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(54) FUEL CELL MANUFACTURING DEVICE AND MANUFACTURING METHOD

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(57) **ABSTRACT**

A fuel cell manufacturing device includes: a conveying unit for conveying a laminate in which components of the fuel cell are laminated and arranged via an adhesive layer containing a thermoplastic resin material; a heating unit for heating the laminate when the laminate conveyed by the conveying unit is positioned in a predetermined heating zone; a cooling unit for cooling the laminate when the laminate conveyed by the conveying unit is positioned in the predetermined cooling zone after passing through the heating zone; and a pressurizing unit for continuously pressurizing the laminate until the laminate is heated in the heating zone and cooled in the cooling zone.

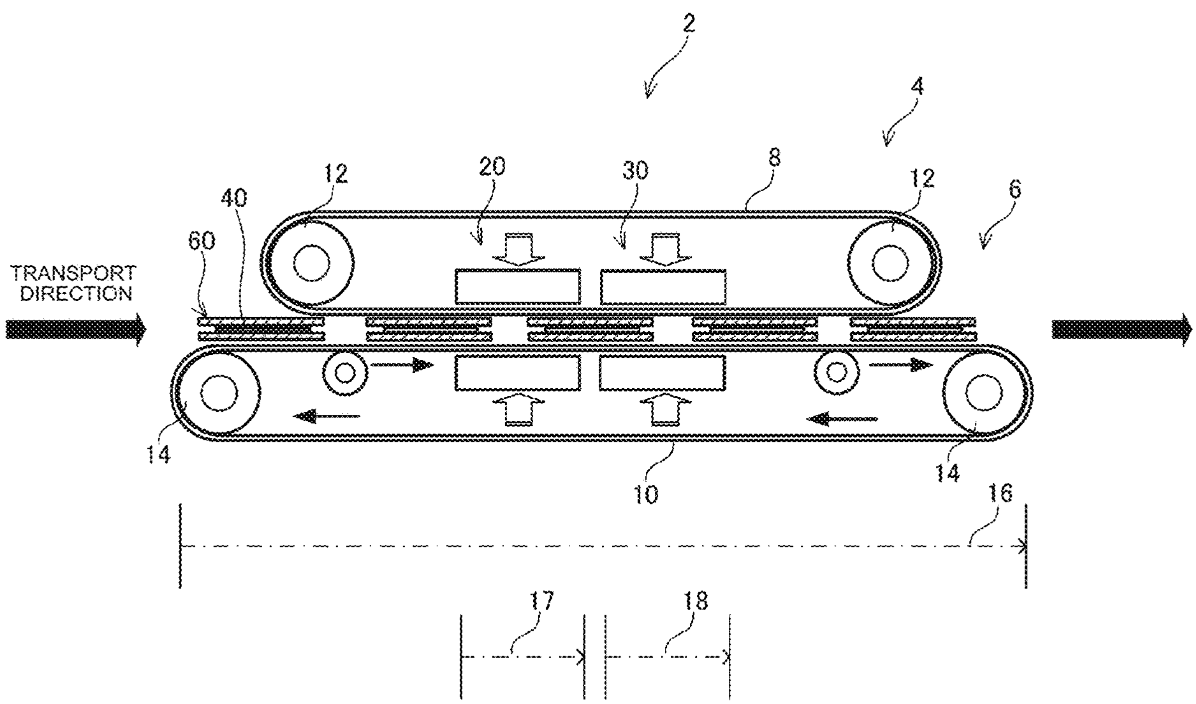


FIG. 1

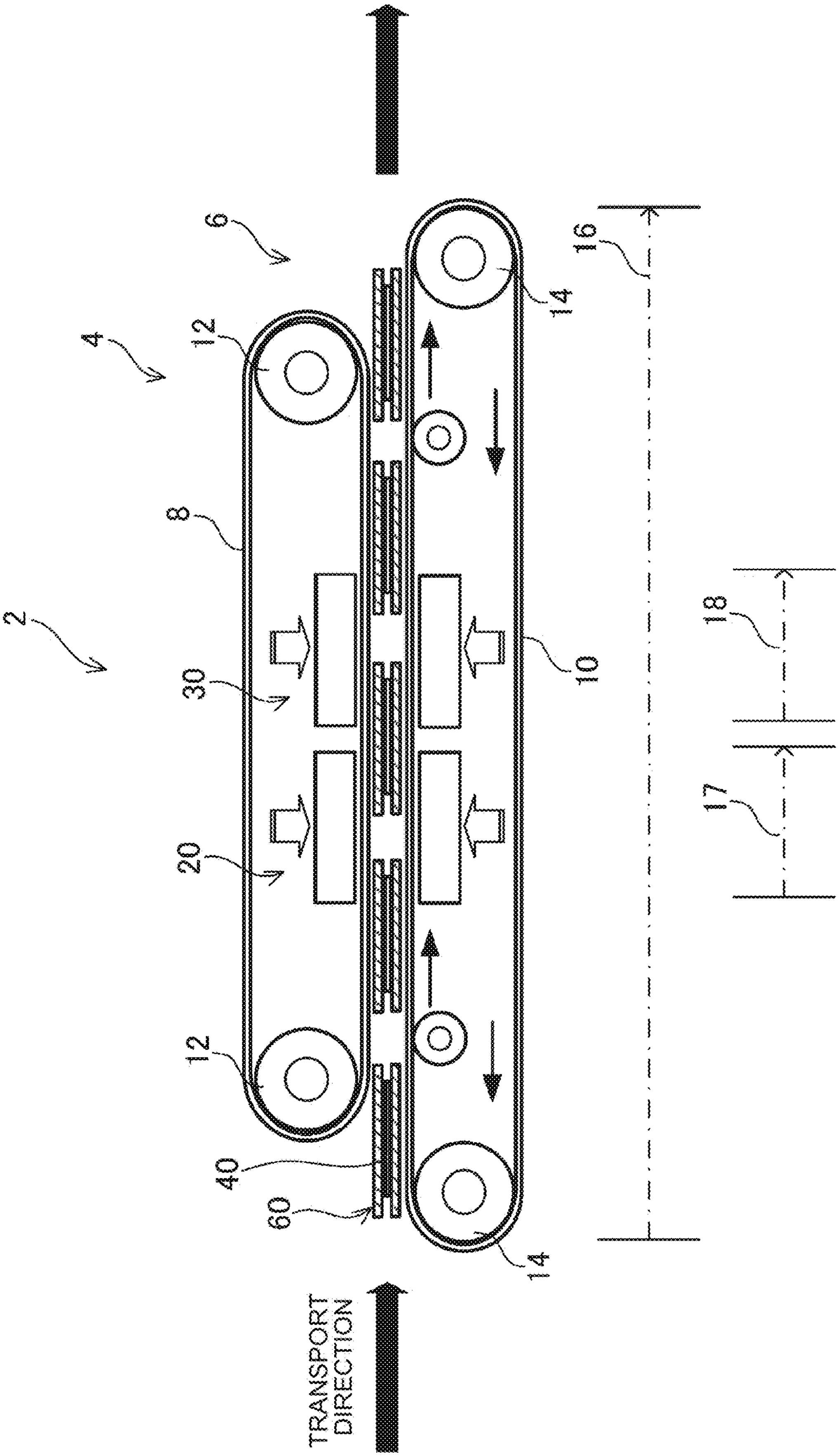


FIG. 2

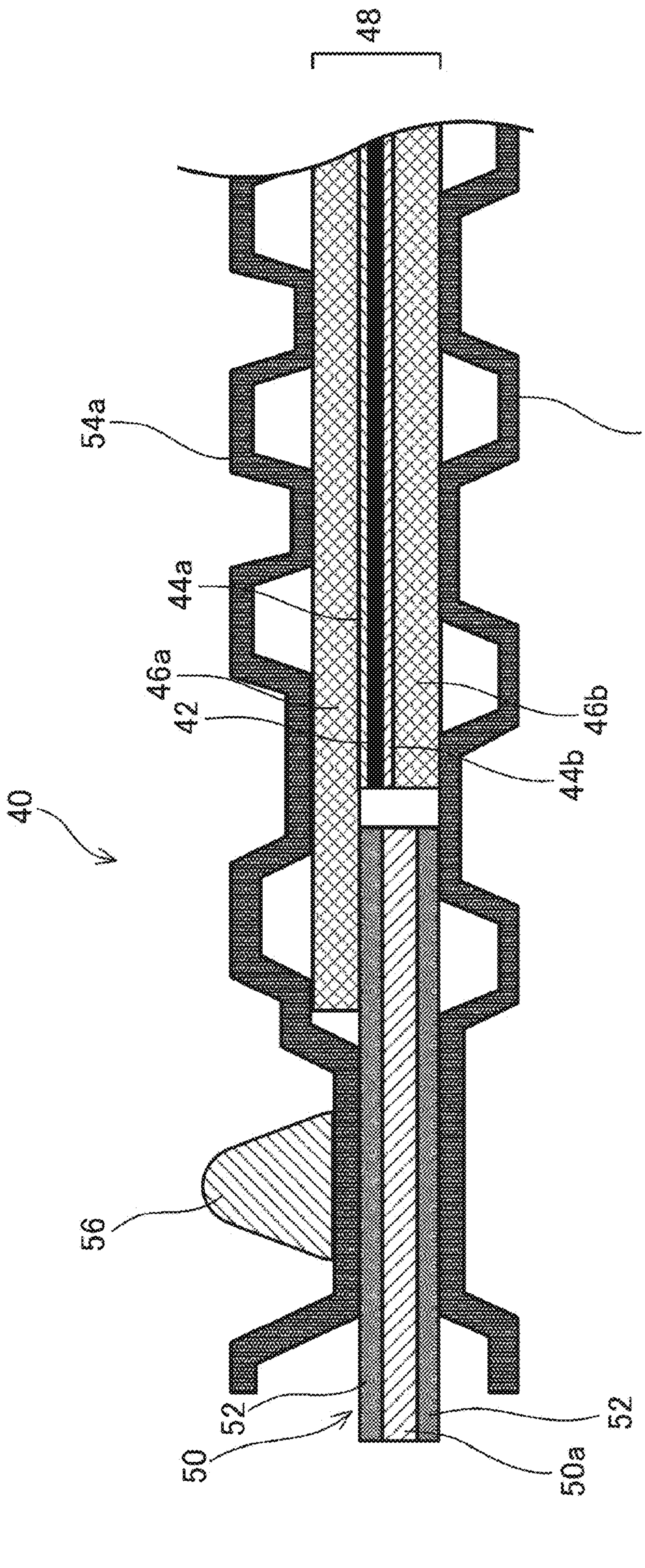


FIG. 3

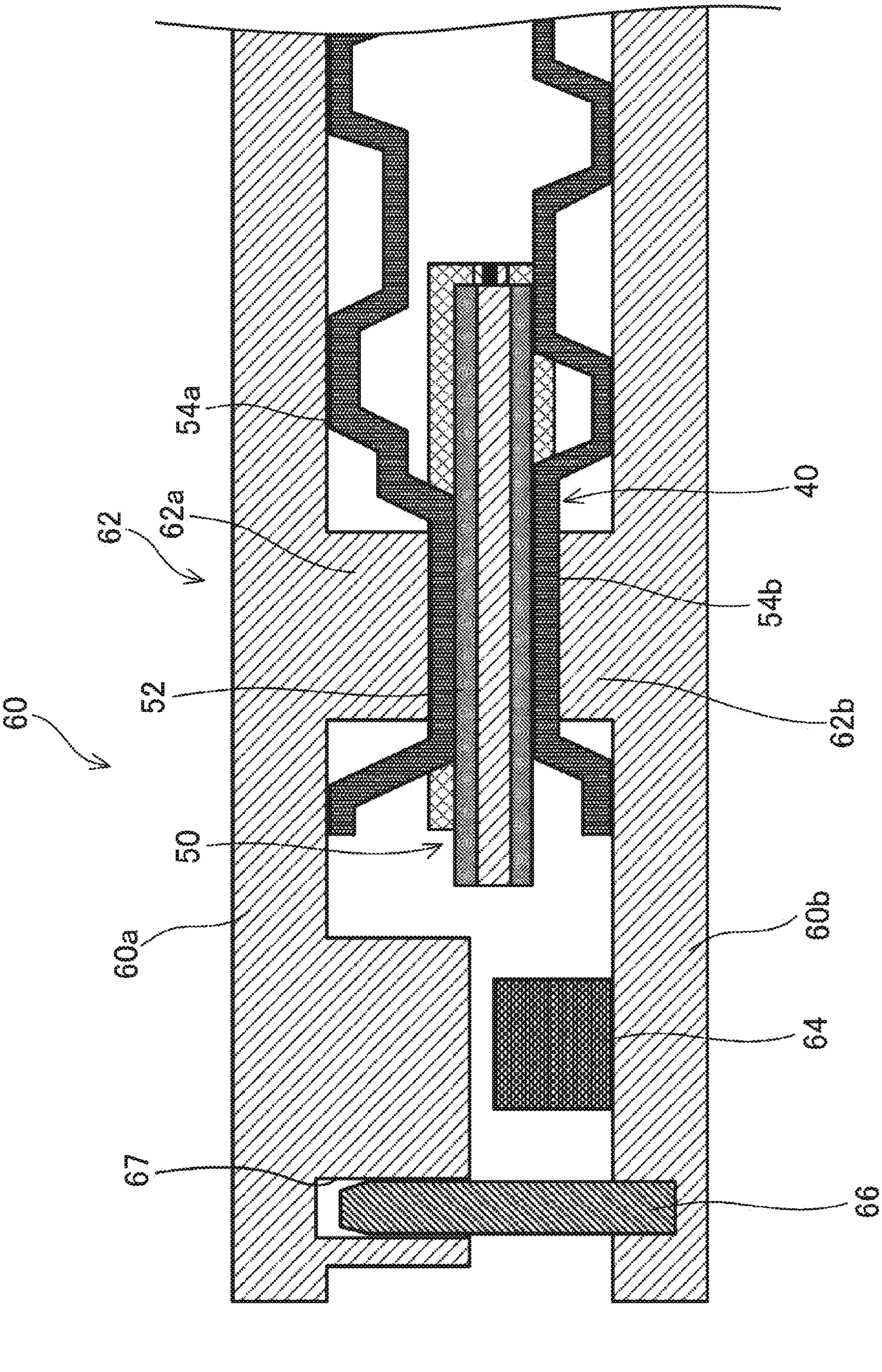


FIG. 4

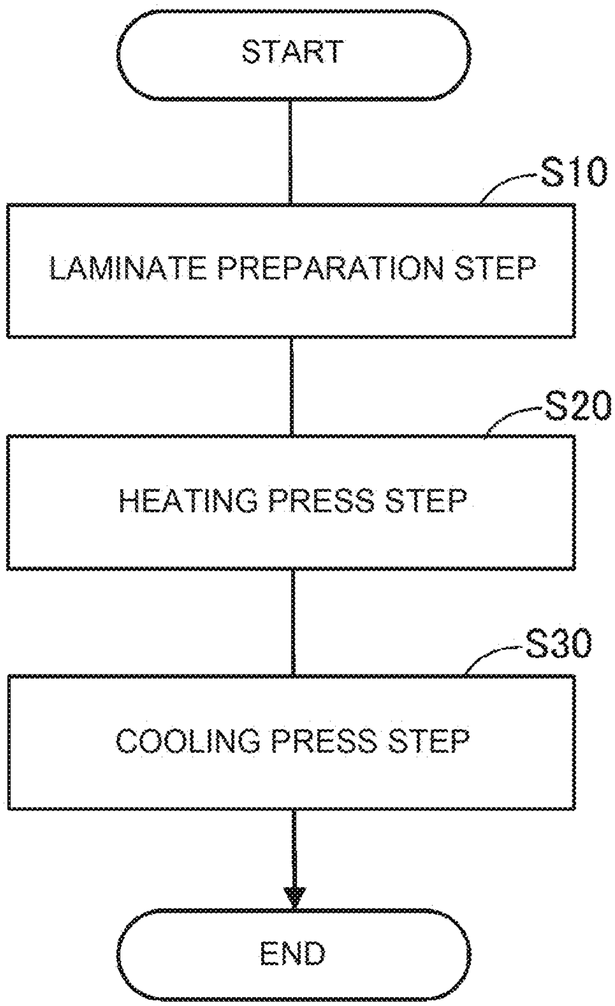

START
S10
LAMINATE PREPARATION STEP
S20
HEATING PRESS STEP
S30
COOLING PRESS STEP
END

FIG. 5

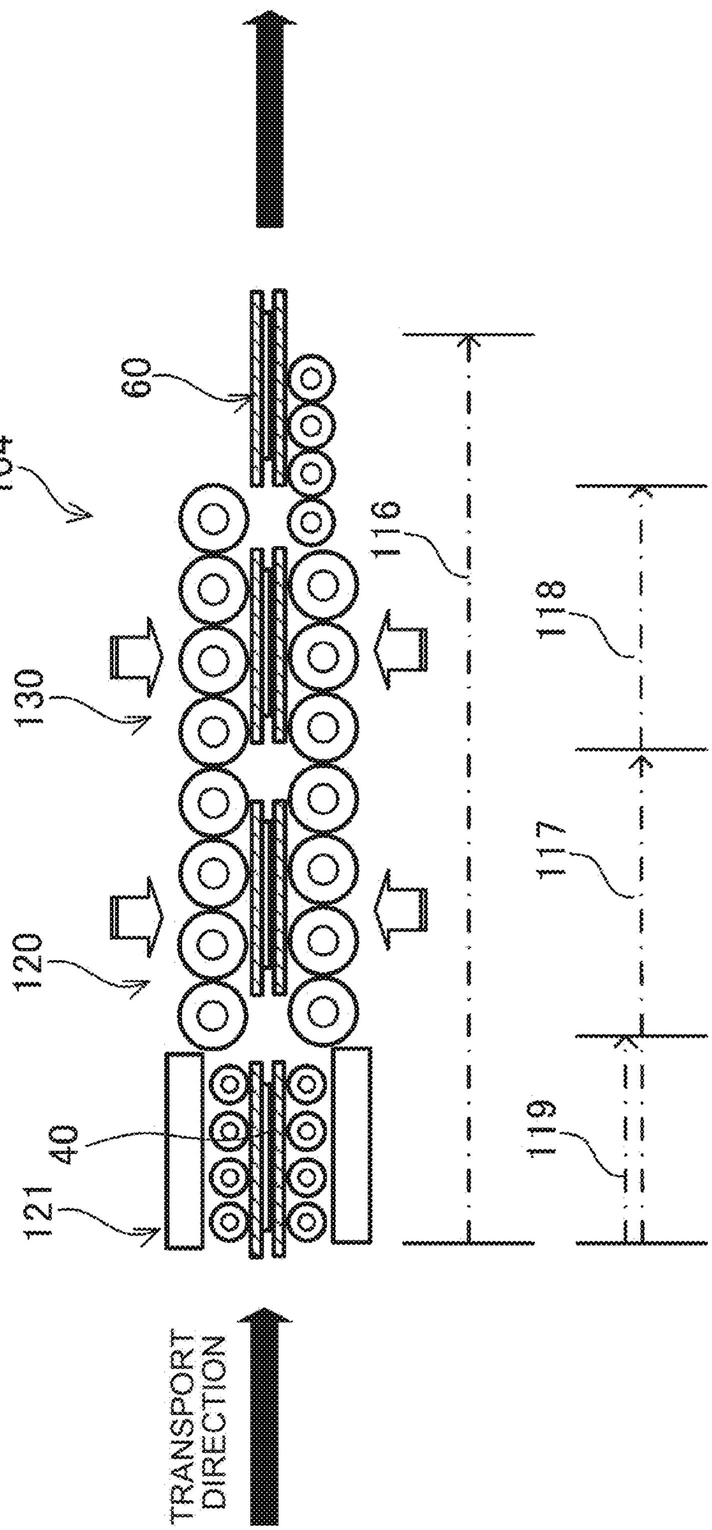
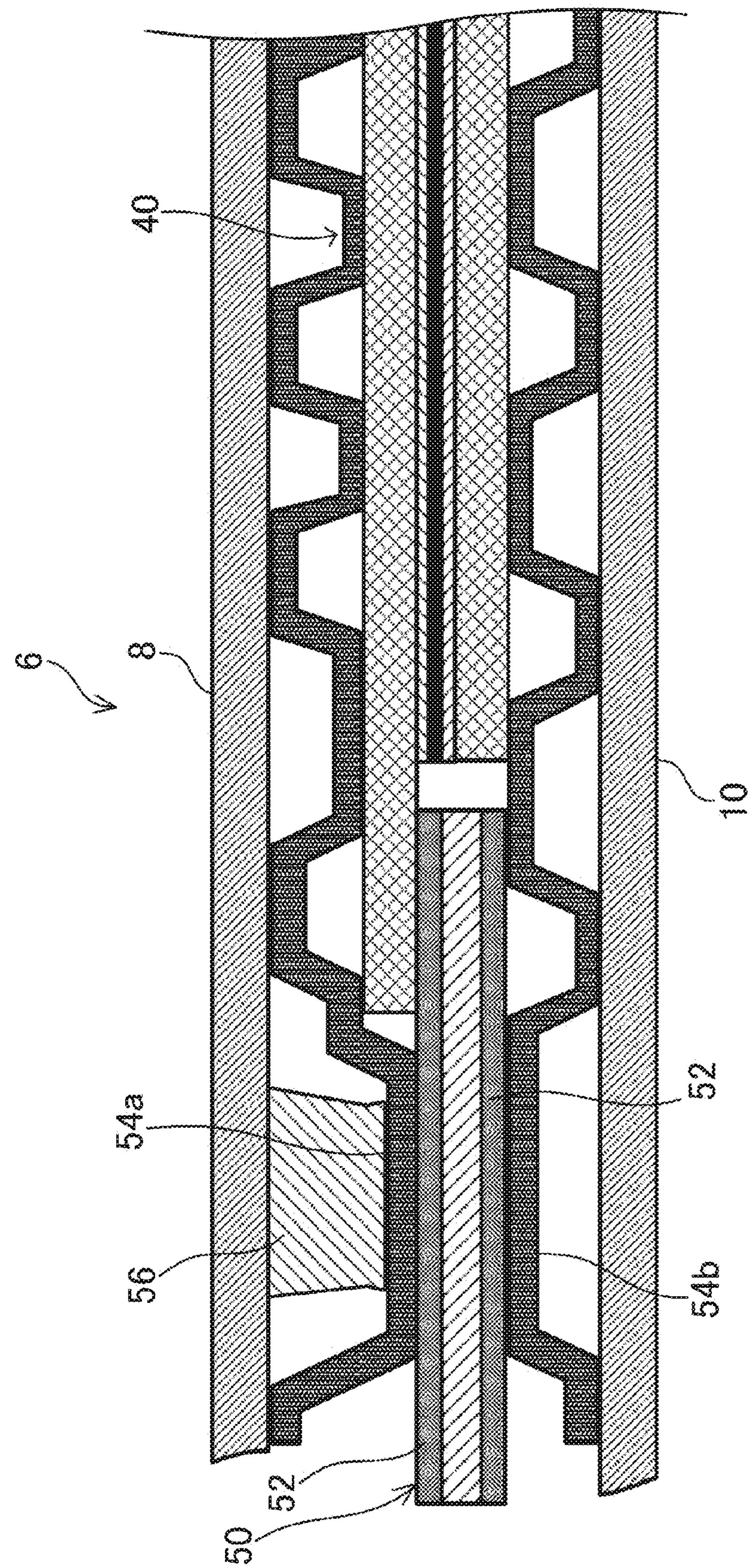


