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(73) Rights holder 000004237
NEC CORPORATION
7-1 Shiba 5-chome, Minato-ku, Tokyo

(72) Inventor TATSUKI OHTA
% NEC Corporation, 7-1 Shiba 5-chome, Minato-ku, Tokyo

(74) Agent 100082935
Patent attorney NAOKI KYOMOTO (and 2 others)

Examiner Hirofumi KOJIMA

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(58) Fields searched (Int. Cl. 7, DB name)
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(54) (TITLE OF THE INVENTION) COOLING DEVICE FOR PLASMA DISPLAY PANEL

(57) (SCOPE OF PATENT CLAIMS)

(CLAIM 1) Cooling device for plasma display panel having a front face plate that is directly mounted at an appropriate space from the plasma display panel so as to form an airtight container between itself and the plasma display panel, and coolant that either flows in/out of the aforesaid airtight container or is sealed within the same, characterized in that: the aforesaid airtight container is formed on the display face side of the plasma display panel; part or all of the container forming the aforesaid airtight container, along with the aforesaid coolant, is permeable to visible light; and the aforesaid coolant is colored.

(CLAIM 2) Cooling device for plasma display panel having a front face plate that is directly mounted at an appropriate space from the plasma display panel so as to form an airtight container between itself and the plasma display panel, and coolant that either flows in/out of the aforesaid airtight container or is sealed within the same, characterized in that: the aforesaid airtight container is formed on the display face side of the plasma display panel; part or all of the container forming the aforesaid airtight container, along with the aforesaid coolant, is permeable to visible light; and the portion of container forming the aforesaid airtight container that is permeable to visible light is colored.

(CLAIM 3) Cooling device for plasma display panel having a front face plate that is directly mounted at an appropriate space from the plasma display panel and a fan for ventilating the aforesaid space, characterized in that: the aforesaid front face plate is formed on the display side of the plasma display panel, and the aforesaid front face plate is permeable to visible light as well as colored.

(CLAIM 4) Cooling device for plasma display panel having a front face plate that is directly mounted at an appropriate

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space from the plasma display panel and a fan for ventilating the aforesaid space, characterized in that: the aforesaid front face plate is formed on the display side of the plasma display panel, and the aforesaid front face plate is permeable to visible light as well as treated to suppress reflection of external light.

(CLAIM 5) Cooling device for plasma display panel having a front face plate that is formed at an appropriate space from the plasma display panel and a fan for ventilating the aforesaid space, characterized in that: the aforesaid front face plate is formed on the display side of the plasma display panel, and the aforesaid front face plate is permeable to visible light as well as colored.

(DETAILED DESCRIPTION OF THE INVENTION)

(0001)

(TECHNICAL FIELD) The present invention relates to a cooling device for plasma display panel, and in particular relates to a cooling device for plasma display panel that is integrally formed with the plasma display panel, and that is able to improve the contrast of the plasma display panel.

(0002)

(PRIOR ART) Prior to now, a cooling device for plasma display panel was either not used at all, or the air cooling method was used, i.e. cooling was accomplished by having a fan directly blow air onto the panel.

(0003)

(PROBLEM TO BE SOLVED BY THE INVENTION) At present, color plasma display panels have very low luminous efficacy, with most of the energy consumed by the panel being converted into heat, such that attempting to achieve adequate brightness will cause the plasma display panel to become hot. For this reason, a cooling device for plasma display panel is needed.

(0004) Prior to now, either no cooling device whatsoever was used in a plasma display panel, or an integrated structure combining a plasma display panel 1, a housing 11, and a cooling fan 10 was used, as shown in FIG. 6, with the primary goal of cooling the drive circuit of the plasma display panel (not shown in the drawing).

(0005) For this reason, plasma display panels were usually cooled from the back side, resulting in the problem of being unable to cool the substrate on the display-facing side. This is particularly an issue in the case of the type of plasma display panel in which almost all display discharge is obtained on the substrate on the display face side, such as AC-driven surface discharge reflection-type plasma display panels.

(0006)

(MEANS FOR SOLVING THE PROBLEM) The cooling device for plasma display panel of the present invention has a container that is directly mounted at an appropriate space from the plasma display panel so as to form an airtight container between itself and the plasma display panel, and coolant that either flows in/out of this airtight container or is sealed within the same.

