TRANSFER APPARATUS

TECHNICAL FIELD

[0001] The present disclosure relates to a transfer apparatus.

BACKGROUND

[0002] For example, Patent Document 1 discloses an equipment front-end module (EFEM) device for delivering a transfer target object to and from a processing apparatus using a transfer robot provided inside a housing.

[Prior Art Document]

[0003] Patent Document

Patent Document 1: International Publication No. 2022/197951

[0004] In such an EFEM transfer apparatus, there is a high demand for reducing an on-site apparatus footprint (occupied area).

[0005] Further, as shown in Patent Document 1, it is known that during maintenance of the transfer robot, the transfer robot is replaced from a front side of the housing (a load port side). In this case, the load port needs to be removed, which worsens operational efficiency for replacement and installation. On the other hand, when the transfer robot is replaced from a lateral side of the housing, a guide structure for the replacement operation needs to be provided inside the housing, which increases the footprint in a depth direction of the device.

[0006] In view of the above, the technology of the present disclosure provides a transfer apparatus for loading and unloading a substrate or the like into and from a processing apparatus for processing the substrate, which can efficiently perform the replacement of a transfer robot while reducing apparatus footprint.

SUMMARY

[0007] According to one embodiment of the present disclosure, there is provided a transfer apparatus for loading and unloading a substrate into and from a processing apparatus configured to process the substrate, the transfer apparatus including: a main body having an internal space defined by a front portion connected to a load port on which a container for accommodating the substrate is mounted and extending in an apparatus width direction, a rear portion connected to a load-lock module provided in the processing apparatus and facing the front portion in an apparatus depth direction, a bottom portion on which a transfer robot for transferring the substrate is mounted, a ceiling portion facing the bottom portion, and a pair of side portions facing each other in the apparatus width direction; and a structural body provided on the bottom portion and including a support to which the transfer robot is fixed, and a structural feature extending in the apparatus width direction, wherein each of the side portions is provided with an opening, and the structural feature includes continuous surfaces configured to be continuous with side surfaces of the support extending in the apparatus width direction.

[0008] According to the present disclosure, a transfer apparatus for loading and unloading a substrate or the like into and from a processing apparatus for processing the substrate can efficiently perform a replacement of a transfer robot while reducing apparatus footprint.

BRIEF DESCRIPTION OF DRAWINGS

[0009] FIG. 1 is a plan view schematically showing a wafer processing system provided with a transfer apparatus according to a first embodiment.

FIG. 2 is a cross-sectional side view of the transfer apparatus, showing a state in which a door is closed.

FIG. 3 is a cross-sectional side view of the transfer apparatus, showing a state in which a door is open.

FIG. 4 is a side view of the transfer apparatus.

FIG. 5 is a cross-sectional plan view of the transfer apparatus.

FIG. 6 is a cross-sectional view of a load port.

FIG. 7 is a rear side view of the load port.

FIG. 8 is a perspective view of a transfer robot.

FIG. 9 is a perspective view of the transfer robot and a support.

FIG. 10 is a partially enlarged view of a lower portion of a main body.

FIG. 11 is a cross-sectional view of a portion of the transfer apparatus different from the portions shown in FIGS. 2 and 3.

FIG. 12 is a perspective view of a transfer robot replacer.

FIG. 13 is a front view of the transfer robot replacer.

FIG. 14 is a rear view of the transfer robot replacer.

FIG. 15 is a side view for explaining a position of the transfer robot replacer relative to the transfer robot and the support.

FIG. 16 is a plan view for explaining the position of the transfer robot replacer relative to the transfer robot and the support.

FIGS. 17A to 17C are an explanatory diagrams showing a state in which the transfer robot is being unloaded from the main body.

FIG. 18 is an explanatory diagram showing a state in which the transfer robot has been unloaded from the main body.

FIG. 19 is an explanatory diagram showing a partial configuration of a transfer robot replacer according to a second embodiment.

DETAILED DESCRIPTION

[0010] The transfer apparatus according to this embodiment will be described below with reference to the drawings. In the present specification and the drawings, elements having substantially the same functional configurations are denoted by the same reference numerals, and redundant descriptions thereof will be omitted. In the drawings, an X direction is an apparatus width direction, which is a direction in which a plurality of load ports 101 to be described later is disposed side by side. A Y direction is an apparatus depth direction, which is a direction in which a front wall 121 and a rear wall 122 of a main body 102 of a transfer apparatus 20 to be described later are disposed side by side. A negative side of the Y direction is a front side, and

a positive side of the Y direction is a rear side. A Z direction is a vertical direction.

(First Embodiment)

<Wafer Processing System 1>

[0011] FIG. 1 is a plan view schematically showing a wafer processing system 1 provided with a transfer apparatus 20 according to a first embodiment.

[0012] As shown in FIG. 1, the wafer processing system 1 includes a processing apparatus 10 and a transfer apparatus 20. The processing apparatus 10 and the transfer apparatus 20 are installed adjacent to each other.

[0013] The processing apparatus 10 is an apparatus for processing a semiconductor wafer (hereinafter referred to as "wafer") W as a substrate, and includes, for example, a processing module 30 and a vacuum transfer module 40.

[0014] A plurality of processing modules 30 is provided, for example. Each processing module 30 processes the wafer W under a reduced pressure atmosphere, that is, a vacuum atmosphere. Processes performed by the processing module 30 includes, for example, a film formation processing, an etching process, an impurity diffusion process, and the like. Further, each processing module 30 includes a vacuum processing chamber 31 in which the above-mentioned processes are performed on the wafer W under the vacuum atmosphere. Each vacuum processing chamber 31 is connected to a vacuum transfer chamber 41 of the vacuum transfer module 40, which will be described later, via a gate valve G1.

[0015] The vacuum transfer module 40 includes the vacuum transfer chamber 41, an interior of which is maintained in the vacuum atmosphere. The vacuum transfer chamber 41 is configured to be sealable and is formed to have a substantially polygonal shape (a quadrilateral shape in the example of the drawings) in a plan view. The vacuum transfer chamber 41, which is connected to each of the processing modules 30, is also connected to a load-lock module 50 to be described later. Specifically, the vacuum transfer chamber 41 is connected to a load-lock chamber 51 of the load-lock module 50 described later via a gate valve (not shown). A transferer 42 for transferring the wafer W is provided inside the vacuum transfer chamber 41. The vacuum

transfer module 40 uses the transferer 42 to load and unload the wafer W between the vacuum processing chambers 31 and the load-lock chambers 51 from the vacuum transfer chamber 41.

[0016] Further, the processing apparatus 10 is provided with the load-lock module 50 at an end at a transfer apparatus 20 side. For example, a plurality of load-lock modules 50 is provided. Each load-lock module 50 is used for delivering the wafer W between a space under a vacuum atmosphere and a space under a non-reduced pressure atmosphere, that is, an atmospheric pressure atmosphere. Each load-lock module 50 includes a load-lock chamber 51 configured such that an interior thereof can be switched between the atmospheric pressure atmosphere and the vacuum atmosphere. The load-lock chamber 51 is provided so as to connect the vacuum transfer module 40 and the transfer apparatus 20.

[0017] The transfer apparatus 20 is an apparatus for loading and unloading the wafer W into and from the processing apparatus 10. Specifically, the transfer apparatus 20 is configured to deliver the wafer W between a front-opening unified pod (FOUP) 900, which is a container for accommodating a plurality of wafers W, and the processing apparatus 10 without exposing the wafers W to an external atmosphere. The transfer apparatus 20 includes a load port 101 and a main body 102, which is also called an EFEM device.

[0018] The load port 101 is configured to accommodate the FOUP 900 and is provided along the apparatus width direction (X direction) in plurality (five in the example of the drawing).

