

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

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

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

it should be substantially clear, so that it will not affect the appearance of the image to a viewer. The circulating gas 700 should also preferably be substantially free of contaminants and/or particulate (ex. dust, dirt, pollen, water vapor, smoke, etc.) in order to prevent an adverse effect on the image quality and/or damage to the internal electronic components.

[0049] The cooling system may run continuously. However, if desired, temperature sensing devices may be incorporated within the electronic display to detect when temperatures have reached a predetermined threshold value. In such a case, the various cooling fans may be selectively engaged when the temperature in the display reaches a predetermined value. Predetermined thresholds may be selected and the system may be configured to advantageously keep the display within an acceptable temperature range. Typical thermostat assemblies can be used to accomplish this task. Thermocouples may be used as the temperature sensing devices.

[0050] It is to be understood that the spirit and scope of the disclosed embodiments provides for the cooling of many types of displays. By way of example and not by way of limitation, embodiments may be used in conjunction with any of the following electronic image assemblies: LCD (all types), light emitting diode (LED), organic light emitting diode (OLED), field emitting display (FED), light emitting polymer (LEP), organic electro luminescence (OEL), plasma displays, and any other thin panel electronic image assembly. Furthermore, embodiments may be used with displays of other types including those not yet discovered. In particular, it is contemplated that the system may be well suited for use with full color, flat panel OLED displays. Exemplary embodiments may also utilize large (55 inches or more) LED

backlit, high definition liquid crystal displays (LCD). While the embodiments described herein are well suited for outdoor environments, they may also be appropriate for indoor applications (e.g., factory/industrial environments, spas, locker rooms) where thermal stability of the display may be at risk.

[0051] As is well known in the art, electronic displays can be oriented in a portrait manner or landscape manner and either can be used with the embodiments herein.

[0052] Having shown and described preferred embodiments, those skilled in the art will realize that many variations and modifications may be made to affect the described embodiments and still be within the scope of the claimed invention. Additionally, many of the elements indicated above may be altered or replaced by different elements which will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

CLAIMS

We claim:

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

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

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

12. The system of claim 9 further comprising:

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

13. The system of claim 9 wherein:

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

14. The system of claim 10 wherein:

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

15. A system for cooling an electronic display comprising:

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

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

16. The system of claim 15 further comprising:

a corrugated metallic heat sink positioned within the first channel.

17. The system of claim 15 wherein:

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

18. The system of claim 15 further comprising:

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

19. A system for cooling an electronic display comprising:

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

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

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

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

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

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

20. The system of claim 19 further comprising:

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

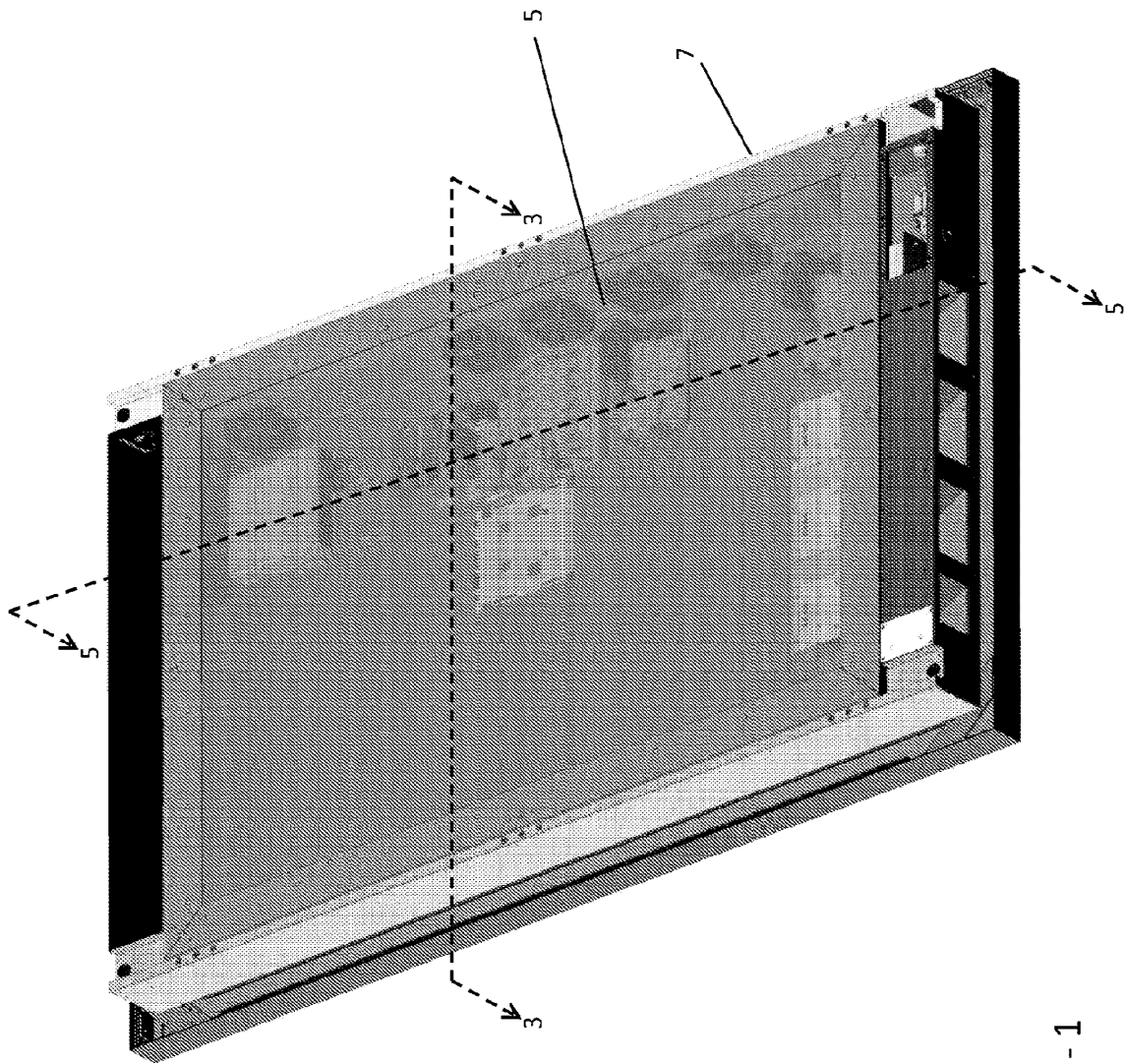
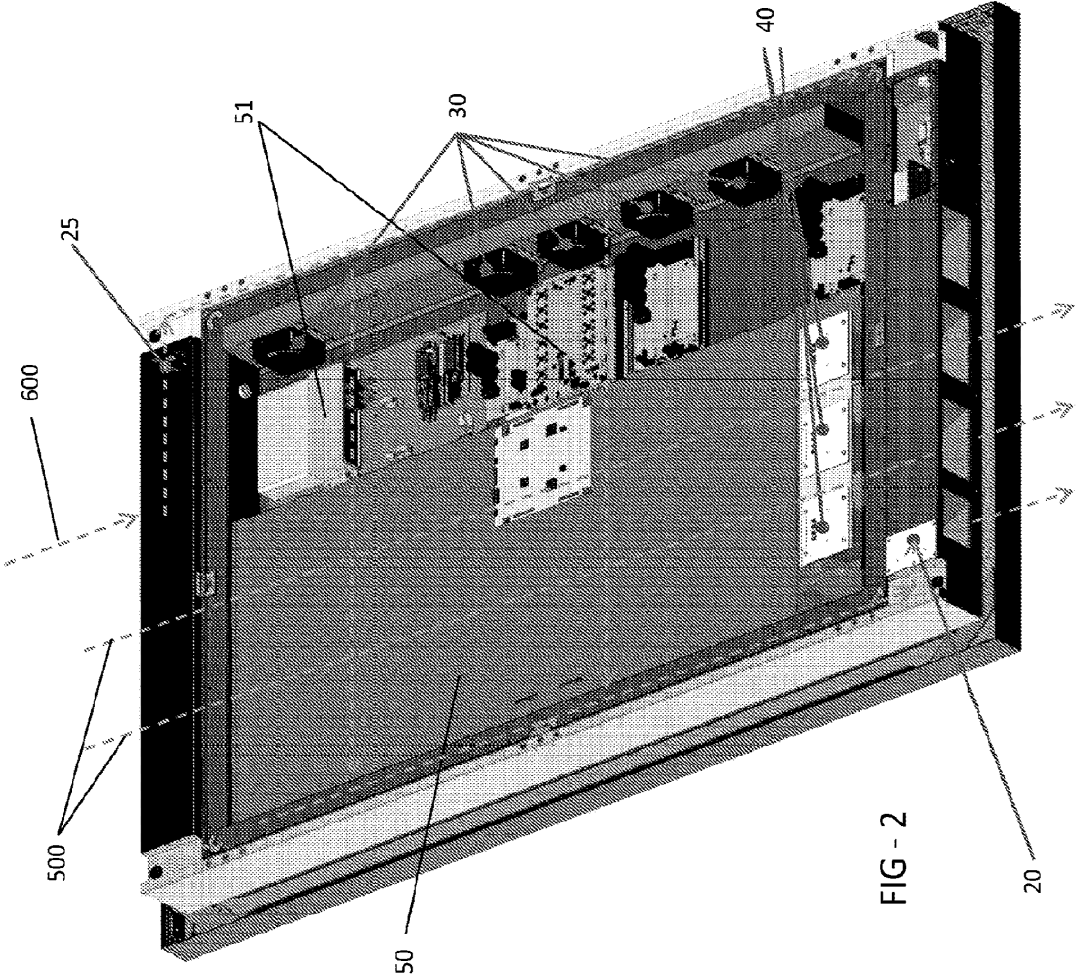
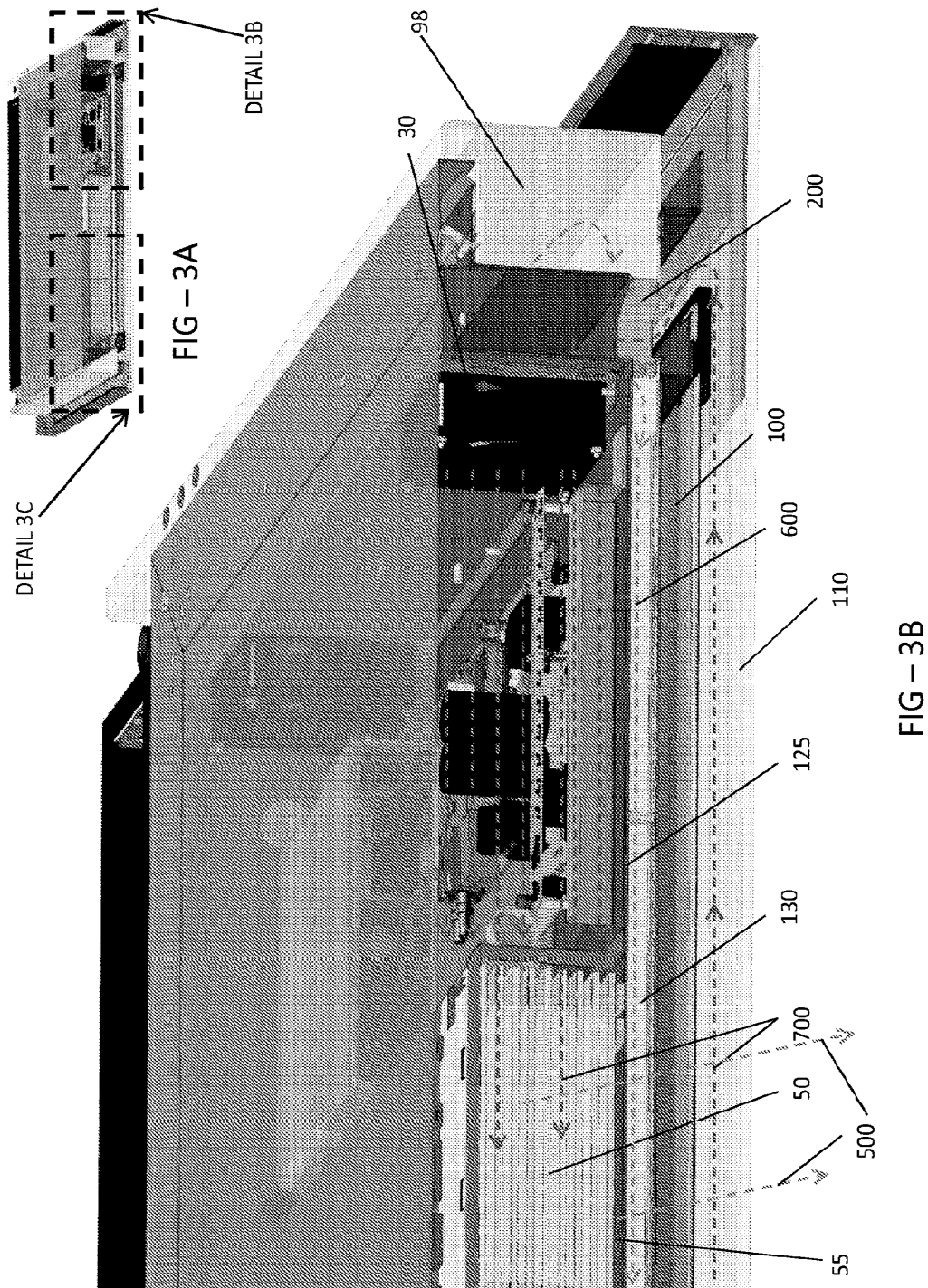
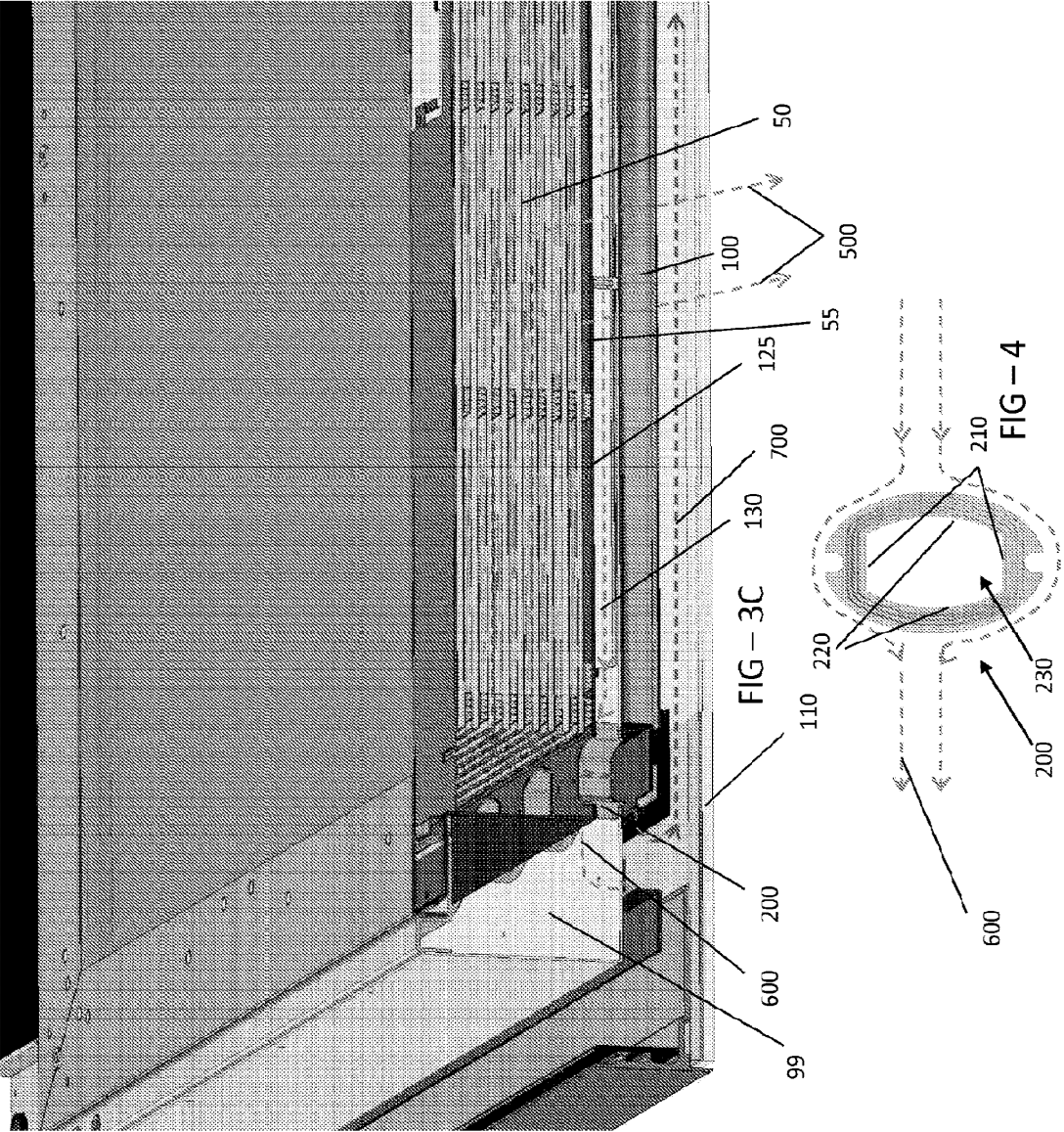
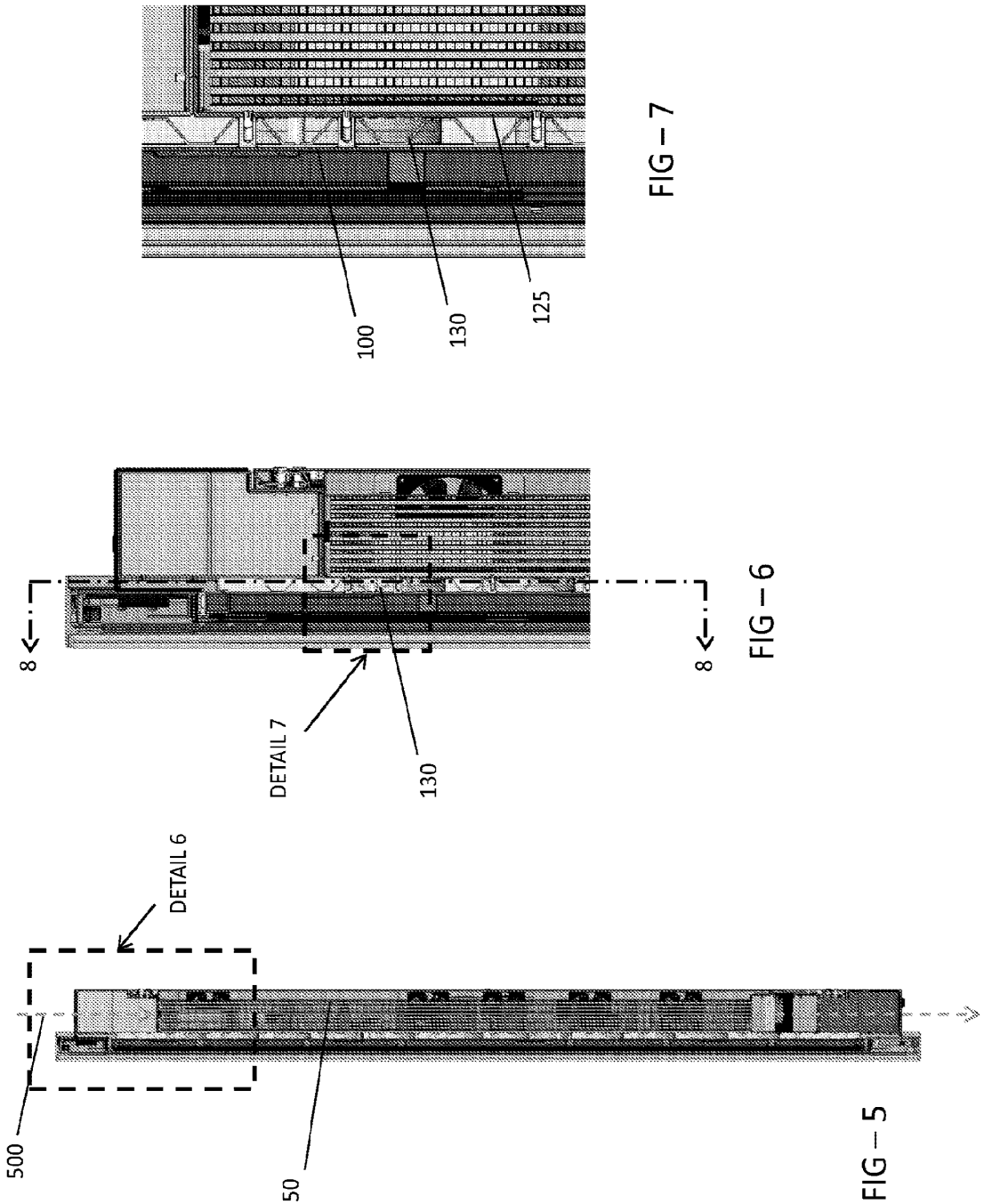


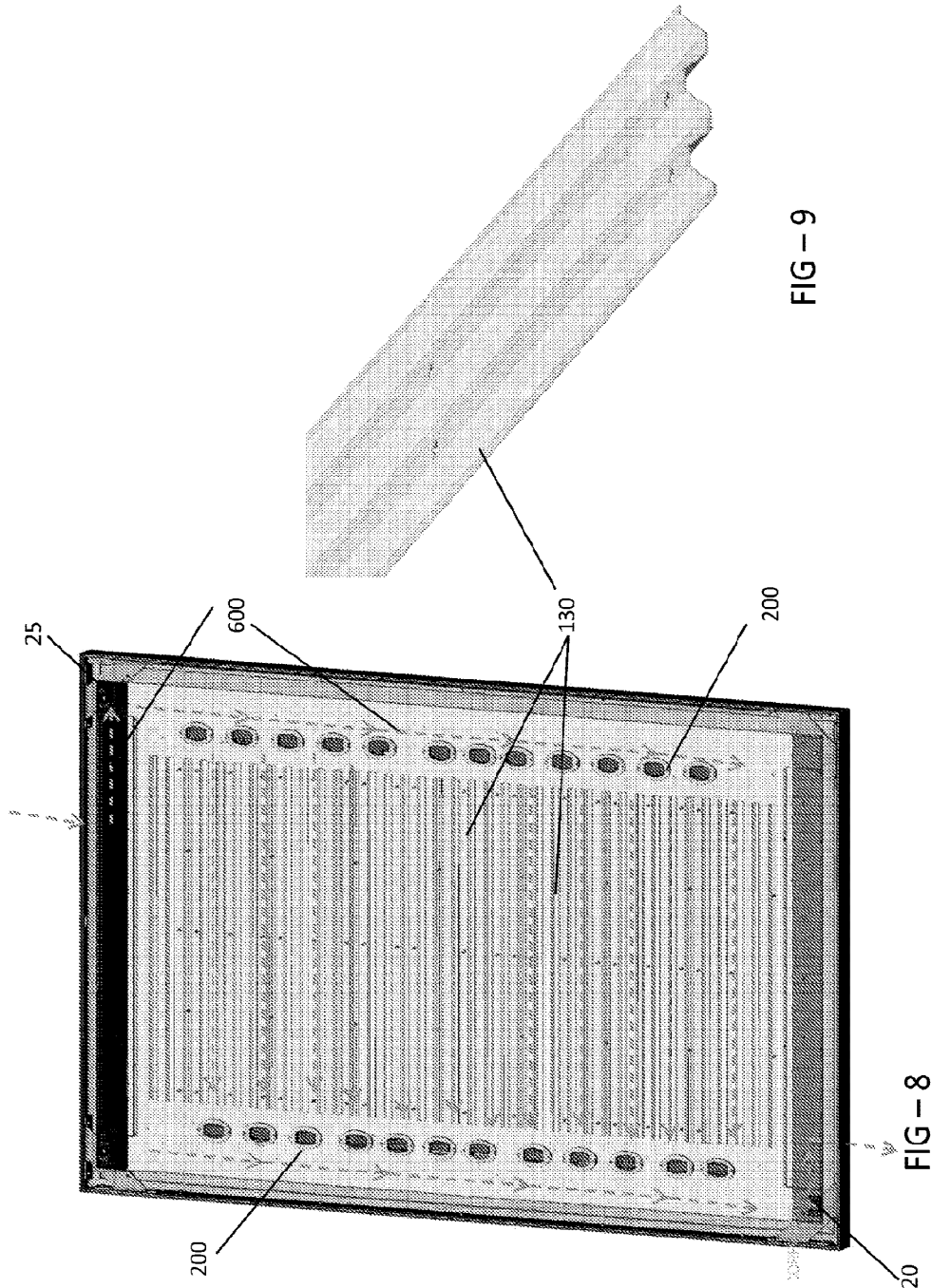
FIG - 1











INTERNATIONAL SEARCH REPORT

International application No.

PCT/US14/21945

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - H05K 5/00, 7/20 (2014.01) USPC - 361/679.47, 696 According to International Patent Classification (IPC) or to both national classification and IPC																													
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC(8) - F28F 13/00; G02F 13/33; G06F 1/16; G09F 9/00; H05K 7/20 (2014.01) USPC - 165/121; 349/161; 361/695, 696, 697, 679.47 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); Google/Google Scholar; Proquest; IP.com; electron*, display, device, panel, cool*, plate*, pan*, first NEAR3 (channel OR duct), second NEAR3 (channel OR duct), first ADJ Fan*, second ADJ fan, heat ADJ exchanger*, standoff*, space, gap, HUBBARD NEAR2 TIM, DUNN NEAR2 WILLIAM																													
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>US 8,369,083 B2 (DUNN, W et al.) February 05, 2013; abstract; figure 1B, 2, 4, 8; claim 8; column 2, lines 37-39, 44-45; column 3, lines 53-54, 65; column 4, lines 3-5, 13-15, 16-20, 43-45; column 5, lines 16-18, 54-56, 66-67; column 6, lines 1-2, column 7, lines 64-65; column 11, 27-30</td> <td>1-2, 4-5, 9-11 3, 6-8</td> </tr> <tr> <td>Y</td> <td>US 2012/0038849 A1 (DUNN, W et al.) February 16, 2012; abstract; figure 1A; paragraphs [0010], [0029], [0030], [0053]</td> <td>3, 6-8</td> </tr> <tr> <td>A</td> <td>US 2012/0255704 A1 (NAKAMICHI, M) October 11, 2012; entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 2012/0106081 A1 (HUBBARD, T et al.) May 03, 2012; entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 2011/0013114 A1 (DUNN, W et al.) January 20, 2011; entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 8,035,968 B2 (KWON, OK et al.) October 11, 2011; entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 2006/0132699 A1 (CHO, JW et al.) June 22, 2006; entire document</td> <td>1-20</td> </tr> <tr> <td>A</td> <td>US 2012/0274876 A1 (CAPPAERT, B et al.) November 01, 2012; entire document</td> <td>1-20</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	US 8,369,083 B2 (DUNN, W et al.) February 05, 2013; abstract; figure 1B, 2, 4, 8; claim 8; column 2, lines 37-39, 44-45; column 3, lines 53-54, 65; column 4, lines 3-5, 13-15, 16-20, 43-45; column 5, lines 16-18, 54-56, 66-67; column 6, lines 1-2, column 7, lines 64-65; column 11, 27-30	1-2, 4-5, 9-11 3, 6-8	Y	US 2012/0038849 A1 (DUNN, W et al.) February 16, 2012; abstract; figure 1A; paragraphs [0010], [0029], [0030], [0053]	3, 6-8	A	US 2012/0255704 A1 (NAKAMICHI, M) October 11, 2012; entire document	1-20	A	US 2012/0106081 A1 (HUBBARD, T et al.) May 03, 2012; entire document	1-20	A	US 2011/0013114 A1 (DUNN, W et al.) January 20, 2011; entire document	1-20	A	US 8,035,968 B2 (KWON, OK et al.) October 11, 2011; entire document	1-20	A	US 2006/0132699 A1 (CHO, JW et al.) June 22, 2006; entire document	1-20	A	US 2012/0274876 A1 (CAPPAERT, B et al.) November 01, 2012; entire document	1-20
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- (74) Agents: **DUNHAM, Tyler, S.** et al.; Standley Law Group LLP, 6300 Riverside Drive, Dublin, OH 43017 (US).
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[Continued on next page]

(54) Title: BACK TO BACK ELECTRONIC DISPLAY ASSEMBLY

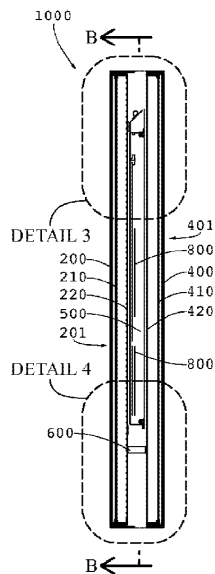


Fig. 2

(57) Abstract: The exemplary embodiments herein comprise a back to back electronic display assembly having a first display assembly positioned back to back with a second display assembly. A plenum is preferably positioned in between the first and second display assemblies with a first gap defined between the plenum and the first display assembly and a second gap defined between the plenum and the second display assembly. A fan is preferably positioned to force air through the first and second gaps. A plenum fan may be used to circulate air around the plenum. Preferably, the second display assembly can move relative to the first display assembly to provide access to the interior of the plenum.

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Back To Back Electronic Display Assembly

Cross-Reference to Related Applications

[0001] This application claims priority to U.S. Application No. 61/986,724 filed on April 30, 2014 and is herein incorporated by reference in its entirety.

Technical Field

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

Background of the Art

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

Summary of the Exemplary Embodiments

[0004] Exemplary embodiments provide a back to back electronic display assembly where the electronic components are contained within a sealed plenum. External air is

ingested and passed between the walls of the plenum and the rear surfaces of the electronic display assemblies. The two electronic display assemblies are permitted to move relative to one another, such that the plenum can be easily opened with the electronics made available for servicing and/or replacement.

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

Brief Description of the Drawings

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

[0007] FIGURE 1 is a front planar view of an exemplary back to back display assembly showing the vertical section line A-A.

[0008] FIGURE 2 is a section view taken along the section line A-A and showing Detail 3 and Detail 4 as well as vertical section line B-B.

[0009] FIGURE 3 is a detailed section view showing Detail 3.

[0010] FIGURE 4 is a detailed section view showing Detail 4.

[0011] FIGURE 5 is a section view taken along the section line A-A and showing the second display assembly rotated away from the first display assembly and also showing Detail 6.

[0012] FIGURE 6 is a detailed section view showing Detail 6.

[0013] FIGURE 7 is a perspective view showing an alternate embodiment where the first display assembly is rotated away from the second display assembly.

[0014] FIGURE 8 is a perspective view taken along the line B-B and indicating Detail 9.

[0015] FIGURE 9 is a detailed perspective view of Detail 9 showing the post.

[0016] FIGURE 10 is a detailed perspective view of the corresponding hook on the second display assembly.

Detailed Description

[0017] 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.

[0018] 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.

[0019] 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.

[0020] 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.

[0021] **FIGURE 1** is a front planar view of an exemplary back to back display assembly 1000 showing the vertical section line A-A. In this orientation the first display assembly 201 is the only display that is viewable.

[0022] **FIGURE 2** is a section view taken along the section line A-A and showing Detail 3 and Detail 4 as well as vertical section line B-B. A first display assembly 201 is positioned back-to-back with a second display assembly 401. In an exemplary embodiment, the two display assemblies 201 and 401 are substantially parallel with the

rear surfaces of each display assembly facing each other. The first display assembly 201 preferably contains a front cover glass 200, LCD panel 210, and LED backlight 220. The second display assembly 401 preferably contains a front cover glass 400, LCD panel 410, and LED backlight 420. Although shown and described herein with LED backlight LCD technology, the exemplary embodiments herein can be practiced with any form of flat panel display, including but not limited to OLED, LED, plasma, and any luminescent polymers. In these embodiments, the rear surface of the LED backlight would simply be the rear surface of an OLED, LED, plasma, or a luminescent polymer display.

[0023] An enclosed plenum 500 preferably contains the electronics 800 for operating the two displays and is positioned between the two display assemblies 201 and 401. A fan 600 is also positioned between the two display assemblies 201 and 401 and is positioned to draw surrounding external air through the assembly 1000, preferably without permitting any of the external air to enter the plenum 500. Although only a single fan 600 is shown, multiple fans may be used in some embodiments, either in the same or a different location than the fan 600 which is shown. Further, while the fan 600 is shown pulling the external air through the assembly 1000, it could also be positioned to push the external air through the assembly 1000. Still further, although shown at the bottom of the display assembly 1000, it could instead be placed at the top.

[0024] **FIGURE 3** is a detailed section view showing Detail 3. **FIGURE 4** is a detailed section view showing Detail 4. The plenum 500 is preferably enclosed by a first wall 740 which faces the first display assembly 201, a second wall 730 which faces the second display assembly 401, a top wall 710, bottom wall 715, and a pair of opposing

sidewalls (not shown in this view). In this embodiment, the first wall 740, a top wall 710, bottom wall 715, and opposing sidewalls are fixed relative to one another while the second wall 730 is movable relative to these pieces. While this is shown here, other embodiments could fix the second wall 730 relative to the top wall 710, bottom wall 715, and opposing sidewalls while the first wall 740 is movable relative to these pieces. Preferably, the walls 740, 710, 715, 730, and the sidewalls are metallic and preferably aluminum.

[0025] The second wall 730 seals the plenum 500 when the gasket 700 is compressed between the second wall 730 and the top wall 710, bottom wall 715, and opposing sidewalls. The electronics 800 contained within the plenum are protected from the external air flows 575 and 550 and any possible contaminants, particulate, or water vapor that may be present. The electronics can include, but are not limited to: power supplies, microprocessors, printed circuit boards, electronic memory, transmitting/receiving devices, and video players. Preferably the electronics 800 are also in thermal communication (preferably conductive) with either the first wall 740, second wall 730, or both. In this way, heat from the electronics 800 can be transferred to the first wall 740 to be removed by first external air flow 575 or the second wall 730 to be removed by the second external air flow 550.

[0026] A first gap is preferably defined between the first display assembly 201 and the first wall 740 of the plenum 500. A second gap is defined between the second display assembly 401 and the second wall 730 of the plenum 500. In this particular embodiment where an LCD with an LED backlight is being used, the first gap is between the rear surface of the LED backlight 220 and the first wall 740 and the second

gap is between the rear surface of the LED backlight 420 and the second wall 730. A first external airflow 575 is ingested into the housing through an inlet aperture, forced through the first gap, and then exhausted out of the housing through an exhaust aperture. A second external airflow 550 is ingested into the housing through an inlet aperture, forced through the second gap, and then exhausted out of the housing through an exhaust aperture. In this way, airflow 575 can remove heat simultaneously from the LED backlight 220 and the first wall 740 while airflow 550 can remove heat simultaneously from the LED backlight 420 and the second wall 730.

[0027] FIGURE 5 is a section view taken along the section line A-A and showing the second display assembly rotated away from the first display assembly and also showing Detail 6. In this embodiment, the first display assembly 201 remains fixed while the second display assembly 401 is permitted to move or rotate away from the first display assembly 201, providing access to the interior of the plenum and the electronics 800 inside.

[0028] FIGURE 6 is a detailed section view showing Detail 6. Here, a sloped rain catcher 705 is placed below the inlet aperture and above the plenum so as to collect any condensation and direct it down the first gap. This figure also shows the movement of the second wall 730 along with the second display assembly 401, as they move away from the first wall 740, a top wall 710, bottom wall 715, and opposing sidewalls to provide access to the interior of the plenum.

[0029] FIGURE 7 is a perspective view showing an alternate embodiment where the first display assembly 201 is rotated away from the second display assembly 401 (which remains fixed). Here, a pair of gas springs 850 are used to help rotate the display

assembly 201 and hold it in an open position while the interior of the plenum 500 is being serviced.

[0030] **FIGURE 8** is a perspective view taken along the line B-B and indicating Detail 9. In this embodiment, the first wall 740 is used to mount the various electronics 800, although these could instead be mounted to the rear wall 730. In some embodiments, electronics 800 may be mounted to both the first wall 740 and the second wall 730. The top wall 710 substantially prohibits airflow from entering the plenum. An opening 120 is preferably placed on or near the top wall 710 to allow airflow 575 to enter the gap defined by the opening of the space between the first wall 740 and the rear of the LED backlight 220. In a similar manner, another opening (not shown here) is preferably provided on or near the top wall 710 to allow airflow 550 to enter the gap defined by the opening of the space between the second wall 730 and the rear of the LED backlight 420.

[0031] A gasket 700 is preferably positioned around the perimeter of the first wall 740 so that the gasket 700 is compressed between the plenum walls (top wall 710, bottom wall 715, and pair of opposing sidewalls) and the second wall 730 when the unit is closed. Preferably, a pair of dividing walls 80/85 are used to define a loop around the plenum 500 which passes through only one of the dividing walls (here 80). Generally speaking, the dividing walls 80/85 should connect between the first wall 740 and second wall 730 of the plenum. In an exemplary embodiment, dividing wall 80 is perpendicular to dividing wall 85. Even more preferably, dividing wall 80 is arranged horizontally and contains the fan(s) while dividing wall 85 is connected to the end of dividing wall 80 but is arranged vertically and does not contain a fan. Although fans are only shown within

the dividing wall 80, they could instead be placed within the dividing wall 85, or only within the dividing wall 85 with no fans placed within dividing wall 80. For exemplary airflow, it has been discovered that placing the first fan 75 near the center of the display assembly and the second fan 77 near the perimeter of the display assembly, causes a pair of circulating gas loops 501 and 510 respectfully.

[0032] A plurality of input/output electrical connections 25 are preferably placed at the top of the display assembly 201 and underneath a sloped rain catcher 705. Also, a pair of mounting pins 50 and 51 are arranged at the top of the display assembly 201. A plurality of latches 120, 122, 125 are preferably arranged at the bottom of the display assembly 201, although shown with three latches embodiments can be practiced with one or two latches only. Also shown in this figure are the attachment brackets 900 and 910 for gas springs 850 or other supporting resistive elements.

[0033] **FIGURE 9** is a detailed perspective view of Detail 9 showing the post. Here, the details of the post 51 may be observed. In this embodiment, a cylinder travels horizontally and is divided by two locating walls 53 (closest to the perimeter of the display assembly 201) and 54 (closest to the center of the display assembly 201). The cylinder can then be identified by the mounting portion 55 (located between walls 53/54) and the interior portion 52 (starting at the wall 54 and travelling towards the center of the module 500).

[0034] **FIGURE 10** is a detailed perspective view of the corresponding hook 450 on the second display assembly 401. A pair of mounting hooks 450 are preferably placed at the top of the second display assembly 401 and correspond to the mounting posts 50 and 51 respectively. Preferably, the hook 450 would wrap around the circumference of

the mounting portions 55, where the hook 300 is stabilized between the walls 54 and 53.

[0035] Having shown and described a preferred embodiment of the invention, those skilled in the art will realize that many variations and modifications may be made to affect the described invention and still be within the scope of the claimed invention. Additionally, many of the elements indicated above may be altered or replaced by different elements which will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

CLAIMS

We claim:

1. A back to back electronic display assembly comprising:
 - a first display assembly positioned back to back with a second display assembly;
 - a plenum positioned in between the first and second display assemblies;
 - a first gap defined between the plenum and the first display assembly;
 - a second gap defined between the plenum and the second display assembly;
 - and
 - a fan positioned to force air through the first and second gaps.
2. The assembly of claim 1 further comprising:
 - a plenum fan positioned within the plenum.
3. The assembly of claim 1 wherein:
 - the plenum is sealed to prevent air being forced by the fan from entering the plenum.
4. The assembly of claim 1 wherein:
 - one or more electronic components for operating the first display positioned within the plenum.
5. The assembly of claim 4 wherein:
 - the electronic component is a power module.

6. The assembly of claim 1 wherein:

the plenum comprises a first wall and second wall which oppose each other, a top wall, bottom wall, and a pair of sidewalls.

7. The assembly of claim 6 further comprising:

a gasket positioned between the top wall and the second wall.

8. The assembly of claim 1 wherein:

the second display assembly is permitted to move relative to the first display assembly.

9. The assembly of claim 1 wherein:

the second display assembly hangs from the first display assembly.

10. The assembly of claim 6 wherein:

the first wall is fixed relative to the first display assembly; and
the second wall is fixed relative to the second display assembly.

11. The assembly of claim 6 wherein:

the first gap is further defined between the first wall of the plenum and an LED backlight for the first display assembly; and

the second gap is further defined between the second wall of the plenum and an LED backlight for the second display assembly.

12. The assembly of claim 1 further comprising:

a first dividing wall positioned within the plenum; and
a second dividing wall positioned within the plenum and oriented substantially perpendicular to the first dividing wall.

13. The assembly of claim 12 further comprising:

a plenum fan positioned within the first or second dividing wall.

14. A back to back electronic display assembly comprising:

a first LED backlit display positioned back to back with a second LED backlit display;
a plenum positioned in between the first and second LED backlit displays; and
a fan positioned to force air around the plenum and along the first and second LED backlights.

15. The assembly of claim 14 wherein:

the second LED backlit display is permitted to move relative to the first LED backlit display.

16. The assembly of claim 15 wherein:

moving the second LED backlit display relative to the first LED backlit display permits access to an interior portion of the plenum.

17. The assembly of claim 14 further comprising:

- a dividing wall positioned within the plenum; and
- a plenum fan attached to the dividing wall so as to cause circulating air to flow through the dividing wall.

18. A back to back electronic display assembly comprising:

- a first LED backlit display positioned back to back with a second LED backlit display;
- a plenum positioned in between the first and second LED backlit displays and comprising:
 - a first wall which faces the first LED backlight,
 - a second wall which faces the second LED backlight,
 - a top wall,
 - a bottom wall, and
 - a pair of sidewalls;
- a first gap defined by the space between the first wall and the first LED backlight;
- a second gap defined by the space between the second wall and the second LED backlight;
- an electronic component attached to the first wall or second wall;
- a first fan positioned to force air through the first gap and the second gap;

a dividing wall positioned within the plenum that connects between the first wall
and second wall of the plenum; and
a second fan positioned on the dividing wall.

19. The assembly of claim 18 wherein:

the first wall is fixed relative to the first display; and
the second wall is fixed relative to the second display.

20. The assembly of claim 18 further comprising:

an additional dividing wall within the plenum which is connected to the first
dividing wall and connects between the first wall and second wall of the
plenum.

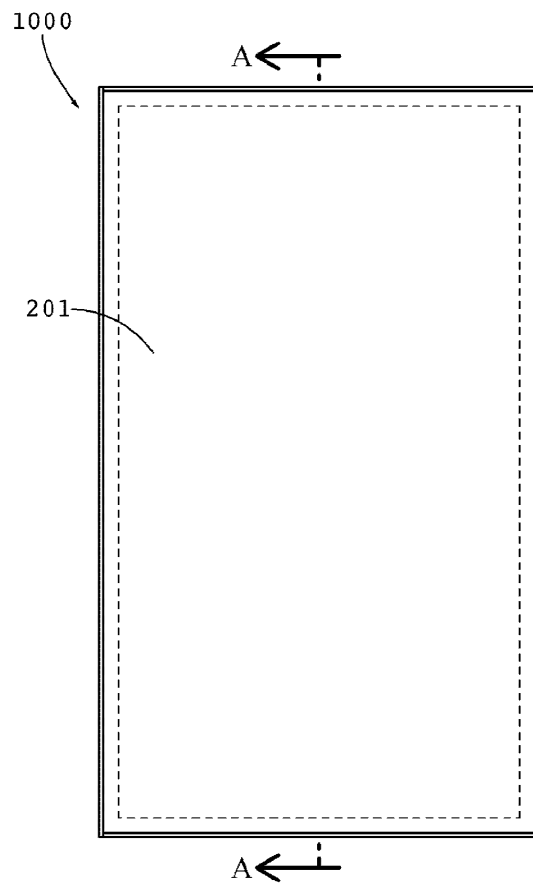


Fig. 1

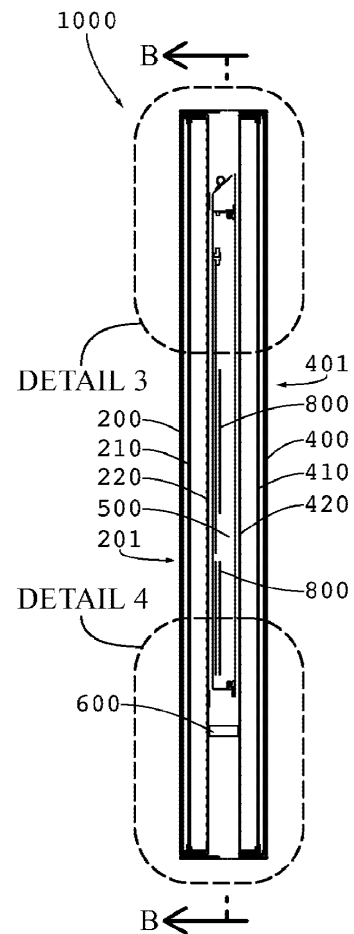
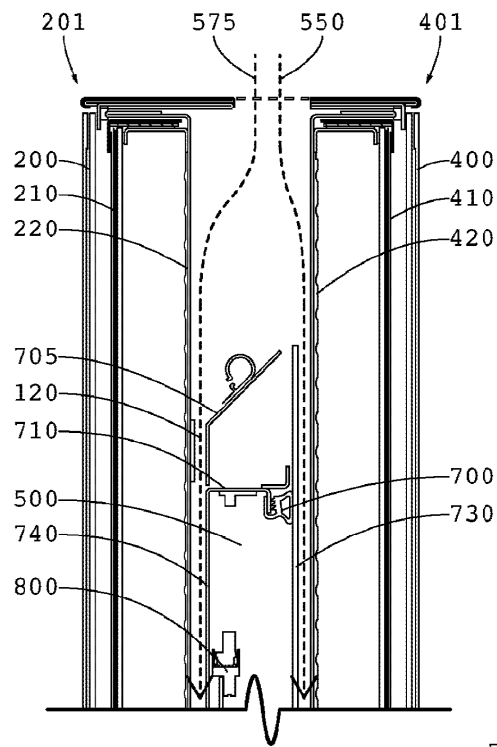
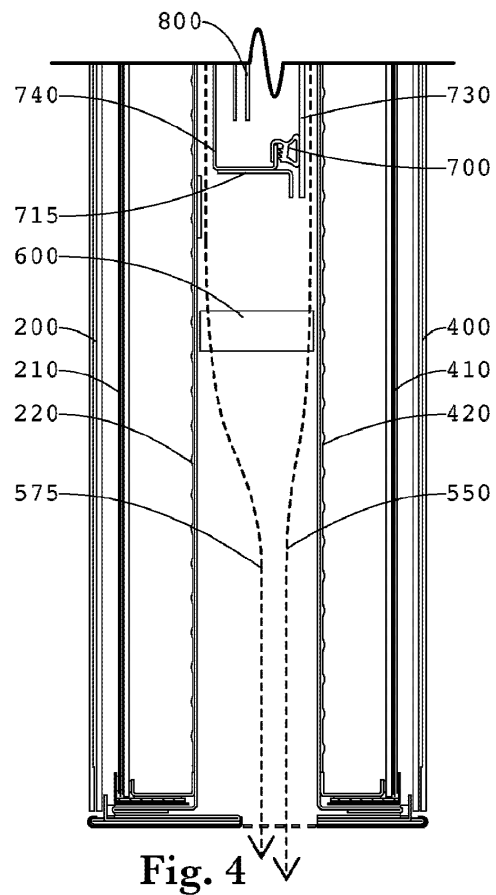


Fig. 2

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**Fig. 3****Fig. 4**

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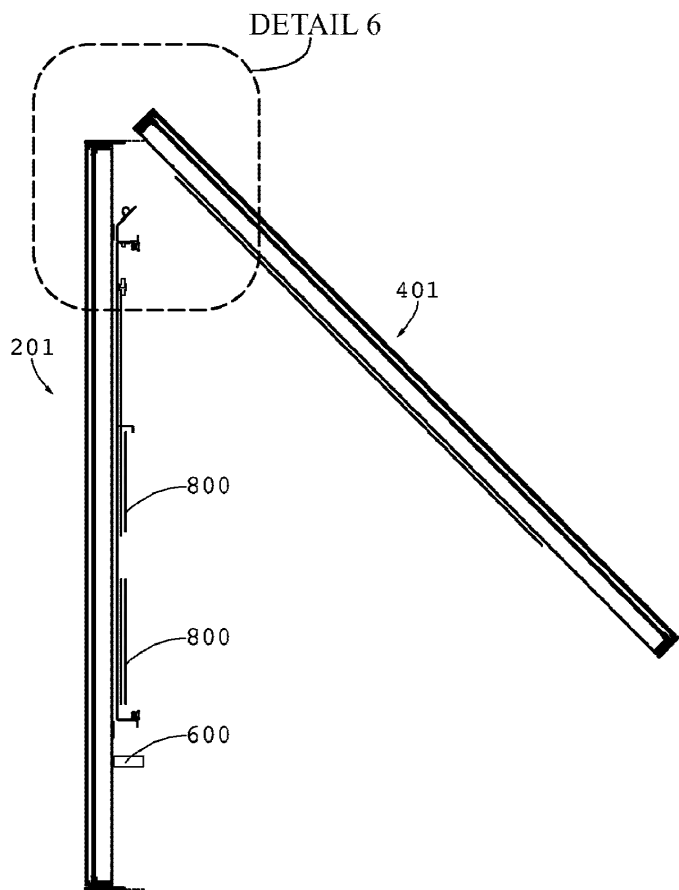


