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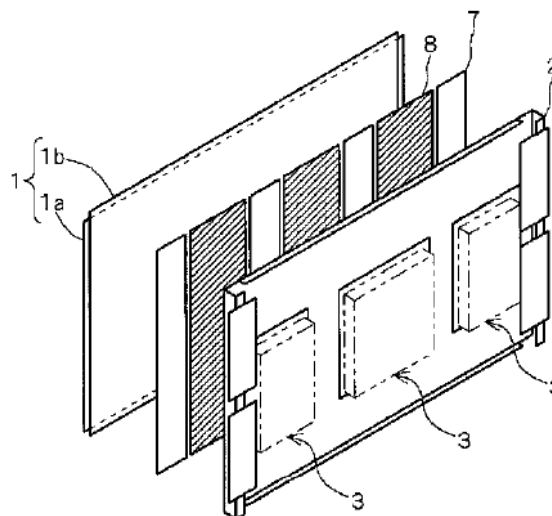
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(54) (TITLE OF THE INVENTION) PLASMA DISPLAY DEVICE

(57) (ABSTRACT)

(PROBLEM) A temperature difference arises in a plasma display panel (PDP) due to heat confined in the gap between a circuit board and a chassis housed inside a plasma display device, which may cause deformation in the PDP. The present invention therefore provides a plasma display device which prevents the deformation of the PDP due to this cause.

(SOLUTION) Thermally conductive sheets extending in the widthwise direction of the PDP are interposed between the chassis and the PDP at positions opposite the circuit boards (sandwiching the chassis).



(SCOPE OF THE PATENT CLAIMS)

(CLAIM 1) A plasma display device comprising:
a plasma display panel for displaying a video image;
circuit boards required to display a video image on the plasma display panel;

a chassis which holds the plasma display panel on one main surface side and holds the circuit boards on another main surface side;

planar fixing means which are selectively interposed between the plasma display panel and the chassis and are used to fix the plasma display panel and the chassis; and thermally conductive sheets which have a higher thermal conductivity than the fixing means and are selectively interposed between the plasma display panel and the chassis while avoiding the fixing means.

(CLAIM 2) The plasma display device according to Claim 1, wherein the thermally conductive sheets are positioned opposite the circuit boards across the chassis.

(CLAIM 3) The plasma display device according to Claim 2, wherein the thermally conductive sheets extend in a widthwise direction of the plasma display panel; and the long sides thereof have a longer shape than the sides in the widthwise direction of the circuit boards.

(CLAIM 4) The plasma display device according to any one of Claims 1 to 3, wherein the thermally conductive sheets extend from one long side part of the plasma display panel to the other long side part.

(CLAIM 5) The plasma display device according to any one of Claims 1 to 4, wherein the fixing means are disposed on a short side part of the plasma display panel.

(CLAIM 6) The plasma display device according to any one of Claims 1 to 5, further comprising:

a case which houses the chassis;

exhaust means corresponding to the circuit boards formed on surfaces of the box opposite the circuit boards so as to discharge heat inside the case to the outside of the case; and suction means for supplying air into the case from outside of the case.

(CLAIM 7) The plasma display device according to Claim 6, wherein the exhaust means are exhaust holes cut out from the case diagonally above the circuit boards; and the suction means are suction holes cut out from the case diagonally below the circuit boards.

(CLAIM 8) The plasma display device according to Claim 6, wherein the exhaust means are exhaust holes with fans provided in the case diagonally above the circuit boards.

(CLAIM 9) The plasma display device according to Claim 6 or 8, wherein the suction means are suction holes with fans provided in the case diagonally below the circuit boards.

(DETAILED DESCRIPTION OF THE INVENTION)

(0001)

(TECHNICAL FIELD OF THE INVENTION) The present invention relates to a video display device using a plasma display panel.

