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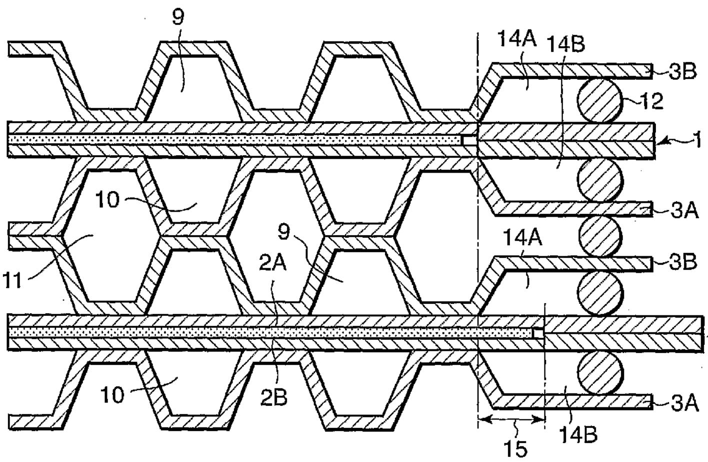
(54) **Title:** MANUFACTURE OF FUEL CELL STACK



(57) **Abstract:** A fuel cell stack is assembled by alternately stacking a membrane electrode assembly (ME) (1) having a reaction surface (2A, 2B) and a separator (3A, 3B) having a reactive gas passage (9, 10) facing the reaction surface (2A, 2B). A supply manifold (6A, 6B) supplying reactive gas to the reactive gas passage (9, 10) passes through a first region on one side of the reaction surface (2A, 2B). A positioning hole (5A) is formed in the ME (1) and the separator (3A, 3B) in a second region situated on the opposite side of the reaction surface (2A, 2B). By fitting a through-pin (5B) in the positioning hole (5A), position offset of the reaction surface (2A, 2B) accompanying the stacking procedure is centered on a part with high reactive gas concentration, and deterioration due to the shortage of reactive gas in the offset reaction surface (2A, 2B) is prevented.

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DESCRIPTION

MANUFACTURE OF FUEL CELL STACK

FIELD OF THE INVENTION

This invention relates to lamination of fuel cells for manufacturing a fuel cell stack.

BACKGROUND OF THE INVENTION

A polymer electrolyte fuel cell (PAVED) generally comprises a membrane electrode assembly (MEA) having an anode and a cathode on either side of an electrolyte membrane which is an ion exchange membrane, and separators which sandwich the MEA. A structure in which a large number of membrane electrode assemblies are laminated together is referred to as a fuel cell stack. In the following description, the MEA and the separators which are laminated are referred to by the general name of laminated parts.

At the anode, hydrogen in the fuel gas supplied to the anode of the fuel cell is converted to hydrogen ions, and moves to the cathode via the electrolyte membrane which is suitably humidified. The electrons so produced are removed by an external circuit, and used as direct current electrical energy. An oxidant gas, such as the atmosphere, is supplied to the cathode, where oxygen in the oxidant gas reacts with the hydrogen ions and electrons at the cathode to produce water.

The above electrochemical reactions at the anode and cathode may be expressed by the following chemical equations:

anode: $H_2 \to 2H^+ + 2e^-$

cathode: $2H^+ + 2e^- + (1/2)\ O_2 \to H_2O$

JP2004-103255A published by the Japanese Patent Office in 2004 proposes making the cross-sectional shape of the separator wave-shaped to improve the output of the fuel cell. This wave-like separator is provided with many parallel slots. Among these, slots which are facing the anode are used as a fuel gas passage, and slots which are facing the cathode are used as an oxidant gas passage. Slots situated between adjoining separators are used as a cooling fluid passage. Sealing members are gripped between the separators and MEA, and between adjoining separators. The sealing members are disposed along the circumference of the separators.

SUMMARY OF THE INVENTION

In parts where the fuel gas or oxidant gas cannot easily reach, for example contact parts with the sealing members at the anode and cathode, the electrochemical reaction is inactive.

Such reaction inactive parts reduce the power generation efficiency of the fuel cell stack. Deterioration of the anode and cathode in the reaction inactive parts also occurs early. Therefore, it is desirable not to form an anode or cathode in parts where the electrochemical reaction is inactive.

However, when laminating the laminated parts to form the stack, a position offset accompanying lamination may occur between laminated parts.

Due to this position offset, even when the design is such that neither the anode nor the cathode reaches the electrochemical reaction inhibition parts, some parts of the anode and cathode may intrude into the electrochemical reaction inhibition parts. In order to suppress the position offset accompanying lamination of the MEA or separators, it is desirable to perform positioning during lamination not by points, but by lines. However, thin press-formed metal plates are often used for the separators. These separators tend to distort at the ends, and it is then difficult to set the base lines for positioning at the ends of the separators.

It is therefore an object of this invention to prevent the position offset accompanying lamination of laminated parts from inhibiting the electrochemical reaction at the anode or cathode.

In order to achieve the above object, this invention provides a method of manufacturing a fuel cell stack, wherein the fuel cell stack is a laminate of laminated parts comprising a membrane electrode assembly having a reaction surface, and a separator having a reactive gas passage facing the reaction surface. Each of the laminated parts comprises a first region situated on one side of the reaction surface, and a second region situated on the opposite side of the reaction surface, wherein a reactive gas supply manifold which supplies reactive gas to the reactive gas passage is formed in the first region through the laminated parts. The method comprises setting a positioning part at an identical position in the second region of each of the laminated parts, and laminating the laminated parts while positioning the positioning part of each of the laminated parts using a positioning jig prepared beforehand.

This invention also provides a fuel cell stack formed by laminating laminated parts comprising a membrane electrode assembly having a reaction surface, and a separator provided with a reactive gas passage facing the reaction surface. Each of the laminated parts comprises a first region situated on one side of the reaction surface, and a second region on the opposite side of the reaction surface. A reactive gas supply manifold which supplies reactive gas to the reactive gas passage is formed in the first region through the laminated parts, a positioning part is set at an identical position in the second region of each of the laminated parts, and the laminated parts are laminated by positioning the positioning parts by a positioning jig prepared beforehand.

The details as well as other features and advantages of this invention are set forth in the remainder of the specification and are shown in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is a plan view of the main parts of a fuel cell stack to which this invention is applied.

FIG.2 is a longitudinal sectional view of the fuel cell stack in the vicinity of a positioning pin according to this invention.

FIG.3 is a plan view of a membrane electrode assembly (MEA) and a separator which form a fuel cell stack.

FIG.4 is a longitudinal sectional view of the main parts of the fuel cell stack taken along a line IV-IV of FIG.3.

FIG.5 is a plan view of the main parts of the separator describing the arrangement of sealing members in the fuel cell stack.

FIG.6 is a plan view of the main parts of a fuel cell stack according to a second embodiment of this invention.

FIG.7 is a plan view of the main parts of a fuel cell stack according to a third embodiment of this invention.

FIG.8 is a plan view of the main parts of a fuel cell stack according to a fourth embodiment of this invention.

FIG.9 is a plan view of the main parts of a fuel cell stack according to a fifth embodiment of this invention.

FIG.10 is a plan view of the main parts of a fuel cell stack according to a sixth embodiment of this invention.

FIG.11 is a plan view of the main parts of a fuel cell stack according to a seventh embodiment of this invention.

FIG.12 is a plan view of the main parts of a fuel cell stack according to an eighth embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG.1 of the drawings, a membrane electrode assembly (MEA) 1 which has a rectangular plane shape has a cathode reaction surface 2A and an anode reaction surface 2B on both sides at its center. The reaction surface in the claims is a general term for describing the cathode reaction surface 2A and anode reaction surface 2B.

