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(54) SUBSTRATE PROCESSING METHOD

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(57) **ABSTRACT**

A substrate processing method including: a first assembly process of positioning a first substrate at a first position among the first position, a second position, a third position, a fourth position, and a fifth position; a second assembly process of positioning a second substrate at the second position by combining a second arrangement with a substrate group; a third assembly process of positioning a third substrate at the third position by combining a third arrangement with the substrate group; a fourth assembly process of positioning a fourth substrate at the fourth position by combining a fourth arrangement with the substrate group; and a fifth assembly process of positioning a fifth substrate at the fifth position by combining a fifth arrangement with the substrate group.

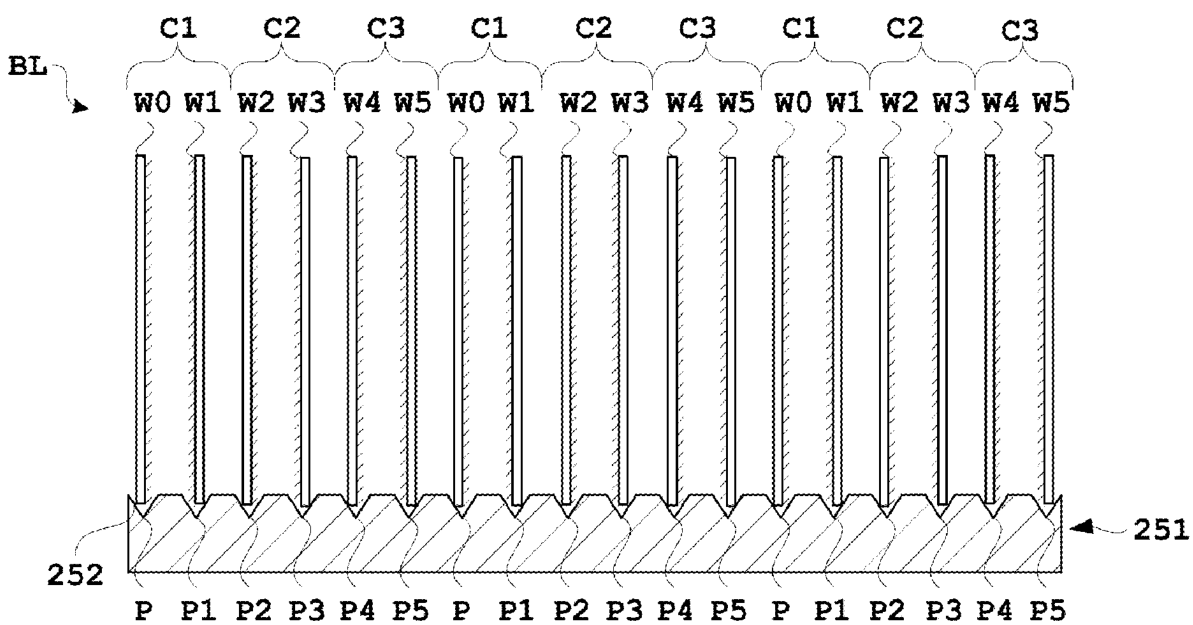
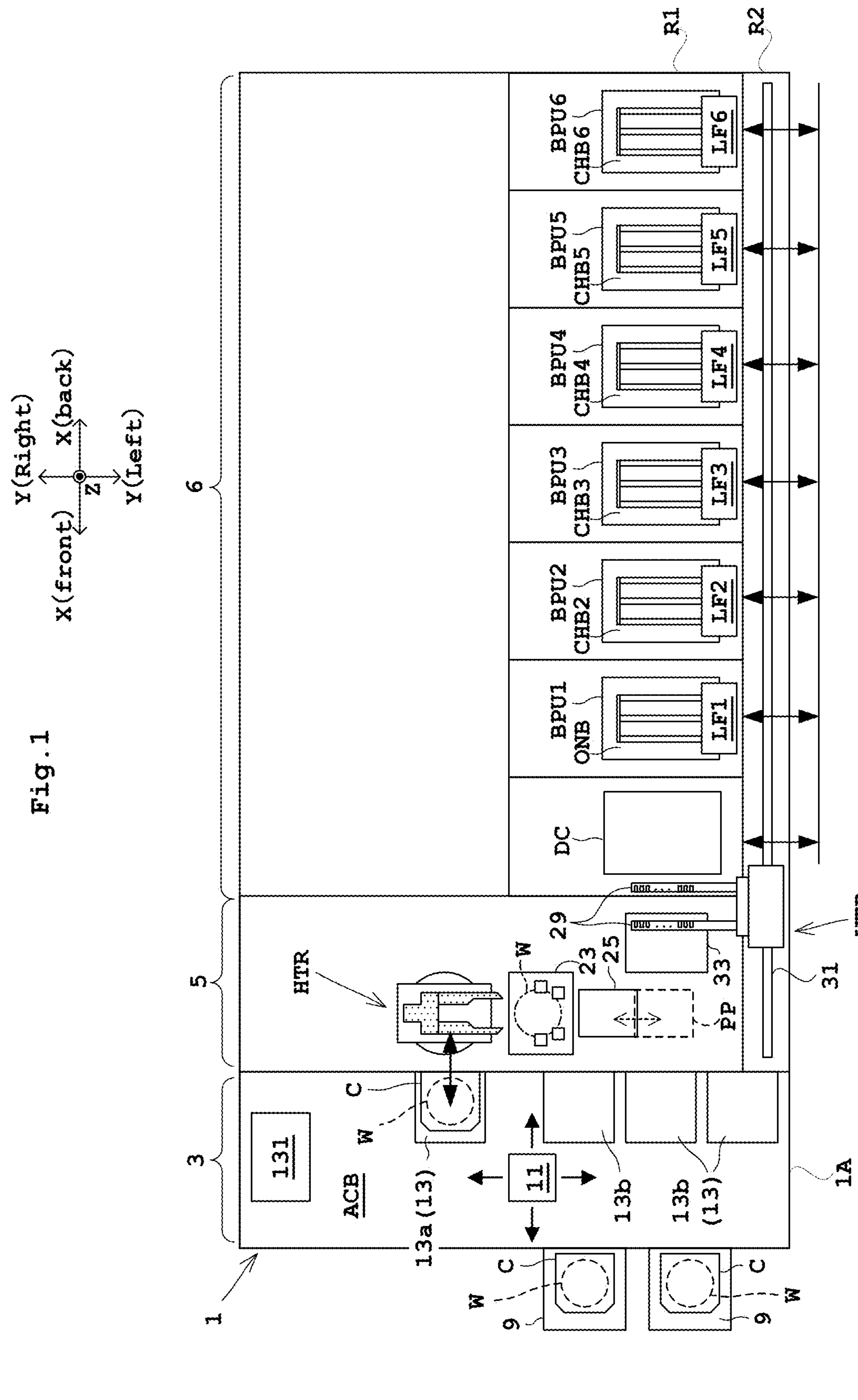