(0002)

(CONVENTIONAL TECHNOLOGY) A plasma display device generates a large amount of heat at the time of light emission (at the time of electric discharge), so the temperature of a display area 51a of a plasma display panel 51 illustrated in FIG. 11 (plasma display panel is abbreviated as "PDP" hereinafter) rises substantially. On the other hand, in a non-display area 51b on the outer periphery of the same PDP 51, light emission does not occur, so the increase in temperature is small. A difference in thermal expansion arises due to this temperature difference between the display area 51a and the non-display area 51b. In particular, maximum stress occurs at the ends of the PDP 51 in an open state, which causes deformation in the PDP 51. Likewise, within the display area 51a, temperature differences due to differences in brightness or the like on a single screen considerably affect the stress generated at the ends of the PDP 51.

(0003) Therefore, how to equalize the heat of the entire PDP 51 has been a critical problem in order to eliminate the temperature differences of the PDP 51, which are the cause of the deformation of the PDP 51.

(0004) To solve this problem, a plasma display device having the following configuration has existed as conventional technology. FIG. 12 is an exploded perspective view illustrating the configuration of a conventional plasma display device, and FIG. 13 is a cross-sectional view thereof. A PDP 51 onto which a video image is projected consists of a front glass substrate 51c and a back glass substrate 51d, and circuit boards 52 for displaying a video image on the PDP 51 are divided according to their respective functional units and consist of drive-related boards or power supply boards. Here, each circuit board 52 consists of a board body 52a and a group of parts 52b soldered onto the board body 52a. In addition, a chassis 53 having a heat radiating function holds the PDP 51 on one main surface side and holds the circuit boards 52 on the other main surface side. Here, the PDP 51 is fixed to the chassis 53 using divided double-sided adhesive tape 54. Here, the attachment of each circuit board 52 to the chassis 53 is achieved by providing a gap 55 between the chassis 53 and the circuit board 52 (to prevent heat from the chassis 53 from being transmitted directly to the circuit board 52).

(0005) With the configuration described above, the heat of the PDP 51 can be transmitted to the chassis 53 (or the heat

of the chassis 53 to the PDP 51) via the double-sided adhesive tape 54 (having a higher thermal conductivity than air), which equalizes the temperature of the PDP 51 and discharges the heat of the PDP 51 to the outside air with the heat radiating function of the chassis 53 so as to also lower the temperature of the entire PDP 51.

(0006)

(PROBLEM TO BE SOLVED BY THE INVENTION) However, among the group of parts 52b welded to the board body 52a, many parts having a high back such as radiators are used, so the height of the entire circuit board 52 also increases. Therefore, to achieve the thinner profile required for a plasma display device, the gap 55 between the circuit boards 52 and the chassis 53 cannot be very large.

(0007) When the gap 55 is small in this way, ventilation becomes poor, and heat becomes trapped inside the gap 55. In addition to the confinement of heat, the circuit boards 52 themselves generate a large amount of heat, so the temperature of the gap 55 increases further. Although the heat of this gap 55 is diffused to locations other than the gap 55, the amount of heat that is supplied is greater than the amount of heat that is diffused. Due to this effect, temperature differences within the PDP 51 (temperature differences between the area below the gap 55 and other areas) are not resolved, and maximum stress occurs at the ends of the PDP 51, increasing the risk of deformation in the PDP 51.

(0008) Therefore, an object of the present invention is to provide a plasma display device which prevents the deformation of the PDP caused by the confinement of heat in the gap 55.

(0009)

(MEANS FOR SOLVING THE PROBLEM) To achieve the object described above, the plasma display device according to the present invention comprises: a plasma display panel for displaying a video image; circuit boards required to display a video image on the plasma display panel; a chassis which holds the plasma display panel on one main surface side and holds the circuit boards on another main surface side; planar fixing means which are selectively interposed between the plasma display panel and the chassis and are used to fix the plasma display panel and the chassis; and thermally conductive sheets which have a higher thermal conductivity than the fixing means and are selectively interposed between the plasma display panel and the chassis while avoiding the fixing means.