FIG. 6



FUEL CELL MANUFACTURING DEVICE AND MANUFACTURING METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Japanese Patent Application No. 2024-024953 filed on Feb. 21, 2024, incorporated herein by reference in its entirety.

BACKGROUND

1. Technical Field

[0002] The present specification relates to a fuel cell manufacturing device and manufacturing method.

2. Description of Related Art

[0003] A fuel cell is manufactured by integrating a stacked body in which a membrane electrode assembly (MEA) and a gas diffusing layer are sandwiched between a pair of separators by performing heating press and cooling press using an adhesive containing a thermoplastic resin material (Japanese Unexamined Patent Application Publication No. 2020-13734 (JP 2020-13734 A).

SUMMARY

[0004] In the method disclosed in JP 2020-13734 A, the stacked body is set in a predetermined press mold that has been heated, and subjected to heating press under a predetermined condition. After that, the stacked body is demolded, set again in the press mold that has been cooled, and subjected to cooling press. According to the present inventors, it has been found that, according to such a method, positional deviation of cell constituent elements may occur in a fuel cell finally obtained after the heating press. In addition, it has been found that inclusion of air bubbles in the adhesive layer containing the thermoplastic resin material, positional deviation of the adhesive layer, an increase in the non-uniformity of the thickness of the adhesive layer, and thus an increase in the thickness of the entire cell may occur in the fuel cell.

[0005] The present specification provides a technique of stably manufacturing a fuel cell having an excellent quality in manufacturing a fuel cell using an adhesive containing a thermoplastic resin material.

[0006] The technique disclosed in an aspect of the present specification is embodied as a fuel cell (hereinafter occasionally simply referred to as a "cell") manufacturing device (hereinafter occasionally simply referred to as a "manufacturing device").

[0007] The manufacturing device includes:

- [0008] a conveying unit that conveys a stacked body in which constituent elements of a fuel cell are stacked via an adhesive layer containing a thermoplastic resin material;
- [0009] a heating unit that heats the stacked body when the stacked body conveyed by the conveying unit is positioned in a predetermined heating zone;
- [0010] a cooling unit that cools the stacked body when the stacked body conveyed by the conveying unit is positioned in a predetermined cooling zone after passing through the heating zone; and
- [0011] a pressurizing unit that keeps pressurizing the stacked body since the stacked body is heated in the heating zone until the stacked body is cooled in the cooling zone.

[0012] According to this manufacturing device, it is possible to keep pressurizing the stacked body since the stacked body is heated in the heating zone until the stacked body is cooled in the cooling zone.

[0013] According to the present inventors, it has been found that deformation, movement, and separation, such as warpage of a separator, which is a constituent element of the fuel cell, and expansion of a gas diffusion layer, may occur in the stacked body when a load is released from the stacked body that has been heated and pressurized. In addition, it has been found that, as a result, air bubbles may be caught in the thermoplastic resin material in a molten or softened state, and unintended movement of the thermoplastic resin material may occur. It has been found that the various deterioration in the quality of the fuel cell described above may occur when the stacked body in such a state is cooled and pressurized thereafter.

[0014] According to this manufacturing device, the stacked body is kept pressurized even between the heating zone and the cooling zone. Therefore, the above phenomena caused by the release of the load after the heating and pressurizing are suppressed. As a result, positional deviation of cell constituent elements in the finally obtained fuel cell, inclusion of air bubbles in the adhesive layer, positional deviation of the adhesive layer, and an increase in the non-uniformity of the thickness of the adhesive layer are suppressed. Thus, according to this manufacturing device, it is possible to stably manufacture a fuel cell in which constituent elements are bonded with good adhesion by the adhesive layer, the positional deviation of the cell constituent elements and the inclusion of air bubbles in the adhesive layer are suppressed, and the thickness of the adhesive layer is uniform.

[0015] The technology disclosed in another aspect of the present specification is embodied as a fuel cell manufacturing method (hereinafter occasionally simply referred to as a "manufacturing method"). The manufacturing method includes: heating and pressurizing a stacked body including an adhesive layer containing a thermoplastic resin material; and cooling and pressurizing the stacked body after the heating and pressurizing. In the manufacturing method, the stacked body after the heating and pressurizing is supplied to the cooling and pressurizing in a state in which at least a predetermined load on the adhesive layer is maintained.

[0016] According to this manufacturing method, release of the load on the adhesive layer after the heating and pressurizing and before the cooling and pressurizing is suppressed. If release of the load on the adhesive layer is suppressed, deformation, movement, etc., of the separator and the gas diffusion layer to be bonded by the adhesive layer is also suppressed, and inclusion and movement of air bubbles into the thermoplastic material is also suppressed. Therefore, it is possible to stably manufacture a fuel cell in which constituent elements are bonded with good adhesion by the adhesive layer, the positional deviation of the cell constituent elements and the inclusion of air bubbles in the adhesive layer are suppressed, and the thickness of the adhesive layer is uniform.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] 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:

[0018] FIG. **1** is a diagram showing an outline of a fuel cell manufacturing device;

[0019] FIG. **2** is a cross-sectional view showing a part of a laminate provided in the manufacturing device shown in FIG. **1**;

[0020] FIG. **3** is a cross-sectional view showing a part of a state in which a laminate used in the manufacturing device shown in FIG. **1** is sandwiched between jigs;

[0021] FIG. **4** is a diagram illustrating a manufacturing process of a fuel cell;

[0022] FIG. **5** is a diagram illustrating another embodiment of a manufacturing device; and

[0023] FIG. **6** is a view showing another state of the laminate at the time of pressurization.

DETAILED DESCRIPTION OF EMBODIMENTS

[0024] a fuel cell manufacturing device disclosed in the present specification may include the following embodiments in addition to the above-described manufacturing device.

[0025] In another embodiment of the manufacturing device, the manufacturing device includes a double belt press apparatus. The double belt press apparatus includes a pair of upper and lower belts constituting the conveying unit, a heating press part constituting a part of the heating unit and the pressurizing unit, and a cooling press part constituting another part of the cooling unit and the pressurizing unit. According to this manufacturing device, it is efficiently performed to continue pressurizing the laminate during a period from when the laminate is heated in the heating zone to when the laminate is cooled in the cooling zone.