Fig.1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X(back)
X(front)
Z
Y(Left)
R1
R2
6
5
3
1
1A
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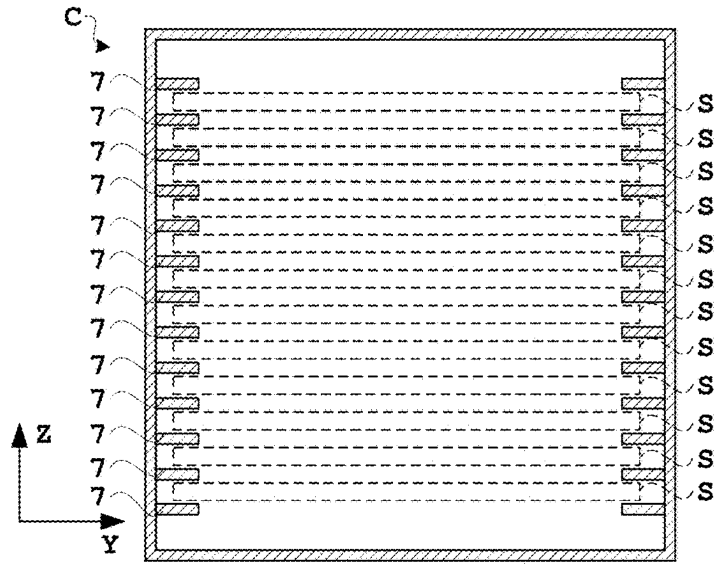
CHB6
LF6
BPU5
CHB5
LF5
BPU4
CHB4
LF4
BPU3
CHB3
LF3
BPU2
CHB2
LF2
BPU1
ONB
LF1
DC
HTR
W
23
25
29
33
PP
31
WTR
C
131
ACB
11
13a(13)
13b
13b
(13)
9
W
C

Fig.2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S
S
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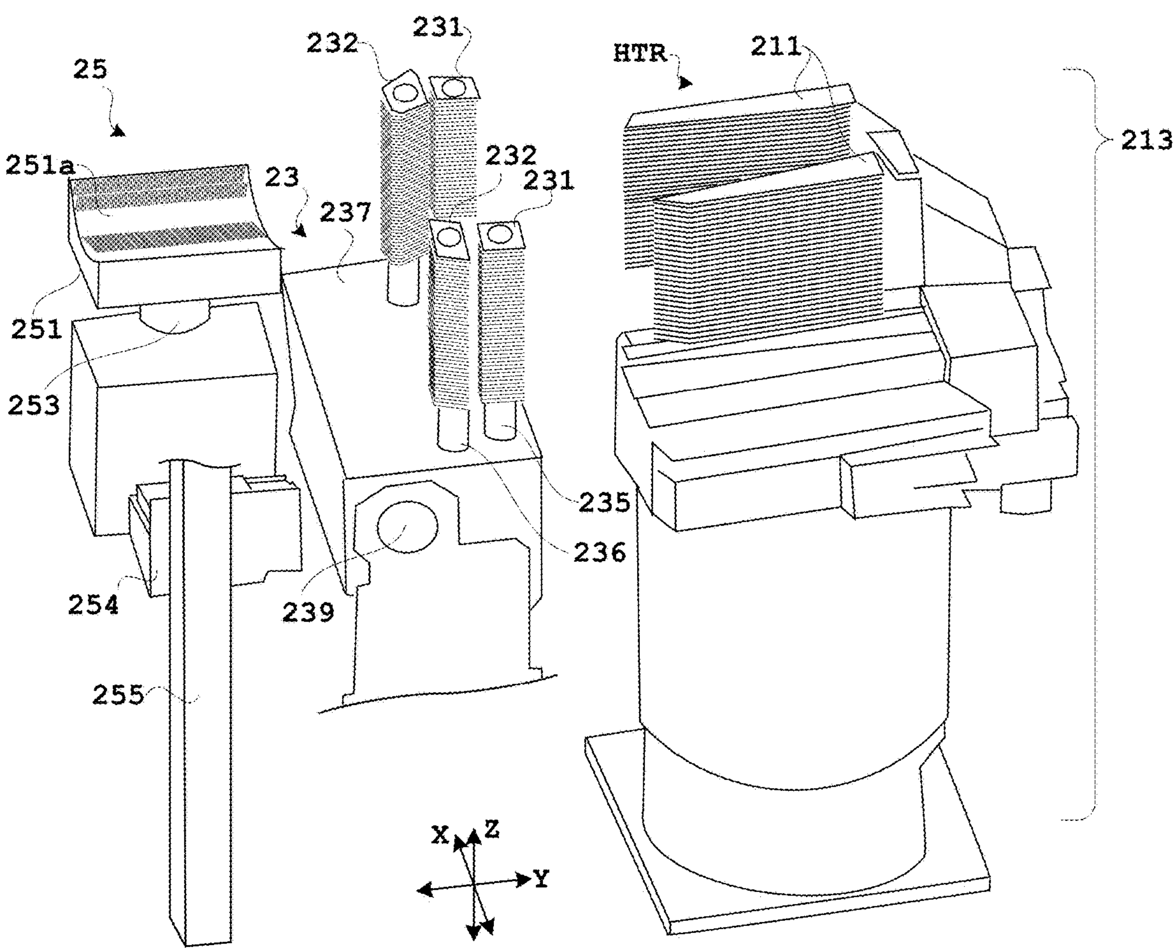
S
S
S
S
S
S
S
S
Z
Y

Fig.3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231
HTR
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251a
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236
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239
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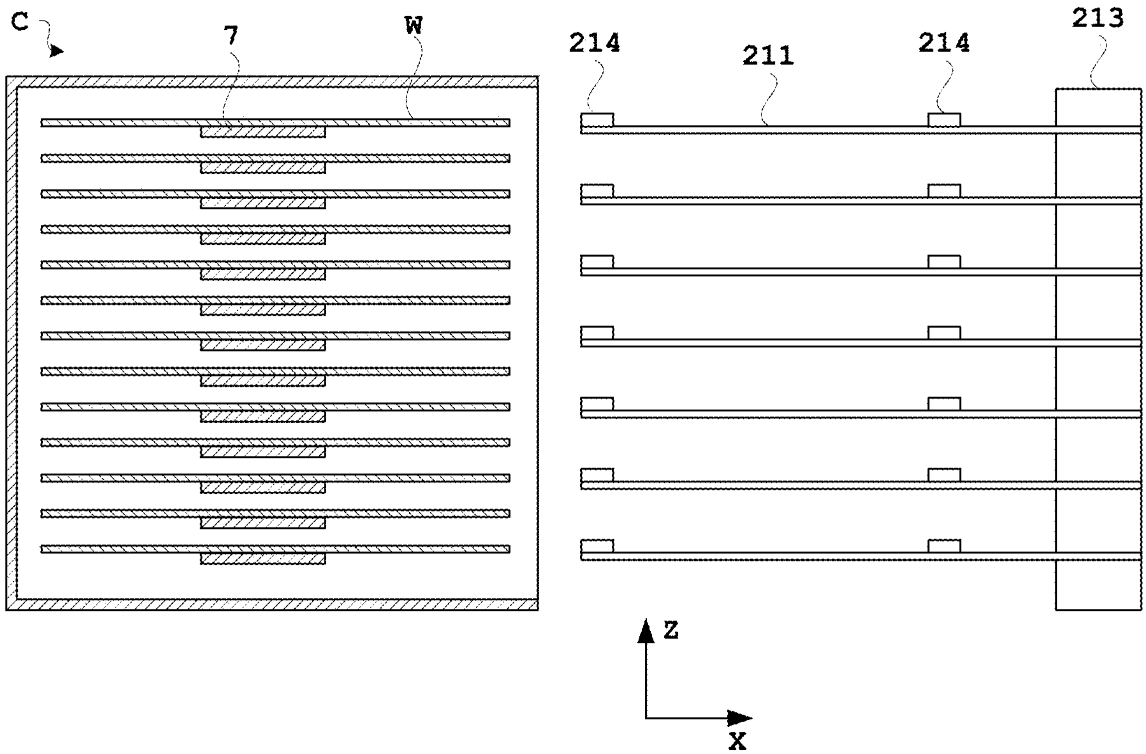
X
Z
Y