(0010) In addition, the thermally conductive sheets may be positioned opposite the circuit boards across the chassis.

(0011) Further, the thermally conductive sheets may extend in a widthwise direction of the plasma display panel; and the long sides thereof may have a longer shape than the sides in the widthwise direction of the circuit boards.

(0012) In addition, the thermally conductive sheets may extend from one long side part of the plasma display panel to the other long side part.

(0013) Further, the fixing means may be disposed on a short side part of the plasma display panel.

(0014) In addition, the plasma display device may further comprise: a case which houses the chassis; exhaust means corresponding to the circuit boards formed on surfaces of the box opposite the circuit boards so as to discharge heat inside the case to the outside of the case; and suction means for supplying air into the case from outside of the case.

(0015) Further, the exhaust means may be exhaust holes cut out from the case diagonally above the circuit boards; and the suction means may be suction holes cut out from the case diagonally below the circuit boards.

(0016) In addition, the exhaust means may be exhaust holes with fans provided in the case diagonally above the circuit boards.

(0017) Further, the suction means may suction holes with fans provided in the case diagonally below the circuit boards.

(0018)

(EMBODIMENTS OF THE INVENTION) The present invention will be described in detail hereinafter with reference drawings illustrating embodiments thereof.

(0019) <Embodiment 1> FIG. 1 is an exploded perspective view illustrating the configuration of a plasma display device of this embodiment, and FIG. 2 is a cross-sectional view thereof. A PDP 1 consists of a front glass substrate 1a and a back substrate 1b, and a video image is projected by inducing an electrical discharge between both glass substrates (1a and 1b). A chassis 2 having a heat radiating function holds the PDP 1 on one main surface side and holds circuit boards 3 required to display a video image (drive-related boards, power supply boards, and the like) on the other main surface side. The respective circuit boards are arranged in the lengthwise direction of the PDP 1 near the center of the widthwise direction of the PDP 1. Here, as illustrated in FIG. 3, each circuit board 3 consists of a board body 3a and a group of parts 3b welded to the board body 3a. The method of fixing the circuit board 3 to the chassis 2 is to fix the circuit board with screws 6 through a chassis support 5, for example, so that there is a gap 4 between the chassis 2 and the board body 3a.

(0020) In addition, double-sided adhesive tapes 7 for fixing the PDP 1 to the chassis 2 and thermally conductive sheets 8 having a higher thermal conductivity than the double-sided adhesive tapes 7 are interposed between the PDP 1 and the chassis 2. The double-sided adhesive tapes 7 and the thermally conductive sheets 8 are respectively arranged in the lengthwise direction of the PDP 1 in a divided state, and the thermally conductive sheets 8 are made to extend in the widthwise direction of the PDP 1 (from one long side part of the plasma display panel to the other long side part) at positions opposite the circuit boards 3 (sandwiching the chassis 2). Similarly, the double-sided adhesive tapes 7 are made to extend in the widthwise direction at other locations. Here, silicone or the like, for example, is used for

the thermally conductive sheets 8. In addition, the short sides of the thermally conductive sheets 8 may be of the same length as or slightly longer or shorter than the sides of the circuit boards 3 in the lengthwise direction.

(0021) By arranging the thermally conductive sheets 8 as in the configuration described above, the amount of thermal conduction increases in the locations where the sheets are disposed, and heat confined in the gap 4 is diffused and discharged through the chassis 2 in the widthwise direction of the PDP 1. As a result, the temperature of the gap 4 decreases, and the temperature differences between the areas of the chassis 2 facing the gap 4 and other locations become small, so the temperature differences within the PDP 1 also become small, which makes it possible to suppress the deformation of the PDP 1.

