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(54) FUEL CELL STACK

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(57) ABSTRACT

The cells of the fuel cell stack have an adhesive sheet between adjacent first cell and second cell. The pressure-sensitive adhesive sheet adheres the first separator of the first cell to the second separator of the second cell. The first separator of the first cell comprises ribs in the adhesive region of the adhesive sheet, the ribs being adhered to the flat surface of the second separator of the second cell by the adhesive sheet. The width of the flat surface is larger than the width of the rib base portion.

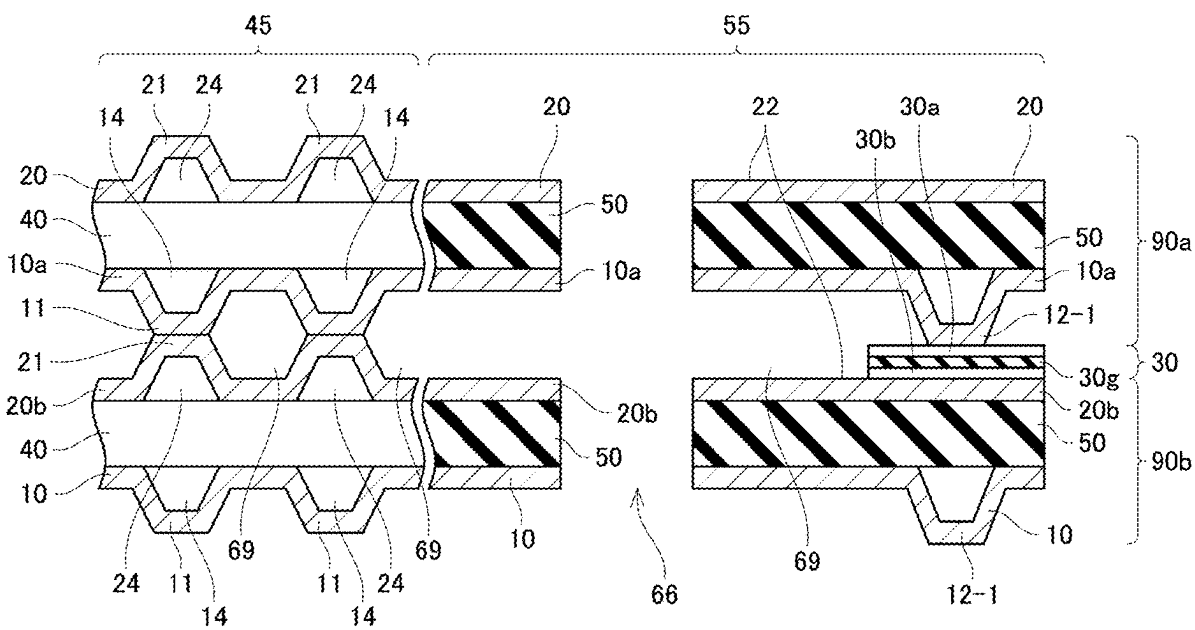


FIG. 1

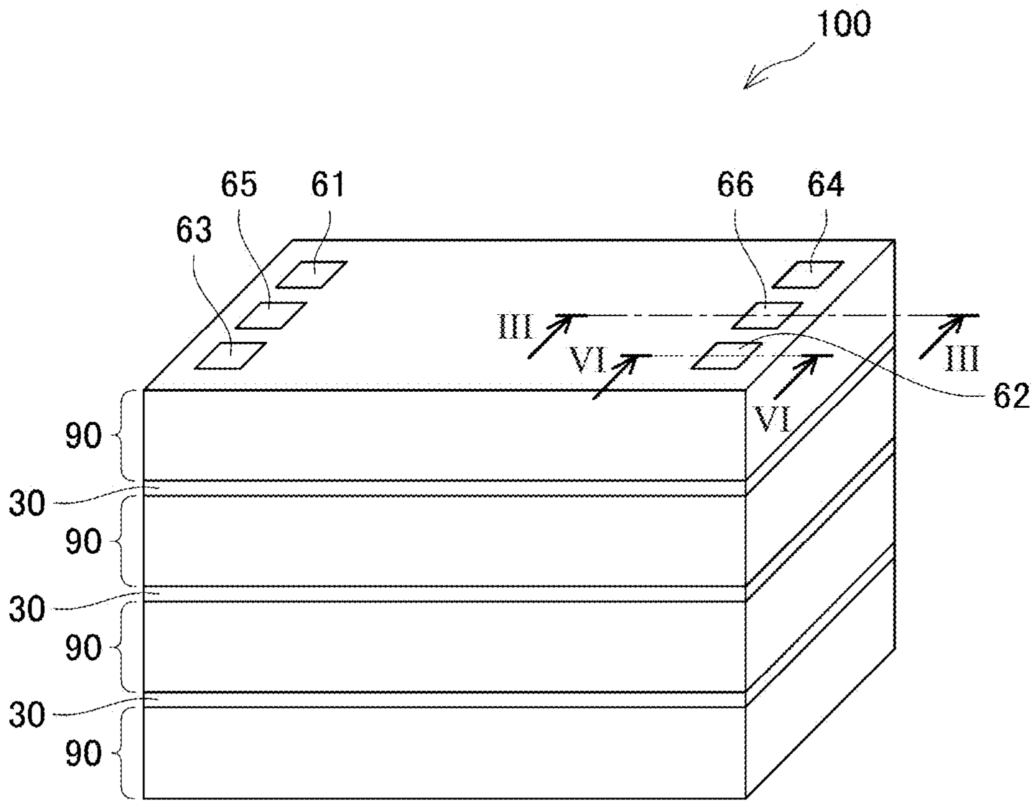


FIG. 2

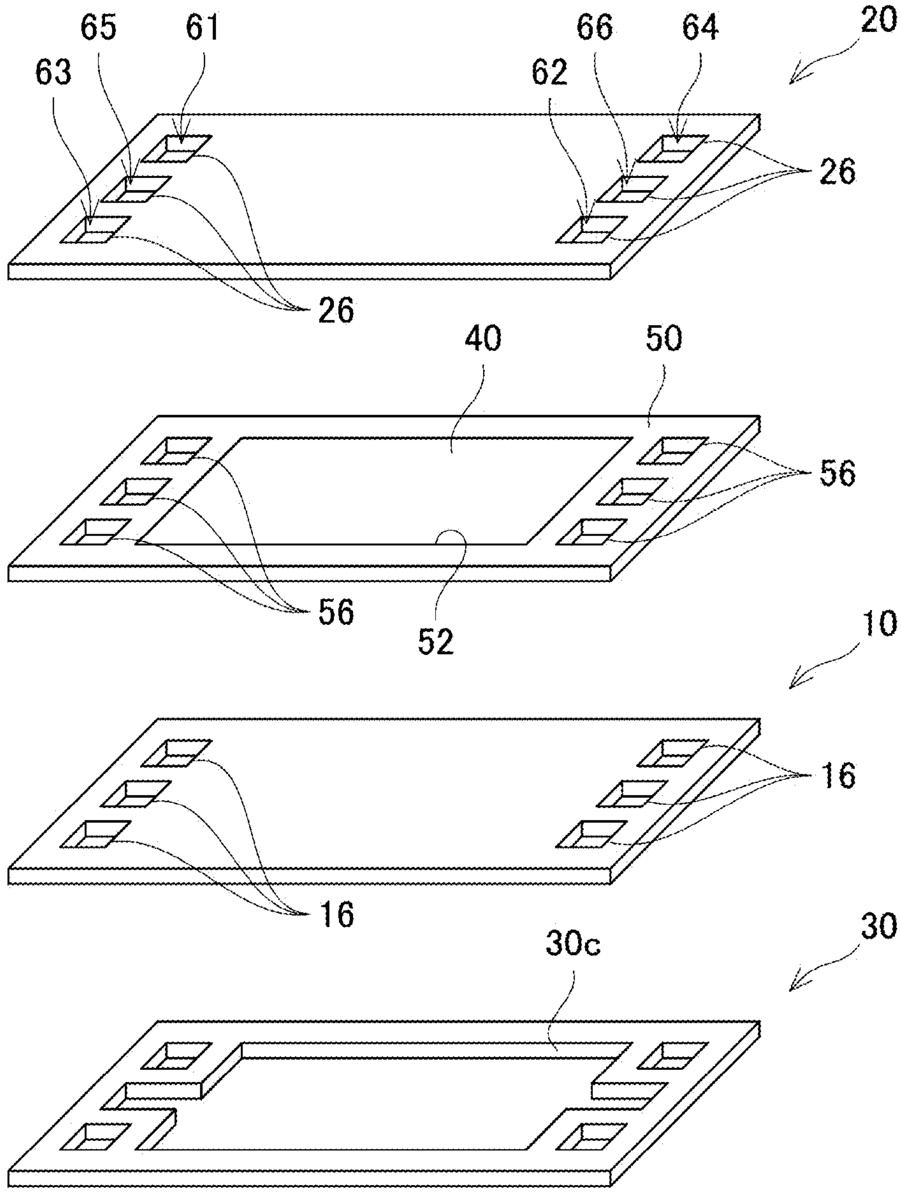


FIG. 3

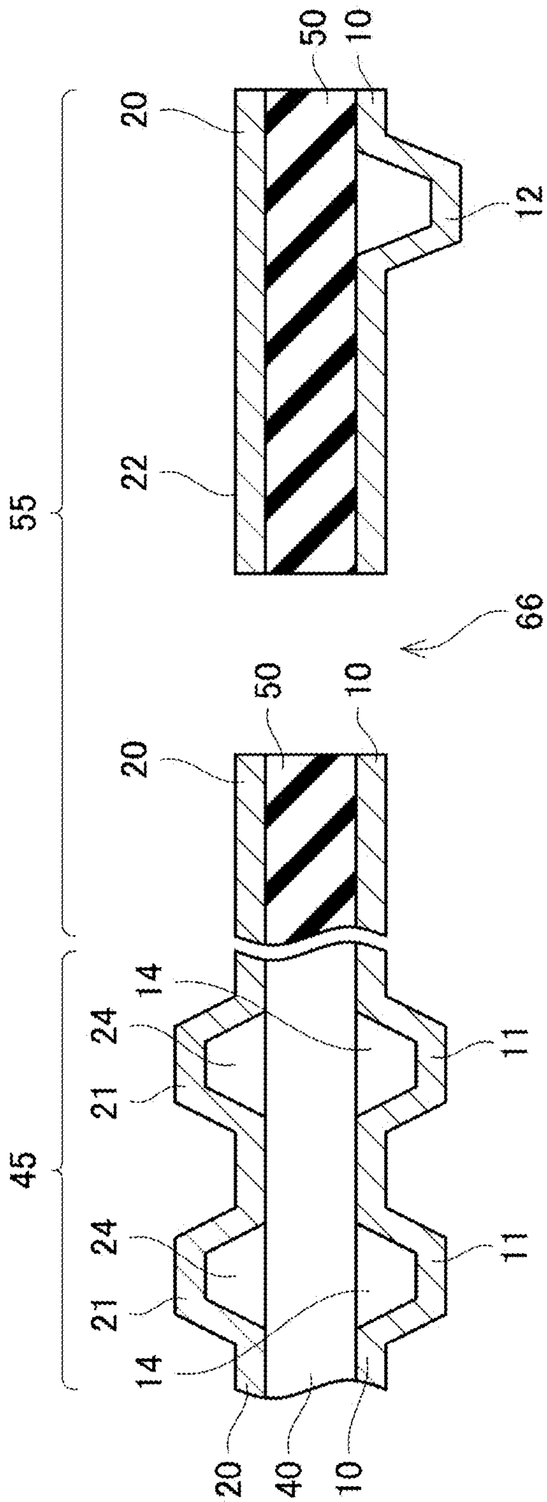


FIG. 4

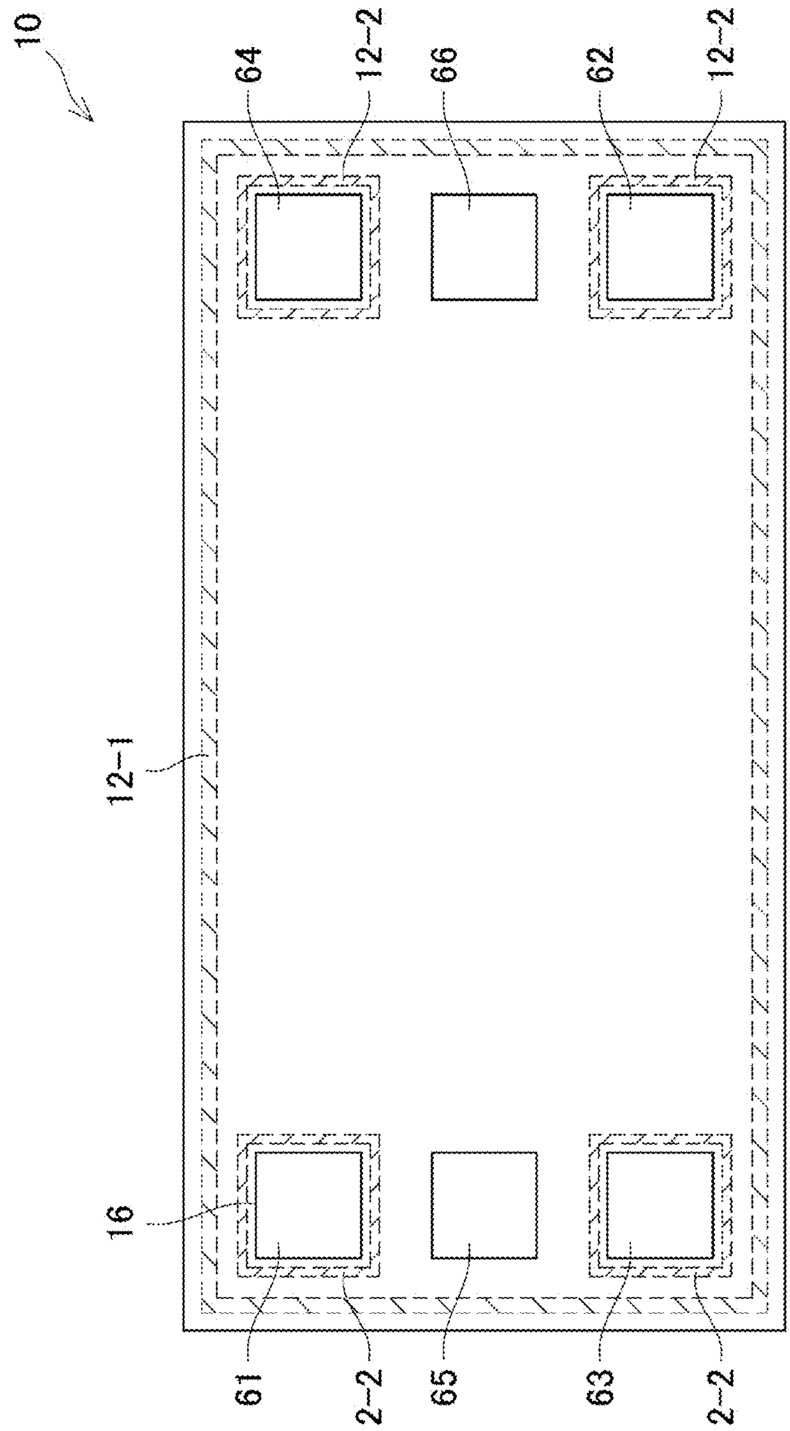
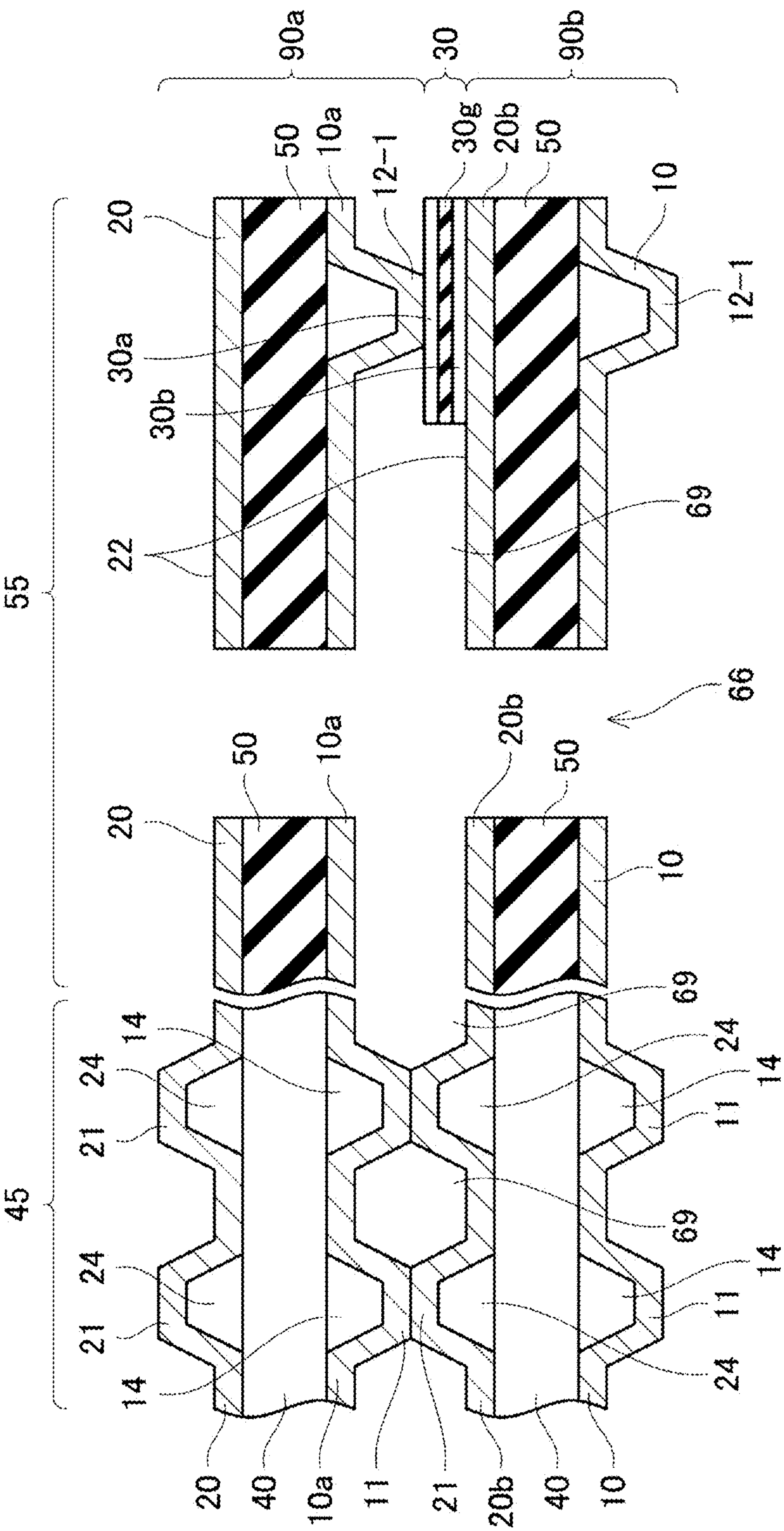