[0019] The main body 102 is disposed on a rear side of the load port 101 (positive side in the Y direction) of the load port 101. Specifically, the main body 102 is disposed adjacent to the load port 101. The load-lock chamber 51 is connected to the main body 102. Specifically, for example, the load-lock chamber 51 is connected to a rear side of the main body 102 (positive side in the Y direction). An interior of the main body 102 is maintained at the atmospheric pressure atmosphere. A transfer robot 110 for supporting and transferring the wafer W is provided inside the main body 102. The transfer robot 110 can transfer the wafer W between the FOUP 900 mounted on the load port 101 and the load-lock chamber 51, or the like.

[0020] The wafer processing system 1 described above is provided with at least one controller C. The controller C processes computer-executable instructions that cause the wafer processing

system 1 to perform the various processes described in the present specification. The controller C may be configured to control individual components of the wafer processing system 1 to perform the various processes described herein. In one embodiment, a part or the entirety of the controller C may be included in the wafer processing system 1. The controller C may include a processor, a memory, and a communication interface. The controller C is implemented, for example, by a computer. The processor may be configured to read a program that provides a logic or routine for enabling various control operations and to perform the various control operations by executing the read program. The program may be stored in the memory in advance, or may be obtained via a medium when needed. The obtained program is stored in the memory and is read from the memory and executed by the processor. The storage medium is non-transitory. The medium may be any computer-readable storage medium, or may be a communication line connected to the communication interface. The processor may be a central processing unit (CPU), or may be one or more circuits. The memory may include a random access memory (RAM), a read only memory (ROM), a hard disk drive (HDD), a solid state drive (SSD), or a combination thereof. The communication interface may communicate with the wafer processing system 1 via a communication line such as a local area network (LAN) or the like.

<Wafer Processing>

[0021] Next, wafer processing performed by the wafer processing system 1 configured as described above will be described. The following wafer processing will be carried out under the control of the controller C.

[0022] First, the wafer W is taken out from the FOUP 900 by the transfer robot 110 and loaded into the load-lock chamber 51 of the load-lock module 50. Subsequently, the load-lock chamber 51 is sealed and kept in a vacuum atmosphere.

[0023] Subsequently, the gate valve (not shown) on a vacuum transfer chamber 41 side of the load-lock chamber 51 is opened, and the wafer W is unloaded from the load-lock chamber 51 to the vacuum transfer chamber 41 by the transferer 42.

[0024] Next, after the gate valve is closed, the gate valve G1 corresponding to the processing module 30 that performs a desired processing is opened. Subsequently, the wafer W is loaded into the vacuum processing chamber 31 of the target processing module 30 by the transferer 42. Thereafter, the gate valve G1 is closed, and the desired processing is performed on the wafer W in the processing module 30.

[0025] After the desired processing is completed, the wafer W is returned from the vacuum processing chamber 31 to the FOUP 900 in the reverse order of when the wafer W is loaded into the vacuum processing chamber 31 from the FOUP 900. This completes a sequence of the wafer processing.

<Transfer Apparatus 20>

[0026] FIGS. 2 and 3 are cross-sectional side views of the transfer apparatus 20. FIG. 2 shows a state in which a door 180 (described later) is closed, and FIG. 3 shows a state in which the door 180 (described later) is open. Figure 4 is a side view of the transfer apparatus 20. FIG. 5 is a cross-sectional plan view of the transfer apparatus 20. FIG. 6 is a cross-sectional view of the load port 101. FIG. 7 is a rear side view of the load port 101. FIG. 8 is a perspective view of the transfer robot 110. FIG. 9 is a perspective view of the transfer robot 110 and a support 240. FIG. 10 is a partially enlarged view of a lower portion of the main body 102. FIG. 11 is a cross-sectional view of a portion of the transfer apparatus 20 that is different from portions shown in FIGS. 2 and 3.

[0027] As shown in FIGS. 2 to 5, the transfer apparatus 20 includes the aforementioned load port 101 and main body 102, and further includes a lower accommodation portion 103 for accommodating various components.

[0028] The main body 102 includes a housing 120 having a substantially rectangular parallelepiped shape. The housing 120 includes a front wall 121 as a front portion, a rear wall 122 as a rear portion, a pair of side walls 123 as side portions, a bottom wall 124 as a bottom portion, and a ceiling wall 125 as a ceiling portion.

[0029] The front wall 121 extends in the apparatus width direction (X direction) in a plan view

on the front side (negative side in the Y direction) of the main body 102. The front wall 121 includes an upper front wall 121A and a lower front wall 121B. The lower front wall 121B is provided so as to protrude forward farther than the upper front wall 121A.

[0030] The load port 101 and the lower accommodation portion 103 are connected to the upper front wall 121A. The lower accommodation portion 103 is disposed below the load port 101. The upper front wall 121A is provided with an opening 126 in which the load port 101 is provided. The upper front wall 121A is also provided with an opening 127 which serves as a load/unload port for the wafer W with respect to the lower accommodation portion 103.

[0031] The rear wall 122 faces the front wall 121 in the apparatus depth direction and extends in the apparatus width direction in a plan view on the rear side (positive side in the Y direction) of the main body 102. The load-lock module 50 is connected to the rear wall 122. An opening 128 is provided in the rear wall 122 at a position corresponding to the load-lock chamber 51. The opening 128 is provided in the rear wall 122 at a vertical position that is substantially the same as a delivery position inside the load-lock chamber 51. The delivery position inside the load-lock chamber 51 is a vertical position of the wafer W when the wafer W is delivered between the load-lock chamber 51 and the transfer robot 110.

[0032] The pair of side walls 123 face each other in the apparatus width direction and extend in the apparatus depth direction in a plan view. Each side wall 123 is provided with an opening 129 for maintenance of the main body 102. A size of the opening 129 is such that the transfer robot 110 can be loaded and unloaded through the opening 129 in order to replace the transfer robot 110, as will be described later. A door 130 for opening and closing the opening 129 is provided at the opening 129.

[0033] The bottom wall 124 and the ceiling wall 125 face each other in the vertical direction and extend along a horizontal direction (X and Y directions), respectively.

[0034] The main body 102 includes an internal space defined by the front wall 121, the rear wall 122, the side walls 123, the bottom wall 124, and the ceiling wall 125. The internal space is divided vertically into a lower transfer space S1 and an upper accommodation space S2 by a partition wall 131 provided between the bottom wall 124 and the ceiling wall 125. As will be

described later, a purified gas is supplied from the accommodation space S2 to the transfer space S1, and the partition wall 131 is provided with an opening 132 for supplying the gas.

[0035] As shown in FIGS. 6 and 7, the load port 101 includes a connecting plate 140, an isolation cover 150, and a main cover 151.

[0036] The connecting plate 140 is attached to a front surface of the upper front wall 121A so as to cover the opening 126 when the connecting plate 140 is connected to the main body 102. An upper side of the connecting plate 140 protrudes and extends from above the main cover 151. An opening 141, which is a load/unload port for the wafer W, is provided on the upper side of the connecting plate 140 above the isolation cover 150 and the main cover 151. A lower side of the connecting plate 140 extends so as to cover a rear surface of the isolation cover 150 and a rear surface of the main cover 151. A slit 142 for raising and lowering an arm 192 of a mover 190, which will be described later, is provided at the lower side of the connecting plate 140 so as to extend in the vertical direction.

[0037] An accommodation space S3, which accommodates the mover 190 to be described later, is defined by the isolation cover 150 and a front surface of the connecting plate 140. Further, the isolation cover 150 covers the slit 142 from the front side. By providing the isolation cover 150, a gas inside the transfer space S1 of the main body 102 can be suppressed from leaking out of the transfer apparatus 20.

[0038] An accommodation space S4, which accommodates a forward/backward mover 170 to be described later, is defined by the main cover 151, the connecting plate 140, and the isolation cover 150. Further, the main cover 151 covers the forward/backward mover 170 to be described later and the isolation cover 150. In this embodiment, the main cover 151 covers a front wall and a ceiling wall of the isolation cover 150, but does not cover a bottom wall of the isolation cover 150.