Fig.4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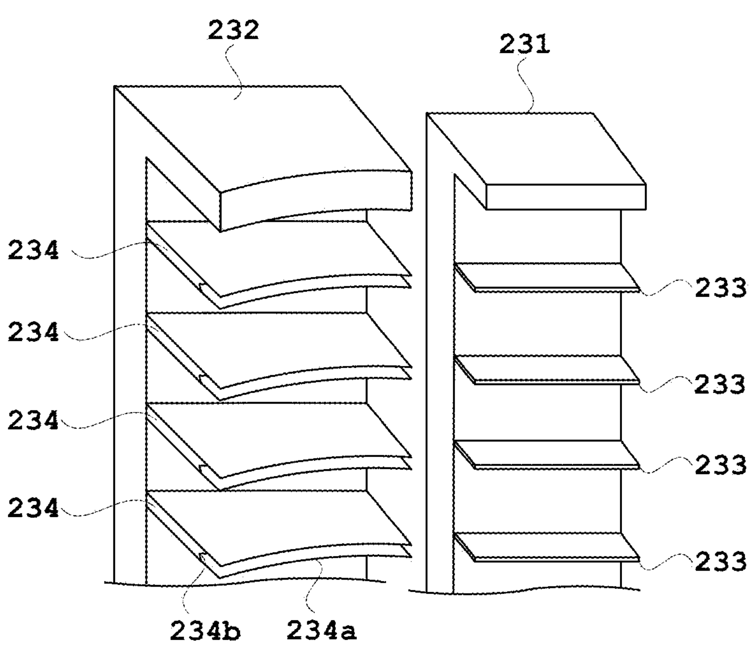
X

