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(54) **WATER ELECTROLYSIS STACK**

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CPC ***C25B 1/04*** (2013.01); ***C25B 9/60*** (2021.01); ***C25B 9/70*** (2021.01); ***C25B 11/032*** (2021.01)

(57) **ABSTRACT**

To provide a water electrolysis stack capable of suppressing deterioration in sealability. A water electrolysis stack configured by laminating a plurality of water electrolysis cells to generate hydrogen by supplying water to the water electrolysis cell and applying electric power, wherein a laminated member for improving sealing property, which is a member that does not introduce water therein, is laminated at a predetermined position of the water electrolysis cell to be laminated.

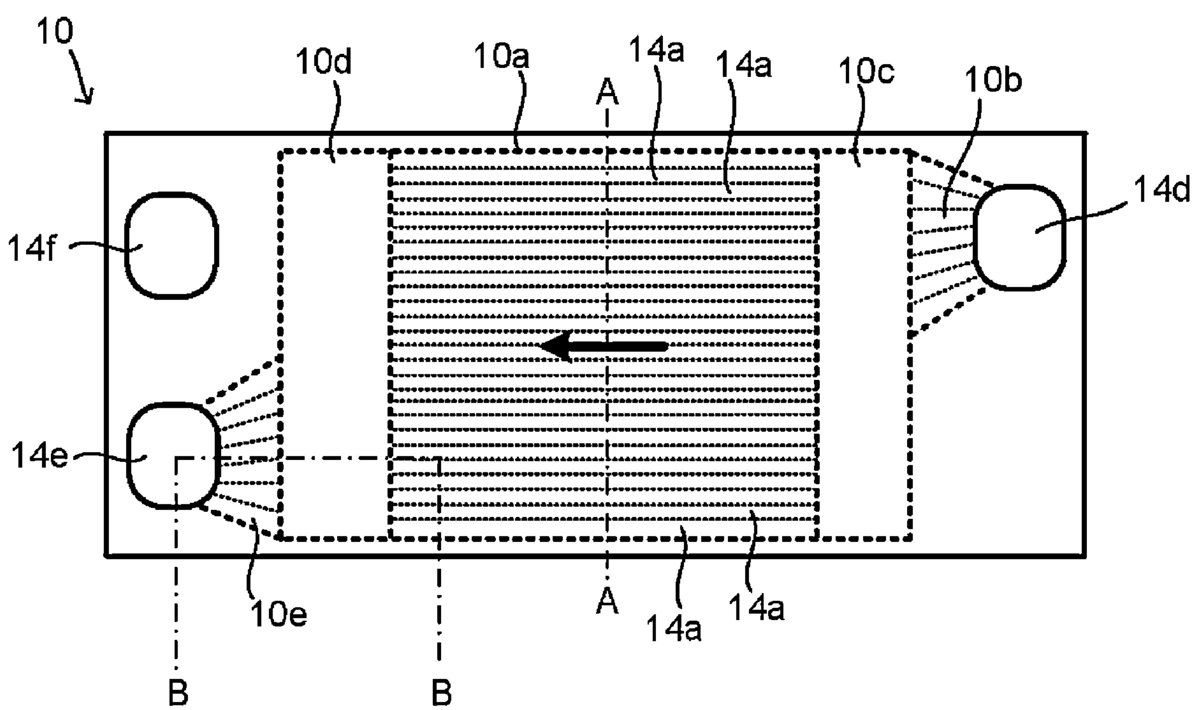

Fig. 1

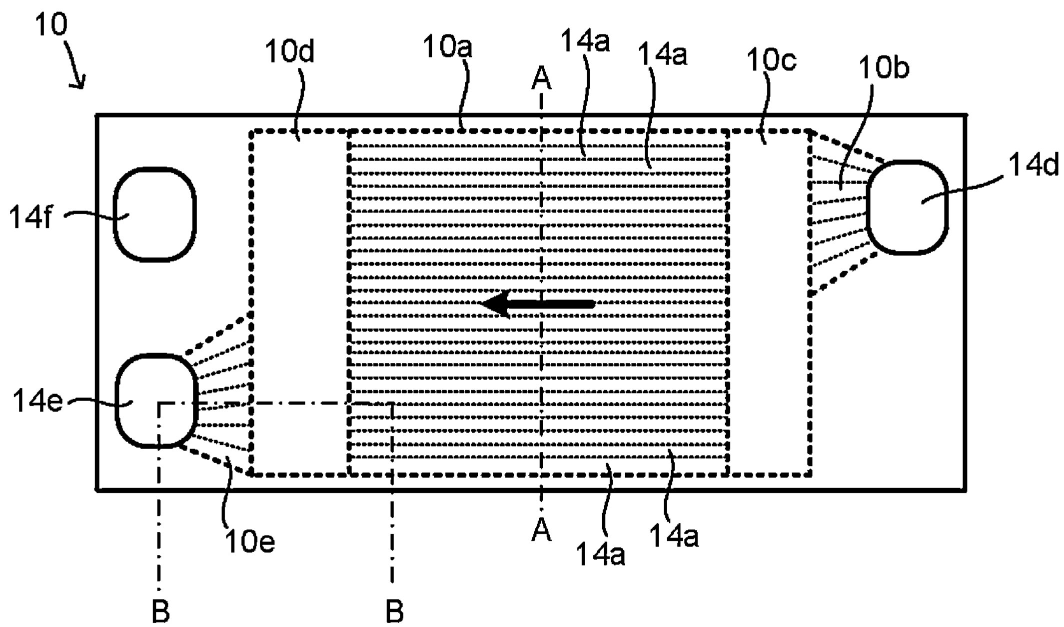

Fig. 2

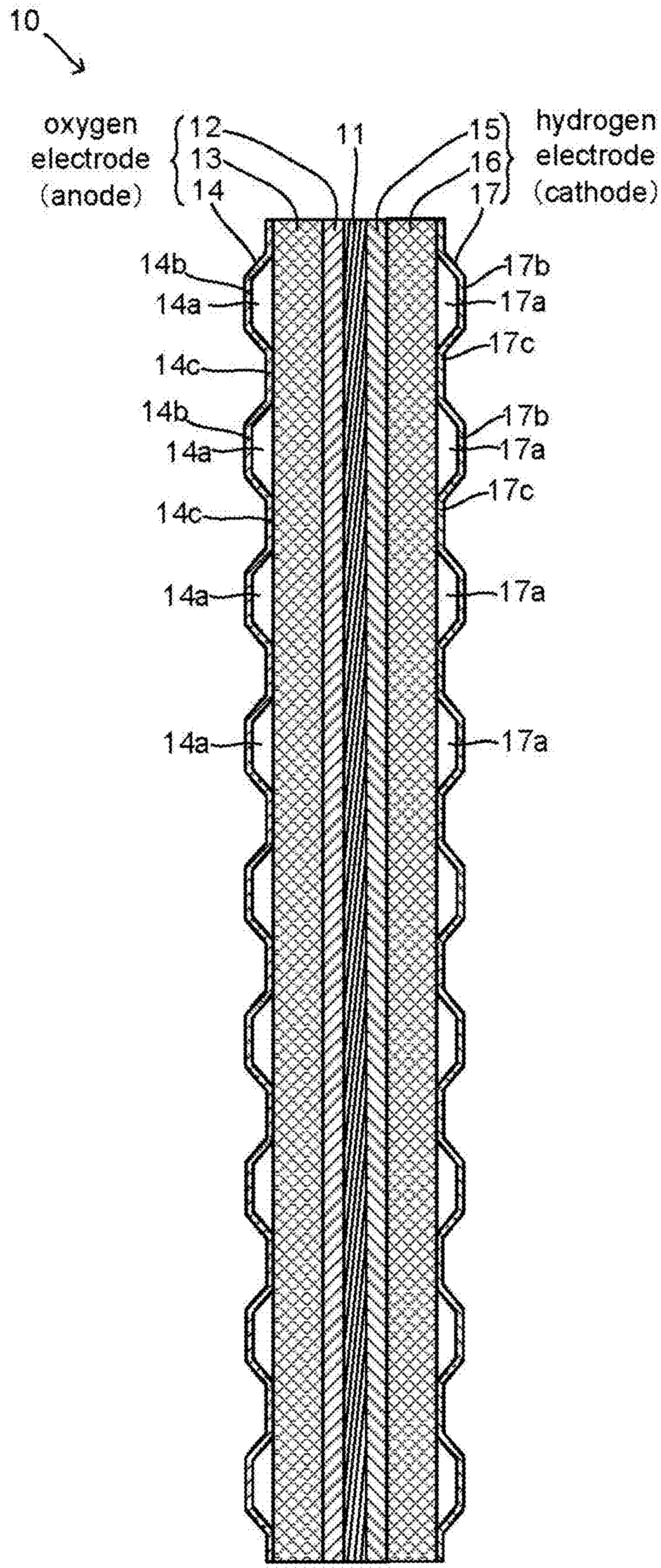
10
oxygen
electrode
(anode)
12
13
14
11
15
16
17
hydrogen
electrode
(cathode)
14b
14a
14c
14b
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Fig. 3

