력이 사용되는 것이 일반적이다. 또한, 시장에서는 보다 대형의 그리고 보다 밝은 디스플레이 장치를, 때로는 고해상도 디스플레이 장치를 요구한다. 전자 디스플레이 장치가 대형화함에 따라, 태양으로부터 다량의 열을 흡수하게 되고, 다량의 열이 디스플레이 장치 내로 전달되게 된다. 태양으로부터 나오는 주변 빛과 주위 표면에서 반사되는 빛과 경쟁하여, 디스플레이 장치들은 더 많은 양의 빛을 발생시켜야 하며, 이는 디스플레이 장치 및/또는 백라이트 어셈블리로부터 더 많은 열이 발생되게 한다.

[0004] 또한, 일부 응용 분야에서, 온도는 실온보다 상당히 밑으로 떨어질 수도 있다. 전자 디스플레이 장치가 저온에 노출됨으로써, 일부 부품들이 오작동하거나 영구적으로 손상될 수 있다. 예를 들어, 액정 디스플레이(LCD) 내의 액정 소재의 성능이 저온에 의한 영향을 받을 수 있다.

발명의 내용

해결하려는 과제

[0005] 예시적 실시형태들은 본 명세서에 기재되어 있는 하나 또는 그 이상의 열 제어 피쳐(feature)들을 구비할 수 있다. 복수의 열 제어 피쳐들이 기재되어 있으며, 이들 피쳐들은 개별적으로 사용되거나, 임의로 서로 조합되어 사용될 수 있다. 이들 피쳐들의 특정한 조합은 대상으로 하는 디스플레이 장치의 냉각/가열 수요에 따라 달라질 수 있고, 디스플레이 장치의 종류, 크기 및 특히 사용 환경에 따라 달라질 수 있다. 예시적 실시형태들은 LCD, 발광 다이오드(LED), 유기발광 다이오드(OLED), 전계 방출형 디스플레이(FED), 음극선관(CRT), 플라즈마 및 프로젝션 디스플레이를 포함하는 어떠한 형태의 전자 디스플레이 장치에서 실시될 수 있다. 다만, 이들 디스플레이 장치만으로 한정되는 것은 아니다.

과제의 해결 수단

[0006] 하나의 열 피쳐(thermal feature)는 고립 가스 냉각 시스템에 관한 것이다. 가스 냉각 시스템은 투명 전방판을 포함하는 제1 가스 챔버와 냉각 플레넘을 포함하는 제2 가스 챔버를 포함하여 구성되는 폐쇄형 루프인 것이 바람직하다. 상기 제1 가스 챔버가 앞쪽에 있으며, 전자 디스플레이 장치의 가시 화면과 동연(同延)한다. 상기 투명 전방판은 상기 제1 가스 챔버의 깊이를 획정하는 전자 디스플레이 장치 표면의 앞에 설치될 수 있다. 냉각 챔버 팬 또는 이와 균등한 수단이 냉각 플레넘 앞에 위치하여, 가스가 고립 가스 냉각 챔버 루프 주위를 돌게 하는 데에 사용될 수 있다. 가스가 제1 가스 챔버를 지나감에 따라, 가스는 전자 디스플레이 장치 표면과 접촉하여 그 표면으로부터 열을 흡수하게 된다. 가스와 상기 제1 가스 챔버의 관계된 표면은 투명하기 때문에, 화질은 여전히 탁월한 상태를 유지한다. 가스가 상기 투명 제1 가스 챔버를 통과한 후, 그 가스는 가스가 냉각되는 후방의 냉각 플레넘을 향하게 된다.

[0007] 다른 열적 피쳐는 그 냉각 능력을 대신하거나 그 냉각 능력에 추가하여, 고립 가스 시스템을 가열 장치로서 사용한다. 고립 가스 가열 시스템은 상기 디스플레이 표면의 전방에 있는 제1 가스 챔버와 가열 플레넘 또는 냉각/가열 플레넘을 포함하는 제2 챔버를 구비하는 폐쇄형 루프 시스템일 수 있다. 가열 요소들은 제2 챔버 내의 가

스를 가열하기 위해, 상기 플레넘 안쪽에 배치될 수 있다. 가스가 제1 챔버 내로 강제로 넣어짐에 따라, 가스의 열이 디스플레이 표면으로 전달될 수 있다. 그런 다음, 다른 가열 사이클을 수행하기 위해, 가스는 상기 플레넘으로 복귀한다. 특정 디스플레이 장치와 그 특정 작동 환경에 따라, 상기 플레넘은 냉각 플레넘만으로 또는 가열 플레넘만으로 가능하거나 또는 가열/냉각 플레넘의 조합으로 가능하다.

[0008] 일부 실시형태들은 상기 전자 디스플레이 장치를 작동하는 데에 사용되는 전자 부품들을 상기 고립 가스 챔버의 플레넘 내에 배치시킬 수 있다. 상기 전자 부품들은 변압기, 회로판, 프로세서, 레지스터, 커패시터, 배터리, 모터, 전원 장치, 조명 장치, 배선과 배선 하니스, 및 스위치를 포함할 수 있다. 다만, 이들만으로 한정되는 것은 아니다. 플레넘이 냉각 플레넘으로 사용되는 경우, 상기 플레넘 내의 냉각 가스는 작동 중에 자연적으로 열을 발생시키는 전자 부품들을 냉각시키는 데에 추가로 사용될 수 있다. 또한, 플레넘이 디스플레이 장치용 열원으로 사용되는 경우, 전자 부품들로부터 나오는 자연 열이 플레넘 내의 가스를 가열하여 가열 요소에 공급되어야 하는 에너지 양을 줄여주게 된다.

[0009] 일부 실시형태에서, 전자 디스플레이 장치 위에 가해지는 태양에너지를 추가로 줄이기 위해 선형 편광판(linear polarizer)이 사용될 수 있다. 이 편광판은 고립 가스 챔버와 조합되어 사용되거나, 단순히 그 편광판과 디스플레이 장치 사이에 절연 겹을 구비하는 전자 디스플레이 장치의 전방에 위치하여 사용될 수 있다. 상기 절연 겹은 편광판과 디스플레이 장치 사이에 전달되는 열의 양을 줄여준다.

[0010] 일례로 LCD와 같은 일부 전자 디스플레이 장치들은 디스플레이 표면에 이미지를 형성하기 위해 백라이트 어셈블리를 필요로 한다. 상기 백라이트 어셈블리들은 일반적으로 디스플레이 장치에 있어 대형의 열 발생원이다. 따라서, 일부 실시형태들은 수축 대류 시스템(constricted convection system)을 사용하여 디스플레이 장치용 백라이트 유닛을 냉각한다. 상기 수축 대류 시스템은 상기 백라이트 어셈블리에 근접하게 위치하여 겹을 형성하는 수축 대류판을 포함할 수 있다. 백라이트 어셈블리를 보다 용이하고 효율적으로 냉각하기 위해, 가스가 상기 겹을 통해 강제 유동한다. 일부 실시형태에서, 플레넘의 벽은 수축 대류판을 구성한다.

[0011] 일부 실시형태들은 또한 상기 디스플레이 어셈블리의 외부 표면 위로 공기(찬 공기 또는 더운 공기)를 강제 송풍시키는 에어커튼 장치를 사용할 수 있다.

[0012] 마지막으로, 일부 실시형태들은 디스플레이 표면을 냉각하기 위해 유체가 디스플레이 표면과 접촉하는 유체 어셈블리를 사용할 수도 있다. 유체는 실질적으로 투명한 형태의 냉각 유체로, 유체는 디스플레이 표면에 포함되어 있는 전방 캐비티를 통해 평평된다.

[0013] 아래의 발명의 상세한 설명과 첨부된 도면들을 통해 예시적 실시형태를 보다 잘 이해될 것이다. 도면에서 동일한 도면부호는 동일한 부분을 지칭한다.

발명의 효과

[0014] 본 발명에 의한 전자 디스플레이 장치의 열 제어 장치는 비교적 대형, 고화질의 LCD 디스플레이 장치에 사용될 수 있으며, 또한 태양이 강렬한 속의 환경에 사용되기에 적합할 수도 있으며, 디스플레이 장치의 열적 안정성이 문제가 되는 실내 장치(일례로, 공장 환경, 쿨러/냉동고 등)에 적합할 수도 있다.

도면의 간단한 설명

[0015] 도 1은 예시적 전자 디스플레이 장치와 결합된 예시적 실시형태의 사시도이다.

도 2는 고립 가스 냉각 시스템의 구성부품들을 보여주는, 예시적 실시형태의 분해 사시도이다.

도 3은 상기 냉각 챔버의 예시적 실시형태의 평면도이다.

도 4는 고립 냉각 챔버, 복귀 제1 가스 챔버의 전방면이 투명한 일 실시형태의 전방 사시도이다.

도 5는 플레넘 내에 배치된 선택적인 전자 구성부품들을 보여주는, 고립 냉각 챔버의 일 실시형태의 후방 사시도이다.

도 6은 상기 플레넘에 포함될 수 있는 변 피쳐들을 보여주는, 고립 냉각 챔버의 일 실시형태의 후방 사시도이다.

도 7은 상기 플레넘에 포함될 수 있는 변 피쳐들을 보여주는, 고립 냉각 챔버의 일 실시형태의 평면도이다.

도 8은 열전기 모듈을 포함하는 고립 냉각 챔버의 일 실시형태의 전방 사시도이다.

- 도 9는 열전기 모듈을 포함하는 고립 냉각 챔버의 예시적 실시형태의 평면도이다.
- 도 10은 고립 가스 냉각 시스템의 구성부품들을 보여주는, 예시적 실시형태의 분해 사시도이다.
- 도 11은 가열 챔버의 예시적 실시형태의 평면도이다.
- 도 12는 가열 요소들과 선택적인 전기 구성부품들을 보여주는, 가열 챔버의 일 실시형태의 후방 사시도이다.
- 도 13 및 도 14는 고립 가스 시스템 또는 절연 집을 구비하는 선행 편광관을 사용하는 예시적 실시형태의 단면도이다.
- 도 15a 및 도 15b는 수축 대류관을 구비하는 수축 대류 냉각 시스템의 예시적 실시형태의 측면도이다.
- 도 16은 냉각 플레넘이 수축 대류관으로 사용되는, 예시적 실시형태의 평면도이다.
- 도 17a 내지 도 17c는 냉각 플레넘이 수축 대류관으로 사용되는, 실시형태의 단면도이다.
- 도 18은 에어커튼 장치를 사용하는 디스플레이 장치의 정면도이다.
- 도 19는 에어커튼 장치를 사용하는 디스플레이 장치의 단면도이다.
- 도 20은 액체 냉각 디스플레이 장치용 구성부품들을 보여주는 도면이다.