FIG. 5


90a
30
90b
50
10a
12-1
30g
20b
50
20
10
12-1
30a
30b
22
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55
66
20
50
10a
20b
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21
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10a
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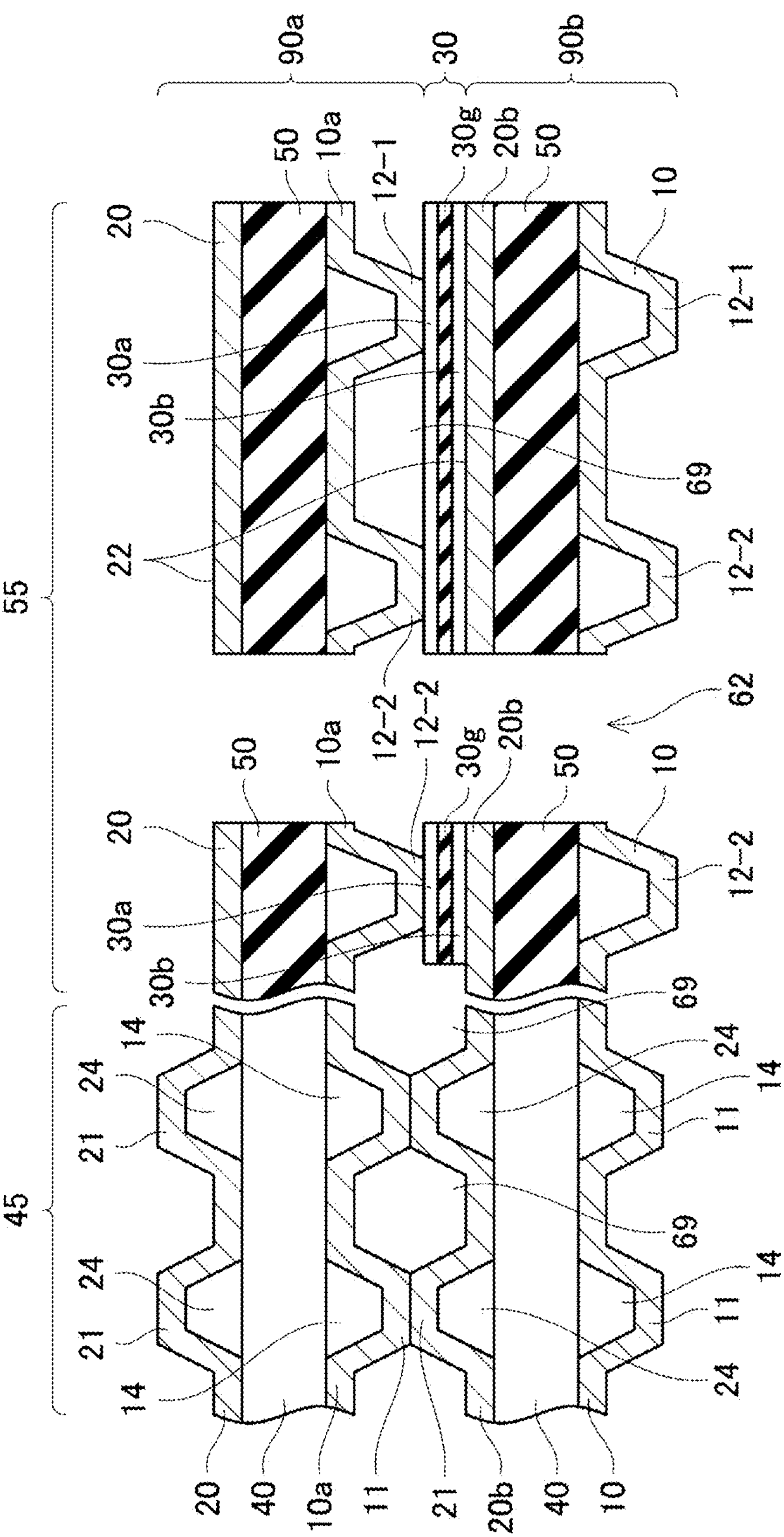
21
20b
40
10