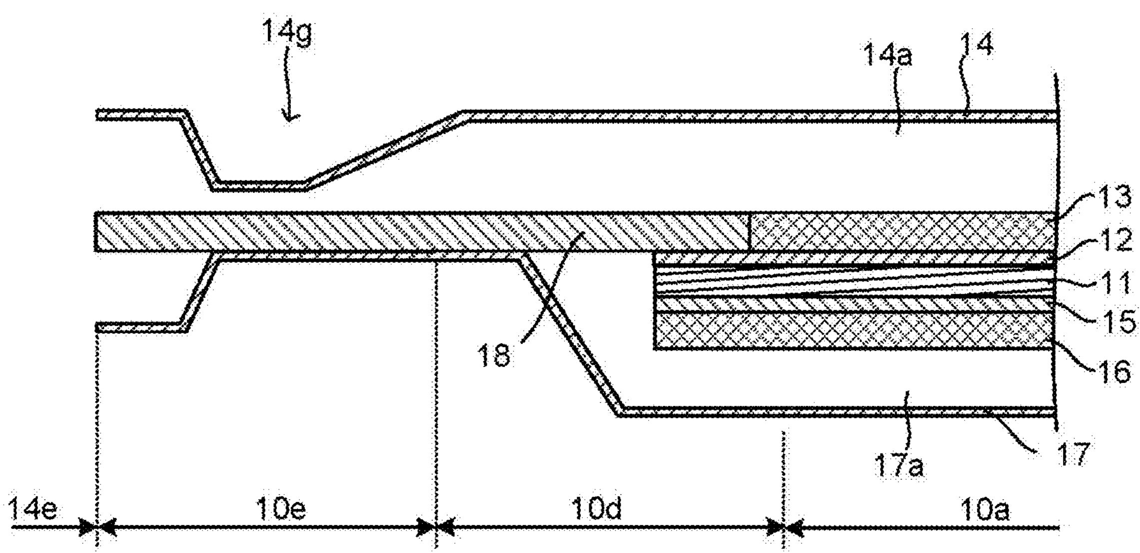


Fig. 4

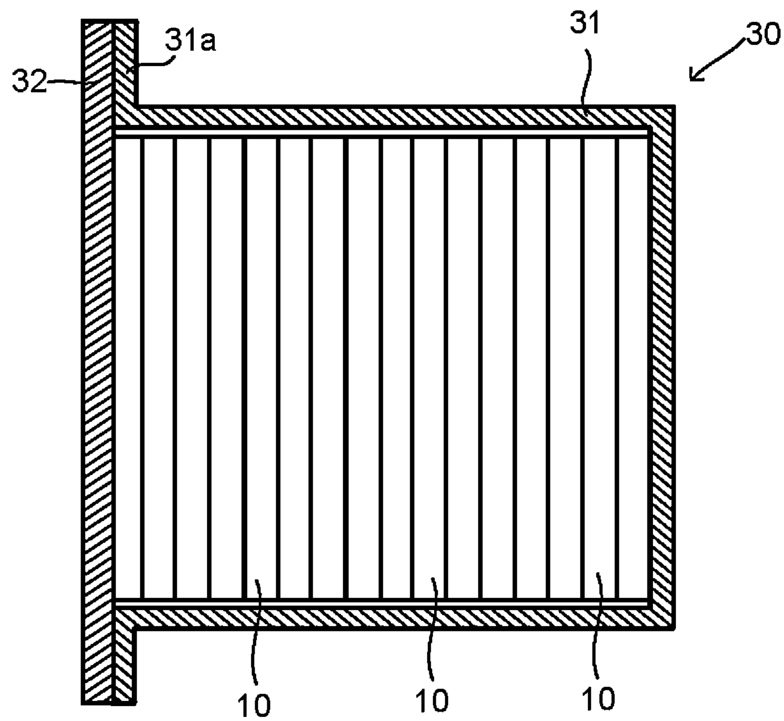


Fig. 5

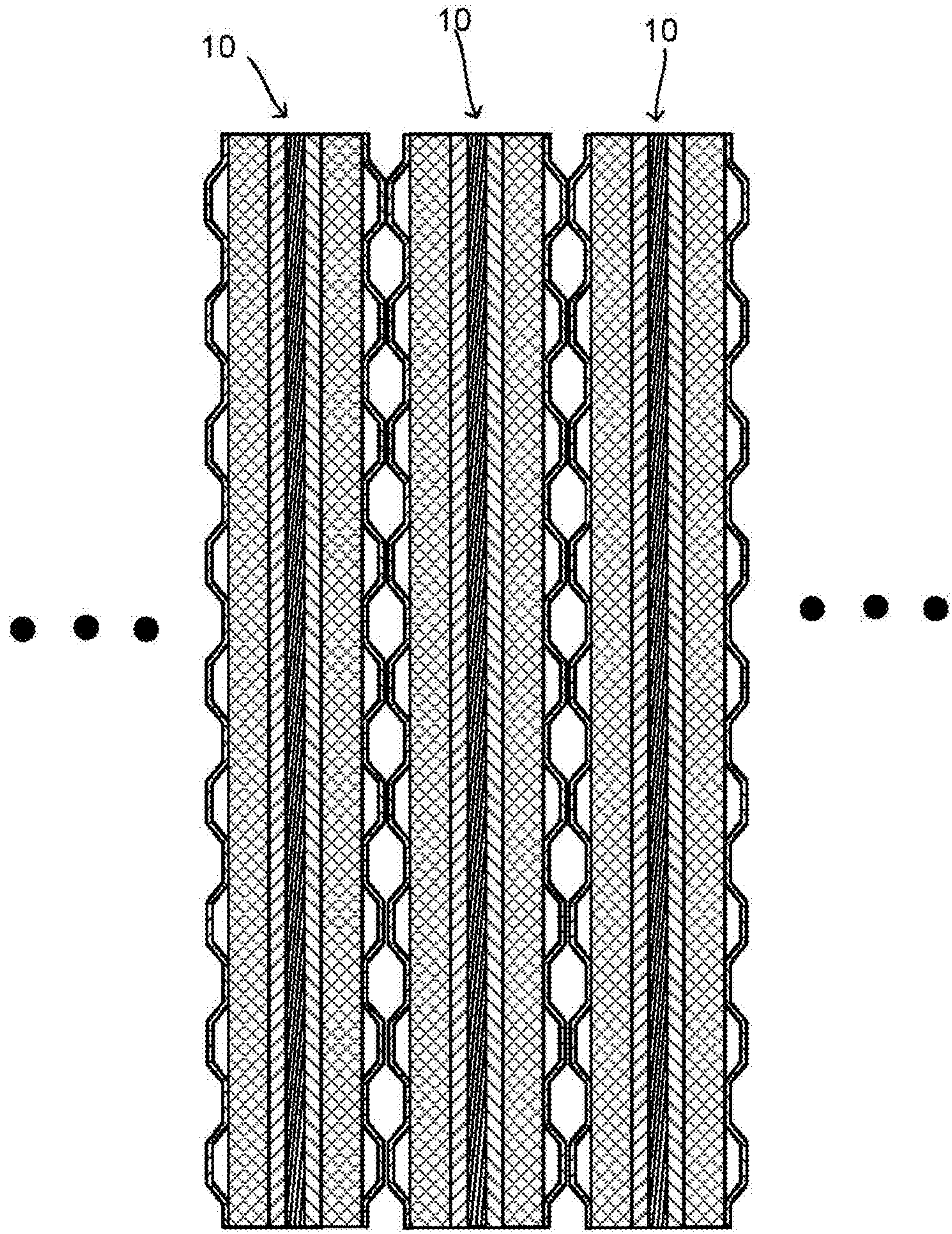


Fig. 6

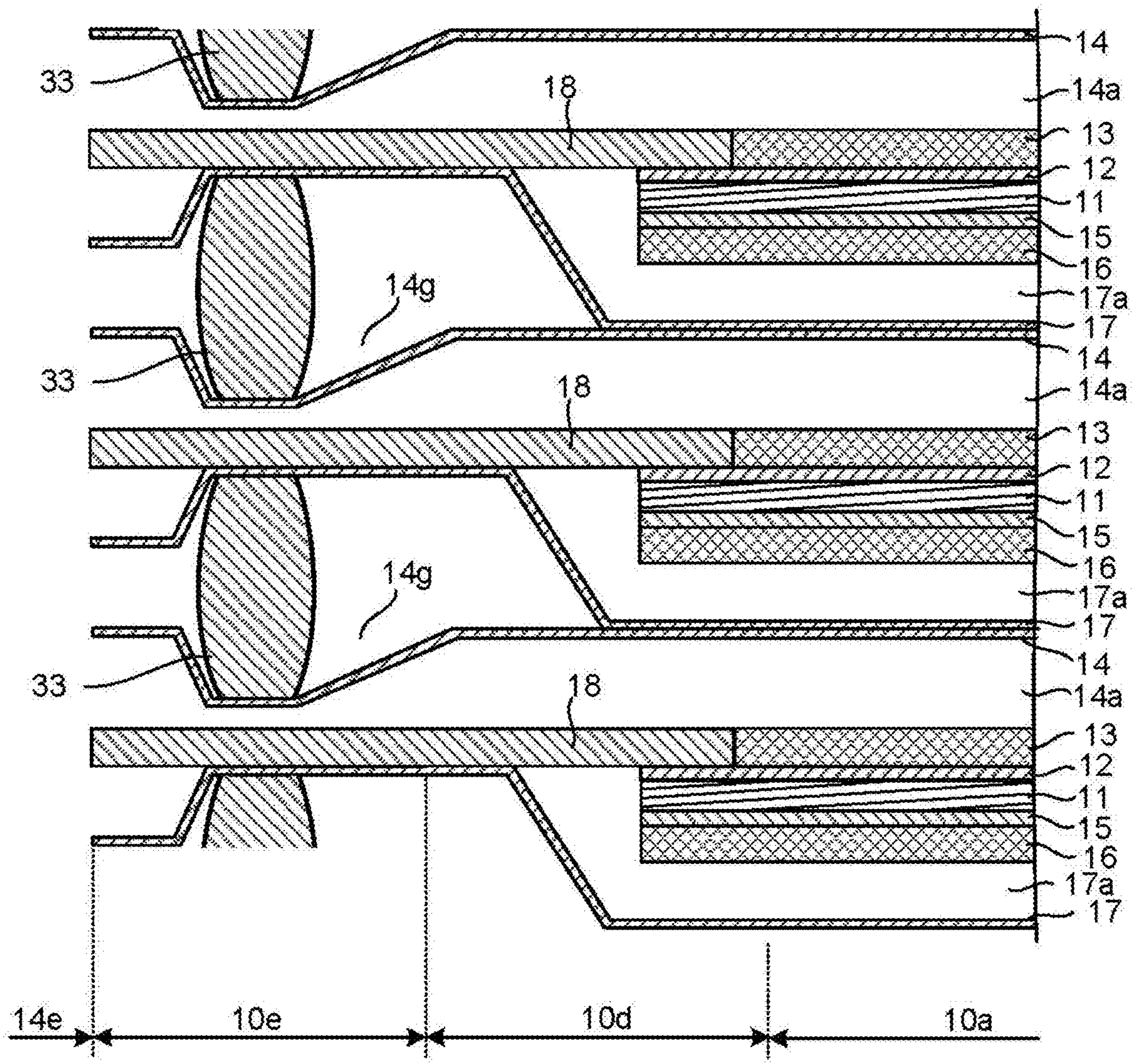


Fig. 7

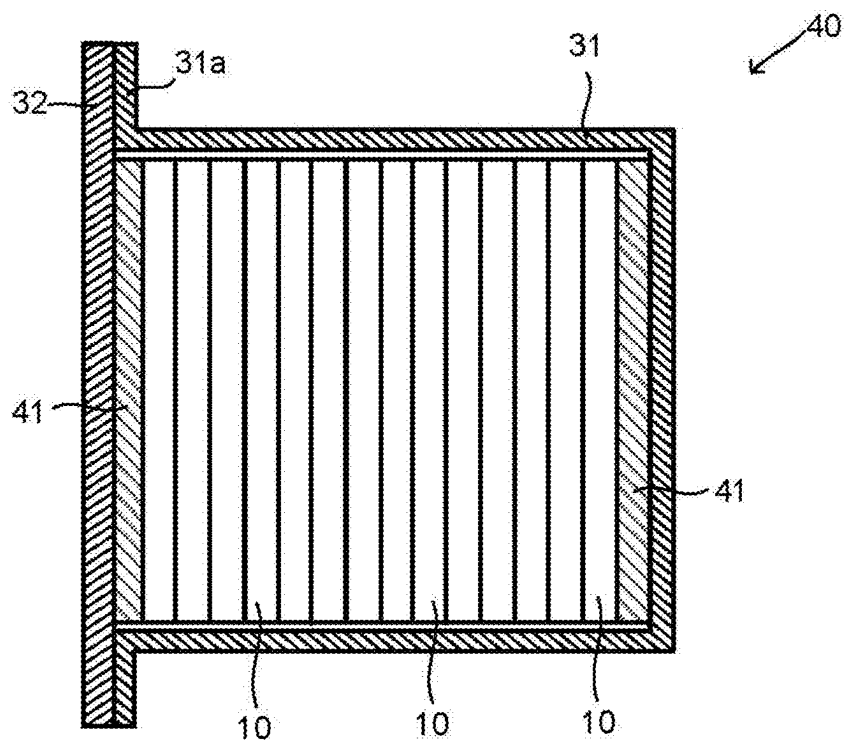