발명을 실시하기 위한 구체적인 내용

- [0016] 개시된 실시형태들의 기술사상과 범위는 LCD를 포함하는 디스플레이 장치의 열 제어 디스플레이 장치를 포함하지만, LCD만으로 한정되는 것이 아님을 이해해야 한다. 설명을 간단하게 할 목적으로 LCD 디스플레이용 부품과 연계하여 실시형태들을 개시할 것이다. 일례로 실시형태들은 LCD, 발광 다이오드(LED), 유기발광 다이오드(OLED), 전계 방출형 디스플레이(FED), 음극선관(CRT), 플라즈마 및 프로젝션 디스플레이 중에서 선택된 디스플레이 장치와 결합될 수 있다. 다만, 이들만으로 한정하는 것은 아니다. 또한, 실시형태들은 아직 개발되지 않은 유형의 디스플레이 장치에 사용될 수도 있다. 특히, 실시형태들이 완전 칼라, 평면 패널 OLED 디스플레이 장치에 꽤 적합한 것으로 생각될 수 있다. 또한, 실시형태들이 비교적 대형, 고화질의 LCD 디스플레이 장치에 사용될 수 있는 것도 생각할 수 있다. 본 명세서에 개시된 실시형태들이 옥외 환경에 사용되기에 적합할 수도 있는 반면, 실시형태들이 디스플레이 장치의 열적 안정성이 문제가 되는 실내 장치(일례로, 공장 환경, 쿨러/냉동고 등)에 적합할 수도 있다.
- [0017] 고립 가스 냉각 시스템(isolated gas cooling system)
- [0018] 도 1에 도시한 바와 같이, 디스플레이 장치(10)가 실외 환경에 노출되어 있는 경우에 냉각 장치를 사용하지 않으면, 디스플레이 장치(10) 내부의 온도는 상당히 변화할 수 있다. 이에 따라, 디스플레이 장치(10)는 제대로 작동하지 않거나, 사용 수명이 상당히 감소하게 된다. 디스플레이 장치(10)의 내부 온도를 증가시키는 요인으로, 태양 복사량이 특히 문제가 된다.
- [0019] 도 1에서, 도시되어 있는 전자 디스플레이 장치의 디스플레이 영역은 좁은 가스 챔버를 포함하는데, 상기 가스 챔버는 전자 디스플레이 장치 표면의 전방에 그리고 디스플레이 장치 표면과 동연(coextensive)되어 있다. 도시된 디스플레이 장치에는 흡전으로 에어커튼 장치(114)가 부착되어 있다. 에어커튼 장치(114)는 아래에서 상세하게 논의된다. 선택적으로, 상기 디스플레이 표면 상에서 태양광의 반사를 줄이기 위해, 상기 디스플레이 장치는 반사 실드(119)를 포함할 수 있다. 추가적으로, 실외 환경에서, 하우징(70)은 태양광을 반사하는 색상인 것이 바람직하다.
- [0020] 도 2에 도시한 바와 같이, 디스플레이 장치(10)의 예시적 실시형태는 디스플레이 하우징(70) 내에 수용되는 고립 가스 냉각 챔버(20)를 포함한다. 스페이서(100)와 투명 전방판(90)에 의해, 투명 제1 가스 챔버가 형성된다. 제2 투명 전방판(130)이 전방판(90)에 라미네이트되어 전방판(90)이 파손되는 것을 방지하고 디스플레이 장치의 내부를 보호할 수 있다. 냉각 챔버(20)는 디스플레이 스택(80)과 이와 연계된 백라이트 어셈블리(140)를 둘러싼다.
- [0021] 디스플레이 장치(10)는 상기 제2 가스 챔버 내에 수용되는 냉각 가스를 위한 수단을 포함할 수 있다. 이 수단은 디스플레이 하우징(70)의 베이스에 위치할 수 있는 하나 또는 그 이상의 팬(60)을 포함할 수 있다. 팬(60)은 차가운 공기를 빨아들이고, 빨아들인 더 차가운 공기를 후방 냉각 플레넘(45)의 적어도 하나의 외부 표면 위로 강제 송풍시킨다. 필요하다면, 플레넘(45)의 외부 표면과 접촉하는 공기를 냉각시키기 위해, 공기조화기(미도시)

- 가 사용될 수도 있다. 선택적으로, 팬(60)은 단순히 주위 공기를 뿜어줄 수 있다.
- [0022] 도 3을 참조하면, 고립 가스 냉각 챔버(20)의 실시형태들은 제1 가스 챔버(30)와 제2 가스 챔버(40)를 포함하는 폐쇄형 루프를 포함할 수 있다. 상기 제1 가스 챔버는 투명판(90)을 포함한다. 상기 제2 가스 챔버는 냉각 플레넘(45)을 포함한다. "고립 가스"(isolated gas)란 용어는 고립 가스 냉각 챔버(20) 내의 가스가 본래 디스플레이 장치의 하우징 내의 외부 공기와 격리(isolation)되어 있다는 것을 의미한다. 제1 가스 챔버(30)가 전자 디스플레이 표면(85)의 전방에 위치하기 때문에, 가스에는 디스플레이 화질에 악 영향을 줄 수 있는, 먼지 또는 다른 오염물질이 실질적으로 없어야 한다. 오염을 방지하고 먼지가 제1 가스 챔버(30) 내로 들어오는 것을 방지하기 위해, 선택적 필터(바도시)가 사용될 수 있다.
- [0023] 상기 고립 가스는 거의 투명한 가스로, 그 예로는 보통의 공기, 질소, 헬륨 또는 기타의 다른 투명 가스가 있다. 상기 가스는 화질에 영향을 주지 않도록 무색인 것이 바람직하다. 또한, 고립 가스 냉각 챔버(20)는 외부 공기에 대해 반드시 긴밀하게 밀봉될 필요는 없다. 챔버 내의 가스는 먼지와 오염물질들이 실질적으로 제1 가스 챔버 내로 유입되는 것이 실질적으로 방지될 수 있을 정도로 격리되는 것만으로 충분하다.
- [0024] 도 3에 도시된 폐쇄형 루프 장치에서, 제1 가스 챔버(30)는 제2 가스 챔버(40)와 가스 연통하고 있다. 냉각 플레넘(45) 내에 냉각 챔버 팬(50)이 제공되어서 고립 가스 냉각 챔버(20) 주위로 가스를 추진시키는 데 사용될 수 있다. 제1 가스 챔버(30)는 전자 디스플레이 표면(85)의 전방에 장착되어 있는 적어도 하나의 전방 유리(90)를 포함한다.
- [0025] 도 4를 참조하면, 전방판(90)은 이격 부재(spacing member)(100)에 의해 전자 디스플레이 표면(85)으로부터 앞쪽으로 나와 있다. 이격 부재(100)는 전자 디스플레이 표면(85)의 전방을 통과하는 협폭 채널의 깊이를 정의한다. 이격 부재(100)는 장치의 다른 구성부품들과 독립된 별개의 부재일 수 있고, 선택적으로는 이들 부품들과 일체로 통합 구성될 수도 있다(일체로 전방판(90)과 일체로 구성). 전자 디스플레이 표면(85), 이격 부재(100) 및 투명 전방판(90)은 제1 가스 챔버(30)를 형성한다. 챔버(30)는 인입 개구(110)와 인출 개구(120)를 통해 플레넘(45)과 가스 연통하고 있다.
- [0026] 도 3에 도시되어 있는 바와 같이, 제1 가스 챔버(30)의 후방면은 디스플레이 스택(80)의 전자 디스플레이 표면(85)을 포함하는 것이 바람직하다. 제1 가스 챔버(30) 내의 고립 가스가 디스플레이 장치를 지나감에 따라, 고립 가스는 전자 디스플레이 표면(85)과 접촉한다. 냉각 가스가 전자 디스플레이 표면(85)과 직접 접촉함으로써, 전자 디스플레이 표면(85)으로부터 대류 열전달 방출이 향상된다. 예시적 실시형태에서, 전자 디스플레이 표면(85)은 제1 가스 챔버(30)의 후방면을 포함한다. 이에 따라, "전자 디스플레이 표면"(electronic display surface)이란 용어는 (본 명세서에 기재된 실시형태에는 없는) 일반적인 전자 디스플레이 장치의 전방 표면을 의미하는 것이다.
- [0027] 예시적 실시형태에서, 전자 디스플레이 표면(85), 전방판(90) 및 선택적 제2 전방판(130)은 유리 기판으로 구성될 수 있다. 그러나, 전자 디스플레이 표면(85), 투명 전방판(90), 선택적 제2 전방판(130)이 반드시 유리일 필요는 없다. 따라서 본 명세서에서, "유리"(glass)란 용어는 판(plate)이란 용어로 혼용될 수도 있으며, 유리 소재만이 필요한 것은 아니다. 또한, 전자 디스플레이 표면(85)이 반드시 전방 가스 격실(30)의 전방면 벽을 포함할 필요는 없다. 추가의 판이 사용될 수도 있다. 그러나, 가스 격실(30)의 후방면 벽으로 전자 디스플레이 표면(85)을 사용함으로써, 디스플레이 장치를 관통하는 가시광이 더 작은 면과 충돌할 수 있다. 또한, 장치가 더 경량화되며 제조 비용이 낮아질 수 있다.
- [0028] 도시된 실시형태들이 전자 디스플레이 표면(85)을 사용하고 있지만, 장치의 광학 성능을 향상시키거나 가스 냉각제를 수용하기 위해, 어느 변형물 및/또는 코팅(일체로, 반사 방지 코팅)이 전자 디스플레이 표면(85)에 또는 본 시스템의 다른 구성부품들에 부가될 수 있다. 도시된 실시형태에서, 전자 디스플레이 표면(85)은 액정 디스플레이(LCD) 스택의 전방 유리판일 수 있다. 그러나, 본 냉각 시스템의 실시형태들에 적합한 임의의 다른 디스플레이 표면일 수도 있다. 필수적인 것은 아니지만, 전자 디스플레이 표면(85)과 접촉하도록 제1 가스 챔버(30) 내에 냉각 가스를 흐르게 하는 것이 바람직하다. 이러한 방식으로, 디스플레이 부품으로부터 순환하는 가스로의 대류 열전달이 극대화될 수 있다.
- [0029] 도 4를 참조하면, 제1 가스 챔버(30)의 전방판(90)은 투명하고, 전자 디스플레이 표면(85)의 앞쪽에 위치하고 있다. 도시되어 있는 화살표는 제1 가스 챔버(30)를 통한 고립 가스의 이동방향을 나타낸다. 도시되어 있는 바와 같이, 고립 가스는 제1 가스 챔버(30) 내에서 수평방향으로 이동한다. 가스가 수평방향 또는 수직방향 중 어느 한 방향으로 이동하는 것으로 냉각 시스템(20)이 구성될 수 있지만, 수평방향으로 추진시키는 것이 바람직하다.

- 다. 이러한 방식으로, 먼지 또는 오염물들이 제1 가스 챔버(30)로 유입되는 경우, 먼지 또는 오염물들은 디스플레이 장치의 가시 영역의 외부로 챔버(30)의 바닥으로 떨어지게 된다. 본 시스템은 공기를 좌측에서 우측으로, 또는 선택적으로는 우측에서 좌측으로 이동시킬 수 있다. 가스가 제1 가스 챔버(30)를 지나간 후, 가스는 인출 개구(120)를 통해 빠져나간다. 인출 개구(120)는 후방 냉각 플레넘(45)에 대해서는 일구부를 형성한다.
- [0030] 도 5는 후방 냉각 플레넘(설명을 위해 투명하게 도시)을 개략적으로 도시하고 있다. 플레넘 내의 하나 또는 그 이상의 팬(50)은 고립 가스가 고립 가스 냉각 챔버를 관통하는 때에 필요한 힘을 제공한다. 제1 가스 챔버(30)는 디스플레이 장치의 전자 디스플레이 표면(85)으로부터 열을 수집하도록 설계되는 반면, 제2 가스 챔버(40)는 가스로부터 열을 추출하여 상기 냉각 챔버(20)로부터 열을 제거하도록 설계된다. 제2 가스 챔버(40)는 주어진 전자 디스플레이 장치 내에서 내부 구조물들을 수용하기 위한 다양한 윤곽과 피쳐들을 구비할 수 있다.
- [0031] 필요하다면, 제2 가스 챔버(40) 전체의 어느 곳에도 다양한 전자 부품들(200)이 배치될 수 있다. 전자 부품들(200)은 변압기, 회로판, 프로세서, 레지스터, 커패시터, 배터리, 모터, 전원 장치, 조명 장치, 배선과 배선 하니스, 및 스위치를 포함할 수 있지만, 이들만으로 한정되는 것은 아니다. 이들 부품들은 챔버의 벽 위에 직접 장착될 수도 있고, 막대 또는 포스트(209) 상에 지지될 수도 있다. 이에 따라, 냉각 플레넘은 제1 가스 챔버(30)로부터 열을 빼앗으면서도 이들 각종 전자 부품들(200)을 냉각시키도록 설계될 수 있다(추가적으로 아래에서 논의하고 있는 바와 같이, 고립 가스 시스템이 디스플레이 장치를 가열하는 데에 사용되는 경우, 전자 부품들은 고립 가스의 가열을 조장할 수 있음).
- [0032] 도 6 및 도 7을 참조하면, 플레넘(45)으로부터의 열 방출을 개선하기 위해, 다양한 면 피쳐들(150)이 추가될 수 있다. 이들 면 피쳐들(150)은 큰 표면적을 형성하여, 제2 가스 챔버(40) 내의 가스로부터 열을 방출시키도록 한다. 이들 피쳐들(150)은 플레넘(45) 표면 위의 많은 지점에 위치할 수 있다.
- [0033] 도 8 및 도 9를 참조하면, 제2 가스 챔버(40) 내에 포함되어 있는 가스를 추가로 냉각하기 위해, 적어도 하나의 플레넘(45) 표면 위에 하나 또는 그 이상의 열전기 모듈(160)이 위치할 수 있다. 열전기 모듈(160)은 면 피쳐들(150)과 독립하여 또는 면 피쳐들과 결합하여 사용될 수 있다. 선택적으로, 추운 환경에서 고립 가스 시스템이 디스플레이 장치를 가열하는 데에 사용되는 경우, 열전기 모듈(160)은 플레넘 내에서 가스를 가열하는 데에 사용될 수 있다.
- [0034] 도 10은 후방 플레넘(45)에 포함되어 있는 가스에서 열을 제거하는 예시적 방법을 나타낸다. 공기를 빨아들이고, 그 공기를 플레넘(45)의 전방면과 후방면으로 끌어넣기 위해 팬(60)이 위치할 수 있다. 팬(60)은 공기 조화된 공기를 디스플레이 장치 하우징(70) 내로 빨아들이거나 단순히 주워 공기를 빨아들일 수 있다. 또한, 본 장치에서, 팬(60)은 공기가 전자 디스플레이 장치의 열 발생 부품(일례로, 디스플레이 스택(80)과 백라이트 어셈블리(140))를 강제로 통과하도록 하여 디스플레이 장치 전체의 냉각 능력을 추가로 개선할 수 있다. 본 실시형태는 아래에서 상세하게 논의되는 수축 대류 냉각 방법과 조합될 수 있음에 주목해야 한다. 가열된 배기 공기는 디스플레이 하우징(70) 상에 위치하는 하나 또는 그 이상의 작은구멍(aperture)(179)을 통해 빠져나갈 수 있다.
- [0035] 고립 가스 가열 시스템(isolated gas heating system)
- [0036] 전술한 바와 같이, 고립 가스 시스템은 전자 디스플레이 장치를 가열하는 데에도 사용될 수 있다. 도 11 및 도 12를 참조하면, 가열 요소들(220)이 제2 가스 챔버(40) 내에 위치할 수 있으며, 가스가 제2 가스 챔버(40)를 통과할 때에 가스를 대우도록 작동한다. 이들 가열 요소들은 관용될 수 있는 많은 가열 요소들 또는 열전기 모듈들 중 어느 하나일 수 있다. 여러 번, 이들 요소들은 단순히 전기 저항이 큰 소재일 수 있으며, 이에 따라 전류가 이들 요소들을 흐를 때에 열을 발생하게 된다. 가열 요소들은 다음의 요소들 중 어느 하나일 수 있지만, 이들만으로 한정되는 것은 아니다: 니크롬 와이어 또는 리본, 세라믹 절연 금속(일반적으로 강) 플레이트 상에 적층된 스크린 프린트 금속/세라믹 트랙, CalRod(일반적으로 터프 금속 셀 내에 세라믹 막안드가 밀봉되어 있는 니크롬 미세 코일), 히트 램프 및 저항 세라믹 PTC(positive thermal coefficient).
- [0037] 전술한 바와 같이, 플레넘(45)은 전자 디스플레이 장치에 전원을 공급하고 제어하는 전기 부품들(200)을 포함할 수 있다. 상기 전기 부품들은 변압기, 마이크로프로세서, 인쇄회로기판, 전원장치, 레지스터, 모터, 와이어 하니스 및 커패시터들 중 어느 하나일 수 있다. 전기 부품들(200)용 전기 연결은 플레넘(45) 벽을 관통할 수 있다. 상기 전기 부품들(200)은 플레넘(45) 내의 어느 곳에도 위치할 수 있다. 전기 부품들(200)은 상기 플레넘의 전방면 또는 후방면 상에 장착될 수 있고, 플레넘 표면 위에 바로 장착되거나 마운팅 포스트에 의해 현가되어 가스가 상기 부품의 모든 불레투위를 지나갈 수 있게 할 수도 있다.