(0022) In addition, when heat is confined in the gap 4, the temperature difference between the PDP 1 and the chassis 2 becomes small, and the movement speed of heat between the two becomes slower than between a PDP 1 and a chassis 2 without a gap 4 therebetween, so the equalization of the heat of the PDP 1 also took a long time (when heat equalization is too slow, the temperature differences of the PDP 1 are not easily resolved, and there is also a risk of deformation in the PDP 1). However, by introducing the thermally conductive sheets 8, the movement speed of heat between the PDP 1 and the chassis 2 at those locations can be increased, which allows heat to be discharged from the PDP 1 more quickly and also reduces the time required for the heat equalization of the PDP 1.

(0023) Here, in FIG. 1, the thermally conductive sheets 8 are made to extend from one long side part of the PDP 1 to the other long side part, but as illustrated in FIG. 4, the same effect – although to a lesser degree than in the case of the form illustrated in FIG. 1 – can be achieved with a configuration having a larger shape in the widthwise direction than the size of the circuit boards 3 (the heat radiation (heat diffusion) effect becomes greater as the length in the widthwise direction of the thermally conductive sheets 8 increases). In addition, the double-sided adhesive tapes 7 are disposed in the regions from the short side parts of the thermally conductive sheets 8 to the long side part of the PDP 1.

(0024) Further, as illustrated in FIG. 1 or FIG. 4, when the double-sided adhesive tapes 7 are used on the short side part of the PDP 1, it is possible to suppress the generation of gaps between the parts, which is primarily caused by a difference in the coefficient of thermal expansion between the PDP 1 and the chassis 2.

(0025) <Embodiment 2> FIG. 5 illustrates a perspective view of a plasma display device of this embodiment, and FIG. 6 illustrates a cross-sectional view thereof. A front case 9, a front filter 10, and a back cover 11 (together, these are simply referred to as a "case") are incorporated so as to house the members of Embodiment 1 from the front and back. The back cover 11 is provided with suction holes 11a and exhaust holes 11b at positions of the back cover 11 diagonally opposite the circuit boards 3 so that they do not overlap with the circuit boards 3 themselves and at positions in the widthwise direction of the back cover 11. The suction holes 11a and the exhaust holes 11b are respectively provided on the plane of the back cover 11 so as to correspond to each of the circuit boards 3. In

particular, the exhaust holes 11b are provided from a main surface 11c of the back cover 11 to a skirt part 11d of the long side part of the back cover 11. Here, in the vertical direction at the time of the use of the plasma display device, the suction holes 11a are provided at the lower part of the back cover 11 (lower than the position of the circuit boards 3), and the exhaust holes 11b are provided at the upper part (higher than the position of the circuit boards 3).

(0026) By providing the suction holes 11a and the exhaust holes 11b at the aforementioned positions of the back cover 11, air having a higher temperature in the plasma display device rises and is discharged to the outside of the display device through the exhaust holes 11b, and air having a lower temperature than the outside air is fed into the display device from the suction holes 11a by the pressure difference between the interior and exterior of the display device. Therefore, at the time of the use of the plasma display device, the natural convection 12 illustrated in FIG. 6 always occurs, which promotes the heat radiating effect of the gap 4 and also enables the effective cooling of the group of parts 3b in the circuit boards 3, the chassis 2, or the like.

(0027) Here, in this embodiment, the form is used together with Embodiment 1, but the above effect can be anticipated to a certain degree even when the back cover 11 having the configuration described above is used alone without using the thermally conductive sheets 8 of Embodiment 1.

(0028) <Embodiment 3> A perspective view of a plasma display device of this embodiment is illustrated in FIG. 7, and a cross-sectional view thereof is illustrated in FIG. 8. A front case 9, a front filter 10, and a back cover 11 (together, these are simply referred to as a "case") are incorporated so as to house the members of Embodiment 1 from the front and back. The back cover 11 is provided with suction holes 11a and exhaust holes 11e at positions of the back cover 11 diagonally opposite the circuit boards 3 so that they do not overlap with the circuit boards 3 themselves and at positions in the widthwise direction of the back cover 11. The suction holes 11a and the exhaust holes 11e are respectively provided on a main surface 11c of the back cover 11 so as to correspond to each of the circuit boards 3. In particular, the exhaust holes 11e are provided with fans. Here, when the widthwise direction of the plasma display device is defined as the vertical direction, the suction holes 11a are provided at the lower part of the back cover 11 (lower than the position of the circuit boards 3), and the exhaust holes 11e are provided at the upper part (higher than the position of the circuit boards 3).