Fig. 8

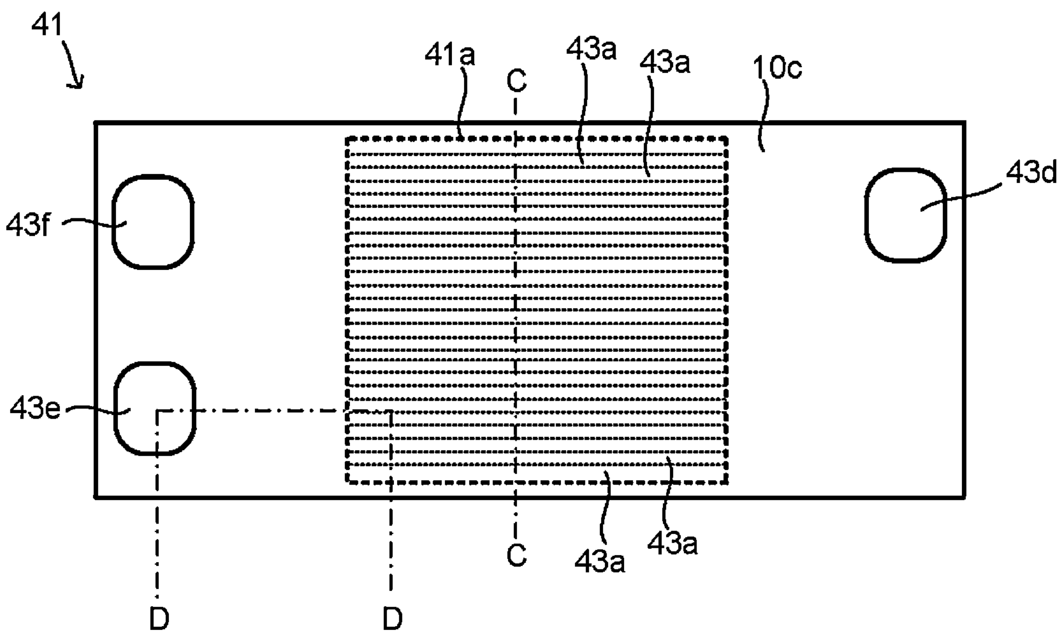
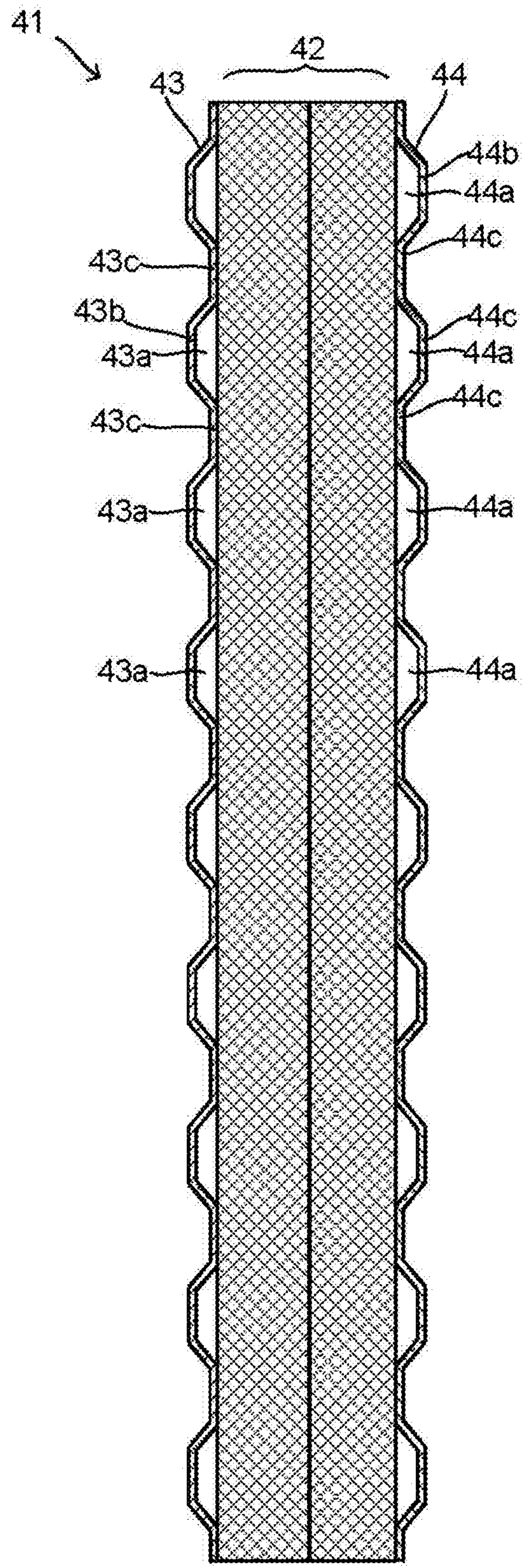


Fig. 9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44
44b
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44a