- [0038] 디스플레이 장치가 작동하는 동안, 고립 가스 냉각 시스템이 연속적으로 작동할 수 있다. 그러나, 필요하다면, 온도 센서(미도시)와 스위치(미도시)가 전자 디스플레이 장치 내에 통합될 수 있다. 이에 따라, 온도가 사전에 결정된 문턱값에 도달했는지를 감지하고, 디스플레이 장치 내의 온도가 사전에 결정된 온도에 도달한 경우에 고립 가스 시스템이 선택적으로 작동하도록, 서모스탯(thermostat)이 사용될 수 있다. 사전에 미리 결정된 문턱 온도(threshold temperature)가 선택되고, 고립 가스 시스템이 디스플레이 장치를 가열, 냉각 또는 가열과 냉각 모두를 수행하도록 구성되는 것이 디스플레이 장치를 용인할 수 있는 온도 범위 내에서 유지하는 데에 유리하다.
- [0039] 선택적 절연체 겹을 구비한 선형 편광판(linear polarizer with optional insulator gap)
- [0040] 도 13은 다른 열 제어 피치를 위한 다른 예시적 실시형태의 단면도이다. 도시된 장치에서, 전방판(90)과 제2 전방판(130)은 유리로 이루어질 수 있으며, 서로 라미네이트되어 있다. 제1 및 제2 전방 패널(90, 130)은 인덱스 정합형 광학 접착제(201) 층에 의해 서로가 고정되어 전방 글라스 유닛(206)을 형성할 수 있다. 디스플레이 스택(80)은 전방 편광판(216)과 후방 편광판(214) 사이에 개재되어 있는 액정 어셈블리(212)를 포함할 수 있다. 다른 실시형태에서, 상기 디스플레이 스택(80)은 다른 유형의 전자 디스플레이 장치용의 다른 종류의 어셈블리일 수 있다. 디스플레이 스택(80)과 전방 글라스 유닛(206) 사이의 공간은 절연체 겹(300)을 확장한다. 상기 절연체 겹(300)은 상기 LCD 스택(80)과 상기 전방 글라스 유닛(206)을 열 격리시킨다. 이러한 열 격리는 태양광이 LCD 스택에 부하를 가하기보다는 열이 전방 글라스 유닛 위로만 국한되도록 한다. 고립 가스 시스템과 조합하여 사용되는 경우, 상기 절연체 겹(300)은 제1 가스 챔버(30)를 포함할 수 있다. 다른 실시형태에서, 절연체 겹(300)은 고립 가스 시스템을 사용하지 않으면서 단순히 태양광 부하와 주위 공기 모두로부터 절연시키는 절연층으로 사용될 수 있다.
- [0041] 제2 전방 패널은 제1 표면(202)과 제2 표면(208)을 구비할 수 있다. 상기 제1 표면(202)은 요소들에 노출될 수 있는 반면, 제2 표면(208)은 상기 인덱스 정합형 광학 접착제(201)에 의해 제1 전방판(90)에 고정될 수 있다. 상기 제1 전방판(90)은 제3 표면(209)과 제4 표면(204)을 구비할 수 있다. 제3 표면(209)은 상기 인덱스 정합형 광학 접착제(201)에 의해 제2 전방판(130)에 고정될 수 있는 반면, 제4 표면은 절연체 겹(300)에 직접적으로 인접할 수 있다. 일부 실시형태에서, 디스플레이 스택(80)에 대한 태양광 부하를 줄이고 영상 화질을 개선하기 위해, 상기 제1 표면(202)과 제4 표면(204) 위에 반사방지 코팅이 부착될 수 있다. 다른 실시형태에서, 반사방지 코팅은 상기 제1, 제2, 제3 또는 제4 표면(202, 208, 209, 204)들 중 적어도 어느 하나의 표면에만 부착될 수도 있다.
- [0042] 도 14는 전방 글라스 유닛(206)의 다른 예시적 실시형태의 단면도이다. 도시된 장치에서, 전방 글라스 유닛(206)은 제2 전방판(130), 인덱스 정합형 광학 접착제 층(201), 선형 편광판(400) 및 제1 전방판(90)을 포함한다. 상기 선형 편광판(400)은 적어도 하나의 제1, 제2, 제3 또는 제4 표면(202, 208, 209, 204) 각각에 접촉될 수 있다. 반사방지 층들이 적어도 하나의 제1, 제2, 제3 또는 제4 표면(202, 208, 209, 204) 각각에 부착될 수 있다. 전방 글라스 유닛(206)에 선형 편광판(400)을 포함시키면, 디스플레이 스택(80)에 대한 태양광 부하를 추가로 줄일 수 있다. 태양광 부하의 감소는 전자 디스플레이 장치 내부 온도를 상당히 감소시킬 수 있다. 선형 편광판(300)은 또한 전방 글라스 유닛(206)과 디스플레이 스택(80)의 기울 반사도 감소시킬 수 있다. 전술한 바와 같이, 고립 가스 시스템과 조합하여 사용되는 경우, 절연체 겹(300)은 제1 가스 챔버(30)를 포함할 수 있다. 다른 실시형태에서, 절연체 겹(300)은 상기 고립 가스 시스템을 사용하지 않고 단순히 태양광 부하와 주위 공기 모두로부터 격리시키는 절연층으로 사용될 수 있다. 상기 디스플레이 스택(80)은 LCD 스택일 수 있고, 또한 디스플레이 스택(80)은 다른 유형의 전자 디스플레이 장치일 수도 있다는 점을 인지해야 한다.
- [0043] 또한 제2 전방판(130)이 사용되지 않을 수도 있다는 점을 인식해야 한다. 실시형태들은 전방판(90)의 전방면 또는 후방면에 선형 편광판이 부착되어 있는 제1 전방판(90)만을 사용할 수도 있다. 반사방지 층이 상기 전방판(90)의 전방면 또는 후방면에 부착될 수도 있다. 제2 전방판(130)없이 전방판(90)만을 사용하는 경우, 강도를 추가로 증가시키기 위해 전방판(90)을 템퍼링할 수 있다.
- [0044] 수축 대류(constricted convection)
- [0045] 가시 스크린 상에 화상을 형성하기 위해, 일부 종류의 전자 디스플레이 장치는 백라이트 어셈블리를 필요로 한다. LCD는 백라이트 어셈블리를 필요로 하는 디스플레이 장치 중의 하나이다. 플라스마 디스플레이 및 OLED와 같은 다른 유형의 디스플레이 장치는 이들 자체가 발광하기 때문에, 백라이트 어셈블리를 필요로 하지 않는다. 그러나, 이러한 종류의 디스플레이 장치는 여전히 상당한 양의 열을 발생한다. 따라서, 전술한 사항에서, 백라이트 어셈블리와 관련하여 수축 대류 시스템을 기재하지만, 상기 실시형태들이 다른 종류의 디스플레이 장치에