Fig.5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233
233
234b
234a

Fig.6

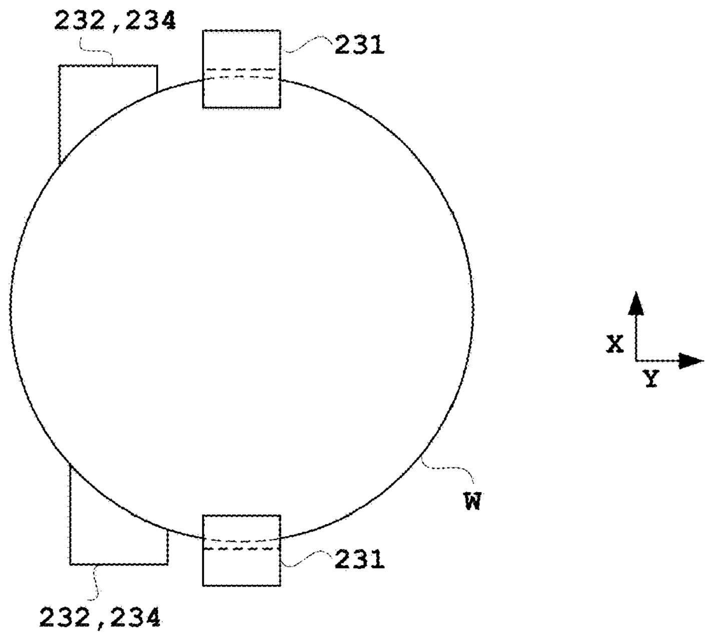


Fig.7

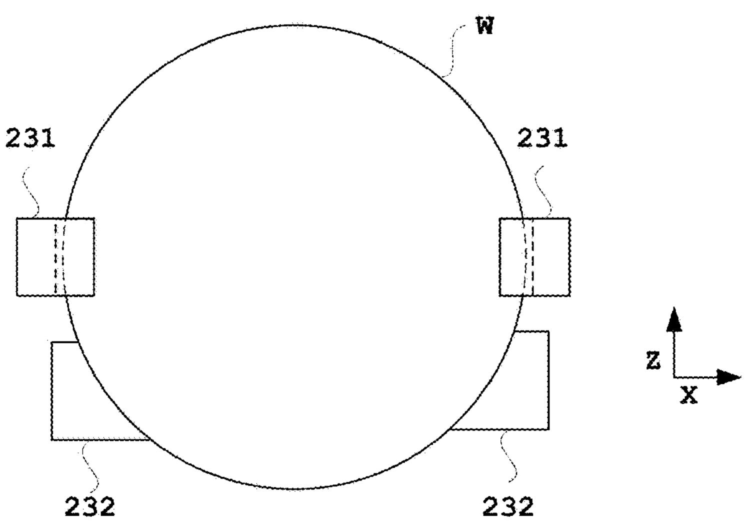


Fig.8

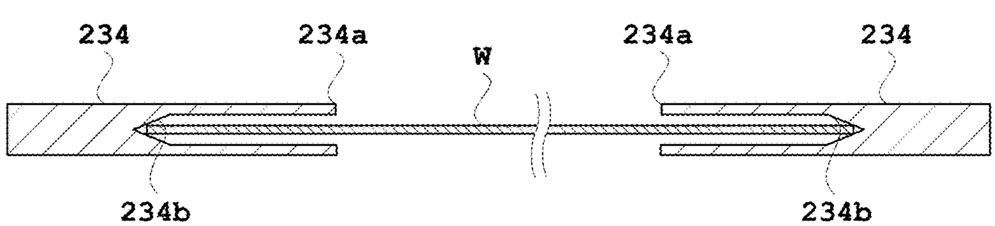


Fig.9

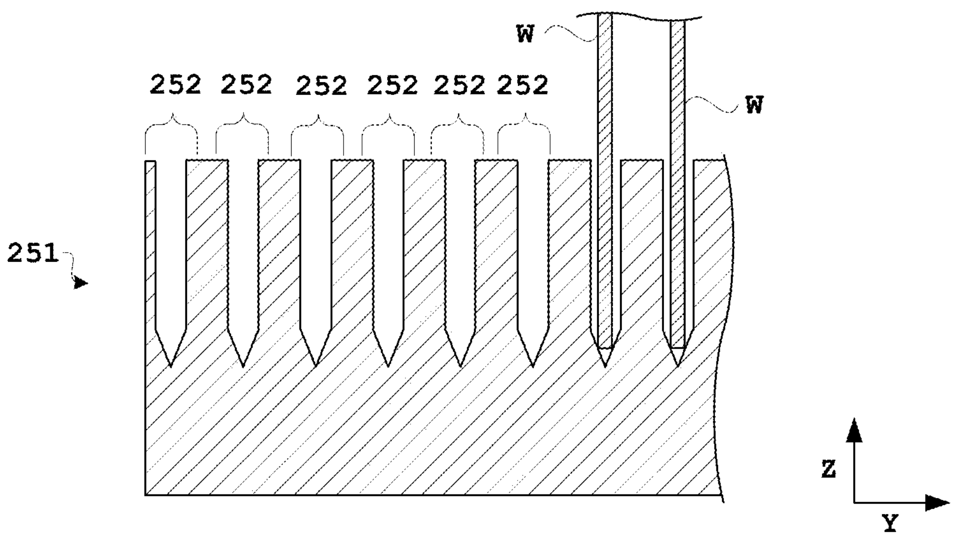


Fig.10

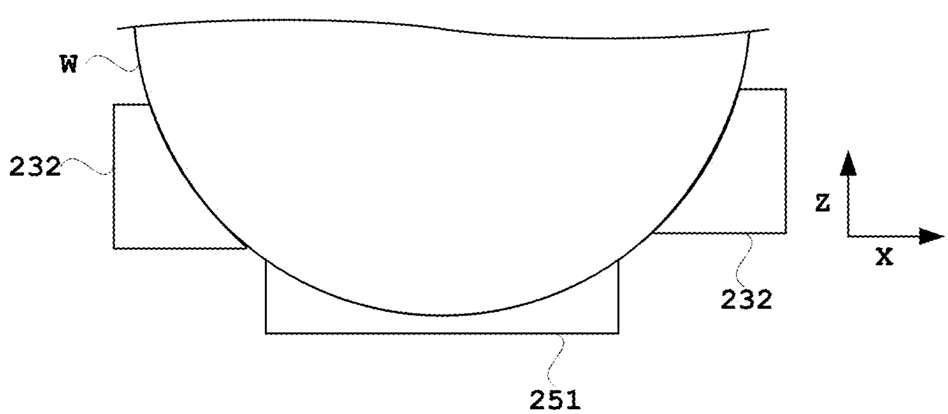


Fig.11A

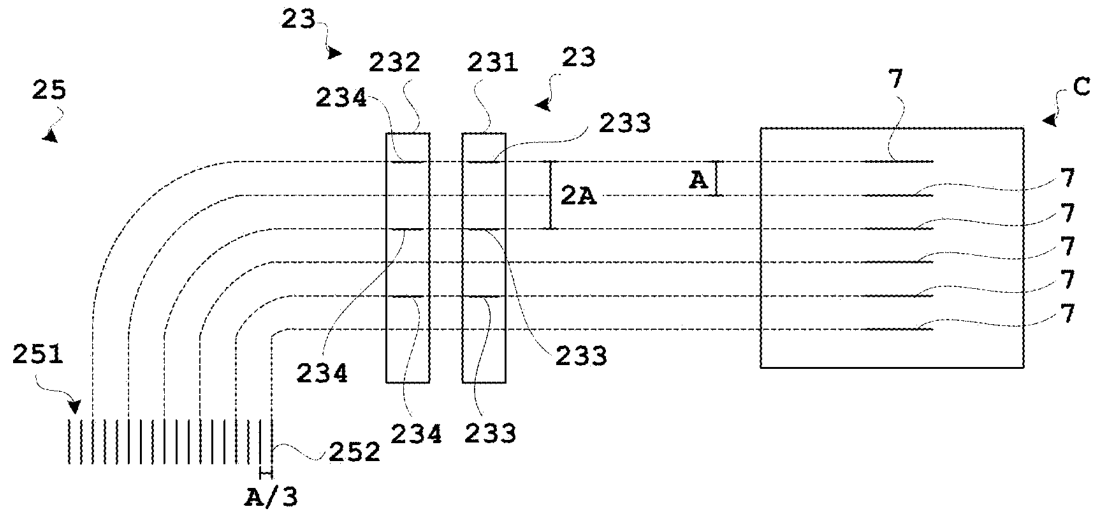


Fig.11B

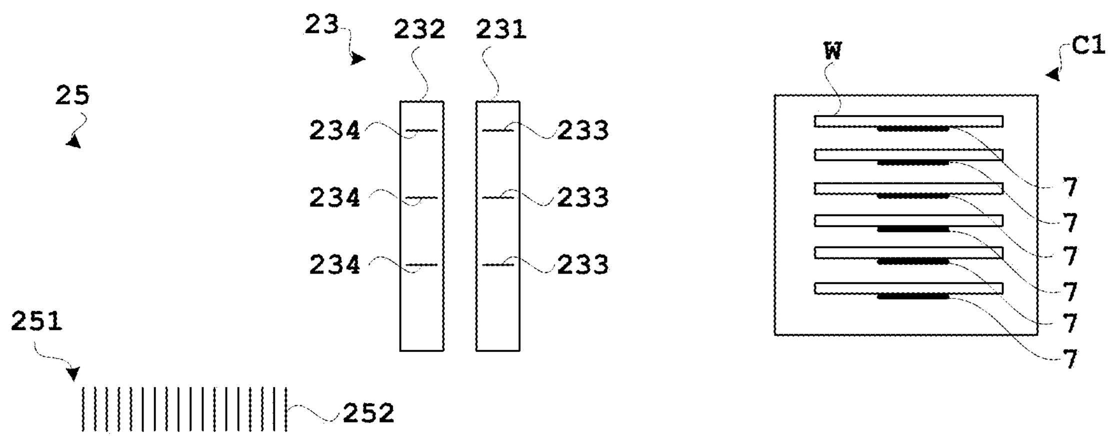


Fig.11C

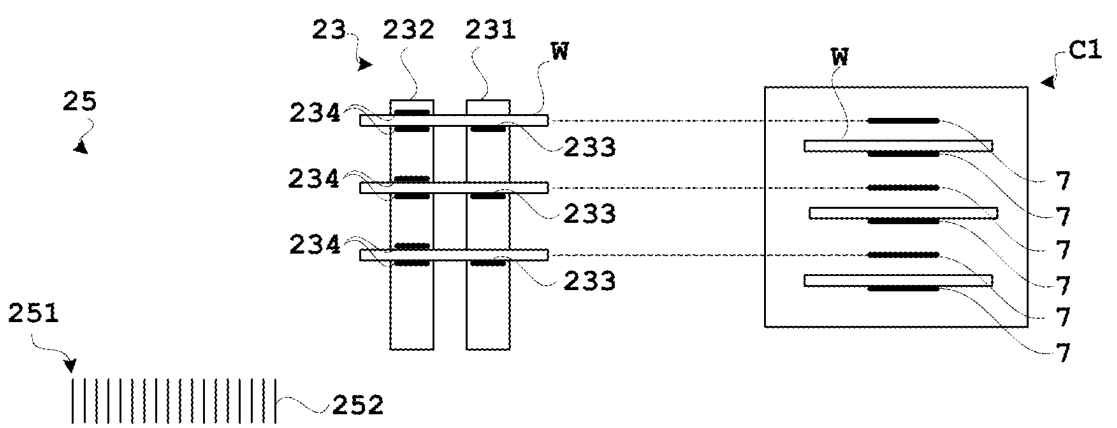


Fig.11D

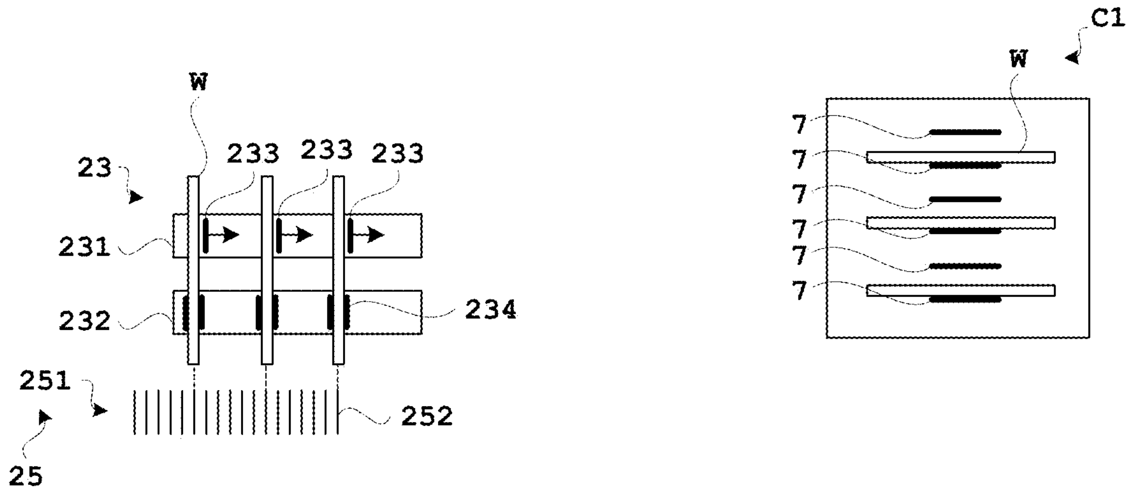