(0007) Another cooling device for plasma display panel of the present invention has a front face plate that is directly mounted at an appropriate space from the plasma display panel, and a fan that ventilates the interior of this space.

(0008)

(ACTION) With the cooling device for plasma display panel of the present invention, cooling can be freely achieved on the display face side as well as on the rear side by using material that is permeable to visible light for both the container that forms the airtight container and for the coolant.

(0009)

(EMBODIMENT EXAMPLES) Next, the present invention will be described with reference to the drawings. FIG. 1 is a longitudinal cross-section of embodiment example 1 of the cooling device for plasma display panel of the present invention.

(0010) A plasma display panel 1, produced by first sealing two glass substrates on which electrodes have been formed in such a way as to maintain the space necessary for discharge and then filling the space with a noble gas, is incorporated with a front face plate 3 that is sufficiently permeable to visible light by interposing a sealant 2 also serving as spacer therebetween along the edges, so as to form an airtight container between the same and the display face of the plasma display panel 1. At the top of the plasma display panel 1, a metal plate 4 is fastened to the front face plate 3, between the front face plate 3 and the sealant 2, and is positioned in such a way as to not impede the visibility of the plasma display panel 1. A heat sink 5 is attached to the portion of the metal plate 4 extending beyond the airtight container formed between the front face plate 3 and the display face of the plasma display panel 1. The interior of the airtight container formed between the front face plate 3 and the display face of the plasma display panel 1 is filled with a coolant fluid 6 colored with black dye so as to achieve roughly 50% permeability to visible light.

(0011) Here, an AC-driven surface discharge reflection-type color plasma display panel was used for the plasma display panel; rubber packing material with a thickness of 10 mm was used for the sealant 2; 2t soda glass plate was used for the front face plate 3; integrally machined aluminum was used for the metal plate 4 and the heat sink 5; and ethylene glycol was used for the coolant fluid 6.

(0012) When this plasma display panel with cooling device is operated, the temperature of the panel increases primarily due to Joule heat. This causes the coolant fluid 6 to warm up, producing convection within the airtight container formed between the front face plate 3 and the display face of the plasma display panel 1. Consequently, the heat from the plasma display panel 1 is transferred to the metal plate 4 via the cooling fluid 6, and the panel is cooled when the heat is discharged to the exterior from the heat sink 5. Whereas the panel display temperature of a plasma display panel without a cooling device can attain up to roughly 60 ºC, the increase in the display face temperature of the plasma display panel with cooling device of this embodiment example was suppressed to no greater than roughly 40 ºC.

(0013) Additionally, whereas the contrast of a plasma display panel with an exposed display face was roughly 15:1 with 1001x ambient illumination, the plasma display panel with cooling device of the present invention yielded higher contrast of roughly 30:1 due to the fact that the coolant fluid was colored black, which suppressed reflection of external light.

(0014) In FIG. 2, a front face plate 3 with sufficient permeability to visible light is integrated with a plasma display panel 1 by interposing sealant 2 also serving as

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spacer therebetween along the edges, so as to form an airtight container between the same and the display face of the plasma display panel 1 according to the present invention. The top and bottom ends of the interior of the airtight container formed between the front face plate 3 and the display face of the plasma display panel 1 are connected by means of a convection tube 7, and heat sinks 5 are formed along the length of the convection tube 7. The interior of the airtight container formed between the front face plate 3 and the display face of the plasma display panel 1 and the convection tube 7 is filled with coolant fluid 6 colored with black pigment so as to achieve roughly 50% permeability to visible light.

(0015) Here, an AC-driven surface discharge reflection-type color plasma display panel was used for the plasma display panel; rubber packing material with a thickness of 10 mm was used for the sealant 2; 2t soda glass plate was used for the front face plate 3; aluminum pipe with an inner diameter of φ6 was used for the convection tube 7; aluminum plate was used for heat sink 5; and ethylene glycol was used for the coolant fluid 6.