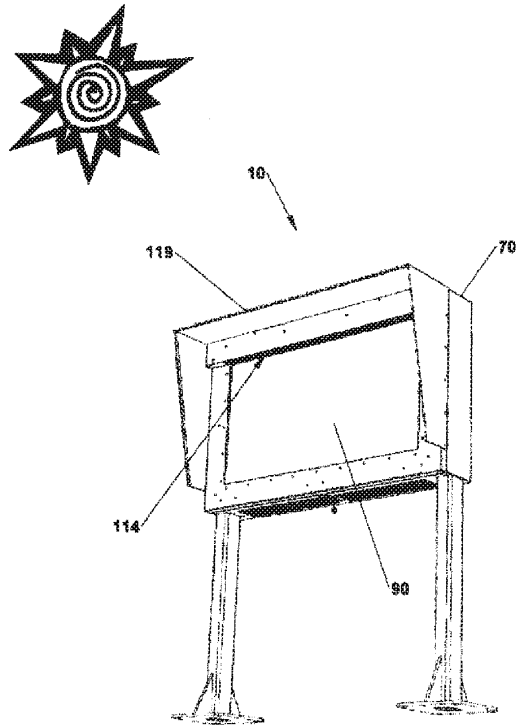
- 서도 사용될 수 있다는 점을 인식해야 한다. 따라서, 백라이트 또는 백라이트 어셈블리에 대해 논의할 때, 이들 어셈블리들은 다른 열-발생 디스플레이 장치의 후방면일 수도 있고, 상기 수축 대류 시스템은 이들 다른 디스플레이 장치를 보다 효율적으로 냉각시킬 수도 있다. 도 15a 및 도 15b와 도 17a 내지 도 17c는 축척에 맞추어 도시된 것이 아님을 알아야 한다. 요소들 간의 관계는 설명의 목적으로 과장되어 있을 수 있다.
- [0046] 도 15a는 수축 대류관(300)과 백라이트(140)의 단면도로, 이들 물체들 사이의 공간은 좁은 갭(305)을 형성한다. 상기 갭의 크기는 디스플레이 장치의 크기, 디스플레이 장치의 작동 조건, 백라이트 어셈블리와 그 후방면 소재의 종류, 및 다양한 수축 대류 팬의 수량과 어들에 공급되는 전력량을 포함하는 여러 요인들에 따라 변할 수 있다. 일부 예시적 실시형태들은 약 0.25-3.5 인치의 갭 거리를 사용할 수 있다. 다른 실시형태들은 이보다 좀 더 큰 갭을 사용할 수 있다. 상기 갭(305)을 통한 공기의 강제 송풍은 백라이트(140)의 냉각 능력을 증가시킨다는 것을 알 수 있었다. 상기 갭(305)을 통해 공기를 빨아들이기 위해 하나 또는 그 이상의 수축 대류 팬(310)이 사용될 수 있다. 도 15b는 상기 갭(305)을 통해 공기를 밀어 넣기 위해 하나 또는 그 이상의 수축 대류 팬(310)이 사용되는 수축 대류 시스템에 대한 다른 실시형태의 단면도이다.
- [0047] 도 16은 전술한 코립 가스 시스템의 평면도이다. 상기 코립 가스 시스템을 관통하는 단면라인 17-17'이 도시되어 있다.
- [0048] 도 17a 내지 도 17c는 도 16에 도시되어 있는 17-17' 부분의 단면을 도시한다. 먼저 도 17a를 참조하면, 전자 디스플레이 장치(80)와 연결하고 있는 제1 가스 챔버(30)가 디스플레이 장치의 전방을 향하고 있다. 상기 제1 가스 챔버(30)의 앞쪽에는 전방판(90)이 있다. 디스플레이 장치의 후방부에서, 백라이트(140)가 제2 가스 챔버(40)와 근접하게 배치되어 있다. 본 장치에서, 제2 가스 챔버(40)의 외벽은 수축 대류관으로 기능한다. 본 실시형태는 수축 대류 팬을 사용하지 않는 대신에 상기 디스플레이 장치 하우징의 외부로부터 공기를 빨아들여 그 공기를 제2 가스 챔버(40)의 표면으로 강제 송풍시키는 팬(60)을 사용하고 있다. 전술한 바와 같이, 이 공기는 단순히 주위 공기이거나 선택적으로는 공기조화 장치(미도시)에서 나온 공기일 수 있다. 백라이트(140)와 냉각 챔버(40) 사이에서의 공기 흐름을 용이하게 하기 위해, 가이드 장치(320)가 사용될 수 있다.
- [0049] 도 17b를 참조하면, 냉각 챔버(40)는 가이드 피쳐(41)를 포함한다. 가이드 피쳐(41)는 상기 가이드 장치(320)와 함께 조합되어 백라이트와 냉각 챔버 사이에서의 공기 흐름을 용이하게 한다. 도 17c는 외부 팬(60)과 수축 대류 팬(310) 모두가 사용되는 선택적 실시형태를 나타낸다. 이 실시형태는 또한 도 17a 및 도 17b에 도시된 가이드 장치들을 사용할 수도 있다.
- [0050] 백라이트(140)는 전자 디스플레이 장치(80)와 대면하는 사이드에 장착되는 복수의 라이트를 구비한 인쇄회로기판(PCB)을 포함할 수 있다. 상기 백라이트 내의 상기 라이트들은 LED, 유기발광 다이오드(OLED), 전계 방출형 디스플레이(FED), 발광 폴리머(LEP: light emitting polymer) 또는 유기 전계 발광(OEL) 라이트 중 어느 하나일 수 있다. 예시적 실시형태에서, 백라이트(140)는 전자 디스플레이 장치(80)와 대면하는 사이드의 제2 가스 챔버와 대면하는 사이드 사이의 열 저항이 작은 것이 이상적이다. 이와 같이 낮은 레벨의 열 저항을 달성하기 위해, 금속 인쇄회로기판(PCB) 기술로 백라이트(140)를 구성하여 상기 라이트들로부터 더 많은 열을 방출시킬 수 있다. 대류 열전달 특성을 추가로 향상시키기 위해, 백라이트(140)의 후방면은 금속 또는 다른 열전도성 소재일 수 있다. 상기 표면은 대류 열전달 특성을 추가로 개선하기 위해 핀(fin)과 같은 복수의 표면 피쳐들을 구비할 수 있다. 수축 대류 팬(310)은 더운 공기를 배출구(179)(도 2에 도시)를 통해 내보냄으로써 공기가 디스플레이 장치를 완전히 빠져나가게 된다.
- [0051] 디스플레이 장치가 작동하는 중에, 외부 팬(60)과 수축 대류 팬(310)도 연속적으로 작동할 수 있다. 그러나, 원하는 경우, 온도 센서(미도시)와 스위치(미도시)가 전자 디스플레이 장치 내에 통합되어 있을 수 있다. 온도가 사전에 결정된 문턱값에 도달했는지를 감지하기 위해 효과적인 서모스탯이 사용될 수 있다. 이러한 경우, 디스플레이 장치 내의 온도가 사전에 결정된 값에 도달했을 때에, 여러 팬들이 선택적으로 작동할 수 있다. 디스플레이 장치가 용인가능한 온도 영역 내에 유지되도록 하기 위해, 문턱값이 사전에 선택되고, 시스템은 서모스탯(미도시)을 구비하여 구성되는 것이 유리하다. 이는 장치의 사용 수명에 유용할 뿐만 아니라, 에너지 비용도 절감시킨다.
- [0052] 에어 커튼(air curtain)
- [0053] 전술한 다양한 열 조절 피쳐들 외에도, 에어 커튼이 사용될 수도 있다. 에어 커튼 장치는 장치 단독으로 사용되거나, 전술한 다른 임의의 열 제어 피쳐들과 조합하여 사용될 수 있다.
- [0054] 도 18은 하우징(70)과 전방판(90)을 구비하는 전자 디스플레이 장치(10)를 도시한다. 에어 커튼용 에어 배플

- (air baffle)(114)이 상기 도면에서 파선으로 도시되어 있다. 단면 라인 19-19도 도시되어 있다.
- [0055] 도 19는 도 18에 도시되어 있는 라인 19-19를 따르는 단면도이다. 이 도면은 팬(60)이 기동할 때에 이루어지는 하우징(70)을 통한 공기의 순환을 보여주고 있다. 전술한 바와 같이, 팬(60)은 인입구(51)를 통해 공기를 하우징(70) 내로 빨아들인다. 이 공기는 주위 공기일 수 있으며, 선택적으로는 공기 조화된 공기일 수 있다. 빨아들여진 공기의 유동 방향이 화살표 121로 표시되어 있다. 상기 디스플레이 하우징(70) 내에서, 공기는 화살표(121)를 따라 위쪽으로 유동한다. 이 공기는 전술한 열 제어 피쳐들 중 어느 하나와 함께 사용될 수 있다. 일례로, 공기는 제2 챔버(플래닛) 내의 고압 가스를 냉각하는 데에 사용되거나 전술한 수축 배류 시스템에서 사용될 수도 있다.
- [0056] 설명의 목적으로, 디스플레이 장치의 내부 부품들에 대한 상세한 사항은 도면에 기재하지 않았으며, 단지 캐비티(61)만을 도시하였다. 에어 커튼이 다른 어떠한 유형의 전자 디스플레이 장치에서 실시될 수 있으며, 전술한 열 제어 피쳐들과 조합되어도 실시될 수 있다는 점을 주목해야 한다. 공기가 배플(114)을 향해 흐르도록 하기 위해, 캐비티(61) 내에 여러 내부 피쳐들(미도시)이 배치될 수 있다. 빨아들여진 공기는 화살표(121)를 따라 캐비티(61)를 관통해 연속 유동해서 배플(114)에 도달한다. 배플(114)은 공기를 디스플레이 장치의 외부면 쪽으로 지향시킨다. 이 외부면은 제1 전방판(90)일 수 있으며, 선택적으로는 위에서 상술한 추가적인 전방판(일례로 제2 전방판(130))일 수 있다.
- [0057] 이에 따라, 에어 커튼은 디스플레이 장치의 내부 부품들을 냉각하기 위한 배출구로 사용될 수 있다. 선택적으로, 에어 커튼으로부터 나오는 차가운 공기는 상당한 태양광 부하를 받거나 또는 주위의 뜨거운 공기로부터 열을 전달받는 디스플레이 장치의 외부 전방면을 추가로 식히는 데에 사용될 수 있다.
- [0058] 유체 냉각 시스템(fluid cooling system)
- [0059] 도 20은 다른 열 제어 피쳐를 설명하는 예시적 개략도이다. 도면으로부터 이해할 수 있는 바와 같이, 냉각 시스템(22)은 유체 연통하는 여러 부품들을 포함한다. 바람직하기로는, 유체 연통은 부품들을 일련의 튜브들 또는 파이프들(개념적으로 설명하기 위해 점선으로 표시)로 연결함으로써 달성된다. 냉각 시스템(22) 부품들은 유체 연통하는 저장 탱크(37), 펌프(47) 및 냉각 챔버(4)를 포함한다. 바람직하기로는, 상기 시스템은 역시 유체 연통하는 필터(83)와 라디에이터(72)도 포함한다. 선택적으로, 상기 시스템은 팬 유닛(94)을 포함한다. 그러나, 선택적 팬 유닛은 다른 부품들과는 유체 연통하지 않는 것이 바람직하다.
- [0060] 저장 탱크(37)는 냉각 유체의 대부분의 양을 보유하며, 냉각 유체가 탱크(37) 내에 저장되어 있는 동안에 유체로부터 열 방출을 수행하는 표면을 제공한다. 상기 탱크는 출구포트(3)와 복귀포트(14)의 적어도 2개의 개구부를 구비한다. 선택적으로, 저장 탱크는 환기포트(66)를 포함한다. 펌프(47)는 냉각 유체가 시스템(22)을 관통해서 이동하도록 한다. 통상의 기술자라면 이해할 수 있는 바와 같이, 펌프(47)는 적당한 성과를 얻기 위해 냉각 유체 동로를 따라 복수의 지점에 위치할 수 있다. 그러나 플레이트들(44, 128)의 곡률을 최소화하기 위해서는, 냉각 챔버(4) 뒤에 펌프(47)를 배치하여, 펌프가 냉각 챔버(4)의 바닥에서 상부로 액상 냉각제를 끌어올리도록 하는 것이 바람직하다. 펌프가 이와 같이 배치되면 상기 펌프는 냉각 챔버(4)의 상부에 저가압 영역을 생성할 수 있다. 이러한 방식으로, 유체는 화살표를 따라 냉각 챔버(4)를 통해 유동한다. 일부 냉각 유체들은 "미끄러짐성"(slipperiness)이 있기 때문에, 펌프(47)는 용적식 펌프(positive displacement pump)인 것이 바람직하다.
- [0061] 냉각 챔버를 통과하는 냉각 유체의 유량을 조절하기 위해, 밸브(634)를 구비하는 바이패스 라인이 제공될 수 있다. 상기 바이패스 라인은 냉각 유체가 냉각 챔버(4)를 우회하도록 하는 우회루트를 제공한다. 밸브(634)는 바이패스 라인을 통과하여 우회하는 냉각 유체의 양을 용이하게 조절할 수 있다. 바이패스 라인과 밸브(634)는 냉각 챔버(4)를 향해 유동하는 유체로부터 사전에 결정된 양의 냉각 유체가 우회하도록 하여 냉각 챔버 자체를 관통하는 유량을 용이하게 조절할 수 있게 된다. 이러한 방식으로, 냉각 챔버를 통과하는 유량이 조절된다.
- [0062] 통상의 기술자라면 냉각 챔버를 통과하는 유동을 조절하기 위해 다른 방법 및 장치들이 사용될 수 있다는 점을 이해할 수 있을 것이다. 일례로, 펌프(47)의 크기와 펌프 속도는 주어진 환경에 따라 최적화될 수 있다. 선택적으로, 가변 속도 펌프가 사용될 수도 있다. 바람직하기로는, 가변 속도 펌프는 적어도 하나의 압력 트랜스듀서(미도시)와 전기적으로 연동되어 있다. 바람직하기로는, 압력 트랜스듀서는 냉각 챔버(4)의 상류부에 위치할 수 있고, 다른 압력 트랜스듀서는 냉각 챔버(4)의 하류부에 위치할 수 있다. 상기 적어도 하나의 압력 트랜스듀서에 의해 제공되는 압력 정보는 가변 속도 펌프의 작동 속도를 설정하는 데에 사용될 수 있다. 이러한 방식에 따라, 냉각 챔버(4)를 통과하는 유량이 조절되어, 장치 내에서 적절한 압력이 유지될 수 있다. 냉각 챔버(4) 내에