(0029) By providing the exhaust holes 11e with fans as described above, it is possible to induce a forced convection 13 such as that illustrated in FIG. 8 with a greater air capacity than the natural convection 12 inside the plasma display device, which further enhances the heat radiating effect of the gap 4 in comparison to the configuration of Embodiment 2 and also further enhances the cooling effect inside the plasma display device.

(0030) Here, in this embodiment, the form is used together with Embodiment 1, but the above effect can be anticipated to a certain degree even when the back cover 11 having the configuration described above is used alone without using the thermally conductive sheets 8 of Embodiment 1.

(0031) <Embodiment 4> A perspective view of a plasma display device of this embodiment is illustrated in FIG. 9, and a cross-sectional view thereof is illustrated in FIG. 10. A front case 9, a front filter 10, and a back cover 11 (together, these are simply referred to as a "case") are incorporated so as to house the members of Embodiment 1 from the front and back. The back cover 11 is provided with suction holes 11f and exhaust holes 11b at positions of the back cover 11 diagonally opposite the circuit boards 3 so that they do not overlap with the circuit boards 3 themselves and at positions in the widthwise direction of the back cover 11. The suction holes 11f and the exhaust holes 11b are respectively provided on a main surface 11c of the back cover 11 so as to correspond to each of the circuit boards 3. In particular, the suction holes 11f are provided with fans. Here, when the widthwise direction of the plasma display device is defined as the vertical direction, the suction holes 11f are provided at the lower part of the back cover 11 (lower than the position of the circuit boards 3), and the exhaust holes 11b are provided at the upper part (higher than the position of the circuit boards 3).

(0032) By providing the suction holes 11f with fans as described above, it is possible to induce a forced convection 13 such as that illustrated in FIG. 10 with a greater air capacity than the natural convection 12 inside the plasma display device, which further enhances the heat radiating effect of the gap 4 in comparison to the configuration of Embodiment 2 and also further enhances the cooling effect because air can be blown directly onto the chassis 2 and the circuit boards 3.

(0033) Here, in this embodiment, the form is used together with Embodiment 1, but the above effect can be anticipated to a certain degree even when the back cover 11 having the configuration described above is used alone without using the thermally conductive sheets 8 of Embodiment 1.

(0034) In addition, in this embodiment, the holes of Embodiment 2 are used as the exhaust holes 11b, but these may also be used in combination with the exhaust holes 11e with fans in Embodiment 3.

(0035)

(EFFECT OF THE INVENTION) The plasma display device described in Claim 1 of the present invention comprises: a plasma display panel for displaying a video image; circuit boards necessary to display a video image on the plasma display panel; a chassis for holding the plasma display panel on one main surface side and holding the circuit boards on another main surface side; planar fixing means which are selectively interposed between the plasma display panel and the chassis and are used to fix the plasma display panel and the chassis; and thermally conductive sheets which have a higher thermal conductivity than the fixing means and are selectively interposed between the plasma display panel and the chassis while avoiding the fixing means. Therefore, by selectively providing the thermally conductive sheets at optimized positions (where heat is less likely to be diffused), the thermal conductivity at those positions improves, so heat is diffused along the thermally conductive sheets. As a result, the temperature differences between locations where heat is less likely to be diffused and other locations become small, and the temperature differences in the plasma display panel also

become small, so it is possible to suppress the deformation of the plasma display panel. Moreover, the movement of heat between the plasma display panel and the chassis is accelerated, so the time required for heat equalization is reduced. Furthermore, by disposing the fixing means at locations other than the locations where the thermally conductive sheets are provided, the adhesion and fixing of the plasma display panel and the chassis are enhanced.