[0026] Another embodiment of the manufacturing device comprises a continuous roller press. The continuous roller press device includes a pair of upper and lower roller conveyors constituting the conveying unit. The pair of upper and lower roller conveyors includes a heating press portion forming a part of the heating unit and the pressurizing unit, and a cooling press portion forming another part of the cooling unit and the pressurizing unit. According to this manufacturing device, it is efficiently performed to continue pressurizing the laminate during a period from when the laminate is heated in the heating zone to when the laminate is cooled in the cooling zone.

[0027] In another embodiment of the manufacturing device, the pressurizing unit includes a jig that sandwiches the laminate in a lamination direction of the laminate and is capable of pressing the adhesive layer. The jig includes a pair of plates sandwiching the laminate, a positioning member for suppressing positional deviation in a direction orthogonal to the stacking direction of the laminate of the pair of plates. By having such a jig, it is possible to easily pressurize the laminate. It is also easier to maintain the load on the laminate. Further, according to such a jig, the positional deviation of the pair of plates is suppressed, and the positional deviation of the cell components in the stacked body is suppressed.

[0028] In addition to the above-described manufacturing method, the manufacturing method of the fuel cell disclosed in the present specification can include an embodiment implemented using the manufacturing device of the various embodiments described above.

[0029] Hereinafter, a manufacturing device and a manufacturing method disclosed in the present specification will be described in detail with reference to the drawings as appropriate. FIG. **1** shows an outline of a manufacturing device, FIG. **2** shows a laminate to be used in a manufacturing device, FIG. **3** shows a state in which the laminate to be used in the manufacturing device is sandwiched by a jig, and FIG. **4** shows a manufacturing process of a fuel cell.

[0030] The manufacturing device **2** is not particularly limited, but can be used, for example, for manufacturing a fuel cell as a driving power source or a mounting power source of a moving body such as a vehicle. The type of the fuel cell is not particularly limited, but may be a polymer electrolyte fuel cell (PEFC) from the viewpoint of operating temperature and the like.

[0031] As shown in FIG. **1**, the manufacturing device **2** is a double belt press type manufacturing device. The manufacturing device **2** includes a double belt portion **4** as a conveying unit, a heating press unit **20** for pressurizing and heating the laminated body **40**, and a cooling press unit **30** for pressurizing and cooling the laminated body **40** in the same manner. The laminated body **40** will be described later.

[0032] As the double belt portion **4**, various known double belt pressing apparatuses can be used. The double belt portion **4** includes a pair of upper and lower belts **6** including an upper belt **8** and a lower belt **10**. The upper belt **8** is disposed between the pair of upper drums **12**. The lower belt **10** is disposed between a pair of lower drums **14**. Each of the upper belt **8** and the lower belt **10** is a metal belt such as stainless steel.

[0033] The pair of belts **6** define a transport zone **16** of the laminated body **40** in its length direction. A heating zone **17** and a cooling zone **18** of the laminated body **40** are included in an area of the pair of belts **6** where the upper belt **8** and the lower belt **10** face each other. A cooling zone **18** is provided downstream of the heating zone **17** in the conveying direction.

[0034] Each of the heating press unit **20** and the cooling press unit **30** is a part of a double belt press apparatus. The heating press unit **20** is arranged in the heating zone **17** of the manufacturing device **2**. It can be said that the heating press unit **20** defines the heating zone **17**. The heating press unit **20** includes a heating press device capable of pressurizing and heating the laminated body **40** sandwiched between the pair of belts **6** at a predetermined pressure and temperature. The heating press unit **20** can be appropriately configured by a person skilled in the art based on a known double belt press apparatus. The heating press unit **20** is an example of a part of the heating unit and the pressurizing unit disclosed herein.

[0035] The cooling press unit **30** is arranged in the cooling zone **18** of the manufacturing device **2**. It can be said that the cooling press unit **30** defines the cooling zone **18**. The cooling press unit **30** includes a cooling press device capable of pressurizing and cooling the laminated body **40** sandwiched between the pair of belts **6** in the cooling zone **18** at a predetermined pressure and temperature. Such a cooling press unit **30** can be appropriately configured by a person skilled in the art based on a known double belt press apparatus. Note that the cooling in the present specification includes not only positive cooling but also natural cooling and air blowing. The cooling press unit **30** is an example of another part of the cooling unit and the pressurizing unit disclosed herein.

[0036] In the embodiment shown in FIG. **1**, the heating press unit **20** and the cooling press unit **30** are disposed close to each other in the transport zone **16**. For example, the cooling press unit **30** is disposed on the downstream side of the heating press unit **20** at a distance of, for example, half or less, 40% or less, 30% or less, 20% or less, or 10% or less of the length along the conveying direction of the laminated body **40**. In this way, the laminated body **40** is subjected to a cooling press in the cooling zone **18** after being heated and pressed in the heating zone **17**, while substantially leaving the load by the heating press unit **20**.

[0037] Downstream of the cooling zone **18**, the laminated body **40** is conveyed further downstream by the lower belt **10**.

[0038] Here, the laminated body **40** will be described. The laminated body **40** is a stacked body before joining a fuel cell (hereinafter, simply referred to as a cell) to be manufactured by the manufacturing device **2**. As illustrated in FIG. **2**, the laminated body **40** includes an electrolyte membrane **42**, an anode catalyst layer **44***a*, a cathode catalyst layer **44***b*, gas diffusion layers **46***a*, **46***b*, a resin sheet **50**, and a pair of separator **54***a*, **54***b*.

[0039] The electrolyte membrane **42** is a solid polymer electrolyte membrane. The anode catalyst layer **44***a* and the cathode catalyst layer **44***b* are stacked with both surfaces of the electrolyte membrane **42** interposed therebetween. The gas diffusion layer **46***a*, **46***b* is a porous material capable of diffusing hydrogen in the anode catalyst layer **44***a* and oxygen in the cathode catalyst layer **44***b*. These components together constitute a MEGA **48**. MEGA **48** is integrated with the resin-sheet **50**. MEGA **48** is sealed to the opening of the resin-sheet **50** by a suitable sealing material (not shown) so that the gas diffusion layers **46***a*, **46***b* do not communicate with each other, and is held at the same time.

[0040] The resin-sheet **50** has a frame shape having an opening portion capable of holding a MEGA **48** at a central portion thereof. As shown in FIG. **2**, the resin sheet **50** has, for example, a three-layer structure. The resin sheet **50** includes an adhesive layer **52** including a thermoplastic resin material on both surfaces of the core layer **50***a*. The core-layer **50***a* is made of a resin having a melting point higher than that of the thermoplastic resin material contained in the adhesive layer **52**, and is made of a resin that does not soften at the time of heating of the laminated body **40**.

[0041] The thermoplastic resin material contained in the adhesive layer **52** is a so-called hot melt adhesive. The adhesive layer **52** is similarly formed in a frame shape on both surfaces of the core-layer **50***a* formed in a frame shape. The adhesive layers **52** are formed in regions where the resin-sheet **50** and the separator **54***a*, **54***b* need to be bonded to each other. The adhesive layers **52** are brought into close contact with and bonded to the separator **54***a*, **54***b* by being heated and cooled, and integrate MEGA **46** and the separator **54***a*, **54***b*.

[0042] The hot melt adhesive is solid at room temperature, melts or softens by heating, and solidifies again by cooling to form a joint. Examples of the hot-melt adhesive include adhesives based on various thermoplastic resins such as polyester-based and modified olefin-based adhesives. The hot-melt adhesive used for the adhesive layer **52** can be appropriately selected from various known hot-melt adhesives in consideration of the melting point and the like.