(0016) When this plasma display panel with cooling device is operated, the temperature of the panel increases primarily due to Joule heat. This causes the coolant fluid 6 to warm up, producing convection within the airtight container formed between the front face plate 3 and the display face of the plasma display panel 1, as well as within the convection tube. Consequently, the heat from the plasma display panel 1 is transferred to the cooling fluid 6, and convection from the convection tube cools the heat sink. Whereas the panel display temperature of a plasma display panel without a cooling device can attain up to roughly 60 ºC, the increase in the display face temperature of the plasma display panel with cooling device of this embodiment example was suppressed to no greater than roughly 40 ºC.

(0017) Additionally, whereas the contrast of a plasma display panel with an exposed display face was roughly 15:1 with 101x ambient illumination, the plasma display panel with cooling device of the present invention yielded higher contrast of roughly 30:1 due to the fact that the coolant fluid was colored black, which suppressed reflection of external light.

(0018) FIG. 3 is a lateral cross-section of embodiment example 3 of the cooling device for plasma display panel according to the present invention.

(0019) As in the case of embodiment example 1, a front face plate 3 with sufficient permeability to visible light is integrated with a plasma display panel 1 by interposing sealant 2 also serving as spacer therebetween along the edges, so as to form an airtight container between the same and the display face of the plasma display panel 1. The top and bottom ends of the interior of the airtight container formed between the front face plate 3 and the display face of the plasma display panel 1 are connected by means of a convection tube 7, and heat sinks 5 and a forced circulation fan 8 are formed along the length of the convection tube 7. The forced circulation fan 8 is furnished with a temperature detection device such as a thermostat or the like to detect the temperature of the plasma display panel 1 and an external power supply (which may be shared with the drive circuit of the plasma display panel) to drive the fan (not shown in the drawing). The interior of the airtight container formed between the front face plate 3 and the display face of the plasma display panel 1 and the convection tube 7 is filled with coolant fluid 6 colored with black pigment so as to achieve roughly 50% permeability to visible light.

(0020) Here, an AC-driven surface discharge reflection-type color plasma display panel was used for the plasma display panel; rubber packing material with a thickness of 10 mm was used for the sealant 2; 2t soda glass plate was used for the front face plate 3; aluminum pipe with an inner diameter of φ6 was used for the convection tube 7; aluminum plate was used for heat sink 5; and ethylene glycol was used for the coolant fluid 6.

(0021) When this plasma display panel with cooling device is operated, the temperature of the panel increases primarily due to Joule heat. When the temperature setting of the thermostat is exceeded, the forced circulation fan 8 activates, causing the cooling fluid 6 to circulate within the interior of the airtight container formed between the front face plate 3 and the display face of the plasma display panel 1 and within the interior of the convection tube, such that the heat from the plasma display panel 1 is expelled to the exterior from the heat sink 5, thereby cooling the panel. Whereas the panel display temperature of a plasma display panel without a cooling device can attain up to roughly 60 ºC, the increase in the display face temperature of the plasma display panel with cooling device of this embodiment example was suppressed to no greater than roughly 40 ºC.

(0022) Additionally, whereas the contrast of a plasma display panel with an exposed display face was roughly 15:1 with 1001x ambient illumination, the plasma display panel with cooling device of the present invention yielded higher contrast of roughly 30:1 due to the fact that the front face plate 3 was colored black, which suppressed reflection of external light.

(0023) In the three embodiment examples described above, the same effect can be achieved by using a front face plate 3 colored to have roughly 50% permeability to visible light, and using transparent cooling fluid 6.

(0024) Note that although in the above-described embodiment examples the heat sink was naturally air-cooled, it goes without saying that it is also acceptable for the heat sink to be forcibly air-cooled or cooled by a method such as fluid cooling or the like.

(0025) FIG. 4 is a lateral cross-section of embodiment example 4 of the cooling device for plasma display panel according to the present invention.

(0026) A plasma display panel 1 is produced by sealing two glass substrates on which electrodes have been formed in such a way as to maintain the space necessary for discharge and filling the space with a dischargeable noble gas, after which the plasma display panel 1 is incorporated with a front face plate 3 colored to achieve roughly 50% permeability to visible light by interposing a spacer 2 therebetween along the edges, so as to maintain an appropriate space between the same and the display face of the plasma display panel 1 and permit the free entry and exit of air. A ventilation pipe 9 is inserted through the spacer at the bottom of the plasma display panel 1 to send outside air into the space between the plasma display panel 1 and the front face plate 3, and a ventilation fan 10 is

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attached to the opposite end of the ventilation pipe 9. The ventilation fan 10 is furnished with a temperature detection device such as a thermostat or the like to detect the temperature of the plasma display panel 1 and an external power supply (which may be shared with the drive circuit of the plasma display panel) to drive the fan (not shown in the drawing).