Fig. 10

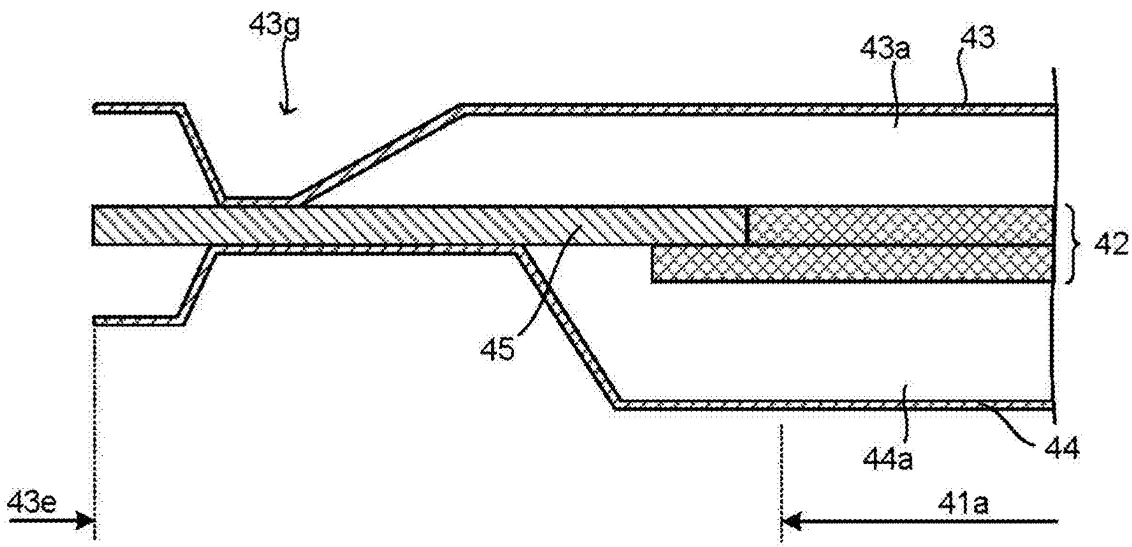


Fig. 11

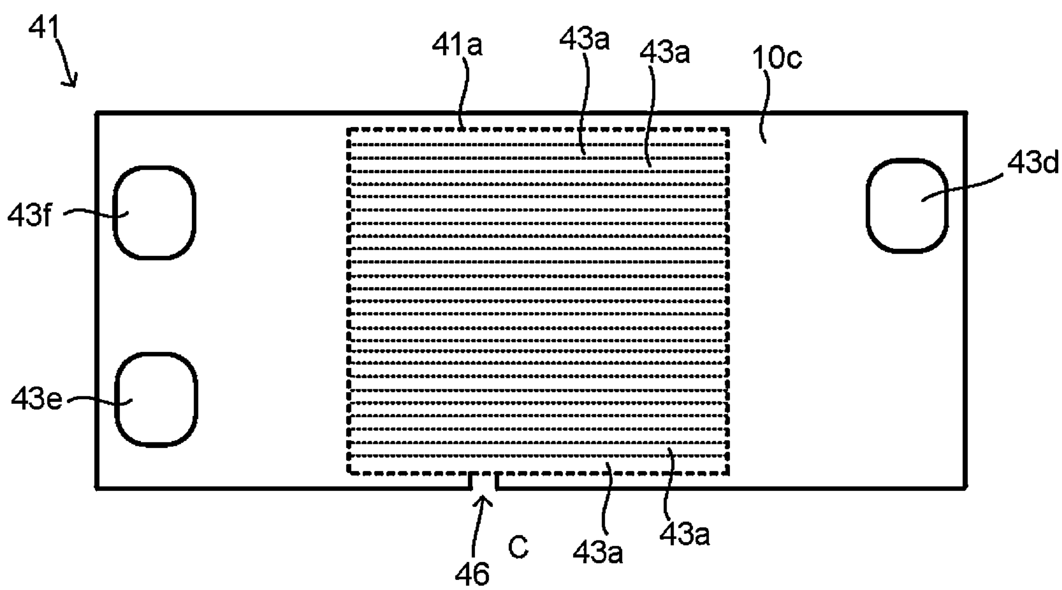


Fig. 12

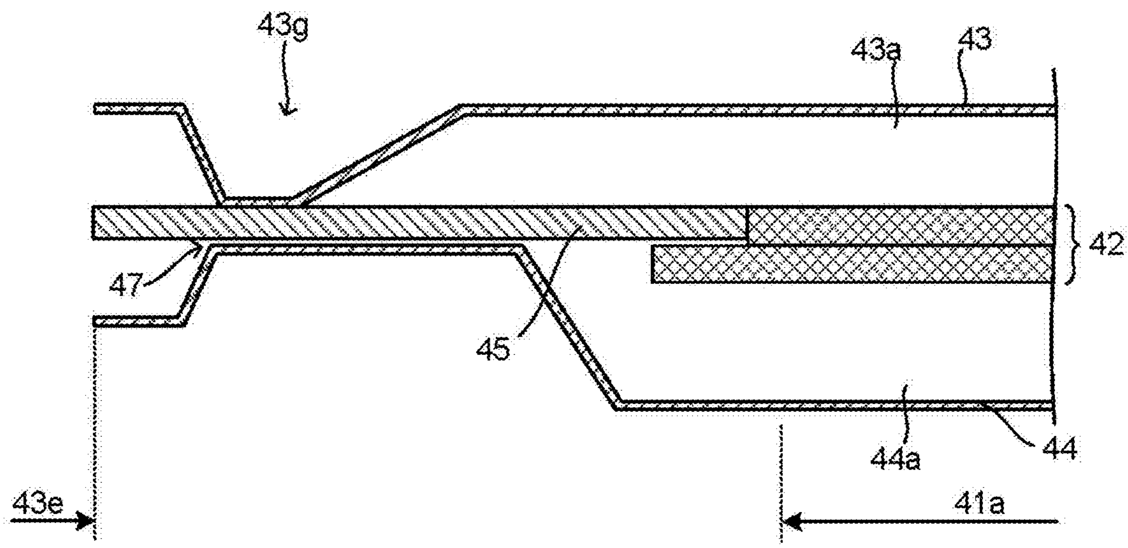


Fig. 13

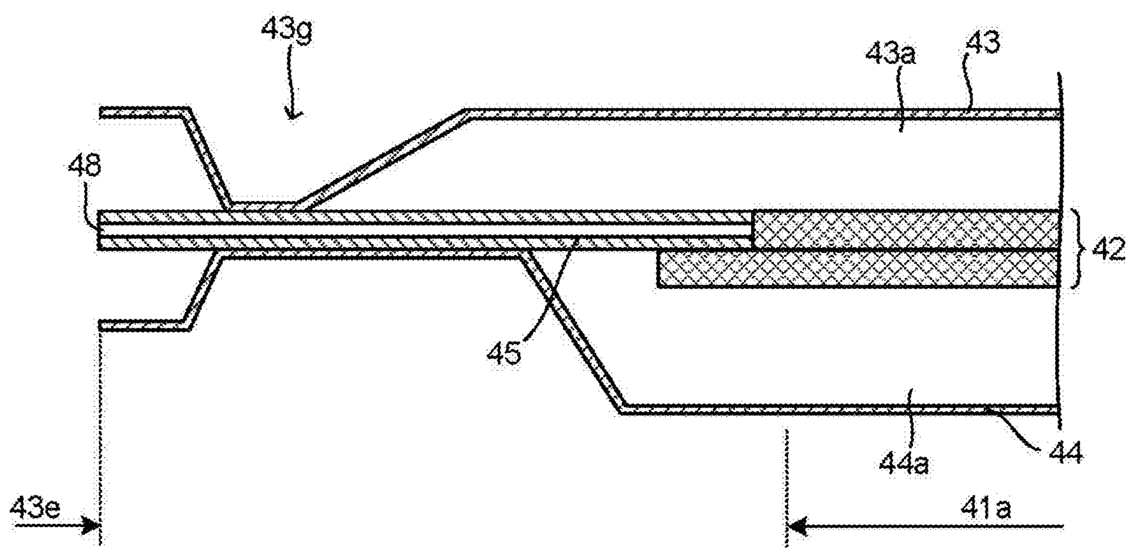


Fig. 14

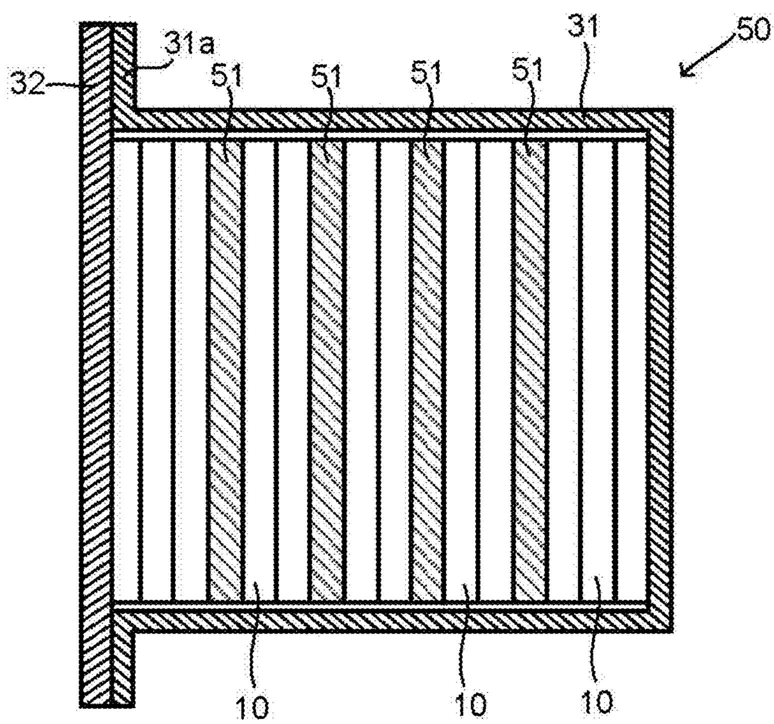


Fig. 15

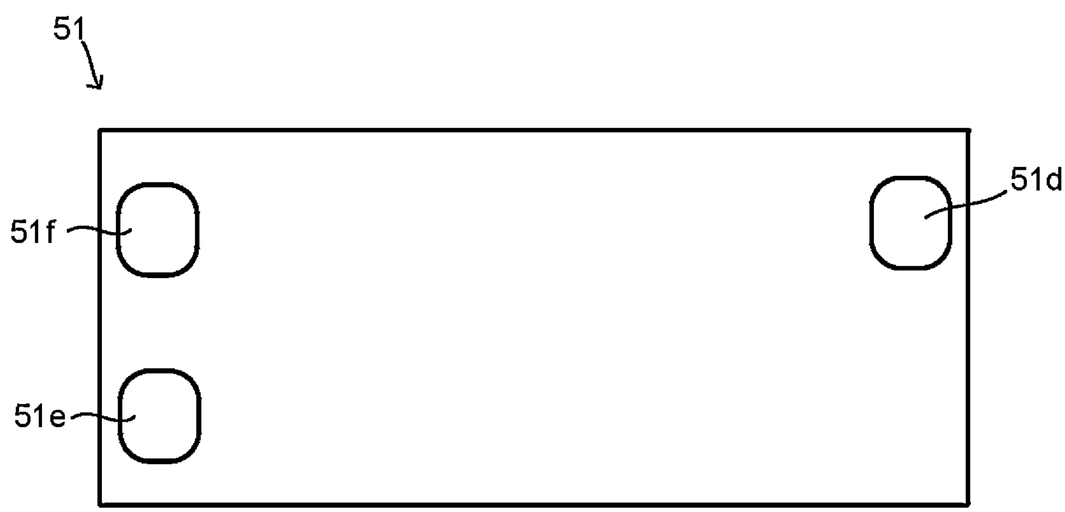
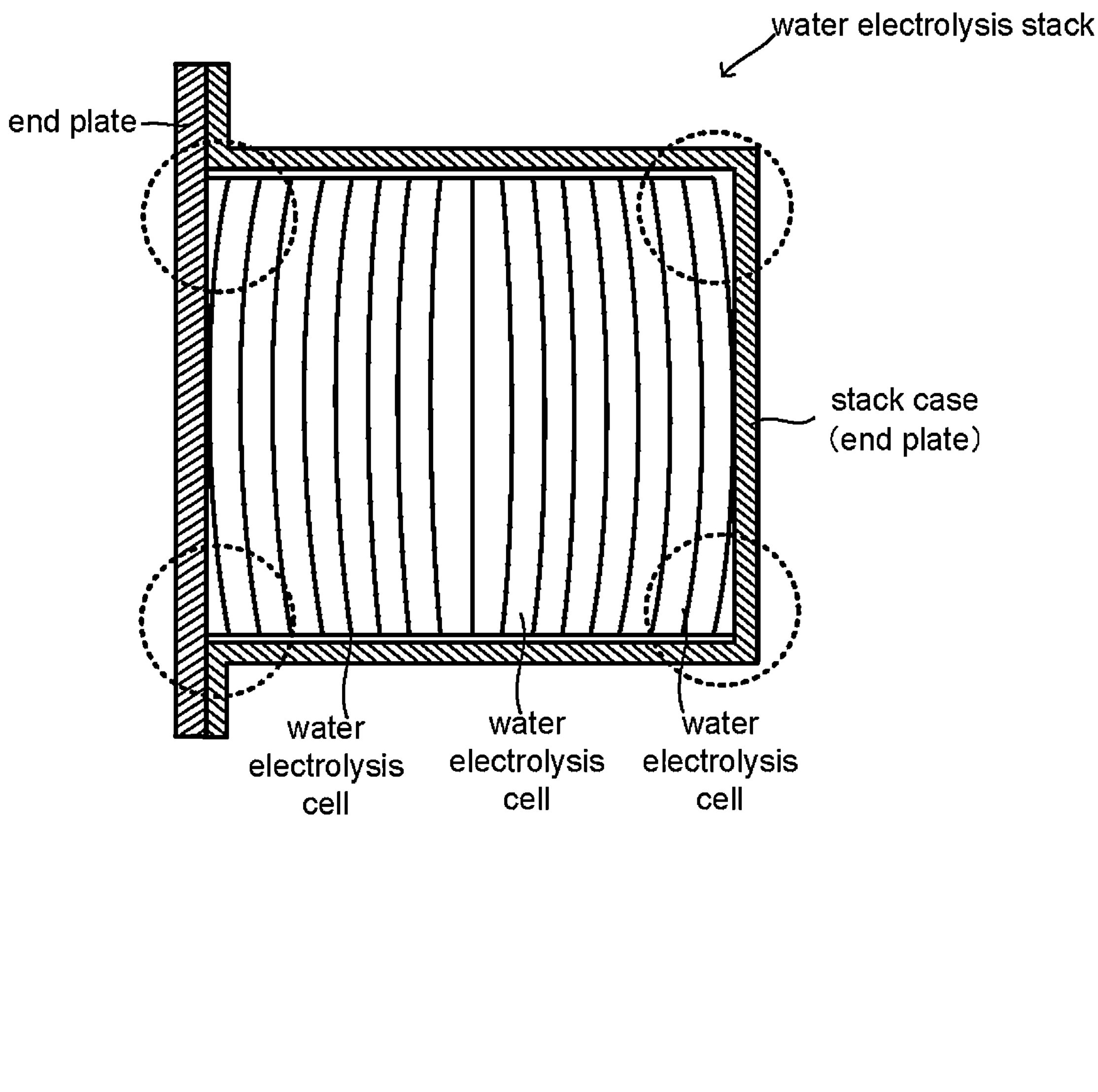


Fig. 16


water electrolysis stack
end plate
stack case
(end plate)
water
electrolysis
cell
water
electrolysis
cell
water
electrolysis
cell

WATER ELECTROLYSIS STACK

FIELD

[0001] The present disclosure relates to a water electrolysis stack in which a water electrolysis cell is laminated.

BACKGROUND

[0002] In Patent Document 1, it is required to supply hydrogen generated by water electrolysis by increasing pressure in a water electrolysis stack, and a high pressure-resistant structure of a seal member at an end portion in a planar direction of a water electrolysis cell is disclosed.