[0043] The separator **54***a*, **54***b* sandwiches MEGA **48** and supplies a predetermined gas to the gas diffusion layers **46***a*, **46***b*. The separator **54***a*, **54***b* is made of, for example, a metallic material such as aluminum or stainless-steel, a carbon-based composite material, or the like. The separator **54***a*, **54***b* has a corrugated configuration in which the gas can be supplied to the gas diffusion layers **46***a*, **46***b* facing each other.

[0044] As shown in FIG. **2**, the laminated body **40** may further include a gasket **56** on a side surface of the separator **54***a* that does not face the resin-sheet **50**. The gasket **56** seals between the cells in the stack of fuel cells. The gasket **56** is formed of an elastic body such as a resin or an elastomer. Gasket **56** is an example of an elastomer used to pressurize the adhesive layer disclosed herein.

[0045] The laminated body **40** shown in FIGS. **2** and **3** has a planar shape having a rectangular shape as a whole. In the laminated body **40**, a gas flow path is formed by a separator **54***a*, **54***b* so as to be able to flow in such a manner that hydrogen and oxygen are opposed to each other along the long side.

[0046] As shown in FIG. **3**, the laminated body **40** is supplied to the manufacturing device **2** in a state of being restrained by a jig **60** that sandwiches the laminated body **40**. The jig **60** includes an upper plate **60***a* and a lower plate **60***b*. The upper plate **60***a* is brought into contact with the upper belt **8** and can apply a load to the laminated body **40** from **54***a* of the separators. The lower plate **60***b* is brought into contact with the lower belt **10** and can apply a load to the laminated body **40** from **54***b* of the separators. The upper plate **60***a* and the lower plate **60***b* each have a larger planar configuration than the outer edge of the laminated body **40**.

[0047] The upper plate **60***a* and the lower plate **60***b* are provided with pressing portion **62** required for joining the separator **54***a*, **54***b* of the laminated body **40** and the adhesive layers **52** of the resin sheet **50**. The pressing portion **62** is a convex portion protruding toward the laminated body **40**. Although the mode of the pressing portion **62** is not particularly limited, for example, as shown in FIG. **3**, the pressing portions **62***a*, **62***b* may be provided so as to face each other.

[0048] The pressing portion **62** may be formed of, for example, a metallic material or the like made of the same material as the upper plate **60***a* and the lower plate **60***b*, or may be formed of an elastic material made of, for example, a resinous material, an elastomeric material, or the like. Note that, at the place where the gasket **56** is disposed, the adhesive layers **52** may be pressed by being sandwiched between the upper plate **60***a* and the lower plate **60***b* without forming the pressing portion **62**. Further, a pressing portion **62** that presses the gasket **56** may be separately provided as necessary.

[0049] Further, the jig **60** includes a restraining member **64** that is restrainable with respect to each other. The restraining member **64** is configured to restrain the upper plate **60***a* and the lower plate **60***b* from the hot pressing process to the cold pressing process of the laminated body **40**. The restraining member **64** is provided at one or a plurality of positions on the outer periphery of the laminated body **40** of the jig **60**. As the restraining member **64**, for example, as shown in FIG. **3**, when the upper plate **60***a* and the lower plate **60***b* are made of a metallic material having magnetism such as stainless-steel, a restraining material made of a magnetic force such as magnets can be used. The restraining member **64**, which is a magnet, is fixed to the lower plate **60***b* so as to be attracted and fixed to the upper plate **60***a,* for example. Thus, once the upper plate **60***a* and the lower plate **60***b* are constrained to each other, the opening of the load to the laminated body **40** is suppressed between them.

[0050] Further, the jig **60** includes a positioning member **66** for positioning the upper plate **60***a* and the lower plate **60***b*. The positioning member **66** fixes mutual positions of the upper plate **60***a* and the lower plate **60***b* in a direction perpendicular to the stacking direction of the laminated body **40** (hereinafter, referred to as a lateral direction) in a predetermined position. As a result, lateral displacement of the upper plate **60***a* and the lower plate **60***b* is suppressed through the hot pressing process and the cold pressing process, and a predetermined load is applied to a predetermined area of the laminated body **40**. In addition, lateral displacement of the separator **54***a,* **54***b,* the gas diffusion layer **46***a,* **46***b,* and the like, which are cell components of the laminated body **40**, is also suppressed.

[0051] Although the embodiment of the positioning member **66** is not particularly limited, for example, as shown in FIG. **3**, a positioning pin fixed to the lower plate **60***b* may be used. The positioning member **66** extends toward the upper plate **60***a* in the thickness direction of the laminated body **40**, and is fitted into a positioning hole **67** formed in the upper plate **60***a*.

[0052] Next, with reference to FIG. **4**, a process of manufacturing a cell from the laminated body **40** will be described. The laminate preparation step S**10** is a step of preparing the laminated body **40** in which the separator **54***a,* **54***b* is laminated on the resin-sheet **50** holding MEGA **48**. Note that the laminate preparation step S**10** may be one in which the laminated body **40** is prepared by manufacturing the laminated body **40**, or one in which the laminated body **40** manufactured in advance is prepared.

[0053] In the present embodiment, the upper plate **60***a* and the lower plate **60***b* are configured such that a load to the laminated body **40** is easily held by the restraining member **64**. Further, the positional displacement of the plate **60***a,* **60***b* is suppressed by the positioning member **66**.

[0054] The prepared laminated body **40** is nipped by the jig **60** and supplied to the transport zone **16** of the manufacturing device **2**. The laminated body **40** is fed onto the lower belt **10** of the manufacturing device **2** and reaches the heating zone **17**.

[0055] The heating press step S**20** is a step of heating and pressurizing the laminated body **40** that has reached the heating zone **17**. The laminated body **40** is heated between the pair of belts **6** by the heating press unit **20** at a predetermined pressure and a predetermined temperature. The heating time in the heating press step S**20** is defined by the time required for the laminated body **40** to stagnate in the heating press unit **20** and/or pass through the hot pressurizing unit **20** by the pair of belts **6**. The temperature, the pressure, and the heating time in the heating press step S**20** are appropriately determined in accordance with the properties of the hot-melt adhesive used for the adhesive layers **52**.

[0056] The laminated body **40** that has passed through the heating press unit **20** is immediately reached to the cooling zone **18** in a state of being sandwiched between the pair of belts **6** together with the jig **60**.

[0057] The cooling press step S**30** is a process of cooling and pressurizing the laminated body **40** that has reached the cooling zone **18**. The laminated body **40** is cooled at a predetermined pressure and a predetermined temperature by the cooling press unit **30** between the pair of belts **6**. The cooling time in the cooling press step S**30** is defined by the time required for the stack to stagnate in the cooling press unit **30** and/or pass through the cooling press unit **30** by the pair of belts **6**. Temperature, pressure, and cooling time in the cooling press step S**30** are appropriately determined in accordance with the properties of the hot melt adhesive used for the adhesive layers **52**, and the like.

[0058] In the present embodiment, in other words, the heating press unit **20** and the cooling press unit **30** are separated from each other by a distance shorter than the length along the conveying direction of the laminated body **40** in the heating zone **17** and the cooling zone **18**. Therefore, the cooling press unit **30** pressurizes the laminated body **40** in a state in which the pressurizing state by the heating press unit **20** is maintained.

[0059] The laminated body **40** that has passed through the cooling press unit **30** is conveyed between the pair of belts **6**, is further conveyed in a predetermined section by the lower belt **10**, and is then taken out from the manufacturing device **2**. Further, the cells are taken out from the jig **60**.