Fig.11E

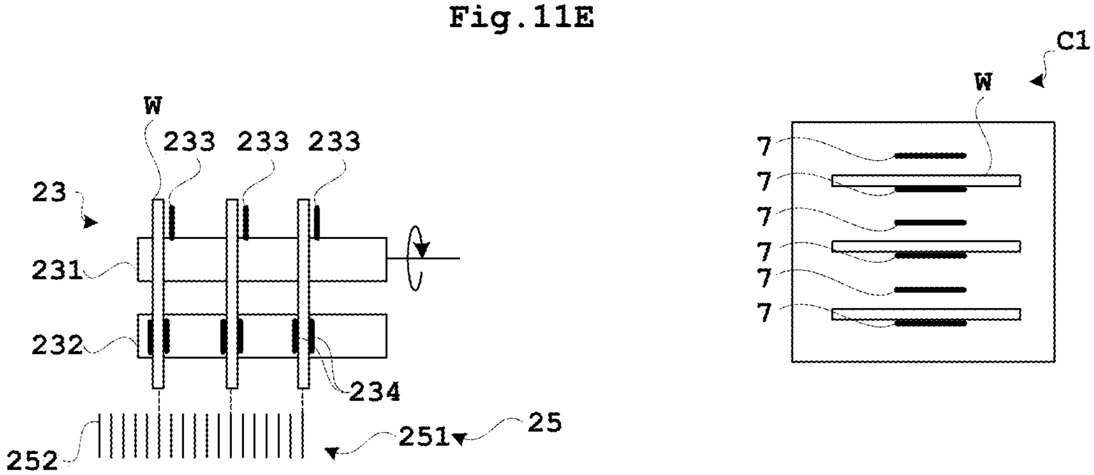


Fig.11F

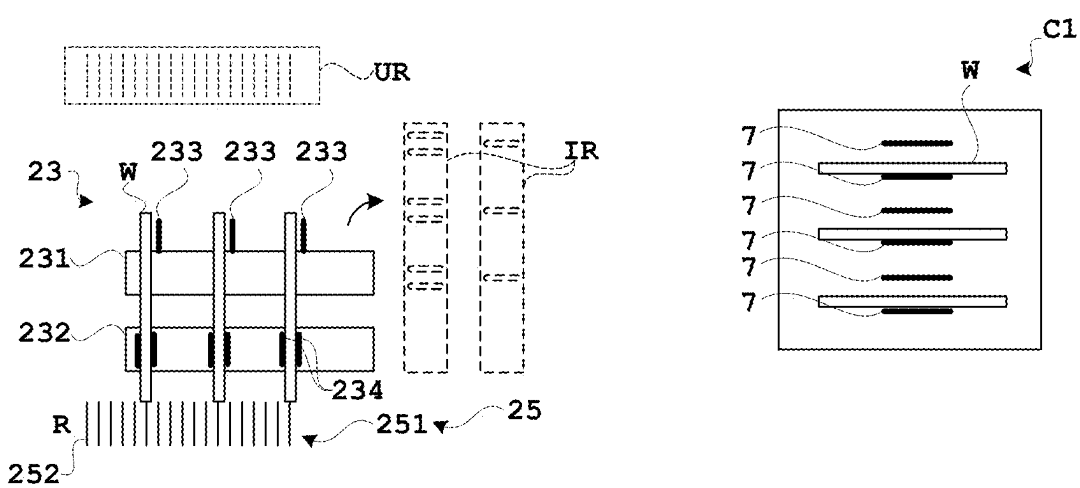


Fig.11G

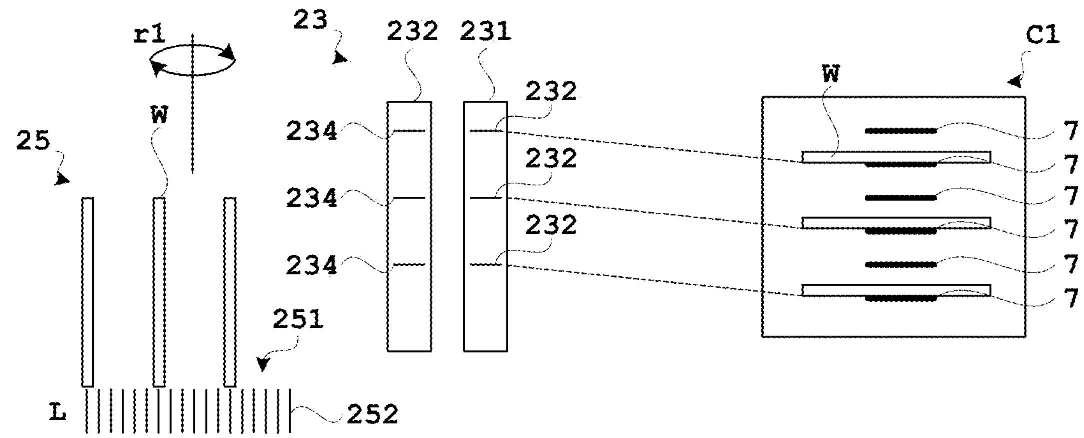


Fig.11H

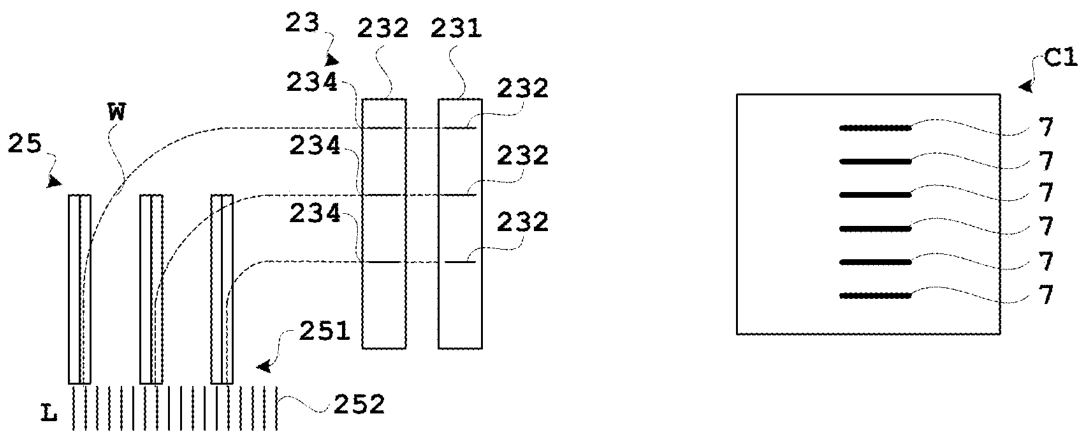


Fig.11I

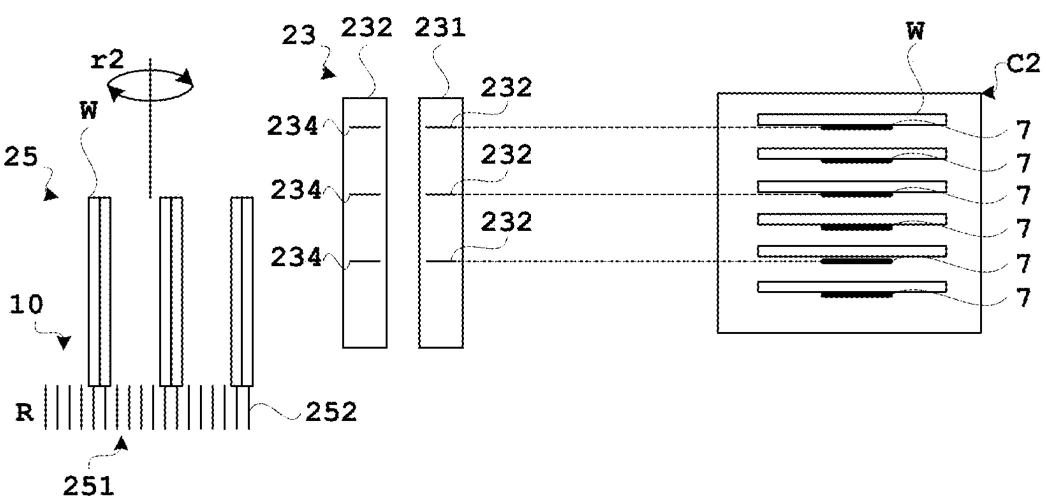


Fig.11J

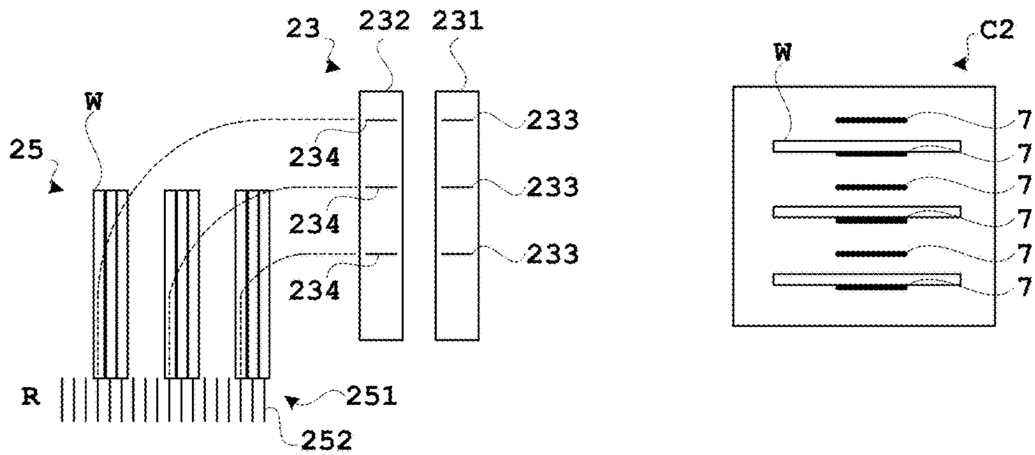


Fig.11K

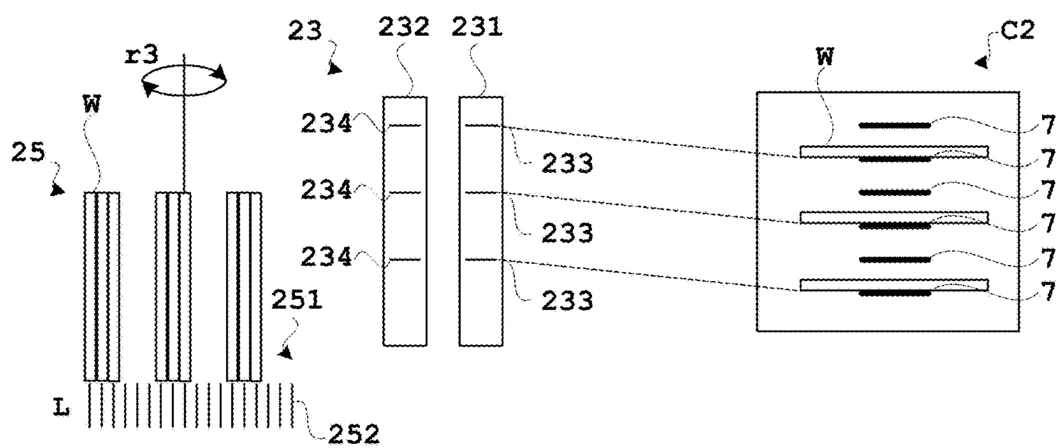


Fig.11L

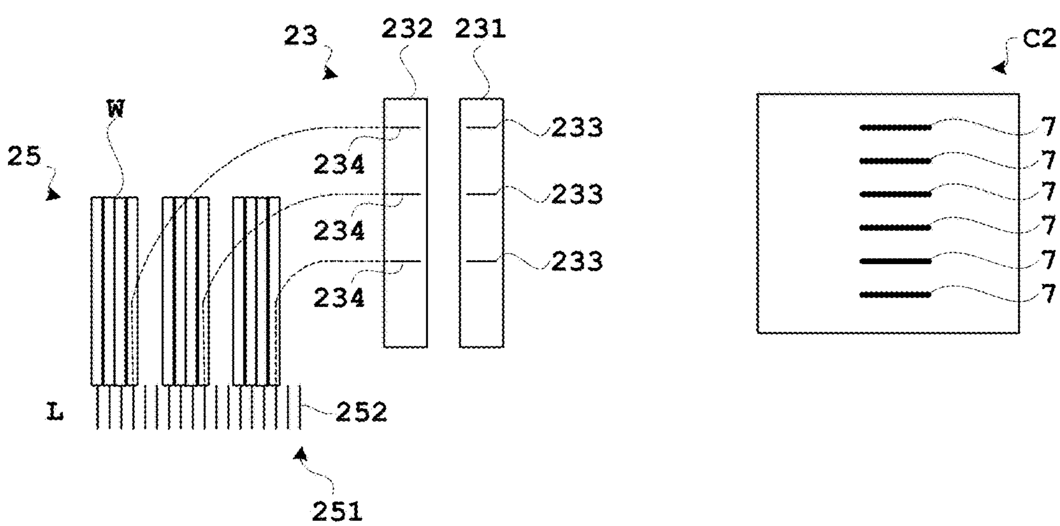


Fig.11M

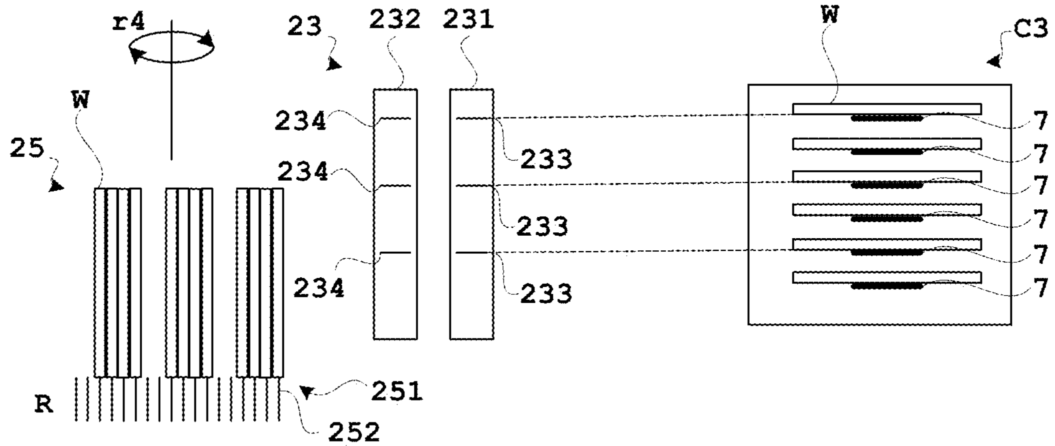


Fig.11N

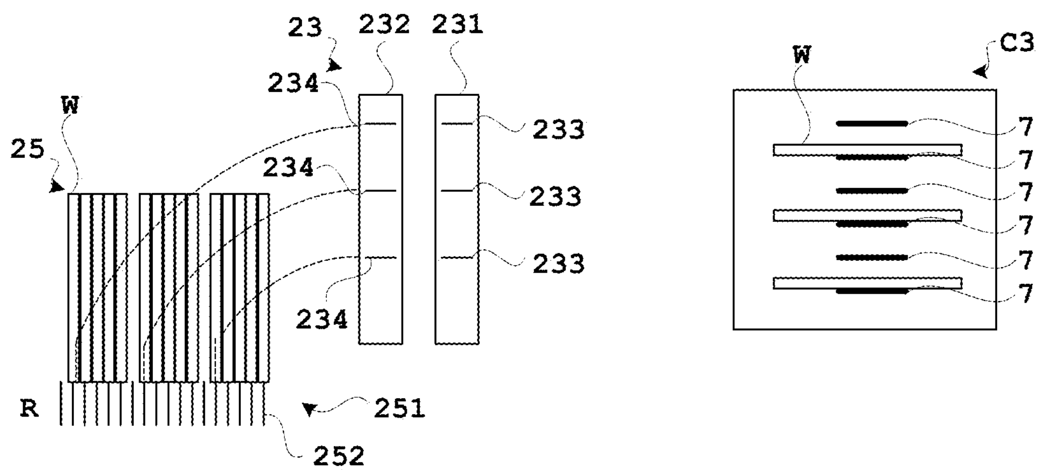