[0039] The bottom wall of the isolation cover 150 and a bottom wall of the main cover 151 constitute a bottom surface of the load port 101. A slider 152 is provided at the bottom surface of the load port 101. When attaching the load port 101 to the main body 102, the slider 152 is made to slide on an upper surface of a first accommodation portion 103A of the lower

accommodation portion 103, which will be described later. When the load port 101 is connected to the main body 102, the slider 152 is disposed to be spaced apart from the upper surface of the first accommodation portion 103A.

[0040] The load port 101 further includes a stage 160 and a forward/backward mover 170.

[0041] The stage 160 includes a mounting surface 160a for the FOUP 900 which accommodates the wafers W. Specifically, an upper surface of the stage 160 serves as the mounting surface 160a of the FOUP 900. The stage 160 supports the FOUP 900 on the mounting surface 160a. The FOUP 900 mounted on the mounting surface 160a is disposed such that a lid 901, which is a door of the FOUP 900, faces the opening 141 of the connecting plate 140. The stage 160 is provided on an upper surface of the main cover 151 described above.

[0042] The stage 160 is provided with a nozzle 161 for supplying a gas to the FOUP 900. Specifically, the nozzle 161 supplies an inert gas such as a nitrogen gas or the like into the FOUP 900 mounted on the stage 160. The nozzle 161 is movable by the forward/backward mover 170. Specifically, the nozzle 161 is movable together with the stage 160 which is moved by the forward/backward mover 170. Further, the nozzle 161 protrudes from a lower surface of the stage 160, and a lower portion of the nozzle 161 protrudes into the aforementioned accommodation space S4.

[0043] The forward/backward mover 170 moves the stage 160 forward and backward in the horizontal direction. Specifically, the forward/backward mover 170 moves the stage 160 forward and backward relative to the opening 141. More specifically, the forward/backward mover 170 moves the stage 160 between a forward position and a rear position. The forward position is a position where the FOUP 900 is delivered between an external transfer device for the FOUP 900 and the stage 160. The rear position is a position where the wafer W is delivered between the FOUP 900 and the interior of the main body 102 via the opening 141.

[0044] The forward/backward mover 170 includes, for example, a guide 171 and a support 172. The guide 171 guides the movement of the stage 160 in the apparatus depth direction. Specifically, the guide 171 guides the movement of the support 172, which supports the stage 160, in a front-rear direction. An upper end of the support 172 is connected to the stage 160,

and a lower end of the support 172 is connected to the guide 171 so that the support 172 is movable in the apparatus depth direction in which the guide 171 extends. The forward/backward mover 170 is accommodated in the aforementioned accommodation space S4.

[0045] The load port 101 further includes a door 180 and a mover 190.

[0046] The door 180 opens and closes the opening 141. The door 180 is configured to unlock the lid 901 of the FOUP 900 and to hold the lid 901. With the unlocked lid 901 being held by door 180, the door 180 is opened to thereby open the lid 901. During the opening/closing operation of the door 180, the door 180 moves inside the main body 102 (specifically, inside the transfer space S1).

[0047] The mover 190 opens and closes the door 180 and the lid 901 and also raises and lowers the door 180 and the lid 901, functioning as an elevator. The mover 190 includes, for example, an actuator 191, an arm 192, and a elevating body 193.

[0048] The actuator 191 drives the door 180 to be raised and lowered. Specifically, the actuator 191 drives the raising and lowering of the elevating body 193 that supports the door 180 via the arm 192. The actuator 191 is provided inside the load port 101 so as to extend in the vertical direction (Z direction). The actuator 191 may be an electro-pneumatic actuator such as an air cylinder, or may be an electromechanical actuator.

[0049] The arm 192 is configured to support the door 180 and is driven by the actuator 191. For example, as shown in FIG. 7, a pair of arms 192 are provided along the apparatus width direction (X direction). An upper end of each arm 192 is connected to the door 180 which may be located inside the main body 102 (specifically, inside the transfer space S1), and a lower end of each arm 192 is connected via the elevating body 193 to the actuator 191 which is located inside the load port 101, that is, outside the main body 102. In order to allow the arms 192 to be raised and lowered in such a connected state, slits 142 are provided in the upper front wall 121A of the main body 102 as described above. That is, the upper front wall 121A of the main body 102 is provided with the slits 142 through which the arms 192 can be inserted and through which the arms 192 can pass when the arms 192 are raised and lowered. For example, the slits 142 are provided for the respective arms 192.

[0050] The elevating body 193 is raised and lowered along the actuator 191. That is, the elevating body 193 is moved in the vertical direction.

[0051] The mover 190 is configured to be capable of moving the door 180 in the apparatus depth direction (Y direction). For example, the arms 192 that support the door 180 are connected to the elevating body 193 so as to be movable in the front-rear direction.

[0052] The mover 190 is accommodated in the accommodation space S4 of the main cover 151 described above. Specifically, the accommodation space S4 accommodates parts of the mover 190 located outside the main body 102, that is, the actuator 191 of the mover 190, portions of the arms 192, and the elevating body 193.

[0053] The mover 190 further includes an actuator (not shown) that drives the forward and backward movement of the door 180. The mover 190 is controlled by the controller C. Specifically, the actuator of the mover 190 and the actuator 191 are controlled by the controller C.

[0054] As shown in FIGS. 2 to 4, the lower accommodation portion 103 is constituted by a plurality of accommodation portions stacked in the vertical direction, and includes, for example, an upper first accommodation portion 103A and a lower second accommodation portion 103B.

[0055] The first accommodation portion 103A accommodates a function expansion module constituted by at least one selected from the group of a measurement module for performing measurements on a film formed on the wafer W, an inspection module for inspecting defects in the wafer W, or an alignment module for adjusting an orientation position of the wafer W. The aforementioned opening 127 is provided in the upper front wall 121A of the main body 102 at a position corresponding to the first accommodation portion 103A.

[0056] The measurement module or the inspection module accommodated in the first accommodation portion 103A includes, for example, a module including a stage (not shown) on which a wafer W is mounted and which is configured to be movable in the horizontal direction, and an imager (not shown) for imaging the wafer W that is mounted on the stage and moving in the horizontal direction. Alternatively, or additionally, the measurement module or the inspection module may include a module in which the imager (not shown) images the wafer W,

which is supported by the transfer robot 110 that has been inserted via the opening 127 and which is moving in the horizontal direction.

[0057] The second accommodation portion 103B accommodates electrical components including a power supply. No opening such as the opening 127 is provided in the second accommodation portion 103B. In other words, between the first accommodation portion 103A and the second accommodation portion 103B, only the upper accommodation portion 103A has an opening that serves as a load/unload port for the wafer W.

[0058] The main body 102 includes a door 200 and an elevator 210.

[0059] The door 200 opens and closes the opening 128 in the rear wall 122 described above. The elevator 210 raises and lowers the door 200 to open and close the opening 128. The door 200 and the elevator 210 are provided inside the main body 102 (specifically inside the transfer space S1).

[0060] Further, the elevator 210 includes an actuator (not shown) that drives the door 200 to be raised and lowered. The elevator 210 is controlled by the controller C. Specifically, the actuator of the elevator 210 is controlled by the controller C.

[0061] Further, the main body 102 includes a transfer robot 110 that supports and transfers the wafer W as described above. Specifically, the transfer robot 110 transfers the wafer W between the opening 141 and the opening 128, or the like. The transfer robot 110 is accommodated in the transfer space S1 described above and is placed on the bottom wall 124.

[0062] As shown in FIGS. 8 and 9, the transfer robot 110 includes a horizontal arm 220 and a vertical articulated arm 230 as transfer arms.

[0063] The horizontal arm 220 is configured to transfer the wafer W in the horizontal direction. The horizontal arm 220 is, for example, an articulated arm and includes a fork 221, a first arm 222, and a second arm 223.

[0064] The fork 221 supports the wafer W at a tip side of the fork 221. The fork 221 is connected to a tip side of the first arm 222 such that the fork 221 is rotatable about an axis (hereinafter referred to as "vertical axis") at a base side of the fork 221 extending in the vertical direction (Z direction). The first arm 222 is connected to a tip side of the second arm 223 such

that the first arm 222 is rotatable about a vertical axis at a base side of the first arm 222. The second arm 223 is connected to a tip portion of the vertical articulated arm 230 so as to be rotatable about a vertical axis.