Referring to FIG. 4, separators 3A, 3B having a waveform-like cross-section are laminated with the MEA 1. The laminate of the MEA 1 and separators 3A, 3B constitutes a unit cell. A fuel cell stack is a laminate of many unit cells.

Referring again to FIG. 1, an oxidant gas supply manifold 6A, a fuel gas supply manifold 6B, and a cooling fluid supply manifold 6C pass through one end of the MEA 1 which is situated outside the cathode and anode reaction surfaces 2A, 2B. An oxidant gas discharge manifold 7A, a fuel gas discharge manifold 7B, and a cooling fluid discharge manifold 7C pass through the other end of the MEA 1 which is situated outside the cathode and anode reaction surfaces 2A, 2B. The supply manifolds 6A-6C and discharge manifolds 7A-7C likewise also penetrate the separators 3A, 3B.

Referring to FIG. 4, an oxidant gas passage 9 comprising plural parallel slots is formed between the separator 3B laminated with the MEA 1, and the cathode reaction surface 2A of the MEA 1. The oxidant gas passage 9 communicates with the oxidant gas supply manifold 6A and oxidant gas discharge manifold 7A.

A fuel gas passage 10 comprising plural parallel slots is formed between the separator 3A laminated with the MEA 1, and the anode reaction surface 2B of the MEA 1. The passage 10 communicates with the fuel gas supply manifold 6B and fuel gas discharge manifold 7B.

Plural parallel spaces formed between the separator 3A and separator 3B are used as a cooling fluid passage 11. The passage 11 communicates with the cooling fluid supply manifold 6C and cooling fluid discharge manifold 7C.

The passages 9-11 are formed in the longitudinal direction of the rectangular fuel cell so as to overlap with the reaction surfaces 2A, 2B of FIG. 1.

Air is used for the oxidant gas, and hydrogen-rich gas is used for the fuel gas.

In the completed fuel cell, after fuel gas is supplied to the passage 10 of each fuel cell from the fuel gas supply manifold 6B and hydrogen in the fuel gas causes the aforesaid electrochemical reaction to occur at the anode reaction surface 2B, residual gas flows into the fuel gas discharge manifold 7B.

Also, after oxidant gas is supplied to the passage 9 of each fuel cell from the oxidant gas supply manifold 6A and oxygen in the oxidant gas causes an electrochemical reaction to occur at the cathode reaction surface 2A, the residual gas containing the vapor generated by the reaction flows into the oxidant gas discharge manifold 7A.

The oxygen content of oxidant gas and hydrogen content of fuel gas are high upstream of the passages 9, 10, and decrease further downstream. In each fuel cell, the flow direction of oxidant gas in the passage 9 and the flow direction of fuel gas in the passage 10 are identical.

A cooling agent is supplied to the passage 11 of each fuel cell from the cooling fluid supply manifold 6C, and after cooling the fuel cells, it flows into the cooling fluid discharge manifold 7C. At both ends of the fuel cell in the transverse cross-section of the passages 9-11 shown in FIG. 4, sealing members 12 are respectively gripped between the separators 3A, separators 3B and MEA 1. FIG. 5 shows the arrangement of the sealing members 12 gripped by the separators 3A and the MEA 1.

Between the separators 3A and the MEA 1, the sealing members 12 are disposed so as to surround the fuel gas passage 10, fuel gas supply manifold 6B and fuel gas discharge manifold 7B. Between the separators 3B and MEA 1, the sealing members 12 are disposed so as to surround the oxidant gas passage 9, oxidant gas supply manifold 6A and oxidant gas discharge manifold 7A. Between the separators 3A, 3B, the sealing members 12 are disposed so as to surround the cooling fluid passage 11, cooling fluid supply manifold 6C and cooling fluid discharge manifold 7C.

Due to a difference in the cross-sectional shape of the fuel gas supply manifold 6B, fuel gas discharge manifold 7B and fuel gas passage 10, spaces 14B formed by the separator 3A, MEA 1 and sealing member 12 are not completely blocked from the fuel gas supply manifold 6B and fuel gas discharge manifold 7B, and as a result, part of the fuel gas supplied to the passage 10 circulates in the space 14B. Likewise, due to a difference in the cross-sectional shape of the oxidant gas supply manifold 6A, oxidant gas discharge manifold 7A and oxidant gas passage 9, a space 14A formed by the separator 3B, MEA 1 and sealing member 12 is not completely blocked from the oxidant gas supply manifold 6A and oxidant gas discharge manifold 7A, and as a result, a small amount of the oxidant gas supplied to the passage 9 circulates in the space 14A.

When the separators 3A, 3B are laminated with the MEA 1, positioning points formed beforehand in each laminated part are made to overlap in an identical plane position. Specifically, a positioning hole 5A is formed at the positioning point 5 of the MEA 1 and the separators 3A, 3B in a laminated part.

Referring to FIG. 2, the members are laminated by passing a through-pin 5B having a diameter which fits the positioning hole 5A straight through the positioning hole 5A. After lamination, the laminated parts are held in the laminated state by a special fixing member, and the through-pin 5B is removed. The through-pin 5B can also be left as part of the fuel cell stack.

Referring to FIG. 3, the positioning point 5 of each laminated part overlaps at an identical position on one plane. At the same time, during the lamination of the laminated parts, as shown in the figure, an arc-shaped offset 16 having the positioning point 5 as center is produced between laminated parts with increasing distance from the positioning point 5.

The position offset 16, as shown in FIG. 4, causes an intrusion of the reaction surfaces 2A, 2B into the spaces 14A, 14B. Among the unit cells shown in the figure, in the upper unit cells, there is no position offset between the MEA 1 and the separators 3A, 3B on both sides, and the reaction surfaces 2A, 2B do not intrude into the spaces 14A, 14B.

On the other hand, in the lower unit cells, a position offset does occur between the MEA 1 and separators 3A, 3B on both sides, and as a result, part of the reaction surfaces 2A, 2B intrudes into the spaces 14A, 14B. In the following description, this part is referred to as an intrusion part 15.

In the spaces 14A, 14B, since it is difficult to obtain sufficient oxidant gas and fuel gas in the intrusion part 15 to provide an electrochemical reaction, in the intrusion part 15, decrease of power generation efficiency and component deterioration tends to occur. Conversely, at the opposite end of the MEA 1, in the passage 10 situated at the lower end of the MEA 1 of FIG. 3, the reaction surface 2 may become insufficient.

In this embodiment, to avoid these problems, the positioning point 5 during lamination of the MEA 1 and separators 3A, 3B is set near the fuel gas discharge manifold 7B. As shown in FIG. 2, the positioning hole 5A through which the through-pin 5B passes is formed beforehand at the positioning point 5 of each laminated part.

However, the position of the positioning point 5 is not limited to the vicinity of the fuel gas discharge manifold 7B. It may be set near the oxidant gas discharge manifold 7A, or the cooling fluid discharge manifold 7C.

In other words, the positioning point 5 should be set at a position distant from the fuel gas supply manifold 6B, or more specifically, on the opposite side of the reaction surface 2, i.e., near the left-hand end of the MEA 1 in FIG. 1.

In the following description, in the MEA 1, the region on one side of the reaction surface 2A(2B) where the supply manifolds 6A-6C are formed is referred to as a first region. The region situated on the opposite side of the reaction surface 2A(2B) to the first region is referred to as a second region. The corresponding regions of the separators 3A, 3B are also referred to as a first region and second region. This invention sets the positioning point 5 in the second region. In this embodiment, the second region corresponds to the region wherein the discharge manifolds 7A-7C are formed.