FIG. 6


90a
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20b
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30a
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12-2
62
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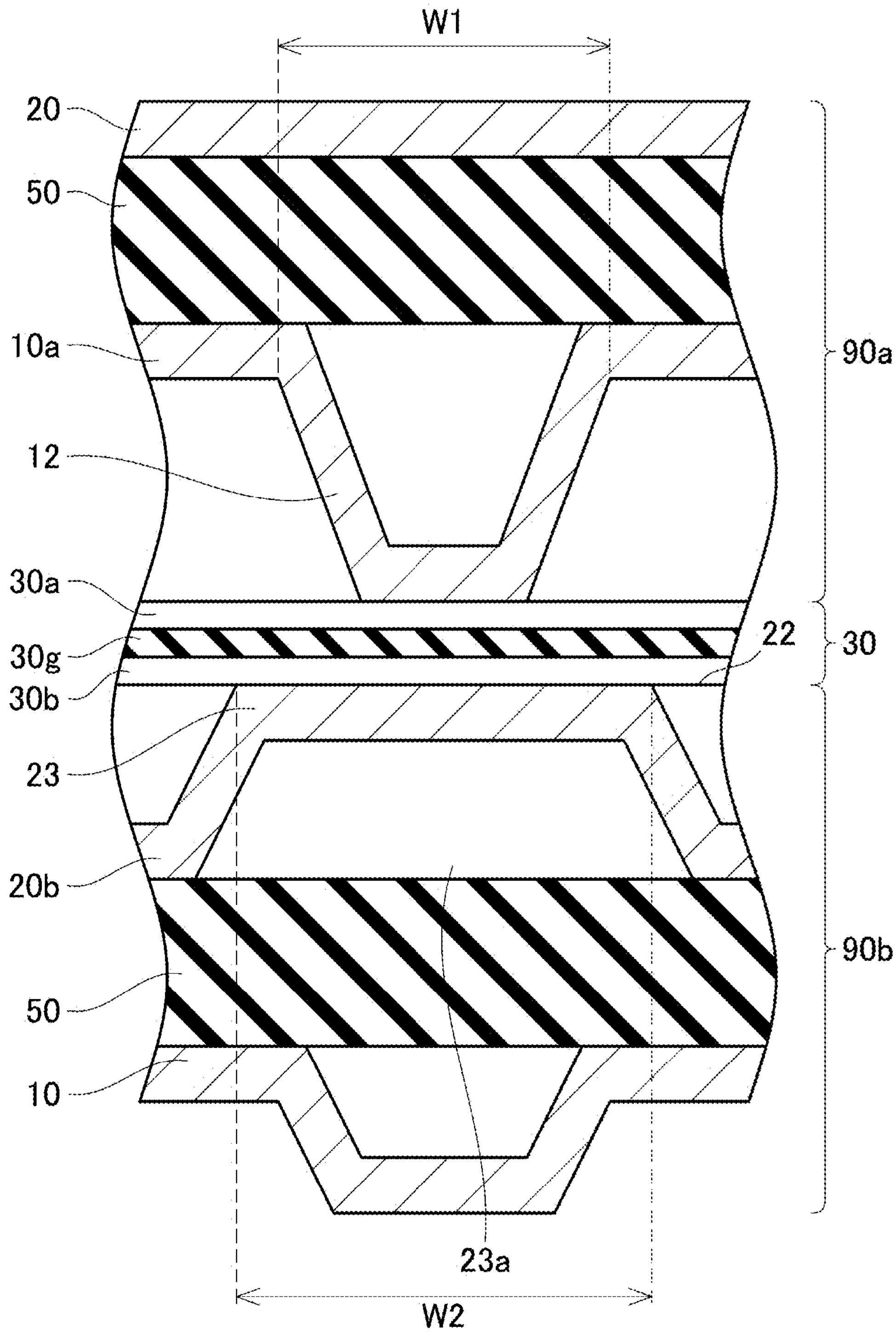
11
40

FIG. 7



FUEL CELL STACK

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Japanese Patent Application No. 2024-019475 filed on Feb. 13, 2024, incorporated herein by reference in its entirety.

BACKGROUND

1. Technical Field

[0002] The technology disclosed in the present specification relates to a fuel cell stack.

2. Description of Related Art

[0003] A fuel cell stack disclosed in Japanese Unexamined Patent Application Publication No. 2022-66778 (JP 2022-66778 A) includes a plurality of stacked cells. Each of the cells includes two separators and a membrane electrode assembly sandwiched between the two separators. An adhesive is disposed between each of the cells. The adhesive adheres the separators of adjacent cells to each other. A protrusion portion that protrudes toward the adhesive is provided in each of the separators. The protrusion portions are adhered to each other by the adhesive. A flow path through which a cooling liquid flows is formed by a space surrounded by the protrusion portions.

SUMMARY

[0004] In the fuel cell stack disclosed in JP 2022-66778 A, the protrusion portions are adhered to each other by the adhesive. In the configuration, when a cell is displaced due to an impact from the outside or the like, the position of each of the protrusion portions may be displaced, and a sealing property of an adhesive surface may be reduced. Also, leakage occurs in the cooling liquid flow path.

[0005] A fuel cell stack of a first embodiment disclosed by the present specification includes

- **[0006]** a plurality of stacked cells, and
- **[0007]** an adhesive sheet.
- **[0008]** Each of the cells includes
- **[0009]** a first separator,
- **[0010]** a second separator, and
- **[0011]** a membrane electrode assembly sandwiched between the first separator and the second separator.
- **[0012]** The cells include a first cell and a second cell adjacent to the first cell.
- **[0013]** A cooling liquid flow path is provided between the first separator of the first cell and the second separator of the second cell.
- **[0014]** The adhesive sheet adheres the first separator of the first cell and the second separator of the second cell.
- **[0015]** The first separator of the first cell includes a protrusion portion within an adhesive region of the adhesive sheet.
- **[0016]** The protrusion portion is adhered to a flat surface of the second separator of the second cell by the adhesive sheet.
- **[0017]** The width of the flat surface is wider than the width of a base portion of the protrusion portion.