[0065] The vertical articulated arm 230 is constituted by an articulated arm and is configured to be capable of at least raising and lowering the horizontal arm 220. In this embodiment, the vertical articulated arm 230 is configured to be capable of moving the horizontal arm 220 in the vertical direction (Z direction) and the apparatus width direction (X direction). The vertical articulated arm 230 includes an arm 231 provided to be capable of pivoting in the vertical direction and a base 232 connected to the arm 231 and fixed to a support 240 which will be described later.

[0066] The arm 231 includes, for example, a first arm 231A and a second arm 231B. The horizontal arm 220 is connected to a tip side of the first arm 231A. Further, the first arm 231A is connected to a tip side of the second arm 231B so as to be rotatable about an axis (hereinafter referred to as "front-rear axis") extending in the apparatus depth direction at a base side of the first arm 231A. The second arm 231B is connected to an upper end of the base 232 so as to be rotatable about a front-rear axis at a base side of the second arm 231B.

[0067] The base 232 supports the horizontal arm 220 via the arm 231. The base 232 includes a pair of plate-shaped members 233 and a bottom member 234.

[0068] The pair of plate-shaped members 233 are disposed side by side in the apparatus depth direction (Y direction). Specifically, of the pair of plate-shaped members 233, the first plate-shaped member 233A is disposed on the front side (negative side in the Y direction), and the second plate-shaped member 233B is disposed on the rear side (positive side in the Y direction). The second arm 231B is pivotally supported between the first plate-shaped member 233A and the second plate-shaped member 233B.

[0069] The plate-shaped member 233 extends along the vertical direction in the transfer space S1. Further, when viewed in the apparatus depth direction, the plate-shaped member 233 is shaped substantially as an isosceles triangle having a pair of long sides extending along the vertical direction and a short side connecting the pair of long sides. In this embodiment, an

interior of the second plate-shaped member 233B is open. However, the present disclosure is not limited thereto.

[0070] A transfer support 235 is provided at a lower portion of a front surface of the first plate-shaped member 233A. The transfer support 235 is a handle that supports a transfer robot replacer 300 to be described later when the transfer robot 110 is replaced by the transfer robot replacer 300. The transfer support 235 protrudes from the front surface of the first plate-shaped member 233A in the apparatus depth direction (Y direction) and extends in the apparatus width direction (X direction).

[0071] The bottom member 234 is disposed to connect a lower end of the first plate-shaped member 233A and a lower end of the second plate-shaped member 233B. As shown in FIG. 9, a positioning structure that can be used to position the transfer robot 110 is formed on a bottom surface of the bottom member 234. For example, the bottom member 234 is provided with a plurality of, for example, two positioning pins 236. The positioning pins 236 are inserted into pin holes 241 provided in the support 240, which will be described later. Although not shown, positioning pins may be provided at a support 240 side, pin holes may be provided at a bottom surface side of the bottom member 234, and the positioning pins on the support 240 side may be inserted into the pin holes in the bottom surface side of the bottom member 234. The structure for positioning the transfer robot 110 is not limited to this embodiment, and may be any structure other than the positioning pins.

[0072] As shown in FIGS. 2, 3, and 5, the main body 102 includes a support 240 and exhaust boxes 250 as a pair of exhausters. The support 240 and the exhaust boxes 250 constitute a structural body of the present disclosure, and the exhaust boxes 250 constitute a structural feature of the present disclosure.

[0073] The support 240 and the pair of exhaust boxes 250 are provided on the bottom wall 124 and arranged side by side in the apparatus width direction (X direction). Specifically, the pair of exhaust boxes 250 are arranged side by side on both sides of the support 240 in the apparatus width direction. A front surface (surface on the negative side in the Y direction) of the support 240 extending in the apparatus width direction and front surfaces of the exhaust boxes 250 are

continuous. Further, a rear surface (surface on the positive side in the Y direction) of the support 240 extending in the apparatus width direction and rear surfaces of the exhaust boxes 250 are continuous. In other words, the front and rear surfaces of the exhaust boxes 250 form a structural feature by constituting continuous surfaces with the front and rear surfaces of the support 240, respectively.

[0074] The support 240 fixes and supports the transfer robot 110. As shown in FIG. 9, an upper surface of the support 240 is provided with a plurality of, for example, two pin holes 241 at positions corresponding to the positioning pins 236 of the transfer robot 110 described above. When the transfer robot 110 is mounted on the support 240, the positioning pins 236 are inserted into the pin holes 241. Thus, the transfer robot 110 is fixed to the support 240 at a desired position.

[0075] As shown in FIG. 10, in the transfer robot 110 supported on the support 240, the transfer support 235 protrudes forward (negative side in the Y direction) from the front surface of the support 240. For this reason, the lower front wall 121B, which is a lower region of the front wall 121 corresponding to the transfer support 235, is provided so as to protrude more forward than the upper front wall 121A. Therefore, even when the transfer support 235 is provided, it is possible to accommodate the transfer support 235 while minimizing a wafer transfer distance between the FOUP 900 of the transfer apparatus 20 and the load-lock chamber 51. A first lower space T1 is formed below the plate-shaped member 233 on which the transfer support 235 is provided, and a part of the first lower space T1 is constituted by the transfer support 235. For example, as shown in FIG. 10, the first lower space T1 is formed of a space surrounded by the transfer support 235, the lower front wall 121B, the first plate-shaped member 233A, the support 240, and the bottom wall 124.

[0076] Further, in the transfer robot 110 supported by the support 240, the second plate-shaped member 233B is disposed to protrude from a rear side (positive side in the Y direction) of the rear surface of the support 240. Thus, a second lower space T2 is formed below the plate-shaped member 233, and a part of the second lower space T2 is constituted by the second plate-shaped member 233B protruding from the support 240. For example, as shown in FIG. 10, the

second lower space T2 is formed of a space surrounded by the second plate-shaped member 233B protruding from the support 240, the rear wall 122, the support 240, and the bottom wall 124.

[0077] Although not shown in the drawings, the first lower space T1 and the second lower space T2 may be disposed in reverse in the apparatus depth direction (Y direction) of the transfer apparatus 20. In other words, the transfer support 235 may be provided at the second plate-shaped member 233B instead of the first plate-shaped member 233A. In this case, the lower front wall 121B that protrudes forward is not formed at a lower portion of the front wall 121, and a lower rear wall that protrudes rearward is formed at a lower portion of the rear wall 122. Thus, the first lower space T1 is formed of a space surrounded by the transfer support 235, the protruding lower rear wall, the second plate-shaped member 233B, the support 240, and the bottom wall 124. On the other hand, the second lower space T2 does not protrude forward and is formed of a space surrounded by the surface that is continuous with the upper front wall 121A, the first plate-shaped member 233A, the support 240, and the bottom wall 124. By causing a lower portion of at least one wall (front wall 121 or rear wall 122) to protrude forward or backward to form the first lower space T1 as described above, the structural feature can be utilized as a guide when replacing the transfer robot while minimizing a width in the apparatus depth direction, thereby ensuring operational efficiency of replacement. Further, although not shown in the drawings, the first lower space T1 may not be formed, and the second lower space T2 may be formed in both sides in the apparatus depth direction (Y direction) of the transfer apparatus 20. In other words, the transfer support 235 may not be formed, and the first plate-shaped member 233A and the second plate-shaped member 233B may be configured so as to protrude beyond the support 240 in the apparatus depth direction. In this case, the lower portions of the front wall 121 and the rear wall 122 do not need to protrude forward or backward. This makes it possible to utilize the structural feature as a guide during the replacement of the transfer robot while suppressing an increase in the number of components such as the transfer support 235 in the transfer robot 110, thereby ensuring of the operational efficiency of replacement. Further, although not shown in the drawings, the second lower space T2 may not

be formed, and the first lower space T1 may be formed in both sides in the apparatus depth direction (Y direction) of the transfer apparatus 20. In other words, the transfer support 235 may be provided in both the first plate-shaped member 233A and the second plate-shaped member 233B.