If the laminated parts are laminated when the through-pin 5B passes through the positioning holes 5A formed in the second region, in the vicinity of the positioning point 5, there is no position offset between the laminated parts, but at the end on the opposite side to the positioning point 5, a position offset may occur between the laminated parts as described above, and part of the reaction surfaces 2A, 2B may intrude into the spaces 14A, 14B as the intrusion part 15 due to this position offset. In other words, upstream of the passages 9-11, the intrusion part 15 is easily formed, but the intrusion part 15 is not formed downstream.

On the other hand, from 1.2 times to 1.4 times the stoichiometric calculated value of fuel gas spent on the electrochemical reaction is supplied to the fuel cell stack so that hydrogen is not in short supply for the reaction in the downstream part of the passage 10. Also, as regards the oxidant gas, a sufficient amount of oxidant gas in excess of the required amount is supplied to the fuel cell stack so that oxygen is not in short supply for the reaction in the downstream part of the passage 9.

Since hydrogen in the fuel gas of the passage 10 is consumed by contact with the anode reaction surface 2B, the hydrogen concentration of the passage 10 is higher upstream, and decreases further downstream.

Since oxygen in the oxidant gas of the passage 9 is consumed by contact with the cathode reaction surface 2A, and mixes with the water vapor formed at the cathode reaction surface 2A, the oxygen concentration of the passage 9 is higher upstream, and decreases further downstream.

Likewise, in the spaces 14B, the hydrogen concentration of the fuel gas is high further upstream, and in the spaces 14A, the oxygen concentration of the oxidant gas is high further upstream.

If the positioning point 5 is set in the second region, in the upstream part of the spaces 14A, 14B with a high concentration of oxygen and hydrogen, the intrusion part 15 will be easily formed, but in the downstream part of the spaces 14A, 14B with a low concentration of oxygen and hydrogen, the intrusion part 15 is not formed.

Regarding the intrusion part 15 which penetrates the upstream part of the spaces 14A, 14B with a high concentration of oxygen and hydrogen, there is no shortage of oxygen or hydrogen required for the electrochemical reaction, and the reaction goes smoothly. Therefore, deterioration of the intrusion part 15 does not easily occur, and the power generation efficiency of the MEA 1 does not easily decline. On the other hand, since the intrusion part 15 is not formed in the downstream part of the spaces 14A, 14B with a low concentration of oxygen and hydrogen, there is no deterioration of components nor decline in power generation efficiency, either.

Hence, due to the aforesaid setup of the positioning point 5, deterioration of the reaction surfaces 2A, 2B can be prevented, and decline in power generation efficiency can be avoided. Also, due to the through-pin 5B which passes through the positioning hole 5A and through the laminated parts, the lamination procedure is easier to perform.

In this embodiment, the cooling fluid passage 11 was formed parallel with the passages 9, 10, but this invention does not depend on the flow direction of the cooling fluid passage 11. This invention may be applied also to a fuel cell wherein the cooling fluid flows in the reverse direction to that of the fuel gas and oxidant gas. This invention moreover is not dependent on the presence or absence of the cooling fluid passage 11.

Next, referring to FIG. 6, a second embodiment of this invention will be described.

In this embodiment, the laminated part is approximately square-shaped, and the fuel gas supply manifold 6B and fuel gas discharge manifold 7B are made to run along one side of the square alongside each other. A middle manifold 13 is made to pass through the opposite side. Half of the plural slots which form the fuel gas passage 10 are connected to the supply manifold 6B and middle manifold 13, the remaining half being connected to the middle manifold 13 and discharge manifold 7B. The fuel gas passage 10 formed between the separator 3A and MEA 1, therefore, as shown by the arrow in the figure, forms a U-shaped flow from the supply manifold 6B to the discharge manifold 7B via the middle manifold 13.

The oxidant gas supply manifold 6A and cooling fluid supply manifold 6C are formed on one side of the two remaining sides of the square laminated part, and the oxidant gas discharge manifold 7A and cooling fluid discharge manifold 7C are formed on the one remaining side. However, various other arrangements of the oxidant gas and cooling fluid manifolds are possible.

In this embodiment, the positioning point 5 is set near the middle manifold 13A when the laminated parts, i.e., the MEA 1, and separators 3A, 3B, are laminated. This region corresponds to the second region situated on the opposite side of the reaction surface 2A(2B).

Also in this embodiment, the position offset 16 between laminated parts produced by lamination of the laminated parts is largest near the fuel gas supply manifold 6B. In other words, the position offset becomes larger in the upstream part of the passage 10 where the fuel gas contains a large amount of hydrogen, and decreases toward the middle manifold 13. Therefore, in this embodiment, as in the first embodiment, deterioration of the reaction surfaces 2A, 2B can be prevented, and decline in power generation efficiency can be avoided.

Next, referring to FIG. 7, a third embodiment of this invention will be described.

In this embodiment, in an identical fuel cell to that of the first embodiment, an end face 50 of the MEA 1 and separators 3A, 3B near the discharge manifolds 7A-7C is used as a positioning line instead of the positioning point 5, and a positioning jig 50A having a guide surface which forms a right angle with the laminated surfaces of these laminated parts, is provided. The end face 50 is brought into contact with the guide surface, and the MEA 1 and separators 3A, 3B are then laminated. Thus, in the fuel cell stack manufactured in this way, the position offset 16 between the laminated parts is concentrated near the supply manifolds 6A-6C.

Also in this embodiment, since the position offset 16 of the laminated parts is concentrated in the upstream part of the oxidant gas passage 9 and fuel gas passage 10 distant from the positioning line 50, a desirable effect is obtained in preventing deterioration of the reaction surfaces 2A, 2B, and avoiding decline in power generation efficiency as in the first embodiment.

Next, referring to FIG.8, a fourth embodiment of this invention will be described.

This embodiment is an embodiment where a through-hole 18 and penetration pin 18A are further added to the first embodiment. The through-hole 18 is formed in a diagonal position to the positioning point 5 which is set as in the first embodiment, and the laminated parts are positioned using the penetration pin 18A which passes through the through-hole 18. Here, the diameter of the through-hole 18 is formed with a predetermined larger dimension than the diameter of the penetration pin 18A. Specifically, the diameter of the through-hole 18 is made larger than the penetration pin 18A by the dimensional tolerance of the laminated parts.

Due to the above construction, the laminated parts are laminated with the through-pin 5B passing through the positioning hole 5A, and the penetration pin 18A passing through the through-hole 18. Since the diameter of the through-hole 18 is larger than the penetration pin 18A by the dimensional tolerance of the laminated parts, all the laminated parts can be laminated with the through-pin 5B in the positioning hole 5A, and the positioning pin 18A in the through-hole 18, respectively. At the same time, due to the penetration of the penetration pin 18A in the through-hole 18, the position offset 16 during lamination can be suppressed still smaller than in the first embodiment. After lamination, the fuel cell stack is held in the laminated state by special fixing members, and the through-pins 5B and 18A are then removed. However, the through-pins 5B and 18A can also be left as part of the fuel cell stack.

Referring to FIG. 9, a fifth embodiment of this invention will now be described.