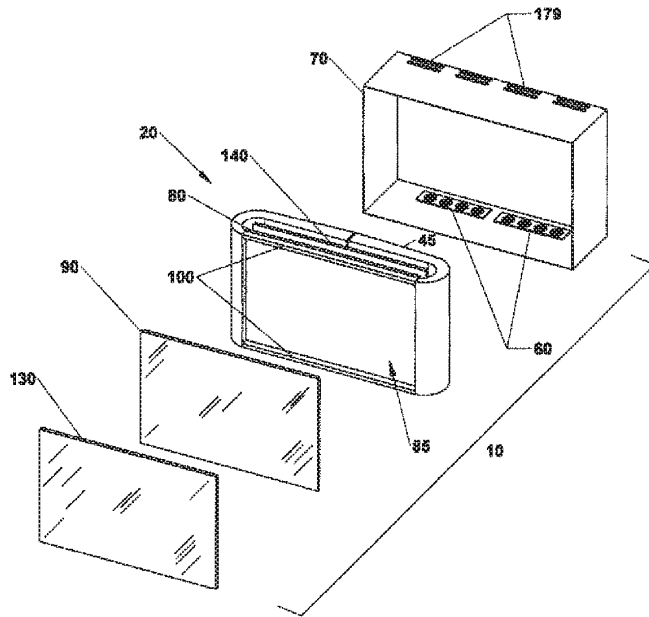
- 서 적절한 압력을 유지하는 것은 디스플레이 글라스의 변형이나 파손을 방지하는 데에 중요하다.
- [0063] 유체 내의 오염물질을 제거하기 위해 선택적 필터(83)가 추가될 수 있다. 바람직하기로는, 보다 큰 열적 안정성을 제공하기 위해 라디에이터(72)와 펌 유닛(94)이 포함될 수도 있다. 선택적으로, 시스템에 냉각 유체를 채우고 시스템에서 냉각 유체를 바꾸는 작업을 용이하게 하기 위해 수도꼭지(spigot)(미도시)가 제공될 수 있다.
- [0064] 작동하는 중에, 유체는 저장 탱크(37)의 아래쪽에 위치하는 출구포트(13)를 통해 저장 탱크(36)를 빠져나간다. 냉각 챔버(4)로 가는 중에, 유체는 선택적 필터(83)를 지나간다. 필터(83)로부터 나온 유체는 매니폴드(59)의 인입구(98)를 통해 다시 냉각 챔버(4)로 들어간다. 냉각 유체는 점선으로 표시된 방향을 따라 냉각 챔버(4)의 유체 격실을 통해 이동한다. 냉각 유체는 상부 매니폴드(60)의 유출구(99)를 통해 냉각 챔버(4)를 빠져나간다. 바람직하기로는, 유체는 선택적 라디에이터(72)에 의해 인입된다. 선택적 라디에이터(72)를 통해 이동하는 중에, 냉각 유체로부터 열을 빼앗는 것을 보조하기 위해, 선택적 펌 유닛(94)이 유체가 라디에이터(72)를 통과하도록 강제한다. 라디에이터(72) 뒤쪽에 위치할 수 있는 펌프(72)가 저장 탱크를 향해 유체를 빨아들인다. 유체는 복귀포트(14)를 통해 저장 탱크(37) 내로 들어간다. 바람직하기로는, 복귀하는 유체가 출구포트(13)를 통해 저장 탱크(37)를 빠져나가기 전에 커다랗게 냉각될 수 있도록 하기 위해, 복귀포트(14)는 출구포트(13)와 상당히 떨어진 곳에 위치할 수 있다.
- [0065] 필요에 따라, 펌 유닛이 디스플레이 장치(15)의 냉각 챔버(4) 바로 위의 하우징(75)의 베이스에 위치할 수 있다. 펌 유닛은 공기 종류가 하우징(75)의 내부를 통과하도록 할 수 있다. 바람직하기로는, 공기유동은 저장 탱크(37)의 적어도 하나의 외부 표면 위로 지향될 수 있다. 전술한 바와 같이, 배기되는 공기 유동은 궁극적으로는 선택적 에어 커튼 시스템(114)에 의해 냉각 챔버 표면(44) 위로 다시 보내질 수 있다.
- [0066] 필요하다면, 온도 센서(미도시)와 스위치(미도시)가 전자 디스플레이 장치 내에 통합될 수 있다. 온도가 사전에 결정된 문턱값에 도달했는지를 감지하기 위해 온도 센서가 사용될 수 있다. 이러한 경우, 디스플레이 장치 내의 온도가 사전에 결정된 온도에 도달한 때에 펌프가 선택적으로 작동될 수 있다. 디스플레이 장치가 비교적 일정한 온도로 유지하거나 적어도 용인할 수 있는 온도 범위 내에서 유지하도록 하기 위해, 소정의 문턱 온도가 사전에 선택되고, 시스템은 서모스탯(미도시)과 함께 구성되는 것이 유리하다. 선택적으로, 서모스탯을 사용하지 않기 위해, 전자 디스플레이 장치가 작동하는 중에 펌프(47)가 연속적으로 작동할 수 있다.

도면

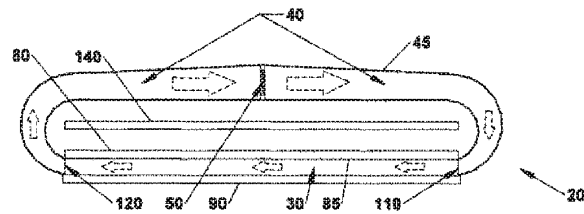
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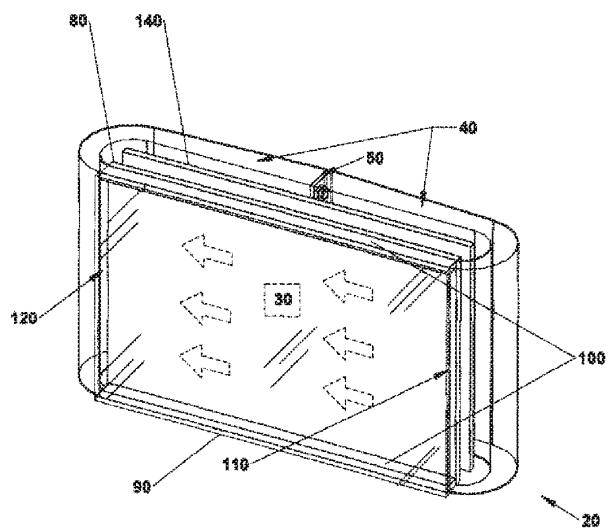
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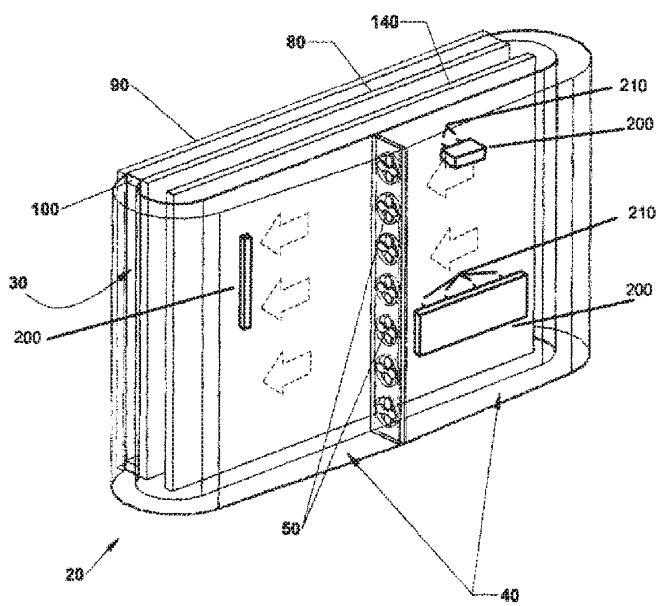
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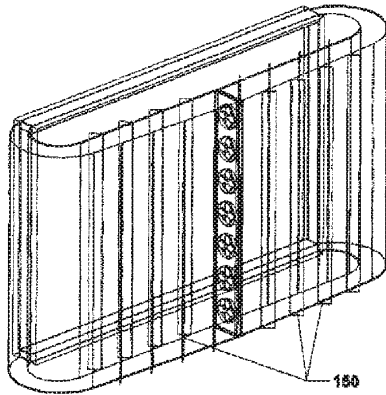
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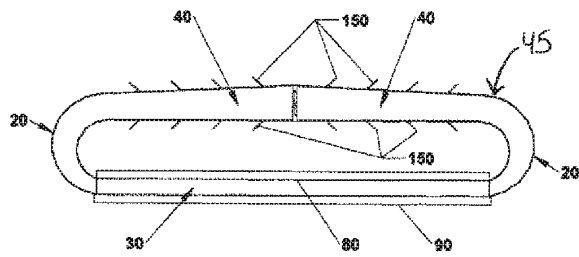
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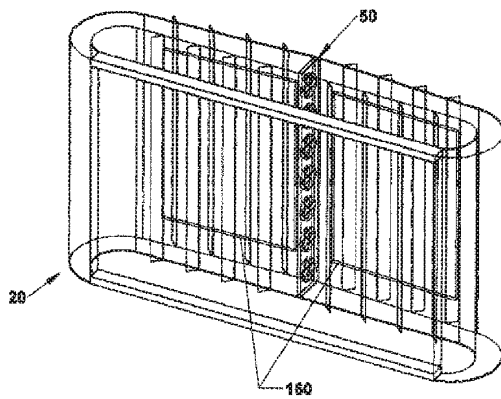
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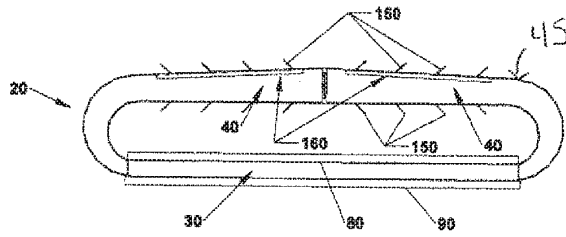
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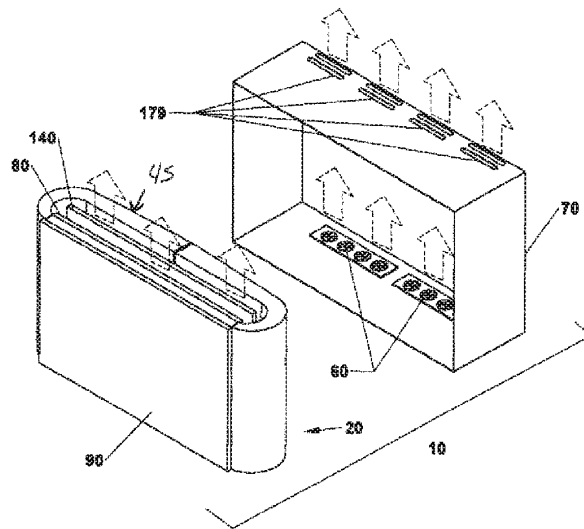
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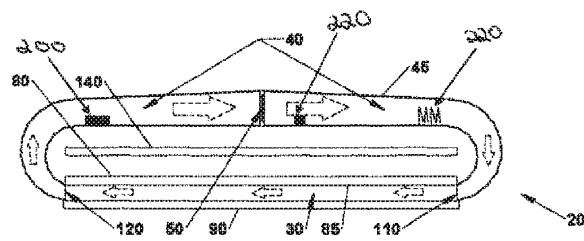
도면9



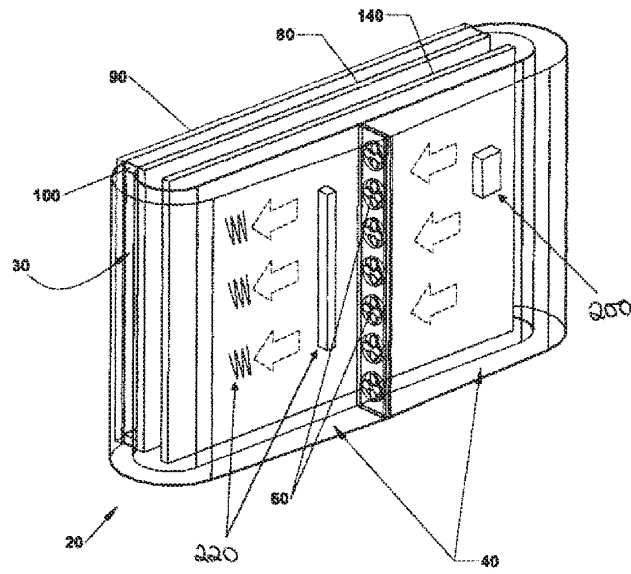
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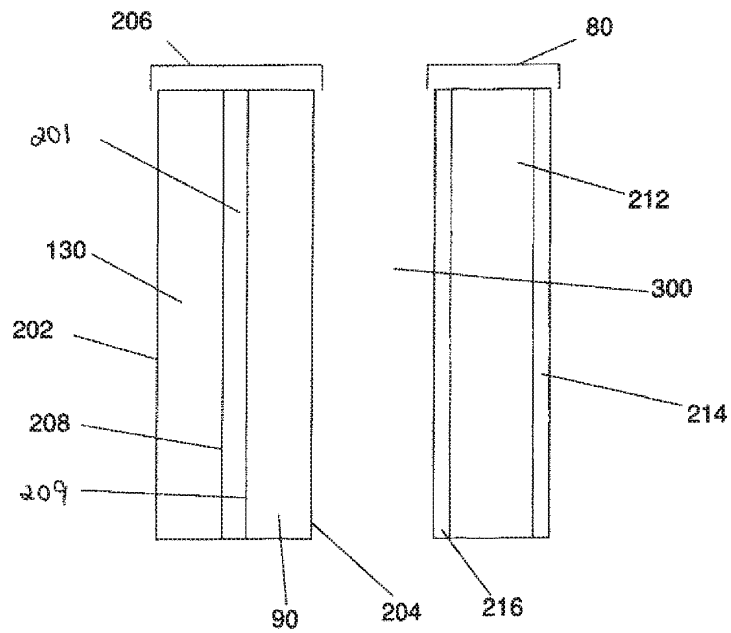
도면11



