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(54) VAPOR DEPOSITION DEVICE

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(52) **U.S. Cl.**

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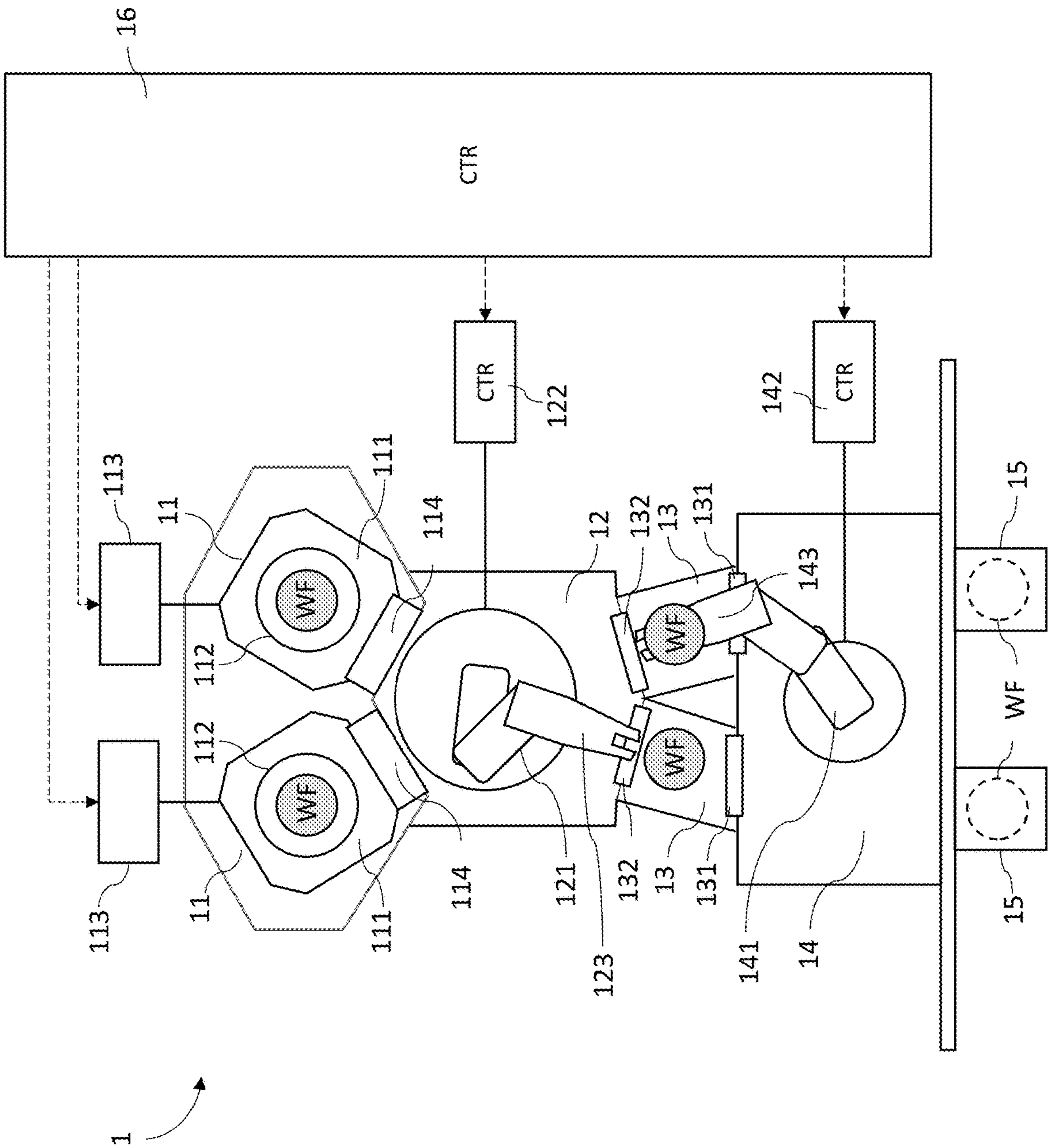
(57) **ABSTRACT**

A vapor deposition device is provided that can perform CVD processing without using a carrier. A first robot is provided with a first blade at a tip, the first blade includes a first recess which supports the carrier and a second recess which supports the wafer. A load-lock chamber is provided with a holder which can support the carrier and the wafer.


16
CTR
CTR
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CTR
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112
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WF
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1

Fig. 1

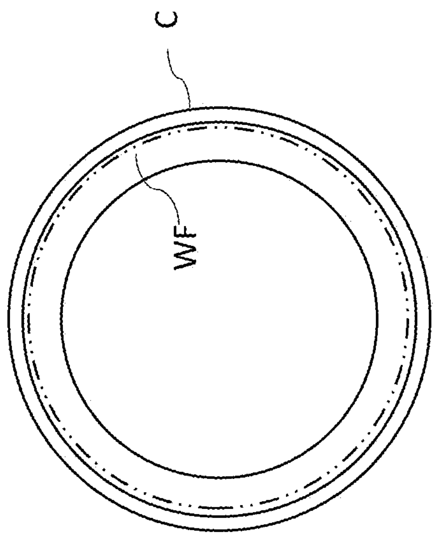

Fig. 2A

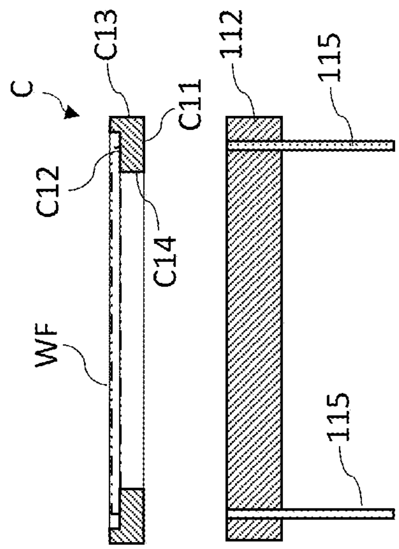

Fig. 2B

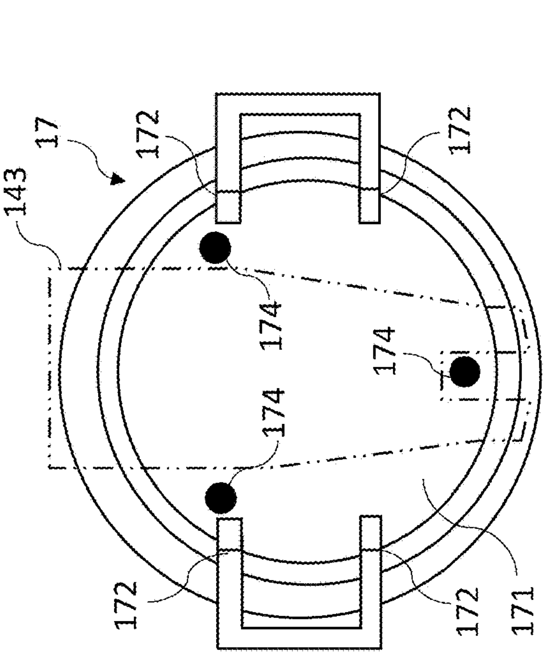
17
143
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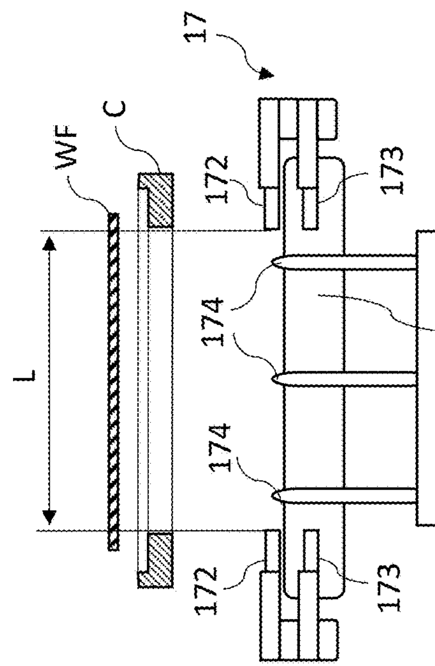
Fig. 3A


17
WF
C
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L
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173

Fig. 3B

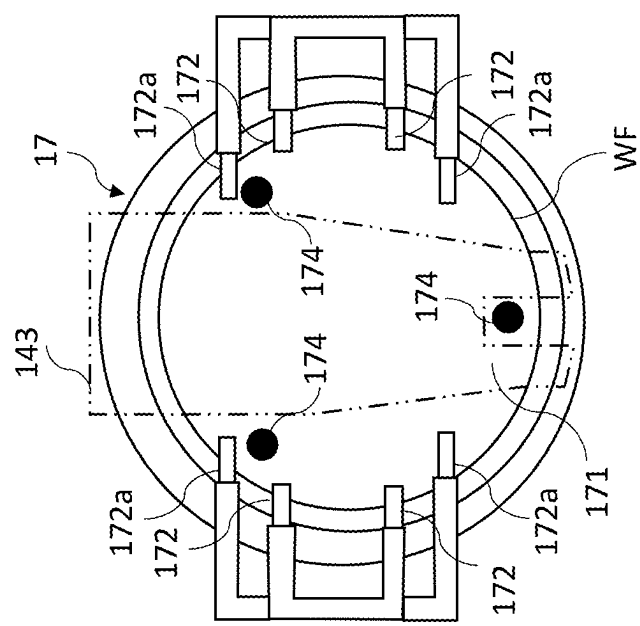


Fig. 3C

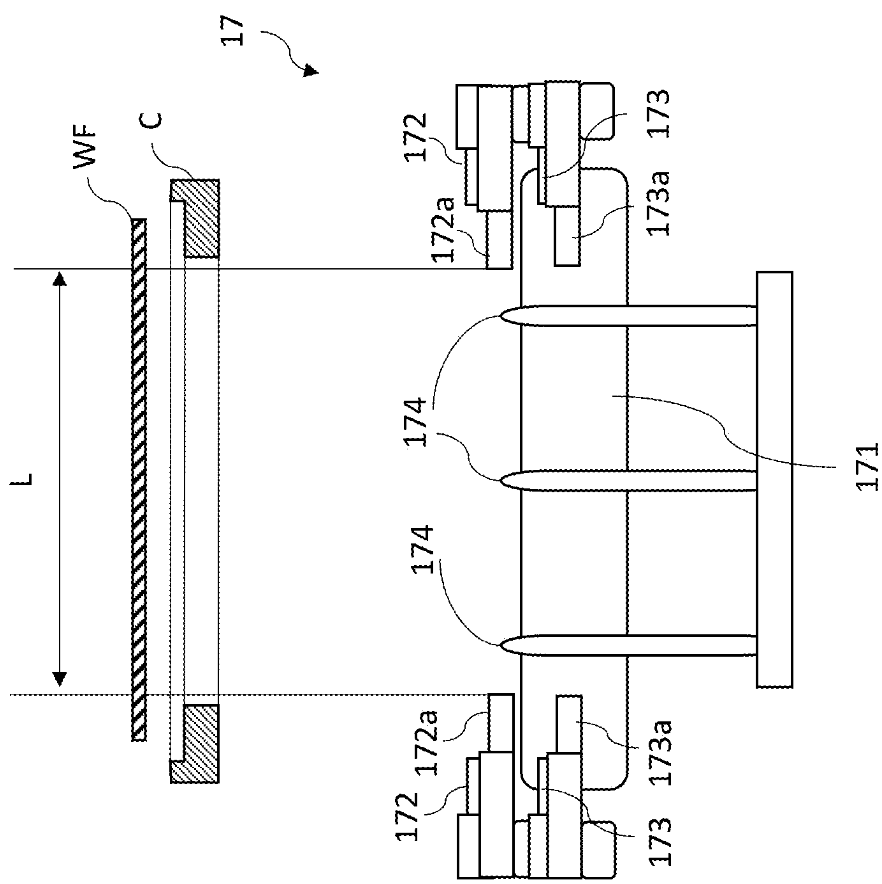


Fig. 3D

Fig. 4A

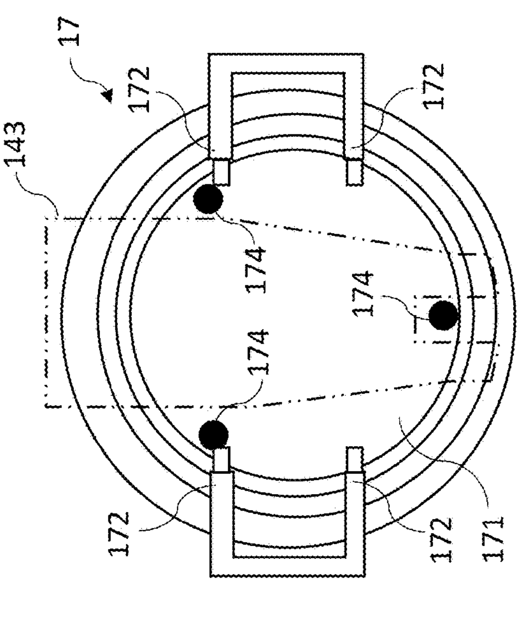


Fig. 4B

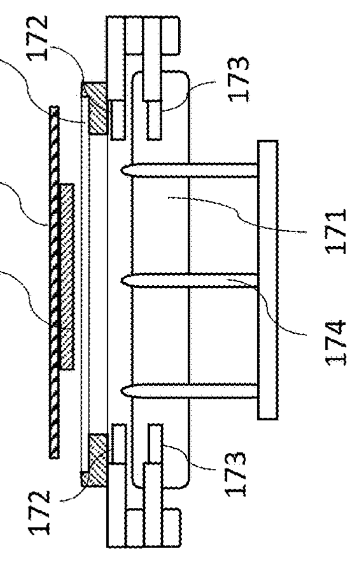


Fig. 4C

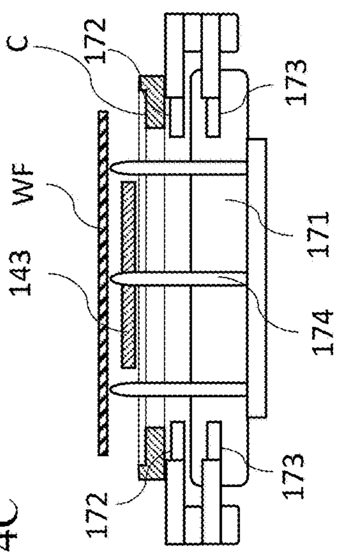


Fig. 4D

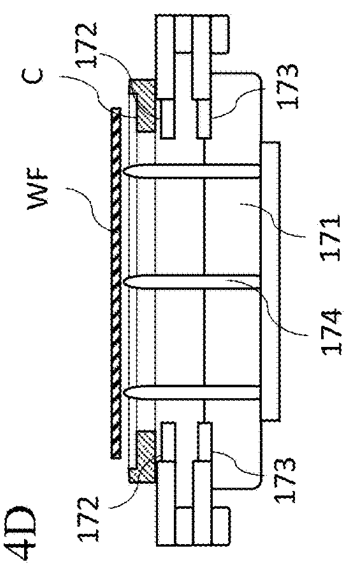
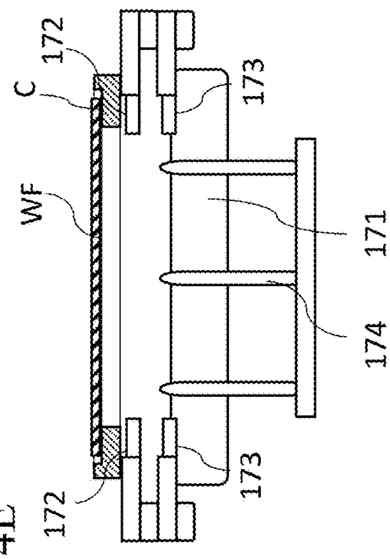