Fig. 5

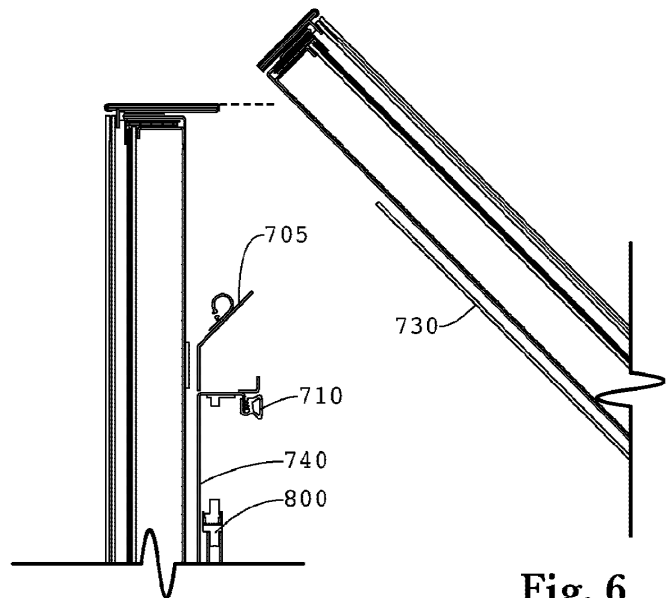
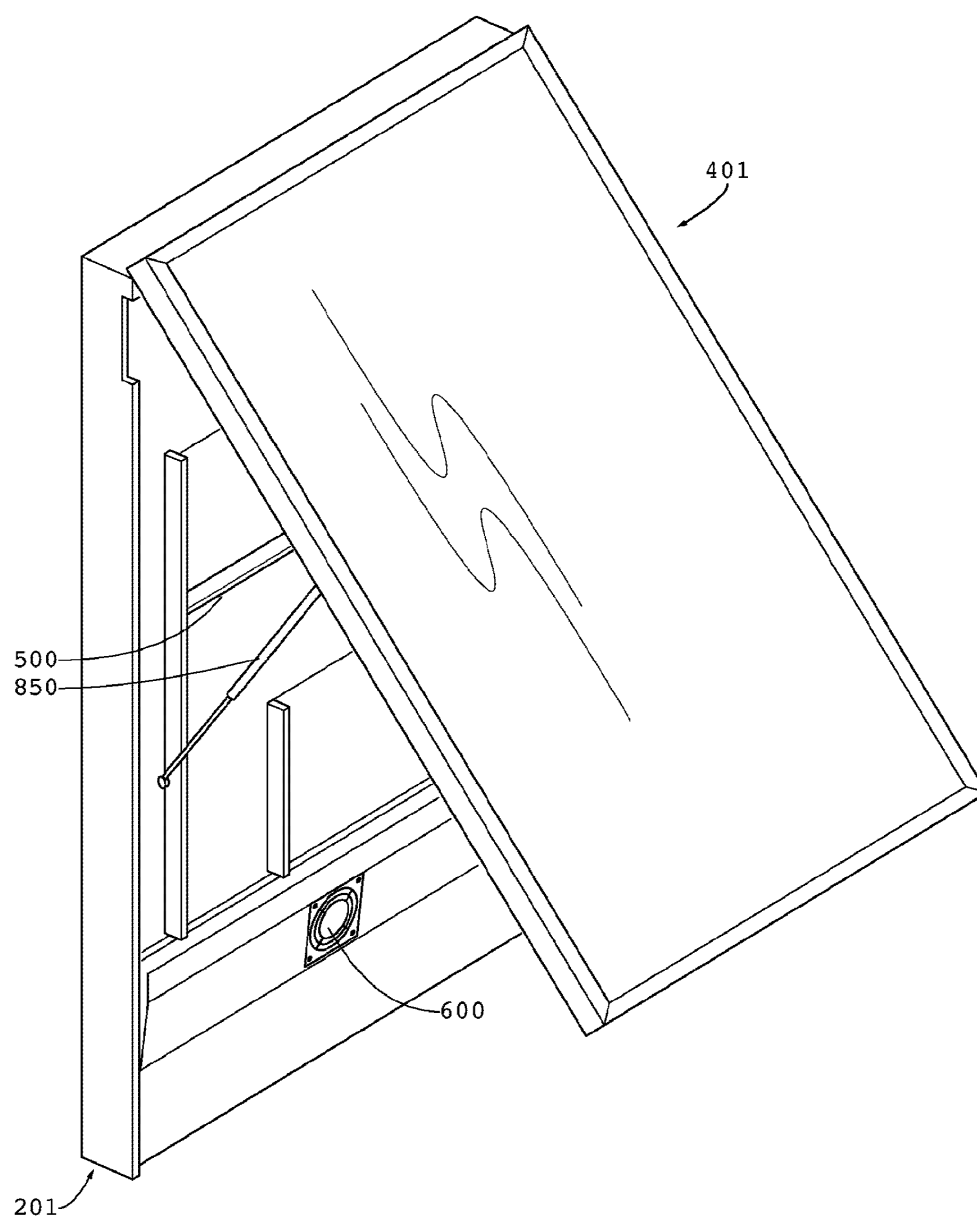
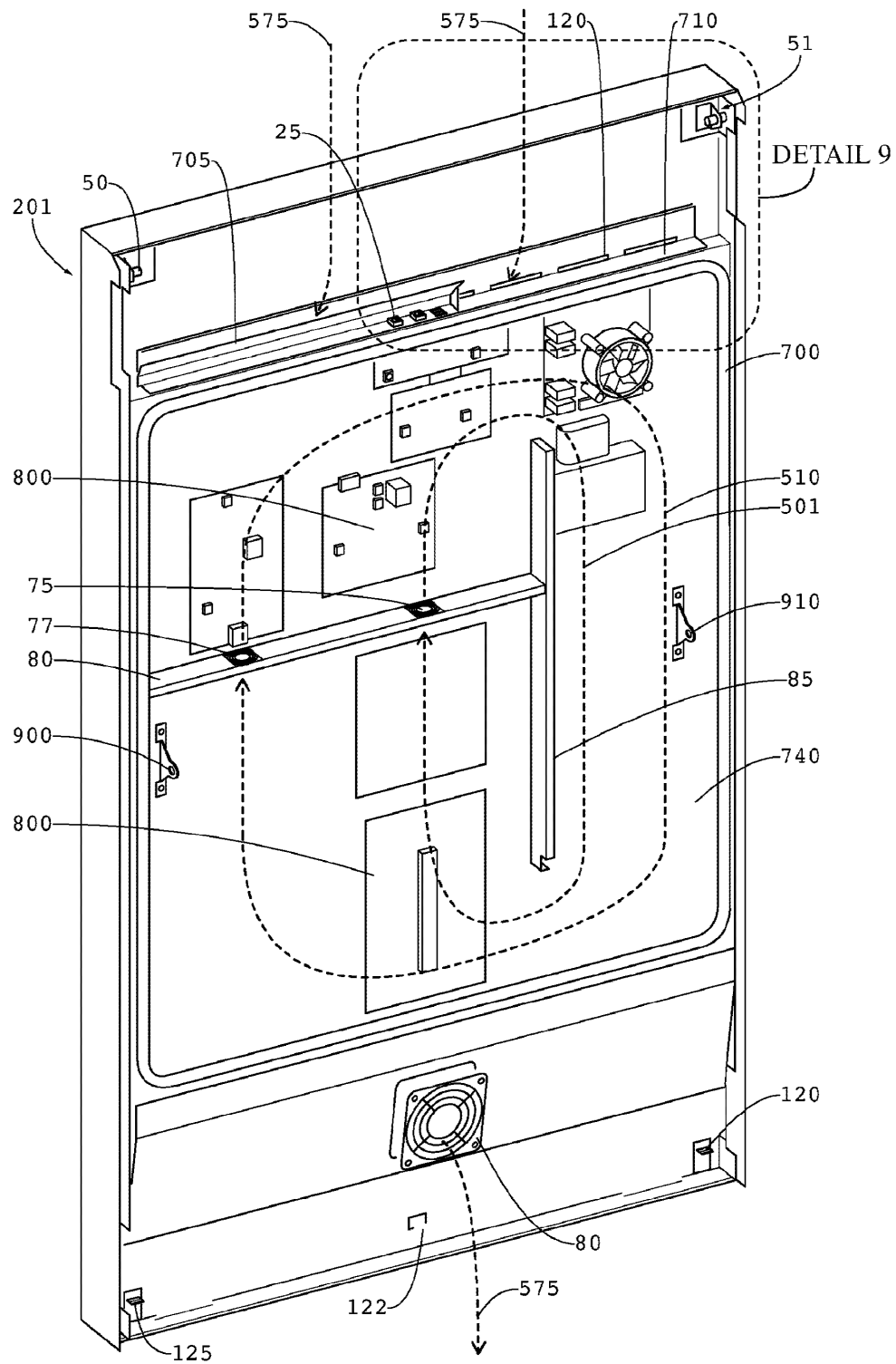


Fig. 6

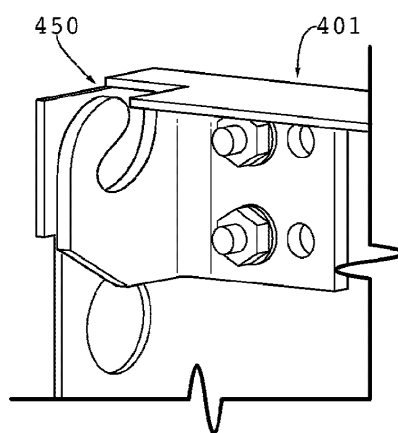
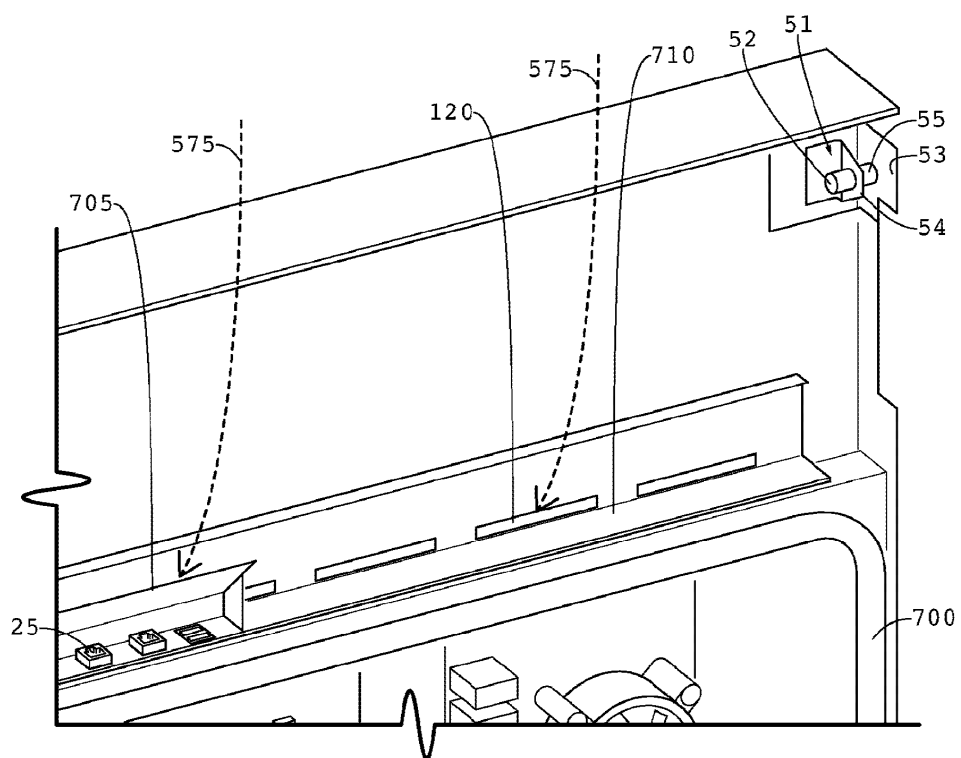
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**Fig. 7**

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**Fig. 8**

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2015/028461

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - H05K 7/20 (2015.01) CPC - H05K 7/20954 (2015.07) 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) - G02F 1/1335; H05K 7/16, 7/20 (2015.01) CPC - G02F 1/133382, 1/133385; H05K 7/20009, 7/20136, 7/20145, 7/202, 7/20954, 7/20972 (2015.07) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched USPC - 349/58, 161; 361/695 (keyword delimited) Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Orbit, Google Patents, Google. Search terms used: display, LCD, LED, multiple, dual, back-to-back, cooling, plenum, hinged		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/0085301 A1 (DUNN) 14 April 2011 (14.04.2011) entire document	1-2, 6, 10-14, 17-19
Y		4-5, 7-9, 15-16
Y	US 2006/0269216 A1 (WIEMEYER et al) 30 November 2006 (30.11.2006) entire document	4-5
Y	US 5,748,269 A (HARRIS et al) 05 May 1998 (05.05.1998) entire document	7
Y	US 2010/0232107 A1 (DUNN) 16 September 2010 (16.09.2010) entire document	8-9, 15-16
A	US 2011/0058326 A1 (IDEMS et al) 10 March 2011 (10.03.2011) entire document	1-20
☐ 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 06 July 2015		Date of mailing of the international search report 29 JUL 2015
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300		Authorized officer Blaine Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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[Continued on next page]

(54) **Title:** LARGE-SCALE ELECTRONIC DISPLAYS AND METHODS OF MANUFACTURING THE SAME

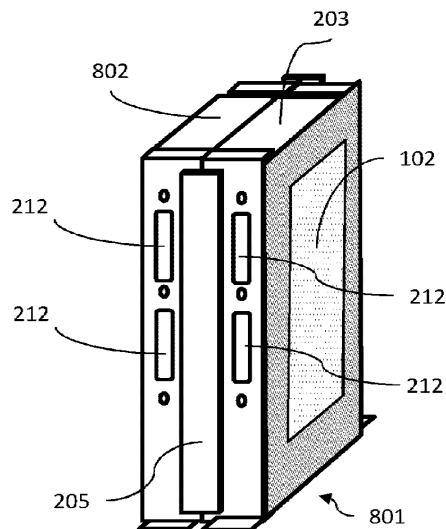


FIG. 8B

(57) **Abstract:** A digital advertising unit (801) comprises a pair of large-scale electronic display modules (203, 802) secured back-to-back. Each of the modules (203, 802) has a display panel (102) that is displaceable to afford access to components behind the display panel (102) for maintenance. Each display (203, 802) has a respective cooling system that draws external air into the display through an inlet (212) at one side of the display and exhausts the air through an outlet on an opposite side of the display. The inlets (212) of both display modules (203, 802) are disposed at one, common side of the pair and the outlets of both displays modules (203), (802) are disposed at an opposite, common side of the pair. This ensures that 'dirty' air output from one of the display modules (203, 802) does not contaminate the 'clean' air input of the other of the display modules. The display modules (203, 802) may be substantially identical, but with their respective cooling systems arranged to cause airflow in the same, common direction from inlets to outlets.

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- 1 -

LARGE-SCALE ELECTRONIC DISPLAYS AND METHODS OF MANUFACTURING THE SAME

The present invention relates to large-scale electronic displays and methods of manufacturing the same. In the context of this specification, “large-
5 scale” means a minimum visible screen size of approximately 50 inches (127 cm), measured diagonally across the screen.

Electronic advertising displays are being used increasingly at the present time. They are now being used in outdoor as well as indoor venues; in locations such as traditional roadside and city centre billboard locations, travel
10 environments (e.g. rail platforms, airports, bus stops, trams, underground rail), retail environments (e.g. shopping malls, supermarkets, petrol stations), entertainment venues (e.g. stadiums, arenas, cinemas, restaurants, bars) and typically any location where advertisers can reach large audiences as they go about their day to day business.

15 Such displays typically use LCD or LED technology and are designed to cater for outdoor environmental conditionals such a weather, temperature, water, wind loading etc and designed to withstand robust environments e.g. vandalism and accidental impacts e.g. from vehicles, shopping trolleys, people, etc.

20 Such displays are typically large – e.g. high brightness 70 inches (178 cm) or more visible screens that can be viewed by a mass audience from a distance and require varied fixing mechanisms to suite the varied application needs – e.g. ground fixed (with suitable foundations), wall mounted, integrated with structures e.g. bus-stops – and often with some creative or branded design to
25 suit the marketing needs of brand, retailer or display owner.

- 2 -

As a result, screens are often extremely heavy, bulky, expensive and difficult to store, transport and install – especially where there are obstacles on-site (e.g. kerbs, pavements, retail canopies, bollards, bins, bus-stops, etc) that need to be navigated or avoided. This generally leads to low volume rollouts,
5 which are difficult to scale up to high volume.

Conventionally, large advertising screens are often manufactured to suit a specific project, often generated as a result of a tender process from a retailer or council, detailing specific requirements. As a result, screens will be designed/created in a bespoke way, to meet the client's needs, often taking time
10 to build from scratch or through a systems integration process using available building blocks; based on modifications to an existing design in order to reduce the design process; or by some level of modular development, in order to help tailor mass produced display housings to client needs e.g. video module, power supply module or display cassette fitted to mass produced housings.

15 A large advertising screen project is often considered complete when the screen network has been installed and where separate maintenance contracts are established by screen suppliers, who charge for ongoing maintenance. As a result, screens are often not designed with ongoing maintenance in mind, particularly with the time pressures to meet tender deadlines, and where the
20 maintenance contracts are valuable to the supplier, who often charge for callouts and repairs etc.

Electronic displays are often created by system integrating mass produced components from different suppliers, which are often over-engineered, expensive and have no consideration for on-going maintenance once
25 delivered. Typical components and sub-assemblies include display housings,

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enclosures, glass assemblies, LCD panels, backlit LCD panels, PC boards, media players, power supplies, cooling systems, communication devices, routers, etc.

- These types of designs make no or little provision for swapping out components / sub-assemblies onsite e.g. fans, fan assemblies, LCD panels, PC-
- 5 boards etc.; where any failures require the entire display to be swapped out. In many cases there is no provision to access serviceable assemblies within the screen, particularly as screens get positioned close to buildings and structures where there is little or no access from the rear of the screen; where there are long and complex cable runs from the base control electronics to the LCD units.
- 10 Typical implementations include (as separate assemblies or integrated in some form) foundations or levelled base to provide a level / solid surface to mount the screen; base unit containing critical control electronics e.g. PC, video control boards, power supplies, communications etc., LCD unit containing LCD panel, backlights, heat sinks, cooling fan arrangements, cladding for side, top front etc.
- 15 Clearly this type of arrangement does not lend itself to “Wall mount” due to the need for an unsightly “control box” below the screen that prevents the creative appearance of a “wall poster” being possible.

- Although some large advertising screens have a level of modularity, they are often “over designed” to cater for worst conditions of “one size fits all”,
- 20 carrying excess cost and weight for many other applications. As an example, fully integrated “LCD cassettes” have been used with mass produced housings, containing the LCD panel, cooling assemblies, control electronics (PC, Video etc), communication component, protective front glass etc. This is installed into the aperture of a mass produced housing that aligns with air flow provision,
- 25 feeds power (e.g. via base), and the rear of the mass produced housing provides alternate advertising medium such as static or dynamic (scrolling posters).

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The mass housing is often installed on site first, and then the “LCD Cassette” fitted at a different time, using contractors of different skill sets, including the need for a qualified electrician to connect power through to the LCD Cassette, resulting in multiple sites visits and additional installation costs.

- 5 Specialised and expensive lifting equipment is required to lift the cassette into the housing using a “suction means” due to the weight of the cassette.

- Access to the control electronics within the cassette is via the rear of the unit; such that if the display is against a wall or other structure (i.e. no rear poster unit), then a mechanism is required to move the housing so that the rear is accessible e.g. housing mounted on a “Single Leg” that allows the screen to pivot/rotate to gain rear access. Any rear static/dynamic poster has to be opened and key related components associate with it removed (e.g. poster back lights) in order to gain access to the rear panel of the “LCD Cassette”. This approach leads to a more complex, time consuming and expensive maintenance and installation processes.
- 10
15

- The front glass of the LCD Cassette is heavily secured, required many bolts to be undone if there is a requirement to change the glass on-site e.g. vandalism. Again, this is made difficult due to the weight of the assembly and need for specialised suction equipment.
- 20

As will be appreciated, the design of a “Back-to-back” digital display based on this approach is not practical due to the requirement for rear access to each LCD Cassette, requiring additional supports and rotational mechanism to gain access. Another factor is the resultant depth of the screen.

- 5 -

One common mass produced housing may not easily meet varied mounting needs (free standing, wall mount, integrated structure etc) without over engineering to have a one-size fits all; however this approach leads to additional weight, cost and complexity.

5 An issue with known solutions is that current solutions are not scalable for large scale rollouts where time, cost and quality are critical. Furthermore, the limited modular nature does not lend itself to a common design philosophy where the modules are insufficiently flexible for easily re-targeting for new customer and application needs. For example, varied structural support needs to
10 cater different structures e.g. bus-stops with downward loading (e.g. snow on top of shelter), other structures or winding loading conditions that generate side twisting forces e.g. shopping malls (no wind), free standing, wall mount, free standing at road side on an open hill where wind loading and structural supports needs vary greatly.

15 The result of this is that new products are still often required to cater for customer and application needs, thus reducing the ability to mass produce common components in volume, decrease costs and reduce implementation timescales.

20 Multiple handling and moving of large assemblies and units leads to increased QA issues

 As the benefits of digital screens become understood by councils, retailers, brands, transportation companies etc (e.g. high impact, time of day advertising, real time control, fast response, localising of global content etc); there is a growing need to reduce overall cost of ownership of electronic
25 displays.

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Furthermore, there is a need to build a greater level of maintenance support into the product itself, such that maintenance services can be wrapped up with product manufacturing costs to enable new business models to be adopted e.g. a pure rental model where the end customer is not liable for
5 maintenance costs.

Preferred embodiments of the present invention aim to provide improved large-scale electronic displays and methods of manufacturing such displays.

According to one aspect of the present invention, there is provided a
10 pair of large-scale electronic displays secured back-to-back, each having a display panel that is displaceable to afford access to components behind the display panel for maintenance, each display having a respective cooling system that draws external air into the display through an inlet at one side of the display and exhausts the air through an outlet an opposite side of the display, wherein the
15 inlets of both displays are disposed at one, common side of the pair and the outlets of both displays are disposed at an opposite, common side of the pair.

Preferably, said displays are substantially identical, but with their respective cooling systems arranged to cause airflow in the same, common direction from said inlets to said outlets.

20 Preferably, each inlet is provided with a replaceable air filter that is accessible from said one side of the pair.

Preferably, each of said inlets is angled towards the front of the respective display.

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Preferably, each of said outlets is angled towards the front of the respective display.

Preferably, at least one of the displays has a housing, a transparent door at the front of the housing and a display panel behind the door, wherein the
5 door is connected to the housing by a hinge mechanism that applies closing pressure around the door when closed and brings the door forward, away from the housing, as it opens by pivoting about the hinge mechanism, and the display panel is connected to the door, the hinge mechanism or a part connected thereto, so that it is also brought forward with the door as it opens.

10 Preferably, the hinge mechanism is located at the top of the door and the door is arranged to open by pivoting upwardly about the hinge mechanism.

Preferably, the display panel hangs from the door when the door is opened.

Preferably, the display panel is connected to the door by interengaging
15 slots and studs, such that the display panel can pivot with respect to the door.

Preferably, the displays further comprise a releasable fastener for fastening the display panel to the door so that it opens with the door.

Preferably, the display panel is releasably connected to the door, the hinge mechanism or a part connected thereto, such that the display panel may be
20 removed and replaced.

Preferably, the displays further comprise at least one gas strut to support the door as it is opened.

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Preferably, the displays further comprise one or more detachable connector that provides electrical connections between the display panel and components within the housing, such that disconnection of the or each connector allows sufficient opening movement of the door and panel to afford
5 access to the components within the housing for maintenance.

Handles that may be detachably secured to sides of the display panel in order to support the display panel as it moved into or out of its operative position.

Preferably, at least one of the displays has a housing that comprises an
10 open-fronted box providing structural strength for the display; components are mounted in the box for the supply of electrical power and signals to the display panel, such that all of said components are accessible from the front of the box when a front door of the display is opened; and the box has attachment points for cladding elements around the periphery of the box.

15 Preferably, the box and display panel are generally rectangular and said attachment points are provided on top, side and bottom regions of the box.

Preferably, said attachment points are mutually spaced at modular intervals.

Preferably, cladding is secured to the box at said attachment points.

20 Preferably, a mounting for the display is secured to a lower portion of the box.

Preferably, said components behind the display panel comprise sub-assemblies comprising one or more of display control sub-assembly;

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environmental control sub-assembly; battery sub-assembly; router sub-assembly; fan sub-assembly; power sub-assembly; fan box sub-assembly; camera sub-assembly; display panel sub-assembly; video sub-assembly.

5 A front door of at least one of the displays may comprise a sheet of polycarbonate material with a silicon oxide outer coating, the sheet being bonded to an outer frame.

At least one outer film may provide anti-reflective, anti-graffiti and/or anti-solar-gain characteristics, on said outer coating.

Preferably, said outer film is removable and replaceable.

10 Said outer frame may comprise metal or a composite plastics material.

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

15 Figure 1A is a rear view of a fully assembled digital advertising display (with optional plinth) and static/scrolling rear advertising panel;

Figure 1B is a front view of the display;

Figure 1C is a rear view of the display with an alternative rear digital advertising display;

20 Figure 2 is a partially exploded view of the fully assembled display with outer cladding removed;

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Figure 3 is a fully exploded view of the fully assembled display, showing constituent modular parts;

Figure 4 is a view of the fully assembled display as a free-standing variation, mounted on a plinth;

5 Figure 5 is a view of the fully assembled display and plinth integrated with a structure e.g. bus stop shelter with inward facing screen;

Figure 6 is a view of the fully assembled display (no rear panel or plinth) mounted on a wall;

10 Figures 7A, 7B, 7C illustrate digital display modular implementations with differing heights, creative look and material (cladding);

Figure 8A illustrated a display with combined front and rear advertising modules;

Figure 8B shows a double-sided (back-to-back) digital advertising display constructed from two single digital displays;

15 Figure 9A is a front view of the internal components of a digital advertising display with a glass door and LCD panel removed;

Figure 9B is a side view of the display of Figure 9A with the glass door open and an LCD panel brought forward;

20 Figures 10A, 10B, 10C are side views showing an opening sequence of a door opening mechanism of the display of Figures 9A and 9B, with the LCD

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panel unattached to the glass door, and with an LCD panel cable unplugged to allow the LCD panel to be removed;

Figures 10D and 10E are side views showing the door opening mechanism, with the LCD panel clipped to the glass door with a catch (922), and
5 with an LCD panel cable unplugged to allow access to rear sub-assemblies for maintenance;

Figures 11A, 11B are perspective views of an unassembled (A) and an assembled (B) transport jig;

Figures 12A, 12B are perspective views of a number of transport jigs
10 stacked and/or interlocked both with (A) and without (B) displays carried on the jigs;

Figure 13 is a view of a loaded transport jig navigating an on-site obstacle such as a kerb, with a wheel raised and pivoted onto the obstacle;

Figure 14 illustrates an end-to-end scalable process for mass low-cost
15 deployment of large-scale electronic displays, with ease of on-site maintenance and serviceability;

Figure 15 illustrates the manufacturing process of Figure 14;

Figure 16A illustrates lifting a display with transport jig;

Figure 16B illustrates stacking displays on a lorry close to one another
20 by interlocking and securing transport jigs;

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Figure 17A illustrates digging the ground, laying foundations e.g. concrete and fixing a plinth for a display;

Figure 17B is a perspective view of completed ground works with the plinth buried - note that the plinth may alternatively protrude or be bolted to a
5 foundation laid above ground e.g. where there is a camber in the ground.;

Figure 18 illustrates a display with transport jig being lifted from transport to the ground on-site;

Figure 19 illustrates the display of Figure 18 being pushed into location above the plinth using the transport jig;

10 Figure 20 illustrates the display of Figure 18 being secured to the plinth in-situ;

Figure 21 illustrates the installed display of Figure 18 integrated with a bus shelter – in this example, the digital screen (LCD panel) of the display is outward facing;

15 Figure 22 illustrates maintenance of the installed display of Figure 21 on-site, where front access to components is provided by opening a glass door to bring the LCD panel forward in order to access rear components and sub-assemblies for ease of on-site maintenance and swap-out;

Figures 23 to 41 illustrate an alternative design of display and transport
20 jig;

Figure 23 illustrates the alternative display in perspective view;

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Figures 23A and 23B are detail views showing C-brackets connecting to a foundation plate;

Figure 24 is a view similar to Figure 3, showing the alternative display as an exploded view;

5 Figure 25 shows a chassis of the display of Figure 23 as a perspective view, with skids to form a wheeled transport jig, with Figure 25 showing a detail view;

Figure 26 is a view similar to Figure 15, illustrating a manufacturing process;

10 Figures 27 and 28 are perspective views from Figure 26, to a larger scale;

Figure 29 is a side view to show details of an LCD panel mounted on the frame of a glass door;

Figure 30 illustrates successive stages of opening of a hinge mechanism for the glass door of the display;

15 Figure 31 is a further detail view of the opening glass door together with handles for handling the LCD display;

Figure 32 is a part exploded view to show a fan box mounted on the glass door of the display;

Figure 33 is a detail view of the mounting of the fan box;

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Figure 34 shows perspective views from the front and opposite sides of the display, mounted on transport skids;

Figure 35 is a perspective view of the display on transport skids with jockey wheels, with a detail view of jockey wheels;

5 Figure 36 is a perspective view of a C-lift frame for lifting the display and installing it under an obstacle such as a bus shelter roof;

Figure 37 shows the display on transport skids, along with jacks that fit to the skids to adjust the height of the display;

10 Figure 38 illustrates the display supported by skids and jacks above a foundation plate that is set in place by concrete, which is curing;

Figure 39 illustrates fixings between the display and a bus shelter roof;

Figures 40 and 41 illustrate a top box cladding option for the top of the display, respectively in perspective and front elevation;

15 Figure 42 is a perspective view, with a detail insert, to show a novel transport system for displays;

Figure 43 illustrates details of the novel transport system and means of loading onto transport;

Figure 44 illustrates a display mounted on a transport frame, with Figure 44A showing detail of fixing transport skids to rails;

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Figure 45 illustrates several displays mounted on the transport frame, with Figure 45A showing details of bracing elements;

Figure 46 is view similar to Figure 46 but showing both lower fixings and upper bracings to secure a block of displays on the transport frame;

5 Figure 47 shows details of the transport frame and fixings to connect adjacent transport frames; and

Figure 48 illustrates a plurality of interconnected transport frames on the load bed of an articulated lorry, carrying many displays.

10 It is to be understood that the various features that are described in the following and/or illustrated in the drawings are preferred but not essential. Combinations of features described and/or illustrated are not considered to be the only possible combinations. Unless stated to the contrary, individual features may be omitted, varied or combined in different combinations, where practical.

15 In the figures, like references denote like or corresponding parts.

Figures 1A to 1C show a display 100 with a forward-facing electronic display panel 102 and a choice of rear-facing display panels 103, 104, mounted on an optional plinth 101 that provides structural support to ground. The plinth 101 and associated fixings may be of variable structural qualities to meet the
20 needs of the application e.g. to cater for high wind loading (horizontal forces) or high structural loading (vertical forces) for applications such as bus shelters loaded with snow. The plinth 101 may sit fully beneath ground or directly on top if there is sufficient strength in the ground construction.

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The rear-facing display panel 103 may be, for example, a static backlit poster panel or a scrolling backlit poster panel. The alternative rear-facing display panel 104 is an electronic display panel similar to the forward-facing electronic display panel 102. The electronic display panels 102, 104 are large-scale electronic display panels with a minimum visible screen size of approximately 50 inches (127 cm) and preferably 70 inches (178 cm) or more, measured diagonally across the screen.

As shown in Figures 2 and 3, a display may be formed from a front digital screen module 203 and a rear module 204 that may take various optional forms such as a blanking plate, a static backlit poster module or a scrolling backlit poster module. The front and rear modules 203, 204 are secured together by fixings 205 which in turn are fixed to plinth 101 by fixings 206. Customisable top, side and front claddings 200, 201 and 202 afford a desired external appearance to the display, with air filters 207 (for a cooling system) fitted prior to adding the side cladding 201; or accessible from the front when the glass door is opened. The outer cladding for the display may be standard, custom, branded, creative designed, cosmetic and of any type of material such as metal, wood, Corian, plastics, etc. It may be of varied height and shapes. It may be an extension of the environment that it is integrated with.

Figure 4 illustrates a free-standing configuration of display 100, in which it is secured to plinth 101 that sits on solid foundations 401, such as concrete or a secure structure, established below ground level 400.

Figure 5 illustrates an “integrated” configuration of display 100 in which the top of the display 100 is secured by a “dropper” 502 to the roof 500 of a bus stop that has a side 501 to provide structural support to the roof 500, which is also supported by the display 100.

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A wall-mounted configuration of display 100 is shown in Figure 6, where the display is mounted in a structurally supported wall 600.

Figures 7A to 7C show various styles of cladding 220 around display panel 102, which is disposed at differing heights above ground level 400, thereby giving different appearances to the display 100. The components of the claddings 220 are affixed around the display 100 by fixings at modular spacings, so that they may readily be interchanged with components of different looks and feel.

Figure 8A shows a combined advertising display 800 constructed from a front digital electronic display module 203 and a rear display module 203 that may be, for example, a static backlit poster panel or a scrolling backlit poster panel. Figure 8B is a similar view of a double-sided (back-to-back) digital advertising display 801 constructed from two single digital screen modules 203 and 802. The rear display module 802 may be of generally the same configuration as the front display module 203. However, a heat-exchanger unit within the rear display module 802 for cooling purposes is oppositely handed, as compared to the front display module 203, such that air intakes 212 for the heat exchanger units of both of the modules 203, 802 are all at one common side of the display 801. Corresponding air outlets (not shown in Figure 8B) for the heat exchanger units of both of the modules 203, 802 are located at a common, opposite side of the display 801. This ensures that 'dirty' air output from one of the display modules 203, 802 does not contaminate the 'clean' air input of the other of the display modules. Fan modules at the side of the display 800 may pump external air from external vents through the heat-exchangers, such that the hot air expels at the opposite side to the inlet side.

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Figure 9A is a front view showing internal components of digital display module 920 with a toughened glass door and LCD panel removed and Figure 9B is a side view of the display module 203 with the glass door 913 open and the LCD panel 915 brought forward.

5 Typical components within the display module 920 without glass door are mounted within a metal chassis 900 and include a top environmental control unit 901, a top heat exchanger 902 and a top pair of circulating fans (919) made up of two top external fans 903. At the lower end of the chassis 900 and provided a bottom heat exchanger 904, a bottom pair of circulating fans 918
10 made up of two bottom external fans 905 and a bottom environmental control unit 906. For controlling the display module 203 and providing data to and from it there are provided a router, an optional Ethernet switch, PC (Personal Computer or other processing device) 909, monitoring and control board 910 and Solid State Drive 911. The PC or equivalent (909) may be mounted on a
15 fold-out panel such that, in normal use, it is substantially flush with the surface of the heat-exchangers 902, 904 or other parts, but is folded out to access the PC for programming or service. Other components may be mounted in a similar manner.

For cooling, a bottom pair of circulating fans 918 and a top pair of
20 circulating fans 919 are provided. The chassis 900 houses power supply assemblies 923. Such circulating fan modules and associated power supplies top and bottom of the unit circulate cool air across the front and rear of the LCD panel 915. An antenna 924 and a camera 925 are provided at the top of the chassis 900, along with a pair of external lifting and fixing ears 926.

25 A respective gas strut 914 is provided at each side of the glass door 913, which is mounted on the chassis 900 by a hinge 931. A boss 930 on glass door

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913 allows a strap with a bracket to slot over the boss 930 to assist lifting and securing of the LCD panel 915 to the glass door 913. The LCD panel 915 is supported on a bracket 917 that carries a video scaler, upscale and timing control 916 for the panel 915.

5 The chassis 900 is mounted on a pair of C-brackets that are secured to a foundation plate 210 or other supporting surface that may be above or below ground level and may bridge utility pipe works, etc. Front and rear claddings 208, 209 cover the C-brackets 211.

 Figures 10A to 10C show sequential steps in the opening of the glass
10 door 913, which pivots upwardly about the front door hinge 931. Preferably, as described in further detail below, the hinge 931 is such as to move the glass door 913 forward, away from the chassis 900, as it pivots upwardly. As may be seen, the LCD panel 915 is brought forward with the glass door 913 as it pivots upwardly. The panel 915 is carried on the hinge 931 or other component such
15 that it hangs down from the glass door 913, for ease of access for service or replacement. It will be appreciated that, in large-scale electronic displays, an LCD panel or the equivalent will generally be very heavy. Thus, affording ready access to the LCD panel 915 as illustrated in Figures 10A to 10C is very advantageous.

20 Figures 10D and 10E are similar to Figures 10B and 10C but, in this case, the LCD panel 915 is secured to the glass door 913 by means of a bracket and strap 922 that engages with the boss 930 on the glass door 913. Therefore, as the glass door 913 opens by pivoting upwardly, the LCD panel 915 pivots upwardly with it, thus affording ready access to the interior of the chassis 900 to
25 enable ready servicing of the components within it. Preferably, the components of the display module are arranged in a modular fashion such that modules of

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various different functions can readily be accessed from the front of the chassis 900 and readily swapped for service or repair. A boss 930 and bracket and strap 922 may be provided on each side of the glass door 913, to secure the LCD panel 915 to the door 913. By way of example, the glass door 913 may be open
5 to an angle of about 45°, to afford access to the LCD panel 915 and/or to the inside of the chassis 900. The LCD panel 915 may be connected to components within the chassis 900 by one or more cables 921 that may readily be disconnected and reconnected, to allow the LCD panel 915 to pivot upwardly and/or to gain access behind the panel 915 to components or sub-assemblies
10 within the chassis 900. Examples of such cables are as follows.

The top environmental control sub-assembly 901 controls and monitors the top portion of the LCD backlight within the LCD display panel 915, and the bottom environmental control sub-assembly 906 controls and monitors the bottom portion of the LCD backlight within the display panel 915; using cabling
15 such as ribbon cables and connectors such as D-type connectors, for example, which can be easily disconnected to allow the LCD panel 915 to be moved away from replaceable sub-assemblies located behind the LCD panel 915.

The PC board 909 on board control sub-assembly 927 provides a video connection to the LCD display panel 915 using typical means such as an HDMI
20 interface and associated cables and connectors, which can be easily disconnected to allow the LCD panel 915 to be moved away from replaceable sub-assemblies located behind the LCD panel 915.

The monitoring and control board 910 on board the control sub-assembly 927 provides a communication connection to sensors on the display
25 panel 915 using typical serial communication means such as I2C, CAN BUS etc and using associated cables such as ribbon cables and connectors such as IDC or

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D-Type connectors, which can be easily disconnected to allow the LCD panel 915 to be moved away from replaceable sub-assemblies located behind the display panel 915.

Figure 11 a shows a transport jig 1100 that is formed on its upper
5 surface with a recess adapted to receive a display module 1105 for transport. The transport jig 1100 is provided with wheels (which term includes rollers or casters) 1103 such that it can readily be rolled over a surface. It is also provided with a set of removable outriggers 1101, 1102 that are adapted to interengage with the transport jig 1100 and are provided with multidirectional casters, the
10 heights of which may be adjusted in the manner of jockey wheels. The wheels 1103 on the transport jig 1100 itself may be of fixed or adjustable height.

Figure 11 B shows the display module 1105 and the outriggers 1101, 1102 engaged with the transport jig 1100. In this configuration, the heavy display module 1105 can readily be transported across a surface. In one
15 example, item 1105 is initially a chassis with structural strength, for a display module to be assembled on the chassis. The chassis may conveniently be transported on the transport jig 1100, with or without the outriggers 1101, 1102 from a chassis supplier to a display manufacturing plant. In the manufacturing plant, the chassis is wheeled along a production line, with or without the
20 outriggers 1101, 1102, where components (already in sub-assemblies where appropriate) are progressively fitted to the chassis, in order to form the display module. A completed display module 1105 may continue to be transported on the transport jig 1100, with or without the outriggers 1101, 1102, for both warehouse storage and subsequent transport and on-site installation.

25 Figure 12A shows a set 1106 of display modules 1105 on respective outriggers 1100 and Figure 12B shows the transport jigs 1100 without the display

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modules 1105. As may be seen, the transport jigs 1100 taper from back to front and are adapted to nest with one another and/or interlock in order to minimise floor space and to enable more efficient storage of display modules 1105 in transport and in warehouse.

5 In Figure 13, a loaded transport jig 1104 with outriggers 1101, 1102 is shown navigating a raised kerb. The casters on the leading outriggers 1102 are respectively lowered and raised in order that a leading caster can mount the kerb, following which the adjacent caster is then raised, so that it too can mount the kerb.

10 Figure 14 shows an end-to-end scalable digital display process 1400 from supply, through manufacture, storage and transportation to site, installation maintenance and ultimately de-installation. Figures 15, 16A and 16B show steps of the process to a larger scale.

 In step 1401, metalwork is supplied as chassis 900 mounted on a
15 wheeled transport jig 1500 suitable for a manufacturing environment where there are no obstacles. In step 1402, a number of chassis 900 mounted on respective transport jigs 1500 are transported in an upright position – e.g. on flatbed trucks, where they can be lifted on and off by simple lifting and passed directly to a production line. Shipping the chassis 900 from a supplier, already
20 fitted to the transport jig 1500, can facilitate transportation from the outset.

 In step 1403, each chassis 900 on its respective jig 1500 is wheeled down the production line and populated with components / subassemblies from the front (i.e. accessed from the front of the chassis), starting with the rear components / assemblies etc and building up the assembly, working with
25 successive components / assemblies from rear to front. Thus, for example, each

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unit may progress on its transport jig 1500 from chassis 900 to assembled display module 920, without glass door, to completed display module 203 with glass door, to combined front and rear display modules 800. For example, the components fitted to the chassis 900 may comprise heat exchange assemblies
5 (top and bottom); fan assemblies (top, bottom, external) and associated ducting; environmental control assemblies (top, bottom); internal network; video circuits; main PC board; power monitoring & control board; battery; main power assemblies distributed (e.g. to provide local power for fans, LED backlighting strips etc); LCD panel; Glass door, etc., all supplied as modular replaceable sub-
10 assemblies.

In step 1404, assembled display modules are transported to warehouse 1405 or directly to site in a way that maximise storage on the truck (or other transport means) and minimises handling of the display modules. Thus, the display modules can continue to be transported vertically on their jigs 1500 from
15 initial supply at step 1401 to eventual installation at step 1406, obviating any reorientation of the heavy display modules.

In step 1405, assembled display modules are readily stacked on their transport jigs 1500 in such a way as to maximise floor space and storage capacity – for example, with nesting of the transport jigs as described above.

20 Step 1406 indicates an on-site installation process, still using the same transport jig 1500 to position the display module in situ. Positioning of the display module is indicated at 1501. 1502 indicates a display module that has been installed at, for example, a bus stop shelter, with a display panel facing outwardly.

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Step 1407 indicates simple on-site maintenance by opening the glass door of the display module such that it brings an LCD panel forward in order to access and swap components and/or sub-assemblies within the chassis. 1503 indicates the front glass door opened.

5 Step 1408 indicates a de-installation process, where a display module may be removed from site and, using a transport jig as before, returned to the warehouse for disposal or refurbishment.

Figures 17 to 22 illustrate how a large-scale electronic display is installed as part of a bus stop or shelter, having a roof 500.

10 In Figures 17A and 17B, a plinth 101 with upstanding support struts is fixed to foundations 401 (e.g. concrete) and the ground 400 is made good above the foundations 401. The plinth 101 may alternatively protrude or be bolted to a foundation laid above ground 400 – e.g. where there is a camber in the ground.

15 In Figure 18, a display 1105 is lifted off its transport (e.g. flatbed truck) using lifting ears 926 and lowered onto ground 400, still fixed to its wheeled transport jig 1100. In Figure 19, the loaded transport jig 1104 is pushed towards the bus shelter roof 500 and the upstanding struts of the plinth 101. The transport jig may be tapered as described above, in order that it may fit between the struts of the plinth 101. Figure 19 corresponds to item 1501 in Figure 14.

20 Figure 20 shows a double-sided digital display 800 secured to the upstanding struts of the plinth 101 by fixings 206, with the transport jig then removed, after which it may be returned for re-use as part of the manufacturing flow, eliminating the need for specialist installation equipment – e.g. suction equipment such as Gekos. Where there is no height restriction – for example,

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where the display is a freestanding unit not located under a roof such as in the bus shelter, then the display can be directly lifted and fixed to the struts of the plinth 101 using standard lifting gear (e.g. HIAB), without the need for the transport jig once the display has been unloaded.

5 In Figure 21, which corresponds to item 1502 of Figure 14, top, side and front cladding is fitted for cosmetic appearance. In addition, easily changed and cleanable air filters are located between the cladding and the cooling system of the display, which filters can be cleaned by low-skilled operatives as part of a cleaning process, without opening the glass door of the display. The display is
10 secured to the bus shelter roof via a ‘dropper’, such that the display 100 provides structural support for the bus shelter. As indicated above, any cladding for any creative “look and feel” can be fitted to the display, using a modular fixing system. Likewise, any rear display module can be supported, including a configuration of two back-to-back digital screens, which may be fitted together
15 on-site or as part of the manufacturing process.

 In Figure 22, which corresponds to item 1503 of Figure 14, digital LCD panel 915 faces inwardly with respect to the bus shelter. A rear advertising poster may be changed as required – e.g. typically on a two-week cycle. Glass door 913 of display 100 may be opened upwardly to bring the LCD panel 915
20 forward, either connected to the glass door 913 to facilitate access within the chassis of the display for servicing and swapping components and modules within; or left to hang from the glass door 913 or its hinge, to facilitate access to the LCD panel 915 for service or exchange. Alternatively, digital LCD panel 915 may face outwardly with respect to the bus shelter.

25 Figures 23 to 41 illustrate alternative design features of large-scale electronic displays.

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Display 100 in Figure 23, with detailed views in Figures 23 a and 20 3B, is mounted on C-brackets 211 to support the display 100 on foundation plate 210. Front and rear plinth cladding is 208, 209 cover the C-brackets 211. Lifting and fixing ears 926 are provided on the top of the display 100, along with an
5 antenna 924.

Figure 24 shows the display 100 in exploded view, similar to Figure 3, with customisable top cladding 200 and side cladding 201. In this example, the display comprises a front digital panel module 203 and rear module 204 that can be of any desired configuration.

10 Figure 25 shows display chassis 900 above a pair of skids 1007 that carry wheels, rollers or casters. The chassis 900 is secured to the skids 1007 by C-brackets or other fixing means. The wheeled skids 1007 thus provide a wheeled transport jig (1000) for transport of the chassis 900 and subsequently assembled display.

15 Figure 26 is a view similar to Figure 15, like reference numerals indicating like or corresponding parts, illustrating stages of manufacture, during which chassis 900 is populated with components and/or sub-assemblies as it is wheeled along a production line on the wheeled skids. 927 indicates a control assembly – for example including a PC or equivalent (909), monitoring and
20 control board (910) and solid-state memory device (911). Also shown is a battery assembly 928. Figures 27 and 28 are perspective views from Figure 26, to a larger scale.

The detail view of Figure 29 shows a curved slot 932 formed in the surround of glass door 913. The slot 932 is open at its left side and closed at its
25 right side, as seen. The slot 932 receives a stud (not shown) on support bracket

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(917) of LCD panel 915 such that the LCD panel 915 may be freely suspended from the door 913. To fit to the LCD panel 915, the stud is firstly introduced into the left side of the slot 932 as seen, raised slightly and then dropped down the right side of the slot 932 as seen, where the weight of the LCD panel 915
5 retains the stud in the slot 932. In order to remove the LCD panel 915, it is lifted sufficiently for the stud to travel up the slot 932 and then dropped back down the left side of the slot 932, where it can exit the slot 932. A slot 932 is provided at each side of the door 913, with respective studs provided on the support bracket of the LCD panel 915 or other associated part. The studs allow
10 the LCD panel 915 to pivot with respect to the door 913, so that the LCD panel may hang freely (as in Figures 10B and 10C, for example) or pivot upwardly with the door 913 (as in Figures 10D and 10E, for example).

Figure 30 shows the glass door hinge 931 in a closed position (at the left side as seen) and in successive stages of opening. In the interests of clarity, the
15 door itself is not shown.

The hinge 931 comprises a parallel linkage in which the outer end of a main support arm 935, which is connected to the door surround or an associated part, is arranged to pivot upwardly as the hinge opens and come forward as it does so. A secondary support arm 936 is pivotally connected at one end to the
20 main support arm 935 and its other end is constrained to move vertically in a slideway 938. Three pivotal links 937 each have one end constrained to move vertically in the slideway 938, one of the pivotal links 937 having its opposite end pivotally connected to the main support arm 935 and the other two pivotal links 937 having their opposite ends pivotally connected to the secondary support arm
25 936. The inner end of the main support arm 935 moved downwardly a little, as the outer end of the main support arm 935 pivots upwardly and moves outwardly.

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Figure 31 shows further detail of the opening glass door 913 with LCD panel 915 hanging from it. The LCD support bracket 917 at each side of the LCD panel 915 is formed with a pair of keyhole slots 1700 with which the heads 1701 of handles 1704 or 1705 are removably engaged, the handles having
5 respective shanks 1702, 1703 of alternative configurations. When secured in the keyhole slots 1700, four handles 1704, 1705 (two each side of the panel 915) may be used to lift the LCD panel 915 into and out of position without needing to touch or mark the front of the LCD panel 915. Thus, this facilitates engaging the LCD panel 915 with the door 913, hanging the panel 915 in its operative
10 position, removing it from that position, or latching the panel 915 to the door 913 for access within the display chassis.

Figure 32 illustrates a novel arrangement for mounting one of more cooling fan. Instead of being mounted in a permanent position on the main chassis, an upper pair of circulating fans 919 are housed in a fan box 1800 that
15 has a pair of apertures to engage with two pillars 1801 that are mounted on the front door 913 or an associated part. When so engaged, the fan box 1800 is secured in place by a pair of clips 1802 that engage with end portions of the pillars 1801. A third clip 1802 engages with a corresponding fastening on the front door 1803, between the two fans 919. Thus, the fan box 1800 forms a
20 sub- assembly that is readily secured to the front door 913 assembly, in a space above the LCD panel 915. Thus, when the door 913 is opened, the fan box 1800 pivots upwardly with it, thereby affording improved access to components or sub- assemblies within the display chassis – e.g. router 907 – for maintenance or replacement. It will be appreciated that the fan box 1800 itself may readily be
25 removed from the front door 913 assembly, for maintenance or replacement.

Figure 33 is a perspective view looking upwards into the display with the front door 913 open, showing the fan box 1800 above the LCD panel 915.

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A door seal 1803 is shown in Figure 32. As described above and illustrated in the preceding figures, the door 913 is subjected to a degree of translational movement, forwardly away from the display chassis, as it is pivoted upwardly to open. Conversely, when the door 913 is pivoted downwardly to close, it is also subjected to a degree of translational movement, backwards
5 towards the chassis, thereby applying a relatively uniform pressure to the door seal 1803 to ensure a good seal to the interior of the display.

Figure 34 shows display 100 carried on a pair of wheeled skids 1007 and provided with a pair of fixing and lifting ears or lugs 926. Figure 35 is a view
10 similar to Figure 13, showing a loaded transport jig 1004 with a display 1005 under transportation, the wheeled skids 1007 affording the transport jig in this case, provided with outriggers 1001, 1002 with casters of adjustable height, which can be engaged with and detached from the wheeled skids 1007.

Figure 36 illustrates a novel device for lifting a display 100 and installing
15 it under an obstacle such as a bus shelter roof 500. We refer to the device as a C-lift frame 1650 as it is generally of C-shape. It comprises a generally upright frame 1651 that supports a telescopic upper arm 1652 and a pair of telescopic lower forks 1655 that are joined by a brace 1656. A counterbalance weight 1654 is mounted at an end of the upper arm 1652. A lifting point 1653 is provided on
20 the upper arm 1652 and may take the form of a lifting eye, U-bolt and/or loop for attachment to lifting equipment – for example a HIAB, small crane or any other suitable means.

In use, the lifting forks 1655 are attached to the lifting ears 926 on the display 100 and lifting equipment lifts the display 100 via the C-lift frame 1650,
25 the weight and position of the counterbalance 1654 being suitably adjusted to ensure that the forks 1655 remain substantially horizontal and the display 100

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remains substantially upright. The C-lift frame 1650 can then be manoeuvred via the lifting equipment until the display 100 is in a required position beneath the bus shelter roof 500, which is accommodated in the space between the upper arm 1652 and the lower forks 1655 of the C-lift frame 1650. When in position,
5 the display 100 is lowered gently until it is supported on its skids 1007, which in turn are supported by means appropriate to the particular installation, an example of which follows. The C-lift frame 1650 can then be disconnected from the display 100 and removed out of position by the lifting equipment.

Figure 37 illustrates a display 100 mounted on skids 1007 to which jacks
10 1008 are removably attached. It may be assumed that the display 100 has just be manoeuvred under a bus shelter roof with the aid of the C-lift frame 1650. In this example, as illustrated in Figure 38, the display 100 is supported on the skids 1007 that in turn are supported by jacks 1008 that in turn are supported on ground surrounding an excavation in which foundation plate 210 with C-
15 brackets 211 attached has been laid. By adjusting the height of the jacks 1008, the display 100 is lowered onto and fixed to the top of the C-brackets 211 using fixing bolts or other means, which are in turn fixed to the foundation plate 210. The dropper 502 is fixed to the fixing ears 926 using fixing bolts. Once fixed, the jacks 1008 raise the height of the display 100, C-Brackets 211 and foundation
20 plate 210, allowing the dropper 502 to be fixed to the bus shelter roof 500, where the entire structure is supported on the jacks 1008. Concrete is poured into the foundations to fill the gaps and secure the foundation plate 210 and C-brackets 211 into the foundations. Once the concrete has set, the skids 1007 and jacks 1008 can be removed and returned to the factory or warehouse for re-use.
25 Where necessary the skids 1007 can be extended to bridge the foundation hole, allowing the jacks to safely support the structure until the concrete has set. This method allows the display, foundations and associated C-brackets and foundations plates to be perfectly aligned with the fixed bus shelter fixing points

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whilst the concrete sets, eliminating any misalignment between foundations and bus shelter roof.

If it is desired to remove the display 100 for maintenance, replacement or disposal, the bus shelter can be temporarily supported e.g. using an Acrow
5 prop, the dropper 502 removed, the display 100 fixed to and supported by the C-lift frame 1650, the display unfixed from the C-brackets 211 and then lifted from beneath the bus shelter. The skids 1007 can then be refit to the display 100 ready for transportation back to the factory or warehouse using a transport means such as a flatbed truck.

10 Similarly a replacement display 100 can be lifted and positioned under the bus shelter roof 500 using a C-lift frame 1650 and fixed to both the stable C-brackets 211 and bus shelter roof 500 using the dropper 502 in the knowledge that the foundation fixings are perfectly aligned with bus shelter fixings as a result of previous methods.

15 The steps outlined above with reference to Figures 37 and 38 are not confined to use for installation of displays 100 under obstructions such as bus shelter roof is 500. If there is no such obstruction, the C-lift frame 1650 does not have to be employed and the display 100 can be positioned over an excavated foundation, utilising lifting ears 926 and/or skids 1007 and/or jacks
20 1008. The skids 1007 and jacks 1008 may also be used where the foundation is not excavated, for convenient positioning of the display 100 with respect to its various fixings. For example, the display 100 may conveniently be raised to meet a bus shelter roof 500 or other structure above it, to which it may be secured.