(0027) Here, an AC-driven surface discharge reflection-type color plasma display panel was used for the plasma display panel; a rubber spacer with a thickness of 10 mm was used for the spacer 2; and acrylic plate was used for the front face plate 3.

(0028) When this plasma display panel with cooling device is operated, the temperature of the panel increases primarily due to Joule heat. When the temperature setting of the thermostat is exceeded, the ventilation fan 10 activates, send outside air through the ventilation pipe 9 into the space between the plasma display panel 1 and the front face plate 3. Consequently, the panel is cooled when the heat of the plasma display panel 1 is discharged to the exterior. Whereas the panel display temperature of a plasma display panel without a cooling device can attain up to roughly 60 ºC, the increase in the display face temperature of the plasma display panel with cooling device of this embodiment example was suppressed to no greater than roughly 35 ºC.

(0029) Additionally, whereas the contrast of a plasma display panel with an exposed display face was roughly 15:1 with 1001x ambient illumination, the plasma display panel with cooling device of the present invention yielded higher contrast of roughly 30:1 due to the fact that the front face panel 3 was colored black, which suppressed reflection of external light.

(0030) FIG. 5 is a lateral cross-section of embodiment example 5 of the cooling device for plasma display panel according to the present invention.

(0031) A plasma display panel 1 is incorporated with a housing 11 having an integrally formed front face plate 3 that maintains an appropriate distance between itself and the display face of the plasma display panel 1. Here, the front face plate 3 is colored to achieve roughly 50% permeability to visible light. A gap is provided at the bottom end of the plasma display panel 1 and the housing 11, making it possible for outside air to be blown into the space between the plasma display panel 1 and the front face plate 3 in the housing 11. Slits are provided behind the ventilation fan of the housing 11 to allow the intake of outside air. The ventilation fan 10 is furnished with a temperature detection device such as a thermostat or the like to detect the temperature of the plasma display panel 1 and an external power supply (which may be shared with the drive circuit of the plasma display panel) to drive the fan (not shown in the drawing).

(0032) Here, an AC-driven surface discharge reflection-type color plasma display panel was used for the plasma display panel, and an acrylic plate was used for the front face plate 3.

(0033) When this plasma display panel with cooling device is operated, the temperature of the panel increases primarily due to Joule heat. When the temperature setting of the thermostat is exceeded, the ventilation fan 10 activates, sending outside air through the housing 11 into the space between the plasma display panel 1 and the front face plate 3. Consequently, the panel is cooled when the heat of the plasma display panel 1 is discharged to the exterior. Whereas the panel display temperature of a plasma display panel without a cooling device can attain up to roughly 60 ºC, the increase in the display face temperature of the plasma display panel with cooling device of this embodiment example was suppressed to no greater than roughly 35 ºC.

(0034) Additionally, whereas the contrast of a plasma display panel with an exposed display face was roughly 15:1 with 1001x ambient illumination, the plasma display panel with cooling device of the present invention yielded higher contrast of roughly 30:1 due to the fact that the front face panel 3 was colored black, which suppressed reflection of external light.

(0035) Furthermore, a characteristic of this embodiment example 5 is that it is also possible to simultaneously cool the drive circuit of the plasma display panel.

(0036)

(EFFECT OF THE INVENTION) As described above, because the cooling device for plasma display panel of the present invention is given a structure comprising a container that, when directly mounted at an appropriate interval from the plasma display panel, forms an airtight container between itself and the plasma display panel, and coolant that either flows in/out of this airtight container or is sealed within the same, or a structure comprising a front face plate that is directly mounted at an appropriate space from the plasma display panel, and a fan that ventilates the interior of this space, it becomes possible, by using material permeable to visible light for both the coolant and the container forming the airtight container, or for the front face plate, to freely and effectively cool both the display face side and the back side of the plasma display panel.

(0037) Furthermore, by coloring part of the container that forms an airtight container between itself and the plasma display panel, or the coolant that either flows in/out of this airtight container or is sealed within the same, or the front face plate that is directly attached in such a way as to maintain an appropriate space between itself and the plasma display panel, it is possible to obtain a plasma display panel with very good contrast.