In this embodiment, instead of the through-hole 18 and penetration pin 18A of the fourth embodiment, a notch 19 is formed near the fuel gas supply manifold 6B of the laminated parts. When the fuel cell stack is laminated, the laminated parts are laminated with the through-pin 5B passing through the positioning hole 5A and the penetration pin 19A passing through the notch 19. The depth of the notch 19 is made larger by the dimensional tolerance of the laminated parts. On the other hand, the width of the notch 19 should be just sufficient to allow insertion of the penetration pin 19A. After lamination, the fuel cell stack is held in the laminated state by special fixing members, and the through-pins 5B and 19A are then removed. However, the through-pins 5B and 19A can also be left as part of the fuel cell stack.

According to this embodiment, the position offset 16 during lamination of the laminated parts can be suppressed still smaller than in the first embodiment. Further, lamination of the laminated parts is easier than in the fourth embodiment.

Referring to FIG.10, a sixth embodiment of this invention will now be described.

According to this embodiment, in addition to the construction of the first embodiment, the laminated parts comprising the MEA 1 and separators 3A, 3B are laminated using a perpendicular guide 20. The perpendicular guide 20 has a guide surface which makes a right angle with the lamination surface of the laminated parts, and it guides a long side of the laminated parts along the guide surface. The perpendicular guide 20 is provided as part of a jig for laminating the laminated parts.

When the fuel cell stack is assembled, as shown in the diagram, the laminated parts are laminated with part of the long side of the laminated parts, which is in a diagonal position relative to the positioning pin 5, pressed against the surface of the perpendicular guide 20, and with the through-pin 5B passing through the positioning hole 5A. As a result, the sides of the laminated parts are evenly disposed, and the position offset 16 of the laminated parts can be suppressed still smaller than in the first embodiment.

If the separators 3A, 3B have sufficient rigidity, the perpendicular guide 20 may be formed in one piece not with a jig, but with the separators 3A, 3B situated at the far end of the fuel cell stack. In this case, the perpendicular guide 20 is not removed after the fuel cell stack is assembled, but forms part of the fuel cell stack. The position of the perpendicular guide 20 is not necessarily limited to a diagonal position relative to the positioning point 5. Even in other positions, a desirable effect is obtained depending on the position.

Referring to FIG.11, a seventh embodiment of this invention will now be described.

In this embodiment, instead of the perpendicular guide 20 of the sixth embodiment, a perpendicular guide 21 which penetrates the oxidant gas supply manifold 6A is used. The perpendicular guide 21 has a guide surface which makes a right angle with the lamination surface of the laminated parts, and as shown in the figure, it guides the wall surface of the oxidant gas supply manifold 6A along the guide surface.

During assembly of the fuel cell stack, as shown in the diagram, the laminated parts are laminated with one side of the oxidant gas supply manifold 6A pressed against the guide surface of the perpendicular guide 21 which has been inserted into the supply manifold 6A, and with the through-pin 5B passing through the positioning hole 5A.

The perpendicular guide 21, like the perpendicular guide 20, is provided as part of a jig for laminating the laminated parts. However, if the separators 3A, 3B have sufficient rigidity, the perpendicular guide 21 may be formed in one piece not with the jig, but with the separators 3A, 3B situated at the far end of the fuel cell stack. In this case, the perpendicular guide 21 is not removed after the fuel cell stack is assembled, but forms part of the fuel cell stack. In that case, the cross-sectional area of the oxidant gas supply manifold 6A must be sufficiently enlarged compared with the cross-sectional area of the perpendicular guide 21 so that the perpendicular guide 21 does not impede circulation of oxidant gas in the oxidant gas supply manifold 6A.

According to this embodiment, the positioning accuracy of the oxidant gas supply manifold 6A is further improved compared to the fifth embodiment, as well as the positioning accuracy of the other supply manifolds 6B, 6C.

Referring to FIG. 12, an eighth embodiment of this invention will now be described.

This embodiment is related with the application of this invention to a fuel cell stack which uses the reaction surfaces 2A, 2B held perpendicularly as shown in the diagram.

In a unit cell forming the fuel cell stack, the fuel gas supply manifold 6B is installed in a diagonal position relative to the fuel gas discharge manifold 7B, and the oxidant gas supply manifold 6A is installed in a diagonal position relative to the oxidant gas discharge manifold 7A. The positioning point 5 comprising the through-hole 5A and through-pin 5B is set near the fuel gas discharge manifold 7B.

In this embodiment also, the through-pin 5B has an identical effect to that of the first embodiment as regards the positioning of the laminated parts.

Also, in this embodiment, the fuel gas flow paths from the fuel gas supply manifold 6B to the fuel discharge manifold 7B are of substantially identical length. The oxidant gas flow paths from the oxidant gas supply manifold 6A to the oxidant gas discharge manifold 7A are also of substantially identical length. As a result, distribution of fuel gas to the slots forming the passage 10, and distribution of oxidant gas to the slots forming the passage 9, are respectively equalized. Hence, scatter in the reaction between plural slots forming the fuel gas passage 10, decreases. Likewise, scatter in the reaction between plural slots forming the oxidant gas passage 9, decreases. Therefore, a desirable reaction efficiency is obtained overall.

In each of the aforesaid embodiments except the second embodiment, the oxidant gas supply manifold 6A and fuel gas supply manifold 6B are disposed on the same side relative to the reaction surface 2A(2B), so the oxidant gas and fuel gas flow in identical directions. The positioning point 5 is provided on the opposite side of the reaction surface 2A(2B) to the oxidant gas supply manifold 6B. Also, all the above-mentioned embodiments use atmosphere as the oxidant gas.

In these fuel cell stacks, specifying the positioning point 5 by the spatial relationship with the fuel gas supply manifold 6B has the following meaning.

When the fuel gas is in short supply for the reaction, all the fuel gas is oxidized and part of carbon which is used in the MEA 1 is also oxidized. This oxidation of carbon brings the MEA 1 a damage. This damage of the MEA 1 not only results in unrecoverable performance deterioration of the fuel cell, but also produces acids such as fluorinated acid and sulfuric acid that bring a problem such as corrosion of the separators.

In contrast, when the oxidant gas is in short supply for the reaction, although electrical output lowers in the part where the oxidant gas is in short supply, since no chemical reaction that may damage the MEA 1 takes place, unrecoverable performance deterioration of the fuel cell is not likely to occur.

This is the reason for specifying the positioning point 5 with respect to the spatial relationship with the fuel gas supply manifold 6B.

However, in order to prevent deterioration of the cathode reaction surface 2A and decline in power generation efficiency due to shortage of oxygen in the spaces 14A, the position at which the positioning point 5 is formed can also be set based on the oxidant gas supply manifold 6A.

In each of the aforesaid embodiments except the second embodiment, the oxidant gas, fuel gas and cooling fluid supply manifolds 6A-6C are formed in the first region on one side of the reaction surface 2A(2B), and the oxidant gas, fuel gas and cooling fluid discharge manifolds 7A-7C are formed in the second region on the opposite side of the reaction surface 2A(2B). In these embodiments, wherever the positioning point 5 is provided in the second region, intrusion in the spaces 14A, 14B of the reaction surfaces 2A, 2B is concentrated in the upstream part relative to the flow of oxidant gas and fuel gas. In these embodiments, therefore, both deterioration of the intrusion part 15 due to insufficient oxygen in the spaces 14A and deterioration of the intrusion part 15 due to insufficient hydrogen in the spaces 14B, can be prevented by this invention. The reactive gas in the claims is a general term for the fuel gas and oxidant gas supplied to the reaction surfaces 2B, 2A.

The contents of Tokugan 2005-32725, with a filing date of February 9, 2005 in Japan, are hereby incorporated by reference.

Although the invention has been described above by reference to certain embodiments of the invention, the invention is not limited to the embodiments described above. Modifications and variations of the embodiments described above will occur to those skilled in the art, within the scope of the claims.