[0018] In the fuel cell stack, since the protrusion portion is adhered to a flat surface that is wider than the width of a base portion of the protrusion portion, leakage of a cooling liquid does not easily occur even if the protrusion portion is displaced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Features, advantages, and technical and industrial significance of exemplary embodiments of the disclosure will be described below with reference to the accompanying drawings, in which like signs denote like elements, and wherein:

[0020] FIG. **1** is a perspective view of a fuel cell stack;

[0021] FIG. **2** is an exploded perspective view of a cell of a fuel cell stack;

[0022] FIG. **3** is a cross-sectional III-III view of FIG. **1**;

[0023] FIG. **4** is a plan view of the first separator;

[0024] FIG. **5** is a cross-sectional view of III-III of FIG. **1** when cells **90** are stacked;

[0025] FIG. **6** is a cross-sectional view of VI-VI of FIG. **1** when cells **90** are stacked; and

[0026] FIG. **7** is an explanatory view of a flat surface according to a modified example.

DETAILED DESCRIPTION OF EMBODIMENTS

[0027] Following Embodiment 1 above, additional configurations of the fuel cell stack disclosed herein are described below.

Embodiment 2

- **[0028]** The fuel cell stack of Embodiment 1, wherein:
- **[0029]** The surface of the second separator of the second cell is flat over the entire adhesive region of the adhesive sheet.

Embodiment 3

- **[0030]** In the fuel cell stack according to any one of Embodiments 1 or 2,
- **[0031]** Each cell surrounds the membrane electrode assembly, and has a frame sheet sandwiched between the first separator and the second separator,
- **[0032]** The protrusion portion is provided in a range overlapping the frame sheet when seen along a stacking direction of the cells.

Embodiment 4

- **[0033]** The fuel cell stack according to any one of Embodiments 1 to 3,
- **[0034]** The protrusion portion has a first annular portion extending in an annular shape along an outer peripheral edge of the first separator.

Embodiment 5

- **[0035]** In the fuel cell stack according to any one of Embodiments 1 to 4
- **[0036]** The first separator of the first cell has a first through hole,
- **[0037]** The second separator of the second cell has a second through hole,
- **[0038]** The gas flow path is constituted by the first through hole and the second through hole,
- **[0039]** The protrusion portion has a second annular portion extending annularly along the outer peripheral edge of the first through hole,

[0040] The second annular portion is bonded to the second separator in an annular region along the outer peripheral edge of the second through hole by the adhesive sheet.

Embodiment 6

[0041] The fuel cell stack according to any one of Embodiments 1 to 5,

[0042] The pressure-sensitive adhesive sheet includes

[0043] Rubber sheet,

[0044] A first adhesive layer for bonding the rubber sheet and the first separator of the first cell,

[0045] A second adhesive layer for bonding the rubber sheet and the second separator of the second cell.

Embodiment 7

[0046] The fuel cell stack according to any one of Embodiments 1 to 6,

[0047] The protrusion portion is a rib formed by a bent portion of the first separator.

[0048] The fuel cell stack is mounted on, for example, a fuel cell electric vehicle using a fuel cell as a power source. The fuel cell stack **100** shown in FIG. **1** includes a plurality of stacked cells **90**. As illustrated in FIG. **2**, each cell **90** includes a first separator **10**, a second separator **20**, a membrane electrode assembly **40**, and a frame sheet **50**.

[0049] The membrane electrode assembly **40** generates electric power by reacting hydrogen with oxygen. Although not shown, the membrane electrode assembly **40** has a structure in which an electrolyte membrane is sandwiched between two catalyst layers. Examples of the material of the electrolyte membrane include an ion exchange membrane. Examples of the material of the catalyst layer include a material in which platinum nanoparticles are supported on carbon particles.

[0050] The frame sheet **50** is made of an insulating resin. As shown in FIG. **2**, an accommodation hole **52** that penetrates the frame sheet **50** is provided in the center of the frame sheet **50**. The membrane electrode assembly **40** is disposed in the accommodation hole **52**. That is, the frame sheet **50** surrounds the membrane electrode assembly **40**.

[0051] The first separator **10** and the second separator **20** are made of a gas impermeable conductive material. Examples of the material of the separator include a metal material such as stainless steel and a carbon material. The membrane electrode assembly **40** and the frame sheet **50** are sandwiched between the first separator **10** and the second separator **20**. That is, the first separator **10** is in contact with one surface of the membrane electrode assembly **40** and the frame sheet **50**. The second separator **20** is in contact with the other surface of the membrane electrode assembly **40** and the frame sheet **50**. Hereinafter, a region overlapping with the membrane electrode assembly **40** when viewed along the stacking direction is referred to as a main region **45**, and a region overlapping with the frame sheet **50** is referred to as an outer peripheral region **55**.

[0052] As shown in FIG. **3**, the rib **11** is provided in the first separator **10** in the main region **45**. The rib **11** is a portion protruding outward (i.e., on the opposite side of the membrane electrode assembly **40**) due to bending of the first separator **10**. The space between the rib **11** and the membrane electrode assembly **40** constitutes the hydrogen gas flow path **14**. In the main region **45**, the second separator **20** is provided with ribs **21**. The rib **21** is a portion protruding outward (i.e., on the opposite side of the membrane electrode assembly **40**) due to bending of the second separator **20**. The oxidizing gas flow path **24** is formed by the space between the rib **21** and the membrane electrode assembly **40**. Note that the oxidizing gas is a gas containing oxygen, and is air in the present embodiment.