(BRIEF DESCRIPTION OF THE DRAWINGS)

(FIG. 1) Lateral cross-section of embodiment example 1 of the present invention.

(FIG. 2) Lateral cross-section of embodiment example 2 of the present invention.

(FIG. 3) Lateral cross-section of embodiment example 3 of the present invention.

(FIG. 4) Lateral cross-section of embodiment example 4 of the present invention.

(FIG. 5) Lateral cross-section of embodiment example 5 of the present invention.

(FIG. 6) Lateral cross-section of a prior-art cooling device for plasma display panel.

(DESCRIPTION OF THE SYMBOLS)

1: Plasma display panel
2: Sealant
3: Front face plate
4: Metal plate
5: Heat sink

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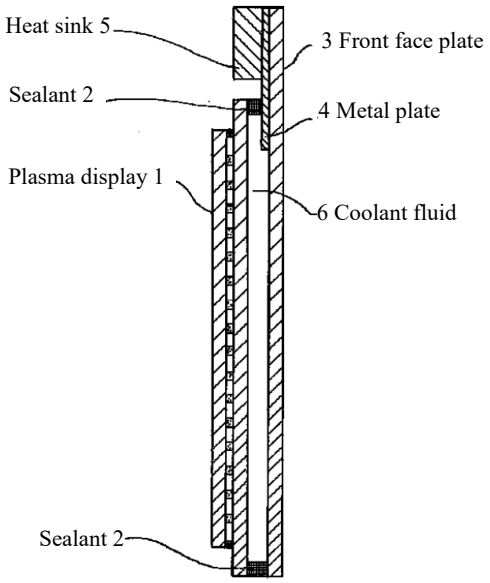
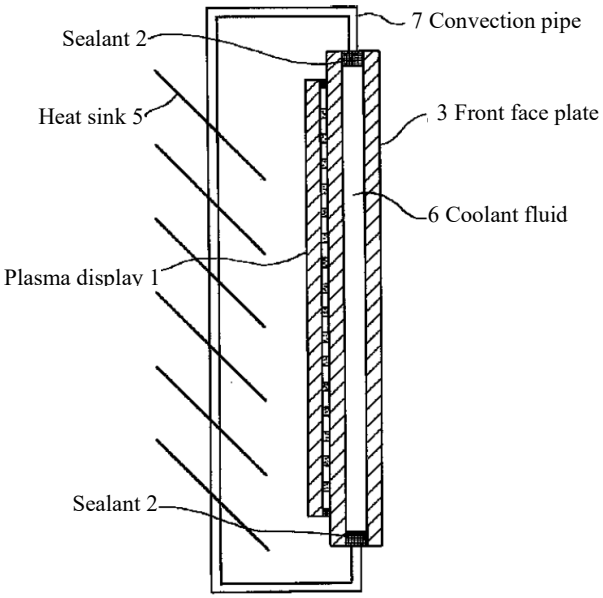
6: Coolant fluid
7: Convection pipe
8: Forced circulation pipe
9: Ventilation pipe
10: Ventilation fan
11: Housing

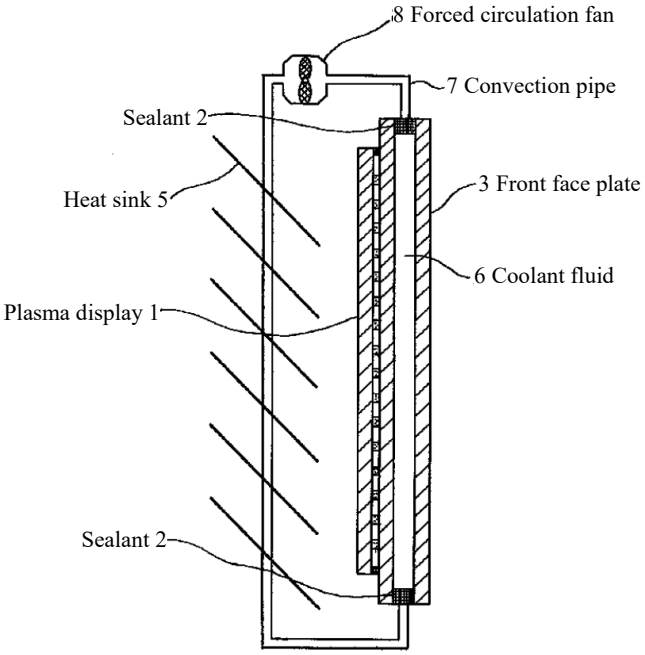
(FIG. 1)