[0078] As shown in FIGS. 2, 3, and 5, the exhaust box 250 is configured such that a downflow gas flows from the transfer space S1 into the exhaust box 250. In this embodiment, the gas that flows into the exhaust box 250 may be returned to the accommodation space S2 via a return path B, which will be described later. Alternatively, the gas may not be returned to the accommodation space S2 via the return path B, but may be discharged outside of the main body 102 (specifically, for example, into a cleanroom where the transfer apparatus 20 is installed). In this case, a fan filter unit (not shown) may be provided inside the exhaust box 250.

[0079] As described above, the front surface of the support 240 and the front surfaces of the exhaust boxes 250 are continuous, and the rear surface of the support 240 and the rear surfaces of the exhaust boxes 250 are continuous. For this reason, the first lower space T1 and the second lower space T2 shown in FIG. 10 also extend to positions corresponding to the exhaust boxes 250.

[0080] As shown in FIGS. 2 and 3, the main body 102 includes a fan filter unit (FFU) 260 as an air-blower.

[0081] The FFU 260 supplies a purified gas, that is, a gas from which particles and/or molecular contaminants have been filtered out, from top to bottom in the transfer space S1. The FFU 260 is provided in the accommodation space S2 described above and is supported, for example, by a partition wall 131. As described above, the opening 132 is formed in the partition wall 131, and the FFU 260 supplies the purified gas to the transfer space S1 via the opening 132.

[0082] In this embodiment, one end of a supply pipe 270 for supplying an inert gas such as a nitrogen gas or the like to the accommodation space S2 may be connected to the main body 102. A gas supplier 271 is connected to the other end of the supply pipe 270. The gas supplier 271 includes, for example, an inert gas source, a switching valve configured to switch between supply and stop of the inert gas, a flow rate adjustment valve configured to adjust the flow rate of

the inert gas, and the like.

[0083] Since the above-described supply pipe 270 is provided, in this embodiment, the FFU 260 can supply the purified inert gas into the accommodation space S2.

[0084] In this embodiment, as shown in FIG. 11, the inert gas can be circulated inside the main body 102 by forming the downflow of gas in the transfer space S1 using a fan provided in the FFU 260. The inert gas may also be circulated using a circulation path constituted by the transfer space S1, the accommodation space S2, and the return path B. That is, the purified inert gas is sent downward from the accommodation space S2 via the opening 132 to the transfer space S1 by the FFU 260, reaches a lower end of the transfer space S1, and is then returned to the accommodation space S2 via the return path B by the exhaust boxes 250. In addition, when a gas inside the housing 120 is not circulated as described above, the gas inside the housing 120 may be discharged outside of the apparatus via the exhaust boxes 250.

[0085] In a case where the return path B is provided, the transfer space S1 and the accommodation space S2 may be provided so as to extend in the vertical direction, and an arrangement thereof may be arbitrarily determined. For example, the return path B may be provided along a rear surface of the front wall 121 of the main body 102, or, as shown in FIG. 11, the return path B may be provided inside a column 133 that constitutes the main body 102. When the return path B is provided inside the column 133 that constitutes the main body 102, a footprint of the main body 102 (EFEM device) can be reduced. Therefore, in such a transfer apparatus 20, when the front and rear surfaces of the exhaust boxes 250 form continuous surfaces with the front and rear surfaces of the support 240, the footprint reduction effect can be further enhanced.

[0086] Further, in the above example, the inert gas is circulated inside the main body 102. Alternatively, a dry air may be circulated. In this case, for example, the dry air is supplied from the gas supplier 271 into the accommodation space S2 via the supply pipe 270.

<Transfer Robot Replacer 300>

[0087] When performing maintenance on the transfer robot 110 described above, a transfer robot

replacer is used to replace the transfer robot 110. FIGS. 12 to 14 are, respectively, a perspective view, a front view, and a rear view of a transfer robot replacer 300. FIGS. 15 and 16 are diagrams for explaining a position of the transfer robot replacer 300 relative to the transfer robot 110 and the support 240.

[0088] As shown in FIGS. 12 to 14, the transfer robot replacer 300 includes a lifter 310 and a guide roller 320. The lifter 310 is configured to be capable of raising and lowering while supporting the transfer robot 110. The guide roller 320 is configured to move in the horizontal direction while supporting the lifter 310.

[0089] The lifter 310 includes a pair of support frames 311, a vertical frame 312, a lifter 313, a guide plate 314, and guide members 315.

[0090] The pair of support frames 311 are arranged side by side in the apparatus depth direction (Y direction). Specifically, of the pair of support frames 311, a first support frame 311A is disposed on the front side (negative side in the Y direction), and the second support frame 311B is disposed on the rear side (positive side in the Y direction). Further, each of the first support frame 311A and the second support frame 311B extends in the apparatus width direction (X direction) and has a length sufficient to support the transfer robot 110. As shown in FIGS. 15 and 16, the first support frame 311A supports the transfer support 235, and the second support frame 311B supports a bottom surface of the second plate-shaped member 233B.

[0091] As shown in FIGS. 12 to 14, the vertical frame 312 is supported by the pair of support frames 311 and extends in the vertical direction (Z direction).

[0092] The elevator 313 raises and lowers the pair of support frames 311 and the vertical frame 312. The configuration of the elevator 313 is arbitrary. For example, the elevator 313 may include a screw (not shown), and a worker may manually raise and lower the pair of support frames 311 and the vertical frame 312. Alternatively, for example, the elevator 313 may include an actuator (not shown) and automatically raise and lower the pair of support frames 311 and the vertical frame 312.

[0093] The guide plate 314 is provided on a lower vertical frame 322 of the guide roller 320, which will be described later, and extends in the vertical direction. In the guide plate 314, slits

316 for raising and lowering the guide members 315 are provided at, for example, two locations and extend in the vertical direction.

[0094] The guide members 315 are provided on the vertical frame 312. Further, the guide members 315 are provided so as to sandwich the guide plate 314 via the slit 316. In this case, when the pair of support frames 311 and the vertical frame 312 are raised and lowered by the elevator 313, the guide members 315 are guided in the vertical direction along the slits 316, thereby causing the pair of support frames 311 and the vertical frame 312 to move in the vertical direction.

[0095] The guide roller 320 includes a pair of horizontal frames 321, a lower vertical frame 322, and an upper vertical frame 323.

[0096] The pair of horizontal frames 321 are disposed side by side in the apparatus depth direction (Y direction). Each of the pair of horizontal frames 321 extends in the apparatus width direction (X direction) and supports the first support frame 311A and the second support frame 311B.

[0097] Each horizontal frame 321 includes a plurality of, for example, two wheels 324 provided at a bottom surface thereof. With this configuration, the transfer robot replacer 300 is configured to be movable in the apparatus width direction (X direction). For example, the transfer robot replacer 300 may be moved manually by an operator, or the transfer robot replacer 300 may be moved automatically by a mover (not shown).

[0098] A plurality of, for example, two rollers 325 are provided on an inner surface of each horizontal frame 321. The rollers 325 protrude slightly from the inner surface of the horizontal frame 321.

[0099] The lower vertical frame 322 is supported by the pair of horizontal frames 321 and extends in the vertical direction. The upper vertical frame 323 is supported by the lower vertical frame 322 and extends in the vertical direction.

[0100] As shown in FIGS. 15 and 16, when the transfer robot replacer 300 is moved in the apparatus width direction (X direction), the first support frame 311A and a horizontal frame 321 move through the first lower space T1, and the second support frame 311B and the other

horizontal frame 321 move through the second lower space T2. At this time, since side surfaces (front and rear surfaces) of the exhaust boxes 250 are continuous surfaces (structural feature) that are continuous with side surfaces (front and rear surfaces) of the support 240, the rollers 325 can guide the movement of the transfer robot replacer 300 in the apparatus width direction by coming into contact with the continuous surfaces without a separate guide structure.