For example, the third to seventh embodiments can be combined with the fuel cell stack of the second embodiment.

INDUSTRIAL FIELD OF APPLICATION

As described above, according to this invention, deterioration of the reaction surface and decline in power generation efficiency due to position offset of the reaction surface with respect to the separators when the fuel cell stack is manufactured, can be suppressed. Therefore, a particularly desirable effect can be obtained by applying it to manufacture of a fuel cell stack for use in a fuel cell vehicle where durability and high power generation efficiency are required.

The embodiments of this invention in which an exclusive property or privilege is claimed are defined as follows:

CLAIMS

1. A method of manufacturing a fuel cell stack, the fuel cell stack being a laminate of laminated parts comprising a membrane electrode assembly having a reaction surface, and a separator having a reactive gas passage facing the reaction surface, each of the laminated parts comprising a first region situated on one side of the reaction surface, and a second region situated on the opposite side of the reaction surface, wherein a reactive gas supply manifold which supplies reactive gas to the reactive gas passage is formed in the first region through the laminated parts, the method comprising:

setting a positioning part at an identical position in the second region of each of the laminated parts; and

laminating the laminated parts while positioning the positioning part of each of the laminated parts using a positioning jig prepared beforehand.

2. The fuel cell stack manufacturing method as defined in Claim 1, wherein the reactive gas comprises one of fuel gas and oxidant gas, or both.

3. The fuel cell stack manufacturing method as defined in Claim 2, wherein the positioning part comprises a positioning hole formed in each of the laminated parts, and the positioning jig comprises a through-pin which fits into the positioning hole.

4. The fuel cell stack manufacturing method as defined in Claim 3, further

comprising removing the through-pin after lamination of the laminated parts is completed.

5. The fuel cell stack manufacturing method as defined in Claim 3, wherein the reactive gas comprises fuel gas and oxidant gas, the reaction surface comprises an anode reaction surface at which an electrochemical reaction of the fuel gas occurs and a cathode reaction surface at which an electrochemical reaction of the oxidant gas occurs, the separator comprises a first separator facing the anode reaction surface and a second separator facing the cathode reaction surface, the reactive gas passage comprises a fuel gas passage formed between the anode reaction surface and the first separator, and an oxidant gas passage formed between the cathode reaction surface and the second separator, the reactive gas supply manifold comprises a fuel gas supply manifold which supplies the fuel gas to the fuel gas passage and an oxidant gas supply manifold which supplies the oxidant gas to the oxidant gas passage, the fuel gas supply manifold and the oxidant gas supply manifold pass through the first region, the fuel cell stack further comprises a fuel gas discharge manifold which discharges the fuel gas after the reaction from the fuel gas passage and an oxidant gas discharge manifold which discharges the oxidant gas after the reaction from the oxidant gas passage, and the fuel gas discharge manifold and the oxidant gas discharge manifold pass through the second region.

6. The fuel cell stack manufacturing method as defined in Claim 5, wherein the positioning hole is formed near the fuel gas discharge manifold.

7. The fuel cell stack manufacturing method as defined in Claim 6, wherein the fuel gas supply manifold is formed at a diagonal position relative to the fuel gas discharge manifold, and the oxidant gas supply manifold is formed at a diagonal position relative to the oxidant gas discharge manifold.

8. The fuel cell stack manufacturing method as defined in Claim 5, further comprising forming a second positioning hole on each of the laminated parts in the first region, and passing a second through-pin, prepared beforehand, through the second positioning hole when laminating the laminated parts.

9. The fuel cell stack manufacturing method as defined in Claim 8, wherein the second positioning hole is formed to have a diameter which is larger than the diameter of the second through-pin by dimensional tolerance of the laminated parts.

10. The fuel cell stack manufacturing method as defined in Claim 8, further comprising removing the second through-pin after lamination of the laminated parts is complete.

11. The fuel cell stack manufacturing method as defined in Claim 5, further comprising forming a notch on each of the laminated parts in the first region, and passing a second through-pin, prepared beforehand, through the notch when laminating the laminated parts.

12. The fuel cell stack manufacturing method as defined in Claim 11, wherein the notch is formed to have a depth which is larger than the diameter of the second through-pin by dimensional tolerance of the laminated parts.

13. The fuel cell stack manufacturing method as defined in Claim 5, further comprising using a guide prepared beforehand when laminating the laminated parts, wherein the guide has a guide surface which makes a right angle with the lamination surface of the laminated parts and is used to guide a side of the laminated parts along the guide surface.

14. The fuel cell stack manufacturing method as defined in Claim 13, further comprising removing the guide after lamination of the laminated parts is completed.

15. The fuel cell stack manufacturing method as defined in Claim 5, further comprising using a guide prepared beforehand when laminating the laminated parts, wherein the guide has a guide surface which makes a right angle with the lamination surface of the laminated parts, the reactive gas supply manifold has a side, and the guide is used to guide the side of the reactive gas supply manifold along the guide surface.

16. The fuel cell stack manufacturing method as defined in Claim 15, further comprising removing the guide after lamination of the laminated parts is

completed.

17. The fuel cell stack manufacturing method as defined in Claim 1, wherein the reactive gas comprises fuel gas and the reactive gas passage comprises a fuel gas passage, the supply manifold comprises a fuel gas supply manifold which supplies the fuel gas to the fuel gas passage, the fuel cell stack further comprises a fuel gas discharge manifold which discharges the fuel gas after reaction from the fuel gas passage and a middle manifold which temporarily retains the fuel gas in the middle of the fuel gas passage, the fuel gas supply manifold and the fuel gas discharge manifold pass through the first region, and the middle manifold passes through the second region.

18. The fuel cell stack manufacturing method as defined in Claim 1, wherein the fuel cell stack further comprises a reactive gas discharge manifold passing through the second region.

19. The fuel cell stack manufacturing method as defined in Claim 1, wherein the positioning part comprises an end surface of the laminated part, and the positioning jig comprises a jig having a guide surface which makes a right angle to the lamination surface of the laminated parts and guides the end surface of the laminated parts.

20. A fuel cell stack formed by laminating laminated parts comprising a membrane electrode assembly having a reaction surface, and a separator

provided with a reactive gas passage facing the reaction surface, each of the laminated parts comprising a first region situated on one side of the reaction surface, and a second region on the opposite side of the reaction surface,

wherein, a reactive gas supply manifold which supplies reactive gas to the reactive gas passage is formed in the first region through the laminated parts,

a positioning part is set at an identical position in the second region of each of the laminated parts, and

the laminated parts are laminated by positioning the positioning parts by a positioning jig prepared beforehand.