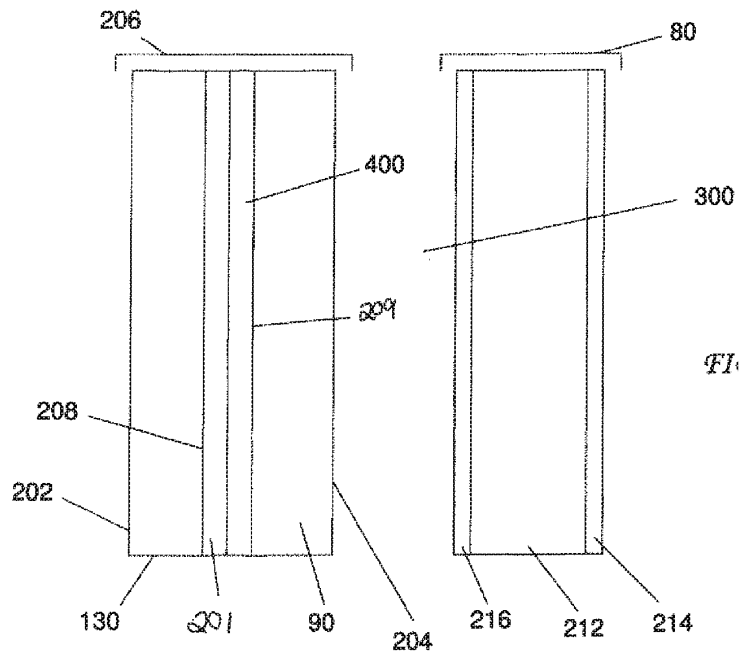
도면12



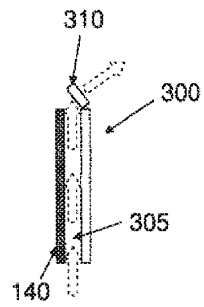
도면13



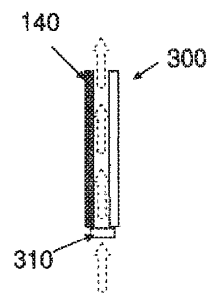
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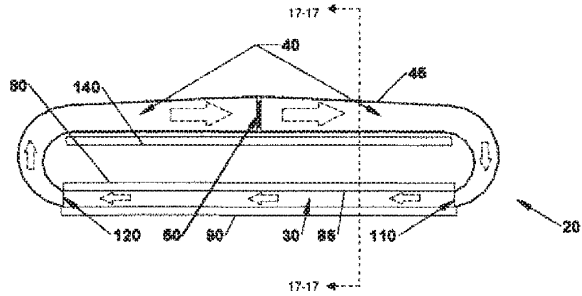
도면15a



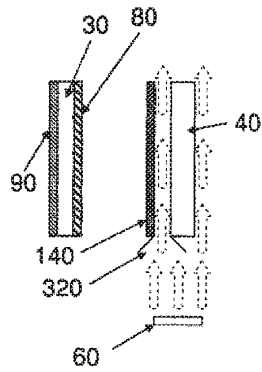
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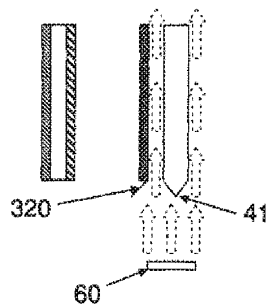
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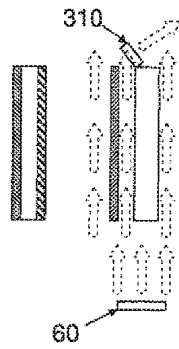
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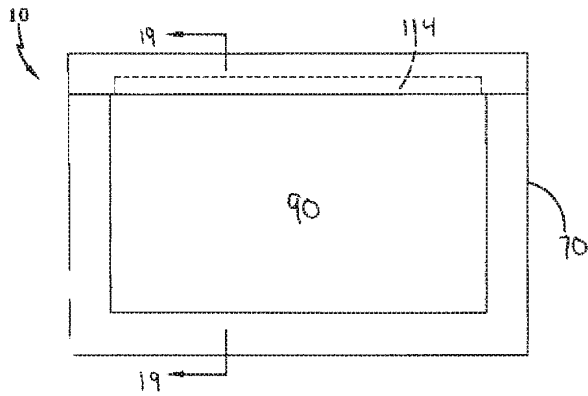
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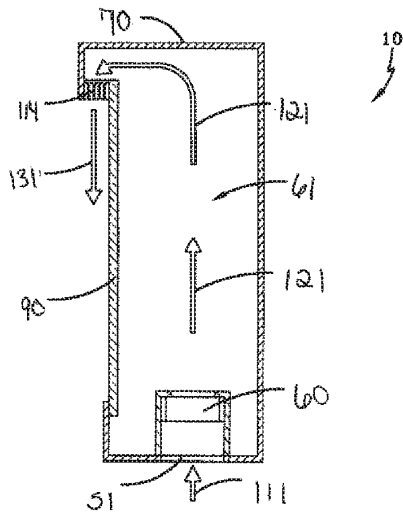
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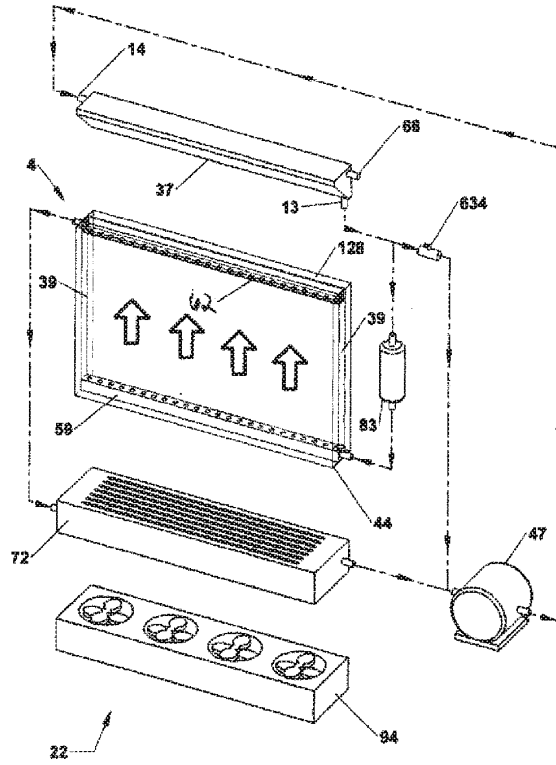
도면18



도면19



도면20



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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): **HUBBARD, Tim** [US/US]; 1600 Union Hill Road, Alpharetta, GA 30005 (US). **DUNN, William** [US/US]; 1600 Union Hill Road, Alpharetta, GA 30005 (US).
- (74) Agents: **STANDLEY, Jeffrey, S.** et al.; Standley Law Group LLP, 6300 Riverside Drive, Dublin, OH 43017 (US).

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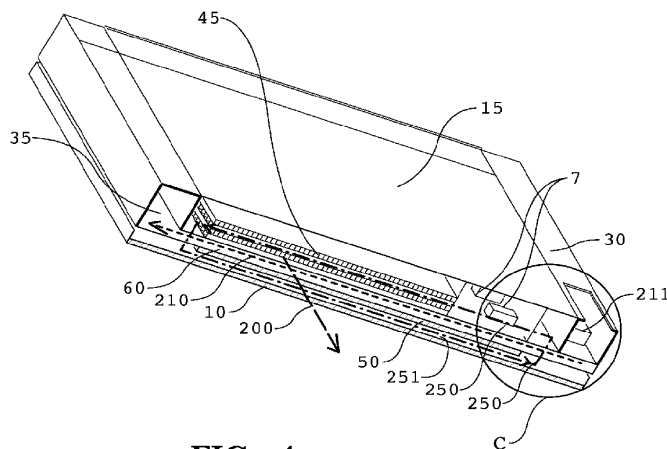


FIG - 4

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

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SYSTEM FOR COOLING AN ELECTRONIC IMAGE ASSEMBLY

Inventors: Tim Hubbard and William Dunn

Technical Field

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

Background of the Art

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

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

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

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

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

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

Summary of the Exemplary Embodiments

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

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

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

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

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

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

Brief Description of the Drawings

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

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

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

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

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

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

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

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

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

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

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

Detailed Description

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CLAIMS

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

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

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

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

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

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

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

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

19. The cooling system of claim 18 wherein:

- the first and second gas pathways are substantially perpendicular.

20. An electronic display assembly comprising:

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

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

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

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

the electronic component is a power module.

35. The cooling assembly of claim 29 wherein:
the heat exchanger is comprised of corrugated layers.
36. The cooling assembly of claim 29 wherein:
the heat exchanger is a cross-flow heat exchanger.
37. An electronic display assembly comprising:
a housing having an inlet aperture and exit aperture for ambient gas;
an electronic image assembly within the housing;
a transparent front plate in front of the electronic image assembly, the space
between the transparent front plate and the electronic image assembly
defining a channel;
a heat exchanger in gaseous communication with the channel, the heat
exchanger comprising two portions, each portion having first and second
gas pathways, where the first gas pathways are in gaseous
communication with the inlet and exit apertures and the second gas
pathways are in gaseous communication with the channel;
a first fan assembly placed between the two portions of the heat exchanger to
force ambient gas through the first gas pathways; and
a second fan assembly positioned to force gas through the channel and the
second gas pathways.
38. The electronic display assembly of claim 37 further comprising:
a power module placed within the path of the circulating gas.
39. The electronic display assembly of claim 37 wherein:
the electronic image assembly is a liquid crystal display.
40. The electronic display assembly of claim 37 wherein:

the electronic image assembly is an OLED display.