[0053] As shown in FIG. **3**, the rib **12** is provided in the first separator **10** in the outer peripheral region **55**. The rib **12** is a portion protruding outward (i.e., on the opposite side of the frame sheet **50**) by bending of the first separator **10**. In the outer peripheral region **55**, no rib is provided in the second separator **20**. That is, in the outer peripheral region **55**, the second separator **20** is flat. Hereinafter, the outer surface of the second separator **20** in the outer peripheral region **55** is referred to as a flat surface **22**.

[0054] As shown in FIG. **2**, the frame sheet **50** is provided with a plurality of through holes **56** around the accommodation hole **52**. The first separator **10** is provided with a plurality of through holes **16**. Each through hole **16** is located at a position overlapping with the through hole **56**. The second separator **20** is provided with a plurality of through holes **26**. Each through hole **26** is located at a position overlapping with the through hole **56**. By connecting the through holes **16**, **26**, and **56**, the flow path **66** is formed from the plurality of flow paths **61** penetrating the cell **90** in the thickness direction. The flow path **61** is a hydrogen gas supply path through which the hydrogen gas flows. The flow path **62** is a hydrogen gas discharge path through which the hydrogen gas flows. The flow path **63** is an oxidizing gas supply path through which the oxidizing gas flows. The flow path **64** is an oxidizing gas discharge path through which the oxidizing gas flows. The flow path **65** is a cooling liquid supply path through which the cooling liquid flows. The flow path **66** is a cooling liquid discharge path through which the cooling liquid flows. As shown in FIG. **1**, a plurality of cells **90** are stacked to form a fuel cell stack **100**. In the fuel cell stack **100**, the flow paths **66** are connected to each other from the flow paths **61** of the cells **90**. Therefore, the flow paths **61** to **66** extend along the stacking direction to both ends of the fuel cell stack **100**. The hydrogen gas in the flow path **61** is discharged to the flow path **62** through the hydrogen gas flow path **14** of each cell **90**. The oxidizing gas in the flow path **63** is discharged to the flow path **64** through the oxidizing gas flow path **24** of each cell **90**.

[0055] As illustrated in FIG. **4**, the rib **12** includes an annular portion **12-1** and a plurality of annular portions **12-2**. The annular portion **12-1** extends annularly along the outer peripheral edge of the first separator **10**. Each annular portion **12-2** extends annularly from the flow path **61** along the outer peripheral edge of each through hole **16** constituting the flow path **64**. The rib **12** is not provided around each of the through holes **16** constituting the flow path **66** from the flow path **65**.

[0056] Next, a structure of a connection portion between adjacent cells **90** will be described. Since the structures of the connection portions are the same, the structure of the connection portion between the cell **90***a* and the cell **90***b* shown in FIG. **5** will be described below. In the following description, the first separator **10** of the cell **90***a* is referred to as a first separator **10***a*, and the second separator **20** of the cell **90***b* is referred to as a second separator **20***b*.

[0057] As shown in FIG. **5**, the first separator **10***a* and the second separator **20***b* are arranged to face each other. The adhesive sheet **30** is sandwiched between the first separator **10***a* and the second separator **20***b*. The pressure-sensitive adhesive sheet **30** adheres the first separator **10***a* to the second separator **20***b*. The adhesive sheet **30** includes a rubber sheet **30***g* and adhesive layers **30***a*, **30***b*. The pressure-sensitive adhesive layers **30***a* adhere the rubber sheet **30***g* to the first separator **10***a*. The pressure-sensitive adhesive layers **30***b* adhere the rubber sheet **30***g* to the second separator **20***b*. That is, one surface of the pressure-sensitive adhesive sheet **30** is bonded to the first separator **10***a*, and the other surface of the pressure-sensitive adhesive sheet **30** is bonded to the second separator **20***b*.

[0058] As illustrated in FIG. **2**, the pressure-sensitive adhesive sheet **30** is provided in the outer peripheral region **55** (that is, a region overlapping with the frame sheet **50**). In the main region **45** (i.e., a region overlapping the membrane electrode assembly **40**), the adhesive sheet **30** is provided with an opening portion **30***c*. The pressure-sensitive adhesive sheet **30** is provided in a range adjoining the outer peripheral edge of the first separator **10***a* and in a range surrounding each of the hydrogen gas supply path **61**, the hydrogen gas discharge path **62**, the oxidizing gas supply path **63**, and the oxidizing gas discharge path **64**. Within these ranges, the pressure-sensitive adhesive sheet **30** adheres the first separator **10***a* and the second separator **20***b*. The pressure-sensitive adhesive sheet **30** is not provided between the opening portion **30***c* and the cooling liquid supply path **65** and between the opening portion **30***c* and the cooling liquid discharge path **66**.

[0059] As shown in FIG. **5** and FIG. **6**, in the outer peripheral region **55**, the ribs **12** of the first separator **10***a* are bonded to the adhesive sheet **30**. In the outer peripheral region **55**, the flat surface **22** of the second separator **20***b* is bonded to the pressure-sensitive adhesive sheet **30**. That is, in the adhesive sheet **30**, the rib **12** of the first separator **10***a* and the flat surface **22** of the second separator **20***b* are bonded to each other in the area of the frame sheet **50**. In other words, in the adhesive area of the pressure-sensitive adhesive sheet **30**, the first separator **10***a* has ribs, and the second separator **20***b* has a flat surface **22**.

[0060] As shown in FIG. **4**, the ribs **12** of the first separator **10***a* have an annular portion **12-1**. As shown in FIGS. **5** and **6**, the annular portion **12-1** is adhered to the adhesive sheet **30**. In addition, the flat surface **22** of the second separator **20***b* adheres to the pressure-sensitive adhesive sheet **30** within the annular portion **12-1**. That is, the adhesive sheet **30** adheres the annular portion **12-1** to the flat surface **22**. Between the first separator **10***a* and the second separator **20***b* is sealed within the annular portion **12-1**.