Skids 1007 may be of different lengths for different installations.
25 However, they may conveniently be of a standard length suitable for most

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purposes, with optional extension pieces to extend the distance between the skids 1007 and jacks 1008 and/or outriggers 1001, 1002.

Figure 39 illustrates fixings between a display 100 and a bus shelter roof 500. A 'dropper' 502 is secured to the fixing ears 926 at the top of the display
5 100 by nuts and bolts or other suitable means and also to the bus shelter roof 500 by nuts and bolts or other suitable means.

Figures 40 and 41 illustrate a 'top box' that may provide a top cladding to a screen 100 of freestanding configuration, without a structure such as a bus shelter roof above it. The top box 1600 has fixing ears 1601 that are located
10 adjacent the fixing ears 926 at the top of the display 100, the ears 926 passing through slots in the base of the top box 1600. The fixing ears 1601 and 96 are secured together by nuts and bolts or other securing means. An antenna extension cable 1602 passes through a sealing grommet at the top of the display
15 100 and connects to antenna 924 on top of the top box 1600 via a hole in the bottom of the top box 1600. The top box 1600 has front and rear panels that can be opened to gain access to components or fixings inside.

A novel transport system for displays is illustrated in Figures 42 to 48.

Figure 42 shows a transport frame base (module) 1901 that is secured to a flat load bed of a lorry (truck) 1900. The transport frame base 1901 may be
20 used as a single item – for example, on a small flatbed lorry – or cascaded with other similar modules – for example, three modules can be used on an articulated lorry. The transport system can also be used on other transport vehicles, vessels or devices.

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The load bed of the truck 1900 is provided with a series of anchor points 1902 – typically along the edges of the load bed. The transport frame base 1901 is secured to the anchor points 1902 by fixings 1903 – for example, turnbuckles, chains, straps, etc. As seen in Figure 43, a display 100 to be
5 transported is mounted on skids 1007, to each of which is fitted a fork bracket 1904 at or adjacent a respective end of the skid 1007. Each of the fork brackets 1904 is formed with an aperture to receive a fork 1905 of a forklift truck. Thus, as illustrated, each of a pair of lifting forks 1905 engages with two fork brackets, one on each of the skids 1007, so that the forklift truck can readily lift and
10 transport the display 100, mounted on the skids 1007.

As seen in Figure 44 and Figure 40 4A, the transport frame base 1901 comprises a plurality of parallel rails 1906 that are secured to the frame base 1901 in pairs. The rails 1906 are of open channel or U-section, as seen. In Figure 44, the rails 1906 are arranged in two spaced sets of three, one set on the
15 left side and the other set on the right side of the frame base 1901, as seen. The figure shows a single display 100 mounted on its skids 1007, which are secured respectively to the right most rail 1906 of each set of three, as seen. To this end, each rail 1906 is formed with pairs of opposite holes at modular intervals, to receive fixing pins 1911 (e.g. clevis pins) that secure the bottom part of a skid
20 bracket 1909. The upper part of the skid bracket 1909 is secured to an end of a respective skid 1007, by means of another fixing pin 1911 that passes through a pair of opposite holes at the respective end of the skid 1007, as shown in Figure 44A.

An upright frame 1907 is secured at one end of the frame base 1901 and
25 held by cross braces 1910. Further braces 1908 are secured between the top of the upright frame 1907 and the fixing ears 926 at the top of the display 100. Thus, the display 100, as shown in Figure 44, is secured firmly on the transport

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frame base 1901 and by the upright frame 1907, the transport frame base 1901 being secured firmly in turn on the load bed of the respective transport vehicle or device.

With a single display 100 secured to the frame base 1901, as shown in
5 Figure 44, the remaining pairs of rails 1906 may then be used to mount and secure additional displays. Thus, the skids 1007 of a second display 100 may be mounted on the centre rails 1906 of each set of 3, such that the second display is disposed slightly behind and to the left (as seen) of the first display 100. This effectively nests the skids 1007 under the displays 100, to minimise the footprint
10 required to load multiple displays 100 and maximise packing density on the transport. A further display 100 may then be mounted in a similar way behind the second display, slightly behind and to the left of it, with the respective skids 1007 being mounted on the leftmost rails 1906 (as seen) of the sets of three. A fourth display 100 may then be mounted behind the third display, again using
15 the right most rails 1906 (as seen) of each set of three, so that the fourth display is lined up behind the first display – and so on.

Figure 45 illustrates such an arrangement, with 4 displays 100 mounted on the transport frame base 1901, one behind the other, with each two successive displays laterally offset. Braces 1908 secure the tops of the displays
20 100 to the top of the upright frame 1907. Where two displays 100 are in alignment, as with the first and fourth displays, successive braces 1908 may be joined at fixing ears 926, as shown in Figure 45, where a fixing pin 1911 secures the respective ends of two successive braces 1908 at a fixing ear 926 of the first display 100.

25 In Figure 46, an additional upright frame 1907 is secured part way along the frame base 1901, with braces 1910 to secure the upright frame 1907 and with

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upper braces 1908 secured to the top of the upright frame 1907. By securing the skids 1007 to the rails 1906 on the frame base 1901 and by securing the tops of the displays 100 by the braces 1908, the displays 100 are formed into a secure block that cannot fall via a “domino effect” during transportation. The load of
5 displays 100 can move only as a whole rather than as individual elements.

As mentioned above, the frame base 1901 is preferably of modular design such that it can be cascaded with other similar units. To this end, as shown in Figure 47, male connectors 1912 and female connectors 1913 are provided at the ends of the frame base 1901 and are adapted to interconnect in
10 order to secure adjacent frame bases 1901 together.

Figure 48 shows an arrangement in which 3 transport frame bases 1901 have been interconnected and to end and secured to the load bed of an articulated lorry 1900. Displays 100 are secured to the frame bases 1901 and upright frames 1907 as described above, to form an integrated load for transport.
15 At the end of the load bed, space is provided for a pallet to transport supplementary fixings – e.g. C-brackets, plinths, cladding, etc.

At a transport destination, one or more displays 100 may be detached from the frame base 1901 and upright frame(s) 1907 and lifted down from the load bed for installation at the respective site. At a suitable point, the fork
20 brackets 1904 may be removed from the skids 1007 and, if they have previously been removed or retracted, wheels, rollers, casters, etc may be redeployed on the skids 1007 – and/or wheeled outriggers may be attached to the skids 1007, to assist as may be required in the respective installation process.

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Illustrated examples of the invention may provide numerous features and advantages, as follows.

Improved access is provided to electronics components and assemblies behind an LCD panel to facilitate easy swap out; without having to provide
5 mechanisms to rotate the screen away from obstacles (e.g. wall) and gain entry from rear panels that require removal of rear advertising assemblies e.g. lighting strips.

Simpler installation is afforded by reducing the weight of assemblies that obviate the need for expensive lifting equipment; particularly through single site
10 visits eliminating installation of different units at different times.

Flexibility of design is afforded, with mechanisms to quickly tailor mass produced assemblies into customer and application specific screens quickly, with the ability to mount freestanding, wall mounted or as part of existing structures without creating fully bespoke designs.

15 A scalable electronic display apparatus combined with a scalable mass process (from supply of components & assemblies, through manufacture, storage, transport logistics, installation, maintenance and ongoing operations) is key for reducing the total cost of ownership for both the advertising screen operator and the screen supplier (who may wrap up the maintenance service into
20 a rental model).

Conventionally, large outdoor screens (large-scale electronic displays) e.g. 60 inch (152 cm) or more are extremely large, bulky and heavy and as a minimum they exceed 100kg in weight and typically greater than 250Kg. This is as a result of the structure, weather-proofing, temperature extremes for the

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environment, and also to ensure audience viewability from long distances in direct sunlight.

Examples of the invention may provide a large outdoor advertising screen module that can be quickly and easily tailored to meet varying client and market needs that change on an ongoing basis, by enabling the module to be mounted, clad and integrated in different ways through attached modular accessories; in a way that can be mass produced for low cost and high volume. Furthermore they adopt features that ease serviceability and maintenance such that the cost of ownership is reduced over the lifetime of the product. The modular end products created (through integration of accessories) are mass produced through a method that spans the life cycle of the module / end products including component supply, manufacture, warehouse, transportation, on-site installation, maintenance and de-installation.

Illustrated in the example of Figure 14 is a method or process of manufacturing a large-scale electronic display having a given orientation, comprising the steps of constructing a chassis to provide structural strength for the display; mounting the chassis on a transport jig; conveying the chassis on the transport jig to an assembly line; moving the chassis on the transport jig along the assembly line; and fitting components for the display to the chassis as it is moved along the assembly line: wherein the chassis is maintained in an orientation corresponding to the given orientation of the display from the time that is mounted on the transport jig until the time that assembly of the display is completed on the assembly line.

In such a process, the desired electronic display end goods are manufactured by successively assembling components, sub-assemblies and modules down a production line; where the process can be extended to simplify

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the complete product life cycle from supply of key components through to installation and ongoing maintenance.

Prior to the production line, key large source assemblies may be prepared and transported with sub-systems and components in a suitable way
5 and using jigs/bogies that minimise handling and dovetail with manufacturing process to simplify and reduce costs.

Post production line, the product is transported and handled using the re-useable jigs / bogies with suitable “accessories / attachments” that simplify the on-site installation.

10 The unit is transported along the production line upright, as it remains throughout storage, shipment and final installation.

Typically, the display in manufacture is successively wheeled on the bogie down the production line for assembly, then test, then to a transportation area; where wheels maybe optionally removed from the bogie and the entire
15 screen assembly (including stable base) lifted onto vehicle for transport to a warehouse. Once taken from warehouse to site, the screen assembly will be lifted, placed on the ground and wheeled jigs attached to the base plates to aid moving the screen assembly into positioned on the plinth, where there is sufficient movement in the jig to traverse and manoeuvre around obstacles such
20 as kerbs, pavements, slopes, bollards, bins ... or under canopies providing restricted head height e.g. forecourt or shop canopies.

The transport jigs, where stacked, may provide additional stability for transporting more than one unit. The transport jigs may allow one or two

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displays to be built upon the jigs by moving the jig between two parallel manufacturing lines.

Handling can be simplified at each stage since there is no need to change the orientation of the display throughout the whole process, e.g. by
5 simply moving the screen on its “bogie” or jig with supplementary aid from relatively simple, traditional lifting equipment such as a crane (within manufacturing plant) or HIAB (at the point of installation); eliminating the multiple site visits of heavy assemblies as associated with previously proposed approaches.

10 These handling features facilitate moving for example, a heavy 250-350kg product that might otherwise cause Health & Safety issues, Quality Assurance issues and increased time.

Two parallel manufacturing lines allow two screen assemblies to be bolted to a common plate/bogie/transport jig and assembled together as they
15 pass between the two process lines – resulting in the two screens being fixed together at bottom and top, to add improved stability for subsequent transport.

Once the display has be located on site then the installer will plug in power from the plinth, noting that the plug in approach avoids the need for an electrician to be on site. Once transport bolts/fixings have been removed from
20 the display assembly, then side air filters will be placed in position and closed off with side cladding. Note that this aids the general maintenance of the screen when non-skilled people can remove the side cladding (without opening up the main screen) to clean or swap filters. Furthermore, since these are at the side, as opposed to the top as with many large screens, this means that no working at
25 heights tools e.g. steps, platforms are required that have a significant impact on

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health and safety, particularly where screens are located at hazardous environments such as roadside, rail platforms, petrol forecourts etc.

Air flow is arranged horizontally across the unit such that air intake filters can be easily cleaned or replaced by non-skilled workers without opening
5 the main unit or having to work at heights in busy locations (as is the case for previously proposed vertical cooling arrangements where air intake is located at the top of the unit).

Serviceability of the display may be facilitated through a front glass door that comprises glass bonded directly to a frame (not replaceable glass) such that
10 the entire glass door can be replaced, rather than just the glass.

Prior art has glass door assemblies (replaceable glass) opening hinged from the top using a fixed hinge; or by bolting the glass door assembly evenly around the seals e.g. as with a 'LCD Cartridge' approach.

Using fixed hinges generally does not apply equal pressure to the seals
15 all around the frame as the door closes, resulting in distortion to the seals.

Bolted glass assemblies require many bolts to be opened making it time consuming; furthermore, once re-attached care has to be taken to apply even pressure to ensure the seals are not damaged

The illustrated example of opening mechanism utilises a cantilever
20 hinge, which brings the glass door assembly forward and away from the frame as it opens, due to the parallelogram action of the hinge.

Key benefits are that it is easy to open without needing many bolts to be undone (reducing time on site); and when the door closes it provides even

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pressure around the door frame seals as the door contacts and closes against the frame; without distortion to the seal around the hinges.

As regards the glass door for the display, prior art shows glass assemblies being using for advertising screens; where the glass is separate and
5 replaceable to the door frame; for use where the glass breaks and can be replaced easily. It also shows glass bolted with many bolts in order to provide a secure seal which is difficult and time consuming to open.

Glass can be bonded directly to the frame such that it is not replaceable, where the frequency / probability of it getting damaged makes it worthwhile
10 bonding as one unit such that the glass door can be opened easily. However, where the glass is broken then the cost of replacing the glass door is expensive.

We propose the use of a new material that has been developed and applied to commercial window applications. Hammerglass, a polycarbonate material with a silicon oxide (glass) surface (developed by
15 www.hammerglass.com) is a durable abrasion-resistant polycarbonate sheet, 300 times stronger than glass and virtually unbreakable. It is 40% lighter than glass, making it easier to handle.

Although it doesn't break when subjected to ballistics, hammers and other attacks, it does however have weaknesses for outdoor advertising
20 applications. It can be scratched with sharp objects; it is very reflective making it not directly suited to use in strong light e.g. sunlight conditions, where the advertising on screen needs to be clearly visible; from a solar gain control perspective (i.e. sunlight heating up the screen), although the manufacturers have Infrared (IR) versions, these may not be optimal optically. Other similar

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unbreakable glass solutions exist e.g. Exatec who are starting to apply similar technology to car glazing with the weight savings that this brings.

We propose a “layered” solution that combines the benefit of a glass door where the glass is bonded directly to the door frame; e.g. where it can then
5 be attached to the outdoor advertising screen using hinges such as fixed or cantilever hinges. We also provide a toughened plastics material in addition to or in place of glass, so that it is rarely needed to be replaced – e.g. polycarbonate. Preferably an anti-graffiti window film is applied to the toughened plastics sheet to tailor the optical and / or solar gain properties of the overall sheet. The extra
10 film provide extra protection for scratching and is easily removable and replaceable. Thus, in case of any damage, the film is simply replaced rather than the glass.

The frame to which the glass (or alternative) is bonded to does not need to be metal. For example, it could be Glass Re-enforced Plastic (GRP),
15 fibreglass etc in order to reduce the weight of overall weight of the door.

The layers of toughened plastics sheet and attached film could be arranged to be replaced and fixed into a glass assembly as per prior art, or could be bolted to a frame through holes in the toughened plastics sheet where seals are made as the bolts are tightened.

20 When combined with the other features as disclosed herein, this provides a cost effective, light weight, easy to work with solution that helps reduce cost and aid mass scalability of large outdoor advertising screens.

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The figures illustrate two displays back-to-back to provide a digital advertising screen on both front and rear. Appropriate cladding will give the appearance that this is just one unit.

This is far more efficient than developing a common housing that takes
5 both LCD screens and requires suitable cooling arrangements; or place two single units together which may result in the unit being very thick.

Heat exchangers can be placed to force air flow to go either left-to-right or right-to-left within each module. This enables two front display modules to be positioned back-to-back as a single combined module, and arranged such that
10 the external air intake on both modules is on the same (common) side; as well as the exhaust outlets also being on the same but opposite side. This ensures that the dirty air output from one display does not contaminate the clean air input of the displays. It also enables external filters placed between the cladding and the display modules to be easily accessible for regular cleaning and replacement as
15 part of an ongoing maintenance process, noting that the operative a) does not have to work at heights since the filters will be on the side rather than the top of the unit and b) does not have to open the display where the sensitive electronics are present – e.g. side cladding can be removed by a low skill operative when the glass is cleaned.

20 In the foregoing, the LCD panel and the box formed by the chassis are typically rectangular, but could be other shapes.

Although LCD panels are mentioned primarily, the invention applies equally to display panels utilising other technology, e.g. LED or plasma.

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In this specification, the verb "comprise" has its normal dictionary meaning, to denote non-exclusive inclusion. That is, use of the word "comprise" (or any of its derivatives) to include one feature or more, does not exclude the possibility of also including further features. The word "preferable" (or any of
5 its derivatives) indicates one feature or more that is preferred but not essential.

The reader's attention is directed to all and any priority documents identified in connection with this application and to all and any papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with
10 this specification, and the contents of all such papers and documents are incorporated herein by reference.

All or any of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all or any of the steps of any method or process so disclosed, may be combined in any combination,
15 except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus,
20 unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any

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accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

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CLAIMS

1. A pair of large-scale electronic displays secured back-to-back, each having a display panel that is displaceable to afford access to components behind the display panel for maintenance, each display having a respective cooling system
5 that draws external air into the display through an inlet at one side of the display and exhausts the air through an outlet an opposite side of the display, wherein the inlets of both displays are disposed at one, common side of the pair and the outlets of both displays are disposed at an opposite, common side of the pair.
2. A pair of large-scale electronic displays according to claim 1, wherein said
10 displays are substantially identical, but with their respective cooling systems arranged to cause airflow in the same, common direction from said inlets to said outlets.
3. A pair of large-scale electronic displays according to claim 1 or 2, wherein each inlet is provided with a replaceable air filter that is accessible from said one
15 side of the pair.
4. A pair of large-scale electronic displays according to claim 1, 2 or 3, wherein each of said inlets is angled towards the front of the respective display.
5. A pair of large-scale electronic displays according to claim 1, 2, 3 or 4, wherein each of said outlets is angled towards the front of the respective display.
- 20 6. A pair of large-scale electronic displays according to any of the preceding claims, wherein at least one of the displays has a housing, a transparent door at the front of the housing and a display panel behind the door, wherein the door is connected to the housing by a hinge mechanism that applies closing pressure around the door when closed and brings the door forward, away from the

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housing, as it opens by pivoting about the hinge mechanism, and the display panel is connected to the door, the hinge mechanism or a part connected thereto, so that it is also brought forward with the door as it opens.

7. A pair of large-scale electronic displays according to claim 6, wherein the
5 hinge mechanism is located at the top of the door and the door is arranged to open by pivoting upwardly about the hinge mechanism.
8. A pair of large-scale electronic displays according to claim 7, wherein the display panel hangs from the door when the door is opened.
9. A pair of large-scale electronic displays according to claim 8, wherein the
10 display panel is connected to the door by interengaging slots and studs, such that the display panel can pivot with respect to the door.
10. A pair of large-scale electronic displays according to any of claims 6 to 9, further comprising a releasable fastener for fastening the display panel to the door so that it opens with the door.
- 15 11. A pair of large-scale electronic displays according to any of claims 6 to 10, wherein the display panel is releasably connected to the door, the hinge mechanism or a part connected thereto, such that the display panel may be removed and replaced.
12. A pair of large-scale electronic displays according to any of claims 6 to 11,
20 further comprising at least one gas strut to support the door as it is opened.
13. A pair of large-scale electronic displays according to any of claims 6 to 12, further comprising one or more detachable connector that provides electrical connections between the display panel and components within the housing, such

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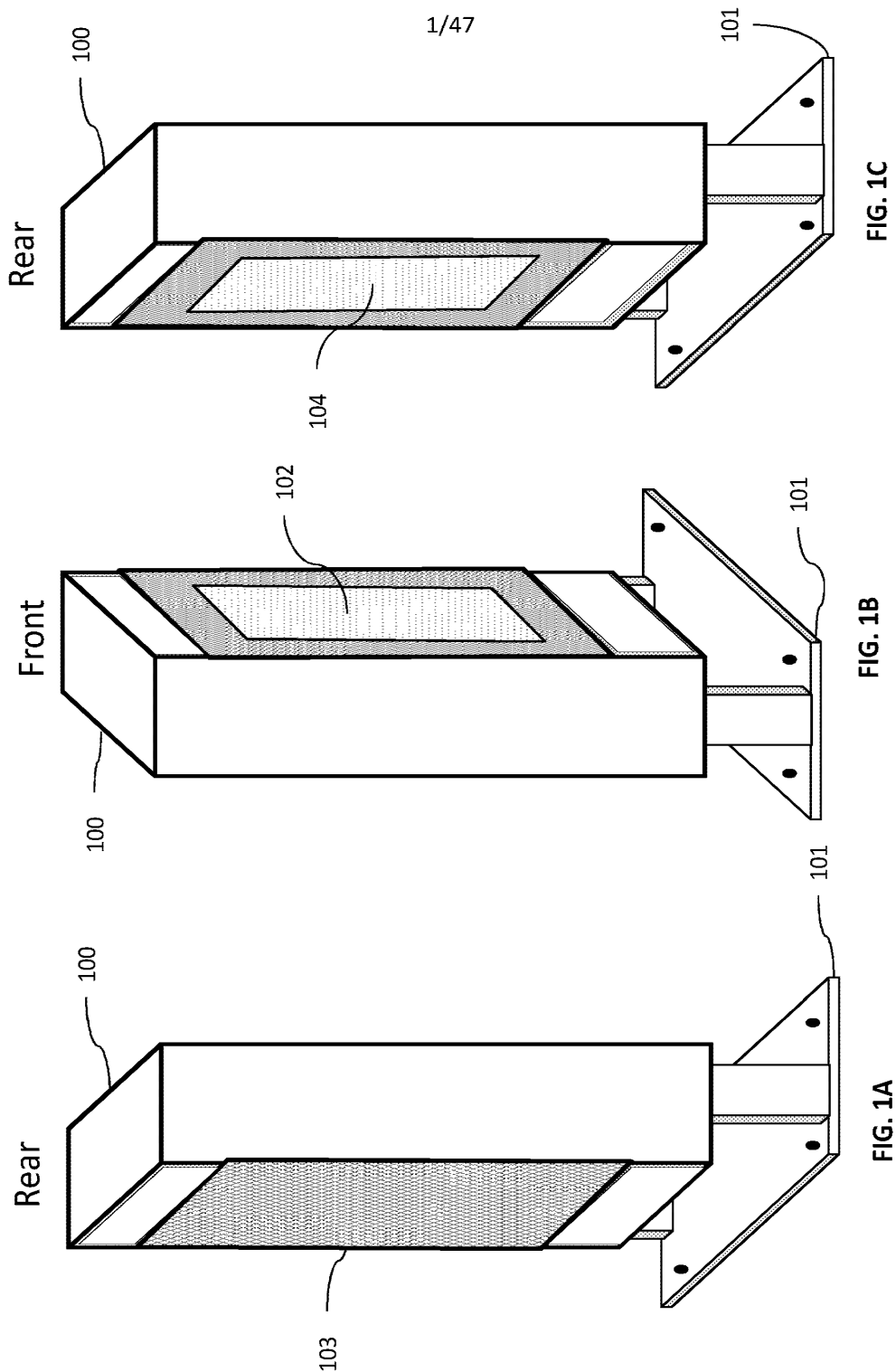
that disconnection of the or each connector allows sufficient opening movement of the door and panel to afford access to the components within the housing for maintenance.

14. A pair of large-scale electronic displays according to any of claims 6 to 13,
5 further comprising handles that may be detachably secured to sides of the display panel in order to support the display panel as it moved into or out of its operative position.
15. A pair of large-scale electronic displays according to any of the preceding claims, wherein at least one of the displays has a housing that comprises an
10 open-fronted box providing structural strength for the display; components are mounted in the box for the supply of electrical power and signals to the display panel, such that all of said components are accessible from the front of the box when a front door of the display is opened; and the box has attachment points for cladding elements around the periphery of the box.
- 15 16. A pair of large-scale electronic displays according to claim 15, wherein the box and display panel are generally rectangular and said attachment points are provided on top, side and bottom regions of the box.
17. A pair of large-scale electronic displays according to claim 15 or 16, wherein said attachment points are mutually spaced at modular intervals.
- 20 18. A pair of large-scale electronic displays according to claim 15, 16 or 17, wherein cladding is secured to the box at said attachment points.
19. A pair of large-scale electronic displays according to any of claims 15 to 18, wherein a mounting for the display is secured to a lower portion of the box.

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20. A pair of large-scale electronic displays according to any of the preceding claims, wherein said components behind the display panel comprise sub-assemblies comprising one or more of display control sub-assembly; environmental control sub-assembly; battery sub-assembly; router sub-assembly; fan sub-assembly; power sub-assembly; fan box sub-assembly; camera sub-assembly; display panel sub-assembly; video sub-assembly.
21. A pair of large-scale electronic displays according to any of the preceding claims, wherein a front door of at least one of the displays comprises a sheet of polycarbonate material with a silicon oxide outer coating, the sheet being bonded to an outer frame.
22. A pair of large-scale electronic displays according to claim 21, further comprising at least one outer film that provides anti-reflective, anti-graffiti and/or anti-solar-gain characteristics, on said outer coating.
23. A pair of large-scale electronic displays according to claim 22, wherein said outer film is removable and replaceable.
24. A pair of large-scale electronic displays according to claim 21, 22 or 23, wherein said outer frame comprises metal or a composite plastics material.
25. A pair of large-scale electronic displays substantially as hereinbefore described with reference to the accompanying drawings.

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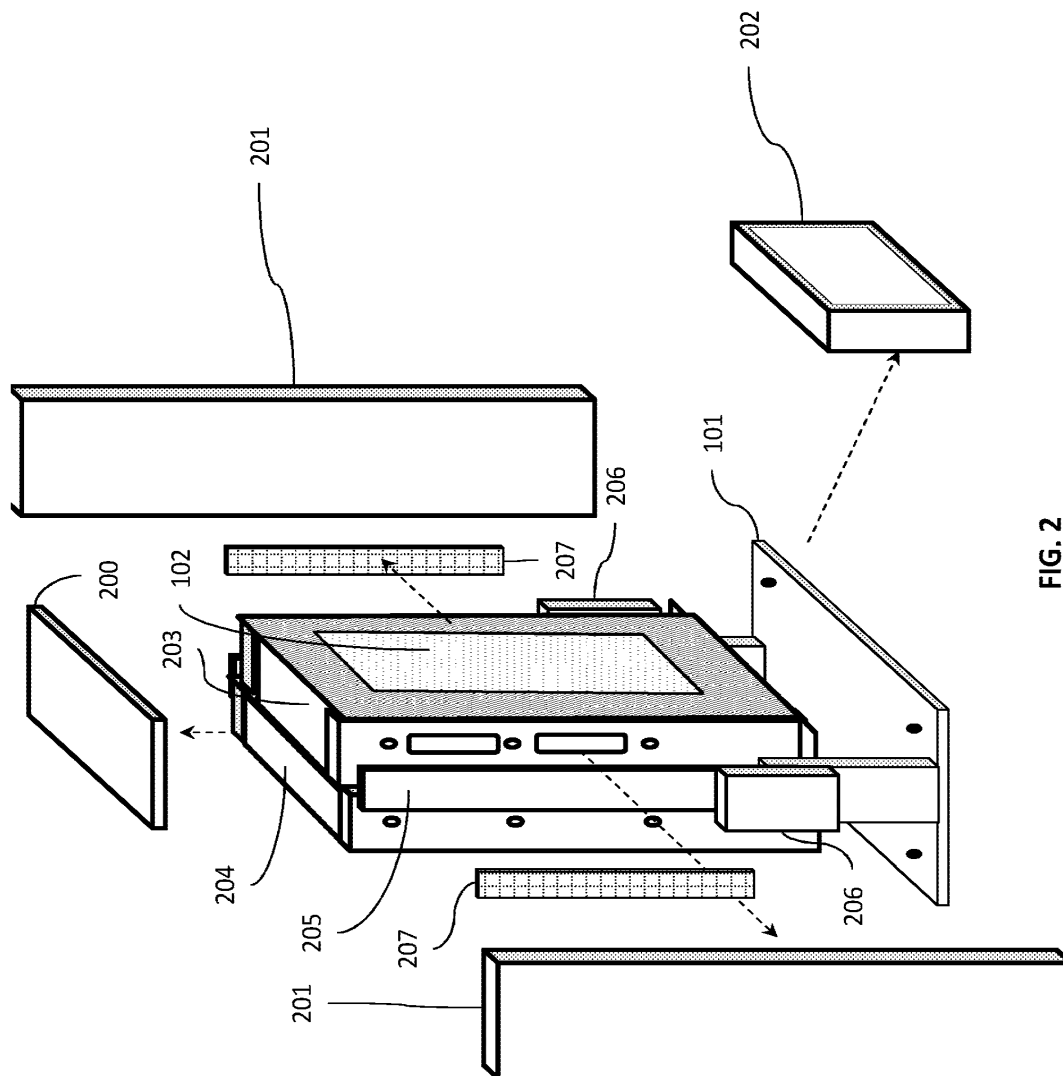
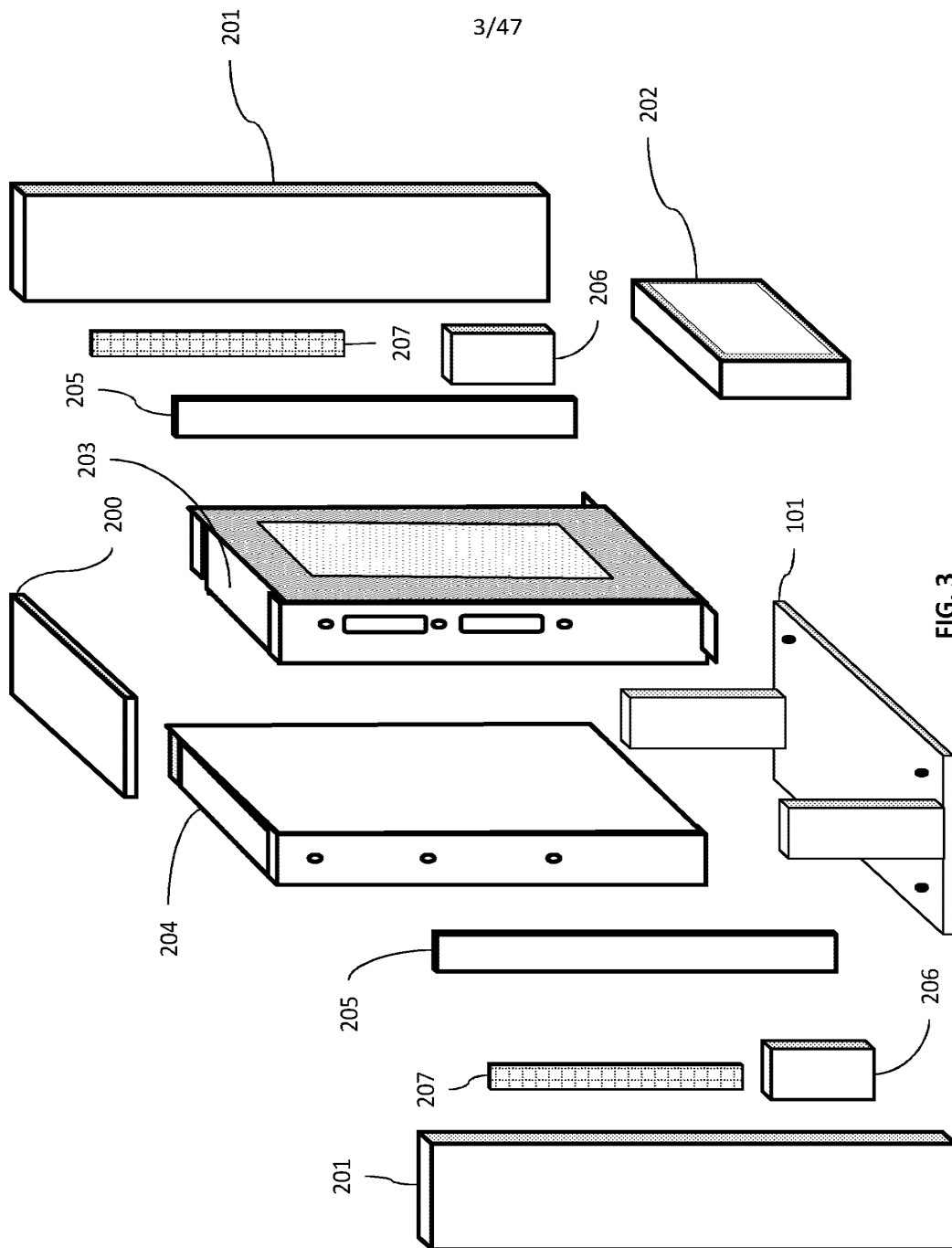
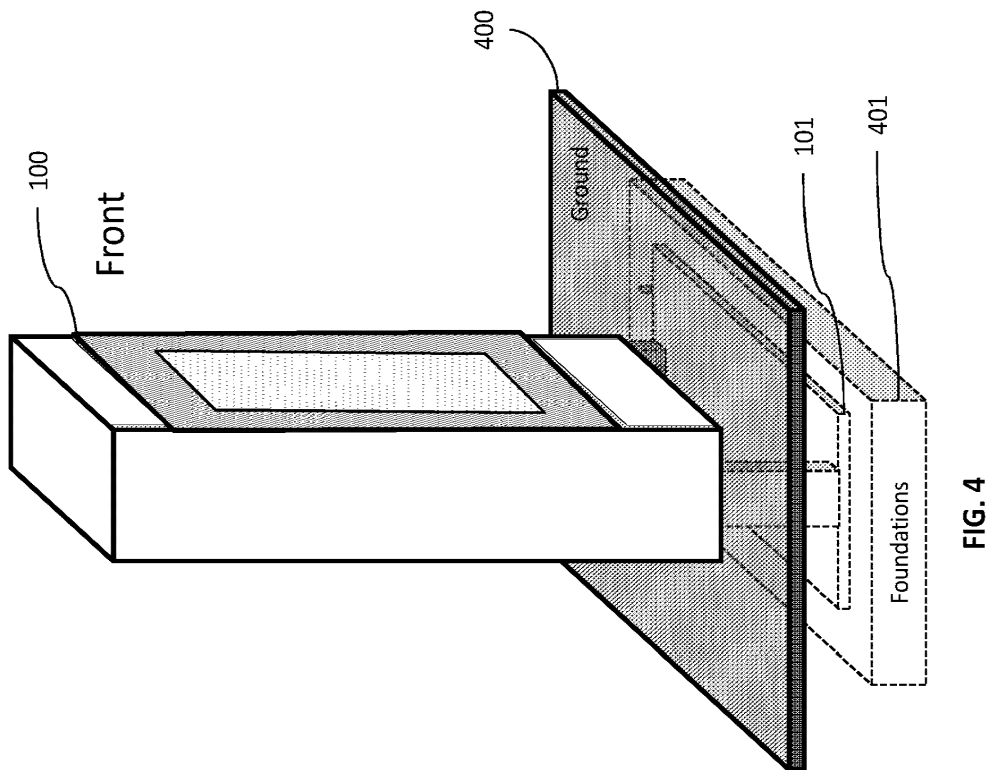
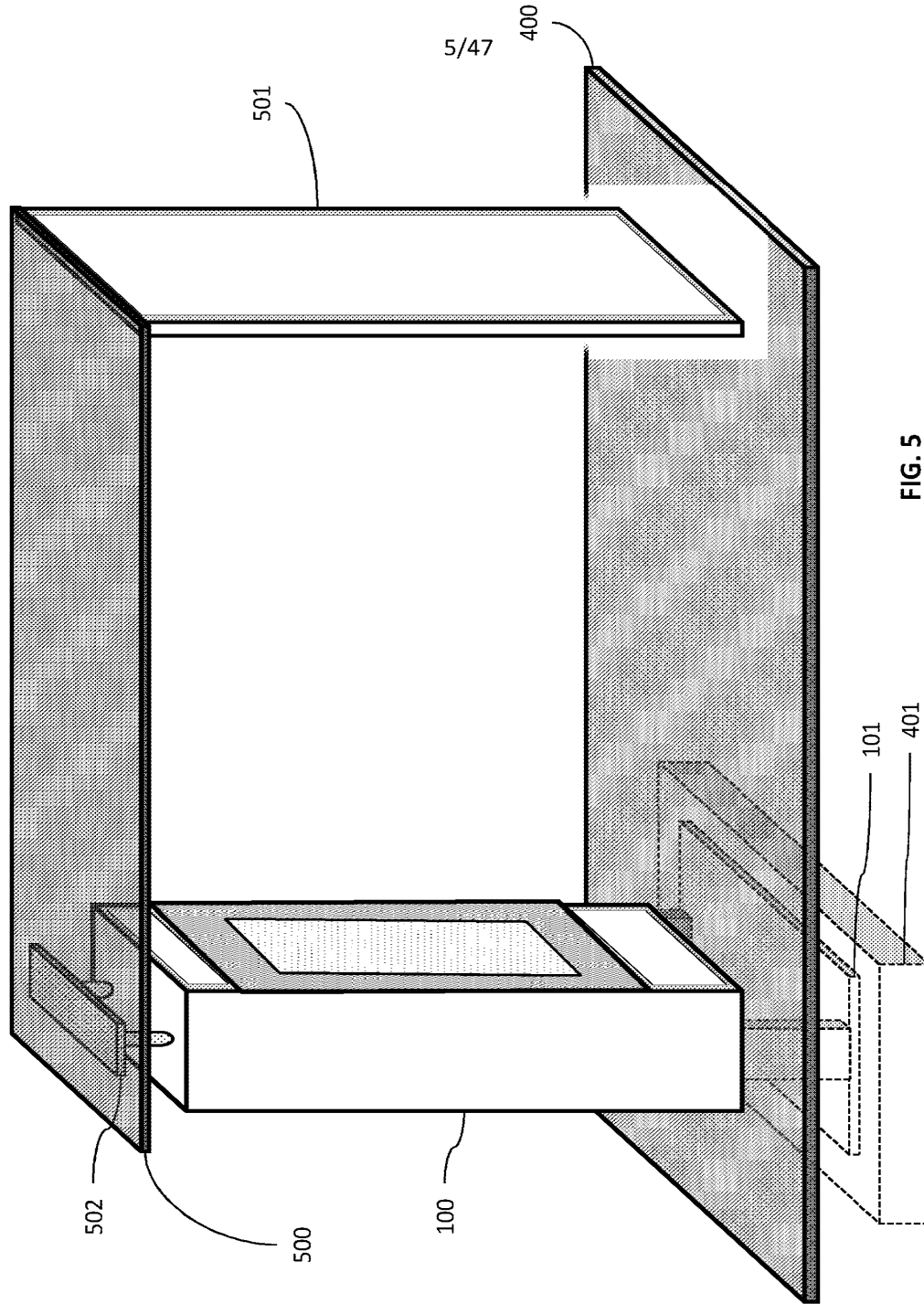


FIG. 2

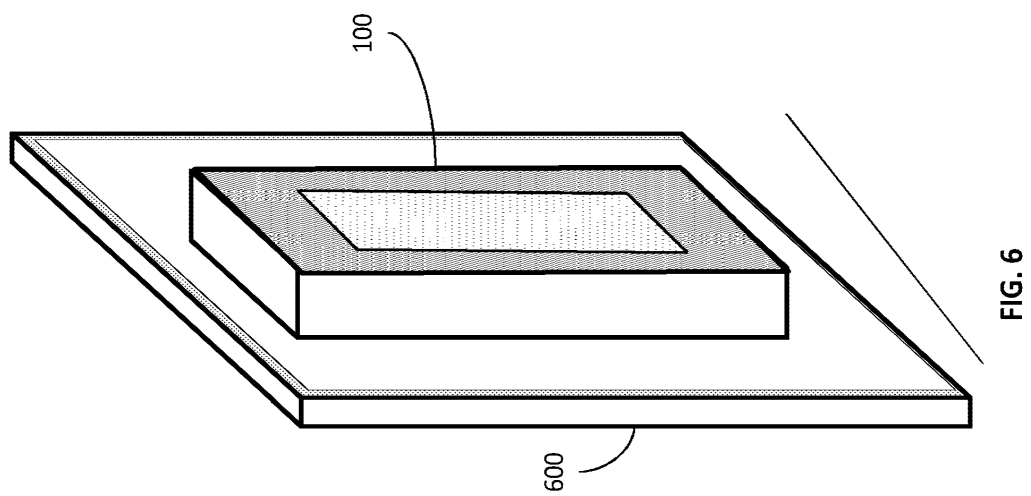


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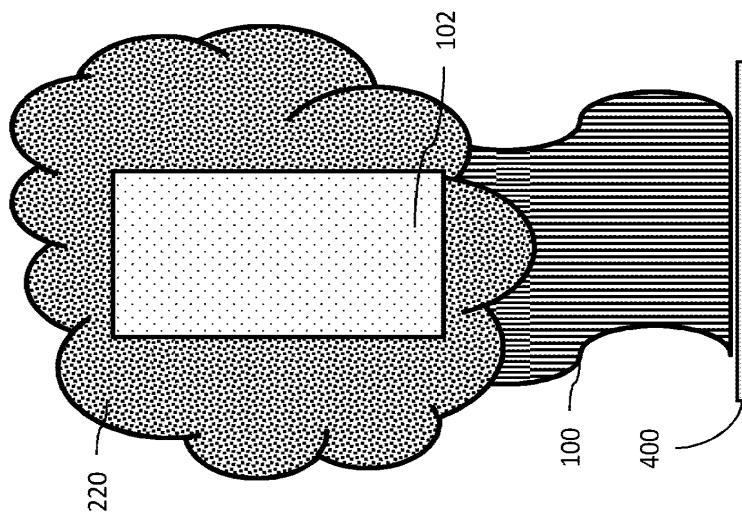


FIG. 7C

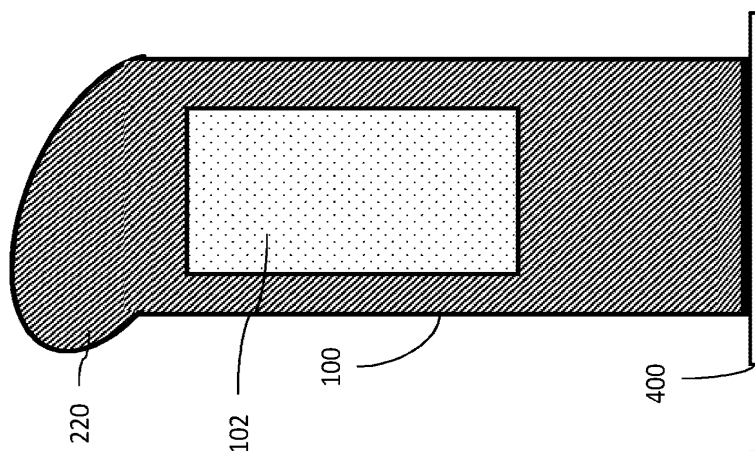


FIG. 7B

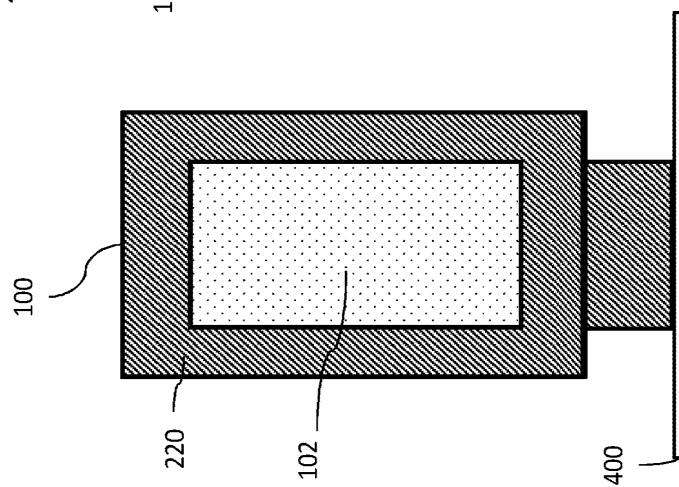


FIG. 7A

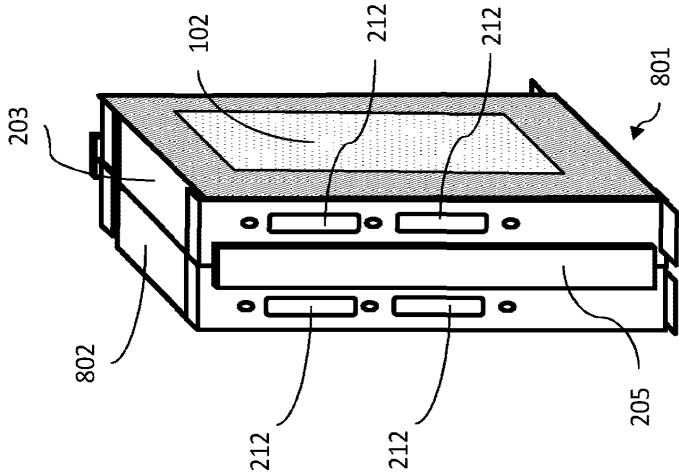


FIG. 8B

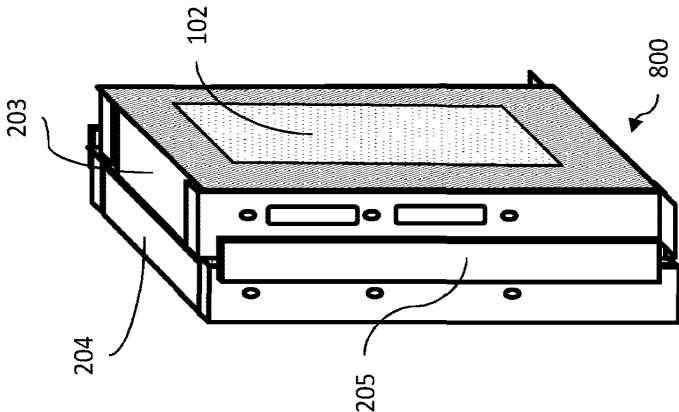
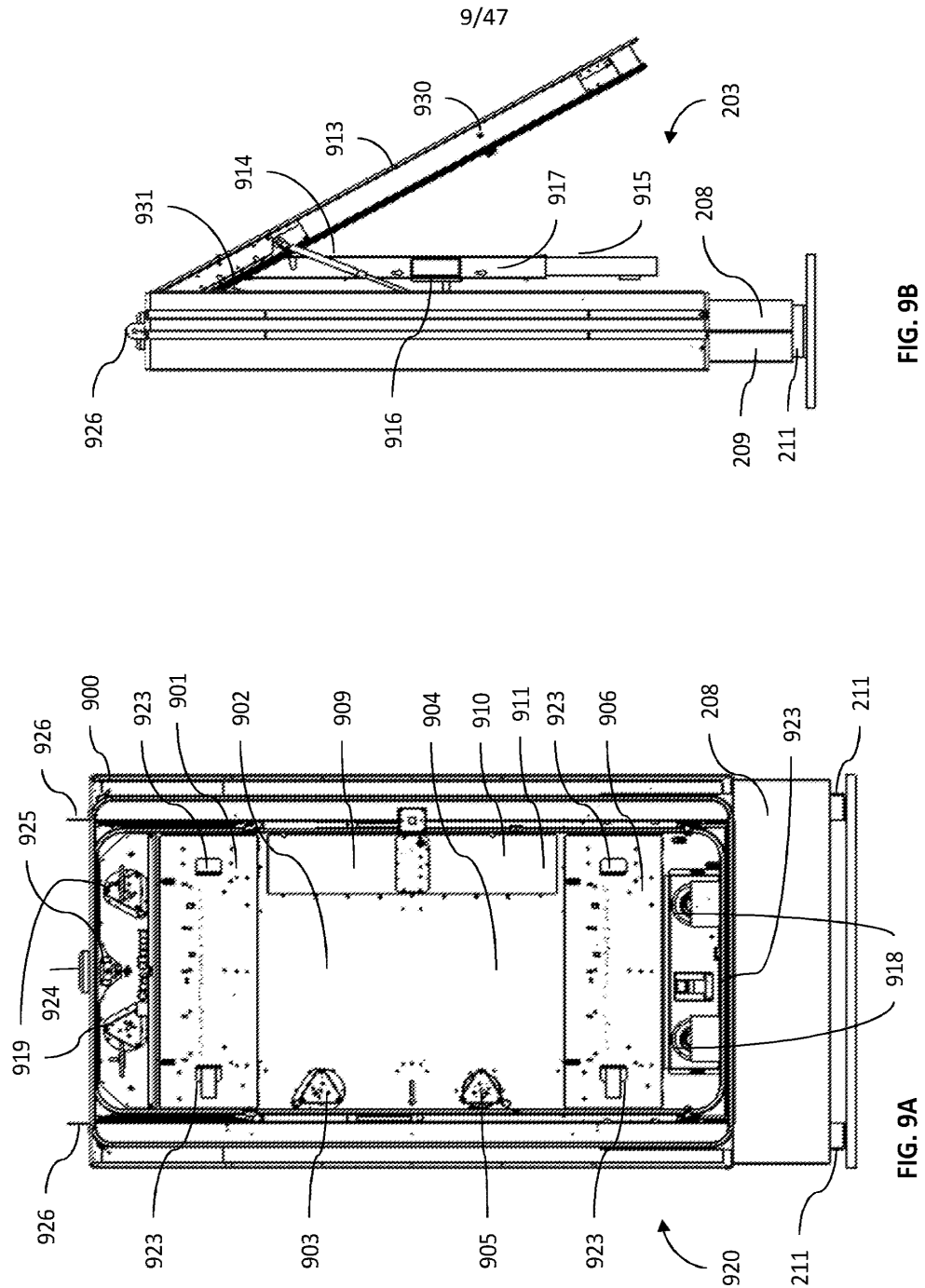


FIG. 8A



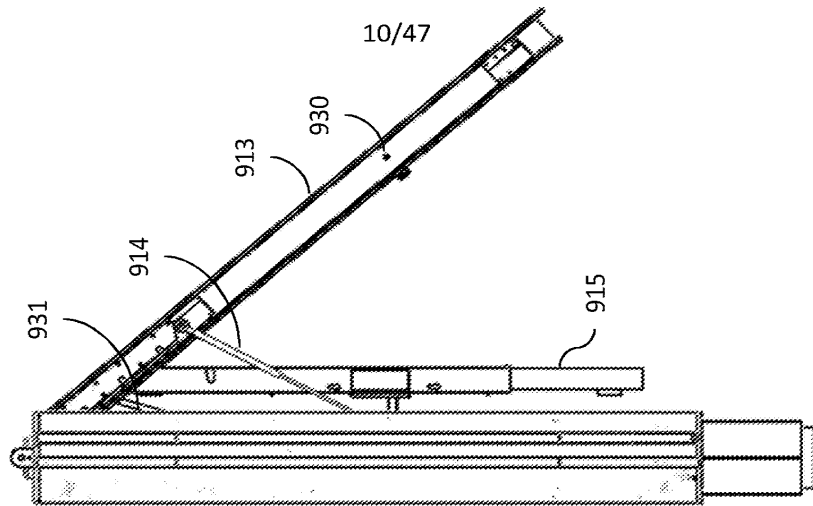


FIG. 10C

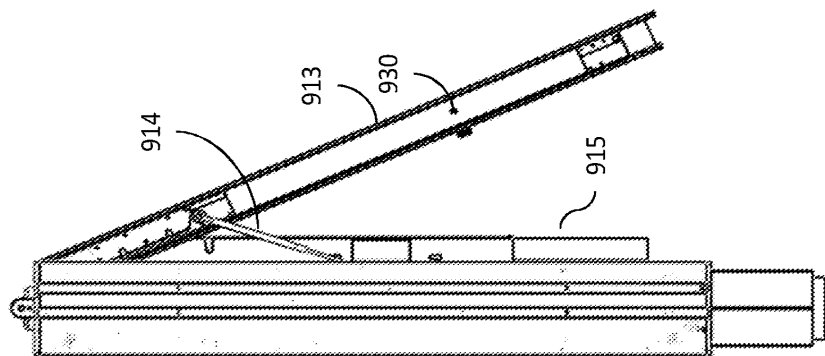


FIG. 10B

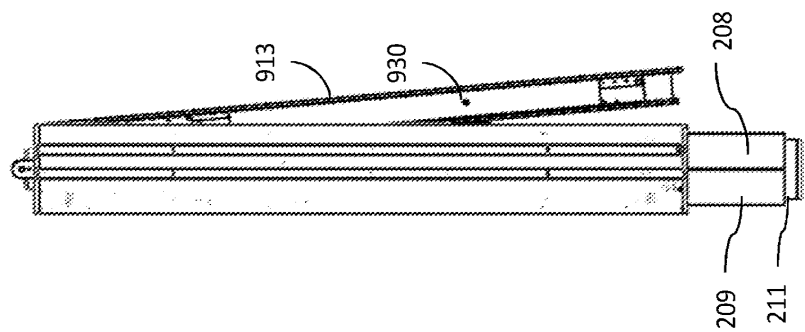


FIG. 10A

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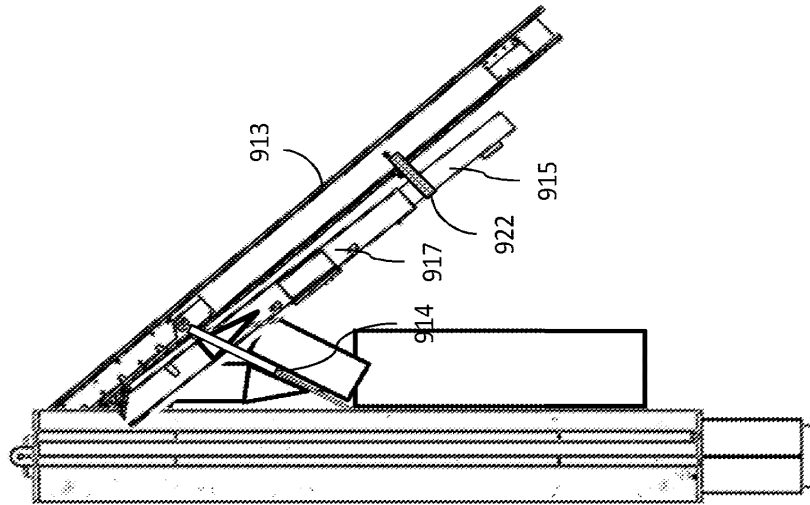