Fig. 4E



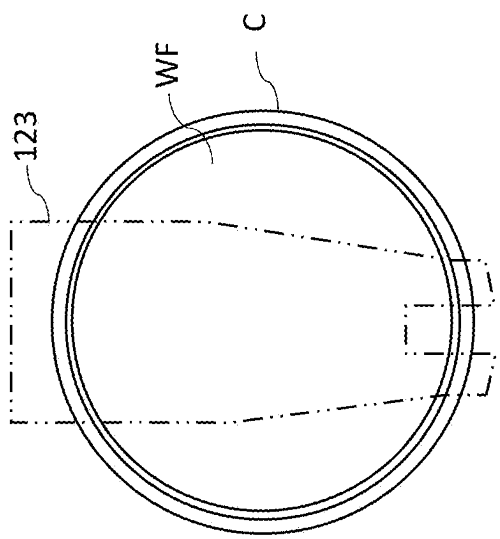


Fig. 5A

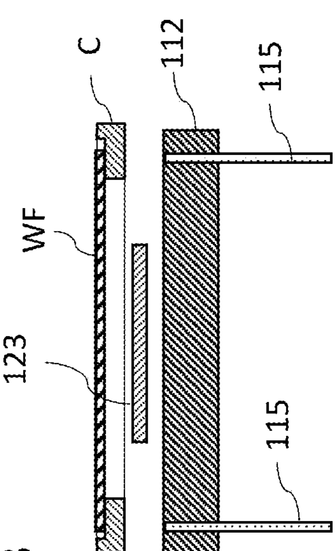


Fig. 5B

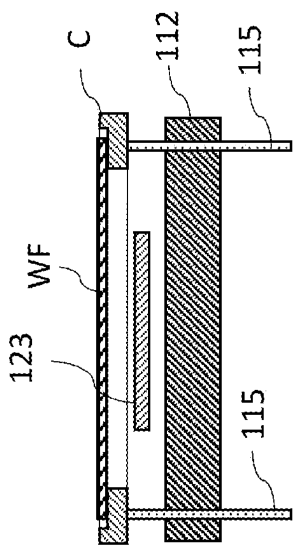


Fig. 5C

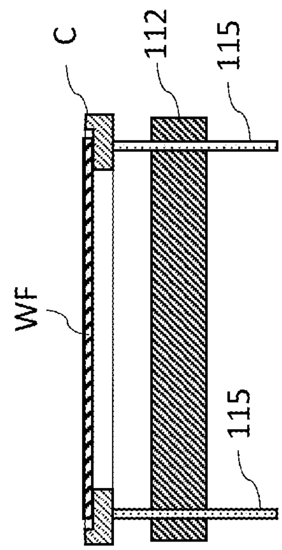


Fig. 5D

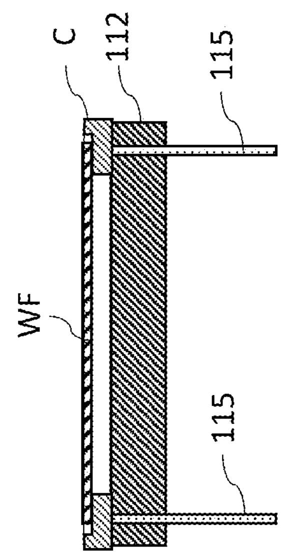


Fig. 5E

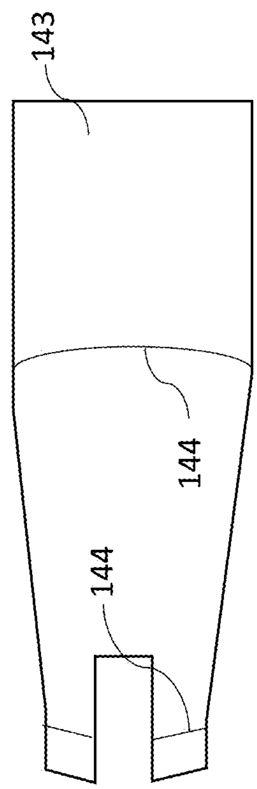


Fig. 6A

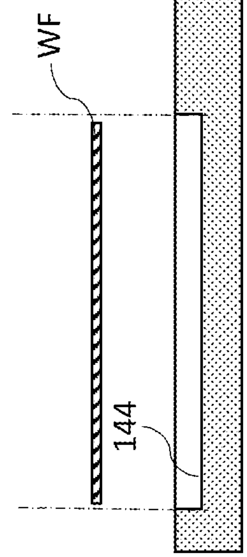


Fig. 6B

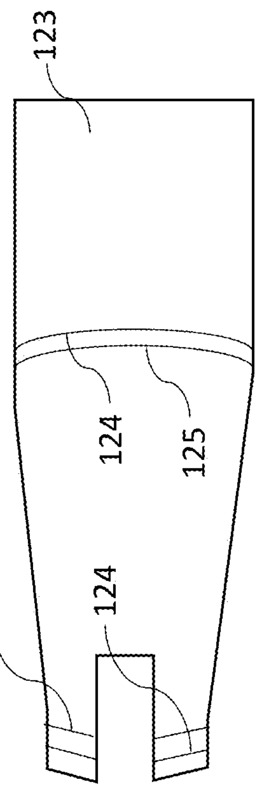


Fig. 7A

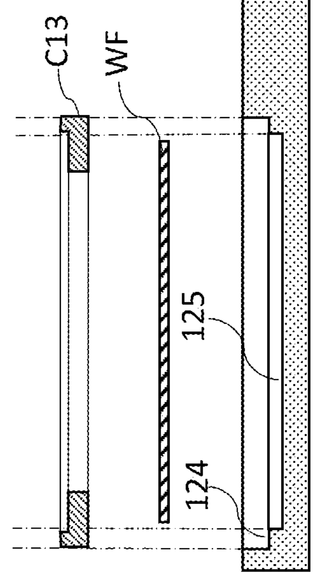
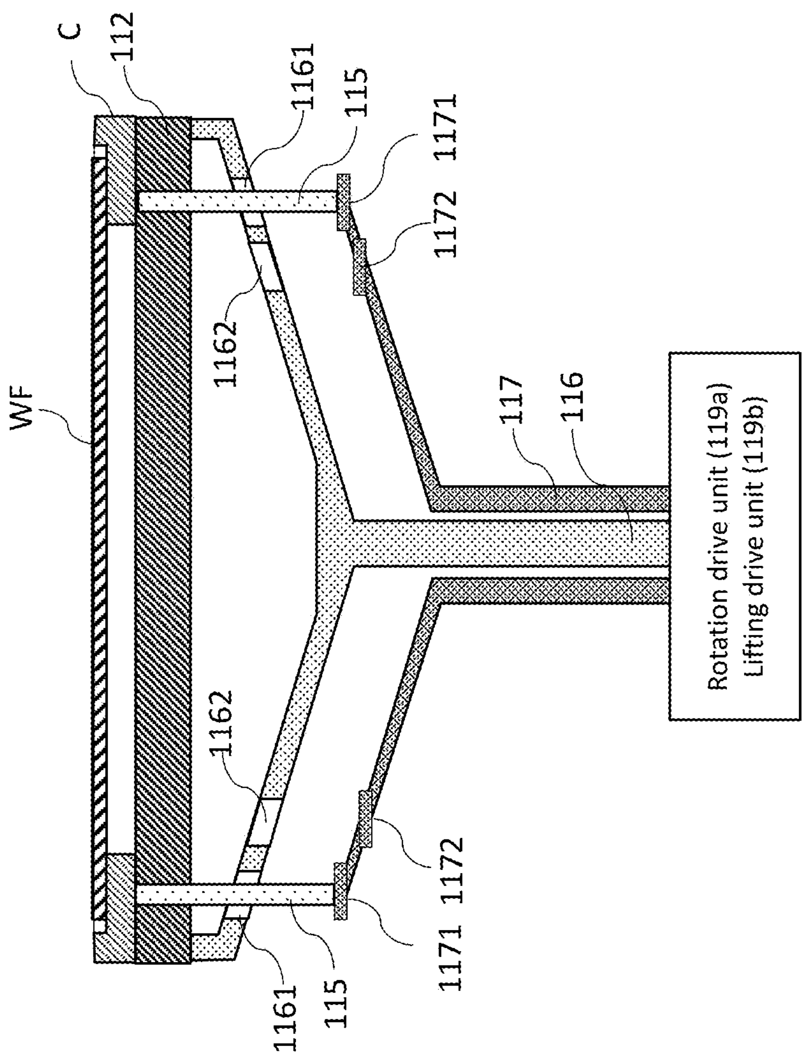


Fig. 7B


WF
C
112
1161
115
1171
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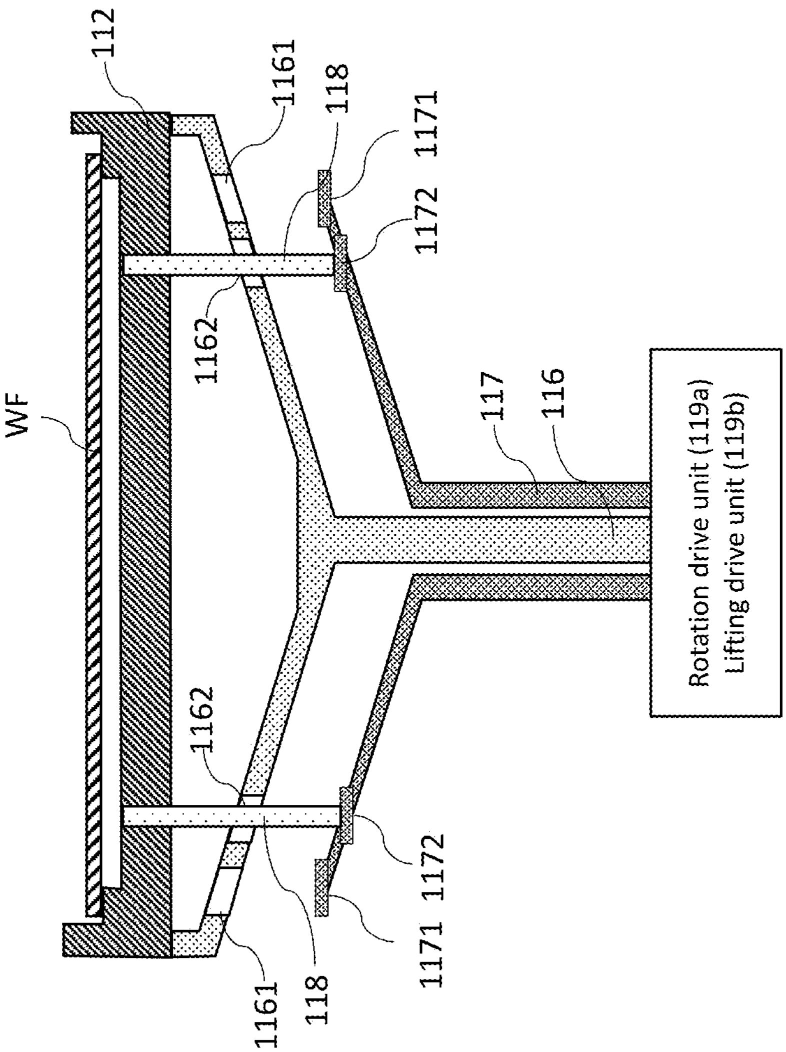
116
Rotation drive unit (119a)
Lifting drive unit (119b)
1162
1172
1171
115
1161

Fig. 8A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WF
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Rotation drive unit (119a)
Lifting drive unit (119b)
1162
1172
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118
1161