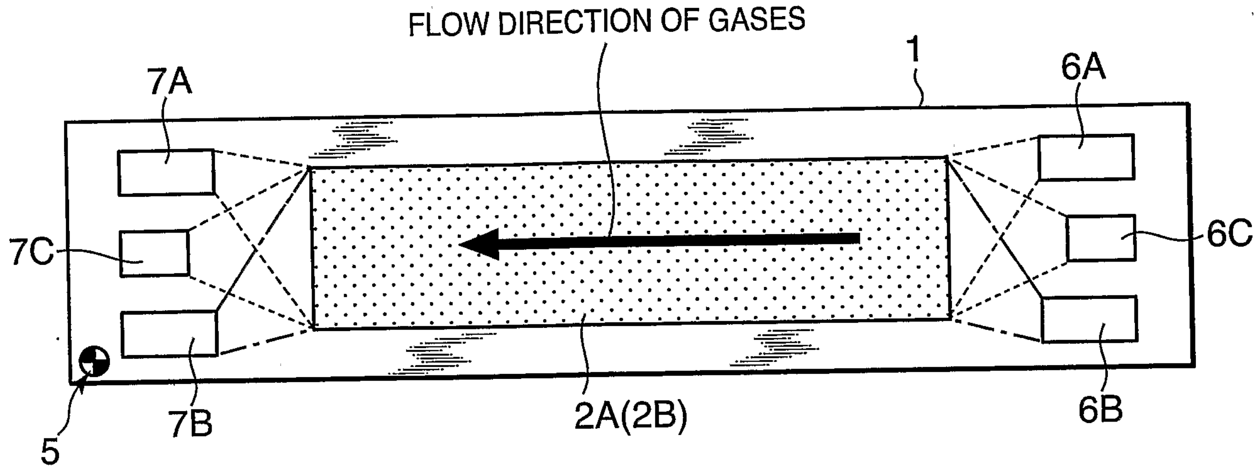
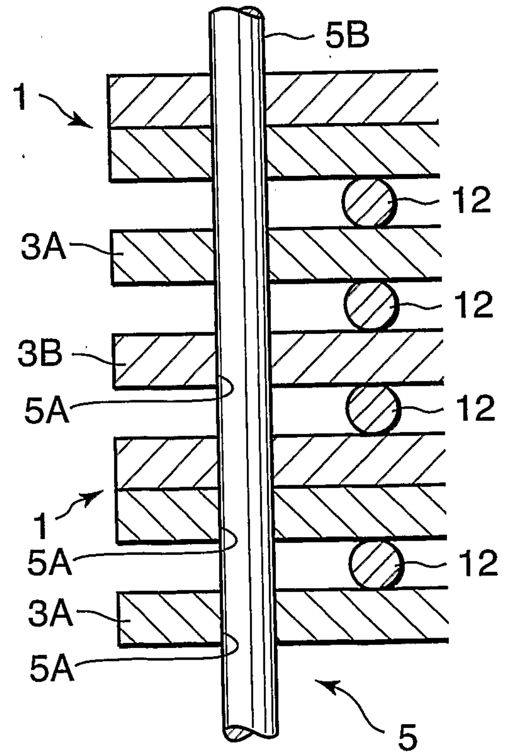

FLOW DIRECTION OF GASES
1
7A
6A
7C
6C
7B
2A(2B)
6B
5

FIG. 1


5B
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12
3A
12
3B
5A
12
1
5A
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3A
5A
5