Fig.11O

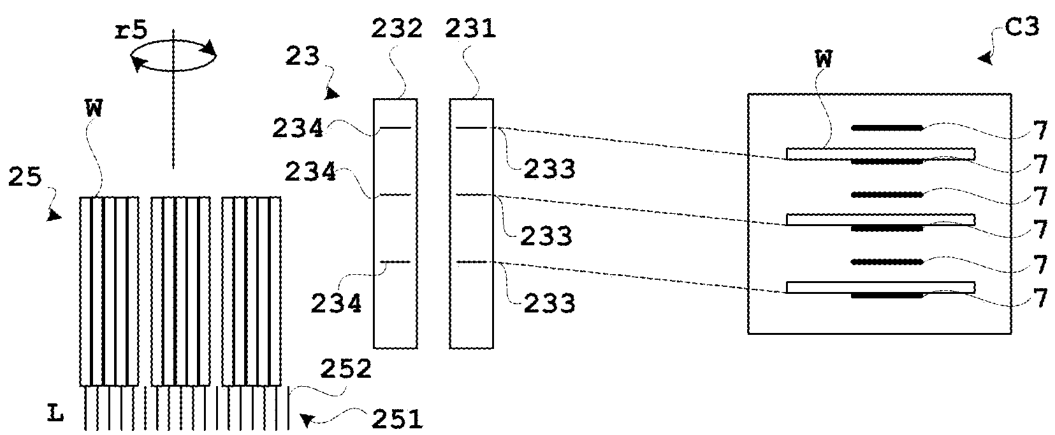


Fig.11P

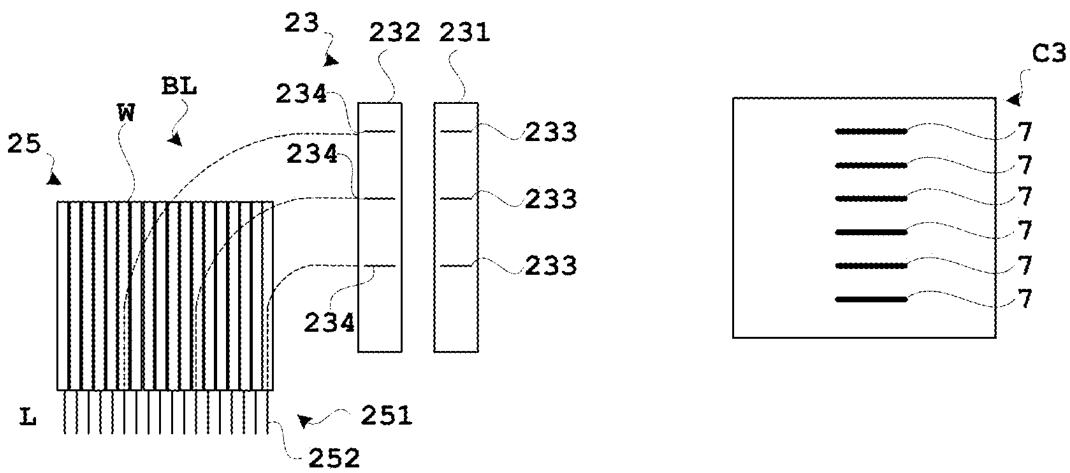


Fig.12

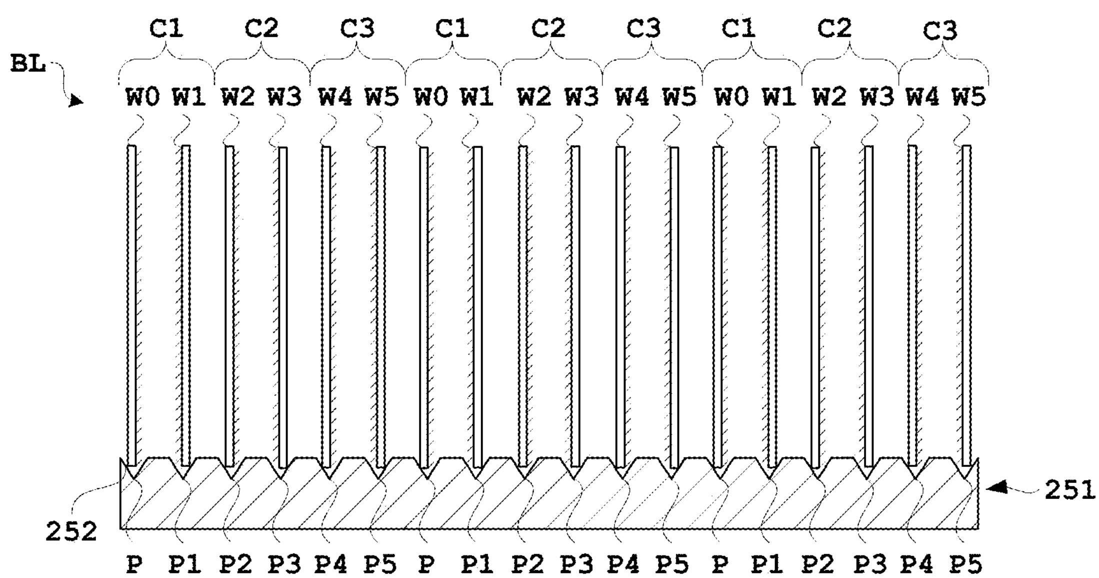


Fig.13

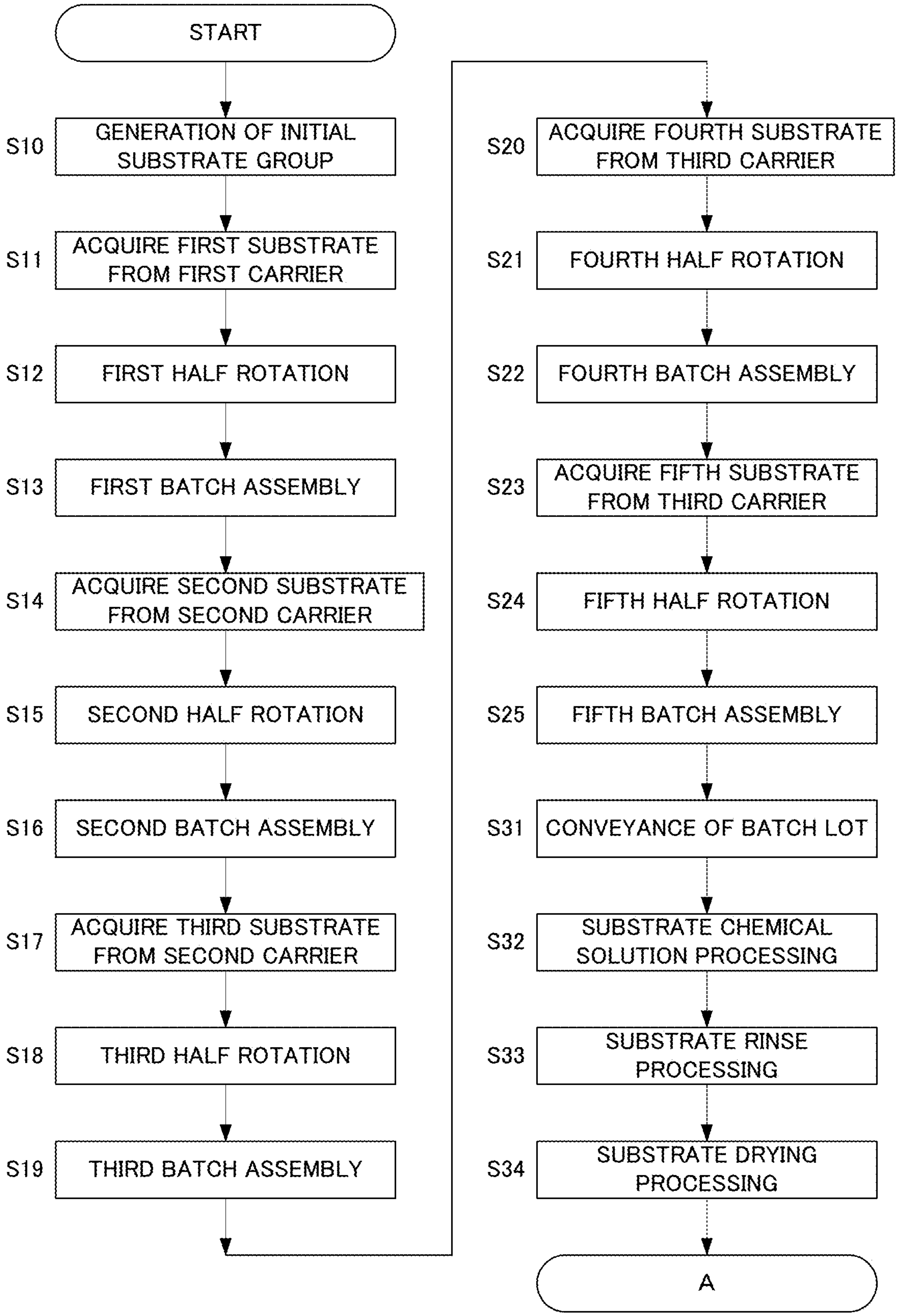

START
S10 GENERATION OF INITIAL SUBSTRATE GROUP
S11 ACQUIRE FIRST SUBSTRATE FROM FIRST CARRIER
S12 FIRST HALF ROTATION
S13 FIRST BATCH ASSEMBLY
S14 ACQUIRE SECOND SUBSTRATE FROM SECOND CARRIER
S15 SECOND HALF ROTATION
S16 SECOND BATCH ASSEMBLY
S17 ACQUIRE THIRD SUBSTRATE FROM SECOND CARRIER