Fig. 8B

Fig. 9

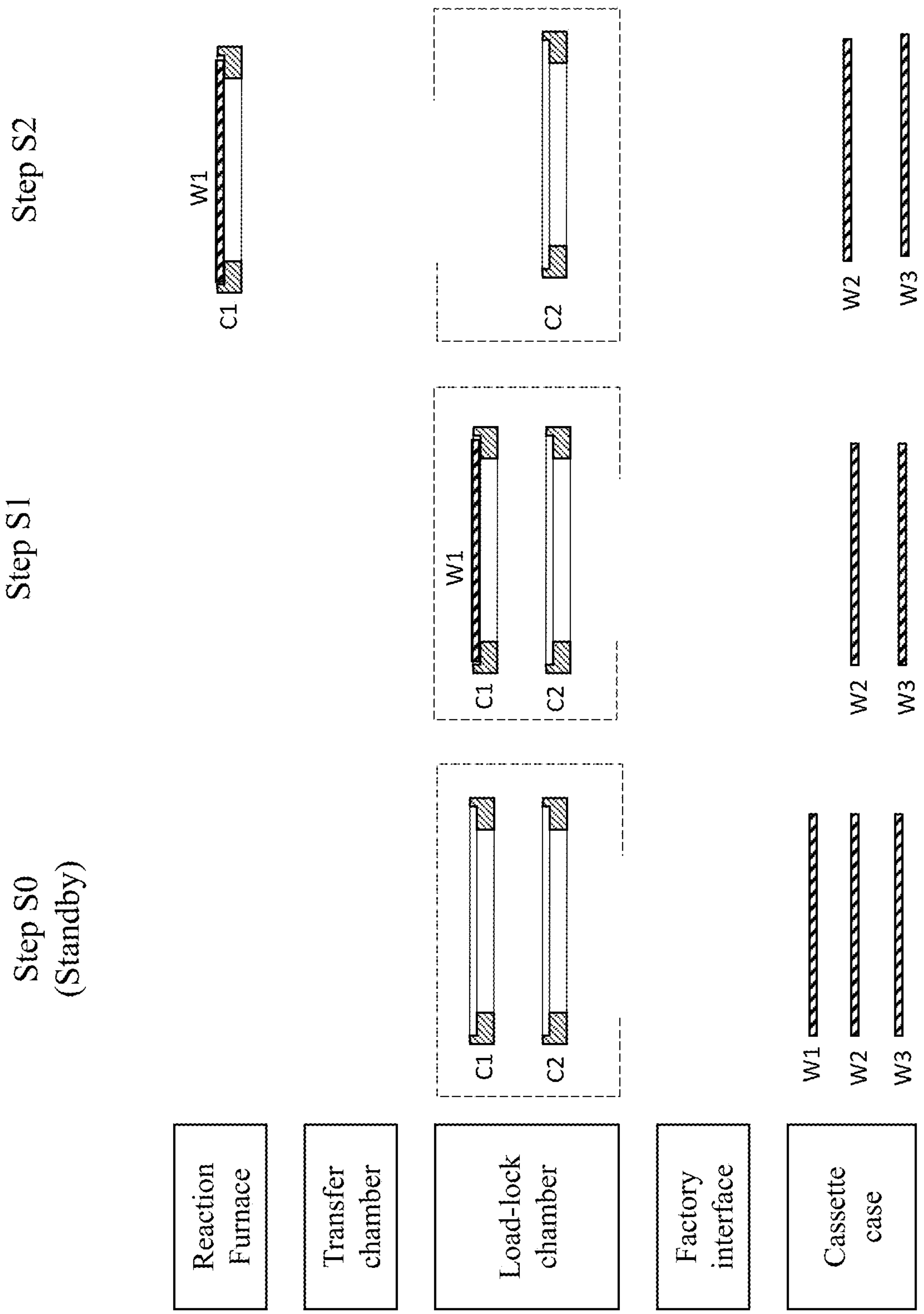

Reaction Furnace
Transfer chamber
Load-lock chamber
Factory interface
Cassette case
Step S0 (Standby)
Step S1
Step S2
C1
C2
W1
W2
W3

Fig. 10

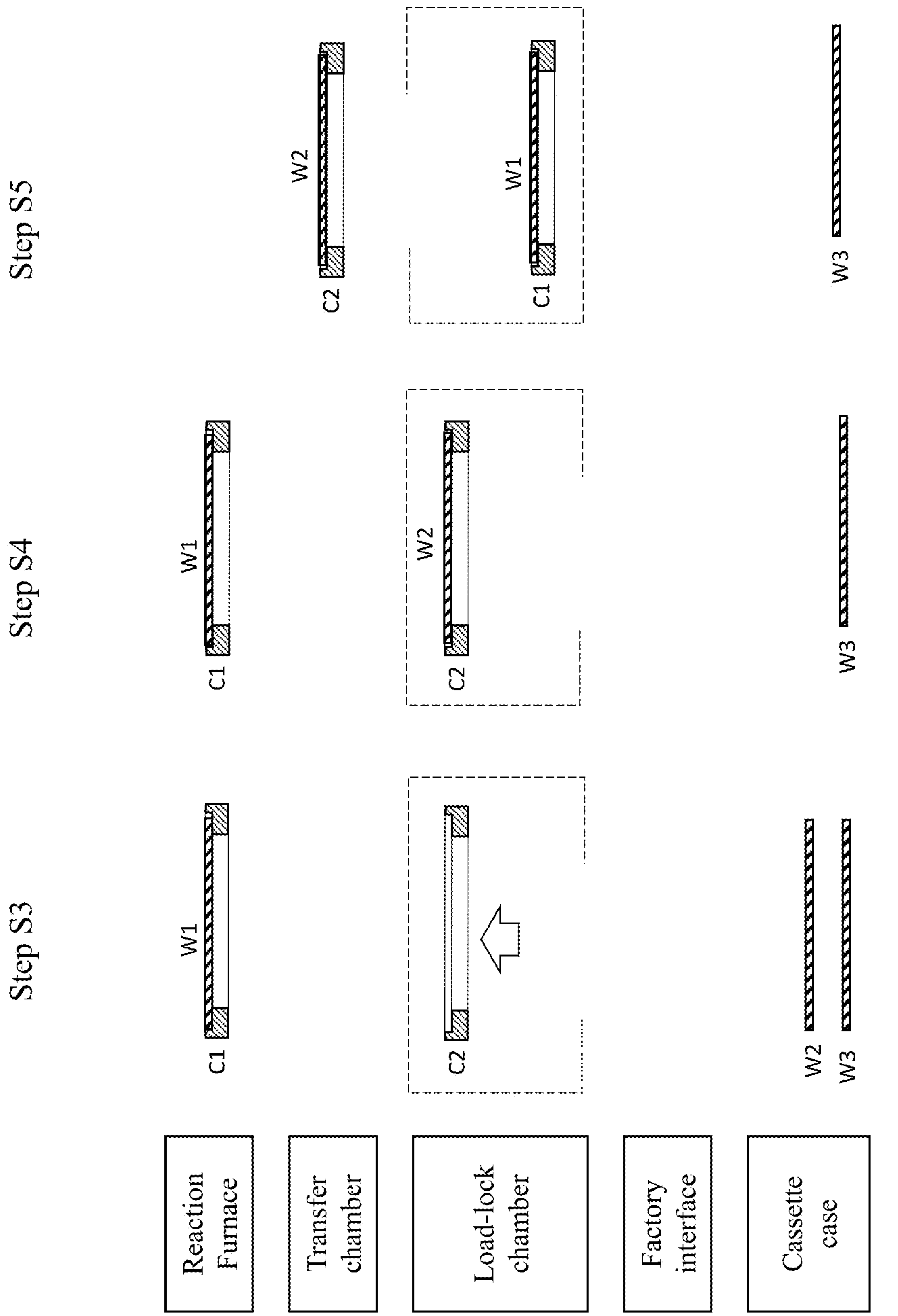

Step S3
Step S4
Step S5
W1
C1
C2
W2
W3
W1
C1
W2
C2
W3
W2
C2
W1
C1
W3
Reaction Furnace
Transfer chamber
Load-lock chamber
Factory interface
Cassette case

Fig. 11

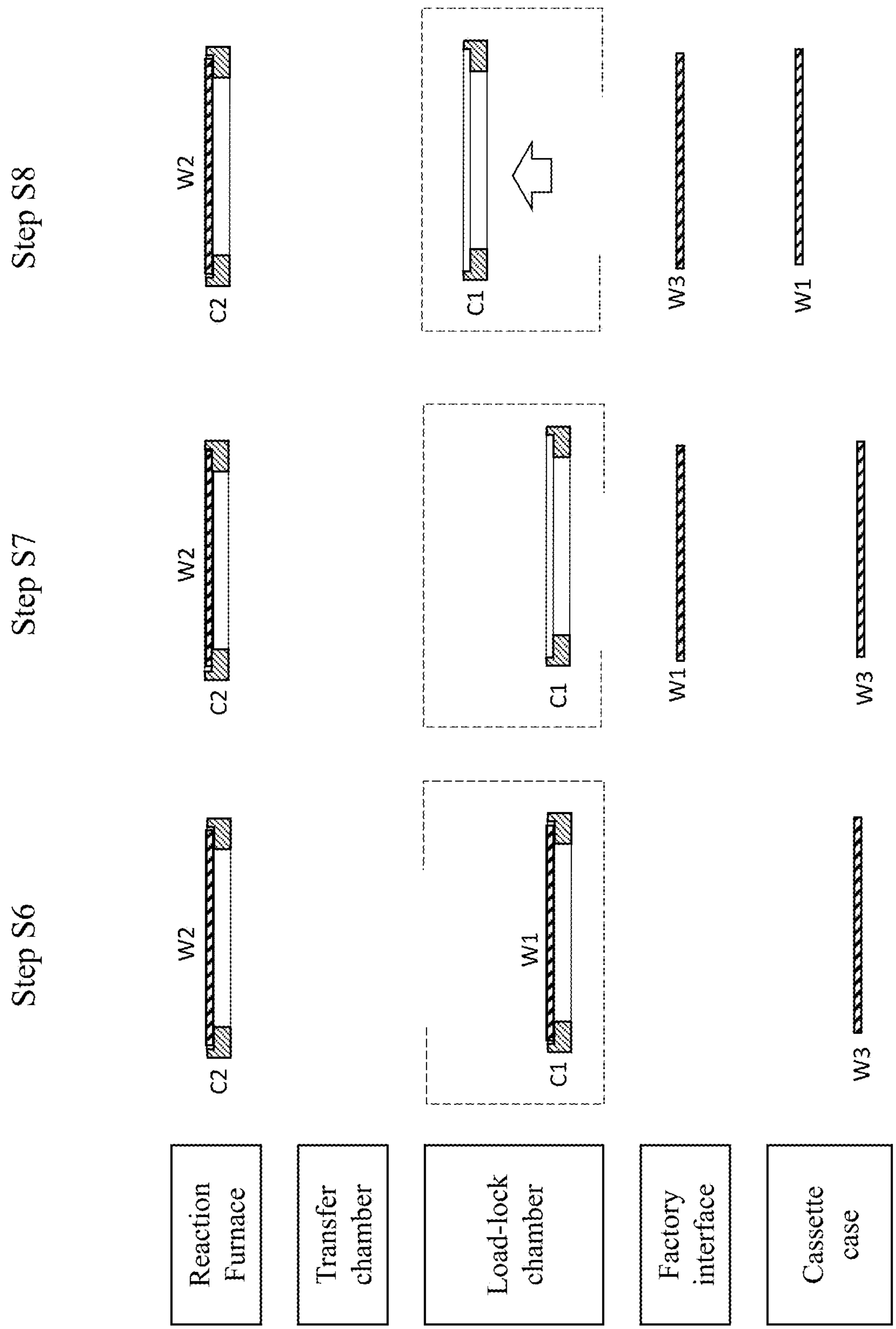
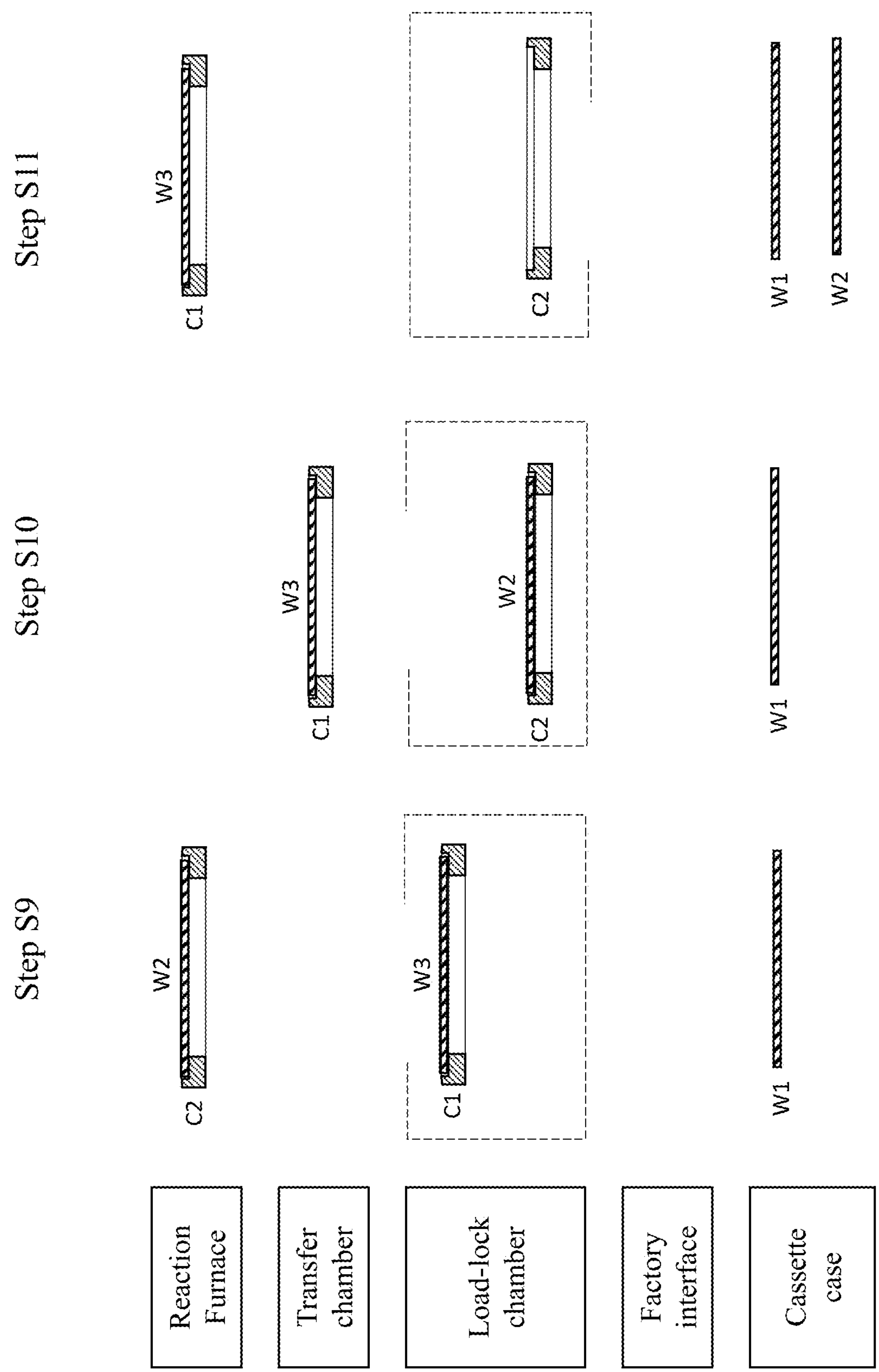
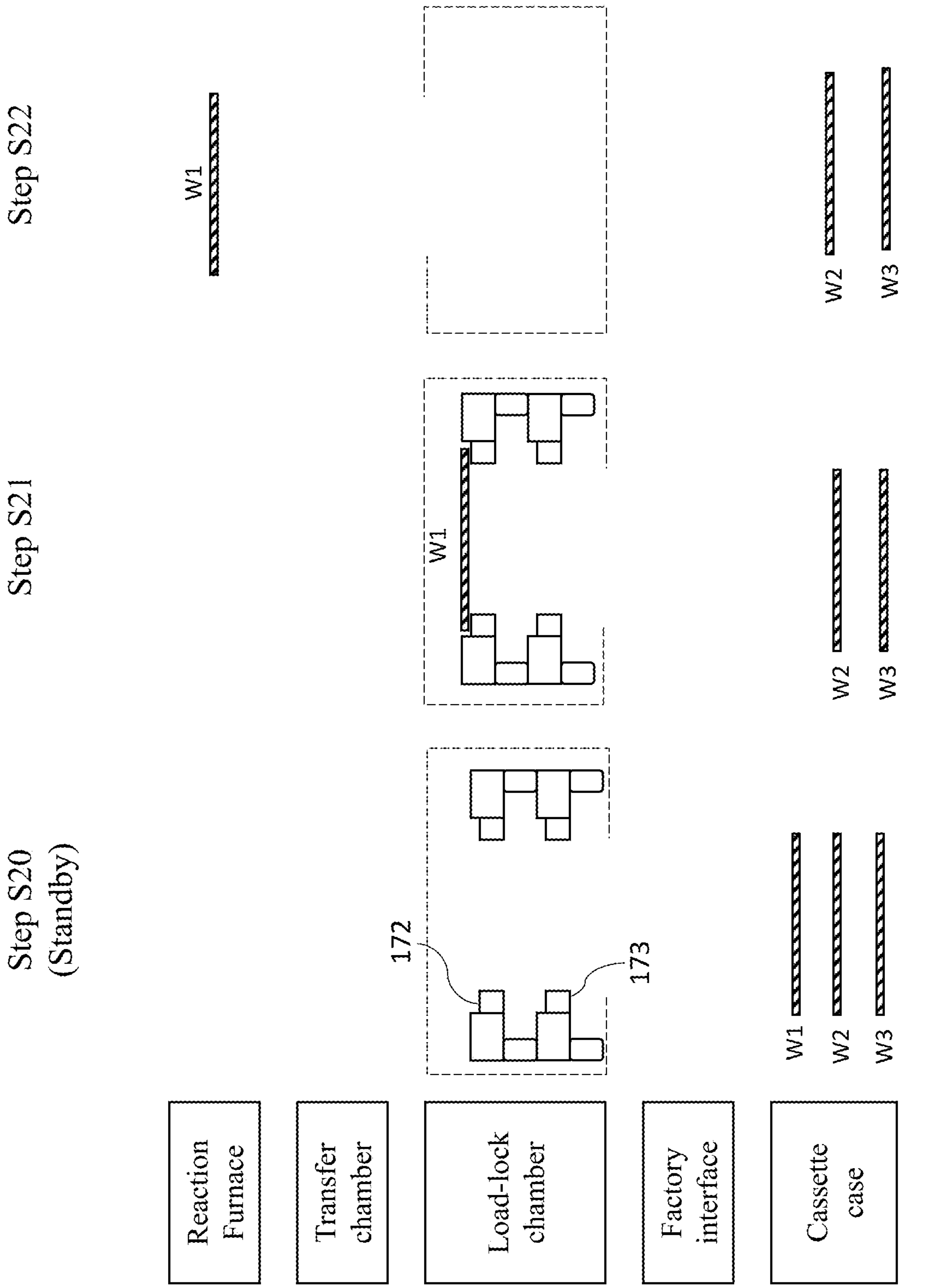