FIG. 10E

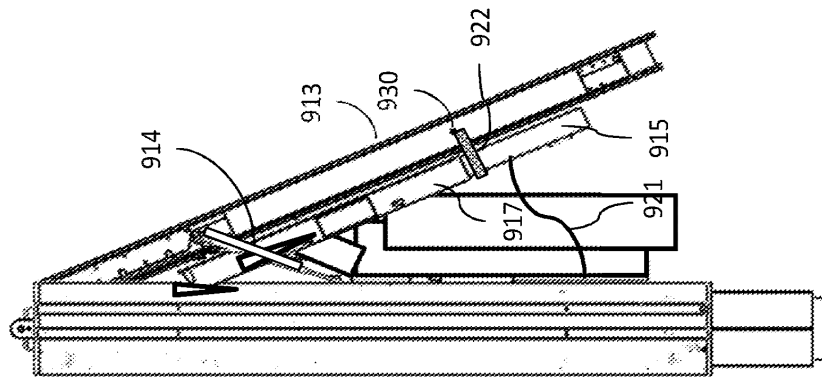


FIG. 10D

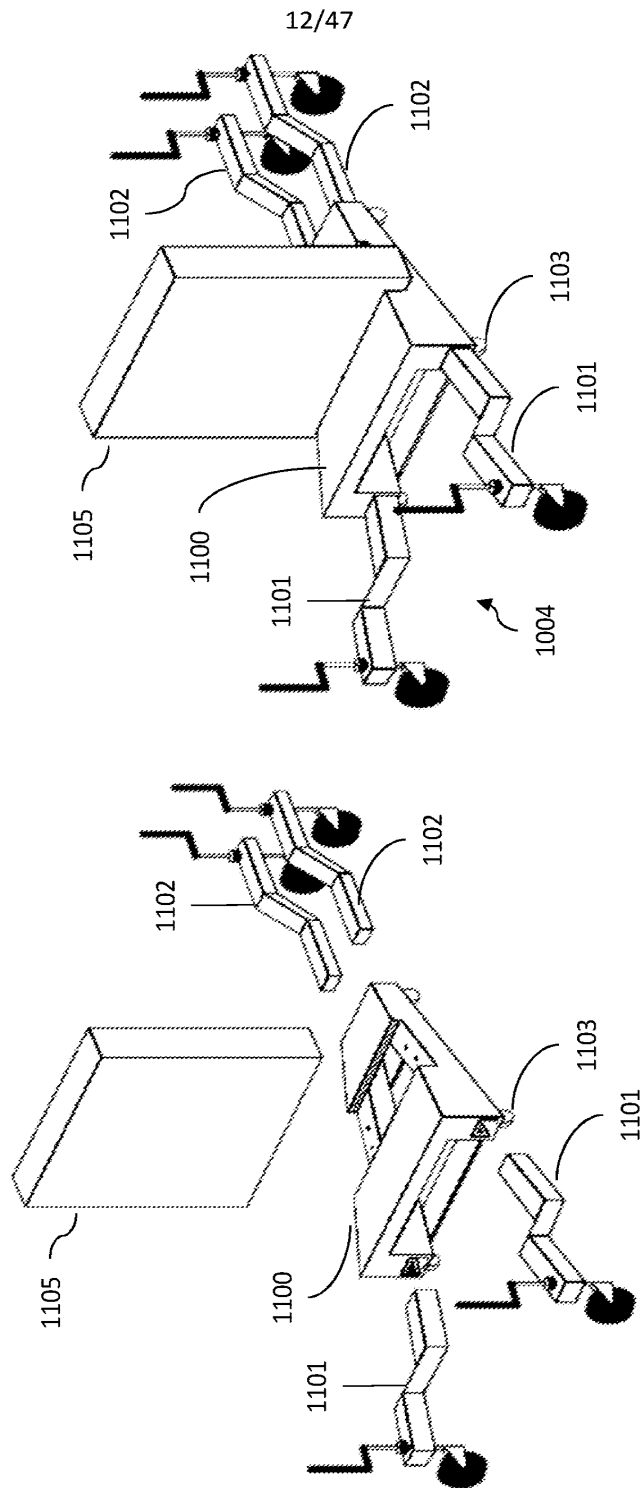


FIG. 11B

FIG. 11A

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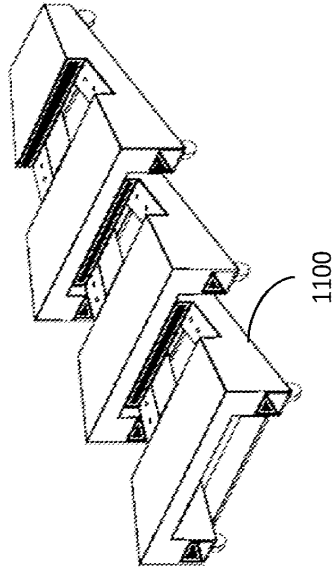


FIG. 12B

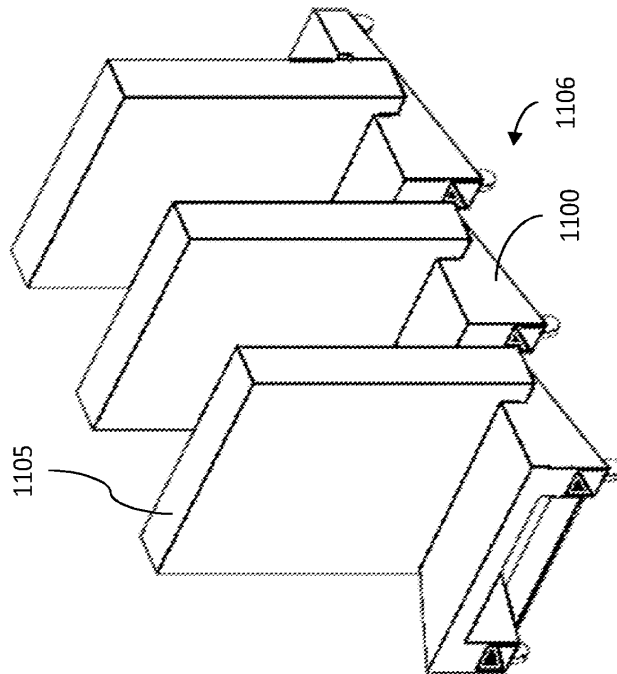
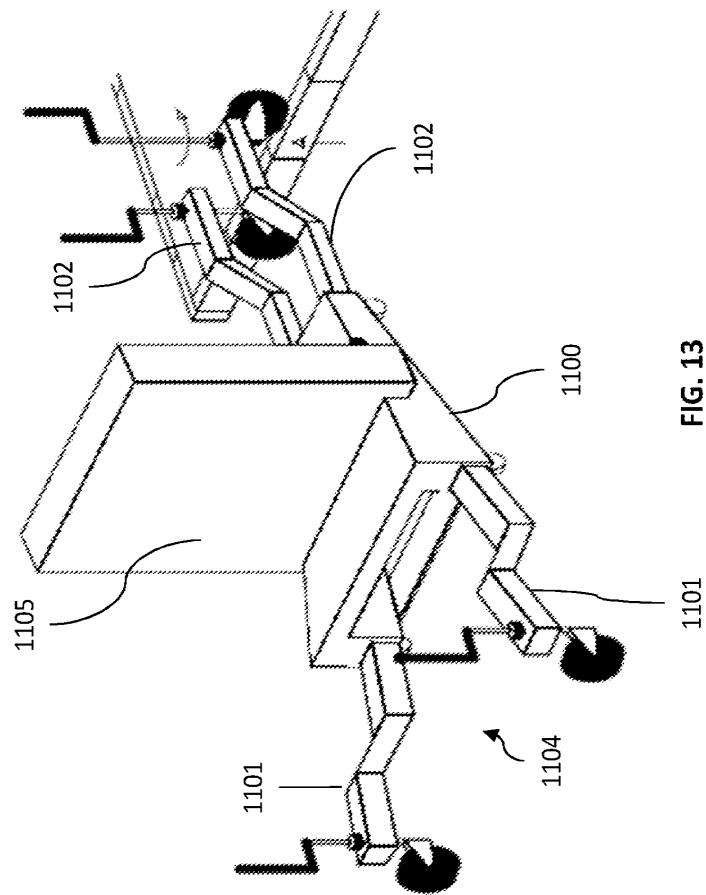


FIG. 12A



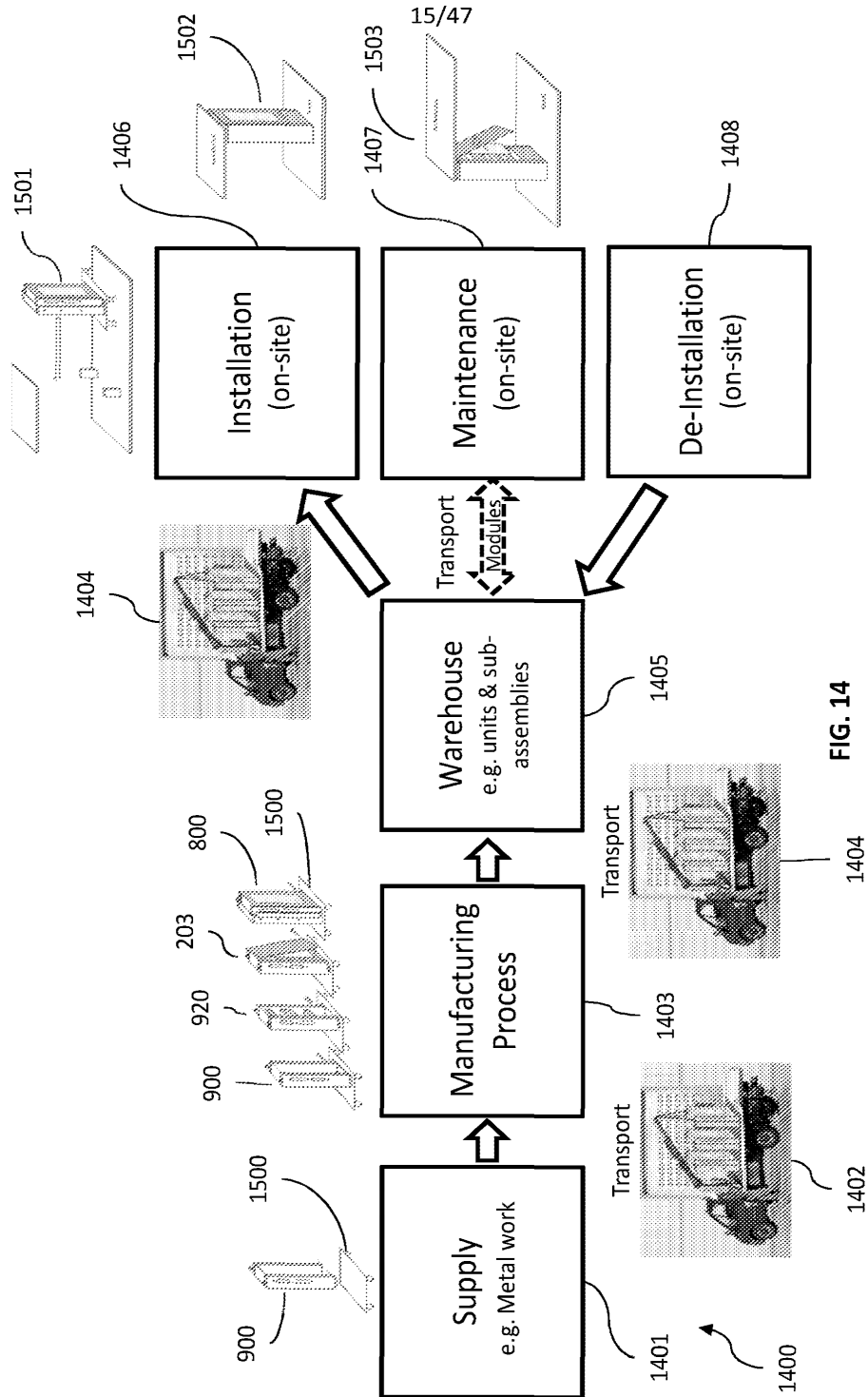
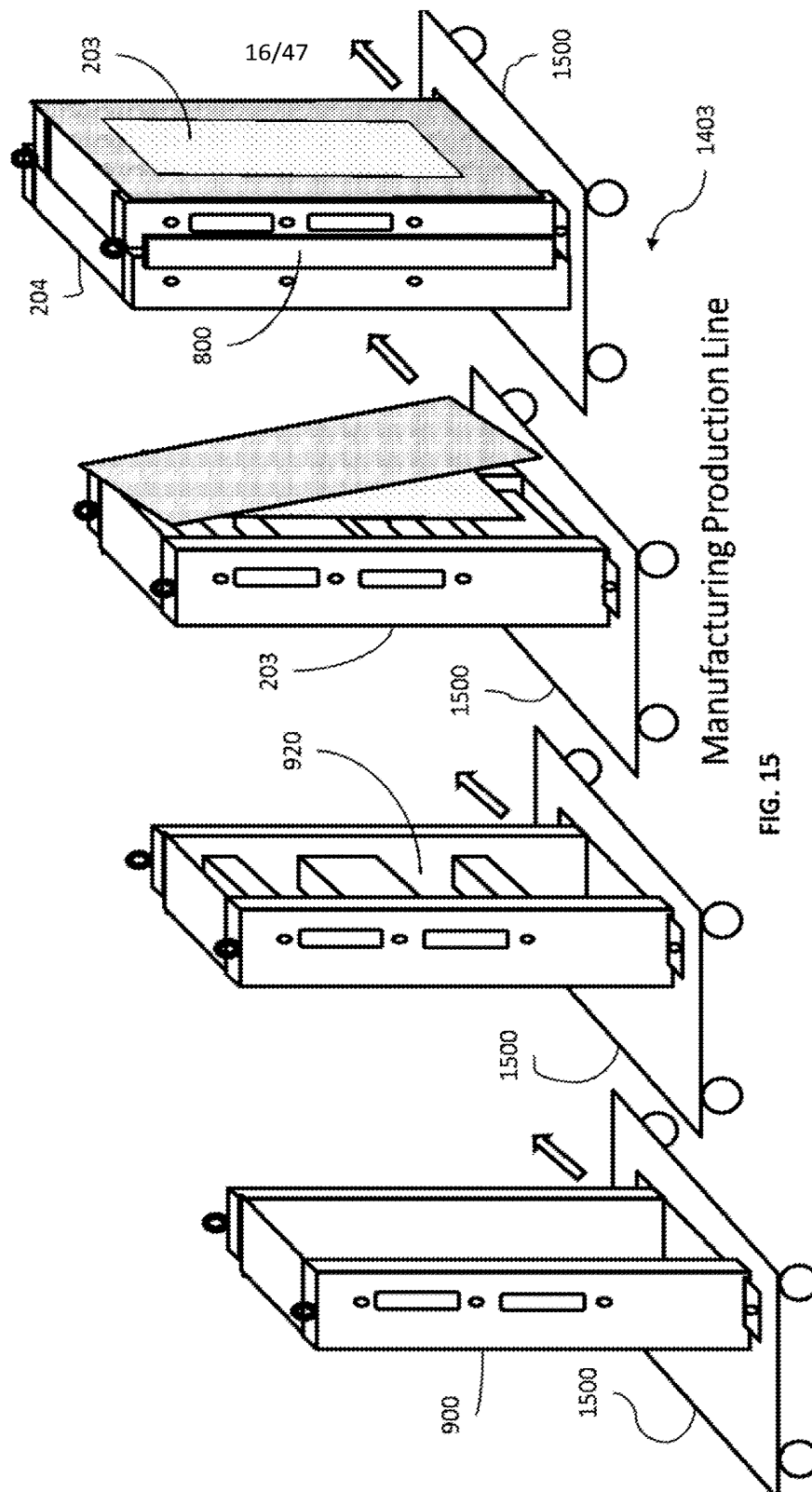


FIG. 14



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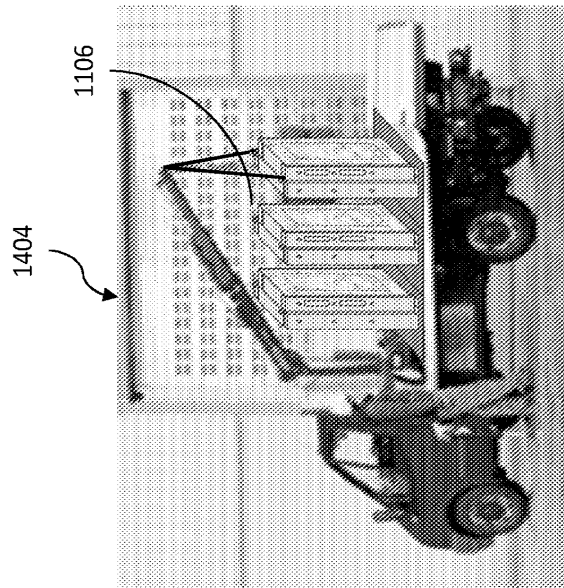


FIG. 16B

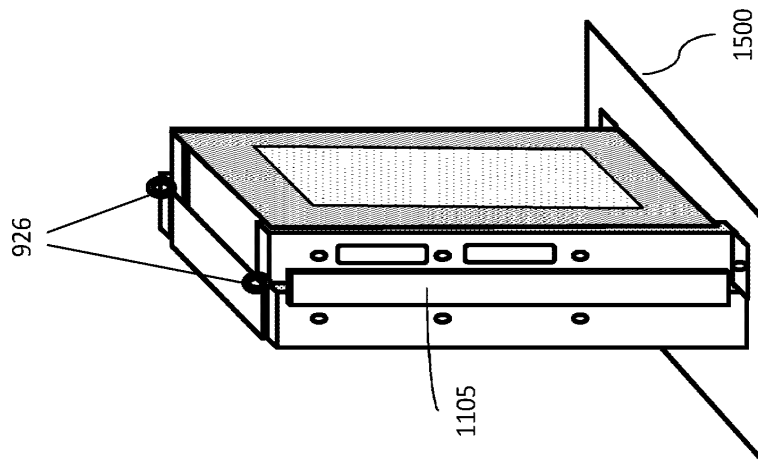


FIG. 16A

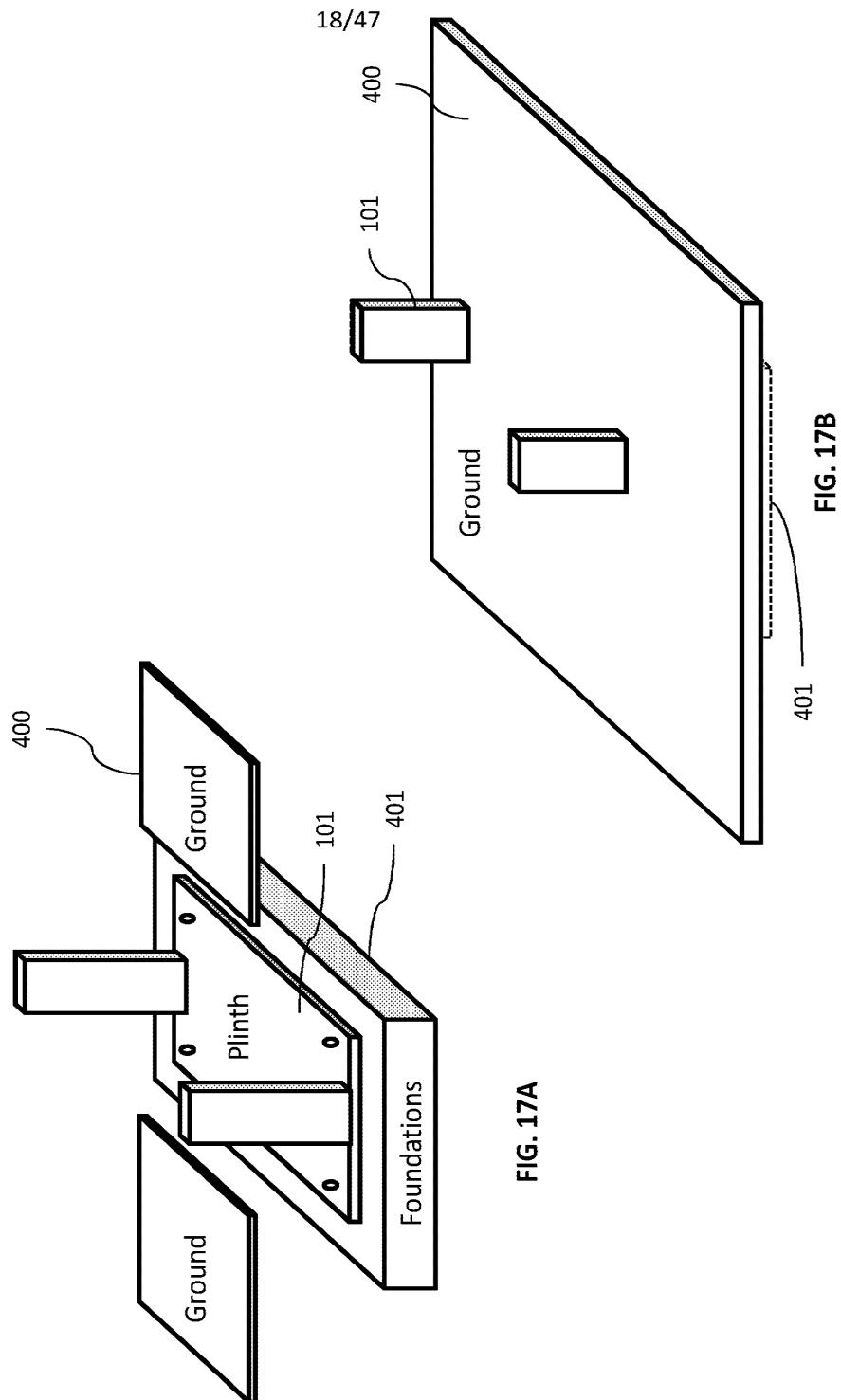
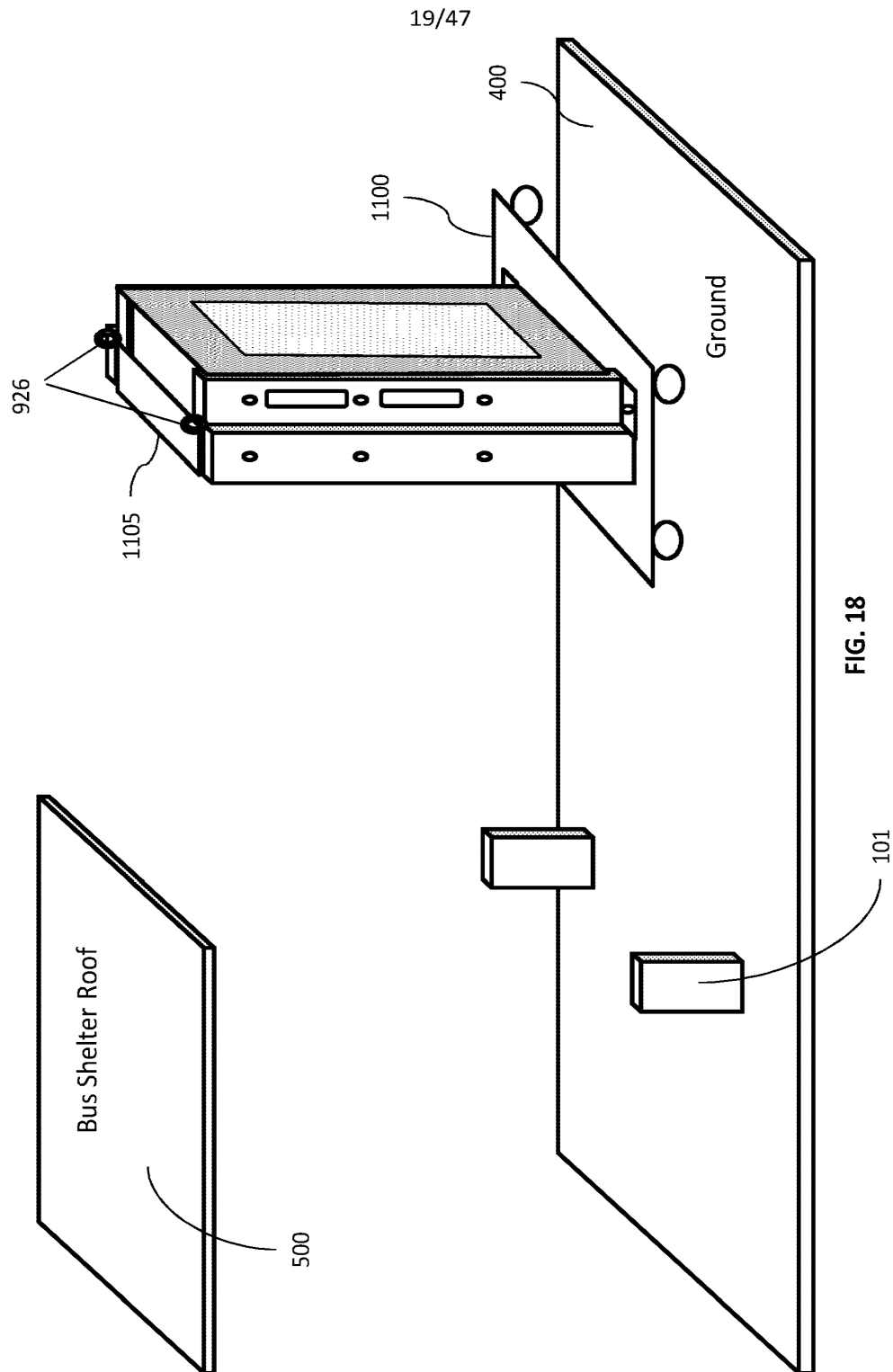
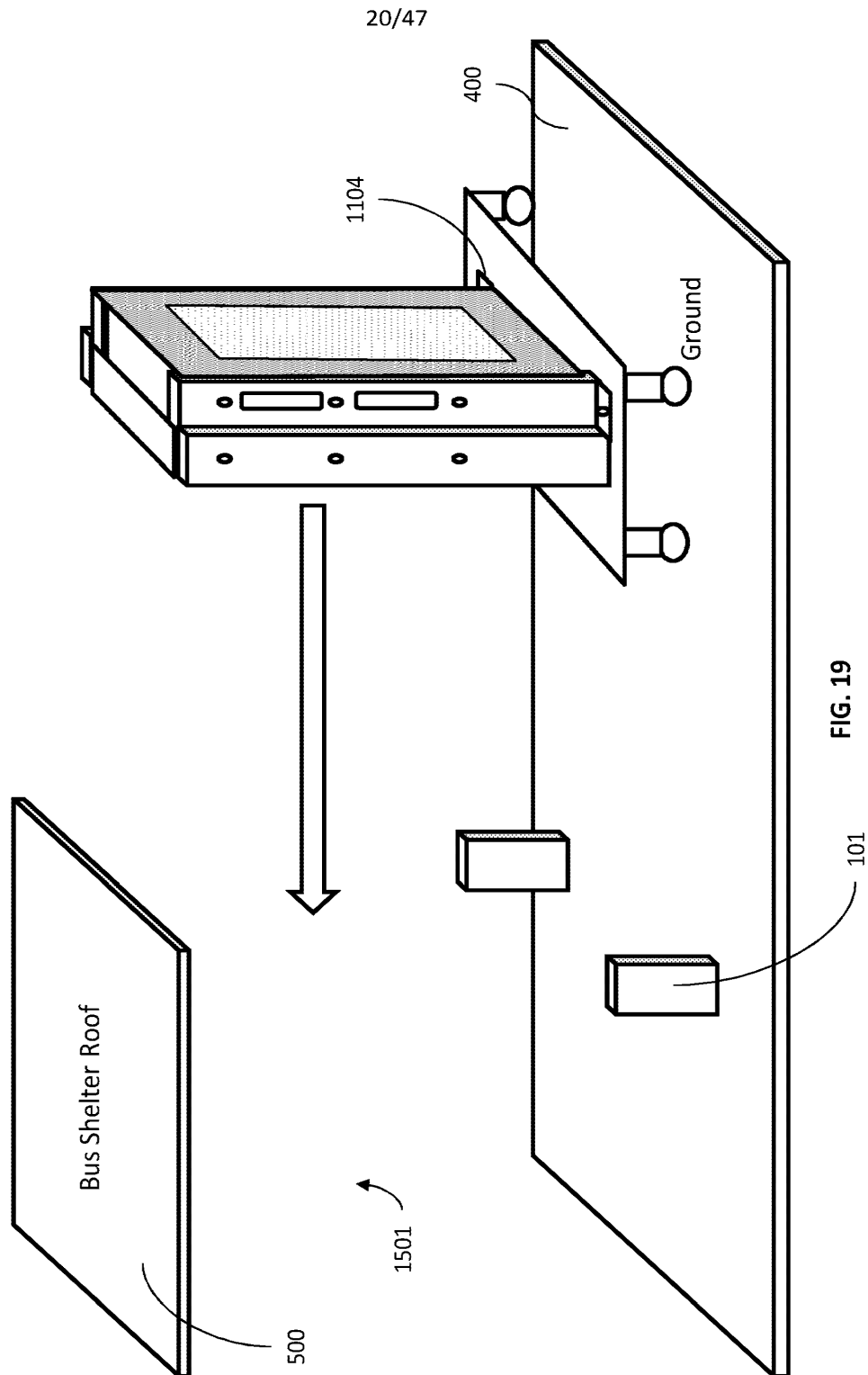
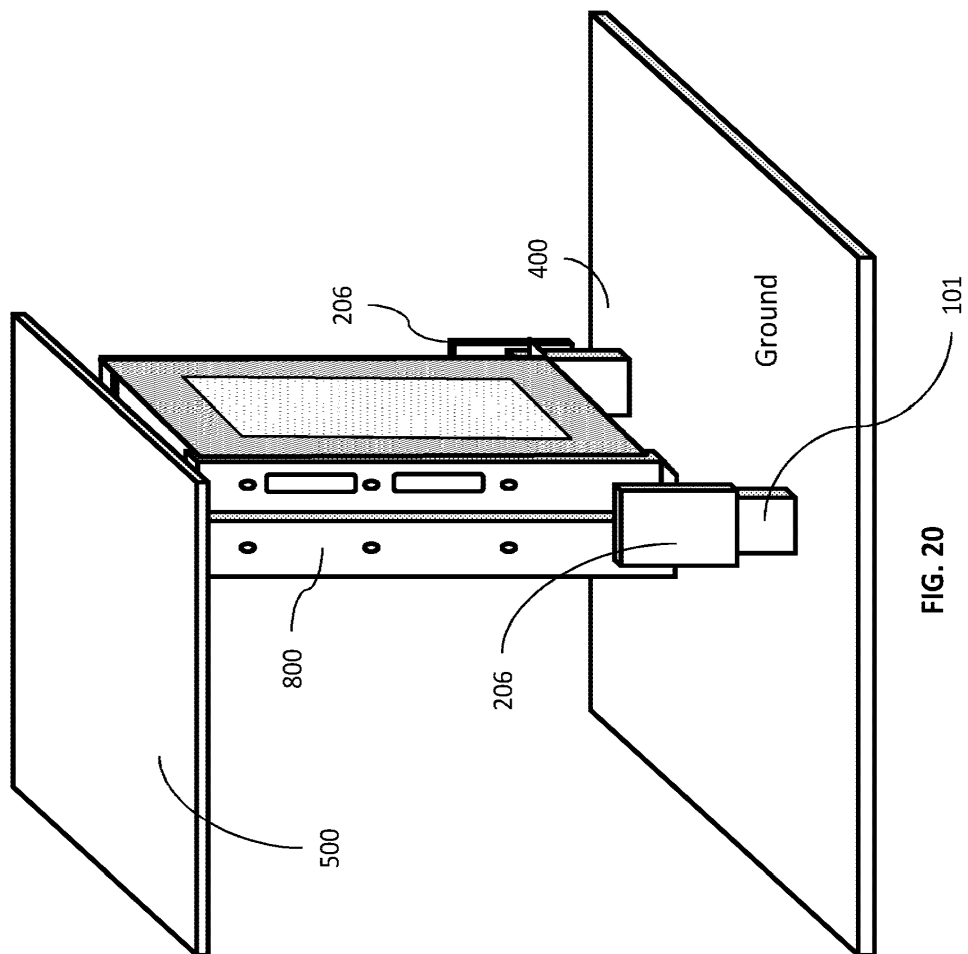


FIG. 17A

FIG. 17B







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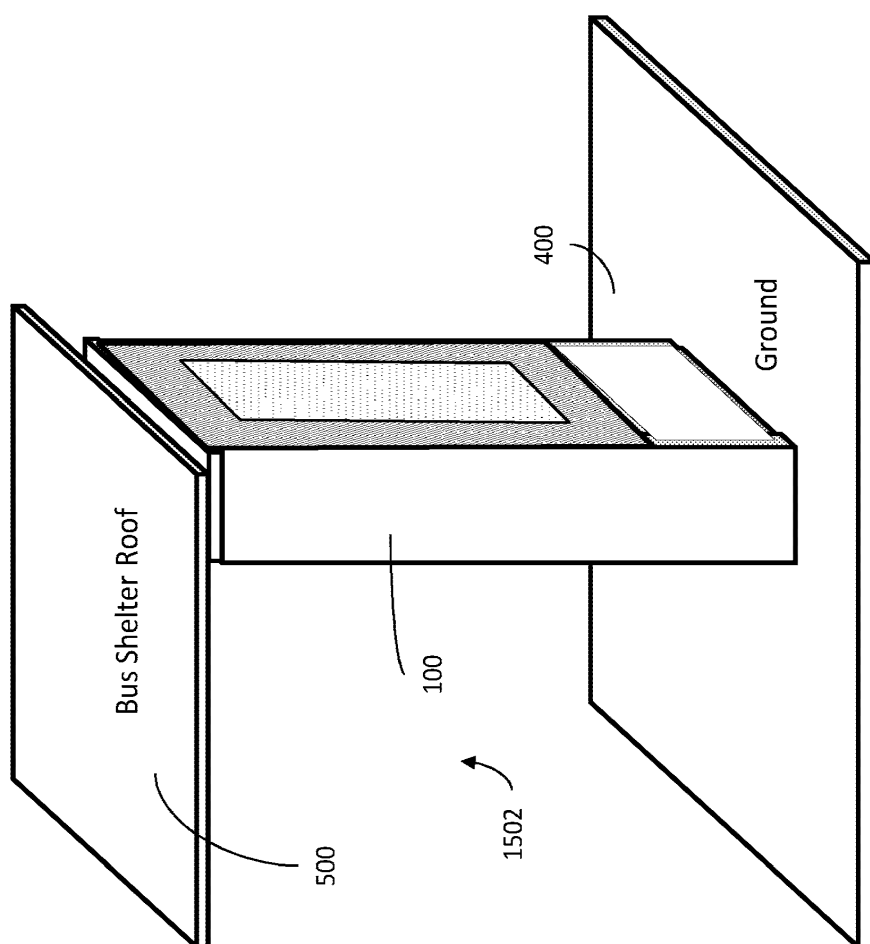


FIG. 21

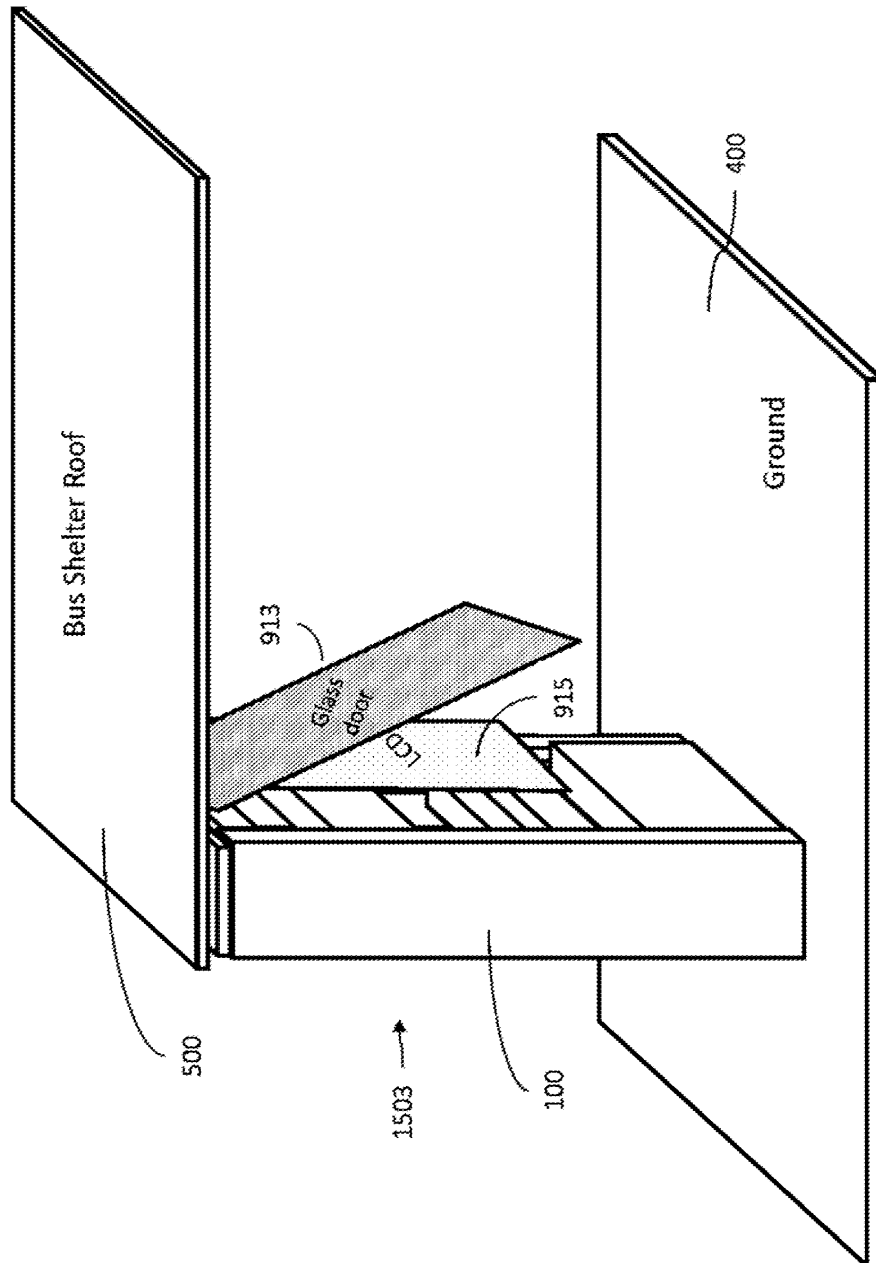


FIG. 22

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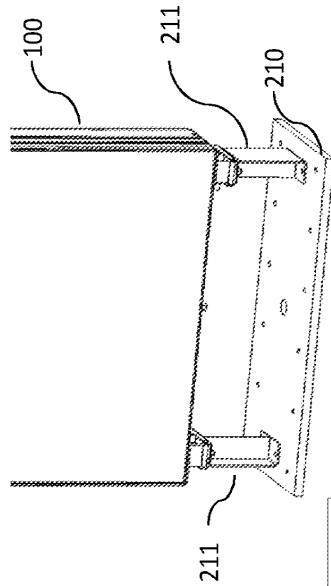


FIG. 23A

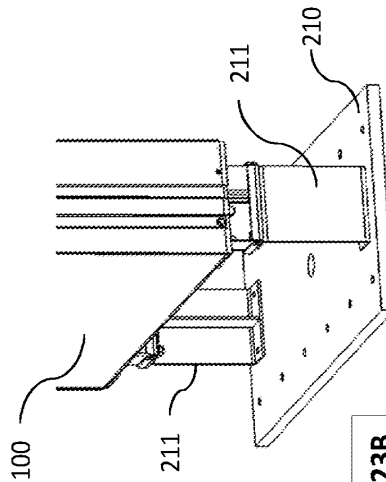


FIG. 23B

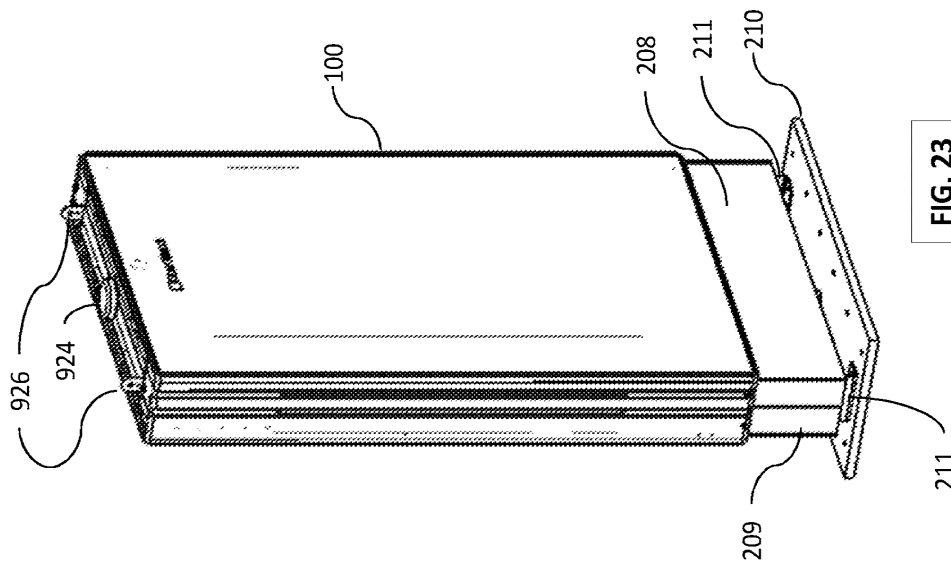


FIG. 23

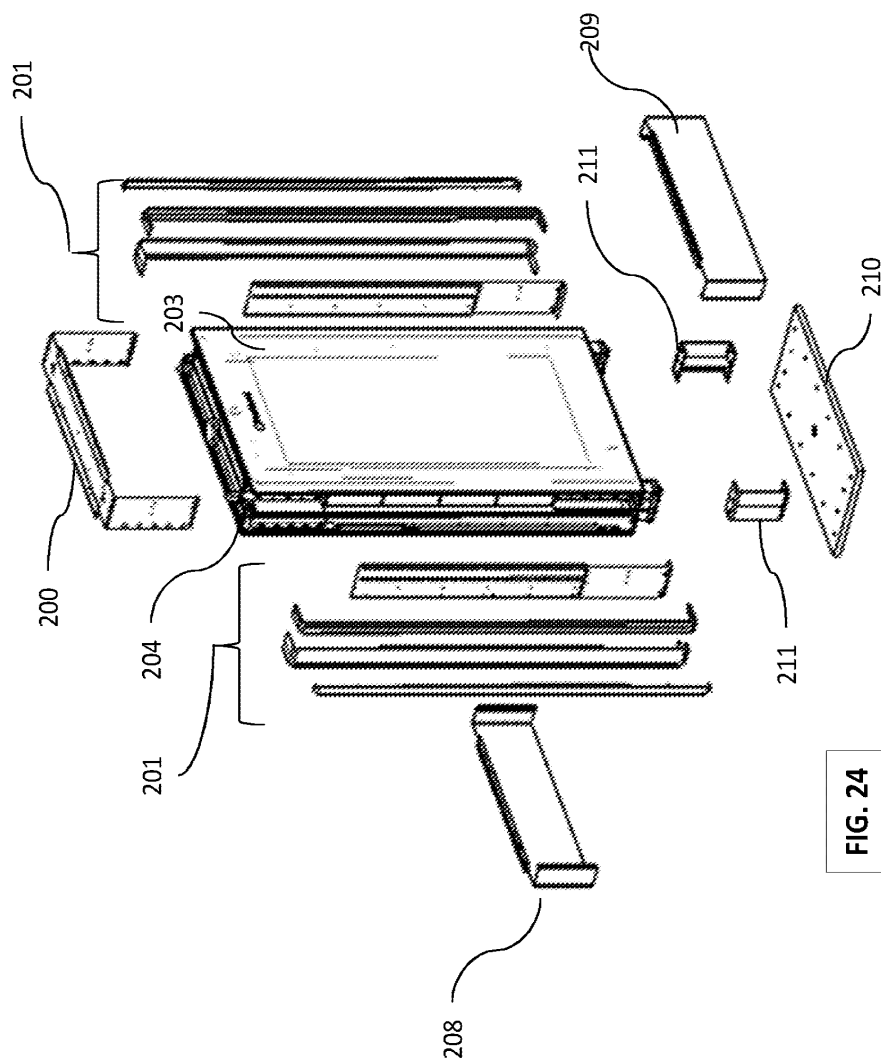
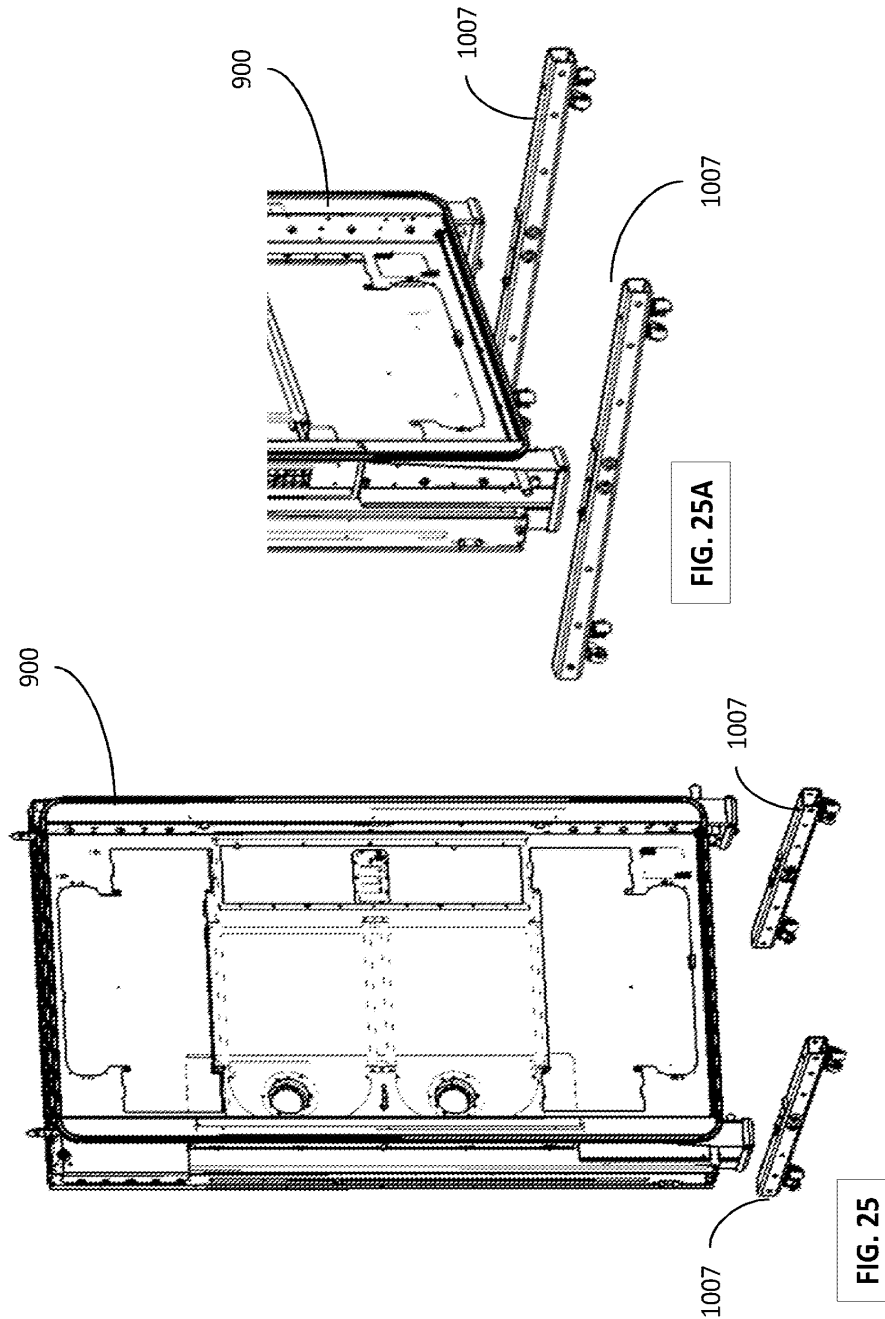
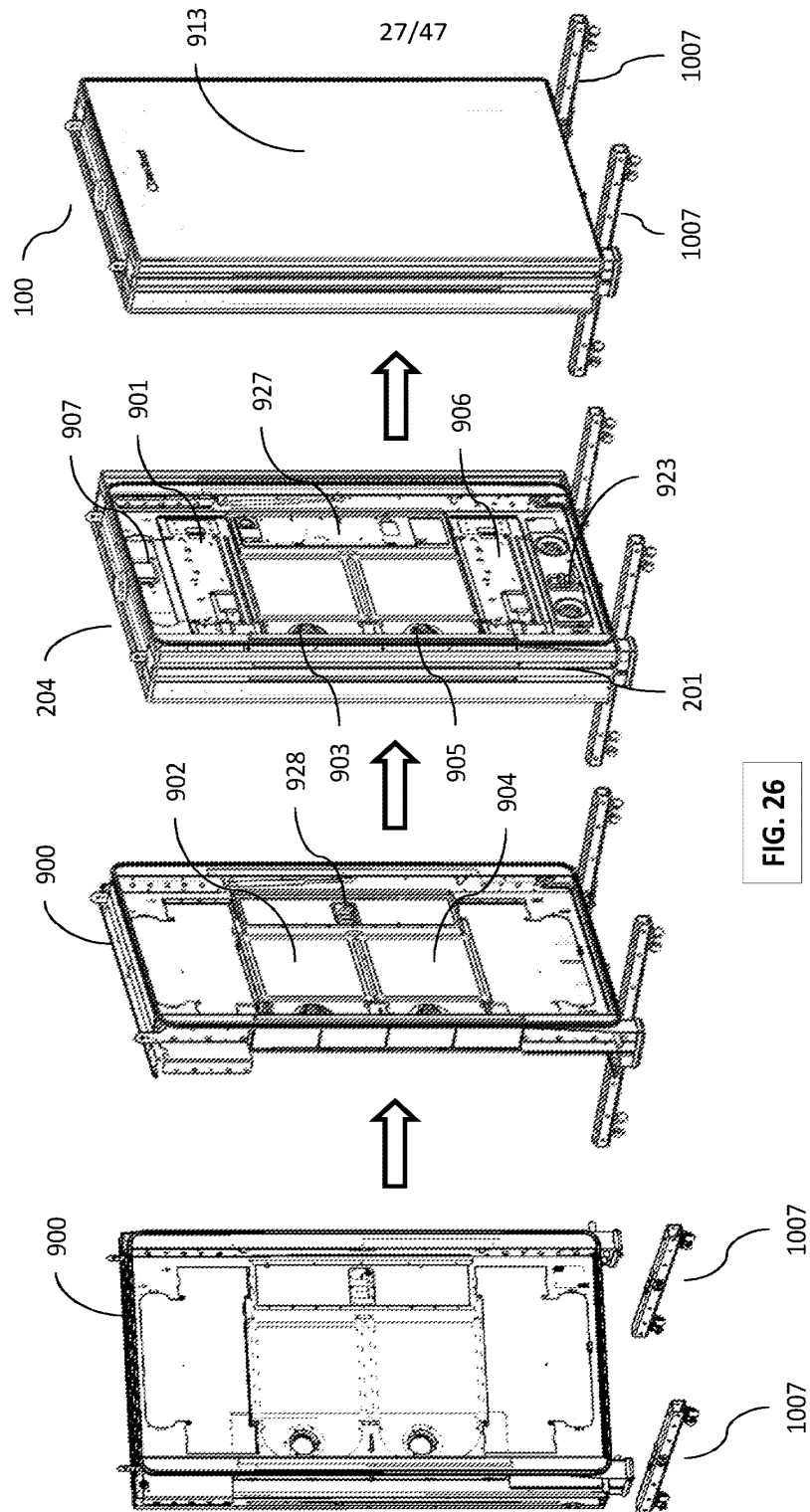