[0060] According to the embodiment described above, the laminated body **40** is cooled and pressurized without removing the pressurization in the heating press step S**20**. Since the load is not completely released prior to the cooling press step S**30** after the heating press step S**20**, the generation of phenomena that may be caused by the release of the load is suppressed. That is, the separators **54***a,* **54***b,* which are the constituent elements of the laminated body **40**, are suppressed from warping or the gas diffusion layers **46***a,* **46***b* are suppressed from expanding. Therefore, the separators **54***a* and the gas diffusion layer **46***a* are suppressed from being separated from each other or from being displaced from each other prior to the cooling press step S**30**.

[0061] Further, even when the hot-melt adhesive of the adhesive layers **52** is melted or softened by heating, the entrapment of bubbles is suppressed prior to the cooling press step S**30**. In addition, prior to the cooling press step S**30**, uneven thickness of the adhesive layers **52** due to unintentional movement of the hot melt adhesive is suppressed.

[0062] As described above, the laminated body **40** in which the load in the heating press step S**20** is not completely released and a predetermined load is maintained is supplied to the cooling press step S**30**, and is cooled and pressurized. Therefore, the adhesive layer **52** is bonded to the cell components such as the separator **54***a* and the gas diffusion layer **46***a* with good adhesion, and the misalignment of the cell components is suppressed. As a result, the inclusion of bubbles in the adhesive layer **52** is suppressed, and a cell in which the thickness of the adhesive layer **52** is uniform is obtained. As a result, the total thickness of the cell is suppressed from being unintentionally increased.

[0063] Further, according to the above-described embodiment, the laminated body **40** is sandwiched by the jig **60**, and the heating press step S**20** and the cooling press step S**30** are performed. When pressurized in the heating press step S**20**, a constant load is maintained on the laminated body **40** by the restraining member **64**. Therefore, the separation and positional deviation of the cell components, the inclusion of bubbles in the adhesive layer **52**, and the non-uniformity of the thickness of the adhesive layer **52** are further suppressed through the manufacturing process. Further, the jig **60** may be useful when the heating zone **17** and the cooling zone **18** are spaced apart from each other by more than the length of the laminated body **40** in the conveying direction. By using the jig **60**, the adhesive layers **52** of the laminated body **40** may be applied with a constant load only by the jig **60** up to the cooling press step S**30** after the heating press step S**20**.

[0064] Further, according to the above-described embodiment, the position of the upper plate **60***a* and the lower plate **60***b* of the jig **60** is fixed and held by the positioning member **66** in the laminated body **40**. Therefore, a lateral positional deviation between the upper plate **60***a* and the lower plate **60***b* due to a velocity difference between the pair of belts **6** and the like, and consequently, a lateral positional deviation of the cell components of the laminated body **40** are suppressed. As a result, misalignment of the cell components, inclusion of bubbles in the adhesive layer **52**, non-uniformity of the thickness of the adhesive layer **52**, and the like are further suppressed.

[0065] In the above embodiment, a double belt press apparatus is used as the manufacturing device **2**, but the present disclosure is not limited thereto. Various known conveying unit, heating unit, cooling unit and pressurizing unit can be combined as appropriate. As another manufacturing device **102**, for example, a continuous roller press apparatus can be used. As illustrated in FIG. **5**, the manufacturing device **102** includes a roller conveyor **104** including a pair of upper and lower rollers arranged in series as a conveying unit. The roller conveyor **104** defines a transport zone **116** and may further define a heating zone **117** and a cooling zone **118**.

[0066] The heating zone **117** includes an appropriate number of roller pairs, and includes a heating press unit **120** that heats and presses the laminated body **40**. The cooling zone **118** is composed of an appropriate number of roller pairs, and includes a cooling press portion **130** for cooling and pressurizing the laminated body **40**. The heating press unit **120** is an example of a portion of the heating unit and the pressurizing unit disclosed herein. The cooling press portion **130** is an example of a portion of the cooling unit and the pressurizing unit disclosed herein.

[0067] As shown in FIG. **5**, the pair of rollers is arranged continuously in each of the heating press unit **120** and the cooling press portion **130**. The most downstream roll pair of the heating press unit **120** and the most upstream roll pair of the cooling press portion **130** are also arranged in succession. As a result, the laminated body **40** sandwiched by the jig **60** continues to be pressurized by the pair of rolls from the heating press unit **120** to the cooling press portion **130**.

[0068] Further, in the manufacturing device **102** shown in FIG. **5**, a preheating unit **121** such as a halogen heater that heats the laminated body **40** from above and below in the lamination direction in advance is provided in front of the heating zone **117**. By providing the preheating unit **121**, the hot melt adhesive can be reliably melted or softened by the heating press unit **120**. In this case, it is preferable that the laminated body **40** is sandwiched by the jig **60** so that movement of the cell component or the like is suppressed. As shown in FIG. **5**, the preheating unit **121** may also be a preheating zone **119** in preparation for a part of the roller conveyor **104**. The preheating unit **121** and the preheating zone **119** may be part of the heating press unit **120** and the heating zone **117**. Further, in the roll pair constituting the cooling press portion **130**, the laminated body **40** may be pressurized while being cooled by cooling, blowing, or the like.

[0069] In the manufacturing device **102** illustrated in FIG. **5**, the laminated body **40** is preferably provided in a state of being sandwiched by a jig **60** or the like.

[0070] In the above-described embodiment, the heating press units **20** and **120** and the cooling press units **30** and **130** are separated from each other by a distance shorter than the length of the laminated body **40** in the conveyance direction. Therefore, the laminated body **40** is supplied to the cooling press step S**30** while the load applied by pressurization is substantially maintained in the heating press step S**20** until the cooling press step S**30** after the heating press step S**20**. That is, the laminated body **40** continues to be pressurized from the time when the laminated body **40** is heated to the time when it is cooled.

[0071] However, the form of maintaining the load on the laminated body **40** is not limited thereto. It is sufficient that a load is applied to the adhesive layers **52** of the laminated body **40** to such an extent that separation or positional deviation of the cell components can be suppressed before the cooling press step S**30** after the heating press step S**20** Such a load can be appropriately set by a person skilled in the art. It is also possible to provide an independent pressing step of maintaining at least a part of the load after the heating press step S**20** prior to the cooling press step S**30** without completely opening the load prior to the heating press step S**20**. In some cases, such a load can be achieved by the restraining member **64** with respect to the jig **60** without using a pressurizing unit such as a pressing device.

[0072] In the above-described embodiment, the jig **60** is used to maintain at least a part of the load applied to the adhesive layers **52** by the heating press step S**20** by continuously pressurizing the entire laminated body **40**, but the present disclosure is not limited thereto. At least a portion of the load may be maintained only in the adhesive layer **52**.

[0073] In the above-described embodiment, the manufacturing devices **2** and **102** perform the heating press step S**20** and the single cooling press step S**30**, but the present disclosure is not limited thereto. The heating press step S**20** and the cooling press step S**30** may each comprise a plurality of sub-steps. It is preferable that a predetermined load is maintained between the plurality of sub-heating steps to the extent that deformation and movement of the cell component can be suppressed. It is preferable that the load is maintained between the plurality of sub-cooling steps as well.