Reaction Furnace
Transfer chamber
Load-lock chamber
Factory interface
Cassette case
Step S6
W2
C2
W1
C1
W3
Step S7
W2
C2
C1
W1
W3
Step S8
W2
C2
C1
W3
W1

Fig. 12



Step S9
Step S10
Step S11
W2
C2
W3
C1
W1
W3
C1
W2
C2
W1
W3
C1
C2
W1
W2
Reaction Furnace
Transfer chamber
Load-lock chamber
Factory interface
Cassette case

Fig. 13



Step S20
(Standby)
Step S21
Step S22
172
173
W1
W2
W3
Reaction Furnace
Transfer chamber
Load-lock chamber
Factory interface
Cassette case

Fig. 14

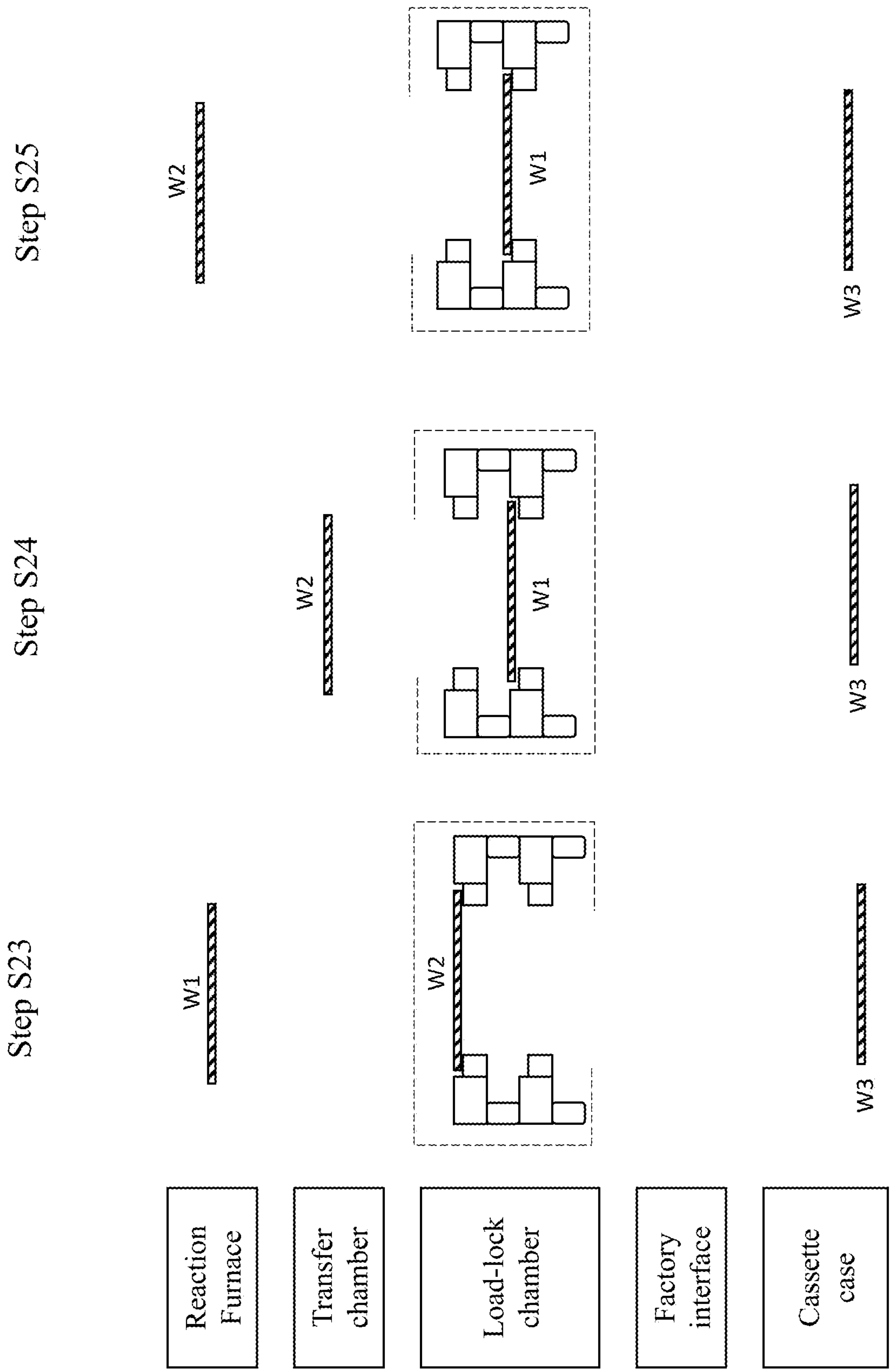

Reaction Furnace
Transfer chamber
Load-lock chamber
Factory interface
Cassette case
Step S23
Step S24
Step S25
W1
W2
W3

Fig. 15

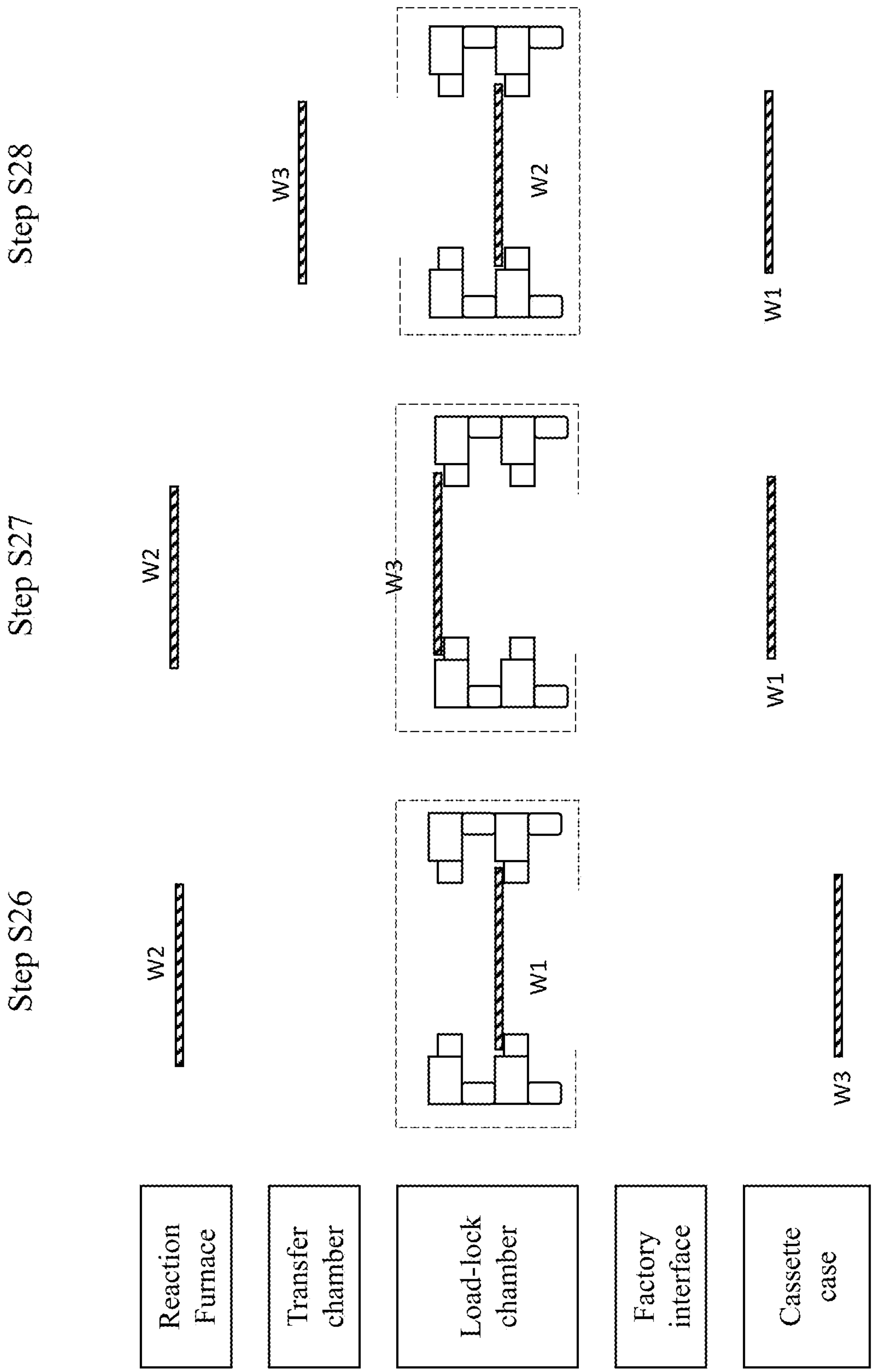
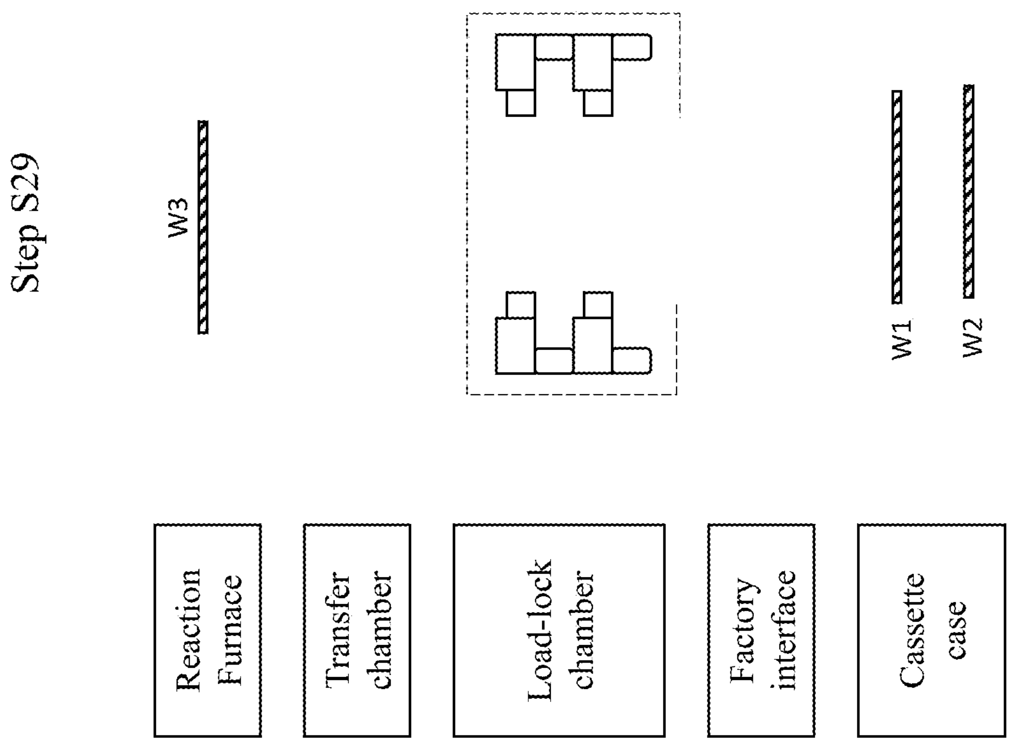

Reaction Furnace
Transfer chamber
Load-lock chamber
Factory interface
Cassette case
Step S26
W2
W1
W3
Step S27
W2
W3
W1
Step S28
W3
W2
W1

Fig. 16


Step S29
W3
W1
W2
Reaction Furnace
Transfer chamber
Load-lock chamber
Factory interface
Cassette case

VAPOR DEPOSITION DEVICE

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application is a continuation of U.S. patent application Ser. No. 17/415,838, filed Jun. 18, 2021, which is a National Phase Application of International Patent Application No. PCT/JP2019/043260, filed Nov. 5, 2019, which claims the benefit of Japanese Patent Application No. 2018-244833, filed Dec. 27, 2018. The disclosures of each of the above-noted documents are expressly incorporated herein by reference in their entirety.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates to a vapor deposition device used in manufacturing epitaxial wafers, for example.