(0036) In the plasma display device described in Claim 2 of the present invention, the thermally conductive sheets are positioned opposite the circuit boards across the chassis. Therefore, heat confined between the circuit boards and the chassis can be diffused along the thermally conductive sheets.

(0037) In the plasma display device described in Claim 3 of the present invention, the thermally conductive sheets extend in a widthwise direction of the plasma display panel; and the long sides thereof have a longer shape than the sides in the widthwise direction of the circuit boards. Therefore, heat confined between the circuit boards and the chassis can be diffused along the widthwise direction, and temperature differences between locations where heat is confined and other locations can be further suppressed.

(0038) In the plasma display device described in Claim 4 of the present invention, the thermally conductive sheets extend from one long side part of the plasma display panel to the other long side part. Therefore, confined heat can be diffused through the chassis over a wider range, and temperature distribution differences in the lengthwise direction of the plasma display panel can be minimized. Moreover, the fixing means and the thermally conductive sheets are simply arranged in an alternating pattern, so the process is simplified.

(0039) In the plasma display device described in Claim 5 of the present invention, the fixing means are disposed on a short side part of the plasma display panel. It is therefore possible to suppress the generation of a gap between the plasma display panel and the chassis primarily caused by a difference in the coefficient of thermal expansion between the plasma display panel and the chassis.

(0040) The plasma display device described in Claim 6 of the present invention further comprises: a case which houses the chassis; exhaust means corresponding to the circuit boards formed on surfaces of the box opposite the circuit boards so as to discharge heat inside the case to the outside of the case; and suction means for supplying air into the case from outside of the case. This enables the circulation of heat flow within the case so that heat is diffused to the outside of the case.

(0041) In the plasma display device described in Claim 7 of the present invention, the exhaust means are exhaust holes cut out from the case diagonally above the circuit boards; and the suction means are suction holes cut out from the case diagonally below the circuit boards. Therefore, air having a higher temperature inside the case rises and is discharged from the exhaust holes to the outside of the case, and a difference in air pressure arises between the inside and outside of the case due to this discharge of air, so air having a lower temperature outside the case is supplied into the case from the suction holes, which makes it possible to generate natural convection. As a result, at the time of the use of the plasma display device, this natural

convection can be utilized to constantly diffuse confined air.

(0042) In the plasma display device described in Claim 8 of the present invention, the exhaust means are exhaust holes with fans provided in the case diagonally above the circuit boards. It is therefore possible to induce a forced convection with a greater air capacity than the natural convection described above, and heat inside the case can be diffused to the outside of the case more effectively.

(0043) In the plasma display device described in Claim 9 of the present invention, the suction means are suction holes with fans provided in the case diagonally below the circuit boards. It is therefore possible to induce a forced convection with a greater air capacity than the natural convection described above, and heat confined inside the case can be diffused to the outside of the case more effectively. Moreover, it becomes possible to blow air from the fan directly onto the chassis, which further enhances the cooling effect of the chassis and the plasma display panel.

(BRIEF DESCRIPTION OF THE DRAWINGS)

FIG. 1 is an exploded perspective view of a plasma display device of Embodiment 1.

FIG. 2 is a cross-sectional view of the plasma display device of Embodiment 1.

FIG. 3 is a schematic diagram illustrating a method of attaching circuit boards to a chassis.

FIG. 4 is a plan view illustrating a state in which thermally

conductive sheets do not reach the long side parts of a PDP. FIG. 5 is a perspective view of a plasma display device of Embodiment 2.

FIG. 6 is a cross-sectional view of the plasma display device of Embodiment 2.

FIG. 7 is a perspective view of a plasma display device having exhaust holes with fans according to Embodiment 3.

FIG. 8 is a cross-sectional view of the plasma display device having exhaust holes with fans according to Embodiment 3.

FIG. 9 is a perspective view of a plasma display device having suction holes with fans according to Embodiment 4.