FIG. 2

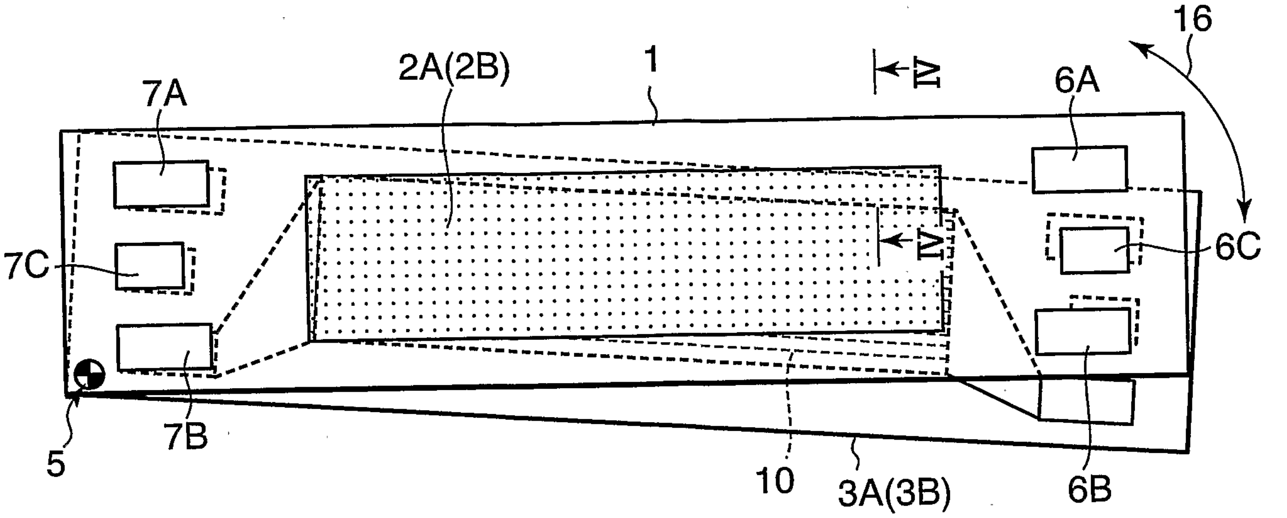

FIG. 3

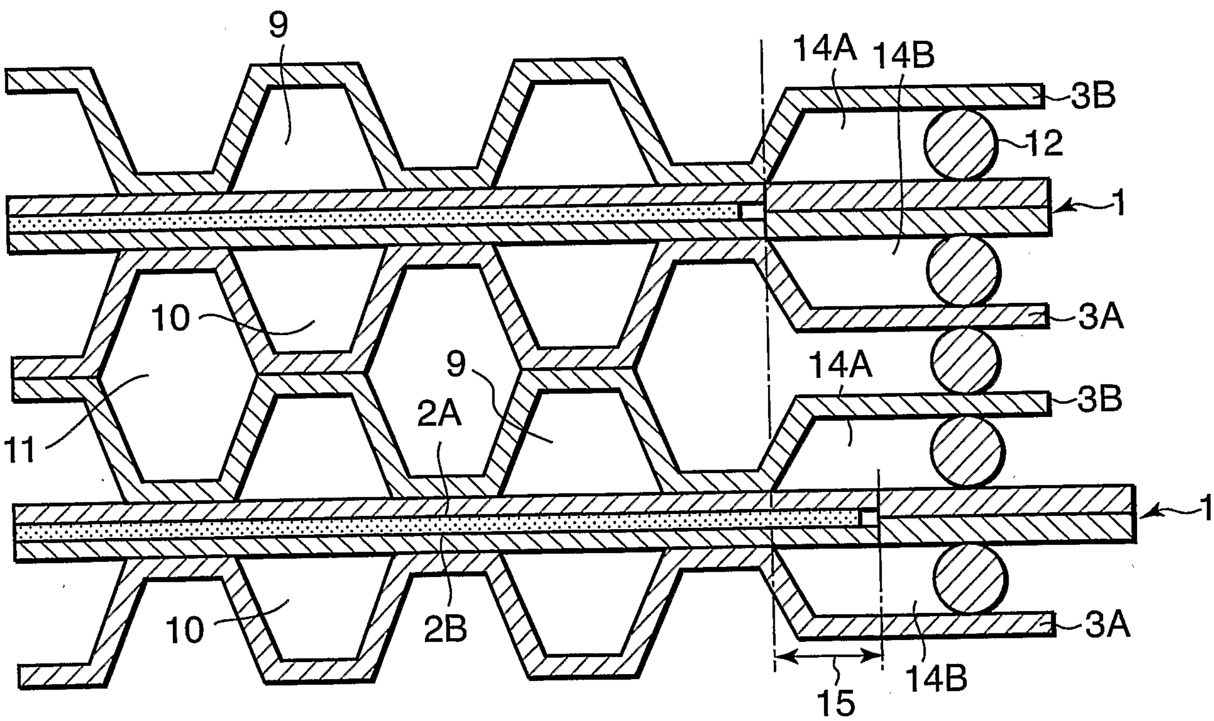

FIG. 4

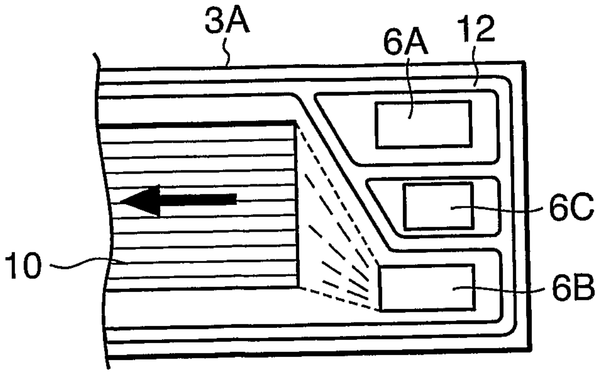

FIG. 5

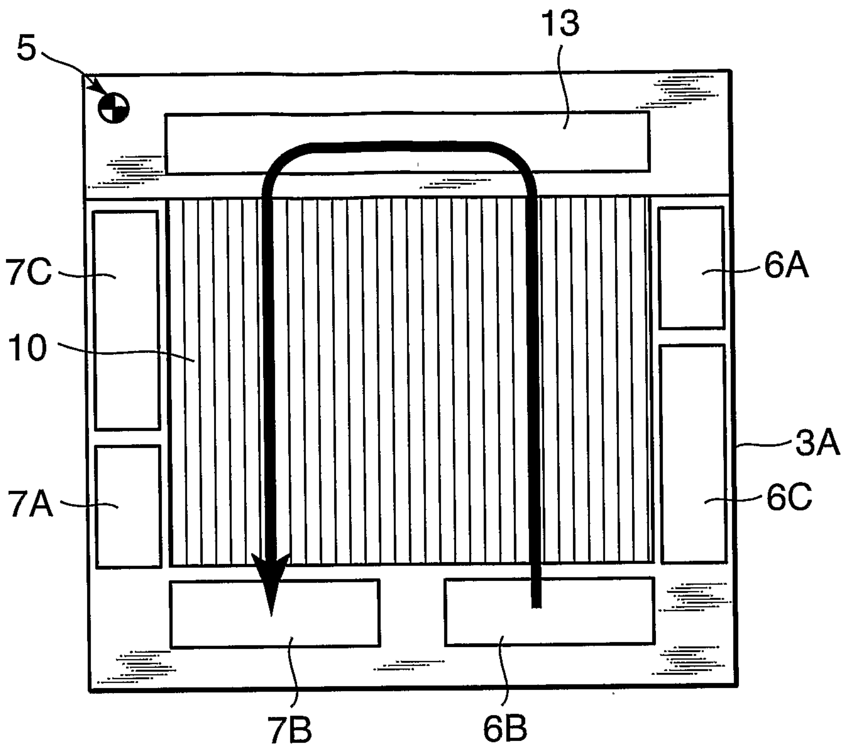

FIG. 6

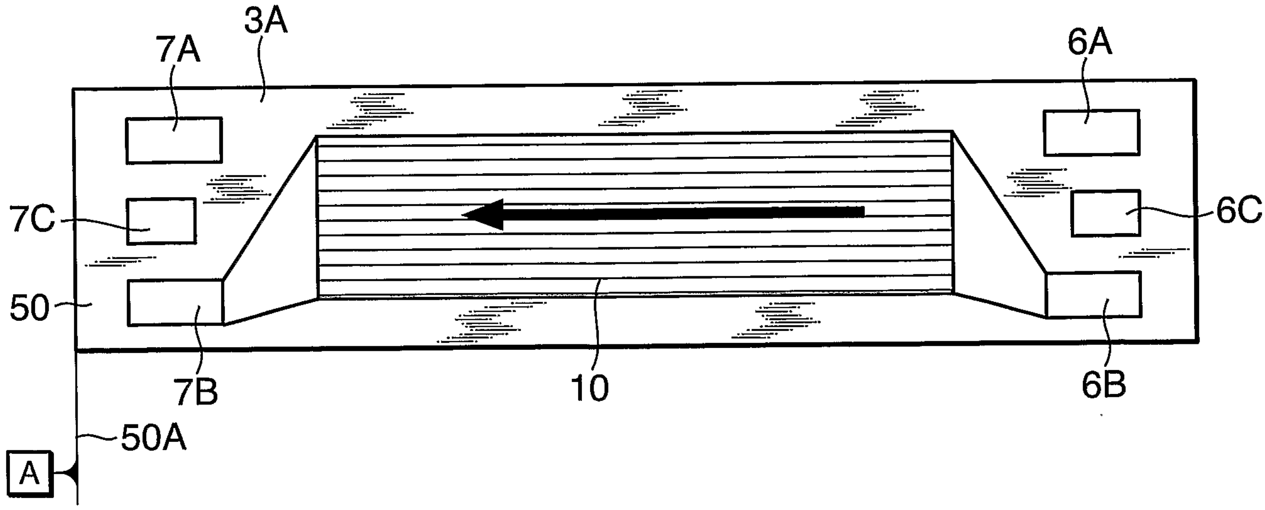

FIG. 7

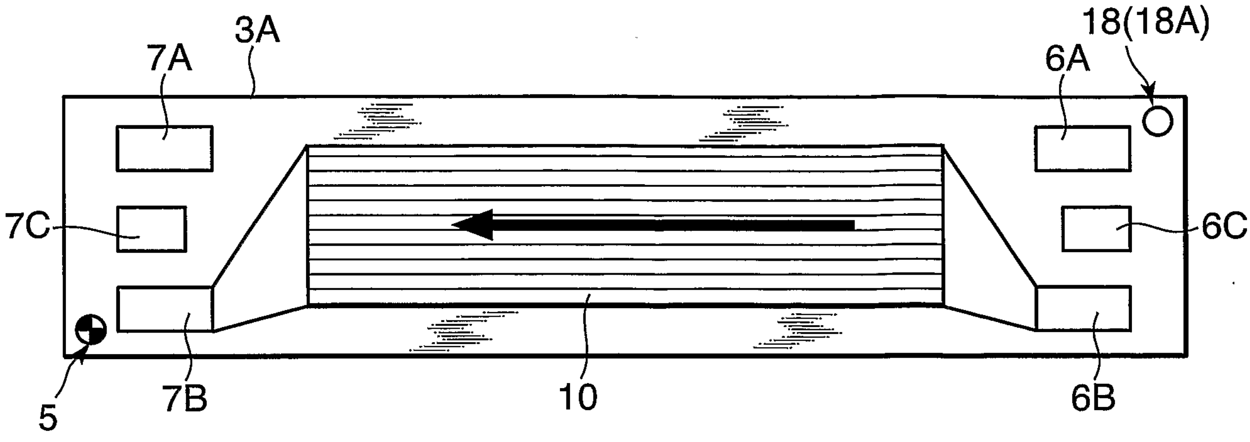

FIG. 8

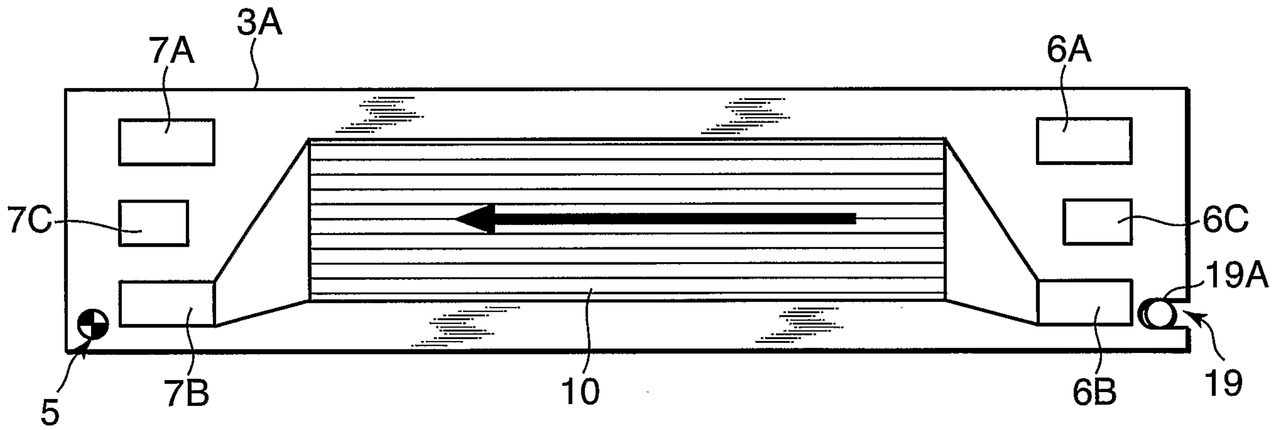

FIG. 9

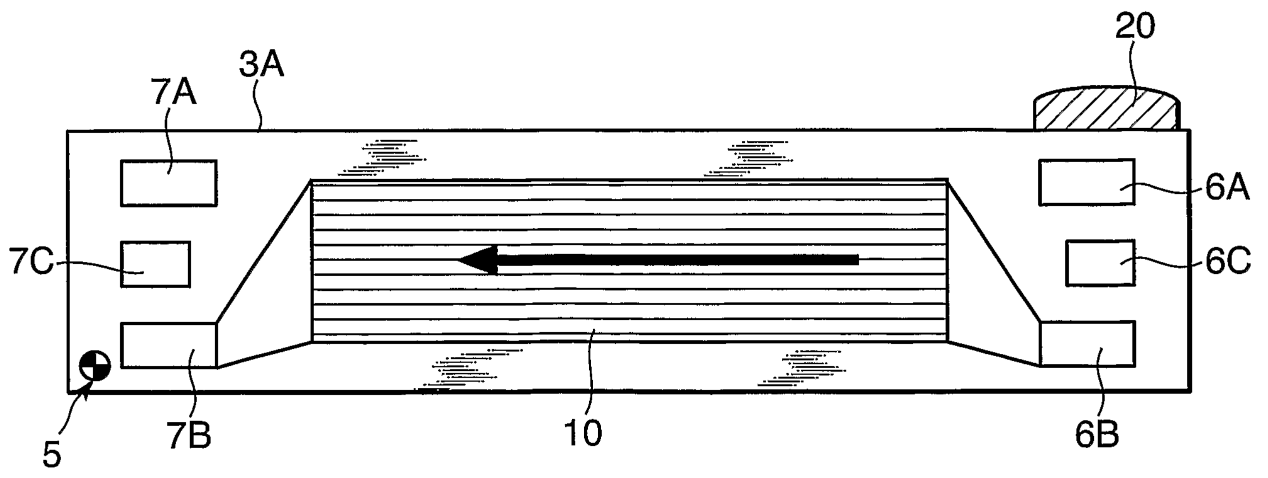

FIG. 10

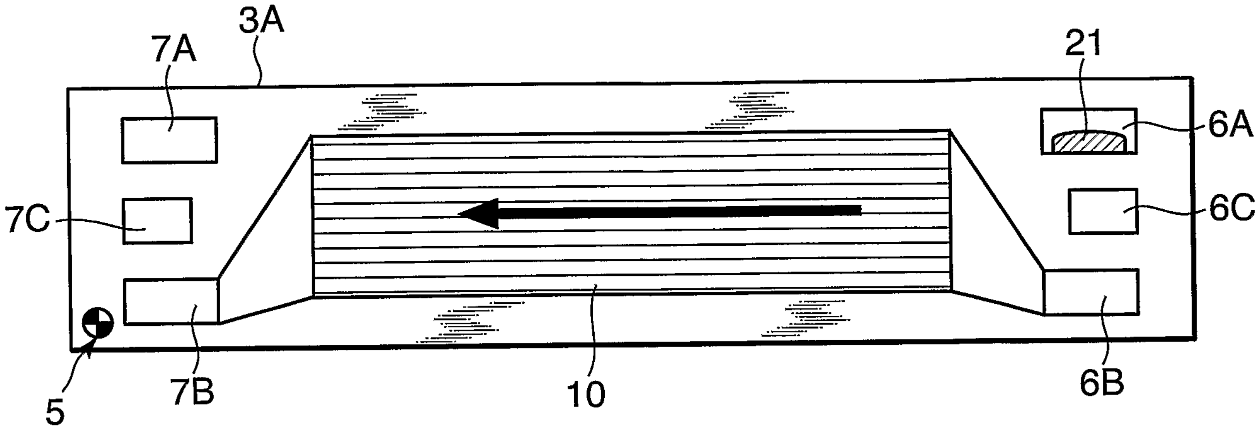

FIG. 11

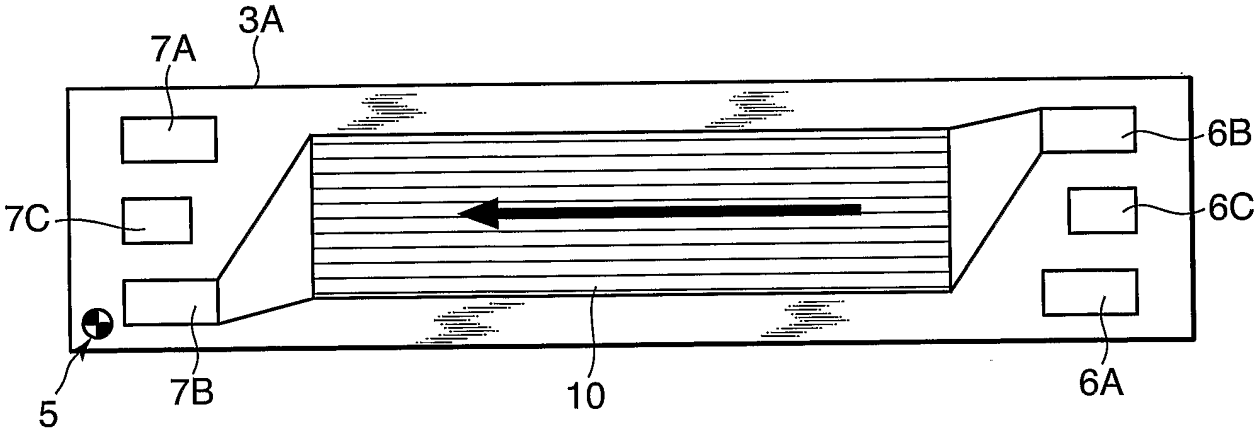

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2006/301703

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01M8/24
ADD. H01M8/10 H01M8/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 09, 30 September 1997 (1997-09-30) -& JP 09 134734 A (TANAKA KIKINZOKU KOGYO KK), 20 May 1997 (1997-05-20) abstract; figures 1-9	1-10,18, 20 11-17,19
X	US 2003/203265 A1 (CHEN RICHARD ET AL) 30 October 2003 (2003-10-30) paragraphs [0007] - [0009]; figures 13,16-18	1-3,18, 20

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 June 2006	28/06/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Raimondi, F

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2006/301703

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No
PCT/JP2006/301703

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