BACKGROUND OF THE DISCLOSURE

[0003] In order to keep damage to a reverse face of a silicon wafer to a minimum in vapor deposition devices used in manufacturing epitaxial wafers, for example, transporting the silicon wafer through steps from a load-lock chamber to a reaction chamber in a state where the silicon wafer is mounted on a ring-shaped carrier has been proposed (Patent Literature 1).

[0004] In this type of vapor deposition device, whereas a before-treatment wafer is mounted on a ring-shaped carrier standing by in the load-lock chamber, an after-treatment wafer is transported from the reaction chamber to the load-lock chamber still mounted on a ring-shaped carrier.

RELATED ART

Patent Literature

[0005] Patent Literature 1: U.S. Patent Application No. 2017/0110352

SUMMARY OF THE DISCLOSURE

Problems to Be Solved by the Disclosure

[0006] However, in the conventional vapor deposition device which transfers wafers by using ring-shaped carrier, there is a problem that the vapor deposition device cannot be used when the carrier is damaged or broken and cannot be used.

[0007] The present disclosure undertakes to solve the issue of providing a vapor deposition device that can perform CVD processing without using a carrier.

Means for Solving the Problems

[0008] The present disclosure provides a vapor deposition device including:

[0009] a wafer storage container;

[0010] a load-lock chamber;

[0011] a wafer transfer chamber configured to communicate with the load-lock chamber via a second door and including a first robot;

[0012] a factory interface configured to communicate with the load-lock chamber via a first door and including a second robot;

[0013] an integrated controller including:

[0014] a first robot controller configured to control the first robot; and

[0015] a second robot controller configured to control the second robot;

[0016] a reaction furnace including a reaction chamber, a susceptor provided in the reaction chamber and a plurality of carrier lift pins and a plurality of wafer lift pins provided through the susceptor;

[0017] a plurality of ring-shaped carriers configured to support an outer edge of a wafer,

wherein:

[0018] a plurality of before-treatment wafers are transportable from the wafer storage container, through the factory interface, the load-lock chamber, and the wafer transfer chamber, to the reaction chamber in that order, and

[0019] a plurality of after-treatment wafers are transportable from the reaction chamber, through the wafer transfer chamber, the load-lock chamber, and the factory interface, to the wafer storage container in that order,

[0020] the wafer transfer chamber communicates, via a gate valve, with the reaction chamber in which a CVD film is formed on the wafer,

[0021] the first robot controller is configured to control the first robot to deposit a before-treatment wafer transported into the load-lock chamber into the reaction chamber in a state where the before-treatment wafer is mounted on any carrier of the plurality of carriers and also withdraw an after-treatment wafer for which treatment in the reaction chamber has ended from the reaction chamber in a state where the after-treatment wafer is mounted on any carrier of the plurality of carriers and transport the wafer to the load-lock chamber,

[0022] the second robot controller is configured to control the second robot to extract a before-treatment wafer from the wafer storage container and mount the wafer on any carrier of the plurality of carriers standing by in the load-lock chamber, store in the wafer storage container an after-treatment wafer mounted on any carrier of the plurality of carriers that has been transported to the load-lock chamber, and dismount the after-treatment wafer mounted on any carrier of the plurality of carriers,

[0023] the load-lock chamber is provided with a carrier holder that supports any carrier of the plurality of carriers in a case of transferring the wafer by using any carrier of the plurality of the carriers, and a wafer holder that supports the wafer in a case of transferring the wafer without using any carrier of the plurality of the carriers,

[0024] the first robot is provided with a first blade at a tip,

[0025] the first blade includes:

[0026] a first recess which supports any carrier of the plurality of carriers in a case of transferring the wafer from the wafer storage container to the reaction chamber by using any carrier of the plurality of the carriers; and

[0027] a second recess which is provided at a bottom surface of the first recess to support the wafer in a case of transferring the wafer from the wafer storage container to the reaction chamber without using any carrier of the plurality of carriers,

[0028] the reaction chamber is provided with a support shaft which supports the susceptor and rotates by a rotation drive unit and a lift shaft which moves up and down with respect to the support shaft by a lifting drive unit,

[0029] the lift shaft is provided with a first mounting portion on which the carrier lifting pin can be mounted and a second mounting portion on which the wafer lifting pin can be mounted,

[0030] the support shaft is provided with a first through hole through which the carrier lifting pin mounted on the first mounting portion can penetrate and a second through hole through which the wafer lifting pin mounted on the second mounting portion can penetrate,

[0031] in the case of transferring the wafer to the reaction chamber by using any carrier of the plurality of the carriers, the integrated controller controls the lift shaft to lift and lower any carrier of the plurality of the carriers via the plurality of carrier lift pins; and

[0032] in the case of transferring the wafer to the reaction chamber without using any carrier of the plurality of the carriers, the integrated controller controls the lift shaft to lift and lower the wafer via the plurality of wafer lift pins.

[0033] More preferably, in the present disclosure, the first recess is a recess corresponding to a part of the outer circumferential wall surface of the carrier, and the second recess is a recess corresponding to a part of an outer shape of the wafer.

[0034] More preferably, in the present disclosure, the first recess and the second recess are formed concentrically.

[0035] More preferably, in the present disclosure, the carrier holder supports the carrier at at least two points on each of a left side and a right side, the wafer holder supports the wafer at at least two points on each of a left side and a right side, the points at which the wafer holder supports the wafer at on each of the left side and the right side is set outside the points at which the carrier holder supports the carrier on each of the left side and the right side.

[0036] More preferably, in the present disclosure, a shaft portion of the support shaft is inserted into a shaft portion of the lift shaft, and the lift shaft rotates and moves up and down together with the support shaft.

[0037] More preferably, in the present disclosure, the plurality of carrier lift pins and the plurality of wafer lift pins are non-simultaneously supported by the lift shaft.

[0038] More preferably, in the present disclosure, in the case of transferring the wafer from the wafer storage container to the reaction chamber by using any carrier of the plurality of the carriers:

[0039] one of the first robot controller and the second robot controller controls a respective one of the first and second robots to transport each of the plurality of before-treatment wafers from the wafer storage container, through the factory interface, to the load-lock chamber in that order, and to transport each of the plurality of before-treatment wafers from the load-lock chamber, through the wafer transfer chamber, to the reaction chamber in that order in a state in which each of the plurality of before-treatment wafers is mounted on any carrier of the plurality of carriers; and

[0040] one of the first robot controller and the second robot controller controls a respective one of the first and second robots to transport each of the plurality of aftertreatment wafers from the reaction chamber, through the wafer transfer chamber, to the load-lock chamber in that order in the state in which each of the plurality of aftertreatment wafers is mounted on any carrier of the plurality of carriers, and to transport each of the plurality of aftertreatment wafers from load-lock chamber, through the factory interface, to the wafer storage container in that order and

[0041] in the case of transferring the wafer from the wafer storage container to the reaction chamber without using any carrier of the plurality of the carriers:

[0042] one of the first robot controller and the second robot controller controls a respective one of the first and second robots to transport each of the plurality of before-treatment wafers from the wafer storage container, through the factory interface, the load-lock chamber, and the wafer transfer chamber, to the reaction chamber in that order in a state in which each of the plurality of before-treatment wafers is not mounted on any carrier of the plurality of carriers; and

[0043] one of the first robot controller and the second robot controller controls a respective one of the first and second robots to transport each of the plurality of aftertreatment wafers from the reaction chamber, through the wafer transfer chamber, the load-lock chamber, and the factory interface, to the wafer storage container in that order in the state in which each of the plurality of aftertreatment wafers is not mounted on any carrier of the plurality of carriers.

Effect of the Disclosure

[0044] According to the present disclosure, the first blade provided at a tip of the first robot includes a second recess which supports the wafer, the load-lock chamber is provided with a holder which can support the carrier and the wafer, or the support shaft is provided with a second through hole through which the wafer lifting pin can penetrate. Therefore, only the wafer can be transported and subjected to CVD processing. As a result, the vapor deposition process can be performed without using the carrier.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] FIG. **1** is a block diagram illustrating a vapor deposition device according to an embodiment of the present disclosure;

[0046] FIG. **2**A is a plan view illustrating a carrier according to the embodiment of the present disclosure;

[0047] FIG. **2**B is a cross-sectional view of the carrier, including a wafer and a reaction furnace susceptor;

[0048] FIG. **3**A is a plan view illustrating a holder provided to a load-lock chamber;

[0049] FIG. **3**B is a cross-sectional view of the holder of FIG. **3**A including the wafer and the carrier;

[0050] FIG. **3**C is a plan view illustrating a holder according to another example provided to a load-lock chamber; and

[0051] FIG. **3**D is a cross-sectional view of the holder of FIG. **3**C including the wafer and the carrier.

[0052] FIGS. **4**A-**4**E are plan views and cross-sectional views illustrating a transfer protocol for the wafer and the carrier in the load-lock chamber; and

[0053] FIGS. **5**A-**5**E are plan views and cross-sectional views illustrating a transfer protocol for the wafer and the carrier within a reaction chamber.

[0054] FIG. **6**A is a plan view illustrating an example of a second blade attached to the tip of a hand of a second robot;

[0055] FIG. **6**B is a cross-sectional view of the second blade including a wafer;

[0056] FIG. **7**A is a plan view illustrating an example of a first blade attached to the tip of a hand of a first robot;

[0057] FIG. **7**B is a cross-sectional view of the first blade including a carrier and a wafer;

[0058] FIG. **8**A is a cross-sectional view illustrating a main part of a susceptor when a wafer is transported by using a carrier; and

[0059] FIG. **8**B is a cross-sectional view illustrating a main part of a susceptor when a wafer is transported without using a carrier.

[0060] FIG. **9** is a diagram (no. 1) illustrating a handling protocol for the wafer and the carrier in the vapor deposition device of the embodiment;

[0061] FIG. **10** is a diagram (no. 2) illustrating the handling protocol for the wafer and the carrier in the vapor deposition device of the embodiment;

[0062] FIG. **11** is a diagram (no. 3) illustrating the handling protocol for the wafer and the carrier in the vapor deposition device of the embodiment; and

[0063] FIG. **12** is a diagram (no. 4) illustrating the handling protocol for the wafer and the carrier in the vapor deposition device of the embodiment.

[0064] FIG. **13** is a diagram (no. 1) illustrating a handling protocol for the wafer without using the carrier in the vapor deposition device of the embodiment;

[0065] FIG. **14** is a diagram (no. 2) illustrating a handling protocol for the wafer without using the carrier in the vapor deposition device of the embodiment;

[0066] FIG. **15** is a diagram (no. 3) illustrating a handling protocol for the wafer without using the carrier in the vapor deposition device of the embodiment; and

[0067] FIG. **16** is a diagram (no. 4) illustrating a handling protocol for the wafer without using the carrier in the vapor deposition device of the embodiment.

MODE FOR CARRYING OUT THE DISCLOSURE

[0068] Hereafter, an embodiment of the present disclosure is described based on the drawings. FIG. **1** is a block diagram illustrating a vapor deposition device **1** according to the embodiment of the present disclosure. A main body of the vapor deposition device **1** shown in the center of the diagram is illustrated in a plan view. The vapor deposition device **1** of the present embodiment is what is known as a CVD device and is provided with a pair of reaction furnaces **11**, **11**; a wafer transfer chamber **12** in which is installed a first robot **121** that handles a wafer WF, such as a single crystal silicon wafer; a pair of load-lock chambers **13**; a factory interface **14** in which is installed a second robot **141** that handles the wafer WF; and a load robot in which is installed a wafer storage container **15** (cassette case) in which a plurality of the wafers WF are stored.

[0069] The factory interface **14** is a zone configured to have the same air atmosphere as a clean room in which the wafer storage container **15** is mounted. The factory interface **14** is provided with the second robot **141**, which extracts a before-treatment wafer WF that is stored in the wafer storage container **15** and deposits the wafer WF in the load-lock chamber **13**, and also stores an after-treatment wafer WF transported to the load-lock chamber **13** in the wafer storage container **15**. The second robot **141** is controlled by a second robot controller **142**, and a second blade **143** mounted on a distal end of a robot hand displaces along a predetermined trajectory that has been taught in advance.

[0070] A first door **131** capable of opening and closing with an airtight seal is provided between the load-lock chamber **13** and the factory interface **14**, while a second door **132** similarly capable of opening and closing with an airtight seal is provided between the load-lock chamber **13** and the wafer transfer chamber **12**. In addition, the load-lock chamber **13** serves as a space where atmospheric gas exchange takes place between the wafer transfer chamber **12**, which is configured to have an inert gas atmosphere, and the factory interface **14**, which is configured to have an air atmosphere. Therefore, an exhaust device that evacuates an interior of the load lock chamber **13** to vacuum and a supply device that supplies inert gas to the load-lock chamber **13** are provided.

[0071] For example, when a before-treatment wafer WF is transported from the wafer storage container **15** to the wafer transfer chamber **12**, in a state where the first door **131** on the factory interface **14** side is closed, the second door **132** on the wafer transfer chamber **12** side is closed, and the load-lock chamber **13** has an inert gas atmosphere, the wafer WF is extracted from the wafer storage container **15** using the second robot **141**, the first door **131** on the factory interface **14** side is opened, and the wafer WF is transported to the load-lock chamber **13**. Next, after the first door **131** on the factory interface **14** side is closed and the load-lock chamber **13** is restored to an inert gas atmosphere, the second door **132** on the wafer transfer chamber **12** side is opened and the wafer WF is transported to the wafer transfer chamber **12** using the first robot **121**.

[0072] Conversely, when an after-treatment wafer WF is transported from the wafer transfer chamber **12** to the wafer storage container **15**, in a state where the first door **131** on the factory interface **14** side is closed, the second door **132** on the wafer transfer chamber **12** side is closed, and the load-lock chamber **13** has an inert gas atmosphere, the second door **132** on the wafer transfer chamber **12** side is opened and the wafer WF in the wafer transfer chamber **12** is transported to the load-lock chamber **13** using the first robot **121**. Next, after the second door **132** on the wafer transfer chamber **12** side is closed and the load-lock chamber **13** is restored to an inert gas atmosphere, the first door **131** on the factory interface **14** side is opened and the wafer WF is transported to the wafer storage container **15** using the second robot **141**.