[0061] As shown in FIG. **4**, the ribs **12** of the first separator **10***a* have a plurality of annular portions **12-2**. The annular portion **12-2** surrounds the respective peripheries of the flow paths **61** to **64**. As shown in FIG. **6**, the plurality of annular portions **12-2** are bonded to the adhesive sheet **30**. In addition, the flat surface **22** of the second separator **20***b* adheres to the pressure-sensitive adhesive sheet **30** in the area of the plurality of annular portions **12-2**. That is, the pressure-sensitive adhesive sheet **30** adheres the plurality of annular portions **12-2** to the flat surface **22**. Between the first separator **10***a* and the second separator **20***b* is sealed within the plurality of annular portions **12-2**.

[0062] As illustrated in FIG. **5** and FIG. **6**, in the main region **45**, the rib **11** of the first separator **10***a* and the rib **21** of the second separator **20***b* are in contact with each other. Thus, the first separator **10***a* and the second separator **20***b* are electrically connected to each other.

[0063] In the outer peripheral region **55**, since the rib **12** is in contact with the flat surface **22**, a space is provided between the first separator **10***a* and the second separator **20***b* at a part other than the rib **12**. In the main region **45**, since the rib **11** is in contact with the rib **21**, a space is provided between the first separator **10***a* and the second separator **20***b* at a part other than the ribs **11** and **21**. The cooling liquid flow path **69** is formed by the distance between the first separator **10***a* and the second separator **20***b*. The cooling liquid in the flow path **65** is discharged to the flow path **66** through the cooling liquid flow path **69** of each cell **90**. The pressure-sensitive adhesive sheet **30** prevents leakage of the cooling liquid in the cooling liquid supply path **65** and the cooling liquid discharge path **66** in the annular portions **12-1** and **12-2**.

[0064] The ribs **12** (i.e., the annular portions **12-1** and **12-2**) are bonded to the flat surface **22** of the second separator **20***b*. Therefore, even if the cell **90***a* and **90***b* are displaced due to an external impact or the like, the sealing property of the adhesive surface is less likely to be deteriorated. Therefore, leakage of the cooling liquid is unlikely to occur in the cooling liquid flow path **69**.

[0065] In the main region **45**, the rib **11** of the first separator **10***a* and the rib **21** of the second separator **20***b* are in contact with each other. Since both sides of the ribs **11** and **12** are the cooling liquid flow paths **69**, a high sealing property is not required at the interface between the rib **11** and the rib **12**. Therefore, even if the rib **11** and the rib **12** are displaced due to an external impact or the like, leakage of the cooling liquid from the cooling liquid flow path **69** to the outside does not occur.

[0066] Further, in the above-described embodiment, the hydrogen gas flow path is provided on the first separator side, and the oxidation gas flow path is provided on the second separator side. However, an oxidation gas flow path may be provided on the first separator side, and a hydrogen gas flow path may be provided on the second separator side. That is, either the first separator or the second separator may be an anode.

[0067] In the above-described embodiment, the entire surface of the second separator **20***b* was the flat surface **22** over the entire area where the pressure-sensitive adhesive sheet **30** was provided. However, as shown in FIG. **7**, the flat surface **22** may be provided in any manner as long as the width W**2** of the flat surface **22** of the second separator **20** (that is, the flat surface to which the rib **12** is bonded) is wider than the width of the base portion in the width W**1** of the rib **12**. For example, as shown in FIG. **7**, the second separator **20** may be provided with a wide rib **23**, and the end surface of the rib **23** may be a flat surface **22**. Here, a reinforcing member may be provided on the inner area **23***a* of the rib **23**.

[0068] While the embodiments have been described in detail above, these are merely illustrative and do not limit the scope of the claims. The technology described in the claims includes various modifications and alterations of the specific examples described above. The technical elements described in this specification or in the drawings may be used alone or in various combinations, and are not limited to the combinations described in the claims at the time of filing. Further, the technology illustrated in the present specification or the drawings achieves a plurality of objects at the same time, and has technical usefulness by achieving one of the objects.

What is claimed is:

1. A fuel cell stack comprising:

a plurality of stacked cells; and

an adhesive sheet, wherein:

each of the cells includes

a first separator,

a second separator, and

a membrane electrode assembly sandwiched between the first separator and the second separator;

the cells include a first cell and a second cell adjacent to the first cell;

a cooling liquid flow path is provided between the first separator of the first cell and the second separator of the second cell;

the adhesive sheet adheres the first separator of the first cell and the second separator of the second cell;

the first separator of the first cell includes a protrusion portion within an adhesive region of the adhesive sheet;

the protrusion portion is adhered to a flat surface of the second separator of the second cell by the adhesive sheet; and

a width of the flat surface is wider than a width of a base portion of the protrusion portion.

2. The fuel cell stack according to claim **1**, wherein a surface of the second separator of the second cell is flat over an entirety of the adhesive region of the adhesive sheet.

3. The fuel cell stack according to claim **1**, wherein:

each of the cells surrounds a periphery of the membrane electrode assembly and has a frame sheet sandwiched between the first separator and the second separator; and

the protrusion portion is provided in a range overlapping the frame sheet when seen along a stacking direction of the cells.

4. The fuel cell stack according to claim **1**, wherein the protrusion portion has a first annular portion extending in an annular shape along an outer peripheral edge of the first separator.

5. The fuel cell stack according to claim **1**, wherein:

the first separator of the first cell has a first through hole;

the second separator of the second cell has a second through hole;

a gas flow path is constituted by the first through hole and the second through hole;

the protrusion portion has a second annular portion extending in an annular shape along an outer peripheral edge of the first through hole; and

the second annular portion is adhered to the second separator in an annular region along an outer peripheral edge of the second through hole by the adhesive sheet.

6. The fuel cell stack according to claim **1**, wherein the adhesive sheet includes

a rubber sheet,

a first adhesive layer that adheres the rubber sheet and the first separator of the first cell, and

a second adhesive layer that adheres the rubber sheet and the second separator of the second cell.

7. The fuel cell stack according to claim **1**, wherein the protrusion portion is a rib constituted by a bent portion of the first separator.

* * * * *