FIG. 10 is a cross-sectional view of the plasma display device having suction holes with fans according to Embodiment 4.

FIG. 11 is a schematic diagram illustrating the appearance of a display area and a non-display area of a PDP.

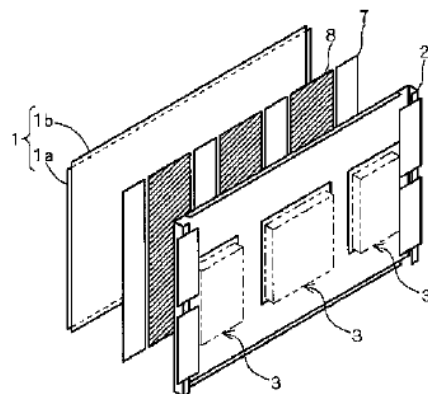
FIG. 12 is an exploded perspective view of a plasma display device of conventional technology.

FIG. 13 is a cross-sectional view of a plasma display device of conventional technology.

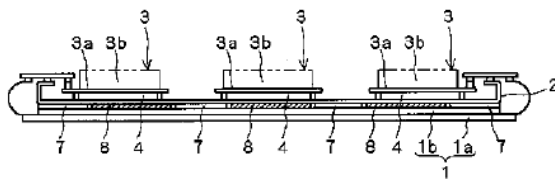
(EXPLANATION OF SYMBOLS)

1: PDP; 2: chassis; 3: circuit board; 4: gap; 7: double-sided adhesive tape; 8: thermally conductive sheet; 11: back cover; 11a: suction hole; 11b: exhaust hole; 11e: exhaust hole with fan; 11f: suction hole with fan; 12: natural convection; 13: forced convection.

(FIG. 1)

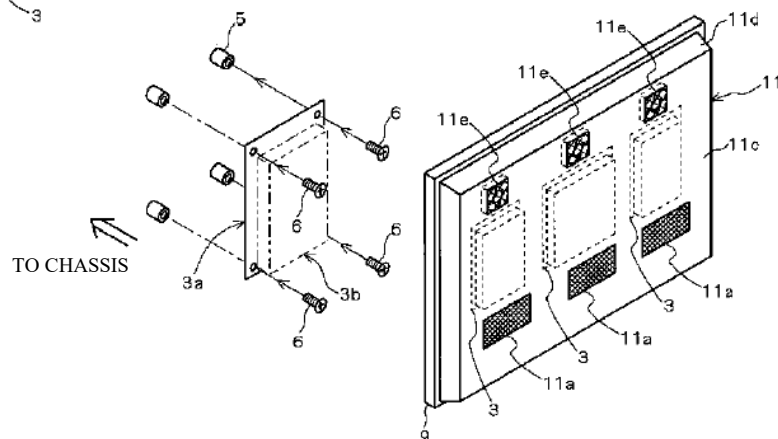


(FIG. 2)

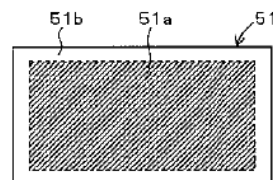


(FIG. 3)

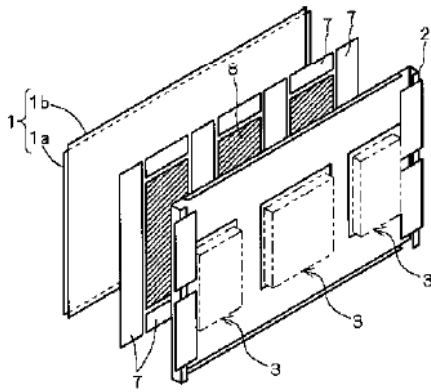
(FIG. 7)



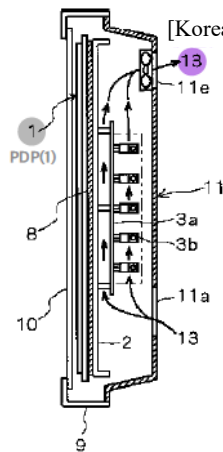
(FIG. 11)