[0073] The wafer transfer chamber **12** is configured by a sealed chamber, connected on one side to the load-lock chamber **13** via the second door **132** that is capable of opening and closing and has an airtight seal, and connected on the other side via a gate valve **114** that is capable of opening and closing and has an airtight seal. The first robot **121**, which transports the before-treatment wafer WF from the load-lock chamber **13** to the reaction chamber **111** and transports the after-treatment wafer WF from the reaction chamber **111** to the load-lock chamber **13**, is installed on the wafer transfer chamber **12**. The first robot **121** is controlled by a first robot controller **122**, and a first blade **123** mounted on a distal end of a robot hand displaces along an operation trajectory that has been taught in advance.

[0074] An integrated controller **16** that integrates control of the entire vapor deposition device **1**, the first robot controller **122**, and the second robot controller **142** send and receive control signals amongst each other. In addition, when an operation command signal from the integrated controller **16** is sent to the first robot controller **122**, the first robot controller **122** controls the operation of the first robot **121**, and an operation result of the first robot **121** is sent from the first robot controller **122** to the integrated controller **16**. Accordingly, the integrated controller **16** recognizes an operation status of the first robot **121**. Similarly, when an operation command signal from the integrated controller **16** is sent to the second robot controller **142**, the second robot controller **142** controls the operation of the second robot **141**, and an operation result of the second robot **141** is sent from the second robot controller **142** to the integrated controller **16**. Accordingly, the integrated controller **16** recognizes an operation status of the second robot **141**.

[0075] Inert gas is supplied to the wafer transfer chamber **12** from an inert gas supply device not shown in the drawings, and gas in the wafer transfer chamber **12** is cleaned with a scrubber (scrubbing dust collector, precipitator) that is connected to an exhaust port, after which the gas is released outside the system. Although a detailed depiction is omitted, this type of scrubber can use a conventionally known pressurized water scrubber, for example.

[0076] The reaction furnace **11** is a device for growing an epitaxial film on a surface of the wafer WF using a CVD method, and includes a reaction chamber **111**; a susceptor **112** on which the wafer WF is placed and rotated is provided inside the reaction chamber **111**, and a gas supply device **113** is also provided that supplies hydrogen gas and raw material gas for growing a CVD film (when the CVD film is a silicon epitaxial film, the raw material gas may be silicon tetrachloride $SiCl_4$ or trichlorosilane $SiHCl_3$, for example) to the reaction chamber **111**. In addition, although omitted from the drawings, a heat lamp for raising the temperature of the wafer WF to a predetermined temperature is provided around the circumference of the reaction chamber **111**. Moreover, a gate valve **114** is provided between the reaction chamber **111** and the wafer transfer chamber **12**, and airtightness with the wafer transfer chamber **12** of the reaction chamber **111** is ensured by closing the gate valve **114**. Various controls, such as driving the susceptor **112** of the reaction furnace **11**, supply and stoppage of gas by the gas supply device **113**, turning the heat lamp on and off, and opening and closing the gate valve **114**, are controlled by a command signal from the integrated controller **16**. The vapor deposition device **1** shown in FIG. **1** depicts an example provided with a pair of reaction furnaces **11**, **11**, but the vapor deposition device **1** may have one reaction furnace **11** or three or more reaction furnaces.

[0077] A scrubber (scrubbing mist eliminator) having a similar configuration to that of the wafer transfer chamber **12** is provided to the reaction furnace **11**. In other words, hydrogen gas or raw material gas supplied from the gas supply device **113** is cleaned by the scrubber connected to an exhaust port provided to the reaction chamber **111** and is then released outside the system. A conventionally known pressurized water scrubber, for example, can be used for this scrubber, as well.

[0078] In the vapor deposition device **1** according to the present embodiment, the wafer WF is transported between the load-lock chamber **13** and the reaction chamber **111** using a ring-shaped carrier C that supports the entire outer circumferential edge of the wafer WF. FIG. **2**A is a plan view of the carrier C, FIG. **2**B is a cross-sectional view of the carrier C including the wafer WF and the susceptor **112** of the reaction furnace **11**, and FIG. **5** is a plan view and cross-sectional views illustrating a transfer protocol for the wafer WF and the carrier C within the reaction chamber **111**.

[0079] The carrier C according to the present embodiment is configured by a material such as SiC, for example, is formed in an endless ring shape; and includes a bottom surface C**11** that rests on a top surface of the susceptor **112** shown in FIG. **2**B, a top surface C**12** that touches and supports the entire outer circumferential edge of a reverse face of the wafer WF, an outer circumferential wall surface C**13**, and an inner circumferential wall surface C**14**. In addition, when the wafer WF supported by the carrier C is transported into the reaction chamber **111**, in a state where the carrier C rests on the first blade **123** of the first robot **121** as illustrated in the plan view of FIG. **5**A, the wafer WF is transported to a top portion of the susceptor **112** as illustrated in FIG. **5**B, the carrier C is temporarily lifted by three or more carrier lifting pins **115** provided to the susceptor **112** so as to be capable of displacing vertically as illustrated in FIG. **5**C, and the first blade **123** is retracted as illustrated in FIG. **5**D, after which the susceptor **112** is raised as illustrated in FIG. **5**E, thereby placing the carrier C on the top surface of the susceptor **112**.

[0080] Conversely, when treatment in the reaction chamber **111** has ended for the wafer WF and the wafer WF is withdrawn in a state mounted on the carrier C, the susceptor **112** is lowered from the state illustrated in FIG. **5**E and supports the carrier C with only the carrier lifting pins **115** as illustrated in FIG. **5**D, the first blade **123** is advanced between the carrier C and the susceptor **112** as illustrated in FIG. **5**C, and then the three carrier lifting pins **115** are lowered to rest the carrier C on the first blade **123** as illustrated in FIG. **5**B, and the hand of the first robot **121** is operated. In this way, the wafer WF for which treatment has ended can be withdrawn in a state mounted on the carrier C.

[0081] Also, in the vapor deposition device **1** according to the present embodiment, the carrier C is transported between processes running from the load-lock chamber **13** to the reaction chamber **111**, and therefore in the load-lock chamber **13**, the before-treatment wafer WF is placed on the carrier C and the after-treatment wafer WF is removed from the carrier C. Therefore, a holder **17** that supports the carrier C at two vertical levels is provided to the load-lock chamber **13**. FIG. **3**A is a plan view illustrating the holder **17** that is provided to the load-lock chamber **13**, and FIG. **3**B is a cross-sectional view of the holder **17** including the carrier C. The holder **17** according to the present embodiment includes a fixed holder base **171**; a first holder **172** and second holder **173** that support two carriers C at two vertical levels, and that are provided to the holder base **171** so as to be capable of lifting and lowering vertically; and three wafer lifting pins **174** that are provided to the holder base **171** so as to be capable of lifting and lowering vertically.

[0082] The first holder **172** and the second holder **173** (in the plan view of FIG. **3**A, the second holder **173** is obscured by the first holder **172** and therefore only the first holder **172** is depicted) have projections for supporting the carrier C at four points, and one carrier C is placed on the first holder **172** and another carrier C is placed on the second holder **173**. The carrier C that rests on the second holder **173** is inserted into a gap between the first holder **172** and the second holder **173**. In particular, as shown in FIG. **3**B, the distance L between the tip of the first holder **172** and the tip of the second holder **173** facing each other is formed to be smaller than the diameter of the wafer WF so that the first holder **172** and the second holder **173** of the present embodiment can support not only the carrier C but also the wafer WF. As a result, the wafer WF can be handled by the holder **17** in the load-lock chamber **13** without using a carrier, and thus the compatibility is improved.

[0083] FIG. **3**C is a plan view illustrating another example of the holder **17** provided in the load-lock chamber **13**, and FIG. **3**D is a cross-sectional view of the holder **17** of FIG. **3**C including the wafer WF. The holder **17** of the present embodiment includes a fixed holder base **171**, a first holder **172** and a second holder **173** which are carrier holders that is provided so as to be able to move up and down with respect to the holder base **171** and supports two carriers C in two upper and lower stages, and three wafer lift pins **174** that can move up and down with respect to the holder base **171**. Each of the first holder **172** and the second holder **173** as carrier holders includes a first wafer holder **172***a* and a second wafer holder **173***a* which are wafer holders that support two wafer WF in two upper and lower stages.

[0084] The first holder **172** which is a carrier holder supports only the carrier C at four

[0085] points, and one carrier C is mounted on the first holder **172**. The second holder **173** which is a carrier holder also supports only the carrier C at four points, and one carrier C is mounted on the second holder **173**. Further, as shown in FIG. **3**C, the first holder **172** and the second holder **173** support the carrier C at four points, but the first holder **172** and the second holder **173** may support the carrier C at four points or more.

[0086] On the other hand, the first wafer holder **172***a* which is a wafer holder supports only the wafer WF at four points, and one wafer WF is mounted on the first wafer holder **172***a*. The second wafer holder **173***a* which is a wafer holder also supports only the wafer WF at four points, and one wafer WF is mounted on the second wafer holder **173***a*. Further, as shown in FIG. **3**C, the first wafer holder **172***a* and the second wafer holder **173***a* support the wafer WF at four points, but the first wafer holder **172***a* and the second wafer holder **173***a* may support the wafer WF at four points or more.

[0087] As shown in FIG. **3**C, the first holder **172** and the second holder **173** may support the carrier C at at least two points on the left and right sides respectively, and the first wafer holder **172***a* and the second wafer holder **173***a* may support the wafer WF at at least two points on the left and right sides respectively. Further, the points where the first wafer holder **172***a* and the second wafer holder **173***a* support the wafer WF on the left and right sides respectively may be set outside the points where the first holder **172** and the second holder **173** support the carrier C on the left and right sides respectively. By providing the points where the wafer holder supports the wafer WF on the outer side, that is, by providing a wide pitch at each of the two points on the left and right, the points supporting the wafer WF approach equal distribution, and the support of the wafer WF is stabilized.

[0088] FIG. **4** is a plan view and cross-sectional views of a transfer protocol for the wafer WF and carrier C in the load-lock chamber **13** and depicts a protocol in which a before-treatment wafer WF rests on the carrier C in a state where the carrier C is supported by the first holder **172**, as illustrated in FIG. **4**B. In other words, the second robot **141** that is provided to the factory interface **14** loads one wafer WF that is stored in the wafer storage container **15** onto the second blade **143** and transports the wafer WF via the first door **131** of the load-lock chamber **13** to a top portion of the holder **17**, as illustrated in FIG. **4**B. Next, as illustrated in FIG. **4**C, the three wafer lifting pins **174** are raised relative to the holder base **171** and temporarily hold up the wafer WF, and the second blade **143** is retracted as illustrated in FIG. **4**D. The three wafer lifting pins **174** are provided in positions that do not interfere with the second blade **143**, as illustrated in the plan view of FIG. **4**A. Next, as illustrated in FIGS. **4**D and **4**E, the three wafer lifting pins **174** are lowered and the first holder **172** and the second holder **173** are raised, whereby the wafer WF is placed on the carrier C.

[0089] Conversely, when the after-treatment wafer WF transported to the load-lock chamber **13** in a state resting on the carrier C is transported to the wafer storage container **15**, as illustrated in FIG. **4**D, the three wafer lifting pins **174** are raised and the first holder **172** and the second holder **173** are lowered from the state illustrated in FIG. **4**E, the wafer WF is supported by only the wafer lifting pins **174**, and the second blade **143** is advanced between the carrier C and the wafer WF as illustrated in FIG. **4**C, after which the three wafer lifting pins **174** are lowered to load the wafer WF on the second blade **143** as illustrated in FIG. **4**B, and the hand of the second robot **141** is operated. In this way, the wafer WF for which treatment has ended can be taken out of the carrier C and into the wafer storage container **15**. In the state illustrated in FIG. **4**E, the wafer WF for which treatment has ended is transported to the first holder **172** in a state resting on the carrier C, but the wafer WF can be taken out of the carrier C and into the wafer storage container **15** with a similar protocol when the wafer WF is transported to the second holder **173**, as well.

[0090] FIG. **6**A is a plan view illustrating an example of a second blade **143** attached to the tip of a hand of a second robot **141**, FIG. **6**B is a cross-sectional view of the second blade **143** including a wafer WF. In the second blade **143** of the present embodiment, a first recess **144** having a diameter corresponding to the wafer WF is formed on one surface of a strip-shaped main body. The diameter of the first recess **144** is formed to be slightly larger than the diameter of the wafer WF. Then, the second robot **141** mounts the wafer WF in the first recess **144** when the wafer WF is taken out from the wafer storage container **15** and when the wafer WF is stored into the wafer storage container **15**.

[0091] FIG. **7**A is a plan view illustrating an example of a first blade **123** attached to the tip of a hand of a first robot **121**, FIG. **7**B is a cross-sectional view of the first blade **123** including a carrier C and a wafer WF. The first blade **123** of the present embodiment has a first recess **124** having a diameter corresponding to the outer circumferential wall surface C13 of the carrier C on one surface of a strip-shaped main body, and an outer shape of a wafer WF on the bottom surface of the first recess **124**. The second recess **125** having a diameter corresponding to the above is formed concentrically. The diameter of the first recess **124** is formed to be slightly larger than the diameter of the outer circumferential wall surface C13 of the carrier C, and the diameter of the second recess **125** is formed to be slightly larger than the outer diameter of the wafer WF.

[0092] Then, when the first robot **121** transports the carrier C on which the wafer WF is mounted, the first robot **121** mounts the carrier C on the first recess **124**. When only the wafer WF is transported without using the carrier C, the wafer WF can be mounted in the second recess **125**. In this way, the carrier C and the wafer WF can be reliably supported by one first blade **123**. Therefore, when switching between the case where the process is executed using the carrier C and the case where the process is executed without using the carrier C, it is not necessary to exchange the first blade **123** or to provide the first robot **121** with two hands. As a result, the compatibility of the vapor deposition device **1** is high.

[0093] The vapor deposition device **1** of the present embodiment transport the WF by using a carrier C to suppress damage and unevenness caused by the wafer lift pin provided on the susceptor **112** of the reaction chamber **111** coming into contact with the back surface of the wafer WF. When the carrier C is insufficient for some reason, or when the order of the wafer production fluctuates, it may be desired to transport the wafer WF without using the carrier C. Therefore, as described above, the holder **17** of the load-lock chamber **13** can support not only the carrier C but also the wafer WF, and the first blade **123** can support not only the carrier C but also the wafer WF. Further, in addition to these, the susceptor **112** of the reactor **11** is also configured so that the process can be easily switched between the case where the process is executed using the carrier C and the case where the process is executed without using the carrier C.