[0074] In the above embodiment, in the heating press step S**20**, the laminated body **40** is pressurized and heated at the same time, but the present disclosure is not limited thereto. For example, as shown in FIG. **5**, the preheating unit **121** may be used to preheat the laminated body **40** to melt or soften the adhesive layer **52**. Further, the heating at the time of the heating press may be replaced by such preheating, and only the pressurization may be performed after the heating. For example, in FIG. **5**, a state in which the hot melt adhesive exhibits adhesiveness by preheating may be maintained, and in a pair of downstream rollers constituting the heating press unit **120**, the special laminated body **40** may be pressurized without heating. Further, the cooling press step

S30 may be, for example, a step of pressurizing the laminated body **40** while cooling by natural cooling without particularly aggressive cooling.

[0075] In the above embodiment, the laminated body **40** is supplied to the manufacturing device **2** in a state of being sandwiched by the jig **60**, but the present disclosure is not limited thereto. For example, as shown in FIG. **6**, an elastic member such as the gasket **56** may be placed on the separator **54***a*, and the gasket **56** may be compressed and deformed by the pair of belts **6**, so that the pressure from the manufacturing device **2** is applied to the adhesive layers **52**. The clastic body is not limited to the gasket **56**, and may be an elastic body separately arranged for pressurization.

[0076] In the above-described embodiment, the restraining member **64** uses a magnetic force, but the present disclosure is not limited thereto. For example, the upper plate **60***a* and the lower plate **60***b* of the jig **60** can be restrained by using a fastening member such as a screw or an elastic member such as a spring with respect to the jig **60** so that the load after the heating press step S**20** is not completely released. The restraining member **64** allows the load on the adhesive layers **52** to be maintained between the heating press step S**20** and the cooling press step S**30**.

[0077] In the above embodiments, the embodiments using the double belt press apparatus and the continuous roller press apparatus have been described, but the manufacturing method disclosed in this specification is not implemented in the embodiments using these apparatuses. For example, a press die that presses the laminated body **40** including the adhesive layer **52** of the laminated body **40** may be used to heat such a press die and then cool the press die without demolding the laminate from the press die. In this manner, it is possible to maintain a predetermined load in the adhesive layers **52** in the heating press step S**20** and to supply the same to the cooling press step S**30**. The step from the heating press step S**20** to the cooling press step S**30** can be performed without using a special conveying unit.

[0078] Alternatively, in the manufacturing methods disclosed herein, the heating press step S**20** may be performed, and thereafter, for example, the cooling press step S**30** may be performed by partially loosening the pressing process by the press mold, and then clamping the mold to perform the cold pressing process at a predetermined pressure.

[0079] In the above-described embodiment, the manufacturing devices **2** and **102** perform the heating press step S**20** and the single cooling press step S**30**, but the present disclosure is not limited thereto. The heating press step S**20** and the cooling press step S**30** may each comprise one or more steps.

[0080] The present specification includes the following aspects.

[0081] [1] A fuel cell manufacturing device, comprising:

[0082] A conveying unit for conveying the laminated body in which the constituent elements of the fuel cell are laminated and arranged through an adhesive layer containing a thermoplastic resin material,

[0083] A heating unit for heating the laminate when the laminate conveyed by the conveying unit is located in a predetermined heating zone,

[0084] cooling unit for cooling the laminate when the laminate conveyed by the conveying unit is located in a predetermined cooling zone after passing through the heating zone,

[0085] pressurizing unit for continuing to pressurize the laminate after it is heated in the heating zone until it is cooled in the cooling zone,

[0086] A manufacturing device comprising:

[0087] [2] The manufacturing device includes a double belt press device,

[0088] The double belt press device,

[0089] A pair of upper and lower belts constituting the conveying unit,

[0090] A heating press part constituting a part of the heating unit and the pressurizing unit,

[0091] A cooling press part constituting another part of the cooling unit and the pressurizing unit,

[0092] The manufacturing device according to [1].

[0093] [3] The manufacturing device includes a continuous roller press device,

[0094] The continuous roller pressing device includes a pair of upper and lower roller conveyors constituting the conveying unit,

[0095] The manufacturing device according to [1] or [2], wherein the pair of upper and lower roller conveyors includes a heating press part constituting a part of the heating unit and the pressurizing unit, and a cooling press part constituting another part of the cooling unit and the pressurizing unit.

[0096] [4] The pressurizing unit includes a jig capable of pressing the adhesive layer while sandwiching the laminate in the laminating direction of the laminate,

[0097] The manufacturing device according to any one of [1] to [3], wherein the jig includes a pair of plates that sandwich the laminate, and includes a positioning member that suppresses a positional deviation of the pair of plates in a direction orthogonal to a stacking direction of the laminate.

[0098] [5] The manufacturing device according to [4], wherein the jig includes a pressing portion that presses the adhesive layer of the laminate.

[0099] [6] The manufacturing device according to [5], wherein the pressing portion includes an elastic body.

[0100] [7] The manufacturing device according to any one of [4] to [6], wherein the jig includes a restraining member capable of holding a load to the adhesive layer.

[0101] [8] A fuel cell manufacturing method, comprising:

[0102] a hot pressing step of heating and pressurizing the laminate comprising an adhesive layer containing a thermoplastic resin material,

[0103] a cooling press step for cooling and pressurizing the laminate after the heating press step, wherein

[0104] a manufacturing method, wherein the laminated body after the hot pressing step is supplied to the cooling pressing step in a state where at least a predetermined load in the adhesive layer is maintained.

[0105] While specific examples of the technology disclosed in the present specification have been described in detail above, these examples are merely illustrative and do not limit the scope of the claims. The technology described in the claims includes various modifications and variations of the specific examples described above, for example, a method of controlling a fuel cell. 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 **10** combinations described in the claims at the time of filing. The technology illustrated in the present specification or the drawings can achieve a plurality of objects at the same time, and has technical usefulness in achieving one of the objects.

What is claimed is:

1. A fuel cell manufacturing device comprising:

a conveying unit that conveys a stacked body in which constituent elements of a fuel cell are stacked via an adhesive layer containing a thermoplastic resin material;

a heating unit that heats the stacked body when the stacked body conveyed by the conveying unit is positioned in a predetermined heating zone;

a cooling unit that cools the stacked body when the stacked body conveyed by the conveying unit is positioned in a predetermined cooling zone after passing through the heating zone; and

a pressurizing unit that keeps pressurizing the stacked body since the stacked body is heated in the heating zone until the stacked body is cooled in the cooling zone.

2. The manufacturing device according to claim **1**, wherein:

the manufacturing device includes a double belt press device; and

the double belt press device includes

a pair of upper and lower belts that constitutes the conveying unit,

a heating press portion that constitutes the heating unit and a part of the pressurizing unit, and

a cooling press portion that constitutes the cooling unit and another part of the pressurizing unit.

3. The manufacturing device according to claim **1**, wherein:

the manufacturing device includes a continuous roller press device;

the continuous roller press device includes a pair of upper and lower roller conveyors that constitutes the conveying unit; and

the upper and lower roller conveyors include a heating press portion that constitutes the heating unit and a part of the pressurizing unit, and a cooling press portion that constitutes the cooling unit and another part of the pressurizing unit.

4. The manufacturing device according to claim **1**, wherein:

the pressurizing unit includes a jig capable of pressurizing the adhesive layer while sandwiching the stacked body in a stacking direction of the stacked body; and

the jig includes a pair of plates that sandwiches the stacked body, and a positioning member that suppresses positional deviation of the plates in a direction orthogonal to the stacking direction of the stacked body.

5. A fuel cell manufacturing method comprising:

heating and pressurizing a stacked body including an adhesive layer containing a thermoplastic resin material; and

cooling and pressurizing the stacked body after the heating and pressurizing, wherein the stacked body after the heating and pressurizing is supplied to the cooling and pressurizing in a state in which at least a predetermined load on the adhesive layer is maintained.

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