FIG. 24

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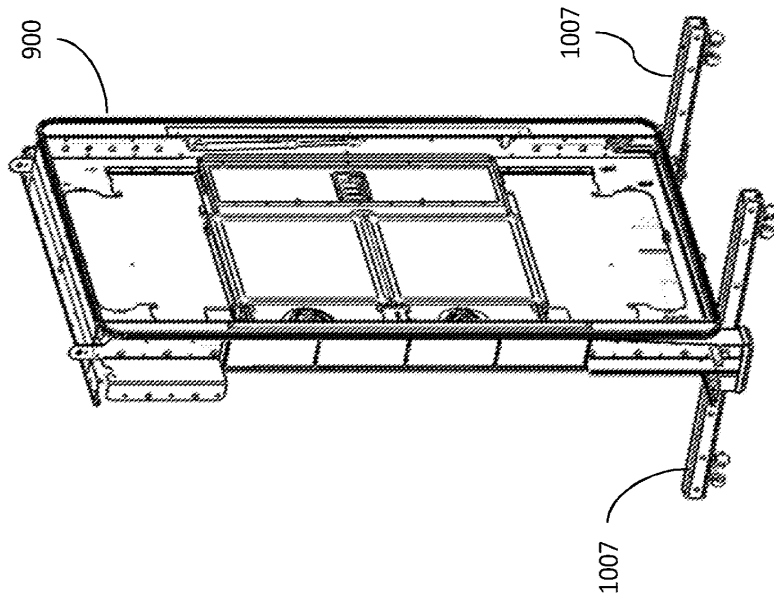
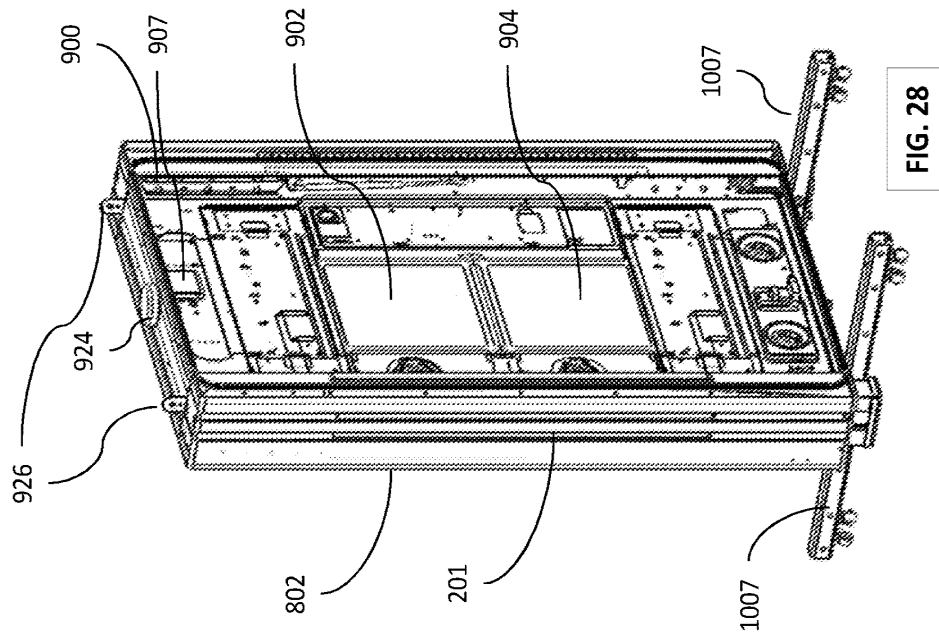
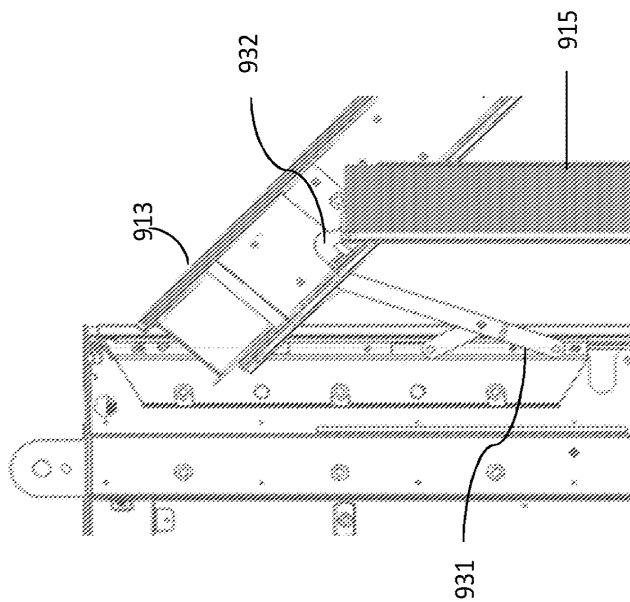


FIG. 29



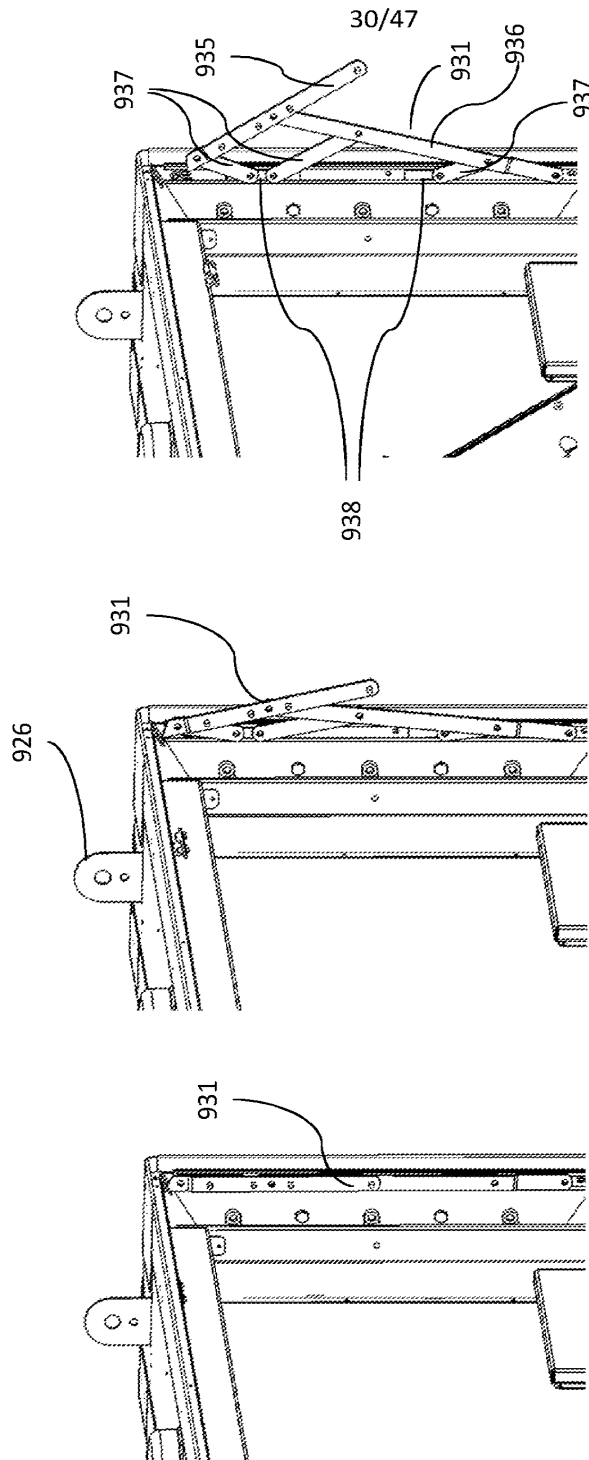
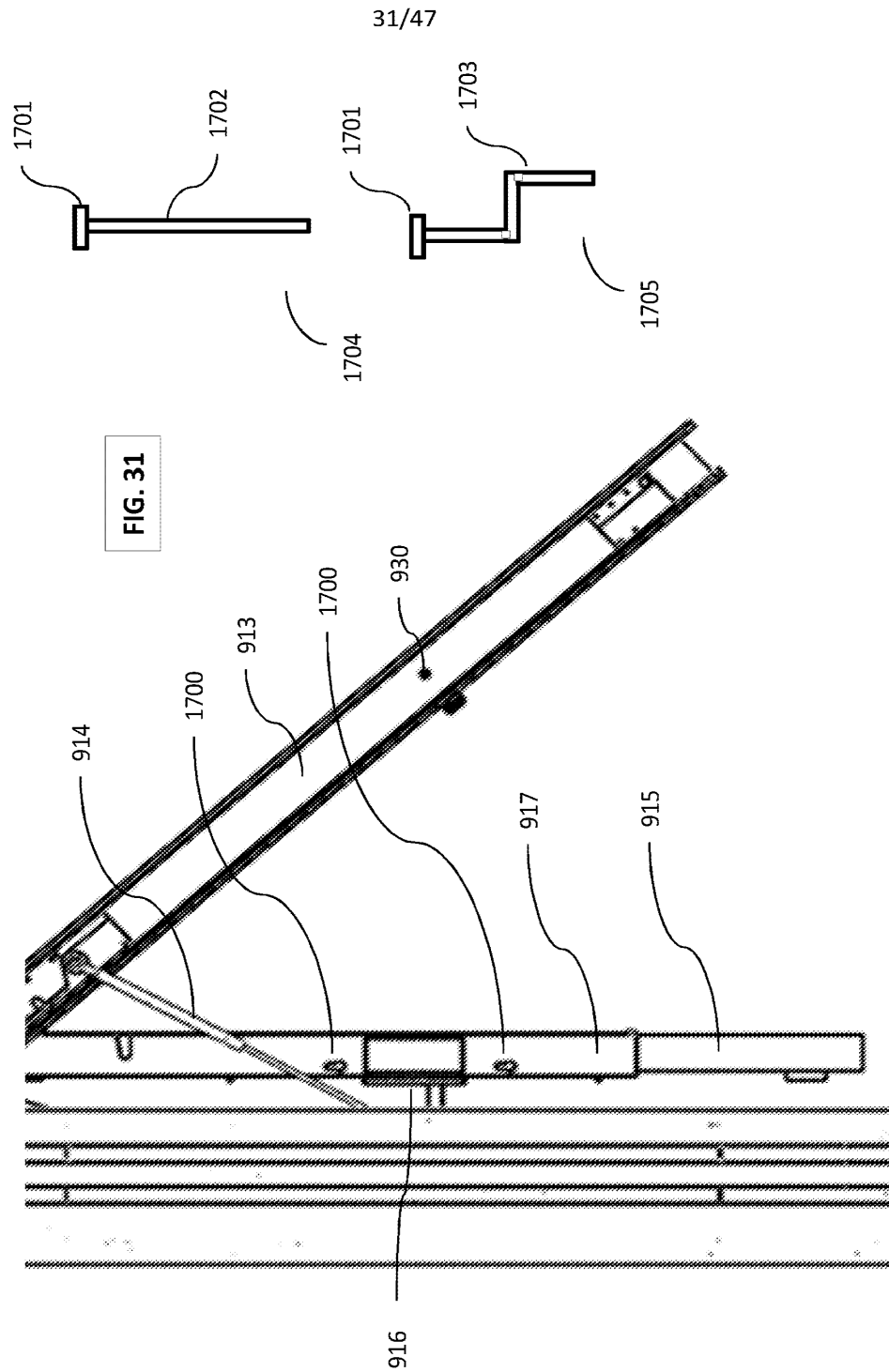


FIG. 30



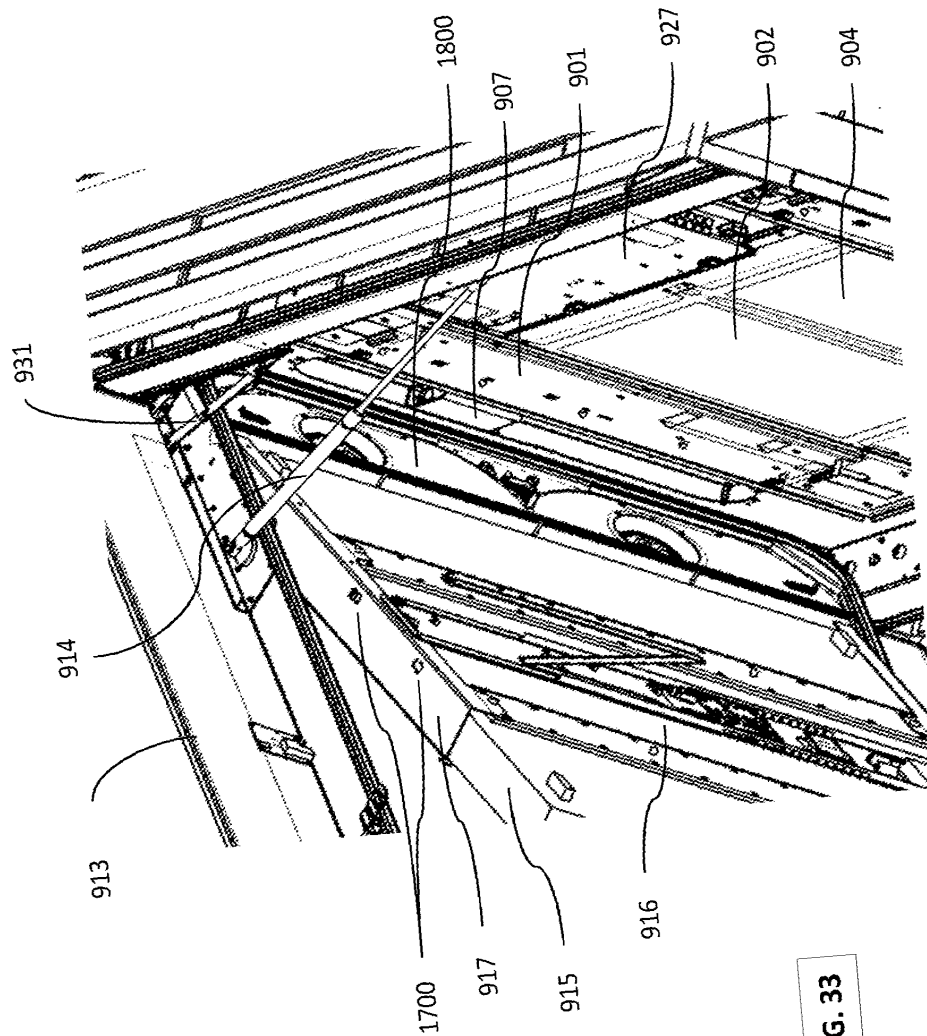


FIG. 33

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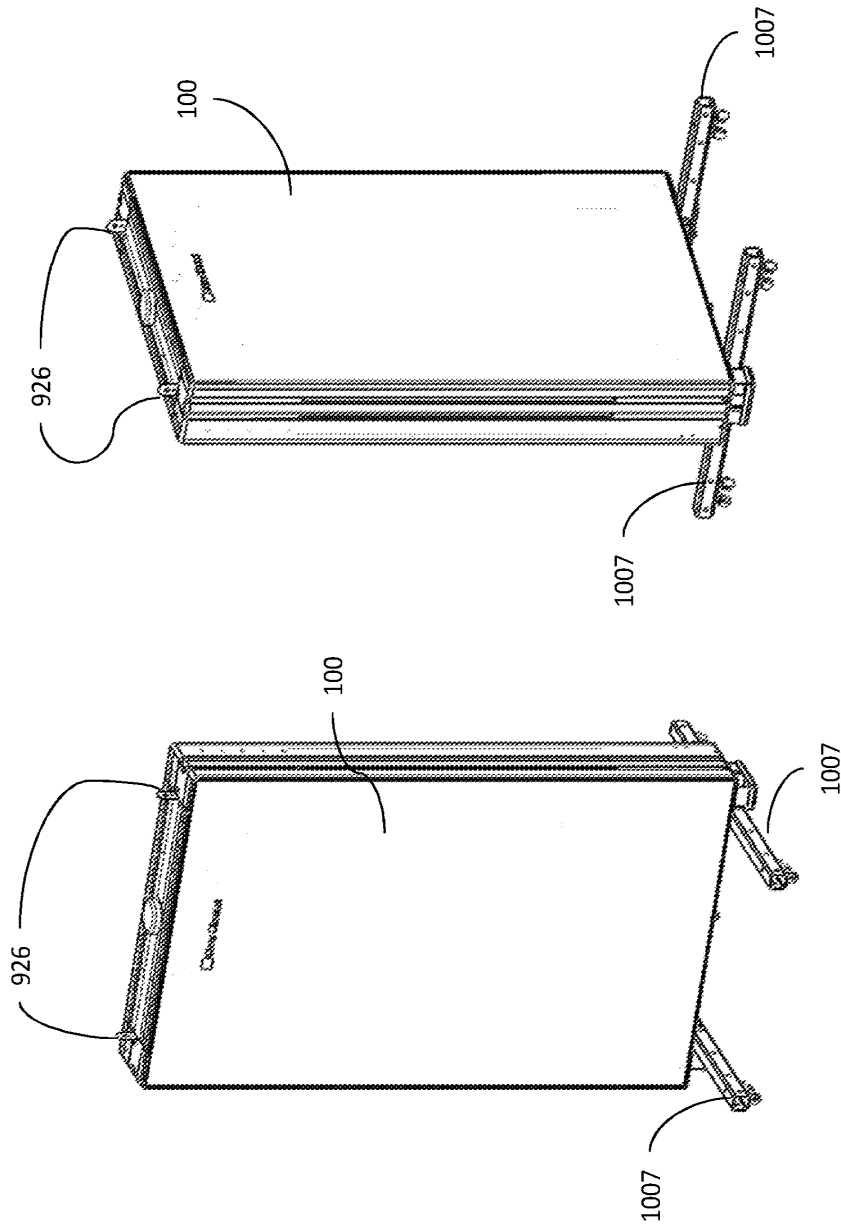
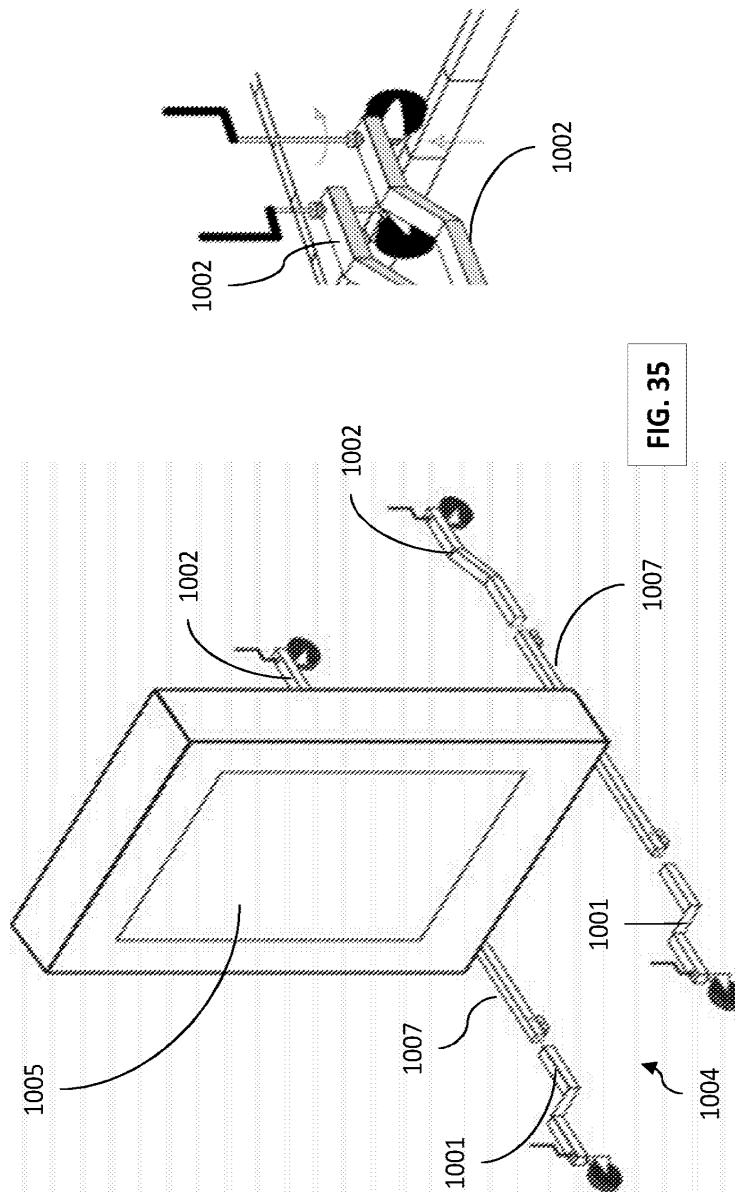
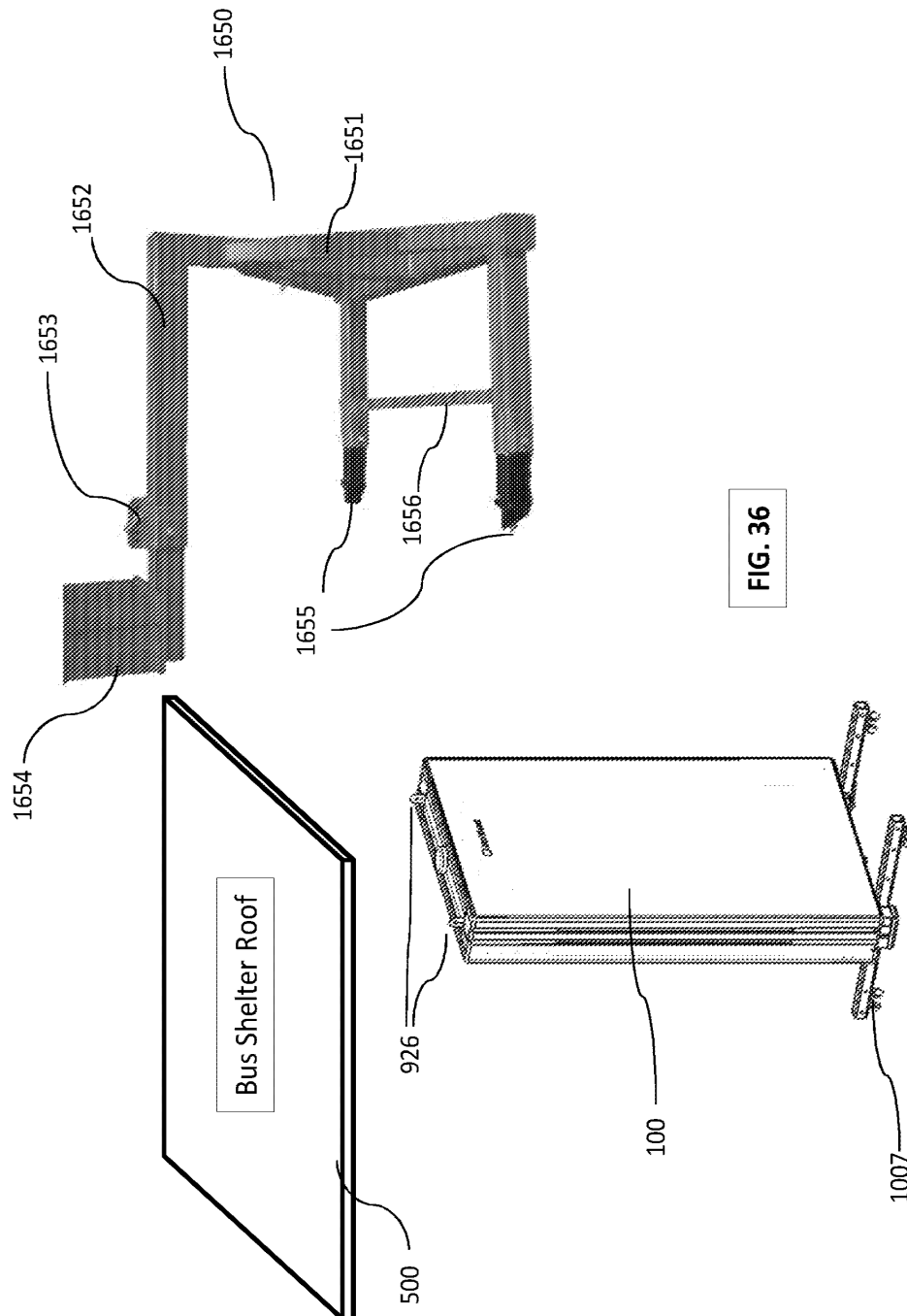


FIG. 34

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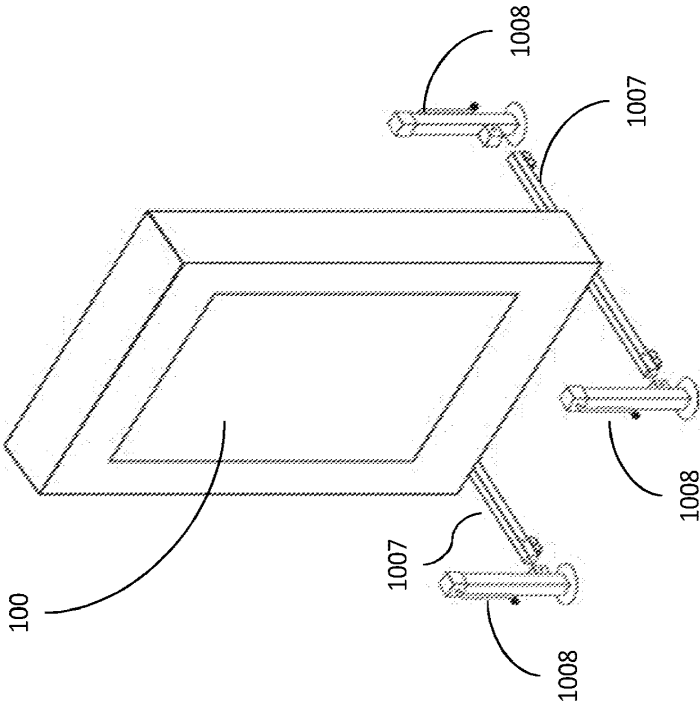


FIG. 37

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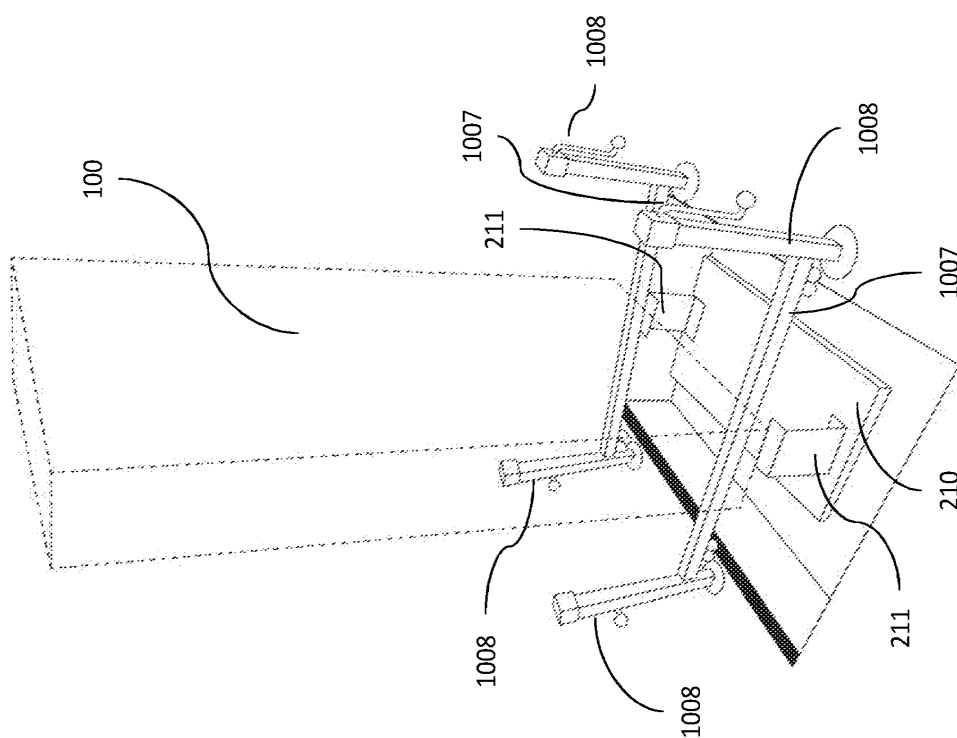


FIG. 38

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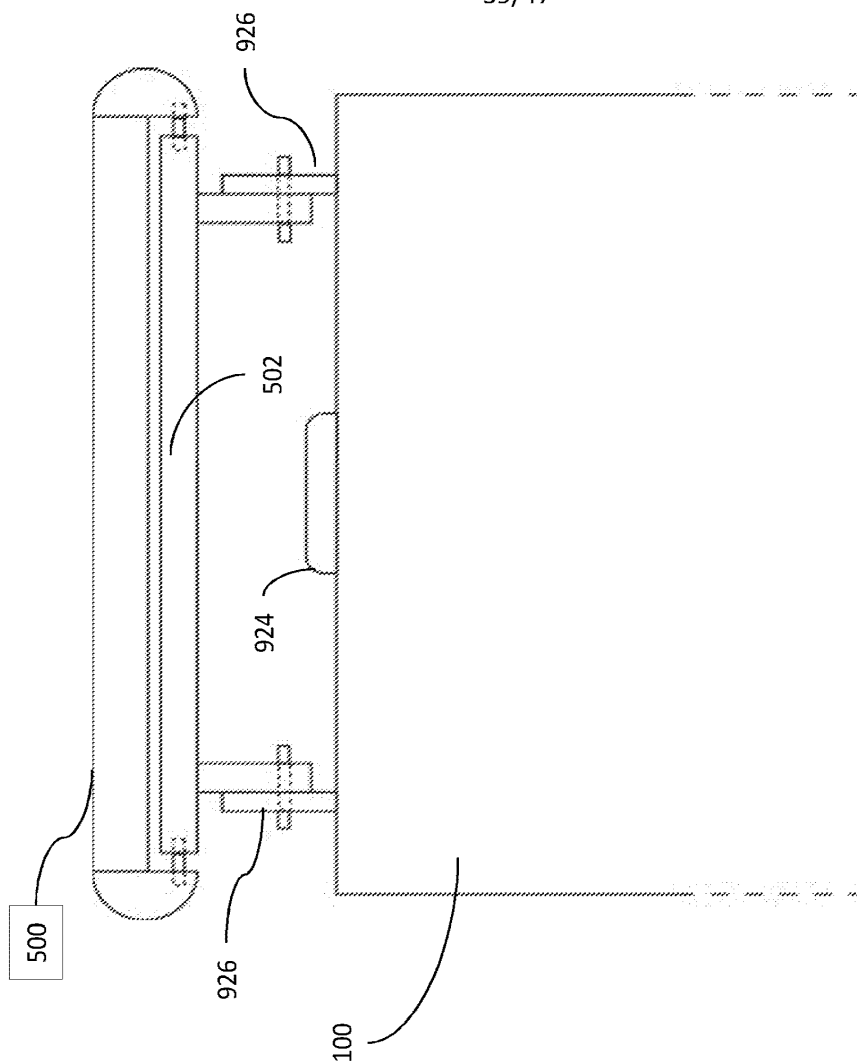


FIG. 39

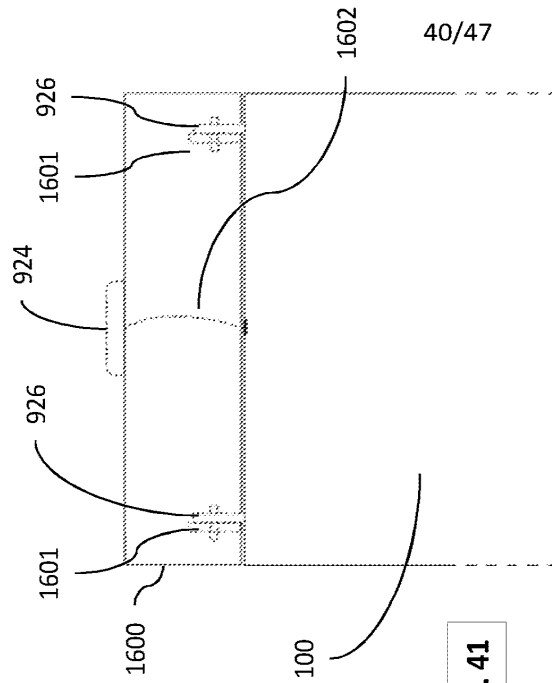


FIG. 41

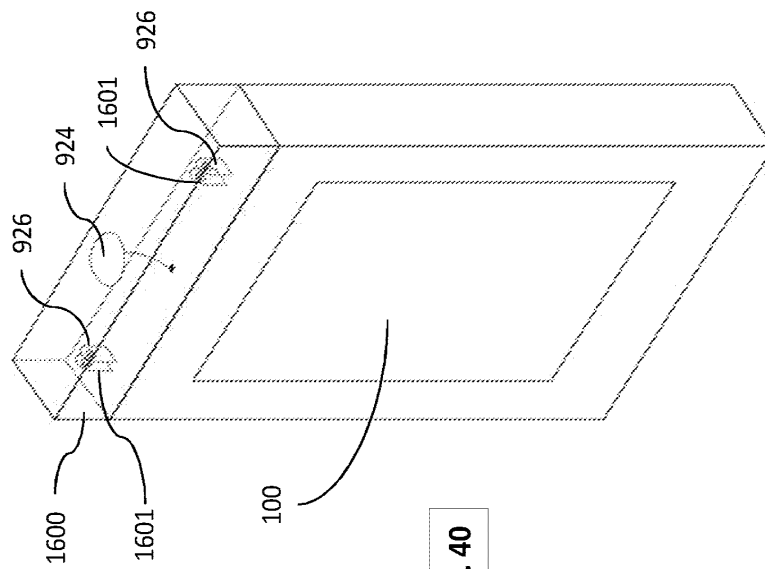
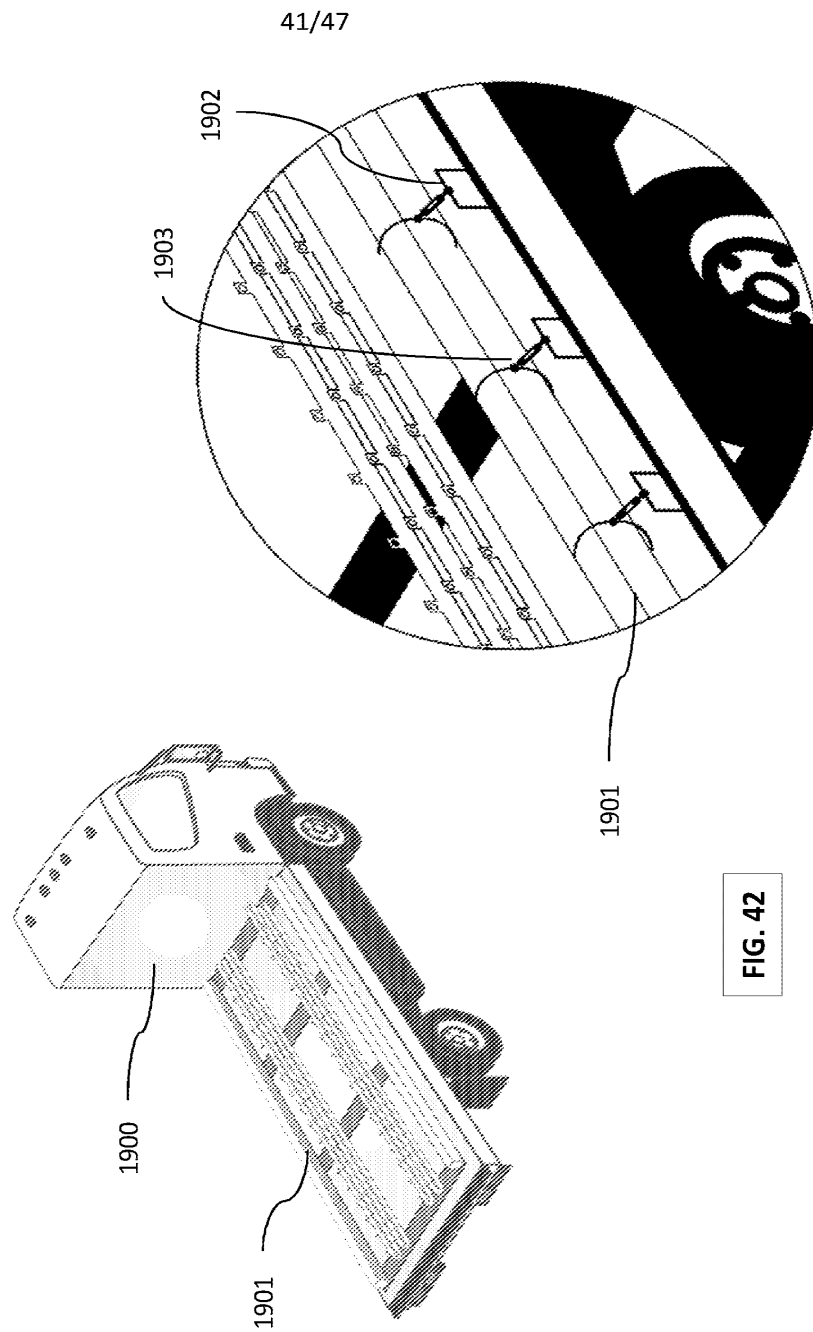
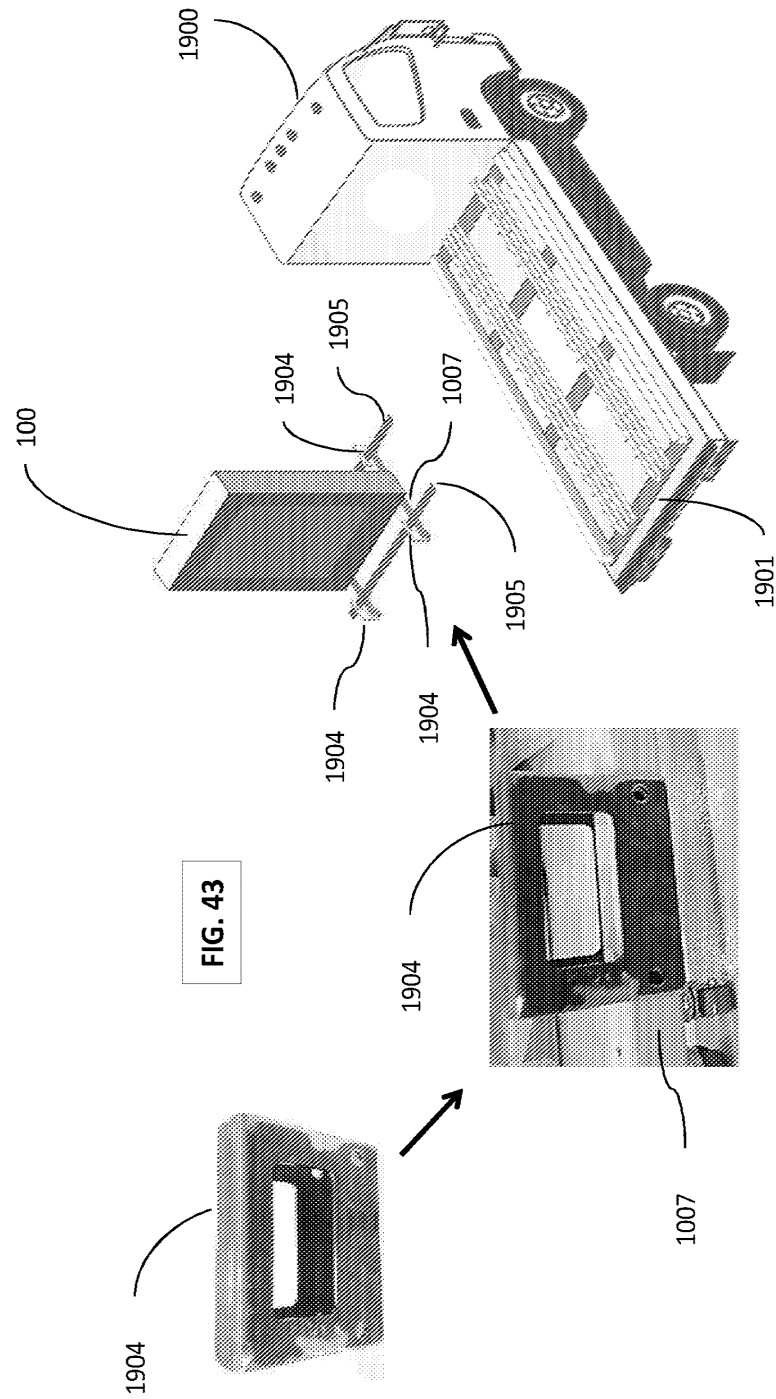
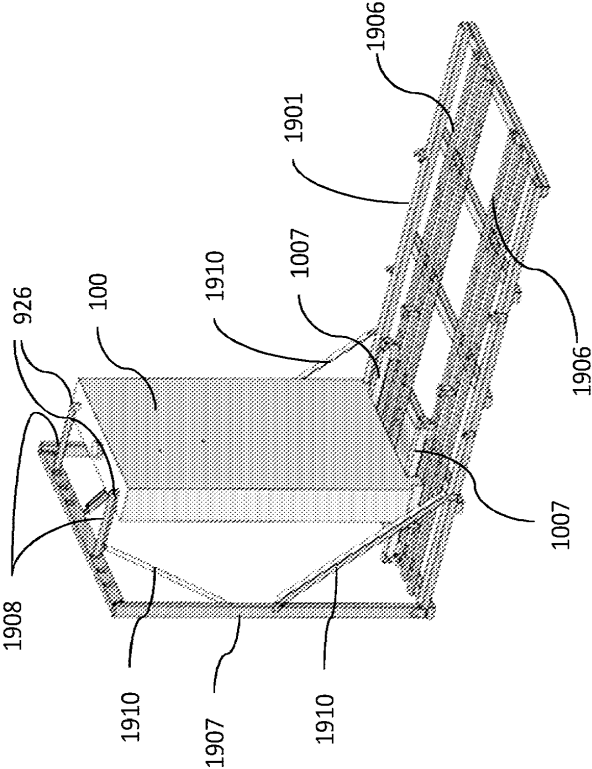
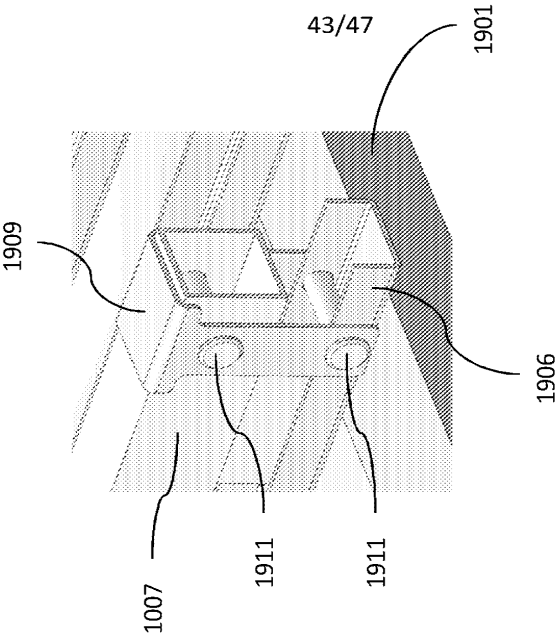


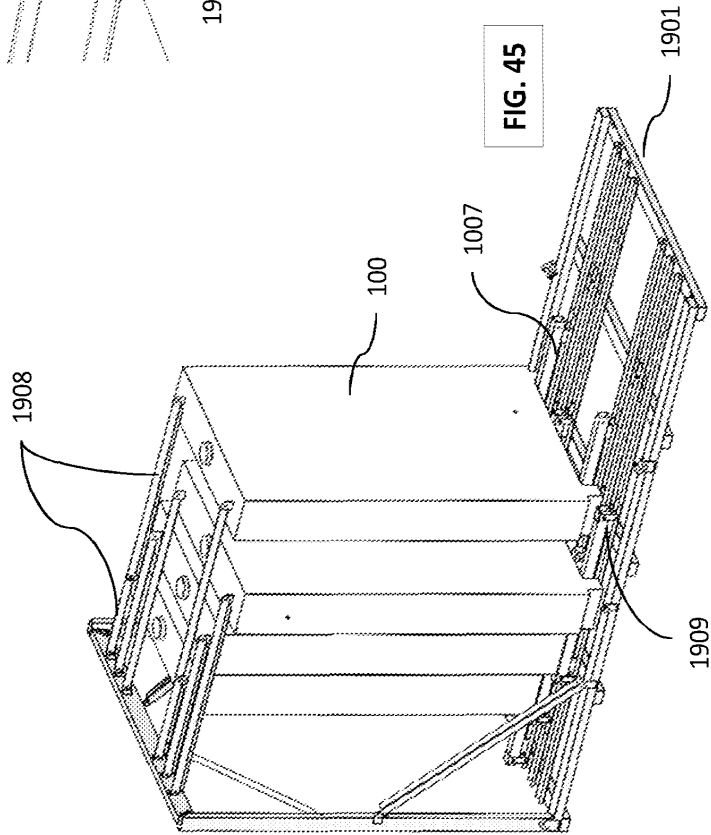
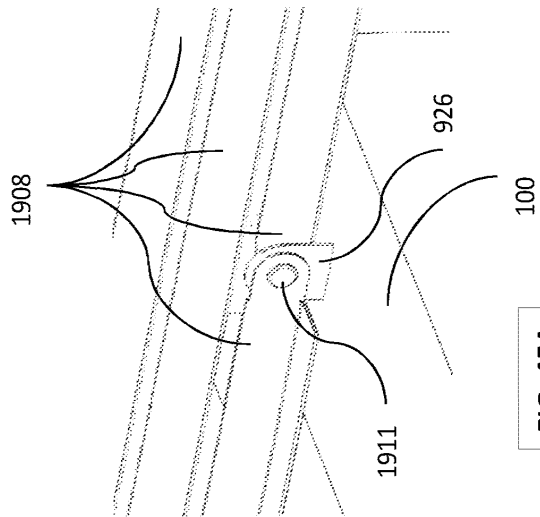
FIG. 40



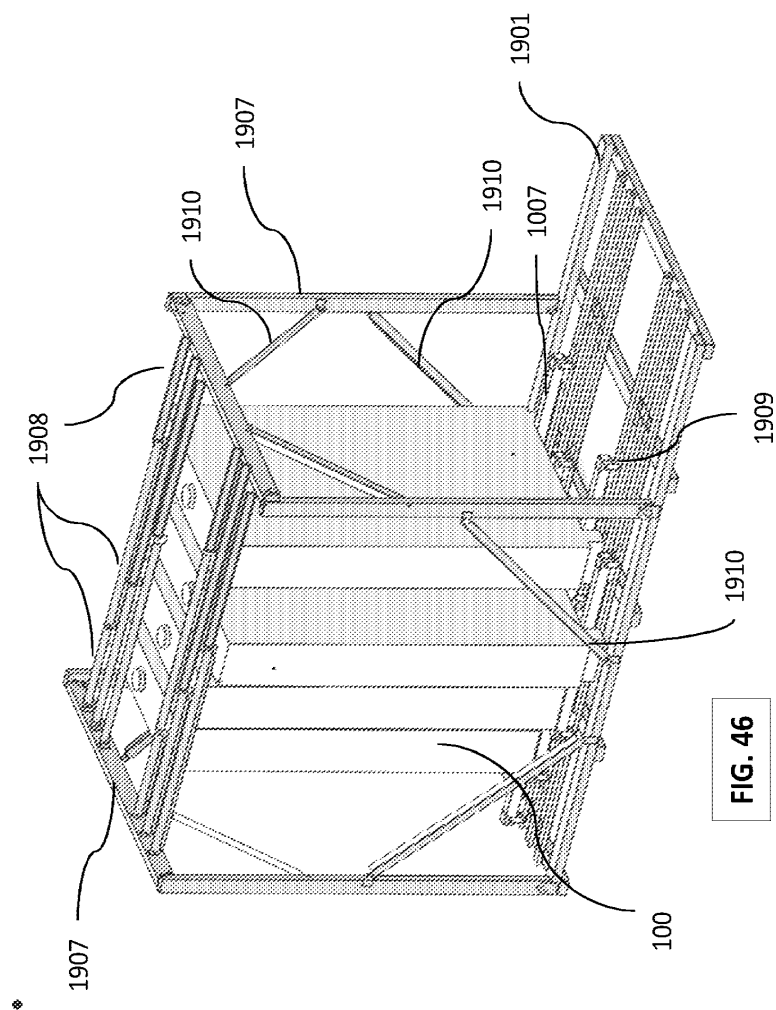
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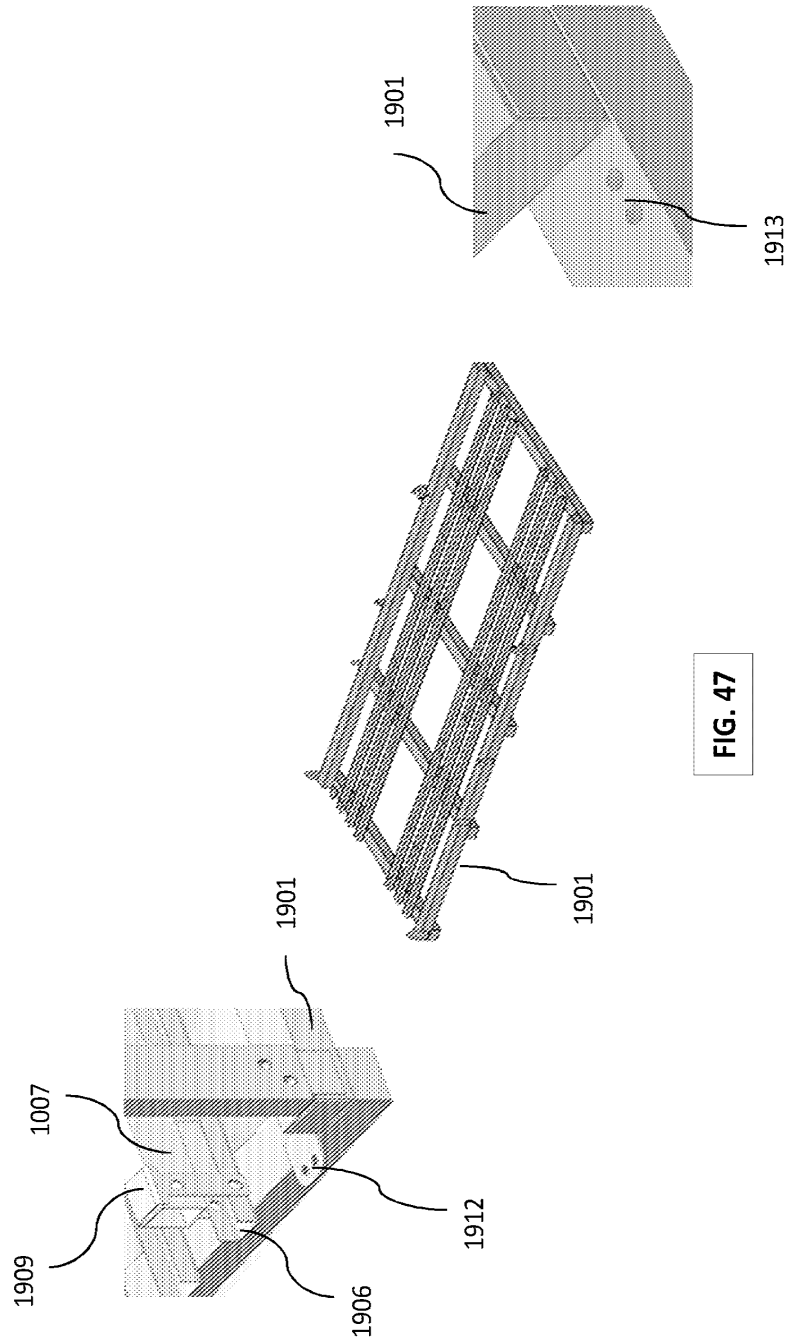




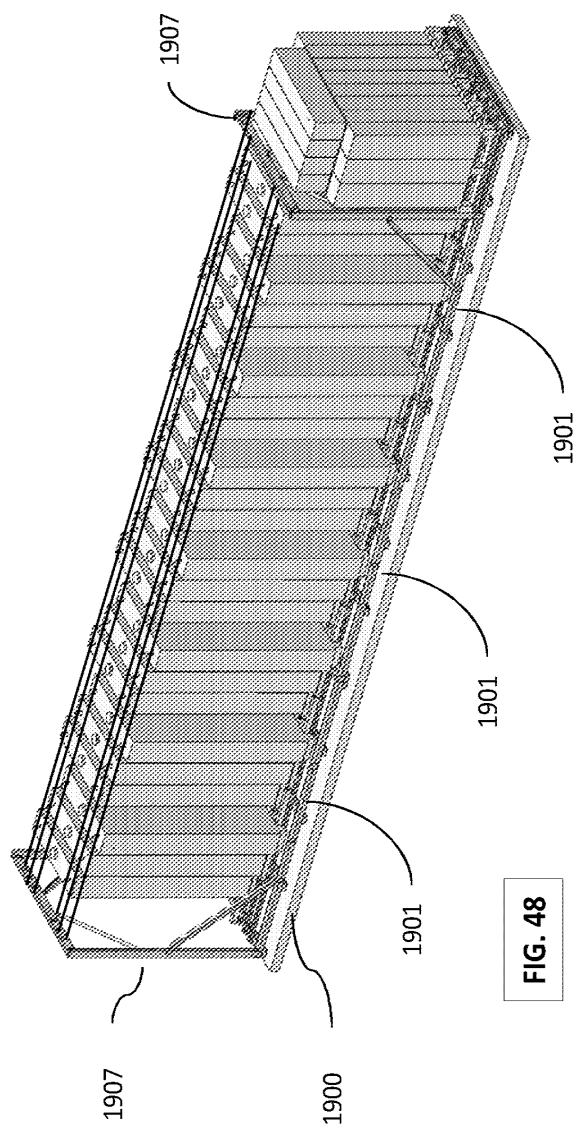
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INTERNATIONAL SEARCH REPORT

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.