[0101] An inner width L1 (distance between inner surfaces) of the pair of support frames 311 and an inner width L1 of the pair of horizontal frames 321 are the same. The inner width L1 is larger than a width L2 of the support 240 (width L2 of the exhaust boxes 250) by an amount by which the rollers 325 protrude from the inner surface of the horizontal frame 321.

<Method for Replacing the Transfer Robot 100>

[0102] Next, a method for replacing the transfer robot 110 using the transfer robot replacer 300 configured as described above will be described. FIGS. 17A to 17C are explanatory diagrams showing a state in which the transfer robot 110 is being unloaded from the main body 102. FIG. 18 is an explanatory diagram showing a state in which the transfer robot 110 has been unloaded from the main body 102.

[0103] First, the door 130 of the main body 102 is opened, and as shown in FIG. 17A, the transfer robot replacer 300 is moved from a trolley 400 into the main body 102 via the opening 129. The trolley 400 may be configured arbitrarily as long as the transfer robot replacer 300 can be mounted thereon. At this time, while keeping the rollers 325 in contact with the side surfaces of the exhaust boxes 250, the transfer robot replacer 300 is moved to the negative side in the X direction.

[0104] Next, as shown in FIG. 17B, the transfer robot replacer 300 is moved further to the negative side in the X direction and disposed on the support 240. At this time, since the side surfaces of the exhaust boxes 250 and the side surfaces of the support 240 are continuous, the rollers 325 come into contact with the side surfaces from the exhaust boxes 250 to the support 240 to guide the transfer robot replacer 300, which makes it possible to move the transfer robot replacer 300 smoothly. In addition, a stopper (not shown) may be provided on the bottom wall

124 of the main body 102 in order to stop the transfer robot replacer 300 at a corresponding position of the support 240 as appropriate.

[0105] Next, the elevator 313 raises and lowers the pair of support frames 311 to support the transfer robot 110 with the pair of support frames 311.

[0106] Next, as shown in FIG. 17C, the transfer robot replacer 300 is moved to the positive side in the X direction, passed through the exhaust box 250, and unloaded from the main body 102. Then, as shown in FIG. 18, the transfer robot replacer 300, which supports the transfer robot 110, is mounted on the trolley 400. The transfer robot 110 is unloaded in such a manner.

[0107] A space in which the trolley 400 stands by is included in a space in which the door 130 is open and closed. Therefore, there is no need to secure a separate space for replacing the transfer robot 110, and the apparatus footprint can be reduced.

[0108] When loading a new transfer robot 110 into the main body 102, the operation in reverse of the operation of unloading the transfer robot 110 is performed. That is, the transfer robot replacer 300, which supports a new transfer robot 110, is moved into the main body 102, moved to the negative side in the X direction, and disposed at the corresponding position of the support 240. Subsequently, the support frame 311 is raised and lowered by the elevator 313 to deliver and mount the new transfer robot 110 onto the support 240. At this time, the positioning pins 236 of the new transfer robot 110 are inserted into the pin holes 241 of the support 240, thereby fixing the new transfer robot 110 at the desired position on the support 240. Then, the empty transfer robot replacer 300 is moved to the positive side in the X direction and unloaded from the main body 102.

[0109] As such, a sequence of replacement for the transfer robot 110 using the transfer robot replacer 300 is completed.

[0110] In this embodiment, the transfer robot 110 is moved forward and backward from the positive side in the X direction of the main body 102 to replace the transfer robot 110. The same applies to a case where the transfer robot 110 is replaced from the negative side in the X direction side of the main body 102.

<Main Effects of the Embodiment>

[0111] The transfer apparatus 20 described above can improve productivity by efficiently replacing the transfer robot 110, while reducing the apparatus footprint. Details are described below.

[0112] In a transfer apparatus of the related art, it is known that during maintenance of a transfer robot, the replacement of the transfer robot is performed on the front side of a main body (EFEM device).

[0113] For example, in the transfer apparatus 20 of this embodiment, in a case where the transfer robot 110 is replaced on the front side (negative side in the Y direction) of the main body 102 as in the related art, a rail for guiding the transfer robot replacer 300 is required. Further, since the rail is installed in front of the main body 102 each time the transfer robot 110 is replaced, a separate space for installing the rail is required, and the apparatus footprint cannot be reduced. In addition, in a case where the rail is installed separately from the main body 102, a high level of relative positional accuracy is required, which increases time and labor costs. Further, for example, in the case where the transfer robot 110 is replaced on the front side of the main body 102 as in the related art, the load port 101 needs to be removed. In such a case, when connecting the load port 101 to the main body 102, repositioning is required. Further, a teaching operation for an overhead hoist transport (OHT) device that mounts the FOUP 900 on the load port 101 is also required, thereby worsening operational efficiency. Moreover, for example, in the case where the transfer robot 110 is replaced on the front side of the main body 102 as in the related art, the lower accommodation portion 103 also needs to be removed. In this case, since the lower accommodation portion 103 contains the power supply, the processing in the wafer processing system 1 needs to be stopped, generating downtime. Therefore, in the case where the transfer robot 110 is replaced on the front side of the main body 102, the operational efficiency of robot replacement deteriorates, significantly reducing the productivity. On the other hand, in a case where the transfer robot 110 is replaced on a lateral side of the main body 102, a separate space is required to install a separate guide rail structure for transferring the transfer robot 110 into the housing, and both operational efficiency of robot replacement and

footprint reduction cannot be achieved.

[0114] However, according to this embodiment, the main body 102 includes the support 240 and the exhaust boxes 250, and has a structural feature in that the side surfaces (front and rear surfaces) of the support 240 and the side surfaces (front and rear surfaces) of the exhaust boxes 250 are continuous. Therefore, the continuous surfaces formed by the side surfaces of the support 240 and the exhaust box 250 can function as a guide for the movement of the transfer robot replacer 300 in the apparatus width direction. In other words, the main body 102 has a configuration in which an apparatus frame (side surfaces of the support 240 and side surfaces of the exhaust boxes 250) and the guide for the transfer robot replacer 300 are integrated. Further, since the opening 129 is formed in the side wall 123 of the main body 102, the transfer robot 110 and the transfer robot replacer 300 can be loaded into and unloaded from the main body 102 via the opening 129. Since the main body 102 has the above configuration, the transfer robot 110 can be replaced by loading and unloading the transfer robot 110 and the transfer robot replacer 300 on the lateral side (X direction) of the main body 102. Therefore, according to this embodiment, the continuous surfaces formed by the side surfaces of the support 240 and the side surfaces of the exhaust boxes 250 function as the guide for the movement of the transfer robot replacer 300 in the apparatus width direction. Therefore, even when the transfer robot 110 is replaced on the lateral side of the main body 102, the rail required for transfer robot replacement in the related art becomes unnecessary. Thus, by enabling robot replacement operations on the lateral side of the main body 102, the apparatus footprint of the transfer apparatus 20 can be reduced while ensuring high operational efficiency (productivity).

[0115] Further, in the transfer apparatus of the related art, a transfer robot constituted only by a horizontal articulated arm is often installed inside the main body (EFEM device). In such a case, arms constituting the horizontal articulated arm are long in the horizontal direction, and an operation range of the transfer robot extends in the horizontal direction (X and Y directions). For this reason, the transfer apparatus of the related art requires a large space in the apparatus depth direction (Y direction).

[0116] In contrast, in the transfer apparatus 20 of this embodiment, the transfer robot 110 can be

selectively configured as a transfer robot including a vertical articulated arm 230. In this case, since an operation range of the vertical articulated arm 230 extends in the vertical direction (Z direction) and the apparatus width direction (X direction), a length of the main body 102 in the apparatus depth direction (Y direction) can be reduced. Further, although the horizontal arm 220 supported by the vertical articulated arm 230 moves in the horizontal direction, each of the first arm 222 and the second arm 223 constituting the horizontal arm 220 is short, which also reduces the length of the main body 102 in the apparatus depth direction (Y direction). Therefore, in the transfer apparatus 20 of this embodiment, when a transfer robot including the vertical articulated arm 230 is used as the transfer robot 110, the length of the main body 102 in the apparatus depth direction can be reduced, thereby further reducing the apparatus footprint.