CITATION LIST

Patent Literature

[0003] [Patent Document 1] JP 2019-123906 A

SUMMARY

Technical Problem

[0004] In the water electrolysis stack, with an increase in the internal pressure of the hydrogen electrode, the central portion bulges in a plurality of water electrolysis cells arranged between the end plates as shown in FIG. **16**, warpage increases in the water electrolysis cells arranged on the most end plate side, deformed as surrounded by dotted circles, there is a possibility that the sealing property by the disposed sealing member of this end portion is lowered. Such a decrease in sealability may not sufficiently increase the hydrogen pressure, or may cause hydrogen leakage.

[0005] In view of the above problems, it is an object of the present disclosure to provide a water electrolysis stack capable of suppressing deterioration in sealability.

Solution to Problem

[0006] The present application discloses a water electrolysis stack that is configured by laminating a plurality of water electrolysis cells and generates hydrogen by supplying water to the water electrolysis cells and applying electric power, wherein a laminated member for improving sealing property is laminated at a predetermined position of the water electrolysis cells to be laminated, the laminated member for improving sealing property, which is a member that does not introduce water therein.

[0007] Sealability improving stacking member, the first outer body is the same shape as the anode separator water electrolysis cell comprises, the second outer body is the same shape as the cathode separator water electrolysis cell comprises, a core material disposed between the first outer body and the second outer body, and the first outer body and the second outer body It is disposed between the frame for bonding the first outer body and the second outer body, it may be configured to have a.

[0008] It may be configured to have a communicating hole for communicating the space and the outside between the first outer body and the second outer body.

[0009] The communicating hole may be provided in at least one of the first exterior body or the second exterior body.

[0010] A communicating hole may be provided in the frame.

[0011] A communicating hole may be formed between the first exterior body or the second exterior body and the frame.

[0012] The core material may be composed of the same material as the cathode gas diffusion layer of the water electrolysis cell.

[0013] Sealability improving stacking member may be disposed at an end portion of the laminate by the water electrolysis stack.

[0014] The laminated member for improving the sealing property may be a plate-like member hardly bent than the water electrolysis cell.

[0015] This laminate member for improving sealability may be disposed between a plurality of water electrolysis stacks.

Advantageous Effects

[0016] According to the present disclosure, by the laminated member for improving the sealing property, it is possible to reduce the water electrolysis cell having a large deformation, it is possible to suppress a decrease in the sealing property in the water electrolysis stack.

BRIEF DESCRIPTION OF DRAWINGS

[0017] FIG. **1** is a plan view of the water electrolysis cell **10**.

[0018] FIG. **2** is a conceptual diagram illustrating the layered structure of the water electrolysis cell **10** **10***a* the water electrolysis area.

[0019] FIG. **3** is a conceptual diagram illustrating a layered configuration at a site of an oxygen electrode deriving-side distribution region **10***d* and an oxygen electrode deriving region **10***e* of the water electrolysis cell **10**.

[0020] FIG. **4** is a conceptual diagram illustrating the structure of the water electrolysis stack **30**.

[0021] FIG. **5** is a diagram illustrating a laminated structure of the water electrolysis cell **10** in the water electrolysis stack **30**.

[0022] FIG. **6** is another view illustrating a laminated structure of the water electrolysis cell **10** in the water electrolysis stack **30**.

[0023] FIG. **7** is a conceptual diagram illustrating the structure of the water electrolysis stack **40**.

[0024] FIG. **8** is a view of a plan view of the sealability improving stacking member **41**.

[0025] FIG. **9** is a cross-sectional view of the sealability improving stacking member **41**.

[0026] FIG. **10** is another cross-sectional view of the sealability improving stacking member **41**.

[0027] FIG. **11** is a diagram for explaining a modification **1** of the sealability improving stacking member **41**.

[0028] FIG. **12** is a diagram illustrating a second modification of the stack member **41** for improving the sealability.

[0029] FIG. **13** is a diagram for explaining a third modification of the sealability improving stacking member **41**.

[0030] FIG. **14** is a conceptual diagram illustrating the structure of the water electrolysis stack **50**.

[0031] FIG. **15** is a view of a plan view of the sealability improving stacking member **51**.

[0032] FIG. **16** is a diagram for explaining the warpage of the water electrolysis cell in the water electrolysis stack.

DESCRIPTION OF EMBODIMENTS

1. Basic Configuration of the Water Electrolysis Stack

[0033] The water electrolysis stack of the present disclosure is characterized in that a laminated member for improving sealability is arranged. First, the basic configuration included in the water electrolysis stack is a target in which the laminated member for improving sealing property is arranged. The sealability improving stacking member and the water electrolysis stack this is disposed will be described thereafter.

1.1. Water Electrolysis Cell

[0034] In a water electrolysis stack, a plurality of water electrolysis cells are stacked and form a main part. FIG. **1** shows a diagram illustrating the structure of the water electrolysis cell **10** according to one embodiment. The water electrolysis cell **10** is a unit element for decomposing pure water into hydrogen and oxygen, and a plurality of such water electrolysis cells **10** are laminated to constitute a water electrolysis stack. FIG. **1** is a plan view of the water electrolysis cell **10** (the stacking direction of the plurality of water electrolysis cells **10** in the plane of the paper/front direction). In FIG. **1**, in order to explain the internal structure of the water electrolysis cell **10**, a portion of the internal structure (particularly, the oxygen electrode side) is represented by a dotted line.

[0035] Water electrolysis in the water electrolysis cell **10** is as known, but the outline thereof is as follows.

[0036] Pure water flows into the oxygen electrode introduction area **10***b* from the oxygen electrode introduction hole (oxygen electrode-side inlet manifold) **14***d.* Thereafter, the pure water reaches the water electrolysis region **10***a* after the uniformity of the distribution is enhanced in the oxygen-electrode introduction-side distribution region **10***c,* where water electrolysis is performed. However, water electrolysis may be performed even in the oxygen-electrode introduction-side distribution area **10***c.*

[0037] In the water electrolysis area **10***a,* a portion of pure water is decomposed into oxygen and hydrogen by a water electrolysis membrane electrode assembly to be described later, and is discharged through the respective flow paths. Oxygen generated and residual pure water is collected by the oxygen electrode lead-out flow path **10***e* through the oxygen electrode lead-out side distribution area **10***d* and discharged from the oxygen electrode lead-out hole (oxygen electrode side outlet manifold) **14***e.*

[0038] On the other hand, the generated hydrogen is transferred to the electrode (hydrogen electrode) opposite to the electrode (oxygen electrode) through which pure water flows across the water electrolytic membrane electrode assembly, and is discharged from the hydrogen electrode lead-out hole (hydrogen electrode side outlet manifold) **14***f* through another channel (not shown) Both of the oxygen electrode and the hydrogen electrode are provided in the water electrolysis cell **10**, but other than the water electrolysis area **10***a,* a respective flow path separated from each other is formed so as to be partitioned by a sealing member (not shown) so that the generated hydrogen and oxygen do not mix.

[0039] It is to be noted that, similarly to the unit cell of the fuel cell, another pair of manifolds may be arranged for flowing a fluid between adjacent water electrolysis cells, and it is desirable to flow hydrogen generated here at this time.

[0040] Hereinafter, a configuration of the water electrolysis cell **10** will be described. FIG. **2** is a view for explaining a layered structure in the water electrolysis area **10***a* which is a part of the A-A cross section of FIG. **1** and in which water electrolysis is mainly performed in the water electrolysis cell **10**. FIG. **3** is a B-B cross-section of FIG. **1**, showing a portion of the oxygen electrode lead-out hole (oxygen electrode side outlet manifold) **14***e,* the oxygen electrode lead-out region **10***e,* the oxygen electrode lead-out side distribution region **10***d,* and a layer configuration of a portion of the water electrolysis region **10***a.*

[0041] The water electrolysis cell **10** is composed of a plurality of layers, and one of them becomes an oxygen electrode (anode) and the other becomes a hydrogen electrode (cathode) with the solid polymer electrolyte membrane **11** sandwiched therebetween.

[0042] In the water electrolysis area **10***a,* as shown in FIG. **2**, the anode is laminated in this order from the solid polymer electrolyte membrane **11** side to the anode catalyst layer **12**, the anode gas diffusion layer **13**, and the anode separator **14**. On the other hand, the cathode includes a cathode catalyst layer **15**, a cathode gas diffusion layer **16**, and a cathode separator **17** in this order from the side of the solid polymer electrolyte membrane **11** Here, the water electrolyte membrane electrode assembly means a stack of a solid polymer electrolyte membrane **11**, an anode catalyst layer **12** disposed on an anode side of the solid polymer electrolyte membrane **11**, and a cathode catalyst layer **15** disposed on a cathode side of the solid polymer electrolyte membrane **11** The thickness of the water electrolysis membrane electrode assembly is typically about 0.4 mm, and the thickness of the water electrolysis cell **10** in the water electrolysis area **10***a* is typically about 1.3 mm At both ends of the water electrolysis area **10***a* of the water electrolysis cell **10**, a frame **18** is provided as shown in FIG. **3**.

[0043] First, an embodiment of each layer will be described, and then a layer configuration in each region will be described.

1.1.1. Aspect of Each Layer

[0044] Each layer provided in the water electrolysis cell **10** has, for example, the following aspect. However, the water electrolysis cell of the present disclosure is not limited to the embodiment.

Solid Polymer Electrolyte Membrane

[0045] The solid polymer electrolyte membrane **11** is an embodiment of an electrolyte membrane having proton conductivity. The material (electrolyte) constituting the solid polymer electrolyte membrane **11** in this form is a solid polymer material, and examples thereof include a proton conductive ion exchange membrane formed of a fluorine-based resin, a hydrocarbon-based resin material, or the like. It exhibits good proton conductivity (electrical conductivity) in the wet state. More specific examples thereof include a membrane made of Nafion (Nafion, registered trademark) which is a perfluoro-based electrolyte.

[0046] The thickness of the solid polymer electrolyte membrane **11** is not particularly limited, but is 200 μm or less, preferably 100 μm or less, and more preferably 30 μm or less.

Anode Catalyst Layer

[0047] The anode catalyst layer (oxygen electrode catalyst layer) **12** is a catalyst layer having a catalyst containing at least one or more of a noble metal catalyst such as Pt, Ru, Ir and an oxide thereof. More specific examples of the catalyst include Pt, iridium oxide, ruthenium oxide, iridium ruthenium oxide, or mixtures thereof.

[0048] Examples of the iridium oxide include iridium oxide (IrO_2, IrO_3), iridium tin oxide, and iridium zirconium oxide.

[0049] Examples of the ruthenium oxide include ruthenium oxide (RuO_2, Ru_2O_3), ruthenium tantalum oxide, ruthenium zirconium oxide, ruthenium titanium oxide, and ruthenium titanium cerium oxide.