[0094] FIG. **8**A is a cross-sectional view illustrating a main part of a surrounding construction of a susceptor when a wafer WF is transported by using a carrier C. The susceptor **112** is fixed and supported at the upper end of the support shaft **116** that is rotated by the rotation drive unit **119***a*. Further, the shaft portion of the support shaft **116** is inserted into the shaft portion of the lift shaft **117**, and a first mounting portion **1171** to which the carrier lift pin **115** for lifting and lowering the carrier C is mounted is formed at the upper end of the lift shaft **117**. The lift shaft **117** rotates together with the support shaft **116**, and is moved up and down between the lifting position and the lowering position by the lifting drive unit **119***b*. Further, when the carrier lift pin **115** is mounted on the first mounting portion **1171** of the lift shaft **117**, the first through hole **1161** is formed at a position penetrating the support shaft **116**.

[0095] Then, when the CVD film is formed in the reaction chamber **111**, as shown in FIG. **8**A, the support shaft **116** is rotated by the rotation drive unit **119***a* in a state where the carrier lift pin **115** is lowered to the lowering position by the lifting drive unit **119***b*. On the other hand, when the carrier C on which the wafer WF is mounted is mounted on the susceptor **112** or when the carrier C mounted on the susceptor **112** is carried out, the lift shaft **117** is moved to the transport position by the lifting drive unit **119***b* and the carrier lift pin **115** receives and lifts the carrier C.

[0096] In particular, the lift shaft **117** of the present embodiment is formed with a second mounting portion **1172** on which a wafer lift pin **118** for lifting and lowering the wafer WF can be mounted, assuming a case where the wafer WF is transported without using the carrier C. Further, when the wafer lift pin **118** is mounted on the second mounting portion **1172** of the lift shaft **117**, the second through hole **1162** is formed at a position penetrating the support shaft **116**. FIG. **8**B is a cross-sectional view illustrating a main part of the surrounding construction of a susceptor **112** when a wafer WF is transported without using a carrier C. When the wafer WF is transported without using the carrier C, the susceptor **112** is replaced with a dedicated part, the carrier lift pin **115** is removed, and the wafer lift pin **118** is mounted on the second mounting portion **1172**.

[0097] At this time, since the second through hole **1162** is formed in advance in the support shaft **116** and the second mounting portion **1172** is formed in advance in the lift shaft **117**, these support shaft **116** and lift shaft **117** can be shared.

[0098] Then, when the CVD film is formed in the reaction chamber **111**, as shown in FIG. **8**B, the support shaft **116** is rotated by the rotation drive unit **119***a* in a state where the wafer lift pin **118** is lowered to the lowering position by the lifting drive unit **119***b*. On the other hand, when the wafer WF is mounted on the susceptor **112** or when the wafer WF mounted on the susceptor **112** is carried out, the susceptor **112** is moved to the transport position by the lifting drive unit **119***b*, and the wafer WF is received by the wafer lift pin **118**.

[0099] Next a protocol is described for handling the carrier C and the wafer WF prior to creating the epitaxial film (hereafter referred to simply as "before-treatment") and after creating the epitaxial film (hereafter referred to simply as "after-treatment") in the vapor deposition device **1** according to the present embodiment. FIGS. **9** to **12** are schematic views illustrating a handling protocol for a wafer WF and a carrier C in the vapor deposition device of the present embodiment and correspond to the wafer storage container **15** on one side of the device, the load-lock chamber **13**, and the reaction furnace **11** in FIG. **1**; a plurality of wafers W1, W2, W3, . . . (for example, a total of **25** wafers) are stored in the wafer storage container **15** and treatment is initiated in that order. FIGS. **9** to **12** show a case of transporting the wafer WF by using the carrier C.

[0100] Step SO in FIG. **9** shows a standby state from which treatment using the vapor deposition device **1** is to begin, and has the plurality of wafers W1, W2, W3, . . . (for example, a total of **25** wafers) stored in the wafer storage container **15**, has an empty carrier Cl supported by the first holder **172** of the load-lock chamber **13**, has an empty carrier C2 supported by the second holder **173**, and has an inert gas atmosphere in the load-lock chamber **13**.

[0101] In the next step (step S1), the second robot **141** loads the wafer W1 that

[0102] is stored in the wafer storage container **15** onto the second blade **143** and transfers the wafer W1 through the first door **131** of the load-lock chamber **13** to the carrier C1 that is supported by the first holder **172**. The protocol for this transfer was described with reference to FIG. **4**.

[0103] In the next step (step S2), the first door **131** of the load-lock chamber **13**

[0104] is closed and, in a state where the second door **132** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to the inert gas atmosphere. Then, the second door **132** is opened, the carrier C1 is loaded onto the first blade **123** of the first robot **121**, the gate valve **114** of the reaction furnace **11** is opened, and the carrier C1 on which the wafer W1 is mounted is transferred through the gate valve **114** to the susceptor **112**. The protocol for this transfer was described with reference to FIG. **4**. In steps S2 to S4, the CVD film creation process is performed on the wafer W1 in the reaction furnace **11**.

[0105] In other words, the carrier C**1** on which the before-treatment wafer W**1** is mounted is transferred to the susceptor **112** of the reaction chamber **111** and the gate valve **114** is closed, and after waiting a predetermined amount of time, the gas supply device **113** supplies hydrogen gas to the reaction chamber **111**, giving the reaction chamber **111** a hydrogen gas atmosphere. Next, the wafer W**1** in the reaction chamber **111** is heated to a predetermined temperature by the heat lamp and pretreatment such as etching or heat treatment is performed as necessary, after which the gas supply device **113** supplies raw material gas while controlling the flow volume and/or supply time. This creates a CVD film on the surface of the wafer W**1**. Once the CVD film is formed, the gas supply device **113** once again supplies the reaction chamber **111** with hydrogen gas and the reaction chamber undergoes gas exchange to a hydrogen gas atmosphere, after which the protocol stands by for a predetermined amount of time.

[0106] While the reaction furnace **11** is treating the wafer W**1** in steps S**2** to S**4**, the second robot **141** extracts the next wafer (W**2**) from the wafer storage container **15** and prepares for the next treatment. Prior to this, in step S**3** in the present embodiment, the second door **132** of the load-lock chamber **13** is closed, and in a state where the first door **131** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to an inert gas atmosphere. Then, the second door **132** is opened, the carrier C**2** supported by the second holder **173** is transferred to the first holder **172** by the first robot **121**. Subsequently, in step S**4**, the second robot **141** loads the wafer W**2** that was stored in the wafer storage container **15** onto the second blade **143**, the first door **131** is opened, and the wafer W**2** is transferred to the carrier C**2** that is supported by the first holder **172** of the load-lock chamber **13**.

[0107] In this way, in the present embodiment, step S**3** is added and the before-treatment wafer WF that was stored in the wafer storage container **15** is mounted on the first holder **172**, which is the topmost-level holder of the holder **17** of the load-lock chamber **13**. This is for the following reasons. Specifically, as illustrated in step S**2**, when the empty carrier C**2** on which the next wafer W**2** is to be mounted is supported by the second holder **173**, once the wafer W**2** is mounted on the carrier C**2**, there is a possibility that the after-treatment wafer W**1** may be transferred to the first holder **172**. The carrier C of the vapor deposition device **1** according to the present embodiment is transported to the reaction chamber **111**, and therefore the carrier C is a factor in particle production, and when the carrier C**1** is held above the before-treatment wafer W**2**, dust may fall on the before-treatment wafer W**2**. Therefore, step S**3** is added and the empty carrier C**2** is transferred to the first holder **172** so that the before-treatment wafer WF is mounted on the topmost-level holder (first holder **172**) of the holder **17** of the load-lock chamber **13**.

[0108] In step S**5**, the first door **131** of the load-lock chamber **13** is closed and, in a state where the second door **132** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to an inert gas atmosphere. Then, the gate valve **114** of the reaction furnace **11** is opened, the first blade **123** of the first robot **121** is inserted into the reaction chamber **111** and is loaded with the carrier C**1** on which the after-treatment wafer W**1** is mounted, the carrier C**1** is withdrawn from the reaction chamber **111**, and the gate valve **114** is closed, after which the second door **132** is opened and the carrier C**1** is transferred to the second holder **173** of the load-lock chamber **13**. Subsequently, the carrier C**2** supported by the first holder **172** is loaded onto the first blade **123** of the first robot **121** and, as illustrated in step S**6**, the gate valve **114** is opened and the carrier C**2** on which the before-treatment wafer W**2** is mounted is transferred through the wafer transfer chamber **12** to the susceptor **112** of the reaction furnace **11**.

[0109] In steps S**6** to S**9**, the CVD film creation process is performed on the wafer W**2** in the reaction furnace **11**. In other words, the carrier C**2** on which the before-treatment wafer W**2** is mounted is transferred to the susceptor **112** of the reaction chamber **111** and the gate valve **114** is closed, and after waiting a predetermined amount of time, the gas supply device **113** supplies hydrogen gas to the reaction chamber **111**, giving the reaction chamber **111** a hydrogen gas atmosphere. Next, the wafer W**2** in the reaction chamber **111** is heated to a predetermined temperature by the heat lamp and pretreatment such as etching or heat treatment is performed as necessary, after which the gas supply device **113** supplies raw material gas while controlling the flow volume and/or supply time. This creates a CVD film on the surface of the wafer W**2**. Once the CVD film is formed, the gas supply device **113** once again supplies the reaction chamber **111** with hydrogen gas and the reaction chamber **111** undergoes gas exchange to a hydrogen gas atmosphere, after which the protocol stands by for a predetermined amount of time.

[0110] In this way, while the reaction furnace **11** is treating the wafer W**2** in steps S**6** to S**9**, the second robot **141** stores the after-treatment wafer W**1** in the wafer storage container **15** and also extracts the next wafer (W**3**) from the wafer storage container **15** and prepares for the next treatment. In other words, in step S**7**, the second door **132** of the load-lock chamber **13** is closed, and in a state where the first door **131** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to an inert gas atmosphere. Then, the first door **131** is opened, the second robot **141** loads the after-treatment wafer W**1** onto the second blade **143** from the carrier C**1** supported by the second holder **173** and, as illustrated in step S**8**, the after-treatment wafer W**1** is stored in the wafer storage container **15**. Subsequently, similarly to step S**3** described above, in step S**7**, the carrier C**1** supported by the second holder **173** is transferred to the first holder **172** by the first robot **121**.

[0111] Subsequently, in step S**8**, the second robot **141** loads the wafer W**3** that was stored in the wafer storage container **15** onto the second blade **143** and, as illustrated in step S**9**, the first door **131** is opened and the wafer W**3** is transferred to the carrier C**1** that is supported by the first holder **172** of the load-lock chamber **13**.

[0112] In step S**10**, similarly to step S**5** described above, the first door **131** of the load-lock chamber **13** is closed, and in a state where the second door **132** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to an inert gas atmosphere. Then, the gate valve **114** of the reaction furnace **11** is opened, the first blade **123** of the first robot **121** is inserted into the reaction chamber **111** and is loaded with the carrier C**2** on which the after-treatment wafer W**2** is mounted, and the gate valve **114** is closed, after which the second door **132** is opened and the carrier C**2** is transferred from the reaction chamber **111** to the second holder **173** of the load-lock chamber **13**. Subsequently, the carrier C**1** supported by the first holder **172** is loaded onto the first blade **123** of the first robot **121** and, as illustrated in step S**11**, the carrier C**1** on which the before-treatment wafer W**3** is mounted is transferred through the wafer transfer chamber **12** to the susceptor **112** of the reaction furnace **11**.

[0113] In step S**10**, similarly to step S**7** described above, the second door **132** of the load-lock chamber **13** is closed, and in a state where the first door **131** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to an inert gas atmosphere. Then, the first door **131** is opened, the second robot **141** loads the post-treatment wafer W**2** onto the second blade **143** from the carrier C**2** that is supported on the second holder **173** and, as illustrated in step S**11**, the post-treatment wafer W**2** is stored in the wafer storage container **15**. Thereafter, the above steps are repeated until treatment for all of the before-treatment wafers WF stored in the wafer storage container **15** ends.

[0114] In the vapor deposition device **1** according to the present embodiment, while treatment is ongoing in the reaction furnace **11**, the next before-treatment wafer WF is extracted from the wafer storage container **15** and prepared, the after-treatment wafer WF is stored in the wafer storage container **15**, and the like, and so the amount of time consumed simply in transport is drastically reduced. In such a case, when a number of standby carriers C in the load lock chamber **13** is set to two or more, as with the holder **17** in the present embodiment, a degree of freedom in shortening the amount of time consumed simply in transport can be substantially increased. Furthermore, when the space dedicated to the load-lock chamber **13** is considered, aligning the plurality of carriers C in multiple vertical levels reduces the space dedicated to the vapor deposition device **1** overall as compared to aligning the plurality of carriers C left-to-right. But, when the plurality of carriers C are aligned in multiple vertical levels, the carrier C may be held above a before-treatment wafer WF and dust may fall on the before-treatment wafer WF. However, in the vapor deposition device **1** according to the present embodiment, steps S**3** and S**8** are added and the empty carrier C**2** is transferred to the first holder **172** so that the before-treatment wafer WF is mounted on the topmost-level holder (first holder **172**) of the holder **17** of the load-lock chamber **13**, and therefore the before-treatment wafer WF is mounted on the topmost-level carrier C. As a result, particles originating from the carrier C can be inhibited from adhering to the wafer WF and LPD quality can be improved.

[0115] In addition, in the vapor deposition device **1** of the present embodiment, the wafer WF can be transported without using the carrier C. FIGS. **13** to **16** are schematic views showing a procedure for handling the wafer WF in the vapor deposition device **1** of the present embodiment. FIGS. **13** to **16** correspond to the wafer storage container **15**, the load-lock chamber **13** and the reaction furnace **11** on one side of FIG. **1**. In FIGS. **13** to **16**, a plurality of wafers W**1**, W**2**, W**3** . . . (For example, a total of 25) are stored in the wafer storage container **15**, and the processing is started in this order. FIGS. **13** to **16** show a case where the wafer WF is transported without using the carrier C.

[0116] Step S**20** in FIG. **13** shows a standby state from which treatment using the vapor deposition device **1** is to begin, and has the plurality of wafers W**1**, W**2**, W**3**, . . . (for example, a total of **25** wafers) stored in the wafer storage container **15**, has an empty carrier C**1** supported by the first holder **172** of the load-lock chamber **13**, has an empty carrier C**2** supported by the second holder **173**, and has an inert gas atmosphere in the load-lock chamber **13**. As described above, both the first holder **172** and the second holder **173** are configured to be able to support the wafer WF too.