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Date of the actual completion of the international search

15 April 2016

Date of mailing of the international search report

25/04/2016

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Lauri, Lauro

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2015/054169

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 1 901 788 A (NANJING LG TONGCHUANG COLOUR [CN]) 24 January 2007 (2007-01-24) figure 7	4,5
A	----- WO 2011/059793 A2 (MRI INC [US]; DUNN WILLIAM [US]; BEDELL WARE [US]; LE DON [US]; WILLIA) 19 May 2011 (2011-05-19) the whole document	1-25
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
US 2006187140 A1	24-08-2006	US 2006187140 A1	24-08-2006
		WO 2006091407 A2	31-08-2006
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		US 2006082271 A1	20-04-2006

Form PCT/ISA/210 (patent family annex) (April 2005)

SEC et al. v. MRI
SEC Exhibit 1022.3140
IPR2023-00221

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Organization
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H05K 7/20 (2006.01) *F21V 29/60* (2015.01)
G02F 1/1335 (2006.01)

(21) International Application Number:
PCT/US2016/017973

(22) International Filing Date:
15 February 2016 (15.02.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
14/624,268 17 February 2015 (17.02.2015) US

(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).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

(54) Title: PERIMETER VENTILATION SYSTEM FOR ELECTRONIC DISPLAY

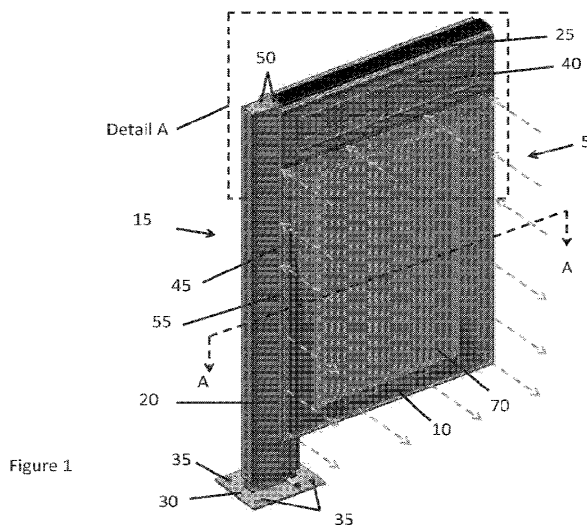


Figure 1

(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.

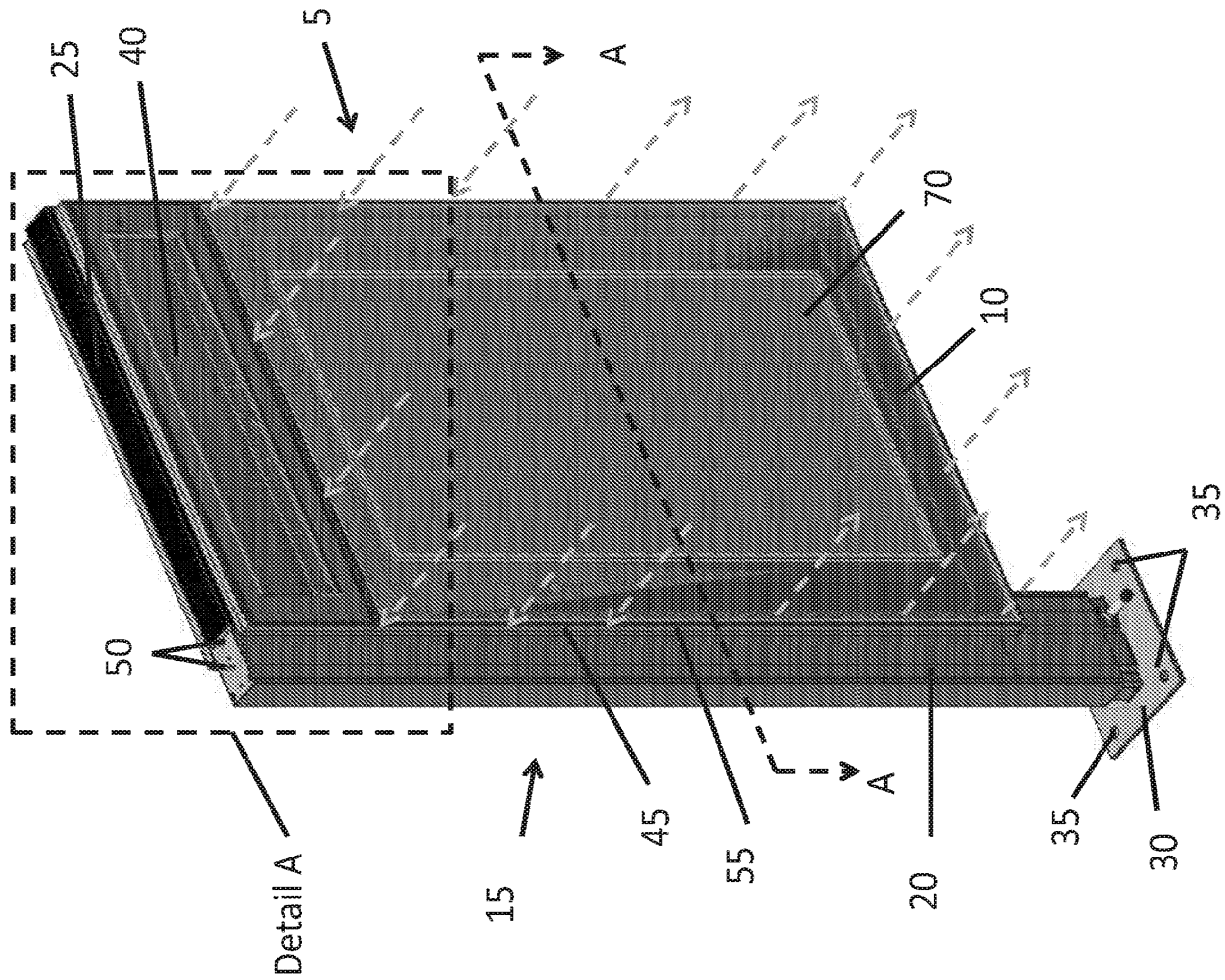


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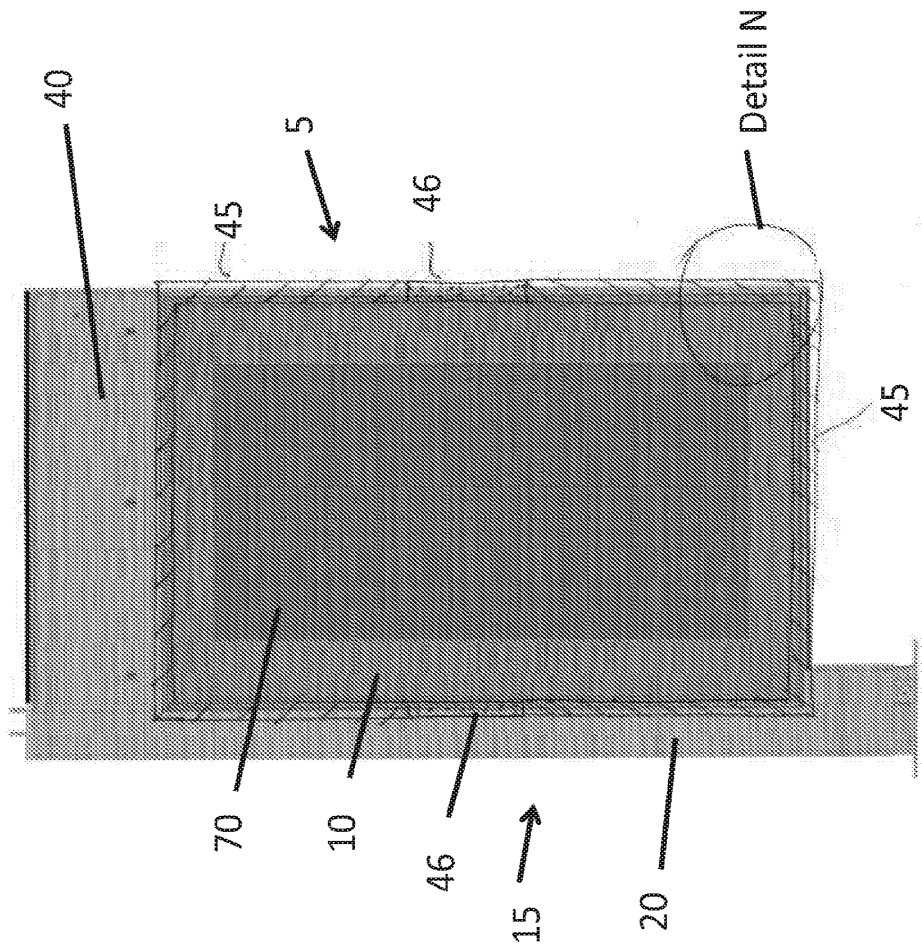


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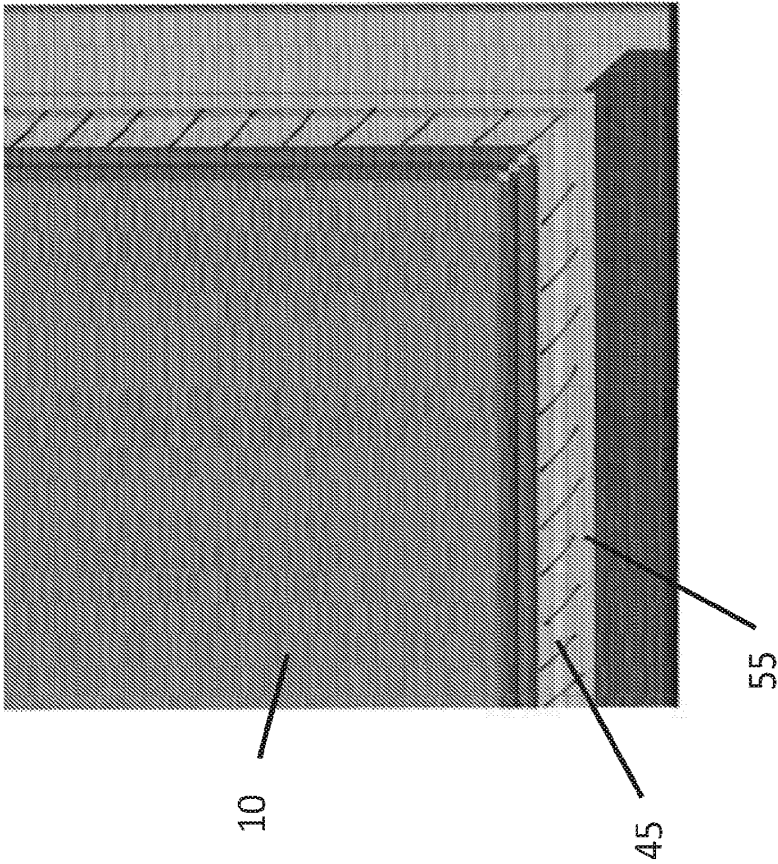


Figure 3

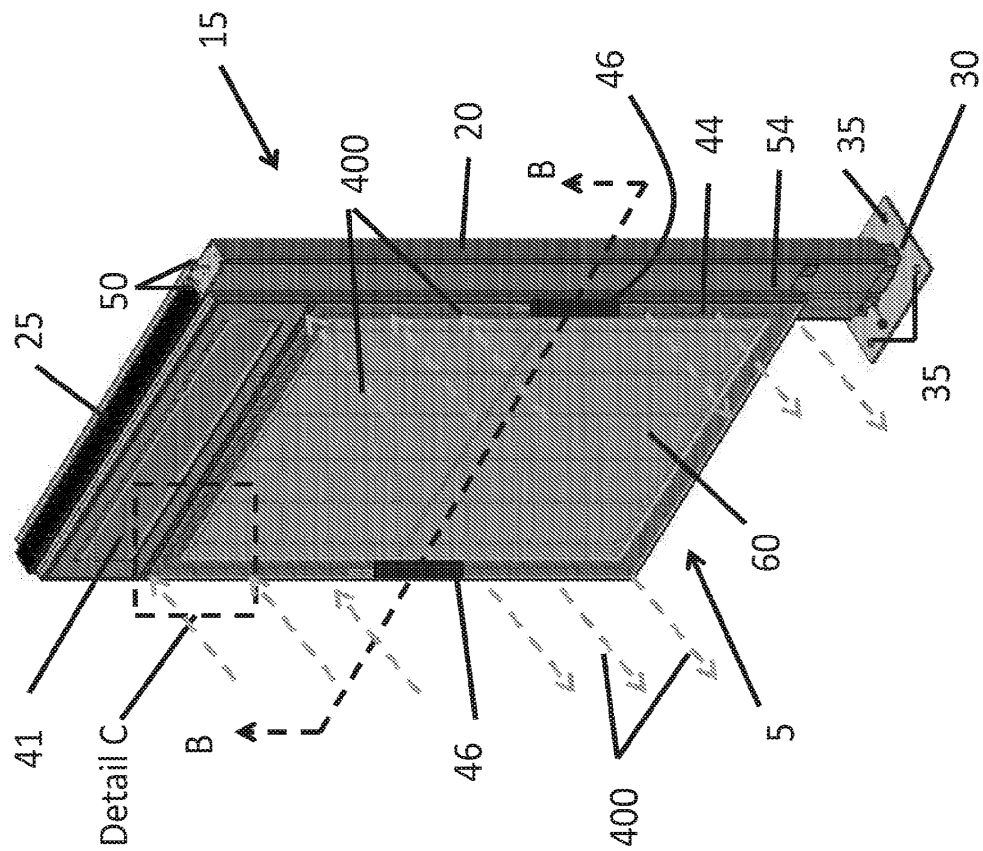


Figure 4

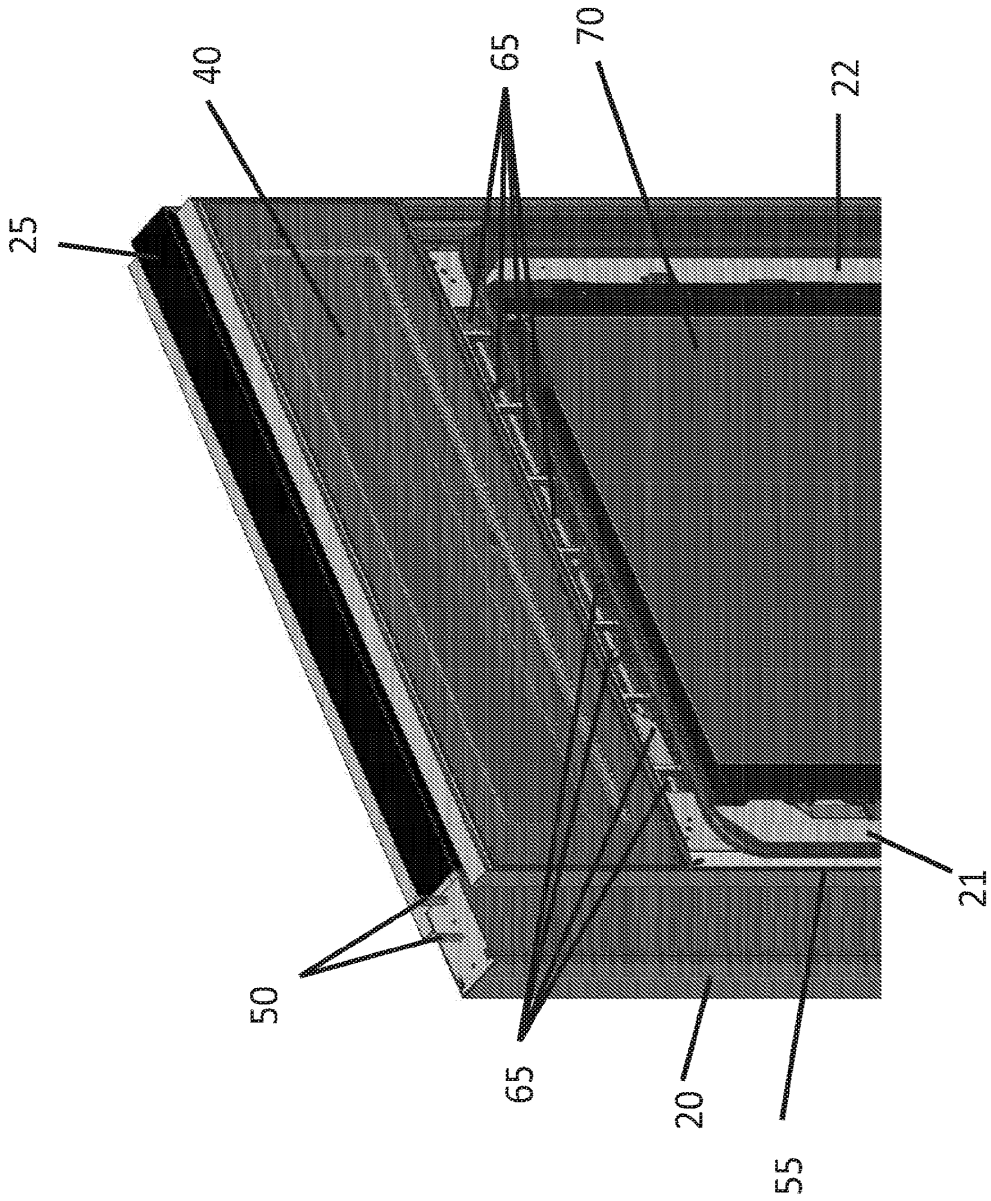


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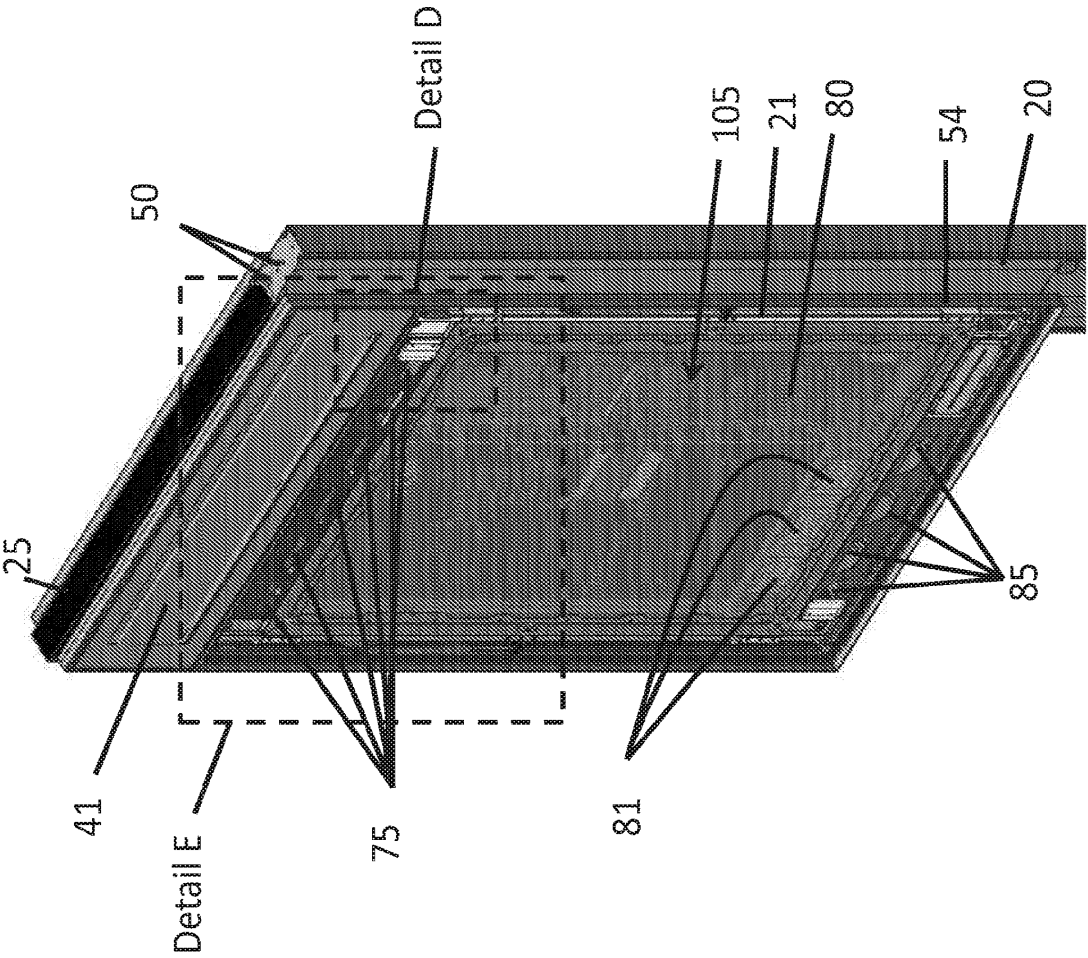


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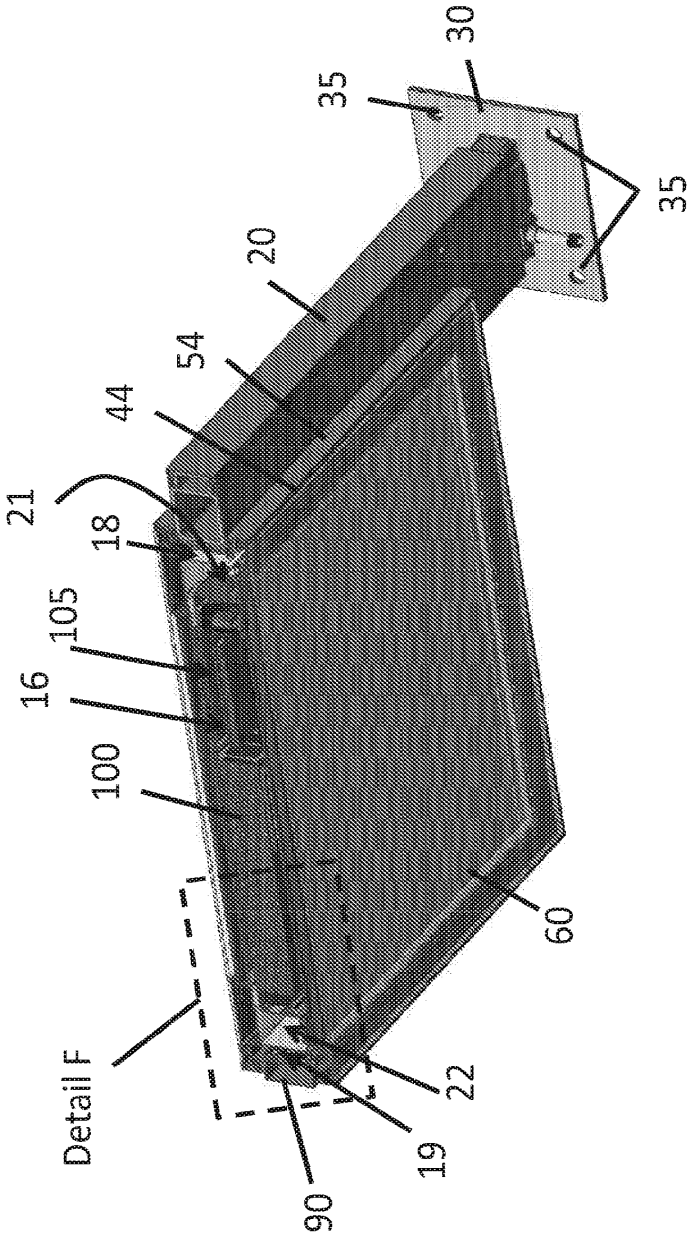


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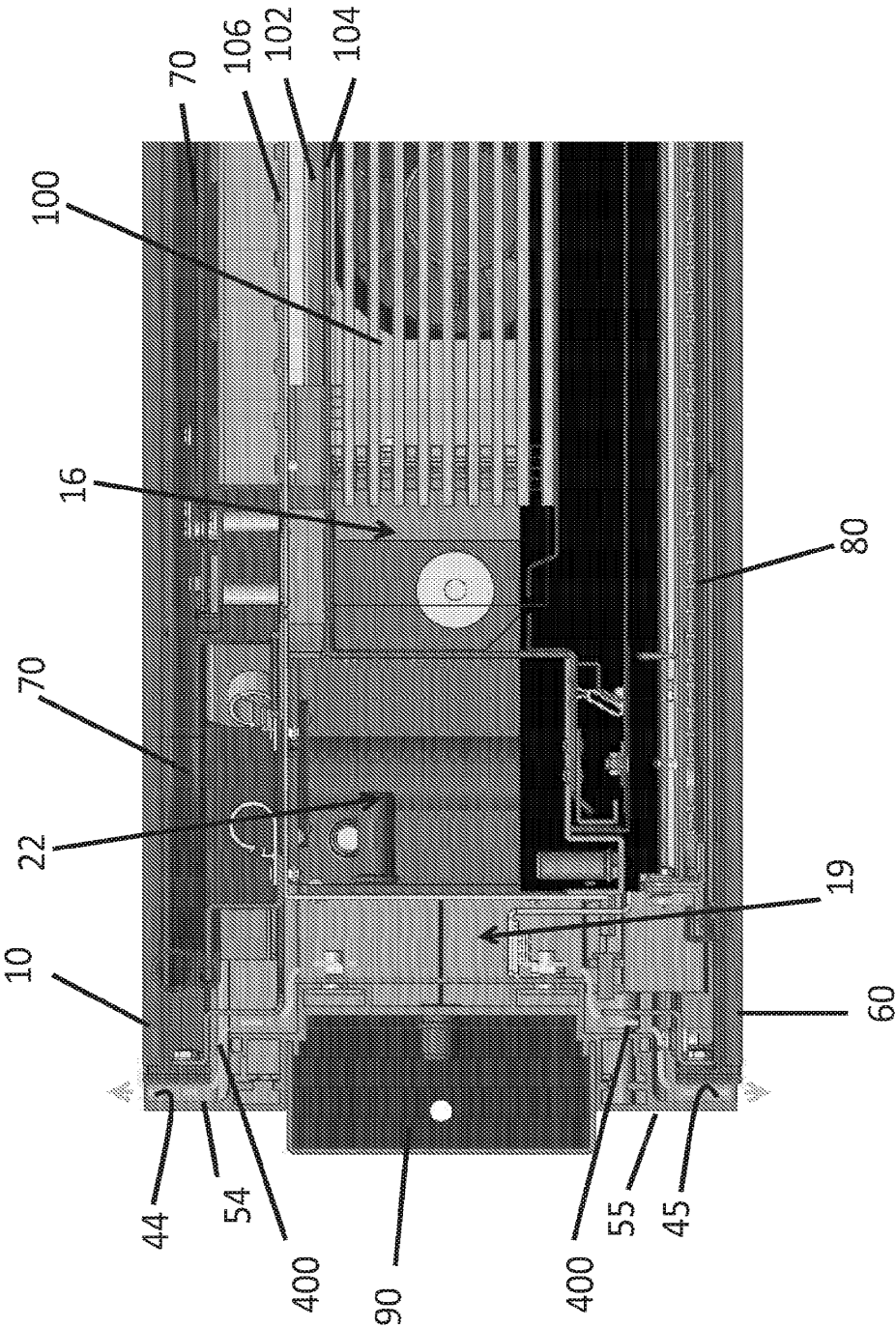


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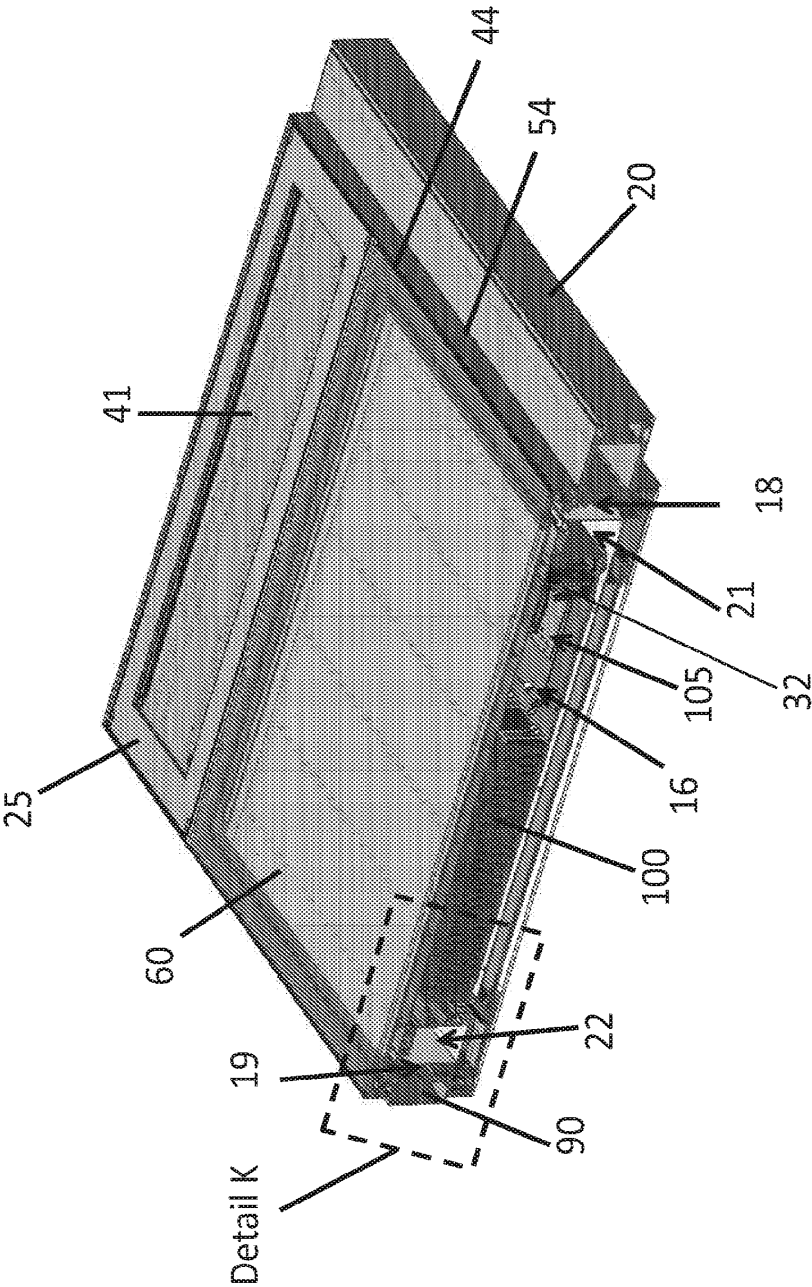


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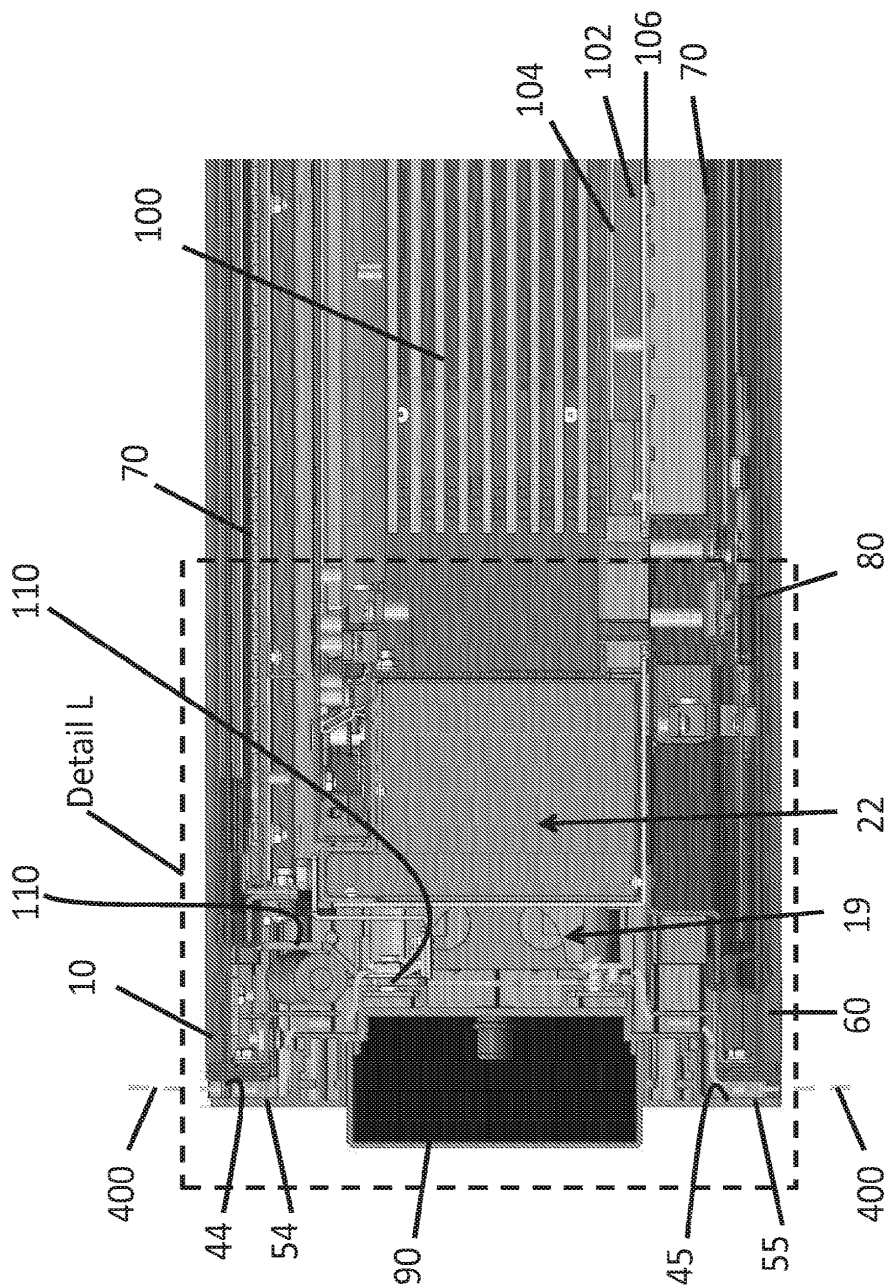


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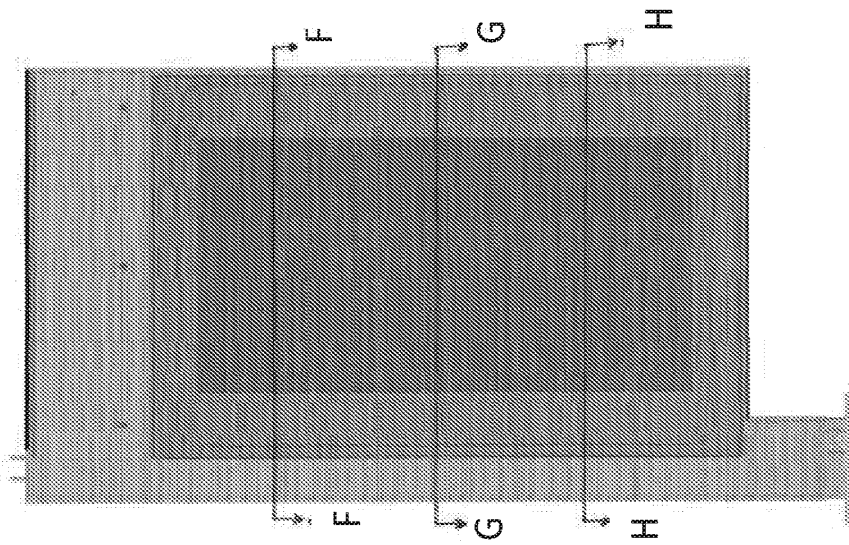


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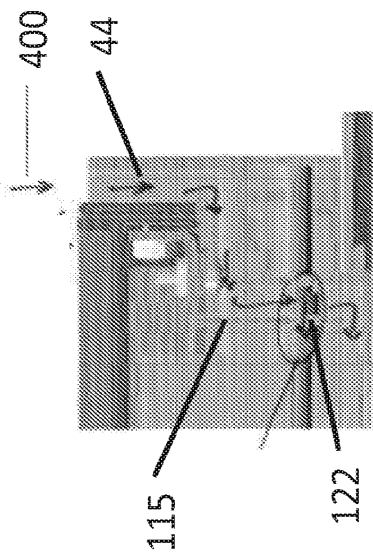


Figure 13A

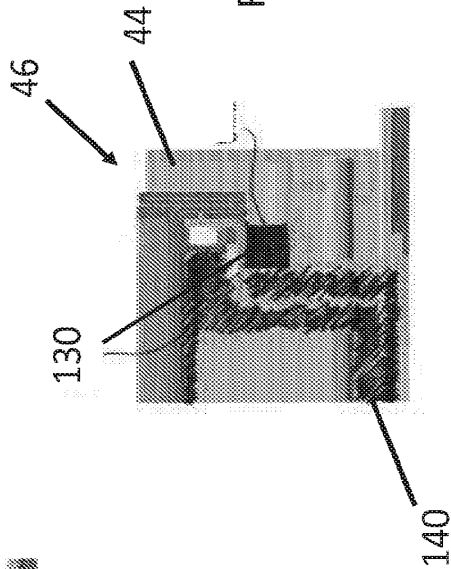


Figure 13B

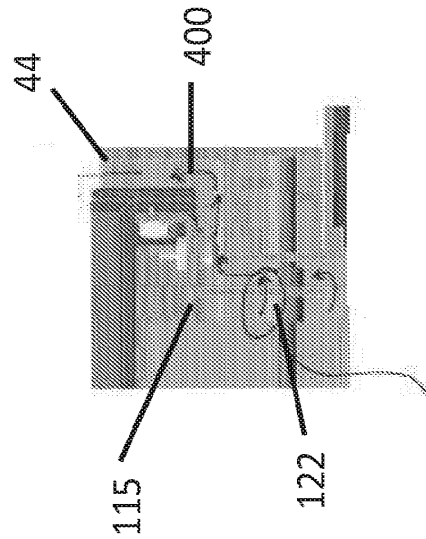


Figure 13C

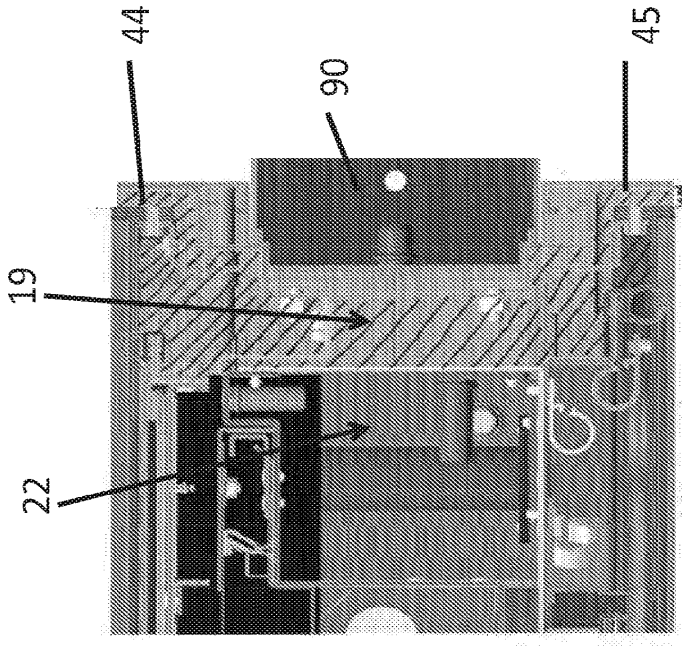


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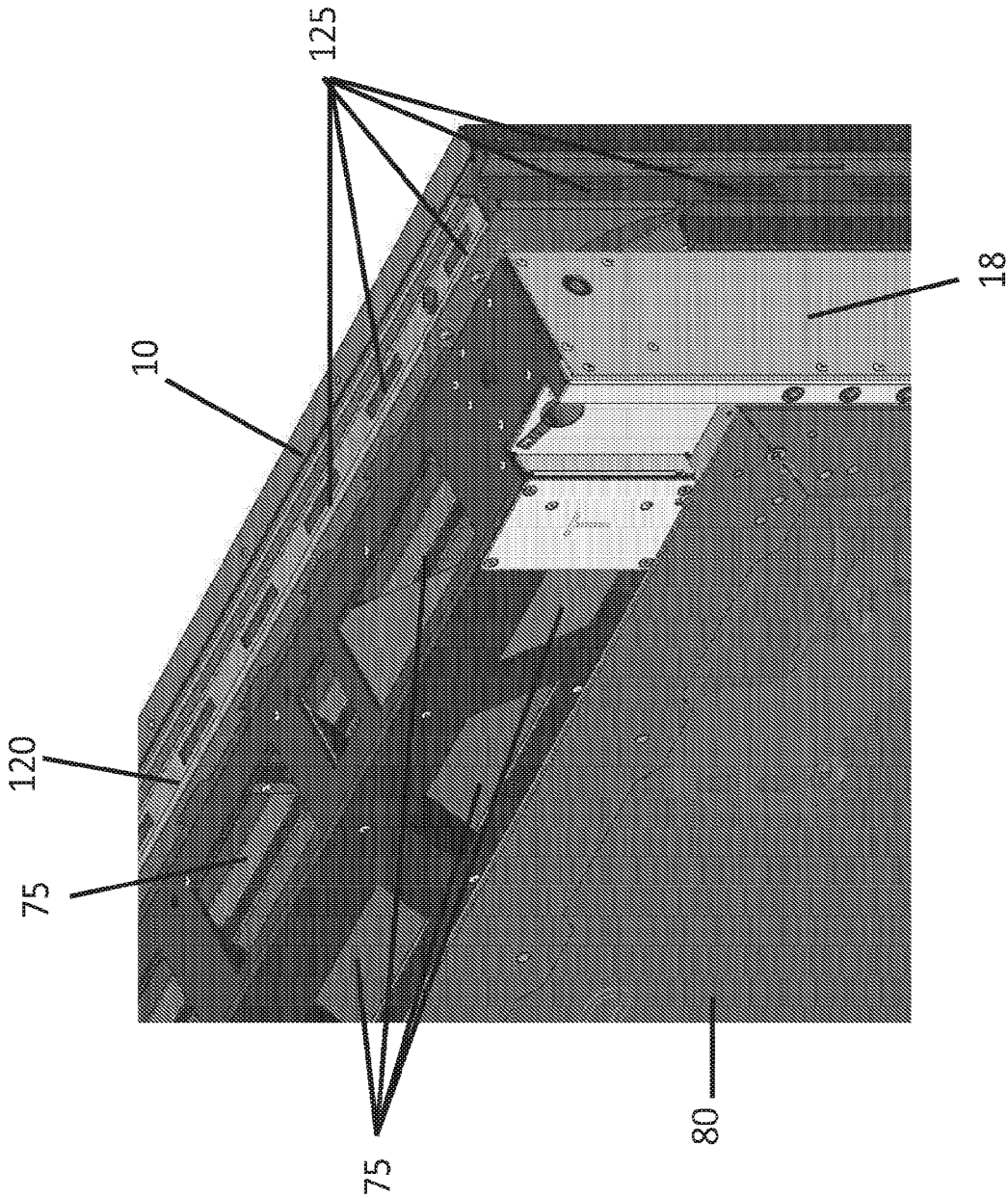


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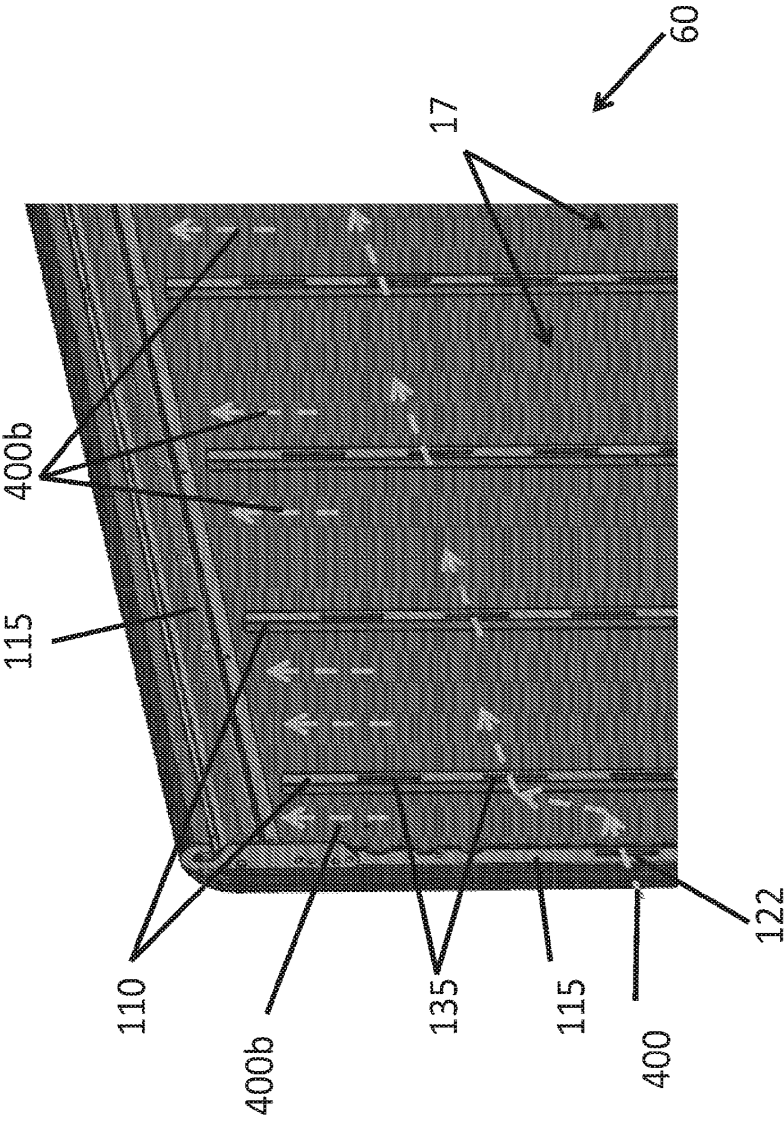


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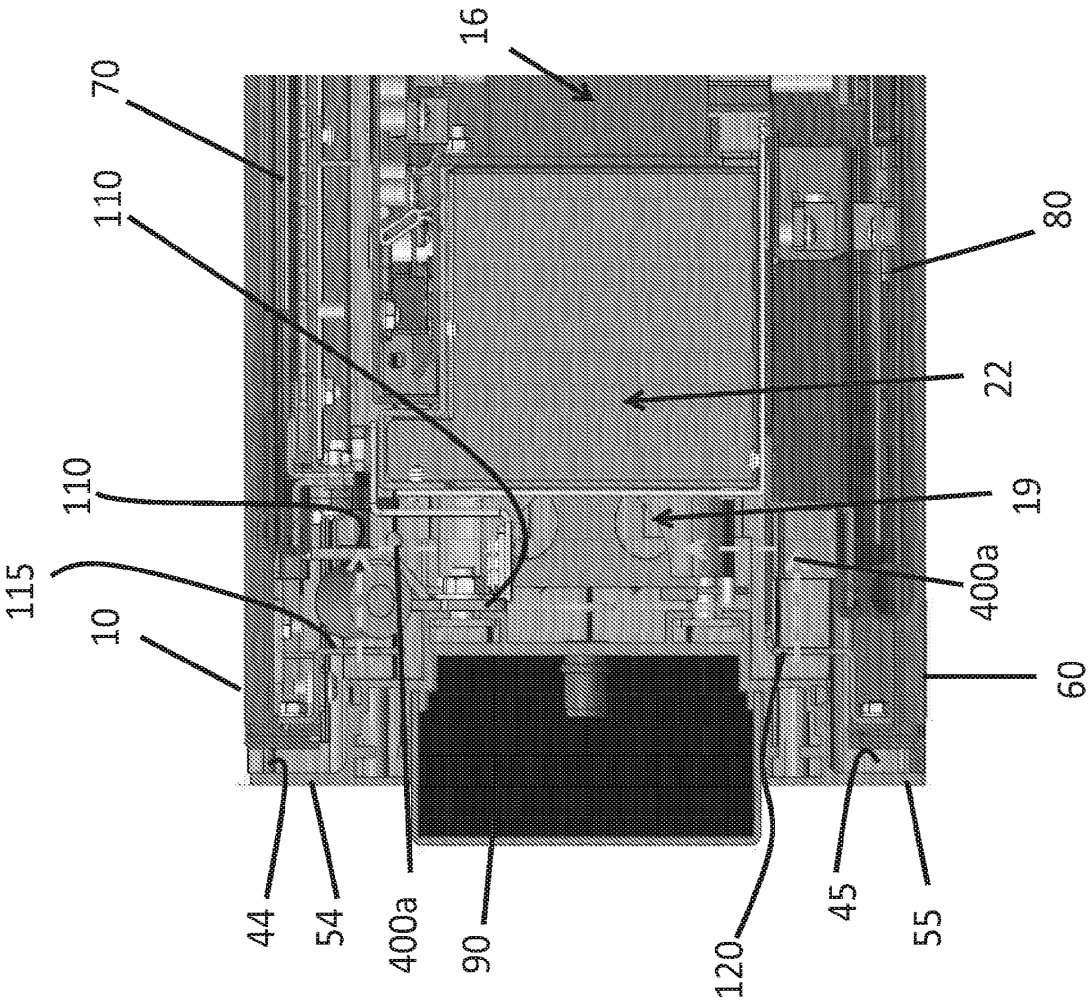