[0050] Examples of the iridium ruthenium oxide include iridium ruthenium cobalt oxide, iridium ruthenium tin oxide, iridium ruthenium iron oxide, and iridium ruthenium nickel oxide.

[0051] The anode catalyst layer **12** may include an ionomer. In addition to improving coatability by including an ionomer, transmission of water supplied during water splitting can be smoothly performed due to its hydrophilicity. Examples of the ionomer to be included include an ionomer containing a perfluoro electrolyte which is an electrolyte used in a solid polymer electrolyte membrane.

Anode Gas Diffusion Layer

[0052] The anode gas diffusion layer **13** is a gas diffusion layer disposed on the anode side, it is possible to use known ones, is constituted by a member having a gas permeability and conductivity. Specific examples thereof include a porous conductive member made of a sintered body such as metal fibers (e.g., titanium fibers) or metal particles (titanium particles)

Anode Separator

[0053] The anode separator **14** is a member (separator) including a channel (water supply channel) **14*a*** through which pure water, decomposed oxygen, and residual water to be supplied to the anode gas diffusion layer **13** flow. The anode separator **14** in this embodiment is a member unevenness is repeated to form a plate-like member in the water electrolysis area **10*a*** is arranged in contact with the anode gas diffusion layer **13** recess **14*c*,** the anode gas diffusion layer **13** and the convex portion between **14*b*** water supply flow path **14*a*** is formed.

[0054] Anode separator **14** can be made by, for example, press molding a titanium thin film, the plate thickness is typically 0.1 mm~0.2 mm, the height of the unevens is typically 0.5 mm degree.

[0055] Further, the anode separator **14**, as shown in FIG. **1** and described above, the oxygen electrode side inlet manifold **14*d*** is an inlet of pure water, the oxygen electrode side outlet manifold **14*e*** is a discharge port of oxygen and remaining water generated, and the hydrogen electrode side outlet manifold **14*f*** is a discharge port of hydrogen and accompanying water generated is provided.

[0056] Further, as shown in FIG. **3**, the anode separator **14** of the present embodiment, the oxygen electrode lead-out area **10*e*,** the squeezed portion **14*g*** is provided so as to be convex toward the cathode separator **17**.

[0057] In addition, in the present embodiment, a groove may be provided on a surface of the anode separator **14** which becomes the cathode separator **17** side in the oxygen electrode lead-out side distribution region **10*d*** and the oxygen electrode lead-out region **10*e*** successive thereto.

[0058] In addition, in the front and back of the anode separator **14**, a conductive layer may be provided at a portion corresponding to the water-electrolyzed region **10*a*** in order to reduce the electric contactresistance. The material constituting the conductive layer may be any material having conductivity, and examples thereof include platinum.

Cathode Catalyst Layer

[0059] The cathode catalyst layer **15** is a catalyst layer containing a catalyst, and a catalyst contained in the cathode catalyst layer **15** may be a known catalyst, and examples thereof include platinum, platinum coated titanium, platinum supported carbon, palladium supported carbon, cobalt trioxime, and nickel glyoxime.

[0060] The cathode catalyst layer **15** may include an ionomer. By including an ionomer, coatability can be improved. Examples of the ionomer to be included include an ionomer comprising a perfluoro electrolyte which is an electrolyte used in a solid polymer electrolyte membrane.

Cathode Gas Diffusion Layer

[0061] Cathode gas diffusion layer **16** is a gas diffusion layer disposed on the cathode side, it is possible to use known ones, is constituted by a member having a gas permeability and conductivity. Specific examples thereof include porous members such as carbon cloth and carbon paper.

Cathode Separator

[0062] The cathode separator **17** is a member including a channel **17*a*** through which hydrogen ions generated by reduction of hydrogen ions and water (accompanying water) accompanying the hydrogen ions permeate through the solid polymer electrolyte membrane **11** reach. Cathode separator **17** in this embodiment is a member unevenness is repeated to form a plate-like member in the water-electrolysis area **10*a*** is placed in contact with the cathode gas diffusion layer **16**, the cathode gas diffusion layer **16** and the convex portion **17*b*** flow path **17*a*** for hydrogen discharge is formed between.

[0063] The cathode separator **17** can be manufactured, for example, by press-molding a titanium thin film, and the plate thickness thereof is typically 0.1 mm~0.2 mm, and the height of the unevenness is typically about 0.5 mm

[0064] Further, the cathode separator **17**, as shown in FIG. **1** and described above, the oxygen electrode side inlet manifold overlapping the oxygen electrode side inlet manifold **14*d*** (not shown), the oxygen electrode side outlet manifold overlapping the oxygen electrode side outlet manifold **14*e*** described above (not shown), and the hydrogen electrode side outlet manifold overlapping the hydrogen electrode side outlet manifold **14*f*** (not shown) is provided.

[0065] Among the front and back surfaces of the cathode separator **17**, a conductive layer may be provided at a portion corresponding to the water-electrolyzed region **10*a*** in order to reduce the electric contactresistance. The material constituting the conductive layer may be any material having conductivity, and examples thereof include platinum.

Frame

[0066] Frame **18** is disposed between the anode separator **14** and the cathode separator **17** in the outer peripheral portion of the water electrolysis cell **10** to seal the inside, and functions as a sealing member for sealing so as to form a required flow path by separating the oxygen electrode side and the hydrogen electrode side.

[0067] Accordingly, the frame **18** surrounds the water electrolysis region **10***a*, the oxygen electrode introduction region **10***b*, the oxygen electrode introduction side dispersion region **10***c*, the oxygen electrode derivation side dispersion region **10***d*, the oxygen electrode derivation region **10***e*, and the like, and is disposed so as to be sandwiched between the anode separator **14** and the cathode separator **17**

[0068] Frame **18**, for example, in the cross-section of FIG. **3**, from the water supply flow path **14***a* of the anode separator **14** oxygen electrode leading side distribution region **10***d*, since flowing oxygen and residual water generated in the oxygen electrode side outlet manifold **14***e* through the oxygen electrode leading region **10***e* is not sealed in the part. On the other hand, in the cross-section of FIG. **3**, the flow of hydrogen from the flow path **17***a* of the cathode separator **17** to the oxygen-electrode-side inlet manifold **14***e* is sealed so as to be blocked. Thus, the frame **18** is adjusted in contact (seal) with the anode separator **14** and cathode separator **17** so that the fluid flow is adequate.

[0069] The frame **18** is made of a thermoplastic resin material having electrical insulation and airtightness and having a relatively high melting point. Such materials may include engineering plastics. Examples of the engineering plastic include a polyethylene naphthalate-based resin (PEN), a polyphenylene sulfide resin (PPS), and a polyphenylsulfone resin (PPSU)

[0070] The thickness of the frame is not particularly limited, but is preferably 0.05 mm or more and 0.25 mm or less.

[0071] An adhesive is disposed on the front and rear sides of the frame **18**, and a portion of the anode separator **14** and a portion of the cathode separator **17** in contact therewith are bonded thereto.

1.1.2. Layer Configuration in the Water Electrolysis Region

[0072] As shown in FIG. **2**, the layer structure of the water electrolysis area **10***a* is such that the anode is laminated in this order from the side of the solid polymer electrolyte membrane **11** to the anode catalyst layer **12**, the anode gas diffusing layer **13**, and the anode separator **14**. On the other hand, the cathode includes a cathode catalyst layer **15**, a cathode gas diffusion layer **16**, and a cathode separator **17** in this order from the side of the solid polymer electrolyte membrane **11**

[0073] The anode separator **14** includes a channel (water supply channel) **14***a* through which pure water and decomposed oxygen are supplied to the anode gas diffusion layer **13** In this embodiment, the anode separator **14** forms a plate-like member in a wavy shape in the water electrolysis area **10***a* and unevens are repeated, by the recess **14***c* is disposed in contact with the anode gas diffusion layer **13**, the anode gas diffusion layer **13** and the water supply flow path **14***a* is formed between the convex portion **14***b*.

[0074] The cathode separator **17** includes a channel **17***a* in which hydrogen ions generated by reduction of hydrogen ions and water (accompanying water) accompanying the hydrogen ions reach when the hydrogen ions permeate through the solid polymer electrolyte membrane **11**, and in the present embodiment, the cathode separator **17** forms a plate-like member in the water electrolysis region **10***a* in a wavy manner, and unevens are repeated, and the concave **17***c* is disposed in contact with the cathode gas diffusion layer **16** to form a channel **17***a* for hydrogen discharge between the cathode gas diffusion layer **16** and the convex portion **17***b*

1.1.3. Composition of Other Regions

[0075] Other regions include an oxygen electrode introduction region **10***b*, an oxygen electrode introduction side distribution region **10***c*, an oxygen electrode derivation side distribution region **10***d*, an oxygen electrode derivation region **10***e*, a hydrogen electrode derivation side distribution region (not shown), and a hydrogen electrode derivation region. The oxygen electrode deriving-side distribution region **10***d* and the oxygen electrode deriving region **10***e* shown in FIGS. **1** and **3** will be exemplified here.

[0076] The oxygen electrode derivation side distribution region **10***d* and the oxygen electrode derivation region **10***e* are regions through which oxygen and residual water generated in the water electrolysis region **10***a* pass by the time they are discharged into the oxygen electrode side outlet manifold **14***e*.

[0077] In the oxygen electrode deriving-side distribution area **10***d*, as can be seen from FIG. **3**, the solid polymer electrolyte membrane **11**, the anode catalyst layer **12**, the anode gas diffusion layer **13**, the cathode catalyst layer **15**, and the end face of the cathode gas diffusion layer **16** are formed. Here, the end face of the anode gas diffusion layer **13** is formed at a position slightly retracted compared to the other end face. Then, it is laminated to the anode catalyst layer **12**, the frame **18** is disposed so as to extend from the end face of the anode gas diffusion layer **13**. The frame **18** is provided to extend into the oxygen electrode lead-out area **10***e* and to the oxygen electrode outlet manifold **14***e*. Further, the cathode separator **17** in the oxygen-electrode lead-side distribution area **10***d* is bent in the thickness direction (stacking direction of each layer) until it contacts the surface of the frame **18**, the hydrogen-electrode side is sealed.

[0078] In the oxygen-electrode lead-out area **10***e*, the diaphragm **14***g* is formed so that the anode separator **14** is bent so as to approach the frame **18**, and the flow passage is narrowed in the thickness direction. However, there is formed a flow path leading to the oxygen electrode outlet manifold **14***e* with a predetermined spacing since the generated oxygen and residual water needs to flow.

[0079] Although the oxygen electrode introduction region **10***b* and the oxygen electrode introduction side distribution region **10***c* differ in the direction in which the fluid flows, the oxygen electrode introduction region **10***b* can be considered similarly to the oxygen electrode lead-out region **10***e*, and the oxygen electrode introduction side distribution region **10***c* can be considered similarly to the oxygen electrode lead-out side distribution region **10***d*.