[0117] In the next step (step S**21**), the second robot **141** loads the wafer W**1** that is stored in the wafer storage container **15** onto the first recess **144** of the second blade **143** and transfers the wafer W**1** through the first door **131** of the load-lock chamber **13** to the first holder **172**.

[0118] In the next step (step S**22**), the first door **131** of the load-lock chamber **13** is closed and, in a state where the second door **132** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to the inert gas atmosphere. Then, the second door **132** is opened, the wafer WF is loaded onto the second recess **125** of the first blade **123** of the first robot **121**, the gate valve **114** of the reaction furnace **11** is opened, and the wafer W**1** is transferred through the gate valve **114** to the susceptor **112**. As shown in FIG. **8**, the surrounding construction of the susceptor **112** is exchanged.

[0119] In other words, the before-treatment wafer W**1** is transferred to the susceptor **112** of the reaction chamber **111** and the gate valve **114** is closed, and after waiting a predetermined amount of time, the gas supply device **113** supplies hydrogen gas to the reaction chamber **111**, giving the reaction chamber **111** a hydrogen gas atmosphere. Next, the wafer W**1** in the reaction chamber **111** is heated to a predetermined temperature by the heat lamp and pretreatment such as etching or heat treatment is performed as necessary, after which the gas supply device **113** supplies raw material gas while controlling the flow volume and/or supply time. This creates a CVD film on the surface of the wafer W**1**. Once the CVD film is formed, the gas supply device **113** once again supplies the reaction chamber **111** with hydrogen gas and the reaction chamber undergoes gas exchange to a hydrogen gas atmosphere, after which the protocol stands by for a predetermined amount of time.

[0120] While the reaction furnace **11** is treating the wafer W**1** in steps S**22** to S**23**, the second robot **141** extracts the next wafer (W**2**) from the wafer storage container **15** and prepares for the next treatment. That is, in step S**23**, the second door **132** of the load-lock chamber **13** is closed, and in a state where the first door **131** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to an inert gas atmosphere. Then, the second robot **141** loads the wafer W**2** that was stored in the wafer storage container **15** onto the first recess **144** of the second blade **143**, the first door **131** is opened, and the wafer W**2** is transferred to the first holder **172** of the load-lock chamber **13**.

[0121] In step S**24**, the first door **131** of the load-lock chamber **13** is closed and, in a state where the second door **132** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to an inert gas atmosphere. Then, the gate valve **114** of the reaction furnace **11** is opened, the first blade **123** of the first robot **121** is inserted into the reaction chamber **111** and is loaded with the after-treatment wafer W**1** on the second recess **125**, the wafer W**1** is withdrawn from the reaction chamber **111**, and the gate valve **114** is closed, after which the second door **132** is opened and the wafer W**1** is transferred to the second holder **173** of the load-lock chamber **13**. Subsequently, the wafer W**2** supported by the first holder **172** is loaded onto the second recess **125** of the first blade **123** of the first robot **121** and, as illustrated in steps S**24** to S**25**, the before-treatment wafer W2 is transferred through the wafer transfer chamber **12** to the susceptor **112** of the reaction furnace **11**.

[0122] In steps S**25** to S**27**, the CVD film creation process is performed on the wafer W**2** in the reaction furnace **11**. In other words, the before-treatment wafer W**2** is transferred to the susceptor **112** of the reaction chamber **111** and the gate valve **114** is closed, and after waiting a predetermined amount of time, the gas supply device **113** supplies hydrogen gas to the reaction chamber **111**, giving the reaction chamber **111** a hydrogen gas atmosphere. Next, the wafer W**2** in the reaction chamber **111** is heated to a predetermined temperature by the heat lamp and pretreatment such as etching or heat treatment is performed as necessary, after which the gas supply device **113** supplies raw material gas while controlling the flow volume and/or supply time. This creates a CVD film on the surface of the wafer W**2**. Once the CVD film is formed, the gas supply device **113** once again supplies the reaction chamber **111** with hydrogen gas and the reaction chamber **111** undergoes gas exchange to a hydrogen gas atmosphere, after which the protocol stands by for a predetermined amount of time.

[0123] In this way, while the reaction furnace **11** is treating the wafer W**2** in steps S**25** to S**27**, the second robot **141** stores the after-treatment wafer W**1** in the wafer storage container **15** and also extracts the next wafer (W**3**) from the wafer storage container **15** and prepares for the next treatment. In other words, in step S**26**, the second door **132** of the load-lock chamber **13** is closed, and in a state where the first door **131** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to an inert gas atmosphere. Then, the first door **131** is opened, the second robot **141** loads the after-treatment wafer W**1** supported by the second holder **173** onto the first recess **144** of the second blade **143** and, as illustrated in step S**27**, the after-treatment wafer W**1** is stored in the wafer storage container **15**. Subsequently, in step S**27**, the wafer W**3** stored in the wafer storage container **15** is leaded on the first recess **144** of the second blade **143** and is transferred to the first holder **172** of the load-lock chamber **13** through the opened first door **131** by the first robot **121**.

[0124] In step S**28**, the first door **131** of the load-lock chamber **13** is closed, and in a state where the second door **132** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to an inert gas atmosphere. Then, the gate valve **114** of the reaction furnace **11** is opened, the first blade **123** of the first robot **121** is inserted into the reaction chamber **111** and is loaded with the carrier C**2** on which the after-treatment wafer W**2** is mounted, and the gate valve **114** is closed, after which the second door **132** is opened and the carrier C**2** is transferred from the reaction chamber **111** to the second holder **173** of the load-lock chamber **13**. Subsequently, the carrier C**1** supported by the first holder **172** is loaded onto the first blade **123** of the first robot **121** and, as illustrated in step S**11**, the carrier C**1** on which the before-treatment wafer W**3** is mounted is transferred through the wafer transfer chamber **12** to the susceptor **112** of the reaction furnace **11**.

[0125] In step S**29**, the second door **132** of the load-lock chamber **13** is closed, and in a state where the first door **131** is also closed, the interior of the load-lock chamber **13** undergoes gas exchange to an inert gas atmosphere. Then, the first door **131** is opened, the second robot **141** loads the post-treatment wafer W**2** onto the first recess **144** of the second blade **143** from the second holder **173** and the post-treatment wafer W**2** is stored in the wafer storage container **15**. Thereafter, the above steps are repeated until treatment for all of the before-treatment wafers WF stored in the wafer storage container **15** ends.

[0126] As described above, the vapor deposition device **1** of the present embodiment can easily switch by performing the minimum setup between the case where the wafer WF is transported using the carrier C and the case where the wafer WF is transported without using the carrier C.

DESCRIPTION OF REFERENCE NUMERALS

[0127] **1** . . . Vapor deposition device
[0128] **11** . . . Reaction furnace
[0129] **111** . . . Reaction chamber
[0130] **112** . . . Susceptor
[0131] **113** . . . Gas supply device
[0132] **114** . . . Gate valve
[0133] **115** . . . Carrier lifting pin
[0134] **116** . . . Support shaft
[0135] **1161** . . . First through hole
[0136] **1162** . . . Second through hole
[0137] **117** . . . Lift shaft
[0138] **1171** . . . First mounting portion
[0139] **1172** . . . Second mounting portion
[0140] **118** . . . Wafer lifting pin
[0141] **119***a* . . . rotation drive unit
[0142] **119***b* . . . lifting drive unit
[0143] **12** . . . Wafer transfer chamber
[0144] **121** . . . First robot
[0145] **122** . . . First robot controller
[0146] **123** . . . First blade
[0147] **124** . . . First recess
[0148] **125** . . . Second recess
[0149] **13** . . . Load-lock chamber
[0150] **131** . . . First door
[0151] **132** . . . Second door
[0152] **14** . . . Factory interface
[0153] **141** . . . Second robot
[0154] **142** . . . Second robot controller
[0155] **143** . . . Second blade
[0156] **144** . . . First recess
[0157] **15** . . . Wafer storage container
[0158] **16** . . . Integrated controller
[0159] **17** . . . Holder
[0160] **171** . . . Holder base
[0161] **172** . . . First holder
[0162] **172***a* . . . First wafer holder
[0163] **173** . . . Second holder
[0164] **173***a* . . . Second wafer holder
[0165] **174** . . . Wafer lifting pin
[0166] C . . . Carrier
[0167] C**11** . . . Bottom surface
[0168] C**12** . . . Top surface
[0169] C**13** . . . Outer circumferential wall surface
[0170] C**14** . . . Inner circumferential wall surface
[0171] WF . . . Wafer

1. A vapor deposition device comprising:
a wafer storage container;
a load-lock chamber;
a wafer transfer chamber configured to communicate with the load-lock chamber via a second door and comprising a first robot;

a factory interface configured to communicate with the load-lock chamber via a first door and comprising a second robot;

an integrated controller comprising:

a first robot controller configured to control the first robot; and

a second robot controller configured to control the second robot;

a reaction furnace comprising a reaction chamber, a susceptor provided in the reaction chamber and a plurality of carrier lift pins and a plurality of wafer lift pins provided through the susceptor;

a plurality of ring-shaped carriers configured to support an outer edge of a wafer,

wherein:

a plurality of before-treatment wafers are transportable from the wafer storage container, through the factory interface, the load-lock chamber, and the wafer transfer chamber, to the reaction chamber in that order, and

a plurality of after-treatment wafers are transportable from the reaction chamber, through the wafer transfer chamber, the load-lock chamber, and the factory interface, to the wafer storage container in that order,

the wafer transfer chamber communicates, via a gate valve, with the reaction chamber in which a CVD film is formed on the wafer,

the first robot controller is configured to control the first robot to deposit a before-treatment wafer transported into the load-lock chamber into the reaction chamber in a state where the before-treatment wafer is mounted on any carrier of the plurality of carriers and also withdraw an after-treatment wafer for which treatment in the reaction chamber has ended from the reaction chamber in a state where the after-treatment wafer is mounted on any carrier of the plurality of carriers and transport the wafer to the load-lock chamber,

the second robot controller is configured to control the second robot to extract a before-treatment wafer from the wafer storage container and mount the wafer on any carrier of the plurality of carriers standing by in the load-lock chamber, store in the wafer storage container an after-treatment wafer mounted on any carrier of the plurality of carriers that has been transported to the load-lock chamber, and dismount the after-treatment wafer mounted on any carrier of the plurality of carriers,

the load-lock chamber is provided with a carrier holder that supports any carrier of the plurality of carriers in a case of transferring the wafer by using any carrier of the plurality of the carriers, and a wafer holder that supports the wafer in a case of transferring the wafer without using any carrier of the plurality of the carriers,

the first robot is provided with a first blade at a tip,

the first blade includes:

a first recess which supports any carrier of the plurality of carriers in a case of transferring the wafer from the wafer storage container to the reaction chamber by using any carrier of the plurality of the carriers; and

a second recess which is provided at a bottom surface of the first recess to support the wafer in a case of transferring the wafer from the wafer storage container to the reaction chamber without using any carrier of the plurality of carriers,

the reaction chamber is provided with a support shaft which supports the susceptor and rotates by a rotation drive unit and a lift shaft which moves up and down with respect to the support shaft by a lifting drive unit,

the lift shaft is provided with a first mounting portion on which the carrier lifting pin can be mounted and a second mounting portion on which the wafer lifting pin can be mounted,

the support shaft is provided with a first through hole through which the carrier lifting pin mounted on the first mounting portion can penetrate and a second through hole through which the wafer lifting pin mounted on the second mounting portion can penetrate,

in the case of transferring the wafer to the reaction chamber by using any carrier of the plurality of the carriers, the integrated controller controls the lift shaft to lift and lower any carrier of the plurality of the carriers via the plurality of carrier lift pins; and

in the case of transferring the wafer to the reaction chamber without using any carrier of the plurality of the carriers, the integrated controller controls the lift shaft to lift and lower the wafer via the plurality of wafer lift pins.

2. The vapor deposition device according to claim **1**, wherein the first recess is a recess corresponding to a part of the outer circumferential wall surface of the carrier, and the second recess is a recess corresponding to a part of an outer shape of the wafer.

3. The vapor deposition device according to claim **1**, wherein the first recess and the second recess are formed concentrically.

4. The vapor deposition device according to claim **1**, wherein

the carrier holder supports the carrier at at least two points on each of a left side and a right side,

the wafer holder supports the wafer at at least two points on each of a left side and a right side,

the points at which the wafer holder supports the wafer at on each of the left side and the right side is set outside the points at which the carrier holder supports the carrier on each of the left side and the right side.

5. The vapor deposition device according to claim **1**, wherein a shaft portion of the support shaft is inserted into a shaft portion of the lift shaft, and the lift shaft rotates and moves up and down together with the support shaft.

6. The vapor deposition device according to claim **1**, wherein the plurality of carrier lift pins and the plurality of wafer lift pins are non-simultaneously supported by the lift shaft.

7. The vapor deposition device according to claim **1**, wherein

in the case of transferring the wafer from the wafer storage container to the reaction chamber by using any carrier of the plurality of the carriers:

one of the first robot controller and the second robot controller controls a respective one of the first and second robots to transport each of the plurality of before-treatment wafers from the wafer storage container, through the factory interface, to the load-lock chamber in that order, and to transport each of the plurality of before-treatment wafers from the load-lock chamber, through the wafer transfer chamber, to the reaction chamber in that order in a state in which each of the plurality of before-treatment wafers is mounted on any carrier of the plurality of carriers; and

one of the first robot controller and the second robot controller controls a respective one of the first and second robots to transport each of the plurality of aftertreatment wafers from the reaction chamber, through the wafer transfer chamber, to the load-lock chamber in that order in the state in which each of the plurality of aftertreatment wafers is mounted on any carrier of the plurality of carriers, and to transport each of the plurality of aftertreatment wafers from load-lock chamber, through the factory interface, to the wafer storage container in that order and

in the case of transferring the wafer from the wafer storage container to the reaction chamber without using any carrier of the plurality of the carriers:

one of the first robot controller and the second robot controller controls a respective one of the first and second robots to transport each of the plurality of before-treatment wafers from the wafer storage container, through the factory interface, the load-lock chamber, and the wafer transfer chamber, to the reaction chamber in that order in a state in which each of the plurality of before-treatment wafers is not mounted on any carrier of the plurality of carriers; and

one of the first robot controller and the second robot controller controls a respective one of the first and second robots to transport each of the plurality of aftertreatment wafers from the reaction chamber, through the wafer transfer chamber, the load-lock chamber, and the factory interface, to the wafer storage container in that order in the state in which each of the plurality of aftertreatment wafers is not mounted on any carrier of the plurality of carriers.

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