41. The electronic display assembly of claim 37 wherein:

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

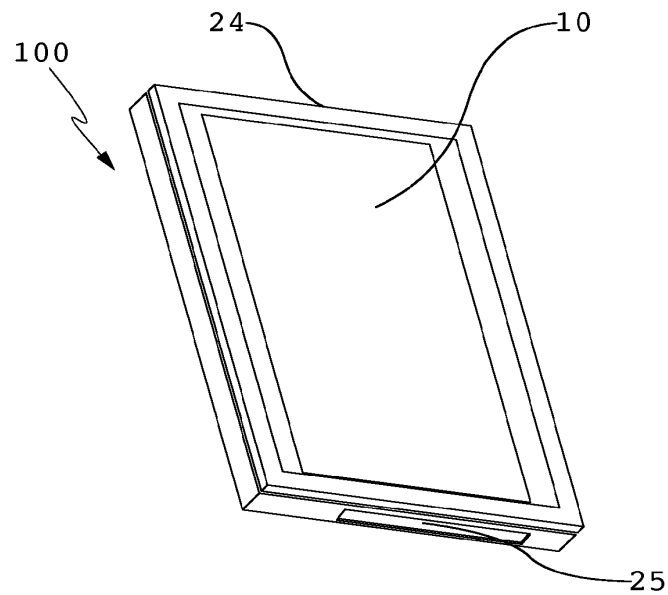


FIG - 1A

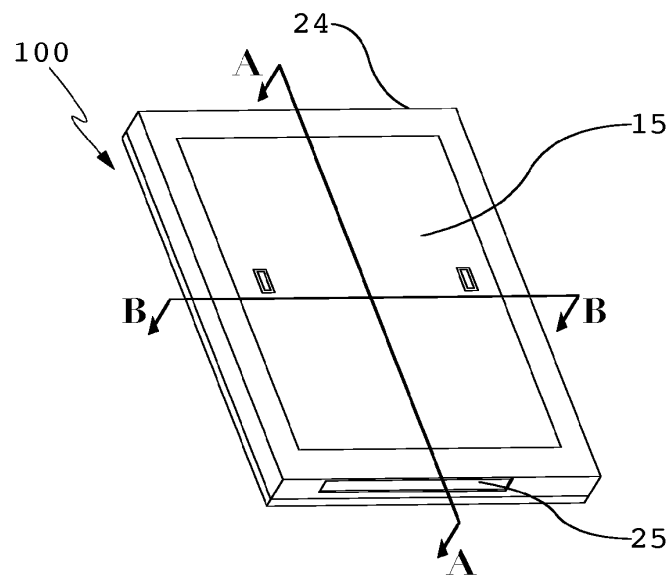


FIG - 1B

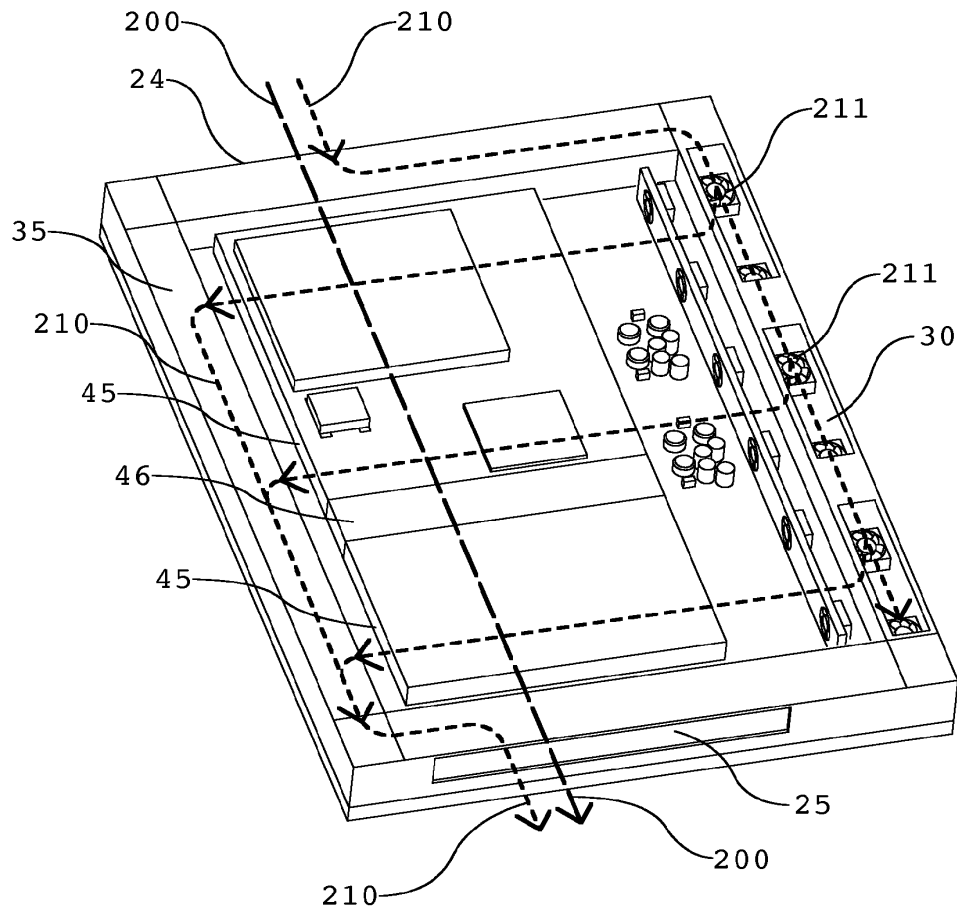
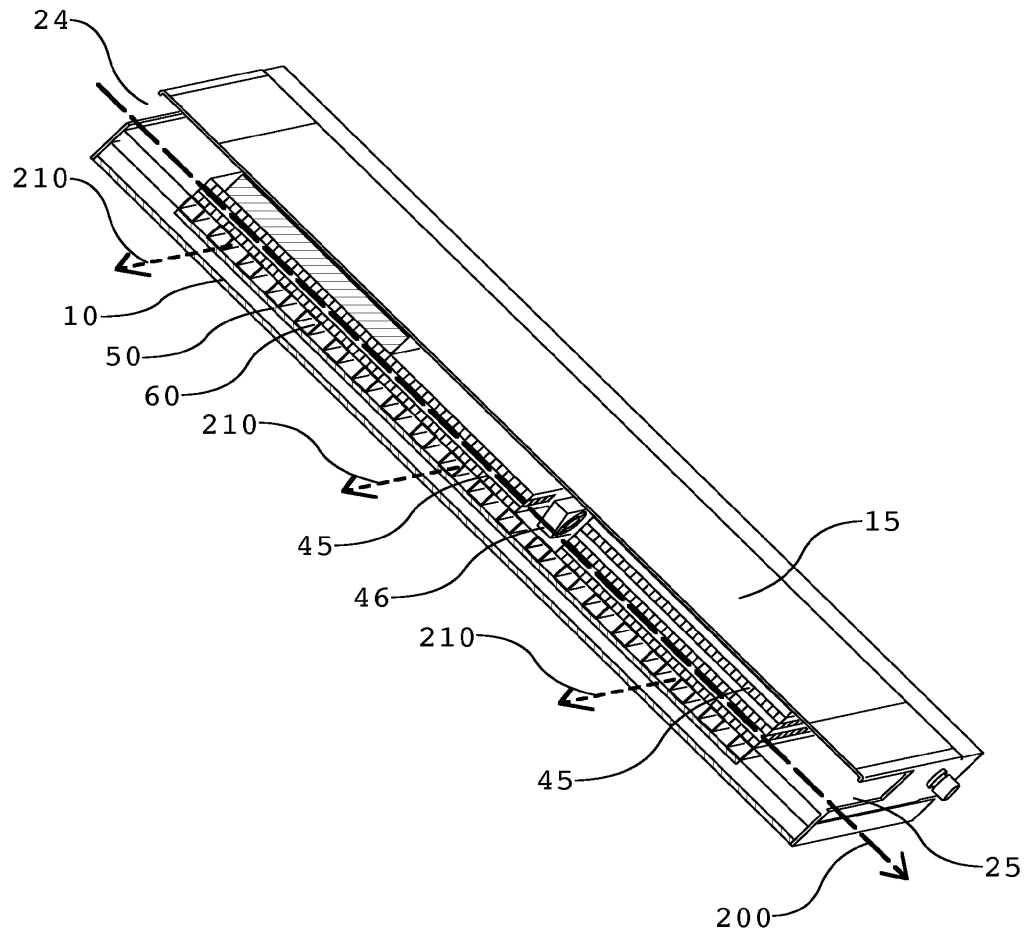