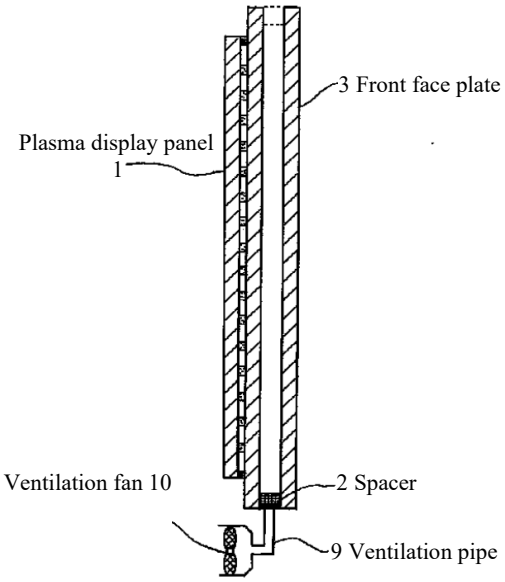
(FIG. 2)



(FIG. 3)



(FIG. 4)



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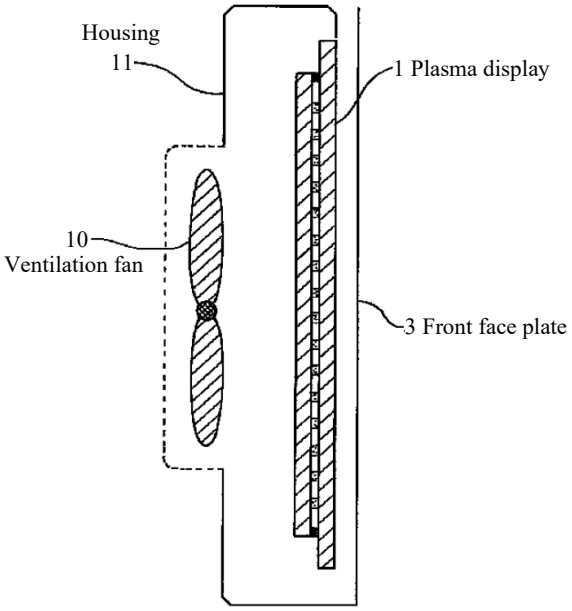
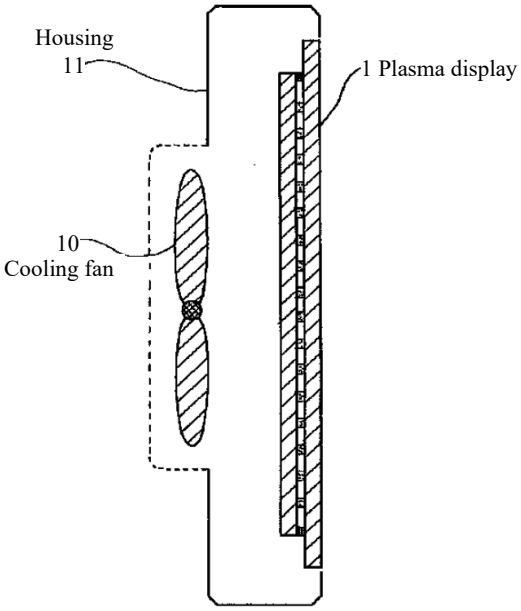
(FIG. 5)


Housing
11
1 Plasma display
10
Ventilation fan
3 Front face plate

(FIG. 6)

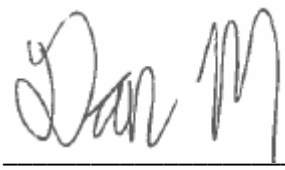

Housing
11
1 Plasma display
10
Cooling fan

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: JP3118907B2

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.



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Dan McCourt

Sworn to before me this
14th December 2022

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Signature, Notary Public

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Stamp, Notary Public