[0117] Here, in this embodiment, the operation range of the vertical articulated arm 230 of the transfer robot 110 extends in the vertical direction (Z direction) and the apparatus width direction (X direction). That is, spaces above the exhaust boxes 250 on outer sides of the vertical articulated arm 230 and the support 240 in the apparatus width direction (positive and negative sides in the X direction) are included in the operation range of the vertical articulated arm 230. In other words, when the vertical articulated arm 230 is employed for the transfer robot 110, the operation range in the vertical direction (Z direction) and the apparatus width direction (X direction) is expanded compared to that when a transfer robot is constituted only by a horizontal articulated arm. Accordingly, a component mounting prohibited region (= operation region) where relatively large components cannot be installed is formed in the lateral region of the transfer robot 110, such as the spaces above the exhaust boxes 250. In this embodiment, in the EFEM device employing the vertical articulated arm 230 for the transfer robot 110, the main body 102 includes the support 240 and the exhaust boxes 250, and has a structural feature in that the side surfaces (front and rear surfaces) of the support 240 and the side surfaces (front and rear surfaces) of the exhaust boxes 250 are continuous. Thus, while eliminating the need for an additional guide structure, the transfer robot 110 can be loaded and unloaded from the lateral side of the main body 102 by effectively utilizing the component mounting prohibited region (the spaces above the exhaust boxes 250). Accordingly, the method for replacing the transfer

robot 110 of the present disclosure can achieve a higher footprint reduction effect when the transfer robot 110 includes the vertical articulated arm 230.

[0118] Further, according to this embodiment, in the main body 102, the lower front wall 121B may be provided so as to protrude more forward (negative side in the Y direction) than the upper front wall 121A, thereby forming the first lower space T1. In other words, the space in the apparatus depth direction between the upper front wall 121A and the transfer robot 110 can be reduced, and the overall footprint of the main body 102 can be reduced.

[0119] Furthermore, on the front surface of the first plate-shaped member 233A of the transfer robot 110, the position of the transfer support 235 is not limited to the lower portion, and may be the upper portion. However, when the transfer support 235 is provided at the lower portion, a vertical length of the lower front wall 121B (first lower space T1) can be reduced and a vertical length of the upper front wall 121A can be increased, thereby increasing a component accommodation space other than the transfer space S1. In other words, the number of components that need to be disposed in the transfer space S1 can be reduced, which contributes to reducing the apparatus footprint of the transfer apparatus 20.

[0120] Furthermore, according to this embodiment, the rollers 325 are provided on the inner surfaces of the horizontal frame 321 in the transfer robot replacer 300. This allows the horizontal frame 321 to be provided close to the side surfaces of the support 240 and the side surfaces of the exhaust boxes 250. In this case, the support frame 311 can be provided close to the plate-shaped member 233, and bending stress applied to the transfer robot 110 when the transfer robot 110 is supported by the support frame 311 can be kept small, which is advantageous in terms of structural strength of the transfer robot 110.

[0121] Furthermore, according to this embodiment, the transfer robot 110 is replaced from the lateral side (X direction) of the main body 102. Therefore, since there is no need to remove the load port 101 as in the related art, repositioning of the load port 101 and teaching operation for the OHT device, which have been performed in the related art, are not necessary. Therefore, the transfer robot 110 can be easily replaced. In addition, since there is no need to remove the lower accommodation portion 103 as in the related art, it is not necessary to stop processing in

the wafer processing system 1 during the replacement of the transfer robot 110, and no downtime occurs as in the related art. Therefore, it is possible to improve the productivity.

[0122] As described above, according to this embodiment, the transfer robot 110 can be efficiently replaced and appropriately maintained while reducing the apparatus footprint of the transfer apparatus 20.

(Second Embodiment)

[0123] FIG. 19 is an explanatory diagram showing a partial configuration of a transfer robot replacer 300 according to a second embodiment.

[0124] When replacing the transfer robot 110 using the transfer robot replacer 300, the first embodiment includes a structural feature in which the side surfaces of the exhaust boxes 250 and the side surfaces of the support 240 form continuous surfaces. Thus, the side surfaces of the exhaust boxes 250 can function as the guide for the movement of the transfer robot replacer 300 in the apparatus width direction. On the other hand, the second embodiment includes a structural feature in which the inner surfaces of the main body 102 in the apparatus depth direction, that is, the rear surface of the lower front wall 121B and the front surface of the rear wall 122 of the main body 102, are configured as surfaces (opposing surfaces) that are spaced apart from and face the side surfaces of the support 240 in parallel. This makes it possible to use the rear surface of the lower front wall 121B and the front surface of the rear wall 122 of the main body 102 as the guide for the movement of the transfer robot replacer 300 in the apparatus width direction.

[0125] Further, as shown in FIG. 19, the transfer robot replacer 300 of the second embodiment includes a pair of support frames 330 instead of the pair of support frames 311 of the first embodiment, and a pair of horizontal frames 340 instead of the pair of horizontal frames 321 of the first embodiment.

[0126] The pair of support frames 330 are arranged side by side in the apparatus depth direction (Y direction). Specifically, of the pair of support frames 330, the first support frame 330A is disposed on the front side (negative side in the Y direction), and the second support frame 330B

is disposed on the rear side (positive side in the Y direction). Further, each of the first support frame 330A and the second support frame 330B extends in the apparatus width direction (X direction) and has a length sufficient to support the transfer robot 110. The first support frame 330A supports the transfer support 235, and the second support frame 330B supports the bottom surface of the second plate-shaped member 233B.

[0127] The pair of horizontal frames 340 are arranged side by side in the apparatus depth direction (Y direction). Each of the pair of horizontal frames 340 extends in the apparatus width direction (X direction) and supports the first support frame 330A and the second support frame 330B.

[0128] Each horizontal frame 340 includes a plurality of, for example, two wheels 341 on the bottom surface thereof. With this configuration, the transfer robot replacer 300 is configured to be movable in the apparatus width direction (X direction).

[0129] A plurality of, for example, two rollers 342 are provided on an outer surface of each horizontal frame 340. The rollers 342 protrude slightly from the outer surface of the horizontal frame 340.

[0130] When the transfer robot replacer 300 is moved in the apparatus width direction (X direction), the first support frame 330A and the horizontal frame 340 move through the first lower space T1, and the second support frame 330B and the horizontal frame 340 move through the second lower space T2. In addition, in the first lower space T1, the rollers 342 come into contact with the rear surface of the lower front wall 121B, and in the second lower space T2, the rollers 342 come into contact with the front surface of the rear wall 122.

[0131] An outer width L3 (distance between outer surfaces) of the pair of support frames 330 and an outer width L3 of the pair of horizontal frames 340 are the same. The outer width L3 is smaller than an inner width L4 (distance between the rear surface of the lower front wall 121B and the front surface of the rear wall 122) in the depth direction of the main body 102 by an amount by which the rollers 342 protrude from the outer surface of the horizontal frame 340.

[0132] In this embodiment, the first lower space T1 and the second lower space T2 constitute the structural feature of the present disclosure. Further, the rear surface of the front wall 121 and

the front surface of the rear wall 122 of the main body 102 constitute the opposing surfaces of the present disclosure.

[0133] According to this embodiment, the rear surface of the lower front wall 121B and the front surface of the rear wall 122 of the main body 102 can function as the guide for the movement of the transfer robot replacer 300 in the apparatus width direction. Therefore, the same effects as those of the first embodiment described above can be achieved in the second embodiment as well.