[0080] The hydrogen electrode deriving side distribution region and the hydrogen electrode deriving region are regions in which a flow path is formed for guiding hydrogen and accompanying water generated on the hydrogen electrode side from the water electrolysis region **10***a* to the hydrogen side outlet manifold **14***f*The configuration of these regions, the oxygen electrode lead-out side distribution region **10***d* form above, and the configuration of the oxygen electrode lead-out region **10***e* may be applied to the hydrogen electrode side.

1.1.4. Action, Etc.

[0081] According to the water electrolysis cell **10**, for example, it acts as follows. When pure water is supplied from the oxygen electrode side inlet manifold **14***d*, pure water reaches the water electrolysis region **10***a* through the oxygen electrode introduction region **10***b* and the oxygen electrode introduction side distribution region **10***c* In the water electrolysis area **10***a*, pure water (H_2O) supplied from the water supply channel **14***a* to the anode (oxygen generation electrode) is decomposed into oxygen, electrons and protons (H+) in the anode catalyst layer **12** having a potential by energizing between the anode and the cathode. At this time, protons pass through the solid polymer electrolyte membrane **11** and move to the cathode catalyst layer **15** On the other hand, electronics separated by the anode catalyst layer **12** pass through an external circuit and reach the cathode catalyst layer **15** Then, protons receive electronics in the cathode catalyst layer **15**, hydrogen (H_2) is generated, and reaches the cathode gas diffusing layer **16** Incidentally, in the cathode gas diffusion layer **16** accompanied water is present together with the generated hydrogen gas.

[0082] Hydrogen gases and associated water present in the cathode gas diffusion **16** reaches the cathode separator **17**, flows through the flow path **17***a* and is discharged from the hydrogen electrode outlet side distribution region (not shown) and the hydrogen electrode outlet manifold **14***f* (hydrogen electrode outlet hole) through the hydrogen electrode outlet region.

[0083] On the other hand, the oxygen generated in the anode catalyst layer **12** and the unused residual water return to the anode separator **14** and are discharged from the oxygen electrode outlet manifold **14***e* through the hydrogen supply channel **14***a* through the oxygen electrode lead-side distribution region **10***d* and the oxygen electrode lead-out region **10***e*.

1.2. Water Electrolysis Stack

[0084] The water electrolysis stack **30** is a member formed by stacking a plurality of (about 50 sheets to about 400 sheets) of the above-described water electrolysis cells **10**, and energizes the plurality of water electrolysis cells **10** to generate hydrogen and oxygen. FIG. **4** shows the outline of the structure. The water electrolysis cell **30** includes a stack case **31**, an end plate **32**, and a plurality of water electrolysis cells **10**

[0085] Stack case **31**, a plurality of water electrolysis cells **10** stacked, and a housing for housing the biasing member **33** inside. Stack case **31** in the present embodiment is open at one end in a rectangular tubular shape, together with the other end is closed, the plate-shaped piece on the opposite side to the opening along the edge of the opening overhangs, to form a flanged **31***a*.

[0086] End plate **32** is a plate-like member, closes the opening of the stack case **31**, and has a manifold connecting portion of the oxygen-hydrogen outlet portion. End plate **32** so as to cover the stack case **31** by bolts and nuts or the like overlapping part of the flanged **31***a* of the stack case **31** is fixed to the stack case **31**.

[0087] Incidentally, a plurality of water electrolysis cells **10** stacked are sandwiched between the end plate **32** and the stack case **31** from both ends in the stacking direction. The portion disposed in the stacking direction end portion of the water electrolysis cell of the stack case also functions as an end plate, the laminate of the plurality of water electrolysis cells **10** according to this will be sandwiched by the stacking direction both ends by the end plate.

[0088] The water electrolysis cell **10** is as described above. A plurality of such water electrolysis cells **10** are overlapped. Here, in this form, as can be seen from FIG. **4**, the water electrolysis cell **10** is configured to be overlapped horizontally, the water electrolysis cell **10** is arranged so that the direction in which the water supply flow path **14***a* are aligned and the direction in which the flow path **17***a* are aligned are the vertical direction as shown in FIG. **1**.

[0089] In addition, a flow path for supplying water is formed by overlapping the oxygen electrode side inlet manifold **14***d* of the respective water electrolysis cells, and a flow path for discharging oxygen and residual water is formed by overlapping the oxygen electrode side outlet manifold **14***e*, and a flow path for discharging hydrogen and accompanying water is formed by overlapping the hydrogen electrode side outlet manifold **14***f*.

[0090] A biasing member (not shown) for pressing the laminate of the water electrolysis cell in the stacking direction as required may be provided. The biasing member fits inside the stack case **31** and imparts a pressing force to the stack of water electrolysis cells **10** in the stacking direction thereof. Examples of the biasing member may include a dish spring.

2.2. Stacking Structure of the Water Electrolysis Cell

[0091] As described above, in the water electrolysis stack **30**, a plurality of water electrolysis cells **10** are laminated. In FIG. **5**, three of the laminated water electrolysis cells **10** were extracted to represent a cross section of a part of the water electrolysis area **10***a*. In FIG. **6**, three of the laminated water electrolysis cell was extracted to represent a section of a portion of the end portion (the oxygen electrode leading-side distribution region **10***d*, and the site **10***e* the oxygen electrode leading-out region).

[0092] As can be seen from FIGS. **5** and **6**, when the water electrolysis cell **10** is stacked, the cathode separator **17** of one water electrolysis cell **10** and the anode separator **14** of the other water electrolysis cell **10** overlap each other in the adjacent water electrolysis cell **10** More specifically, the convex **17***b* of the cathode separator **17** of one water electrolysis cell **10** and the convex **14***b* of the anode separator **14** of the other water electrolysis cell **10** are contacted and overlapped with each other.

[0093] Further, as can be seen from FIG. **6**, the intercell sealing member **33** is disposed between the adjacent water electrolysis cells **10** among the ends of the water electrolysis cells **10** (the squeezed portion **14***g* in the present embodiment). This intercellular sealing member **33** seals to prevent leakage of fluid from the manifolds described above.

2. Water Electrolysis Stack of the Present Disclosure

2.1. Form 1

[0094] FIG. **7**, a diagram illustrating a water electrolysis stack **40**, which is an example of one form according to the water electrolysis stack of the present disclosure, is shown. FIG. **7** is a view from the same viewpoint as in FIG. **4**. Water electrolysis stack **40** according to the first embodiment as can be seen from FIG. **7**, in addition to the water electrolysis stack **30**, the sealability improving stacking member **41** to each of the stacking direction end portion of the plurality of water electrolysis cells **10** are stacked one or more. Water electrolysis stack **40**, except for the sealability improving stacking member **41** can be considered the same manner as the water electrolysis stack **30** will not be described with the same reference numerals here.

[0095] FIG. **8** to **10** shows a diagram for explaining the configuration of the sealability improving stacking member **41** included in the present embodiment. FIG. **8** is a plan view of the lamination member **41** for improving the sealability (the stacking direction of the water electrolysis cell **10** is viewed from the direction of the paper surface back/front). FIG. **9** is a cross section of the site shown in C-C in FIG. **8**. FIG. **10** is a cross section of the site shown in D-D in FIG. **8**. As can be seen from FIG. **8** to FIG. **10**, the laminate member **41** for improving sealability in the present embodiment has a form similar to the water electrolysis cell **10** described above, and the outer shape thereof is generally the same as the water electrolysis cell **10**. However, the sealability improving stacking member **41** is not intended to water electrolysis here, the supply water on the inner side is configured so as not to flow.

[0096] Sealability improving stacking member **41** is made of a plurality of layers, the core member **42**, the first outer plate **43**, the second outer plate **44**, and has a frame **45**.

2.1.1. Aspect of Each Layer

[0097] Each layer provided in the laminate member **41** for improving sealability has, for example, the following aspect.

Core Material

[0098] Core member **42** is disposed between the first cover **43** and the second cover **44**, a plate-shaped member serving as the core of the sealability improving stacking member **41**. The material constituting the core material **42** is not particularly limited as long as it has conductivity and has a strength and cushioning property of a certain degree or more. In this form, the cathode gas diffusion layer **16** described above from these viewpoints is laminated so as to be a 2 layer.

[0099] The thickness of the core material **42** is preferable about the same thickness as the stack disposed between the anode separator **14** and the cathode separator **17** in the water electrolysis cell **10** from the viewpoint of transmission of conductivity and load.

First Outer Body

[0100] The first exterior body **43** is a plate-like member having a form similar to that of the anode separator **14** described above. Therefore, the first exterior body **43** in the present embodiment is a member unevens are repeated by forming a plate-like member in a wavy shape in the region **41***a* where the core material **42** is disposed, the recess **43***c* is disposed in contact with the core material **42**, a cavity **43***a* is formed between the core material **42** and the convex portion **43***b*.

[0101] The first exterior body **43** can be manufactured by press-molding, for example, a titanium-thin film in the same manner as the anode separator **14**, and the plate thickness thereof can be made 0.1 mm~0.2 mm, and the height of the unevenness can be about 0.5 mm.

[0102] Further, the first exterior body **43**, the first hole **43***d* corresponding to the oxygen electrode side inlet manifold **14***d* described above, the second hole **43***e* corresponding to the oxygen electrode side outlet manifold **14***e,* and the third hole **43***f* corresponding to the hydrogen electrode side outlet manifold **14***f* is provided. These holes, when the sealing property improving stack member **41** is laminated in the water electrolysis cell **10** overlaps the corresponding manifold.

[0103] Further, as shown in FIG. **10**, the first exterior body **43** in this form, the squeezed portion **43***g* is provided so as to be convex toward the frame **45**.

[0104] In addition, in the laminated member **41** for improving sealability, there is no intention of causing water electrolysis here as described above, and since water does not need to be supplied to the inside thereof, there is no region corresponding to the oxygen electrode lead-out side distribution region **10***d* and the oxygen electrode lead-out region **10***e* consecutive thereto, which is provided in the anode separator **14**, and is sealed so as to be in contact with the frame **45**.

Second Outer Body

[0105] The second exterior body **44** is a plate-like member having the same form as the cathode separator **17** described above. Therefore, the second exterior body **44** in the present embodiment is a member unevens are repeated by forming a plate-like member in a wavy shape in the region **41***a* in which the core material **42** is disposed, the recess **44***c* is disposed in contact with the core material **42**, a cavity **44***a* is formed between the core material **42** and the convex portion **44***b*.

[0106] The second exterior body **43**, for example, can be produced by press-molding a titanium thin film in the same manner as the anode separator **14**, the plate thickness can be 0.1 mm~0.2 mm, the height of the unevens can be about 0.5 mm.

[0107] Also, the second exterior body **43**, the first hole corresponding to the oxygen electrode side inlet manifold **14***d* described above, the second hole corresponding to the oxygen electrode side outlet manifold **14***e,* and the third hole corresponding to the hydrogen electrode side outlet manifold **14***f* (both not shown) is provided. These holes, when the sealing property improving stack member **41** is laminated in the water electrolysis cell **10** overlaps the corresponding manifold.