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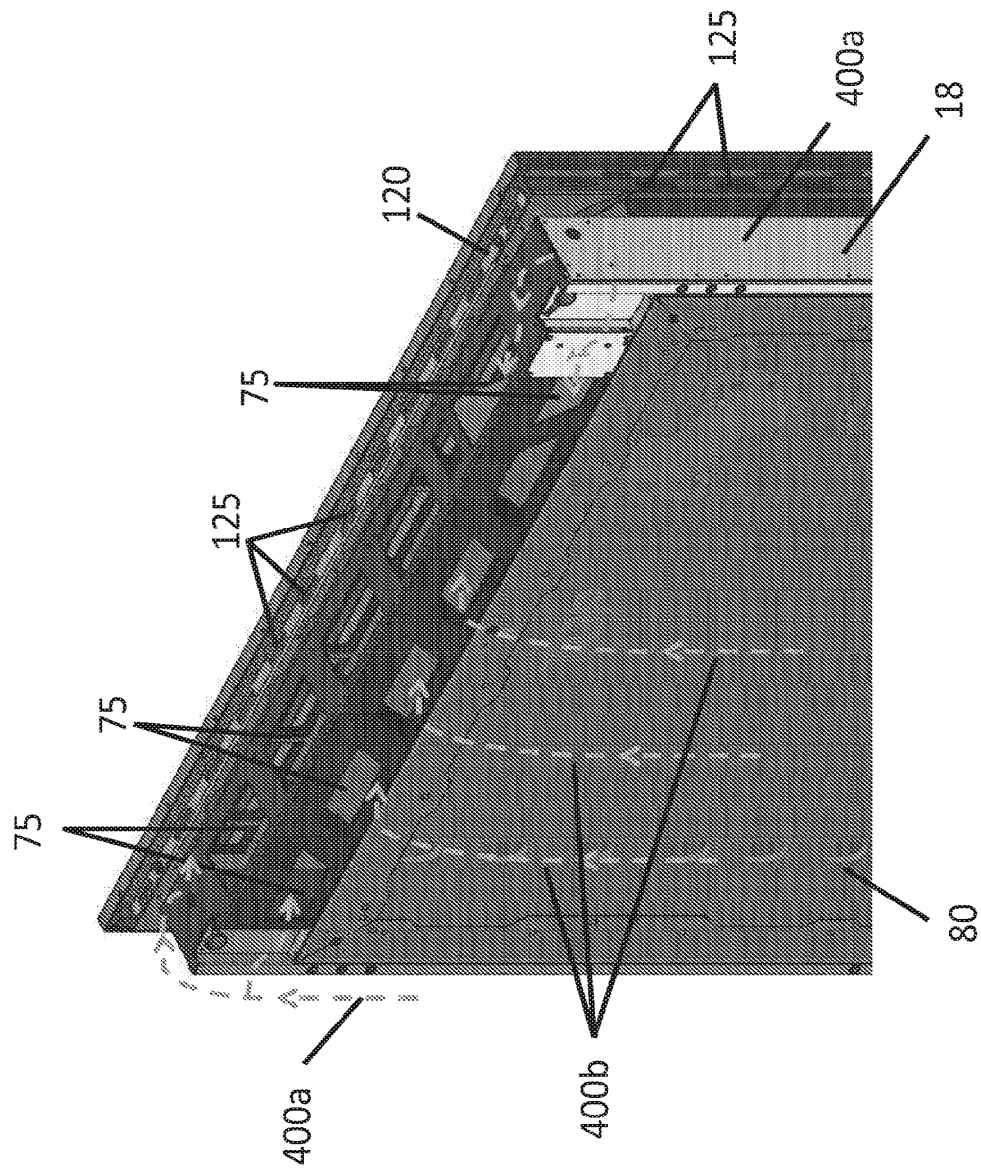


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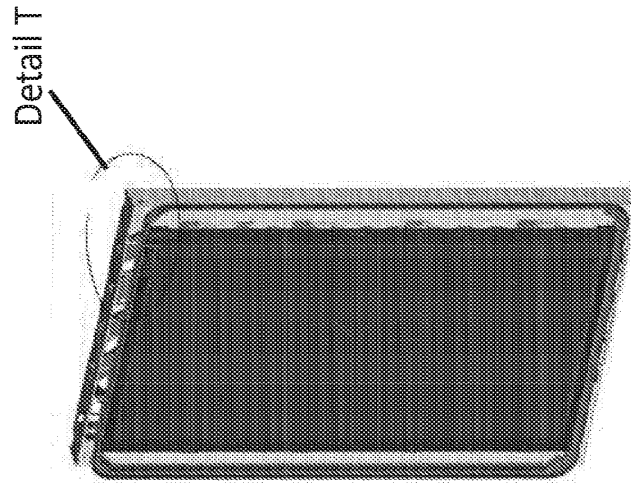


Figure 19B

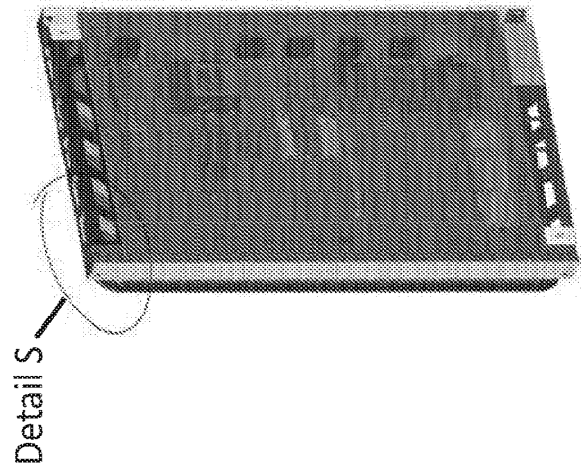


Figure 19A

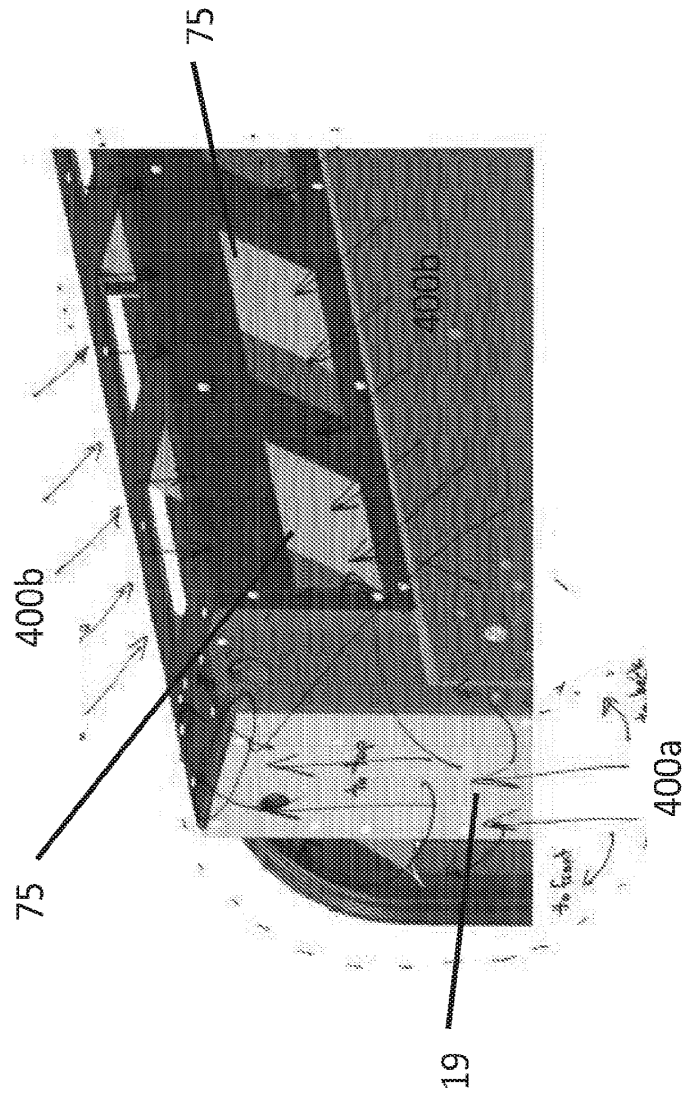


Figure 20

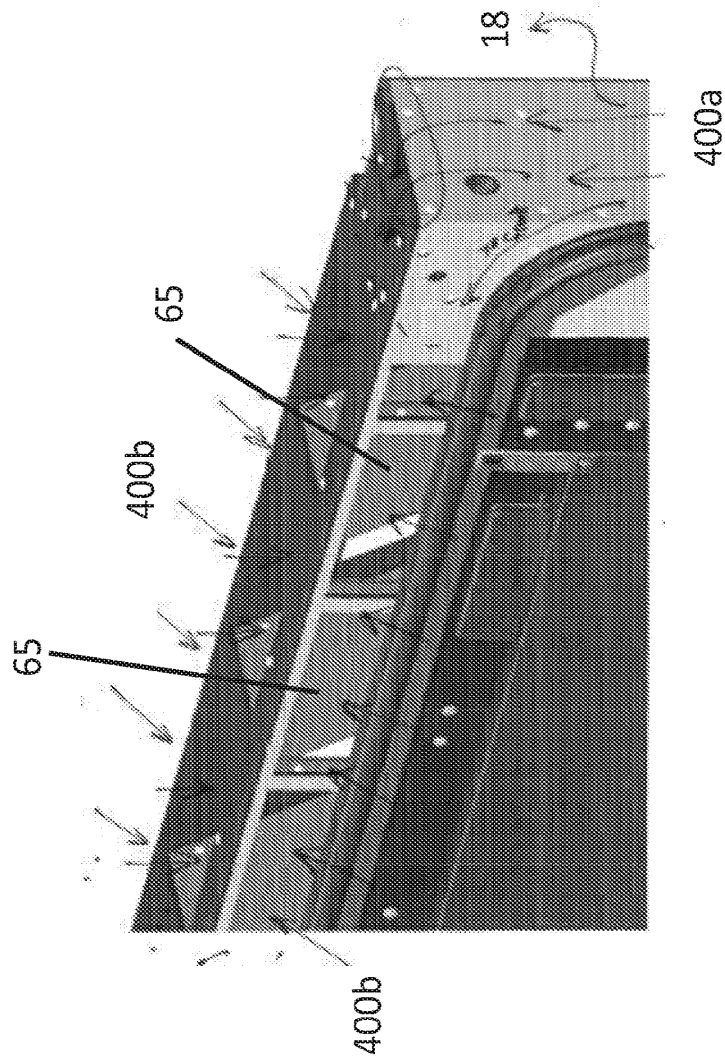


Figure 21

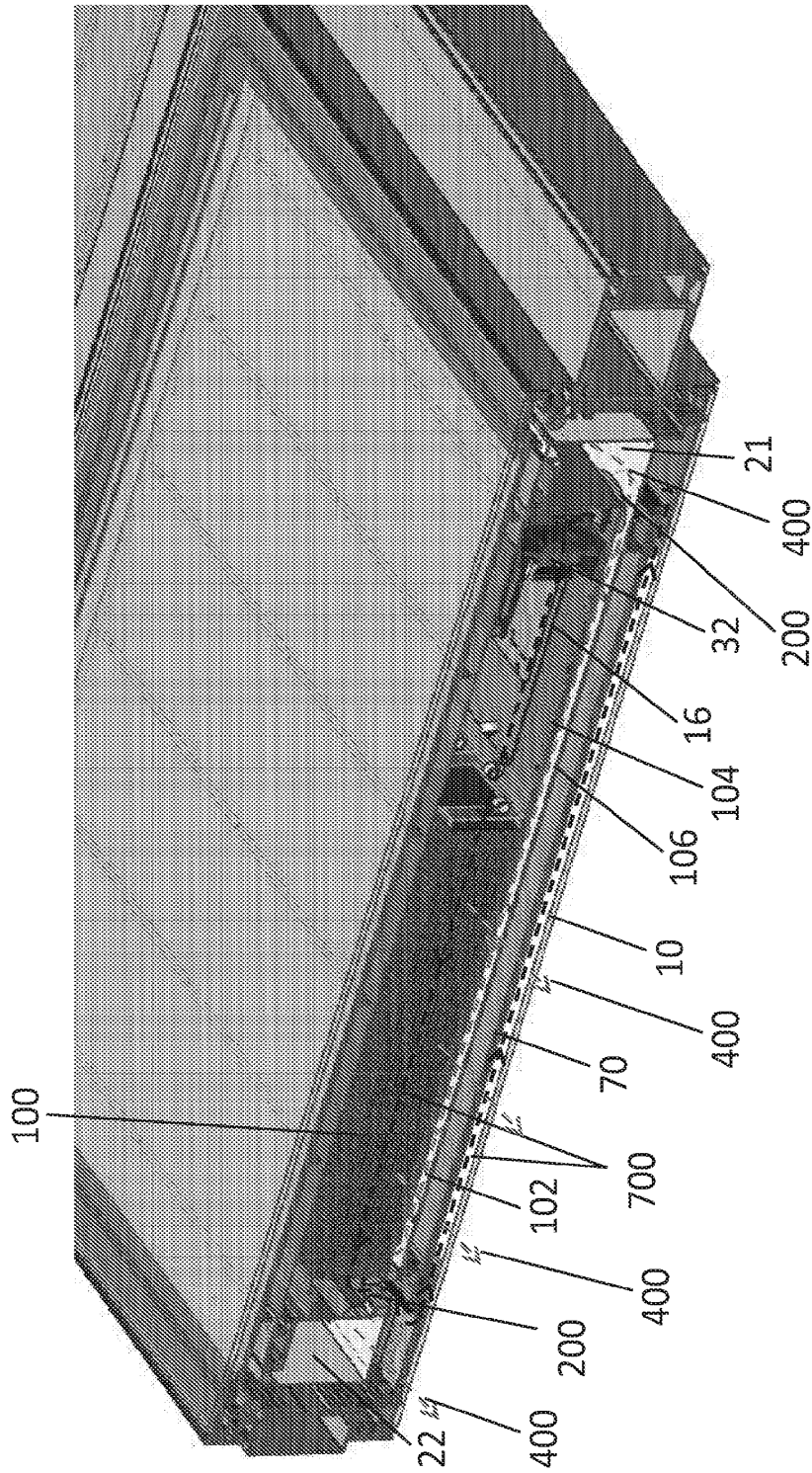


Figure 22

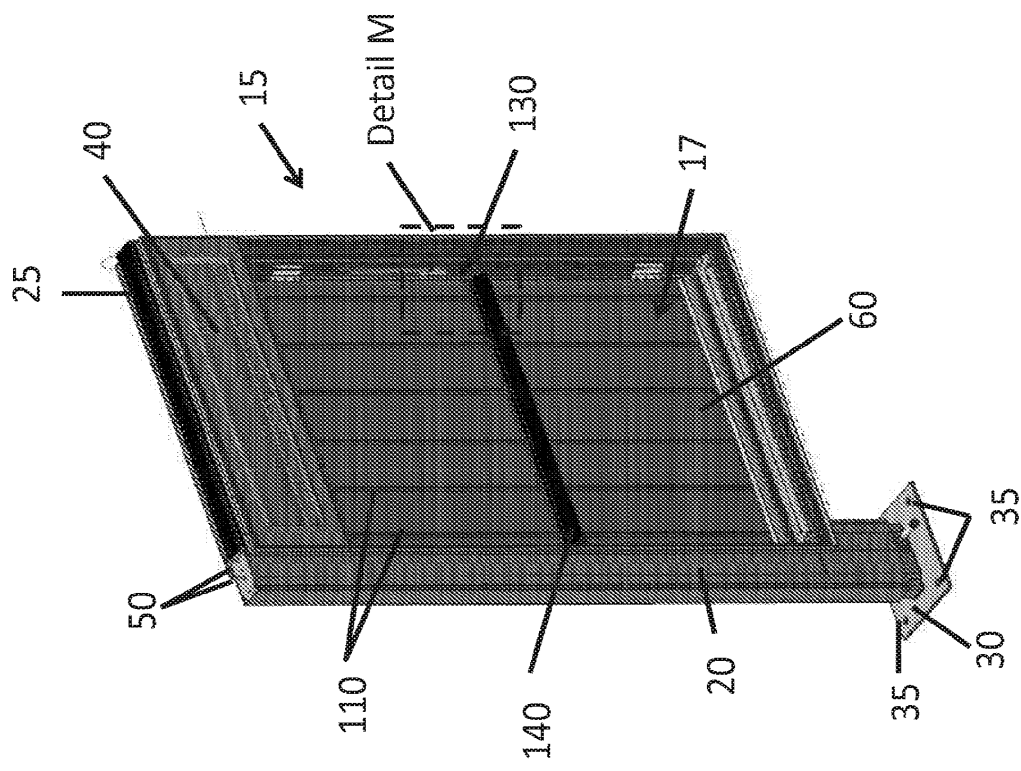


Figure 23

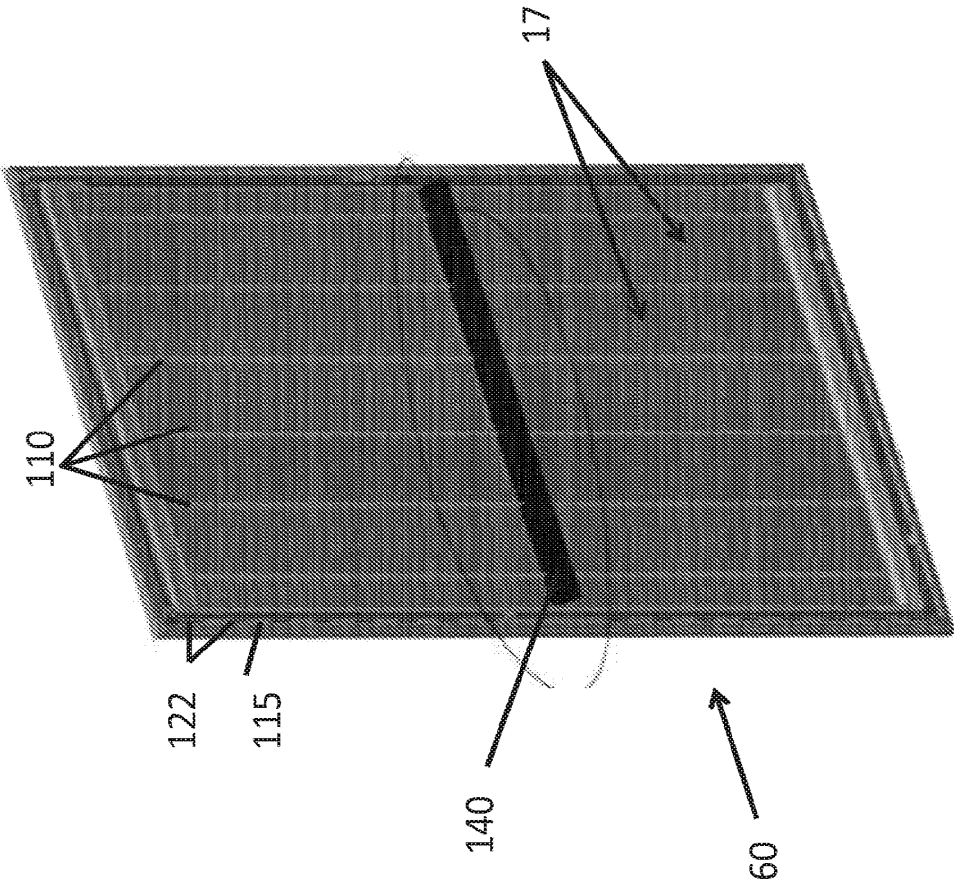


Figure 24

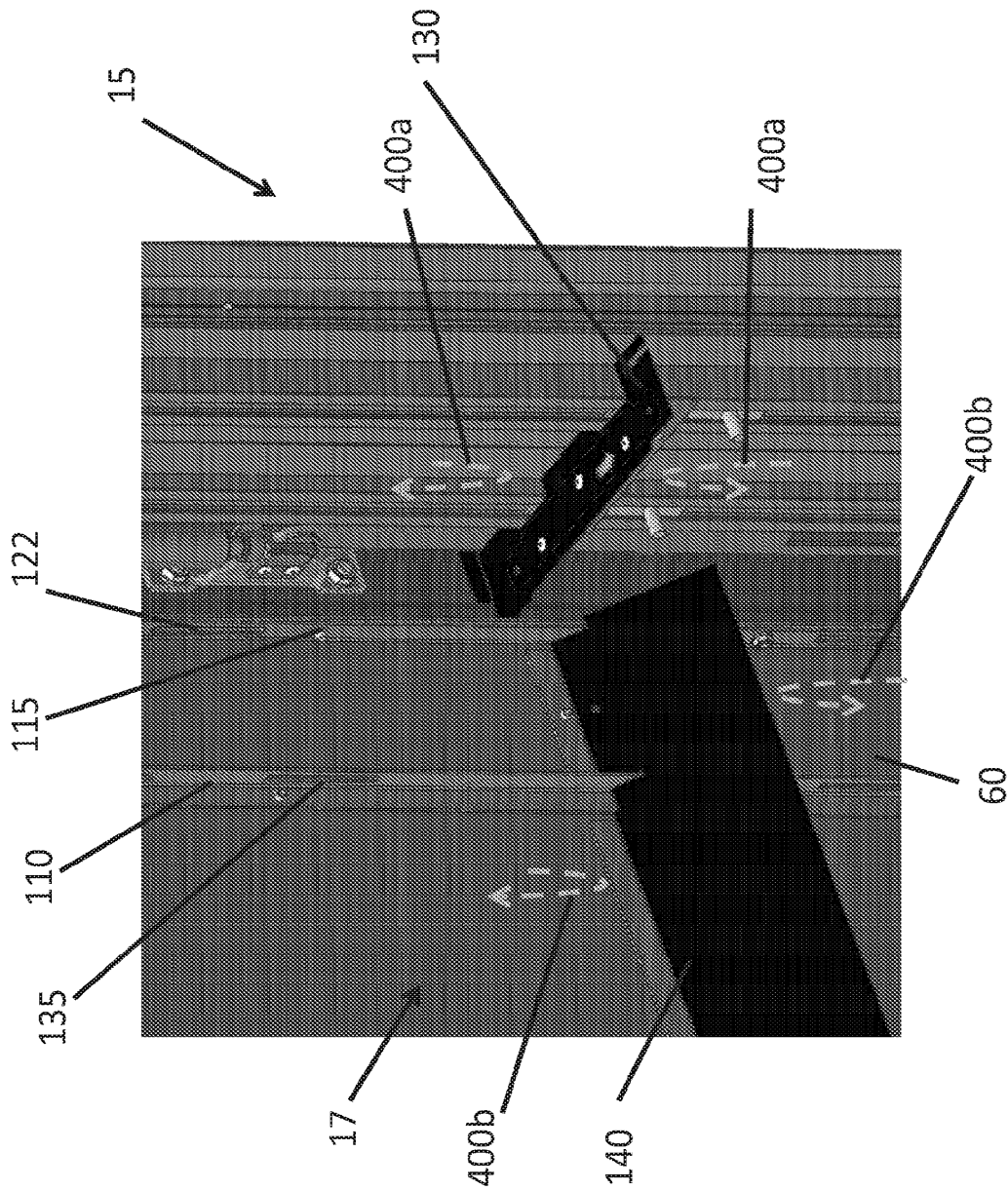


Figure 25

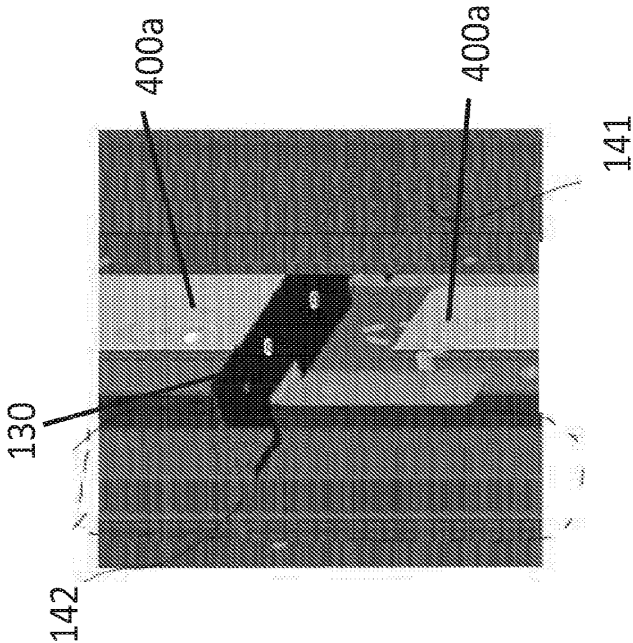


Figure 26B

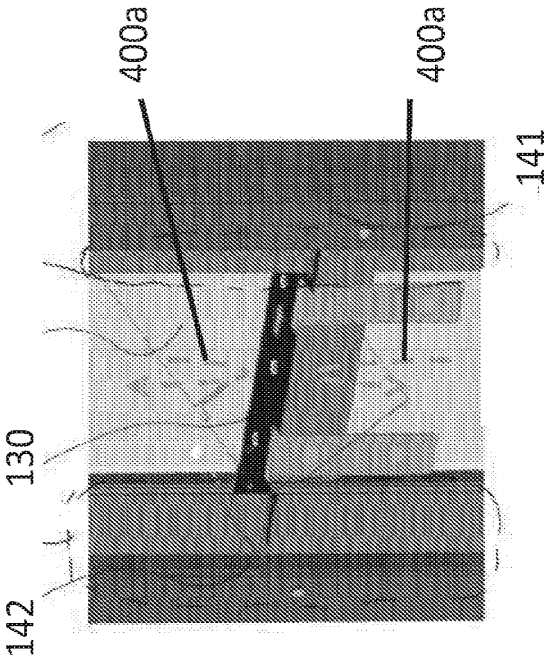


Figure 26A

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 ---
A	US 2008/0209934 A1 (RICHARDS, J) September 04, 2008; figures 8-9; paragraphs [0034-0035]	2, 4, 7, 11-12, 17-20 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)

Electronic Acknowledgement Receipt	
EFS ID:	40383404
Application Number:	16933932
International Application Number:	
Confirmation Number:	5816
Title of Invention:	ELECTRONIC DISPLAY WITH COOLING
First Named Inventor/Applicant Name:	William Dunn
Customer Number:	8698
Filer:	Adam Jeffery Smith/Brianna Lacy
Filer Authorized By:	Adam Jeffery Smith
Attorney Docket Number:	MAN2241-045R
Receipt Date:	26-AUG-2020
Filing Date:	20-JUL-2020
Time Stamp:	09:44:58
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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(54) Title: SYSTEM AND METHOD FOR THERMALLY CONTROLLING AN ELECTRONIC DISPLAY

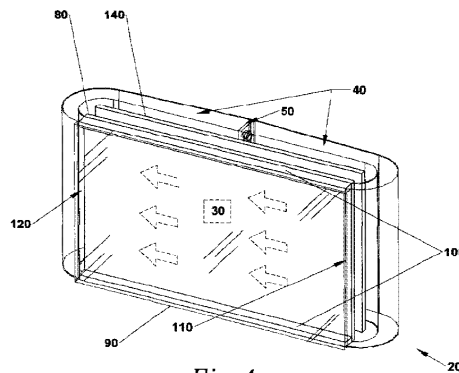


Fig. 4

(57) Abstract: 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 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.

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System and Method for Thermally Controlling an Electronic Display

Technical Field

[0001] Exemplary embodiments generally relate to heating/cooling systems for electronic displays.

Background of the Art

[0002] Electronic displays are typically used in indoor, temperature-controlled environments. Although the temperature surrounding the display might be relatively stable (near room temperature), the components of the display may generate a large amount of heat. If not properly removed, this heat could damage the display or shorten its lifetime. Conductive and convective heat transfer systems have traditionally been used to remove heat from the electronic components in a display through as many sidewalls of the display as possible. While such heat transfer systems have enjoyed a measure of success in the past, today's electronic displays require even greater cooling (and in some case heating) capabilities.

[0003] Modern electronic displays are now being used in outdoor environments as well as other situations where the surrounding temperature may extend above and below room temperature. In addition to heat transfer from the surrounding air, radiative heat transfer from the sun through a display surface may also become a major factor. In some applications and locations, 200 Watts or more of power through such a display surface is common. Furthermore, the market is demanding larger and brighter, sometimes high definition displays. With increased electronic display size more heat will be absorbed from the sun and more heat will be transmitted into the displays. To compete with the ambient light from the sun as well as reflections off surrounding surfaces, displays must produce more light, which also typically results in more heat generated by the display and/or its backlight assembly.

[0004] Further, in some applications the temperature may drop well below room temperature. Some components of an electronic display may malfunction or may be permanently destroyed by exposure to such low temperatures. For example, the performance of the liquid crystal material in a liquid crystal display (LCD) may be effected by low temperatures.

Summary of the Exemplary Embodiments

[0005] Exemplary embodiments may contain one or more of the thermal control features disclosed herein. A plurality of thermal control features are disclosed and these features may be utilized alone or in any combination. The precise combination of features would depend upon the particular cooling/heating needs of the display at issue, which would depend upon the type of display, size of the display, and its particular environment. The embodiments may be practiced with any form of electronic display, including but not limited to: LCD, light emitting diode (LED), organic light emitting diode (OLED), field emitting display (FED), cathode ray tube (CRT), plasma, and projection displays. An exemplary embodiment would be practiced with LCD displays.

[0006] One thermal feature relates to an isolated gas cooling system. The gas cooling system is preferably a closed loop which includes a first gas chamber comprising a transparent anterior plate and a second gas chamber comprising a cooling plenum. The first gas chamber is anterior to and coextensive with the viewable face of the electronic display. The transparent anterior plate may be set forward of the electronic display surface, defining the depth of the first gas chamber. A cooling chamber fan, or equivalent means, may be located within the cooling plenum and may be used to propel gas around the isolated gas cooling chamber loop. As the gas traverses the first gas chamber it contacts the electronic display surface, absorbing heat from the display surface. Because the gas and the relevant surfaces of the first gas chamber are transparent, the image quality remains excellent. After the gas has traversed the transparent first gas chamber, the gas may be directed into the rear cooling plenum where it is cooled.

[0007] Another thermal feature may utilize the isolated gas system as a heating device, either instead of or in addition to its cooling abilities. An isolated gas heating system would also be a closed loop system with a first gas chamber anterior to the display surface and a second chamber comprising a heating plenum or cooling/heating plenum. Heating elements may be placed within the plenum in order to heat the gas within the second chamber. As the gas is forced into the first chamber it may transfer its heat to the display surface. The gas may then return to the plenum for another heating cycle. The plenum may function as a cooling plenum only, heating plenum only, or a combination heating/cooling plenum; all depending upon the particular display and its particular operating environment.

[0008] Some embodiments may place electronic components used to operate the electronic display within the plenum of the isolated gas chamber. The electronic components may include, but are not limited to: transformers, circuit boards, processors, resistors, capacitors, batteries, motors, power supplies, illumination devices, wiring and wiring harnesses, and switches. If the plenum is being utilized as a cooling plenum, the cool gas within the plenum can further aid in the cooling of the electronic components, which will naturally generate heat during operation. Further, if the plenum is being utilized as a source of heat for the display, the natural heat from the electronic components can also heat the gas in the plenum, reducing the amount of energy which needs to be applied to the heating elements.

[0009] A linear polarizer may be used in some embodiments to further reduce the solar loading on the electronic display. This polarizer can be used in combination with the isolated gas chamber, or may simply be placed anterior to the electronic display with an insulating gap between the polarizer and the display. The insulating gap reduces the amount of heat that is transferred between the polarizer and the display.

[0010] Some electronic displays, such as LCDs for example, require a backlight assembly to produce an image upon the display surface. The backlight assemblies are typically a large source of heat for the display. Thus, some embodiments may utilize a constricted convection system to cool the backlight unit for the display. The constricted convection system may comprise a constricted convection plate which is placed in close proximity to the backlight assembly in order to define a gap. Gas is forced

through the gap in order to facilitate more efficient cooling of the backlight assembly. In some embodiments a wall of the plenum may constitute the constricted convection plate.

[0011] Some embodiments may also utilize an air curtain device which forces air (either warm or cold) over the exterior surface of the display assembly.

[0012] Finally, some embodiments may use a fluid assembly which contacts a fluid against the display surface in order to cool it. The fluid may be a substantially clear form of coolant fluid which is pumped through an anterior cavity which includes the display surface.

Brief Description of the Drawings

[0013] A better understanding of the exemplary embodiments will be obtained from a reading of the following detailed description and the accompanying drawings wherein identical reference characters refer to identical parts and in which:

[0014] **FIGURE 1** is a perspective view of an exemplary embodiment in conjunction with an exemplary electronic display.

[0015] **FIGURE 2** is an exploded perspective view of an exemplary embodiment showing components of the isolated gas cooling system.

[0016] **FIGURE 3** is top plan view of an exemplary embodiment of the cooling chamber.

[0017] **FIGURE 4** is a front perspective view of an embodiment of the isolated cooling chamber, particularly the transparent anterior surface of first gas chamber.

[0018] **FIGURE 5** is a rear perspective view of an embodiment of the isolated cooling chamber, showing optional electrical components placed in the plenum.

[0019] **FIGURE 6** is a rear perspective view of an embodiment of the isolated cooling chamber showing surface features that may be included on the plenum

[0020] **FIGURE 7** is a top plan view of an exemplary embodiment of the cooling chamber showing surface features that may be included on the plenum.

[0021] **FIGURE 8** is a front perspective view of an embodiment of the isolated cooling chamber with included thermoelectric modules.

- [0022] **FIGURE 9** is a top plan view of an exemplary embodiment of the cooling chamber with included thermoelectric modules.
- [0023] **FIGURE 10** is an exploded perspective view of an exemplary embodiment showing components of the isolated gas cooling system.
- [0024] **FIGURE 11** is a top plan view of an exemplary embodiment of the heating chamber.
- [0025] **FIGURE 12** is a rear perspective view of an embodiment of the heating chamber, showing optional electrical components and heating elements.
- [0026] **FIGURES 13 and 14** are cross-sectional views of exemplary embodiments for utilizing a linear polarizer with the isolated gas system or an insulating gap.
- [0027] **FIGURES 15A and 15B** are side views of exemplary embodiments of the constricted convection cooling system with a constricted convection plate.
- [0028] **FIGURE 16** is a top plan view of an exemplary embodiment where the cooling plenum is utilized as the constricted convection plate.
- [0029] **FIGURES 17A-17C** are cross-sectional views of embodiments where the cooling plenum is utilized as the constricted convection plate.
- [0030] **FIGURE 18** is a front plan view of a display utilizing an air curtain device.
- [0031] **FIGURE 19** is a cross-sectional view of a display utilizing an air curtain device.
- [0032] **FIGURE 20** is an illustration showing the components for a liquid cooled display.

Detailed Description

[0033] It is to be understood that the spirit and scope of the disclosed embodiments includes thermally controlling displays including, but not limited to LCDs. For simple explanation purposes, embodiments may be described with respect to the components for LCD displays. By way of example and not by way of limitation, embodiments may be used in conjunction with displays selected from among LCD, light emitting diode (LED), organic light emitting diode (OLED), field emitting display (FED), cathode ray tube (CRT), plasma, and projection displays. Furthermore, embodiments may be used

with displays of other types including those not yet discovered. In particular, it is contemplated that embodiments may be well suited for use with full color, flat panel OLED displays. Further, it is particularly contemplated that embodiments may be used with relatively large, high definition LCD displays. While the embodiments described herein are well suited for outdoor environments, they may also be appropriate for indoor applications (e.g., factory environments, coolers/freezers, etc.) where thermal stability of the display may be at risk.

Isolated Gas Cooling System

[0034] As shown in FIGURE 1, when the display 10 is exposed to outdoor elements, the temperatures inside the display 10 may vary greatly without some kind of cooling device. As such, the display 10 may not function properly or may have a greatly reduced life span. Direct sunlight is especially problematic in causing increases in the internal temperature of the display 10.

[0035] In Figure 1, the display area of the electronic display shown includes a narrow gas chamber that is anterior to and coextensive with the electronic display surface. The display shown is also equipped with an optional air curtain device 114. The air curtain device 114 is discussed in detail below. Optionally, the display may have a reflection shield 119, to mitigate reflection of the sunlight on the display surface. Additionally, in outdoor environments, housing 70 is preferably a color which reflects sunlight.

[0036] As shown in FIGURE 2, an exemplary embodiment of the electronic display 10 includes an isolated gas cooling chamber 20 contained within a display housing 70. A transparent first gas chamber is defined by spacers 100 and transparent front plate 90. A second transparent front plate 130 may be laminated to front plate 90 to help prevent breakage of front plate 90 and protect the interior of the display. Cooling chamber 20 surrounds a display stack 80 and associated backlight assembly 140.

[0037] The display 10 may include means for cooling gas contained within the second gas chamber. This means may include one or more fans 60 which may be positioned at the base of the display housing 70. The fans 60 may ingest cool air and force the cooler ingested air over at least one external surface of a posterior cooling plenum 45. If desired, an air conditioner (not shown) may also be utilized to cool the air which

contacts the external surface of plenum 45. Alternatively, the fans 60 may simply ingest ambient air.

[0038] Referring to FIGURE 3, embodiments of the isolated gas cooling chamber 20 may comprise a closed loop which includes a first gas chamber 30 and a second gas chamber 40. The first gas chamber includes a transparent plate 90. The second gas chamber comprises a cooling plenum 45. The term "isolated gas" refers to the fact that the gas within the isolated gas cooling chamber 20 is essentially isolated from external air in the housing of the display. Because the first gas chamber 30 is positioned in front of the electronic display surface 85, the gas should be substantially free of dust or other contaminants that might negatively affect the display image. An optional filter (not shown) may be utilized to assist in preventing contaminants and dust from entering the first gas chamber 30.

[0039] The isolated gas may be almost any transparent gas, for example, normal air, nitrogen, helium, or any other transparent gas. The gas is preferably colorless so as not to affect the image quality. Furthermore, the isolated gas cooling chamber 20 need not necessarily be hermetically sealed from the external air. It is sufficient that the gas in the chamber is isolated to the extent that dust and contaminants may not substantially enter the first gas chamber.

[0040] In the closed loop configuration shown in Fig. 3, the first gas chamber 30 is in gaseous communication with the second gas chamber 40. A cooling chamber fan 50 may be provided within the cooling plenum 45 and utilized to propel gas around the isolated gas cooling chamber 20. The first gas chamber 30 includes at least one front glass 90 mounted in front of an electronic display surface 85.

[0041] Referring to FIGURE 4, the front plate 90 may be set forward from the electronic display surface 85 by spacing members 100. The spacing members 100 define the depth of the narrow channel passing in front of the electronic display surface 85. The spacing members 100 may be independent or alternatively may be integral with some other component of the device (e.g., integral with the front plate 90). The electronic display surface 85, the spacing members 100, and the transparent front plate 90 define a first gas chamber 30. The chamber 30 is in gaseous communication with plenum 45 through entrance opening 110 and exit opening 120.

[0042] As shown in Fig. 3, a posterior surface of the first gas chamber 30 preferably comprises the electronic display surface 85 of the display stack 80. As the isolated gas in the first gas chamber 30 traverses the display it contacts the electronic display surface 85. Contacting the cooling gas directly to the electronic display surface 85 enhances the convective heat transfer away from the electronic display surface 85. In exemplary embodiments the electronic display surface 85 comprises the posterior surface of the first gas chamber 30. Accordingly, the term “electronic display surface” refers to the front surface of a typical electronic display (in the absence of the embodiments disclosed herein).

[0043] In an exemplary embodiment, the electronic display surface 85, front plate 90, and optional second front plate 130 may be comprised of a glass substrate. However, neither display surface 85, nor transparent front plate 90, nor optional second transparent front plate 130 need necessarily be glass. Thus, the term “glass” may be used herein interchangeably with the term plate, but a glass material is by no means required. Further, electronic display surface 85 does not have to comprise the posterior surface wall of the front gas compartment 30. An additional plate may be used. However, by utilizing the electronic display surface 85 as the posterior surface wall of the gas compartment 30, there may be fewer surfaces to impact the visible light traveling through the display. Furthermore, the device will be lighter and cheaper to manufacturer.

[0044] Although the embodiment shown utilizes the electronic display surface 85, certain modifications and/or coatings (e.g., anti-reflective coatings) may be added to the electronic display surface 85, or to other components of the system in order to accommodate the coolant gas or to improve the optical performance of the device. In the embodiment shown, the electronic display surface 85 may be the front glass plate of a liquid crystal display (LCD) stack. However, almost any display surface may be suitable for embodiments of the present cooling system. Although not required, it is preferable to allow the cooling gas in the first gas chamber 30 to contact the electronic display surface 85 directly. In this way, the convective transfer of heat from the display components to the circulating gas will be maximized.

[0045] Referring to Fig. 4, the front plate 90 of the first gas chamber 30 is transparent and is positioned anterior to the electronic display surface 85. The arrows shown represent the movement of the isolated gas through the first gas chamber 30. As shown, the isolated gas traverses the first gas chamber 30 in a horizontal direction. Although cooling system 20 may be designed to move the gas in either a horizontal or a vertical direction, it is preferable to propel the gas in a horizontal direction. In this way, if dust or contaminants do enter the first gas chamber 30, they will tend to fall to the bottom of chamber 30 outside of the viewable area of the display. The system may move air left to right, or alternatively, right to left. After the gas traverses the first gas chamber 30 it exits through exit opening 120. Exit opening 120 defines the entrance junction into the rear cooling plenum 45.

[0046] FIGURE 5 shows a schematic of the rear cooling plenum (illustrated as transparent for explanation). One or more fans 50 within the plenum may provide the force necessary to move the isolated gas through the isolated gas cooling chamber. Whereas the first gas chamber 30 was designed to collect heat from the surface 85 of the display, the second gas chamber 40 is designed to extract the heat from the gas and remove the heat from the cooling chamber 20. The second chamber 40 may have various contours and features to accommodate the internal structures within a given electronic display application.

[0047] If desired, various electronic components 200 can be placed anywhere throughout the second gas chamber 40. The electronic components 200 may include, but are not limited to: transformers, circuit boards, processors, resistors, capacitors, batteries, motors, power supplies, illumination devices, wiring and wiring harnesses, and switches. These components can be mounted directly on the walls of the chamber or supported on rods or posts 209. Thus, the cooling plenum can be designed to not only extract heat from the first gas chamber 30 but also to cool these various electronic components 200. (Additionally, as discussed below, if the isolated gas system is used to heat the display, the electronic components can assist in heating the isolated gas.)

[0048] Referring now to FIGURES 6 and 7, various surface features 150 may be added to improve heat dissipation from the plenum 45. These surface features 150 provide more surface area to radiate heat away from the gas within the second gas

chamber 40. These features 150 may be positioned at numerous locations on the surface of the plenum 45.

[0049] Referring now to FIGURES 8 and 9, one or more thermoelectric modules 160 may be positioned on at least one surface of the plenum 45 to further cool the gas contained in the second gas chamber 40. The thermoelectric modules 160 may be used independently or in conjunction with surface features 150. Alternatively, thermoelectric modules 160 may be used to heat the gas in the plenum if the isolated gas system is utilized to heat a display in a cold environment.

[0050] FIGURE 10 shows an exemplary method for removing heat in the gas contained in the rear plenum 45. Fan 60 may be positioned to ingest air and blow that air across the anterior and posterior surfaces of the plenum 45. Again, fan 60 may ingest air conditioned air into the display housing 70 or may simply ingest ambient surrounding air. Furthermore, in this configuration, fan 60 may also force air past the heat generating components of the electronic display (e.g., the display stack 80 and the backlight assembly 140) to further improve the ability to cool the entire display. It should be noted that this embodiment can be combined with the constricted convection cooling method discussed in detail below. The heated exhaust air may exit through one or more apertures 179 located on the display housing 70.

Isolated Gas Heating System

[0051] As mentioned above, the isolated gas system can be utilized to also heat the electronic display. Referring to FIGURES 11 and 12, heating elements 220 may be located within the second gas chamber 40 and operate to warm the gas as it passes through the second gas chamber 40. These heating elements can be any one of the many commonly available heating elements or thermoelectric modules. Many times, these elements are simply a material which contains a high electrical resistance, and thus generates heat when current flows through it. The heating elements can be, but are not limited to, any one of the following: nichrome wire or ribbon, screen printed metal/ceramic tracks deposited on ceramic insulated metal (generally steel) plates, CalRod (typically a fine coil of nichrome wire in a ceramic binder, sealed inside a tough metal shell), heat lamp, and Positive Thermal Coefficient (PTC) of resistance ceramic.

[0052] As discussed above, the plenum 45 may contain electrical components 200 which power and control the electronic display. The electrical components may be any one of the following: transformers, microprocessors, printed circuit boards, power supplies, resistors, capacitors, motors, wiring harnesses, and connectors. The electrical connections for the electrical components 200 may pass through a wall of the plenum 45. The electrical components 200 can be located anywhere within the plenum 45. The electrical components 200 may be mounted on the posterior or anterior surface of the plenum and may be mounted directly on the surface of the plenum or may be suspended by mounting posts so that gas may pass all around the component.

[0053] While the display is operational, the isolated gas cooling system may run continuously. However, if desired, a temperature sensor (not shown) and a switch (not shown) may be incorporated within the electronic display. Thus, a thermostat may be used to detect when temperatures have reached a predetermined threshold value and the isolated gas system may be selectively engaged when the temperature in the display reaches a predetermined value. Predetermined temperature thresholds may be selected and the system may be configured to heat, cool, or both heat and cool the display to advantageously keep the display within an acceptable temperature range.

Linear Polarizer with Optional Insulator Gap

[0054] FIGURE 13 is a cross-sectional view of another exemplary embodiment for another thermal control feature. In the arrangement shown, the front plate 90 and a second front plate 130 may be comprised of glass and may be laminated together. The first and second front panels 130 and 90 may be fixed to one another with a layer of index matched optical adhesive 201 to form a front glass unit 206. The display stack 80 may comprise a liquid crystal assembly 212 interposed between a front polarizer 216 and a rear polarizer 214. In other embodiments, the display stack 80 may be any other type of assembly for any other type of electronic display. The space between the display stack 80 and the front glass unit 206 defines an insulator gap 300. The insulator gap 300 serves to thermally separate the front glass unit 206 from the LCD stack 80. This thermal separation localizes the heat on the front glass unit rather than allowing solar loading of the LCD stack. If used in combination with the isolated gas system, the insulator gap 300 may comprise the first gas chamber 30. In other

embodiments, the insulator gap 300 may be used without the isolated gas system simply as a layer of insulation from both the ambient air as well as solar loading.

[0055] The second front panel may have a first surface 202 and a second surface 208. The first surface 202 may be exposed to the elements; while the second surface 208 may be fixed to the first front plate 90 by the index matched optical adhesive 201. The first front plate 90 may have a third surface 209 and a fourth surface 204. The third surface 209 may be fixed to the second front plate 130 by the index matched optical adhesive 201; while the fourth surface may be directly adjacent to the insulator gap 300. In some embodiments, to decrease the solar loading of the display stack 80 and improve the viewable image quality, an anti-reflective coating may be applied to the first surface 202 and the fourth surface 204. In other embodiments, the anti-reflective coating may only be applied to at least one of the first, second, third, or fourth surface 202, 208, 209, and 204, respectively.

[0056] FIGURE 14 is a cross-sectional view of another exemplary embodiment of the front glass unit 206. In the arrangement shown, the front glass unit 206 comprises a second front plate 130, a layer of index matched optical adhesive 201, a linear polarizer 400, and a first front plate 90. The linear polarizer 400 may be bonded to at least one of the first, second, third or fourth surfaces 202, 208, 209, and 204, respectively. Again, anti-reflective layers may be applied to at least one of the first, second, third or fourth surfaces 202, 208, 209, and 204, respectively. The linear polarizer 400 may be aligned with the front polarizer 209 found in the LCD stack 85. The inclusion of a linear polarizer 400 in the front glass unit 206, further decreases the solar load on the display stack 80. The reduction in solar loading may significantly reduce the internal temperature of the electronic display. The linear polarizer 300 may also cause a reduction in specular reflection of the front glass unit 206 and the display stack 80. As discussed above, if used in combination with the isolated gas system, the insulator gap 300 may comprise the first gas chamber 30. In other embodiments, the insulator gap 300 may be used without the isolated gas system simply as a layer of insulation from both the ambient air as well as solar loading. Again, it should be noted that the display stack 80 may be an LCD stack, but it can also be any other type of electronic display.

[0057] It should also be noted that the second front plate 130 is not required. Embodiments may utilize only the first front plate 90 with a linear polarizer attached to either the posterior or anterior surface of the front plate 90. An anti-reflective layer may also be attached to either the anterior or posterior surface of the front plate 90. The front plate 90 may be tempered for additional strength if using only the front plate 90 without the second front plate 130.

Constricted Convection

[0058] Some types of electronic displays require a backlight assembly in order to generate an image upon a viewable screen. LCDs are one type of display that requires a backlight assembly. Other types of displays, such as plasma displays and OLEDs, do not require a backlight assembly as they generate light themselves. However, these types of displays still generate a significant amount of heat. Thus, in the foregoing description, the constricted convection system will be described with regard to a backlight assembly, but it should be noted that the embodiments can be practiced with other types of displays. Therefore, when a backlight or backlight assemblies are discussed, these assemblies could also be the rear surfaces of other heat-generating displays and the constricted convection system would facilitate more efficient cooling of these alternate displays. It should also be noted that Figures 15A-15B and Figures 17A-17C are not necessarily drawn to scale. The relationship between the elements may be exaggerated for explanatory purposes.

[0059] FIGURE 15A shows a cross-sectional view of the backlight 140 with the constricted convection plate 300, the space between the two features defines a narrow gap 305. The dimensions of the gap may vary depending on several factors including the size of the display, its operating conditions, the type of backlight assembly and its posterior surface material, and the number and power applied to the various constricted convection fans. Some exemplary embodiments may utilize a gap distance of approximately 0.25-3.5 inches. Other embodiments may utilize a slightly larger gap. It has been found that forcing air through this gap 305 increases the ability to cool the backlight 140. One or more constricted convection fans 310 may be used to pull air through the gap 305. FIGURE 15B shows a cross-sectional view of another

embodiment for the constricted convection system where one or more constricted convection fans 310 push air through the gap 305.

[0060] FIGURE 16 shows a top view of the isolated gas system as discussed above. The cross-section line 17-17 is shown passing through the isolated gas system.

[0061] FIGURES 17A-17C show cross-sectional views of the 17-17 section that is shown in Figure 16. Referring first to Figure 17A, towards the front of the display is the first gas chamber 30 which abuts against the electronic display 80. Anterior to the first gas chamber 30 is the front plate 90. Towards the rear of the display, the backlight 140 is placed in close proximity to the second gas chamber 40. In this arrangement, the outer wall of the second gas chamber 40 may function as the constricted convection plate. This embodiment does not utilize a constrictive convection fan, but instead uses the fan 60 which ingest air from outside the display housing and forces it over the surfaces of the second gas chamber 40. As noted above, this air may simply be ambient air or alternatively this air may come from a conditioning unit (not shown). To facilitate the flow of air between the backlight 140 and the cooling chamber 40, a guiding device 320 may be used.

[0062] Referring now to Figure 17B, the cooling chamber 40 contains a guiding feature 41, which is used in combination with the guiding device 320 to facilitate the flow of air between the backlight and the cooling chamber. Figure 17C shows another embodiment, where both the external fan 60 and the constrictive convection fan 310 is used. This embodiment could also utilize a version of the guiding devices shown in Figures 17A and 17B.

[0063] The backlight 140 may comprise a printed circuit board (PCB) with a plurality of lights mounted to the side facing the electronic display 80. The lights in the backlight may be any one of the following: LED's, organic light emitting diodes (OLED), field emitting display (FED), light emitting polymer (LEP), or organic electro-luminescence (OEL) lights. In an exemplary embodiment, the backlight 140 would ideally have a low level of thermal resistance between the side facing the electronic display 80 and the side facing the second gas chamber. To accomplish this low level of thermal resistance, the backlight 140 may be built using metal printed circuit board (PCB) technology to further transfer heat away from the lights. The rear surface of the

backlight 140 may also be metallic, or some other thermally conductive material, to further enhance the convective heat transferring properties. The surface may even have a plurality of surface features such as fins to further enhance the convective heat transferring properties. The constrictive convective fan 310 may then send the warm air out of an exhaust 179 (shown in Figure 2) so that it may exit the display housing entirely.

[0064] While the display is operational, the external fan 60 and the constrictive convection fan 310 may run continuously. However, if desired, a temperature sensor (not shown) and a switch (not shown) may be incorporated within the electronic display. This effective thermostat may be used to detect when temperatures have reached a predetermined threshold value. In such a case, the various 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 with a thermostat (not shown) to advantageously keep the display within an acceptable temperature range. This would save on both energy costs as well as the useful lifetime of the devices.

Air Curtain

[0065] In addition to the various thermal control features discussed above, an air curtain device can also be used. The air curtain device may be used alone, or in combination with any of the other thermal control features discussed above.

[0066] FIGURE 18 shows an electronic display 10, having a housing 70 and a front plate 90. The air baffles 114 for the air curtain can be seen as a broken line in the figure. Cross-section line 19-19 can also be seen in this figure.

[0067] FIGURE 19 shows the cross-sectional view from the line 19-19 shown in Figure 18. This figure shows the circulation of air through the housing 70 when fans 60 are actuated. As discussed above, fans 60 ingest air into the housing 70 through entrance 51. This air may be ambient air or alternatively may be air conditioned air. The flow of ingested air is shown as arrow 111. Once inside the display housing 70, the air may flow upwards along flow arrow 121. This air may be utilized with any of the above mentioned thermal control features. For example, this air may be used to cool

the isolated gas within the second chamber (plenum) or may be used with the constricted convection system described above.

[0068] For explanatory purposes, the details of the internal components of the display have been omitted from this figure and only a cavity 61 is shown. It should be noted, that the air curtain can be practiced with any type of electronic display and with any combination of the thermal control features described above. Various internal features (not shown) may be placed within the cavity 61 to direct the air towards the baffles 114. The ingested air may continue through the cavity 61 along arrow 121 until it reaches the baffles 114 which may direct the air against the exterior display surface. This exterior surface may be the first front plate 90, or alternatively, any of the additional front plates which are described in detail above (ex. second front plate 130).

[0069] Thus, the air curtain can be used as an exhaust for the cooling of internal components of the display. Alternatively, the cool air from the air curtain can be used to further cool the exterior front surface of the display which may be subjected to significant solar loading or heat transfer from ambient hot air.