FIG - 2

**FIG - 3**

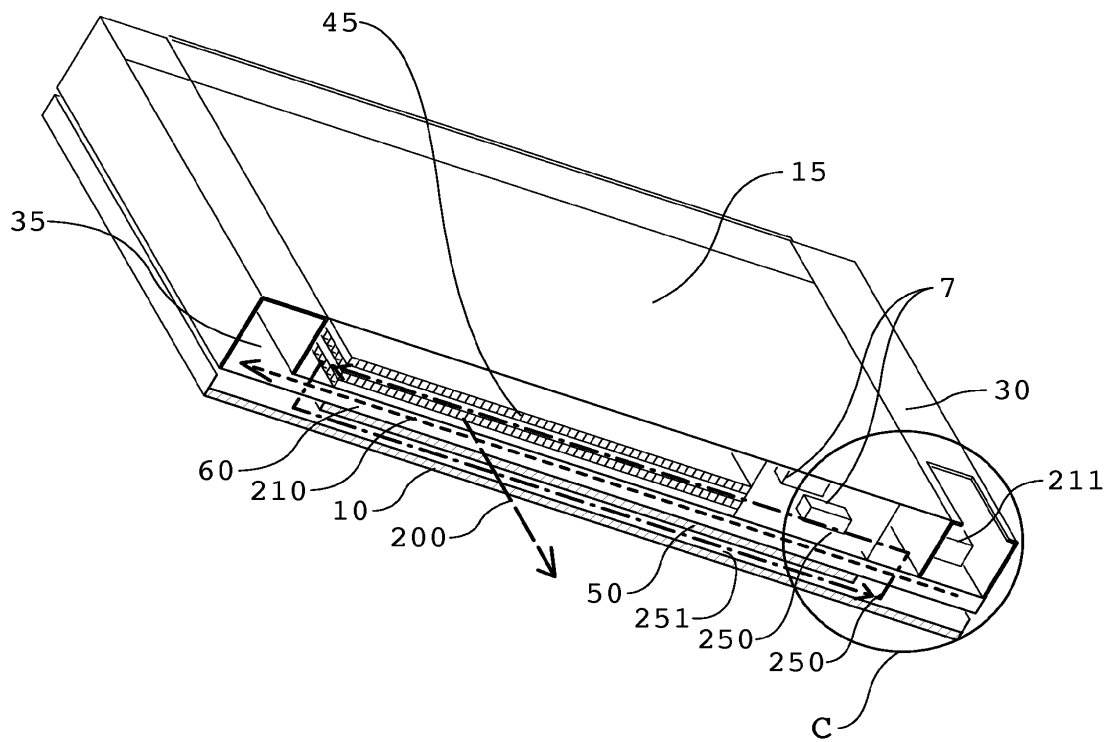


FIG - 4

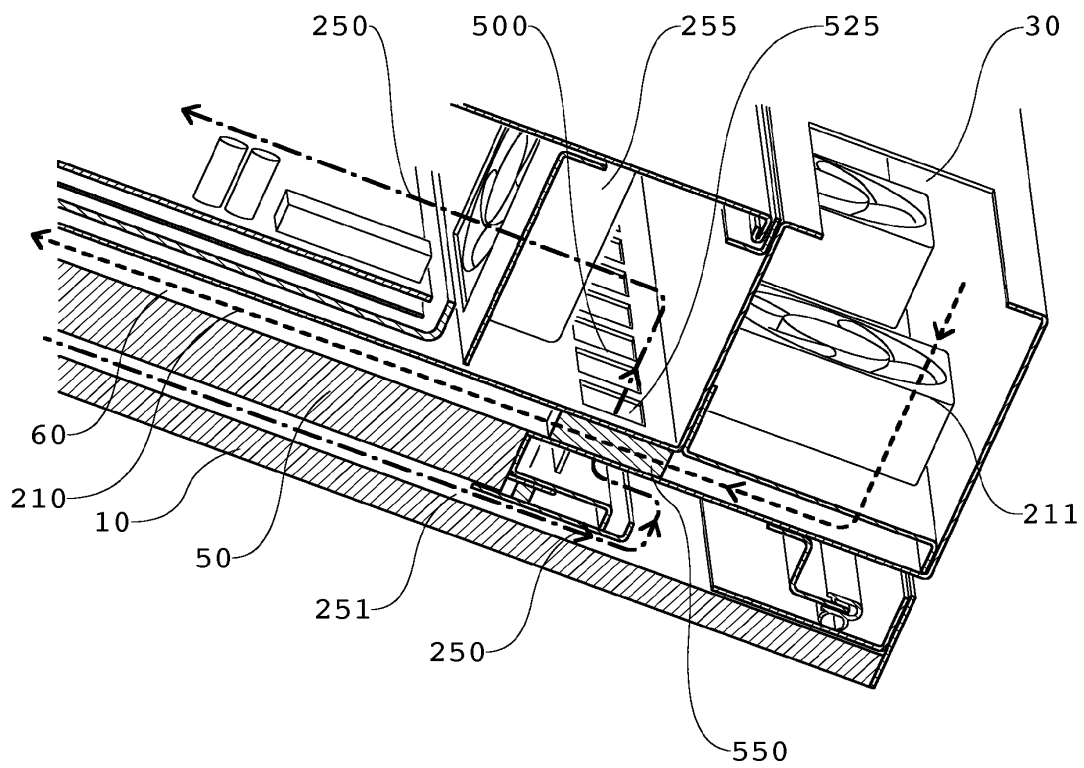


FIG - 5

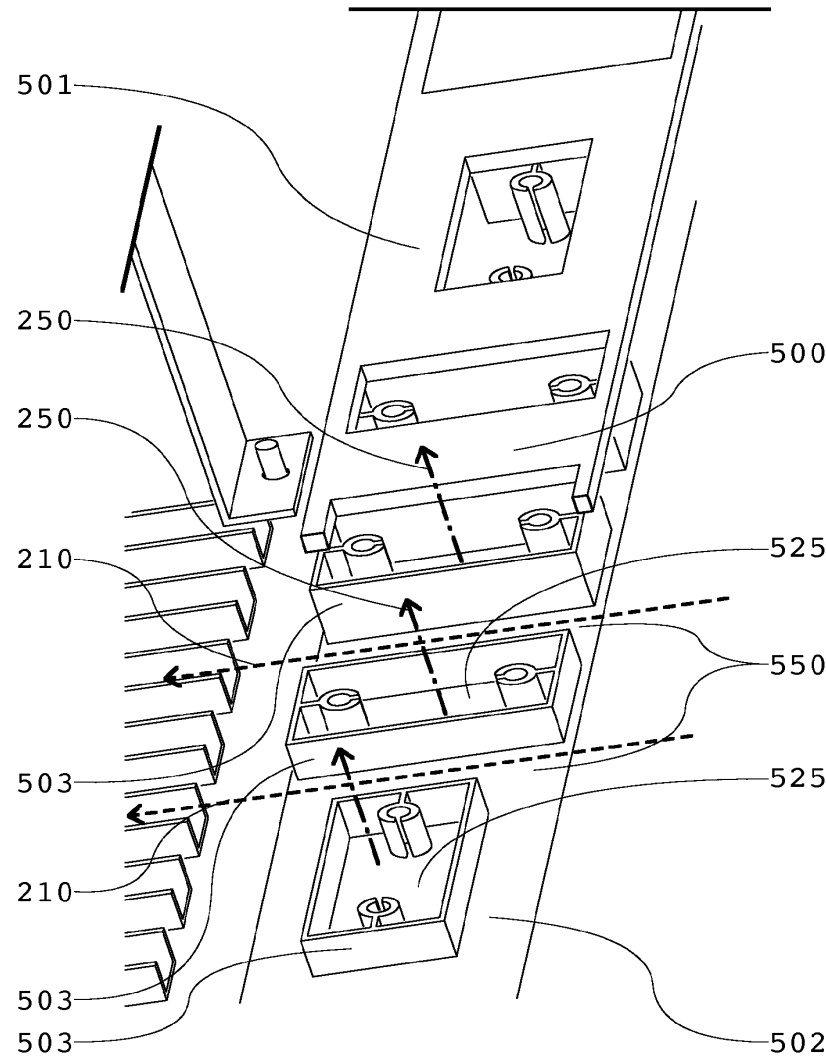


FIG - 6

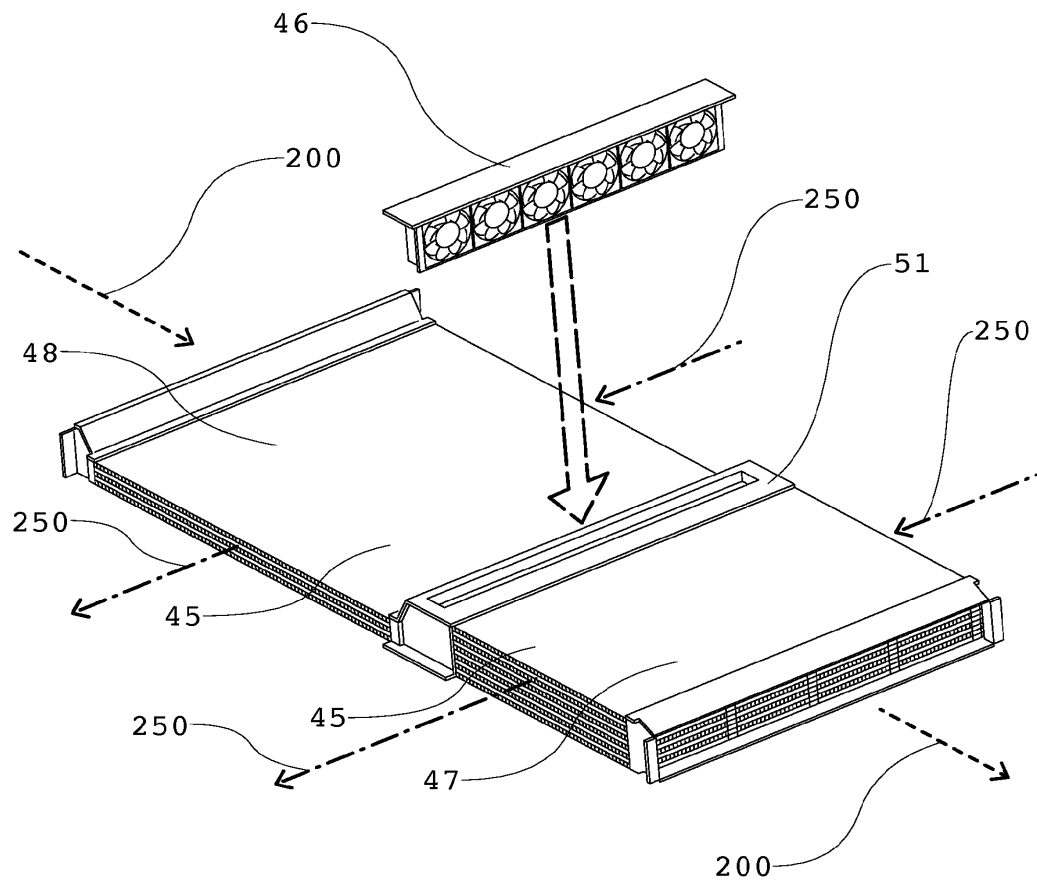


FIG - 7

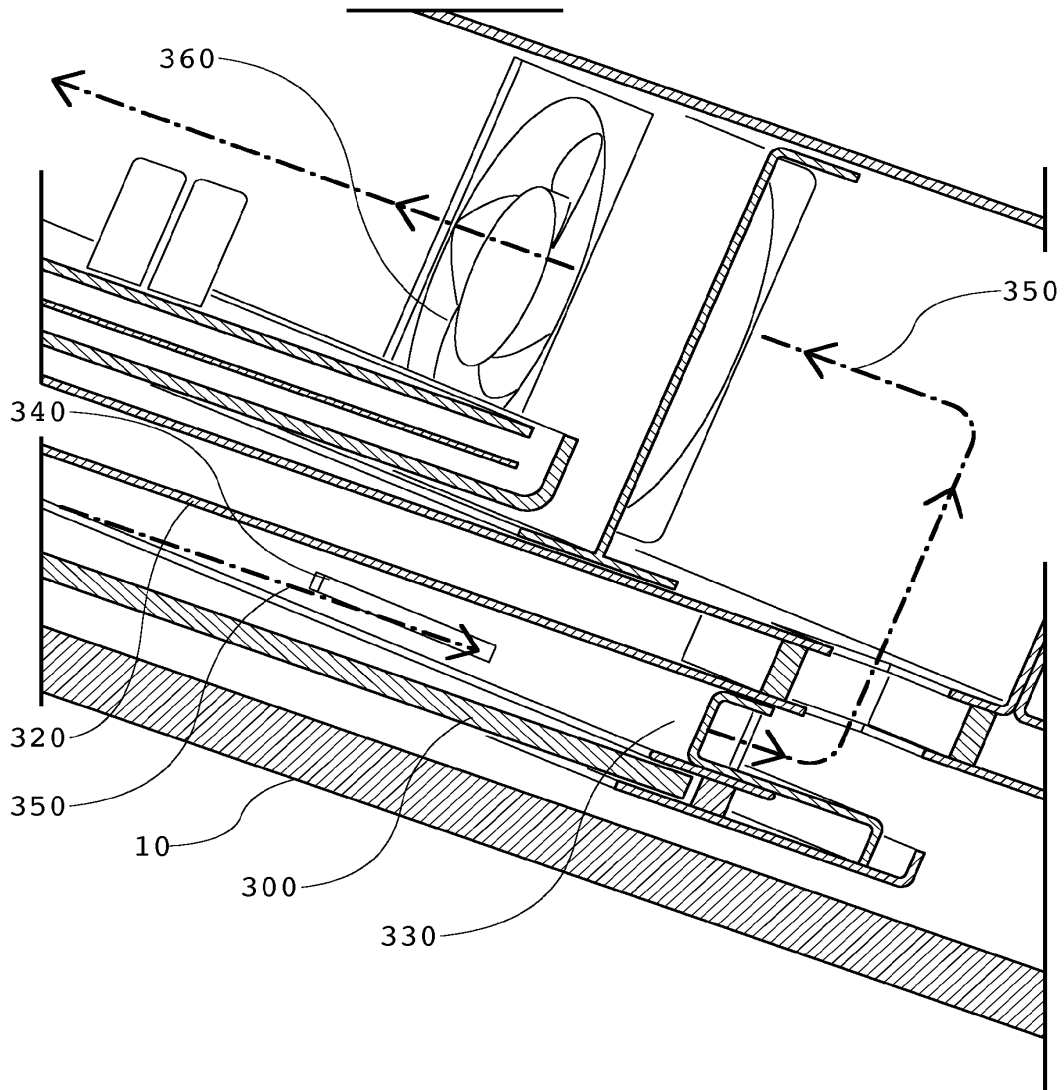


FIG - 8

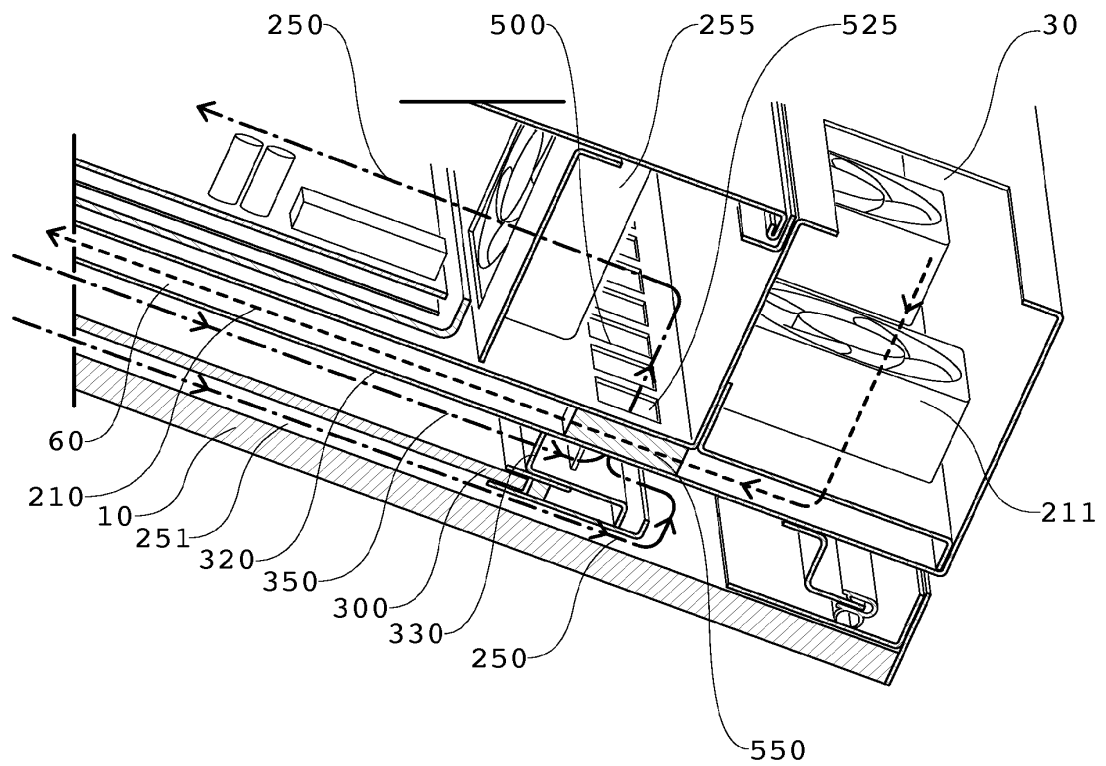


FIG - 9

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(74) Agents: STANDLEY, Jeffrey, S. et al.; Standley Law Group LLP, 6300 Riverside Drive, Dublin, OH 43017 (US).

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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). SWATT, Bill [US/US]; 1600 Union Hill Road, Alpharetta, GA 30005 (US). HUBBARD, Tim [US/US]; 1600 Union Hill Road, Alpharetta, GA 30005 (US).

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[Continued on next page]

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

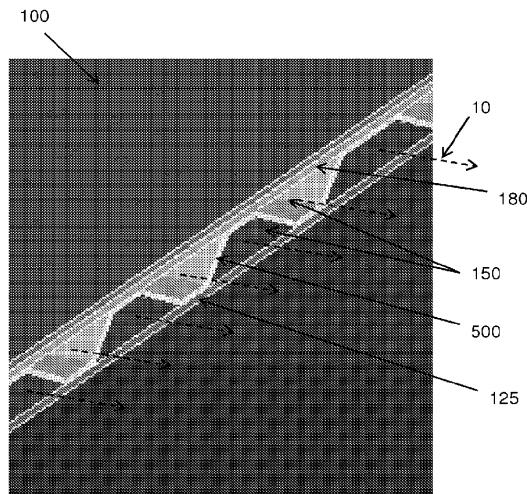


FIG - 1B

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

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

Inventors: William Dunn, Bill Swatt, and Tim Hubbard

Cross-Reference to Related Applications

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

Technical Field

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

Background of the Art

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

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

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

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

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

Summary of the Exemplary Embodiments

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

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

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

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

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

Brief Description of the Drawings

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

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

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

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

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

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

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

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

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

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

Detailed Description

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CLAIMS

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

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

2. The heat sink of claim 1 wherein:

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

3. The heat sink of claim 1 wherein:

the four-sided polygons are trapezoids.

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

the top and bottom portions are substantially parallel.

5. The heat sink of claim 1 wherein:

the four-sided polygons are rectangles.

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

a front plate placed above the continuous sheet; and

a rear plate placed below the continuous sheet.

7. The heat sink of claim 6 wherein:

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

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

8. A liquid crystal display (LCD) comprising:

the heat sink of claim 6;

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

a liquid crystal assembly placed above the LED backlight.

9. The LCD of claim 8 further comprising:

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

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

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