[0108] In addition, in the laminated member **41** for improving sealability, there is no intention of causing water electrolysis here as described above, and since it is not necessary to supply water to the inside thereof, there is no hydrogen electrode lead-out side distribution region (not shown) and a hydrogen electrode lead-out region (not shown) continuous therewith, which is provided in the cathode separator **17**, and is sealed so as to be in contact with the frame **45**

Frame

[0109] Frame **45** functions as a sealing member for sealing the inner is disposed between the first cover **43** and the second cover **44** in the outer peripheral portion of the sealability improving stacking member **41**.

[0110] Accordingly, the frame **45** is disposed and bonded so as to be sandwiched between the first cover **43** and the second cover **44** at the outer peripheral portion of the laminate member **41** for improving sealability.

[0111] Frame **45**, for example, in the cross section of FIG. **10**, between the second hole **43***e* from the region **41***a* core **42** is disposed, the first exterior body **43** is in contact with one surface, the second exterior body **44** is in contact with the other surface, sealed.

[0112] The frame **45** is made of a thermoplastic resin material having electrical insulation and airtightness and having a relatively high melting point. Such materials may include engineering plastics. Examples of the engineering plastic include a polyethylene naphthalate-based resin (PEN), a polyphenylene sulfide resin (PPS), and a polyphenylsulfone resin (PPSU)

[0113] The thickness of the frame is not particularly limited, but is preferably 0.05 mm or more and 0.25 mm or less.

[0114] Frame **45** has an adhesive disposed on the front and back thereof, it is adhered to the portion of the first cover **43** and the second cover **44** in contact therewith.

2.1.2. Layer Configuration of the Region in Which the Core Material is Disposed

[0115] Layered configuration of the region **41***a* in which the core member **42** is disposed, as shown in FIG. **9**, the first cover **43** on one surface of the core member **42**, the second cover **44** is disposed on the other surface. Then, a cavity **43***a* is formed between the first exterior body **43** and the core material **42**, and a cavity **44***a* is formed between the second exterior body **44** and the core material **42**.

2.1.3. Composition of Other Regions

[0116] In other regions, since the laminate member **41** for improving sealability is not intended to perform water electrolysis on the inside thereof as described above, since it is not necessary to supply water to the inside, as shown in FIG. **10**, the first exterior body **43** and the second exterior body **44** are sealed in contact with the frame **45**.

2.1.4. Effect, Etc.

[0117] According to the water electrolysis stack **40** provided with the laminated member **41** for improving the sealing property as described above, as described with reference to FIG. **16**, the central portion bulges in a plurality of water electrolysis cells disposed between the end plates, warpage is increased in the water electrolysis cell disposed most end plate side, the sealing property disposed at the end there is a possibility that is reduced. In contrast, in the laminated member **41** for sealing property improvement, which is not intended for water electrolysis and water for water electrolysis is not supplied, if replacing the site having the largest warpage, the water electrolysis cell having a large deformation (warpage) can be reduced, it is possible to suppress a decrease in sealability in the water electrolysis stack. Since it is possible to suppress the decrease in sealability, it is possible to suppress the occurrence of leakage and also to increase the hydrogen pressure.

[0118] In the above, the laminated member **41** for improving sealability one by one is disposed at both ends in the stacking direction of the water electrolysis cell **10**, but the present invention is not limited thereto, and any one of them may be used, or 3 or more laminated members **41** for improving sealability may be disposed. In this case, since the warpage becomes larger as the side closer to the end plate as described above, it is preferable to dispose the laminated member **41** for improving the sealing property at a portion close to the end plate.

2.1.5. Modification

[0119] A modification will be described below. Since it is a modification of the form of the stack member **41** for improving the sealing property, only described laminated member **41** for improving the sealing property, the description of the other members will be omitted.

[0120] In the stack member **41** for improving sealability, since the inside thereof is sealed by the frame **45** as described above, a gas sealed in the inner **14***a* or the cavity **17***a* may expand due to a load or heat, and a load may be applied to the laminated member **41** for improving sealability at that pressure. Therefore, in a modification, the cavity **14***a* and the cavity **17***a* is provided with a communicating hole communicating with the outside. The communicating holes allow the gas to escape from the cavity **14***a* and the cavity **17***a* to reduce the pressure (burden).

[0121] FIG. **11** is a diagram showing a modification **1**. In this modification, a notch **46** is provided in at least one of the first exterior body and the second exterior body as a communicating hole in the area **41***a* in which the core material is disposed, and the cavity **14***a* and the cavity **17***a* and the outside are communicated with each other via the notch **46**

[0122] FIG. **12** is a diagram showing a modification 2. In this modification, a portion **47** which does not adhere the frame **45** and the second exterior body **44** at a portion of the surface of the frame **45** which is in contact with the second exterior body **44** is provided. This non-adhesive portion **47** functions as a communicating hole, and communicates the cavity **14***a*, the cavity **17***a*, and the outside.

[0123] Although a communicating hole formed between the frame **45** and the second exterior body **44** has been described here, a communicating hole may be formed between the frame and the first exterior body in accordance with (or instead of) this.

[0124] FIG. **13** is a diagram showing a modification 3. In this modification, a hole **48** for communicating the inside and outside of the sealability improving stacking member **41** in a part of the frame **45**. This hole **48** functions as a communicating hole, and communicates the cavity **14***a*, the cavity **17***a*, and the outside.

2.2. Form 2

[0125] FIG. **14** illustrates a diagram illustrating a water electrolysis stack **50**, which is an example of one form according to the water electrolysis stack of the present disclosure. **14** is a view from the same viewpoint as in FIG. As can be seen from FIG. **14**, in the water electrolysis stack **50** according to Form **2**, in addition to the water electrolysis stack **30**, a laminated member **51** for improving sealability is laminated between a plurality of water electrolysis cells **10** Water electrolysis stack **50**, except for the sealability improving stacking member **51** can be considered the same manner as the water electrolysis stack **30** will not be described with the same reference numerals here.

[0126] FIG. **15** shows a diagram for explaining the configuration of the sealability improving stacking member **51** included in the present embodiment. FIG. **15** is a plan view of the lamination member **51** for improving the sealability (the stacking direction of the water electrolysis cell **10** is viewed from the direction of the paper surface back/front). The sealability improving stacking member **51** in this form is a plate-like member.

[0127] The tabular material constituting the laminated member **51** for improving sealability has conductivity, and is not particularly limited as long as it is a material which is harder to bend than the water electrolysis cell, and examples thereof include stainless steel. Although there is no particular limitation on the plate thickness thereof, it is preferable to have the same level as that of the water electrolysis cell **10**, and examples thereof include 0.8 mm or more and 1.5 mm or less. The bending difficulty can be contrasted by the bending test.

[0128] In addition, the laminated member **51** for improving sealability is provided with a first hole **41***d* corresponding to the oxygen electrode side inlet manifold **14***d* described above, a second hole **51***e* corresponding to the oxygen electrode side outlet manifold **14***e*, and a third hole **51***f* corresponding to the hydrogen electrode side outlet manifold **14***f* These holes, when the sealing property improving stack member **51** is laminated in the water electrolysis cell **10** overlaps the corresponding manifold.

[0129] Although there is no particular limitation on the number and position of the stack members **51** for improving sealability to be arranged, it is preferable that a plurality of laminated members **51** for improving sealability are arranged at predetermined intervals.

[0130] According to the water electrolysis stack **50** provided with the laminated member **51** for improving the sealing property as described above, as described with reference to FIG. **16**, the central portion bulges in a plurality of water electrolysis cells disposed between the end plates, warpage is increased in the water electrolysis cells disposed most end plate side, the end there is a possibility that the disposed sealing property is lowered. In contrast, by the laminated member **51** for improving the sealing property is not intended for water electrolysis, hardly deformed (strength, high rigidity) water for water electrolysis is not supplied, deformation (warpage) is large water electrolysis cell it is possible to reduce, it is possible to suppress a decrease in sealing property in the water electrolysis stack. Since it is possible to suppress the decrease in sealability, it is possible to suppress the occurrence of leakage, and it is also possible to mention the hydrogen pressure.

REFERENCE SIGNS LIST

[0131] **10** . . . Water electrolysis cell, **10***a* . . . electrode oxygen inlet region, **10***b* . . . electrode oxygen inlet side distribution region, **10***d* . . . electrode oxygen outlet side distribution region, **10***e* . . . electrode oxygen outlet region, **11** . . . solid polymer electrolyte membrane, **12** . . . anode catalyst layer, **13** . . . anode gas diffusion layer (oxygen electrode gas diffusion layer), **14** . . . anode separator (oxygen electrode separator), **14***a* . . . supply flow path, **14***d* . . . oxygen electrode side inlet manifold (oxygen electrode outlet hole), **14***f* . . . hydrogen electrode side outlet manifold (hydrogen electrode outlet hole), **15** . . . cathode catalyst layer, **16** . . . cathode gas diffusion layer (hydrogen electrode gas diffusion layer), **17** . . . cathode separator (hydrogen electrode separator), **18** . . . frame, **30**, **40**, **50** . . . water electrolysis stack, **41**, **51** . . . laminated member for improving the sealing property

1. A water electrolysis stack configured by stacking a plurality of water electrolysis cells to generate hydrogen by supplying water and electric power to the water electrolysis cells, the water electrolysis stack comprising:
- a sealability improving stacking member stacked on a predetermined location on or in the stacked water electrolysis cells, the water being not introduced into the sealability improving stacking member.

2. The water electrolysis stack according to claim **1**, wherein
- the sealability improving stacking member comprises:
  - a first cover having the same shape as an anode separator included in the water electrolysis cells;
  - a second cover having the same shape as a cathode separator included in the water electrolysis cells;
  - a core material disposed between the first and second covers; and
  - a frame disposed between the first and second covers, the frame adhering the first and second covers.

3. The water electrolysis stack according to claim **2**, comprising:
- a communicating hole allowing a space between the first and second covers, and an outside to communicate.

4. The water electrolysis stack according to claim **3**, wherein
- the communicating hole is provided in at least one of the first and second covers.

5. The water electrolysis stack according to claim **3**, wherein
- the communicating hole is provided in the frame.

6. The water electrolysis stack according to claim **3**, wherein
- the communicating hole is formed between the first or second cover, and the frame.

7. The water electrolysis stack according to claim **2**, wherein
- the core material is made of the same material as a cathode gas diffusion layer of the water electrolysis cells.

8. The water electrolysis stack according to claim **1**, wherein
- the sealability improving stacking member is disposed on an end portion of a stack formed of the water electrolysis cells.

9. The water electrolysis stack according to claim **1**, wherein
- the sealability improving stacking member is a plate-like member that is more difficult to bend than the water electrolysis cells.

10. The water electrolysis stack according to claim **9**, wherein
- a plurality of the sealability improving stacking members are disposed between a plurality of the water electrolysis cells.

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