Fluid Cooling System

[0070] FIGURE 20 is an explanatory schematic illustrating another thermal control feature. As may be appreciated from the drawing, the cooling system 22 includes various components in fluid communication. Preferably, this may be accomplished by connecting the components with a series of tubes or pipes (illustrated conceptually as dotted lines). The cooling system 22 components include a reservoir tank 37, a pump 47, and a cooling chamber 4 in fluid communication. Preferably, the system also includes a filter 83 and a radiator 72, also in fluid communication. Optionally, the system may also include a fan unit 94. However, the optional fan unit is preferably not in fluid communication with the other components.

[0071] Reservoir tank 37 holds the primary volume of coolant fluid and provides surface area to conduct heat away from the fluid while it is contained in the tank 37. The tank has at least two openings, an exit port 13 and a return port 14. Optionally, the reservoir tank includes a ventilation port 66. Pump 47 causes the coolant fluid to move through the system 22. As may be appreciated by those skilled in the art, pump 47 may be located at a number of locations along the coolant fluid pathway with suitable

results. However, in order to minimize curvature of plates 44 and 128, it is preferable to position pump 47 after the cooling chamber 4 so that the pump actually pulls liquid coolant from the bottom to the top of cooling chamber 4. If the pump is so positioned, engaging the pump creates an area of low pressure at the top of the cooling chamber 4. In this way fluid flows through the cooling chamber 4 according to the arrows. Due to the "slipperiness" of some coolant fluids, pump 47 is preferably a positive displacement pump.

[0072] In order to regulate the flow of coolant fluid through the cooling chamber, a bypass line with a valve 634 may be provided. The bypass line provides a bypass route for coolant fluid to bypass the cooling chamber 4. The valve 634 is adapted to facilitate control over the amount of coolant fluid diverted through the bypass line. The bypass line and valve 634 allow a predetermined portion of coolant fluid to be diverted away from the flow directed to the cooling chamber 4 and thereby facilitate control over the flow rate through the cooling chamber itself. In this way, the flow rate through the cooling chamber may be regulated.

[0073] As one skilled in the art will appreciate, other methods and devices may also be used to regulate the flow through the cooling chamber. For example, the size and pump speed of pump 47 may be optimized for a given application. Alternatively, a variable speed pump may also be used. Preferably, the variable speed pump may be in electrical communication with at least one pressure transducer (not shown). Preferably, a pressure transducer may be placed upstream of the cooling chamber 4 and another pressure transducer may be placed downstream of the cooling chamber 4. The pressure information provided by the at least one pressure transducer may be utilized to set the operating speed of the variable speed pump. In that way, the flow rate through the cooling chamber 4 may be adjusted to maintain appropriate pressures in the device. Maintaining appropriate pressures in the cooling chamber 4 is important for preventing deformation or breakage of the display glass.

[0074] An optional filter 83 may be added to remove contamination in the fluid. Preferably, a radiator 72 and fan unit 94 may also be included to provide even greater thermal stability. Optionally, a spigot (not shown) may be provided to facilitate the process of filling and emptying the coolant fluid from the system.

[0075] In operation, fluid exits the reservoir tank 37 from an output port 13 which may be located beneath the tank 37. On its way to the cooling chamber 4, the fluid passes through optional filter 83. From the filter 83, the fluid next enters the cooling chamber 4 through inlet 98 of manifold 59. The fluid coolant travels up through the fluid compartment of the cooling chamber 4 in the direction indicated (dash arrows). The coolant fluid exits cooling chamber 4 through outlet 99 of the upper manifold 60. Preferably, the fluid is then received by an optional radiator 72. While traveling through the optional radiator 72, an optional fan unit 94 may force air past the radiator 72 to assist in transferring heat away from the coolant fluid. Pump 47, which may be positioned after the radiator 72, can pull the fluid toward the reservoir tank. The fluid is received into the reservoir tank 37 through return port 14. Preferably, return port 14 may be disposed at a location that is relatively distant from exit port 13 so as to allow the returning fluid the maximum opportunity to cool before it exits the reservoir tank 37 through port 13.

[0076] If desired, fan units may be located at the base of the housing 75 just behind the cooling chamber 4 of display 15. Fan units may provide a laminar flow of air through the interior of the housing 75. Preferably, the airflow will be directed across at least one external surface of reservoir tank 37. As described above, the air exhaust flow may ultimately be redirected onto the cooling chamber surface 44 by way of an optional air curtain system 114.

[0077] If desired, a temperature sensor (not shown) and a switch (not shown) may be incorporated within the electronic display. The temperature sensor may be used to detect when temperatures have reached a predetermined threshold value. In such a case, the pump can be selectively engaged when the temperature in the display meets a predetermined value. Predetermined thresholds may be selected and the system may be configured with a thermostat (not shown) to advantageously keep the display at a relatively constant temperature, or at least within a range of acceptable temperatures. Alternatively, to avoid the need for a thermostat, the pump 47 may run continuously when the electronic display is operational.

CLAIMS

1. A thermal control system for an electronic display having a display surface and a backlight assembly, the system comprising:

a first gas chamber positioned anterior to the electronic display surface, said first gas chamber having an entrance, exit, and exterior surface;

a second gas chamber in gaseous communication with the entrance and exit of said first gas chamber and positioned posterior to the electronic display surface, said second gas chamber having interior and exterior surfaces;

one or more chamber fans within said second gas chamber to propel gas around the first and second gas chambers; and

means for cooling the isolated gas which is contained within the second gas chamber.

2. The system of claim 1, wherein the means for cooling the isolated gas comprises:

one or more exterior fans adapted to force air over the exterior surfaces of the second gas chamber.

3. The system of claim 1, further comprising:

one or more of the electronic components for operating the electronic display, contained within said second gas chamber.

4. The system of claim 2, further comprising:

one or more surface features on the exterior surfaces of the second gas chamber.

5. The system of claim 1, further comprising:
a means for heating the gas which is contained within the second gas chamber.
6. The system of claim 5, wherein:
the means for heating the gas which is contained within the second gas chamber
comprises one or more heating elements within the second gas chamber.
7. The system of claim 1, wherein:
an exterior surface of the second gas chamber is placed in close proximity to the
backlight assembly, the space between the backlight assembly and the
exterior chamber surface defining a gap, the system further comprising:
one or more constricted convection fans adapted to draw air through said gap.
8. The system of one of claims 1-4, and 7, further comprising:
an air curtain device adapted to force air across the exterior surface of said first
gas chamber.
9. The system of one of claims 1-4 and 7-8 further comprising:
a linear polarizer placed anterior to said first gas chamber.
10. The system of one of claims 2-9, further comprising:
a temperature sensing device adapted to measure the temperature of the display
surface;

a switch in communication with said temperature sensing device and said chamber and exterior fans; and

wherein the fans are switched on when the temperature of the display surface reaches a threshold value.

11. The system of one of claims 1-10 further comprising:

a filter within the second gas chamber.

12. The system of one of claims 2-4 and 7-11 wherein:

said one or more exterior fans are forcing air over the exterior surfaces of the second gas chamber which has been air conditioned.

13. A thermally controlled electronic display comprising:

a display stack;

a backlight assembly positioned posterior to said display stack and having a posterior surface;

a constricted convection plate in close proximity to the posterior surface of said backlight assembly, the space between the convection plate and the posterior surface of the backlight assembly defining a gap;

one or more constricted convection fans adapted to draw air through said gap;

a first plate of anti-reflective glass positioned anterior to said display stack, the space between said anti-reflective glass and said display stack defining an insulating gap;

a linear polarizer positioned anterior to said first plate; and

a second plate of anti-reflective glass positioned anterior to said linear polarizer.

14. The display of claim 13 further comprising:

an air curtain device adapted to force air upon the second plate of anti-reflective glass.

15. The display of one of claims 13 and 14 wherein said backlight assembly comprises:

a printed circuit board (PCB) with an anterior and posterior surface;

a plurality of LEDs attached to the anterior surface of said PCB; and

a metallic coating applied to the posterior surface of said PCB.

16. The display of one of claims 13-15 the display further comprising:

a first gas chamber comprising said insulating gap and having an entrance and exit,

a second gas chamber in gaseous communication with the entrance and exit of said first gas chamber and positioned posterior to the electronic display surface, said second gas chamber having interior and exterior surfaces;

one or more chamber fans within said second gas chamber to propel gas around the first and second gas chambers; and

means for cooling the gas contained within the second gas chamber.

17. A method for thermally controlling an electronic display having a display surface and a backlight assembly, comprising the steps of:

providing an isolated gas system comprising a first gas chamber which is in contact with the electronic display surface and a second gas chamber in gaseous communication with said first gas chamber;

forcing isolated gas into the first gas chamber;

transferring heat from the electronic display surface to the isolated gas;

directing the isolated gas into the second gas chamber;

cooling the isolated gas in the second gas chamber if cooling is desired; and

reintroducing the isolated gas into the first gas chamber.

18. The method of claim 17, wherein the cooling step comprises the steps of:

transferring heat from the isolated gas to the walls of the second chamber;

forcing air over the walls of the second chamber; and

transferring heat from the walls of the second chamber to the air.

19. The method of claim 17, further comprising the step of:

heating the isolated gas within the second chamber if heating is desired.

20. The method of claims 17-19, further comprising the steps of:

providing a constrictive convection plate posterior to the backlight assembly, the area between the constrictive convection plate and the backlight assembly defining a gap;

forcing air through said gap in order to cool the backlight assembly.

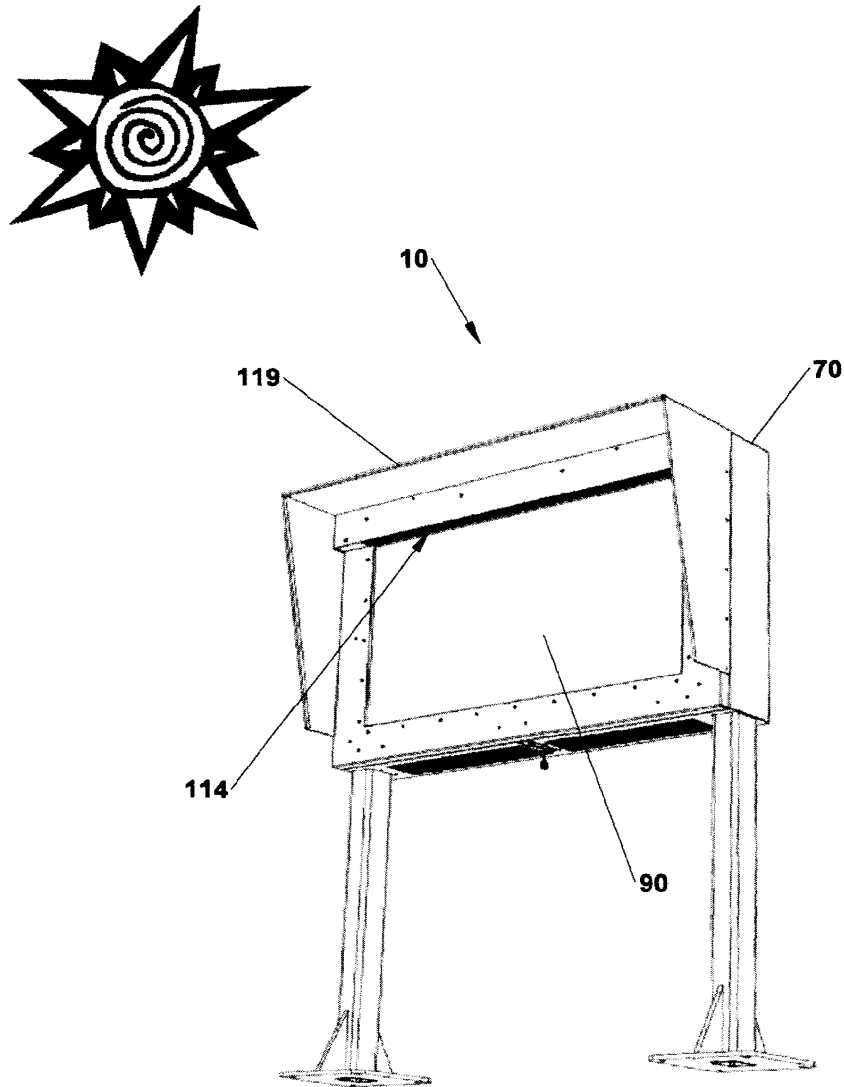
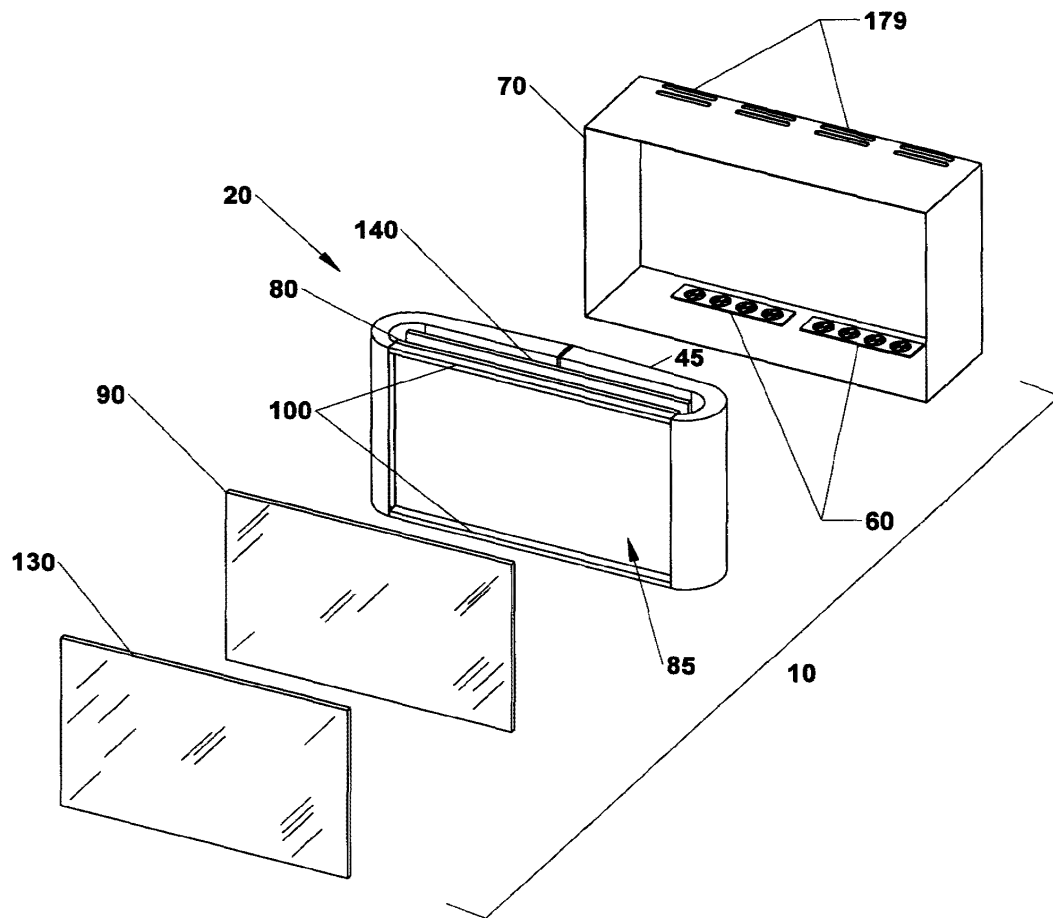


Fig. 1

*Fig. 2*

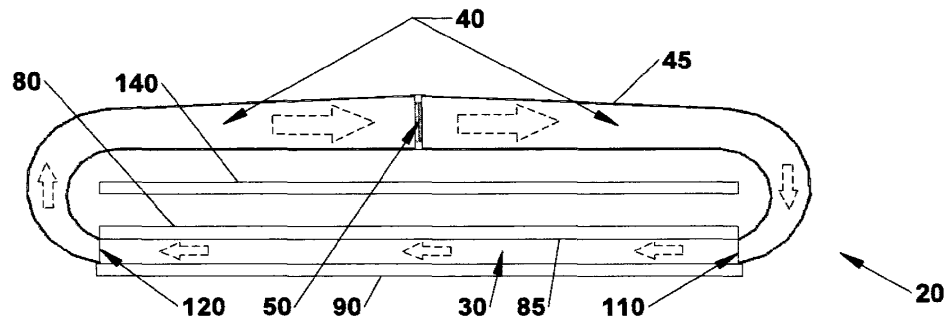


Fig. 3

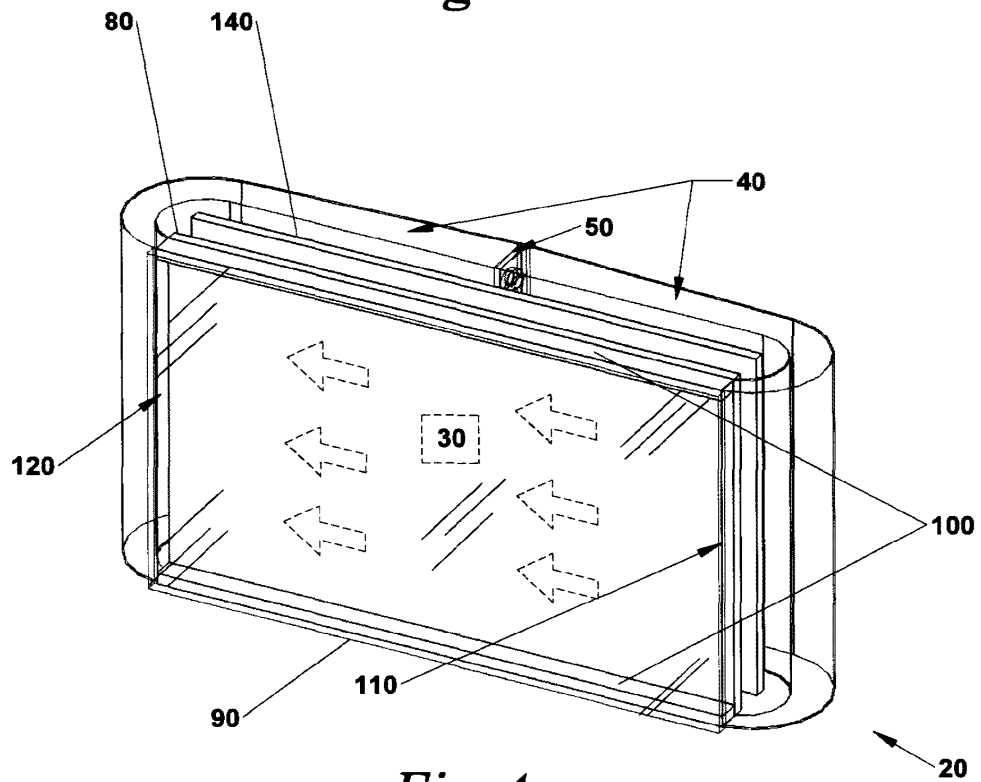


Fig. 4

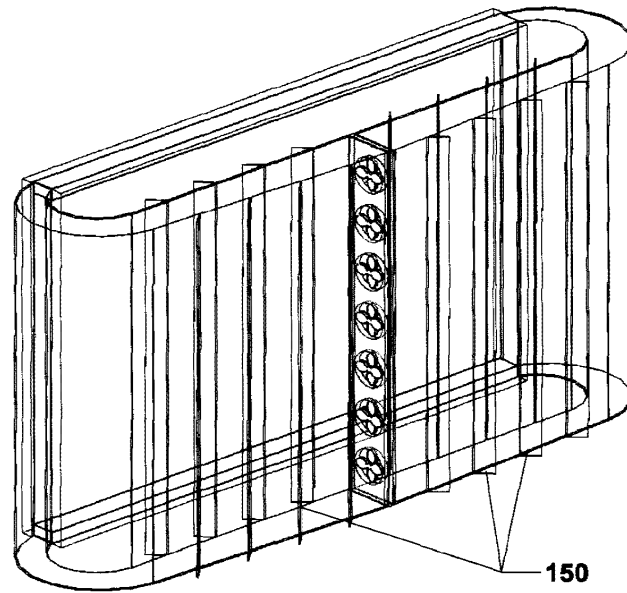


Fig. 6

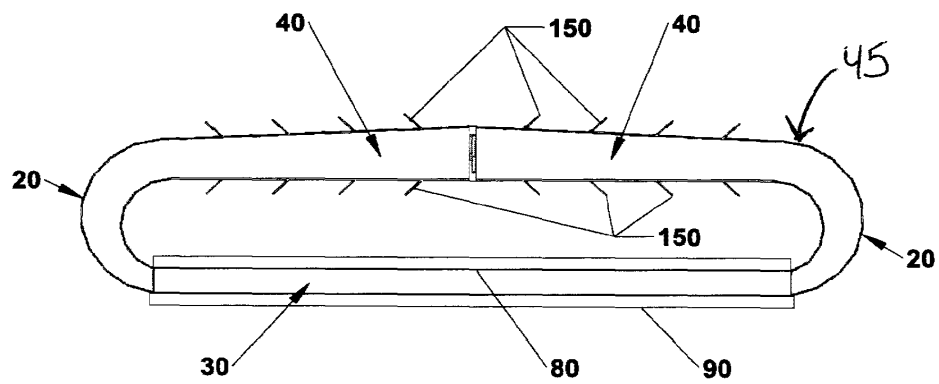


Fig. 7

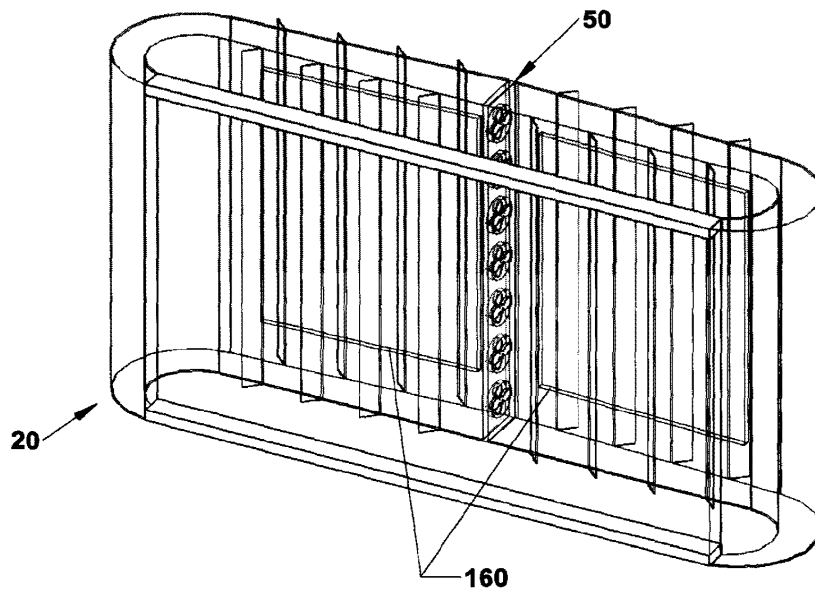


Fig. 8

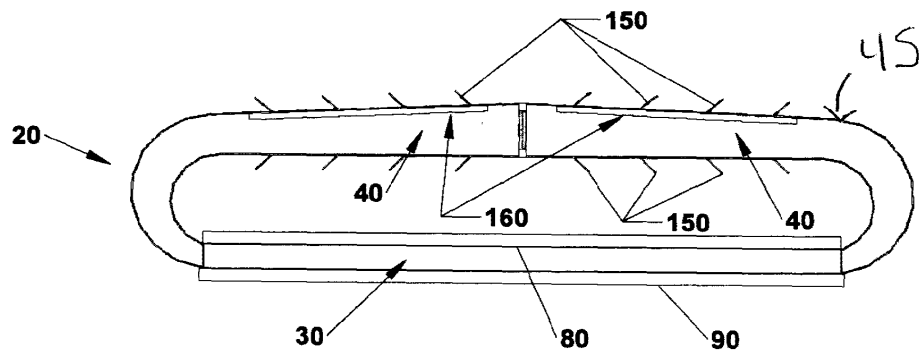
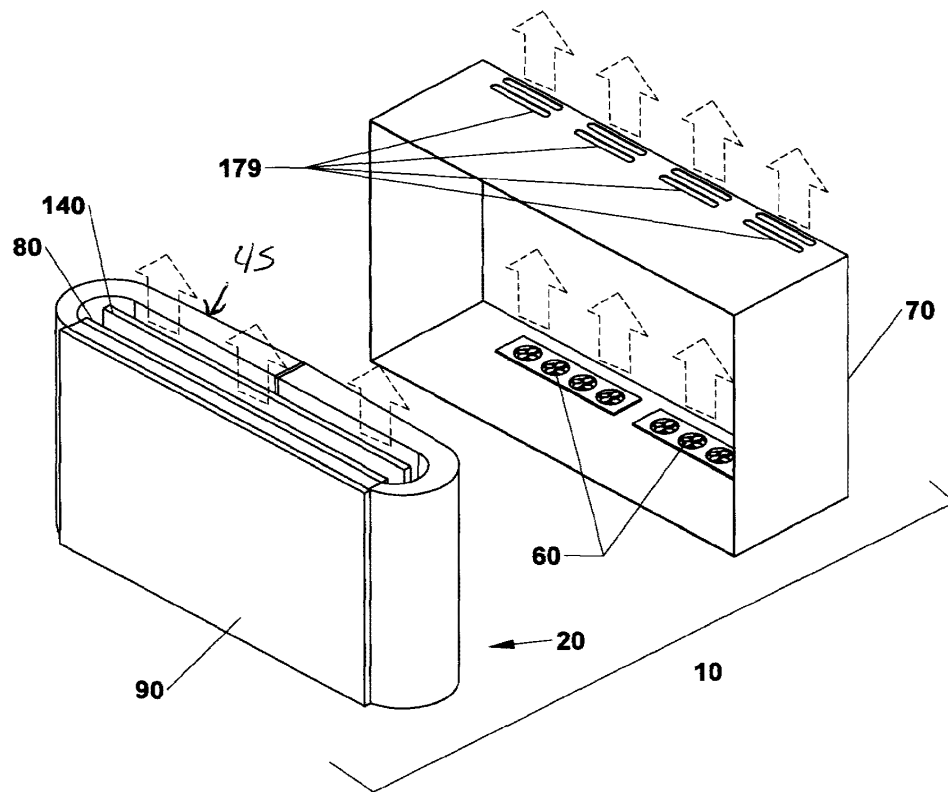


Fig. 9

*Fig. 10*

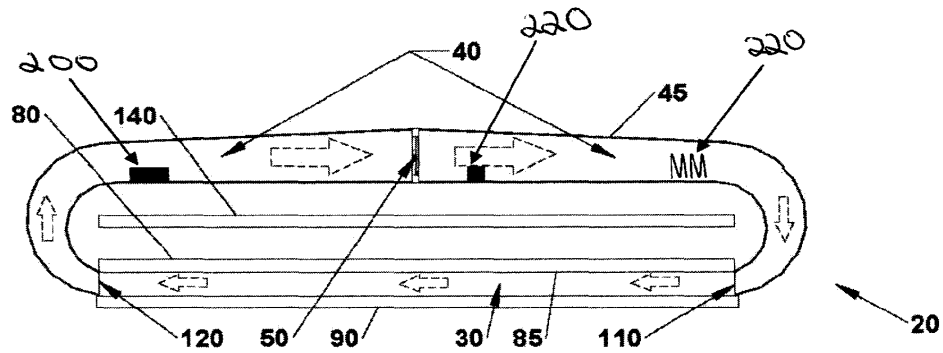


Fig. 11

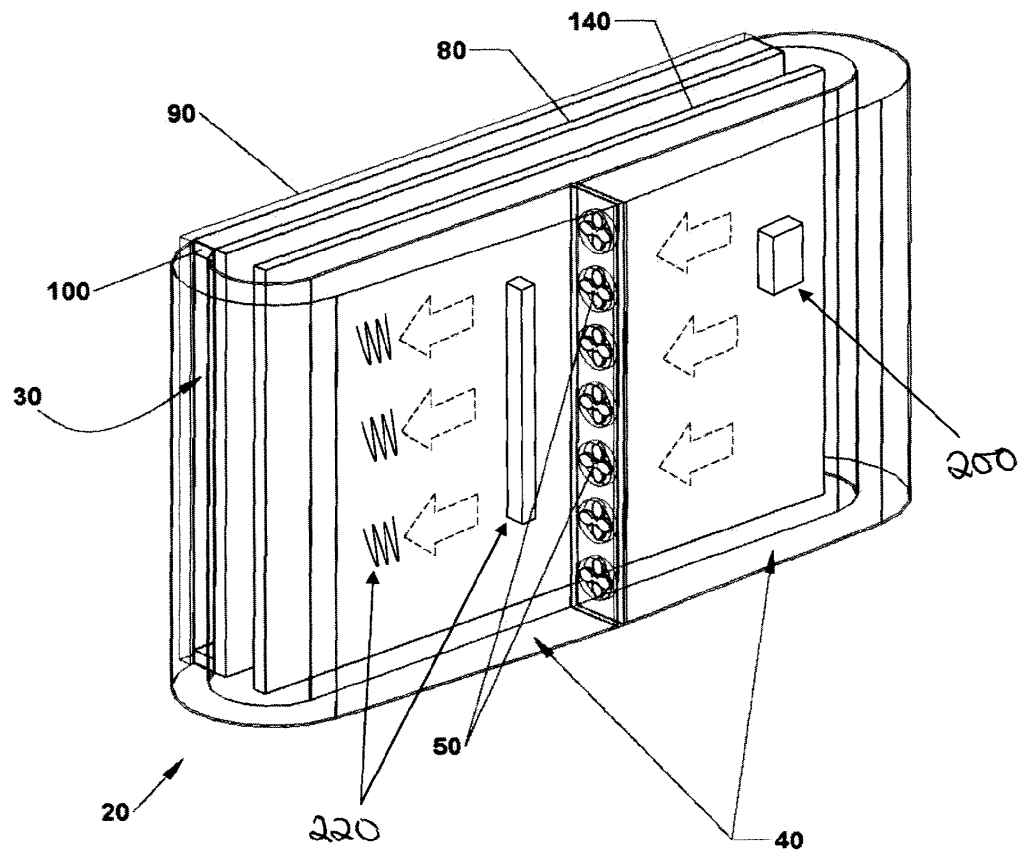
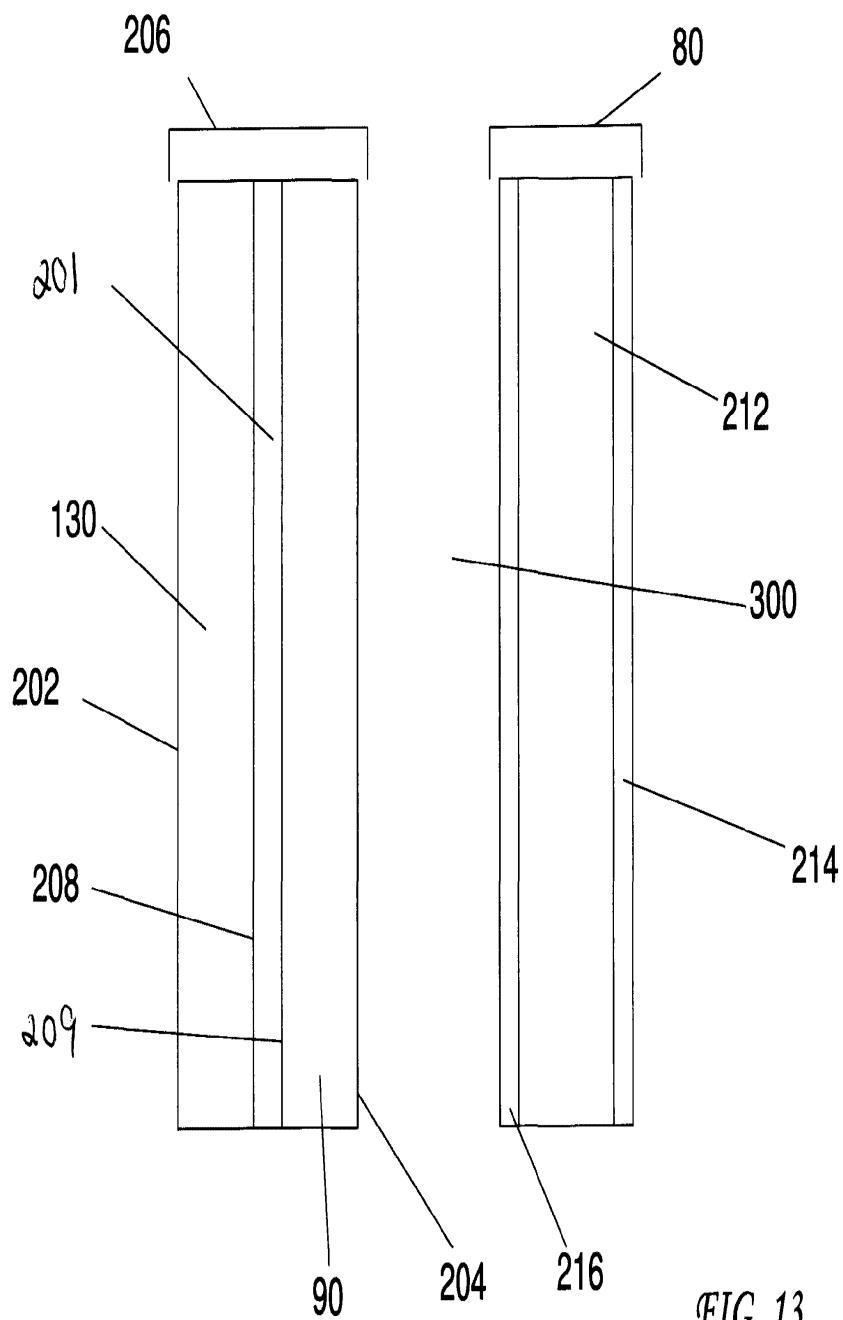
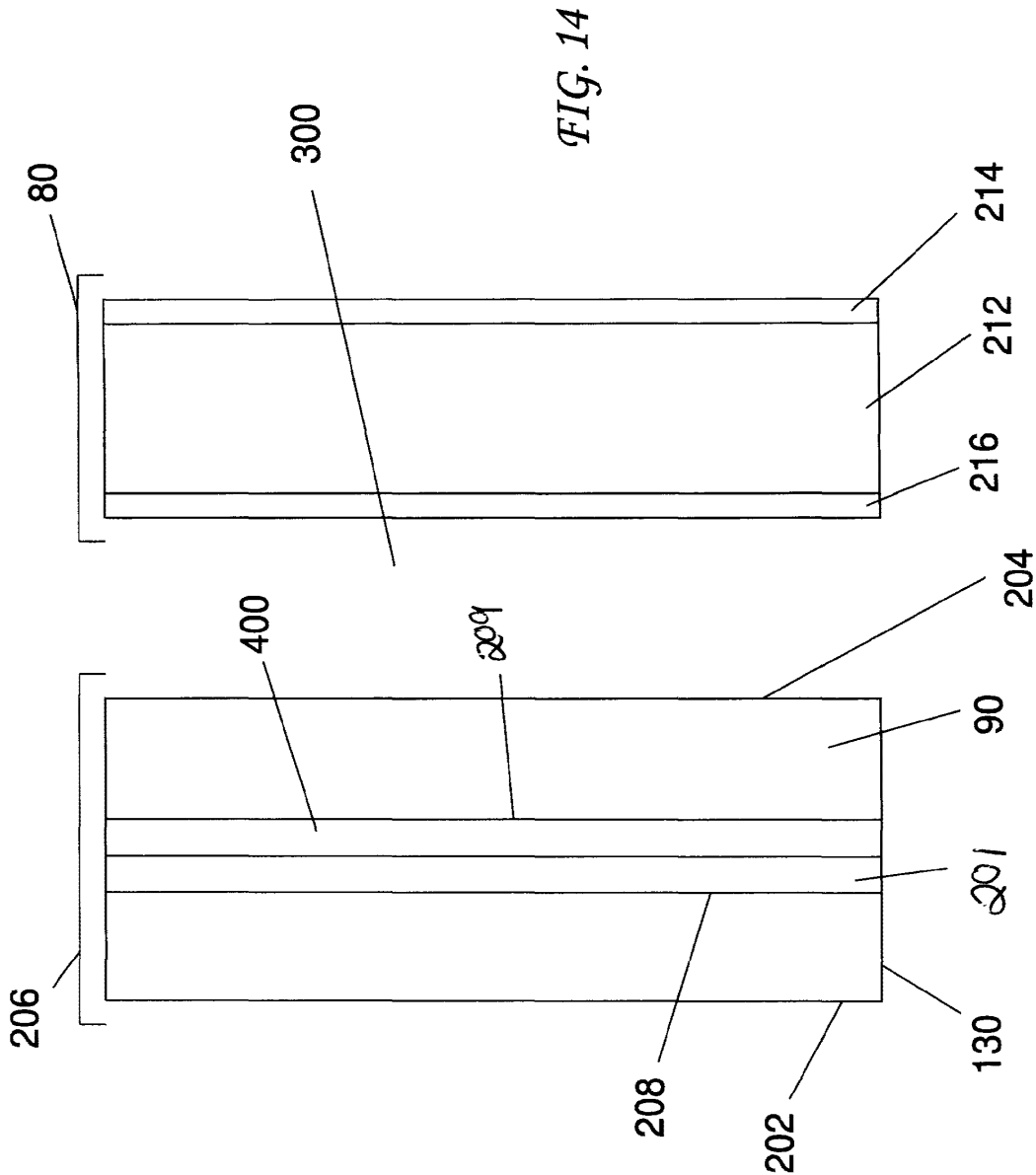


Fig. 12





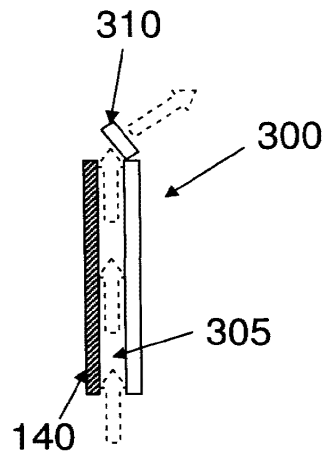


Fig. 15A

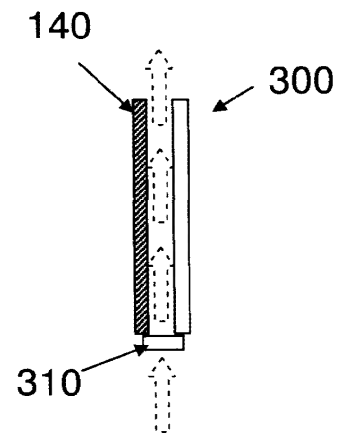


Fig. 15B

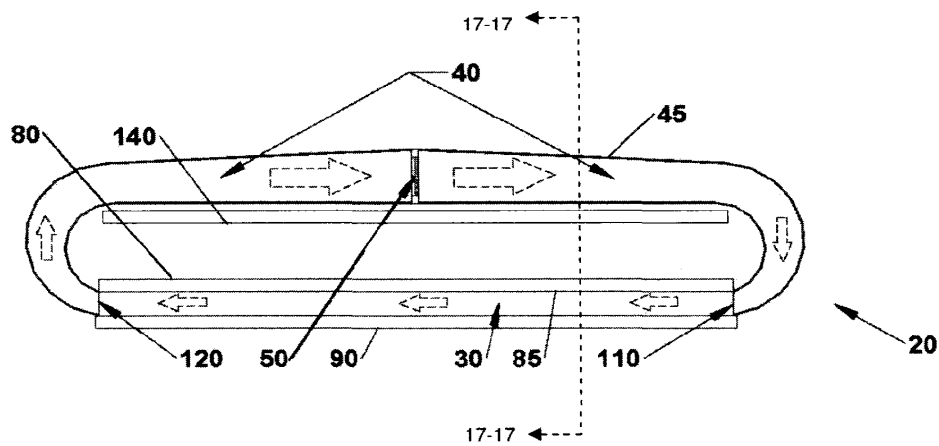


Fig. 16

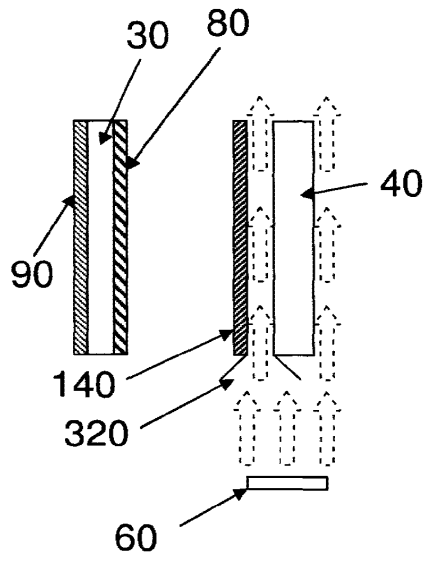


Fig. 17A

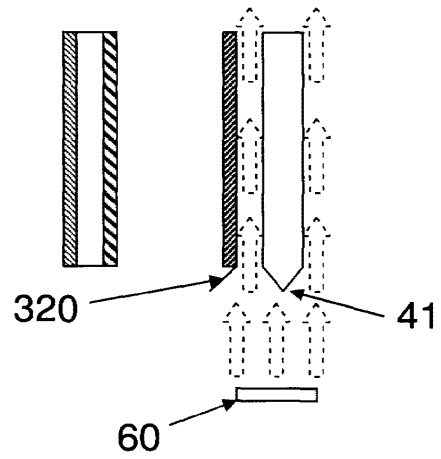


Fig. 17B

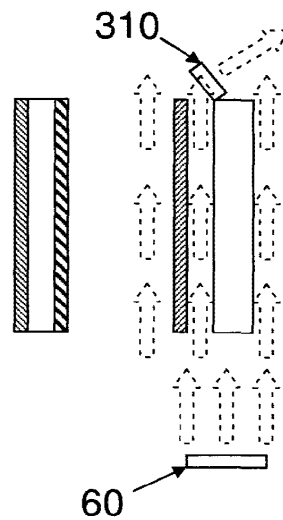
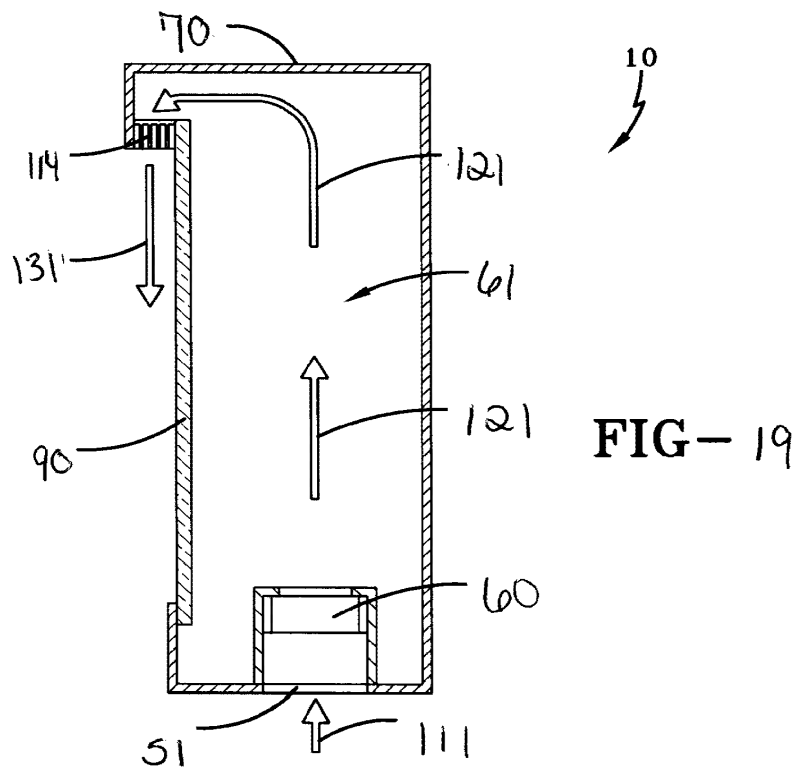
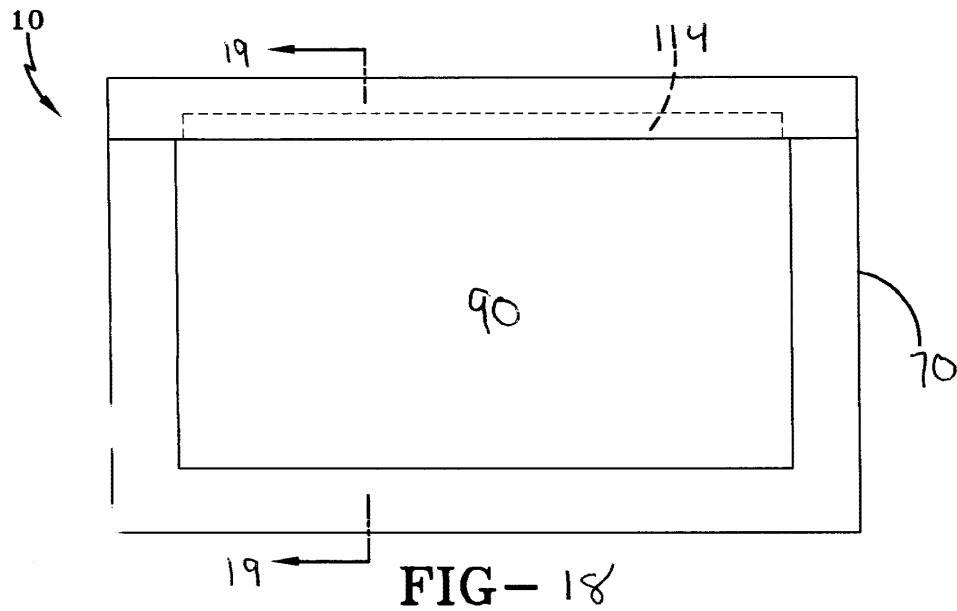


Fig. 17C



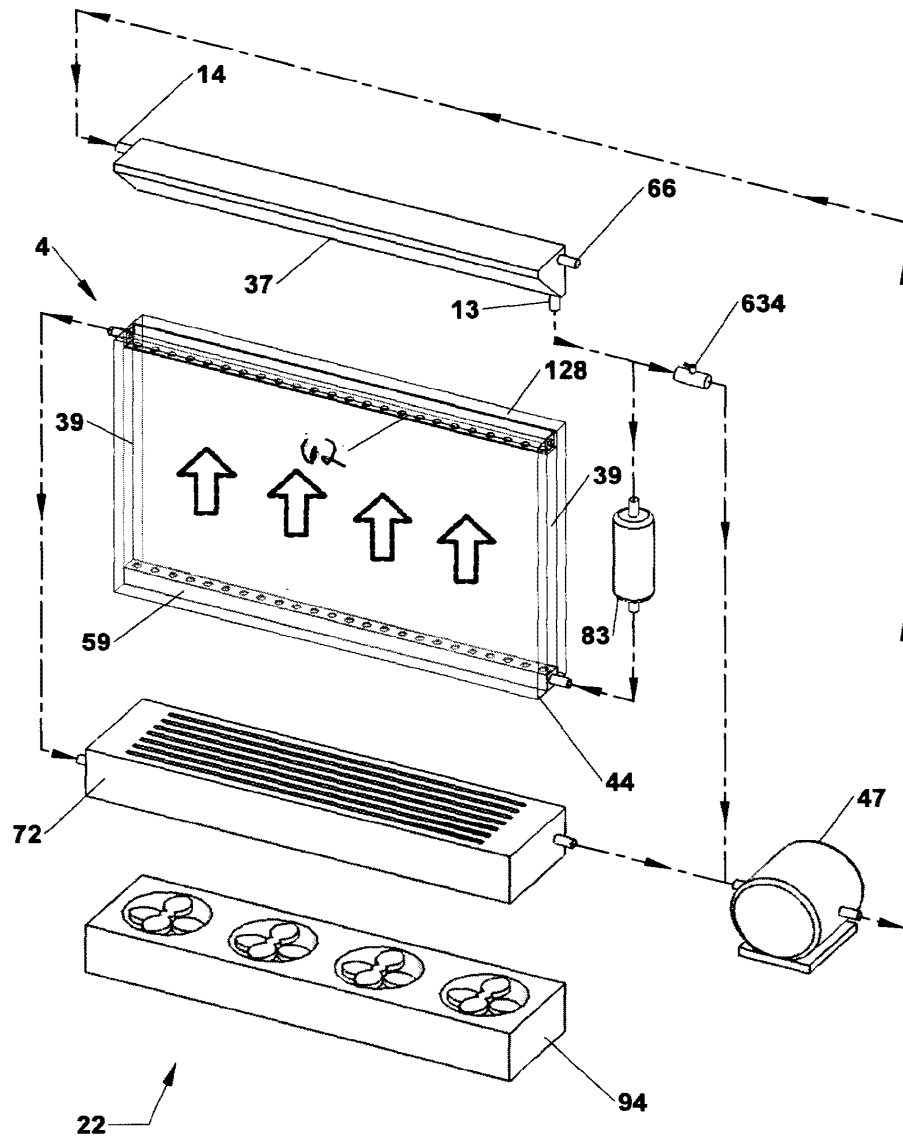


FIG. 20

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- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE,

[Continued on next page]

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

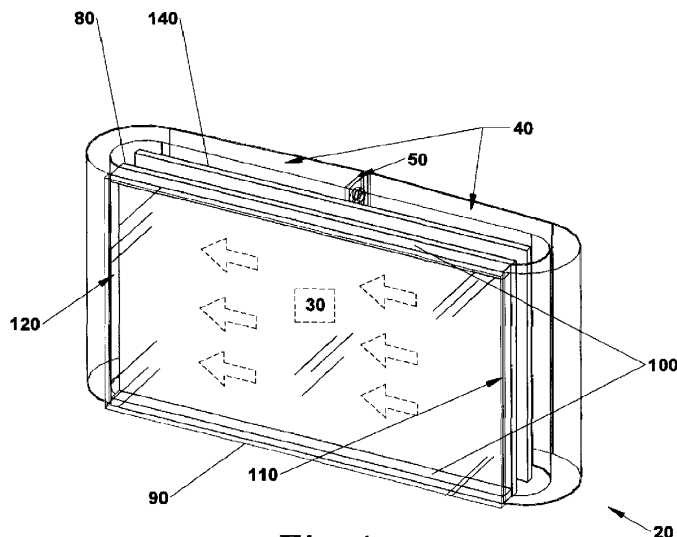


Fig. 4

(57) Abstract: 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 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.

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ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI
(BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR,
NE, SN, TD, TG).

— *before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))*

Published:

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17 September 2009

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/083792**A. CLASSIFICATION OF SUBJECT MATTER****G02F 1/1333(2006.01)i, G02F 1/13357(2006.01)i**

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 G02F, G09F

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

Korean Utility models and applications for Utility models since 1975

Japanese Utility models and applications for Utility models since 1975

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

eKOMPASS (KIPO internal) & keywords: air, gas, cool, temperature, control

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 08-194437 A (MATSUSHITA ELECTRIC WORKS LTD.) 30 July 1996 See figure 1 and paragraph [0010] - paragraph [0012].	1-4
A	JP 2005-134849 A (NAGOYA ELECTRIC WORKS CO., LTD.) 26 May 2005 See abstract, figures 1-4, and their corresponding descriptions.	1-8,13-15,17-20
A	JP 2002-158475 A (FUJITSU GENERAL LTD.) 31 May 2002 See abstract, figures 1-5, and their corresponding descriptions.	1-8,13-15,17-20
A	KR 10-2007-0070675 A (NAUTILUS HYOSUNG INC.) 04 July 2007 See abstract, figures 1-3, and their corresponding descriptions.	1-8,13-15,17-20

☐ 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 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

29 JULY 2009 (29.07.2009)

Date of mailing of the international search report

29 JULY 2009 (29.07.2009)

Name and mailing address of the ISA/KR

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Form PCT/ISA/210 (second sheet) (July 2008)

SEC et al. v. MRI
SEC Exhibit 1022.3246
IPR2023-00221

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2008/083792**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 9-12,16
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

This International Searching Authority found multiple inventions in this international application, as follows:

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

Remark on Protest

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

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2008)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2008/083792

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 08-194437 A	30.07.1996	None	
JP 2005-134849 A	26.05.2005	None	
JP 2002-158475 A	31.05.2002	None	
KR 10-2007-0070675 A	04.07.2007	None	

Form PCT/ISA/210 (patent family annex) (July 2008)

Doc code: IDS

PTO/SB/08a (01-10)

Doc description: Information Disclosure Statement (IDS) Filed

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16933932
	Filing Date	2020-07-20
	First Named Inventor	William Dunn
	Art Unit	2835
	Examiner Name	Michael A Matey
	Attorney Docket Number	MAN2241-045R

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Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16933932
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	First Named Inventor	William Dunn	
	Art Unit	2835	
	Examiner Name	Michael A Matey	
	Attorney Docket Number	MAN2241-045R	

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