<Modifications>

[0134] In the first and second embodiments, the transfer robot 110 includes the first plate-shaped member 233A and the second plate-shaped member 233B. However, the first plate-shaped member 233A may be provided on both sides in the apparatus depth direction, and the second plate-shaped member 233B may be provided on both sides in the apparatus width direction. When the transfer robot 110 includes a pair of first plate-shaped members 233A, the transfer robot 110 includes a pair of transfer supports 235, and first lower spaces T1 are formed on both sides in the apparatus width direction. When the transfer robot 110 includes a pair of second plate-shaped members 233B, the pair of second plate-shaped members 233B are disposed to protrude from the support 240 in the apparatus width direction, and second lower spaces T2 are formed on both sides in the apparatus width direction.

[0135] The embodiments disclosed herein should be considered as exemplary and not limitative in all respects. The embodiments described above may be omitted, replaced, or modified in various ways without departing from the scope and spirit of the appended claims. For example, the constituent elements of the embodiments described above may be combined arbitrarily. Such combinations will naturally provide the functions and effects of the respective constituent elements in the combinations, as well as other functions and effects that will be apparent to those skilled in the art from the description herein.

[0136] Furthermore, the effects described herein are merely descriptive or exemplary and not limitative. In other words, the technique of the present disclosure may provide other effects

that will be apparent to those skilled in the art from the description herein, in addition to or in place of the effects described herein.

[0137] The following configuration examples also fall within the technical scope of the present disclosure.

(1) A transfer apparatus for loading and unloading a substrate into and from a processing apparatus configured to process the substrate, the transfer apparatus including:

a main body having an internal space defined by a front portion connected to a load port on which a container for accommodating the substrate is mounted and extending in an apparatus width direction, a rear portion connected to a load-lock module provided in the processing apparatus and facing the front portion in an apparatus depth direction, a bottom portion on which a transfer robot for transferring the substrate is mounted, a ceiling portion facing the bottom portion, and a pair of side portions facing each other in the apparatus width direction; and

a structural body provided on the bottom portion, and including a support to which the transfer robot is fixed, and a structural feature extending in the apparatus width direction,

wherein each of the side portions is provided with an opening, and

wherein the structural feature includes continuous surfaces configured to be continuous with side surfaces of the support extending in the apparatus width direction.

(2) A transfer apparatus for loading and unloading a substrate into and from a processing apparatus configured to process the substrate, the transfer apparatus including:

a main body having an internal space defined by a front portion connected to a load port on which a container for accommodating the substrate is mounted and extending in an apparatus width direction, a rear portion connected to a load-lock module provided in the processing apparatus and facing the front portion in an apparatus depth direction, a bottom portion on which a transfer robot for transferring the substrate is mounted, a ceiling portion facing the bottom portion, and a pair of side portions facing each other in the apparatus width direction; and

a structural body provided on the bottom portion, and including a support to which the transfer robot is fixed, and a structural feature extending in the apparatus width direction,

wherein each of the side portions is provided with an opening, and

wherein the structural feature includes opposing surfaces that are spaced apart from and face side surfaces of the support extending in the apparatus width direction in parallel.

(3) The transfer apparatus of (1) or (2), wherein the opening is an opening for loading or unloading the transfer robot.

(4) The transfer apparatus of (1), wherein the continuous surfaces of the structural feature are constituted by an exhausters into which a gas in the internal space flows.

(5) The transfer apparatus of (2), wherein the opposing surfaces of the structural feature are constituted by lower inner surfaces of the front portion and the rear portion.

(6) The transfer apparatus of any one of (1) to (5), wherein the transfer robot includes a transfer support protruding from a side surface of the transfer robot in the apparatus depth direction, and

wherein the front portion or the rear portion has a lower portion protruding in the apparatus depth direction at a position corresponding to the transfer support.

(7) The transfer apparatus of any one of (1) to (5), wherein the transfer robot protrudes and extends farther than the support in the apparatus depth direction.

(8) The transfer apparatus of any one of (1) to (7), wherein the transfer robot includes a horizontal arm configured to transfer the substrate in a horizontal direction, and a vertical articulated arm configured to raise and lower the horizontal arm.

(9) The transfer apparatus of (8), wherein the vertical articulated arm includes an arm provided to be pivotable in a vertical direction and the apparatus width direction, and a base connected to the arm and fixed to the support.

(10) The transfer apparatus of any one of (1) to (9), wherein the transfer robot includes a transfer support protruding from a side surface of the transfer robot in the apparatus depth direction.

(11) The transfer apparatus of any one of (1) to (10), wherein the support is provided with a positioning structure for fixing a position of the transfer robot relative to the support.

EXPLANATION OF REFERENCE NUMERALS

[0138] 10: processing apparatus, 20: transfer apparatus, 50: load-lock module, 101: load port, 102: main body, 121: front wall, 122: rear wall, 123: side wall, 124: bottom wall, 125: ceiling

wall, 129: opening, 110: transfer robot, 240: support, 250: exhaust box, 900: FOUP, S1: transfer space, S2: accommodation space, T1: first lower space, T2: second lower space, W: wafer

WHAT IS CLAIMED IS:

1. A transfer apparatus for loading and unloading a substrate into and from a processing apparatus configured to process the substrate, the transfer apparatus comprising:

a main body having an internal space defined by a front portion connected to a load port on which a container for accommodating the substrate is mounted and extending in an apparatus width direction, a rear portion connected to a load-lock module provided in the processing apparatus and facing the front portion in an apparatus depth direction, a bottom portion on which a transfer robot for transferring the substrate is mounted, a ceiling portion facing the bottom portion, and a pair of side portions facing each other in the apparatus width direction; and

a structural body provided on the bottom portion, and including a support to which the transfer robot is fixed, and a structural feature extending in the apparatus width direction,

wherein each of the side portions is provided with an opening, and

wherein the structural feature includes continuous surfaces configured to be continuous with side surfaces of the support extending in the apparatus width direction.

2. A transfer apparatus for loading and unloading a substrate into and from a processing apparatus configured to process the substrate, the transfer apparatus comprising:

a main body having an internal space defined by a front portion connected to a load port on which a container for accommodating the substrate is mounted and extending in an apparatus width direction, a rear portion connected to a load-lock module provided in the processing apparatus and facing the front portion in an apparatus depth direction, a bottom portion on which a transfer robot for transferring the substrate is mounted, a ceiling portion facing the bottom portion, and a pair of side portions facing each other in the apparatus width direction; and

a structural body provided on the bottom portion, and including a support to which the transfer robot is fixed, and a structural feature extending in the apparatus width direction,

wherein each of the side portions is provided with an opening, and

wherein the structural feature includes opposing surfaces that are spaced apart from and

face side surfaces of the support extending in the apparatus width direction.

3. The transfer apparatus of Claim 1 or 2, wherein the opening is an opening for loading or unloading the transfer robot.

4. The transfer apparatus of Claim 1, wherein the continuous surfaces of the structural feature are constituted by exhausters into which a gas in the internal space flows.

5. The transfer apparatus of Claim 2, wherein the opposing surfaces of the structural feature are constituted by lower inner surfaces of the front portion and the rear portion.

6. The transfer apparatus of Claim 1 or 2, wherein the transfer robot includes a transfer support protruding from a side surface of the transfer robot in the apparatus depth direction, and

wherein the front portion or the rear portion has a lower portion protruding in the apparatus depth direction at a position corresponding to the transfer support.

7. The transfer apparatus of Claim 1 or 2, wherein the transfer robot protrudes and extends farther than the support in the apparatus depth direction.

8. The transfer apparatus of Claim 1 or 2, wherein the transfer robot includes a horizontal arm configured to transfer the substrate in a horizontal direction, and a vertical articulated arm configured to raise and lower the horizontal arm.

9. The transfer apparatus of Claim 8, wherein the vertical articulated arm includes an arm provided to be pivotable in a vertical direction and the apparatus width direction, and a base connected to the arm and fixed to the support.

10. The transfer apparatus of Claim 1 or 2, wherein the transfer robot includes a transfer

support protruding from side surfaces of the transfer robot in the apparatus depth direction.

11. The transfer apparatus of Claim 1 or 2, wherein the support is provided with a positioning structure for fixing a position of the transfer robot relative to the support.