(FIG. 4)

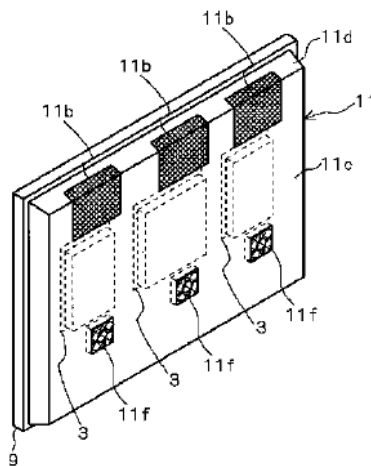


(FIG. 8)

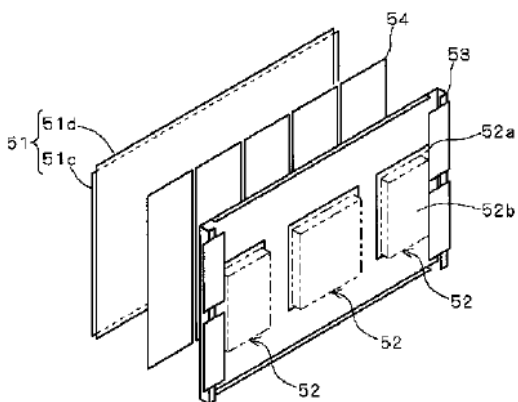


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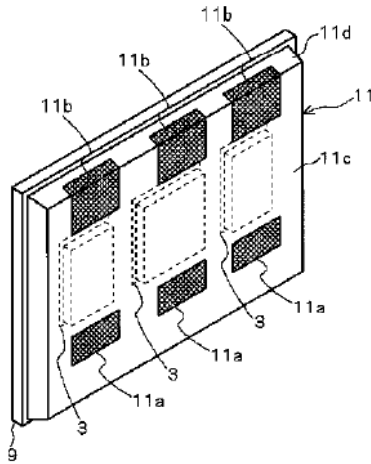
(FIG. 9)



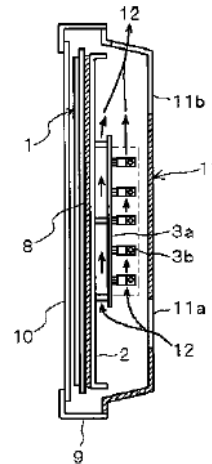
(FIG. 12)



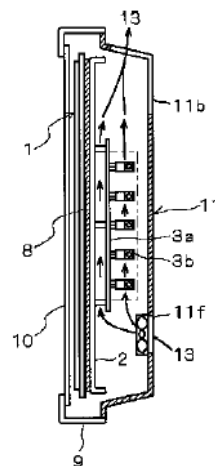
(FIG. 5)



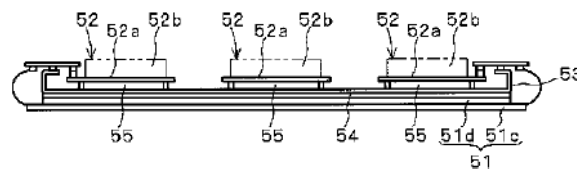
(FIG. 6)



(FIG. 10)



(FIG. 13)



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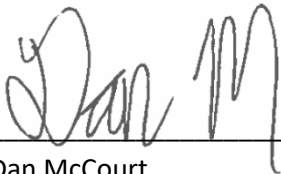
F terms (reference)	5C094	AA31	AA33	AA43	AA48	BA31
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CERTIFICATE OF TRANSLATION

I, Dan McCourt, hereby certify that the document identified below, translated from Japanese into English, is true and accurate, to the best of my knowledge and belief.

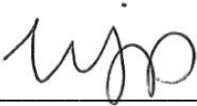
Reference: JP2003-162228A

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.



Dan McCourt

Sworn to before me this
30th day of November 2022



Signature, Notary Public