S18 THIRD HALF ROTATION
S19 THIRD BATCH ASSEMBLY
S20 ACQUIRE FOURTH SUBSTRATE FROM THIRD CARRIER
S21 FOURTH HALF ROTATION
S22 FOURTH BATCH ASSEMBLY
S23 ACQUIRE FIFTH SUBSTRATE FROM THIRD CARRIER
S24 FIFTH HALF ROTATION
S25 FIFTH BATCH ASSEMBLY
S31 CONVEYANCE OF BATCH LOT
S32 SUBSTRATE CHEMICAL SOLUTION PROCESSING
S33 SUBSTRATE RINSE PROCESSING
S34 SUBSTRATE DRYING PROCESSING
A

Fig.14

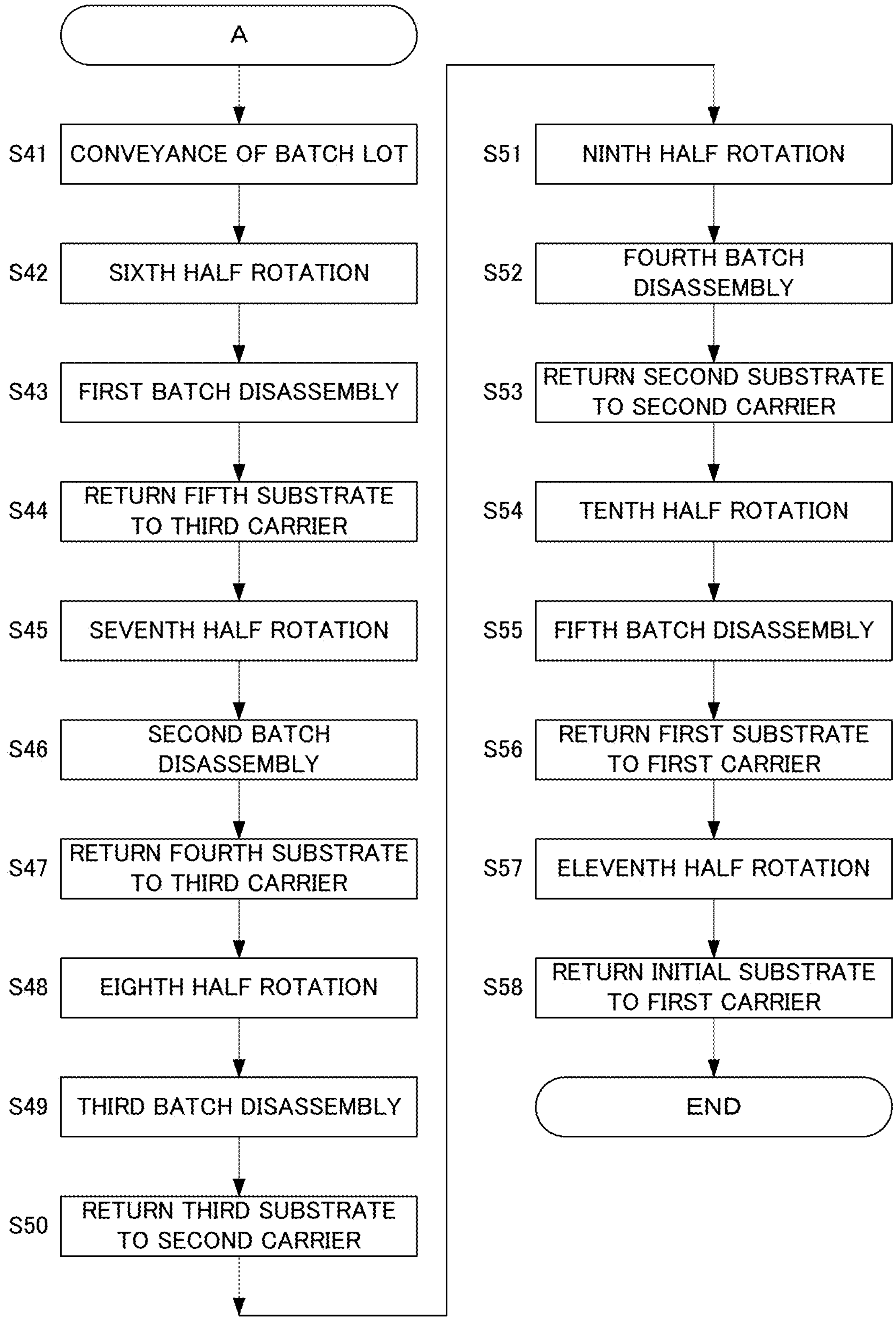

A
S41 CONVEYANCE OF BATCH LOT
S42 SIXTH HALF ROTATION
S43 FIRST BATCH DISASSEMBLY
S44 RETURN FIFTH SUBSTRATE TO THIRD CARRIER
S45 SEVENTH HALF ROTATION
S46 SECOND BATCH DISASSEMBLY
S47 RETURN FOURTH SUBSTRATE TO THIRD CARRIER
S48 EIGHTH HALF ROTATION
S49 THIRD BATCH DISASSEMBLY
S50 RETURN THIRD SUBSTRATE TO SECOND CARRIER
S51 NINTH HALF ROTATION
S52 FOURTH BATCH DISASSEMBLY
S53 RETURN SECOND SUBSTRATE TO SECOND CARRIER
S54 TENTH HALF ROTATION
S55 FIFTH BATCH DISASSEMBLY
S56 RETURN FIRST SUBSTRATE TO FIRST CARRIER
S57 ELEVENTH HALF ROTATION
S58 RETURN INITIAL SUBSTRATE TO FIRST CARRIER
END

Fig.15

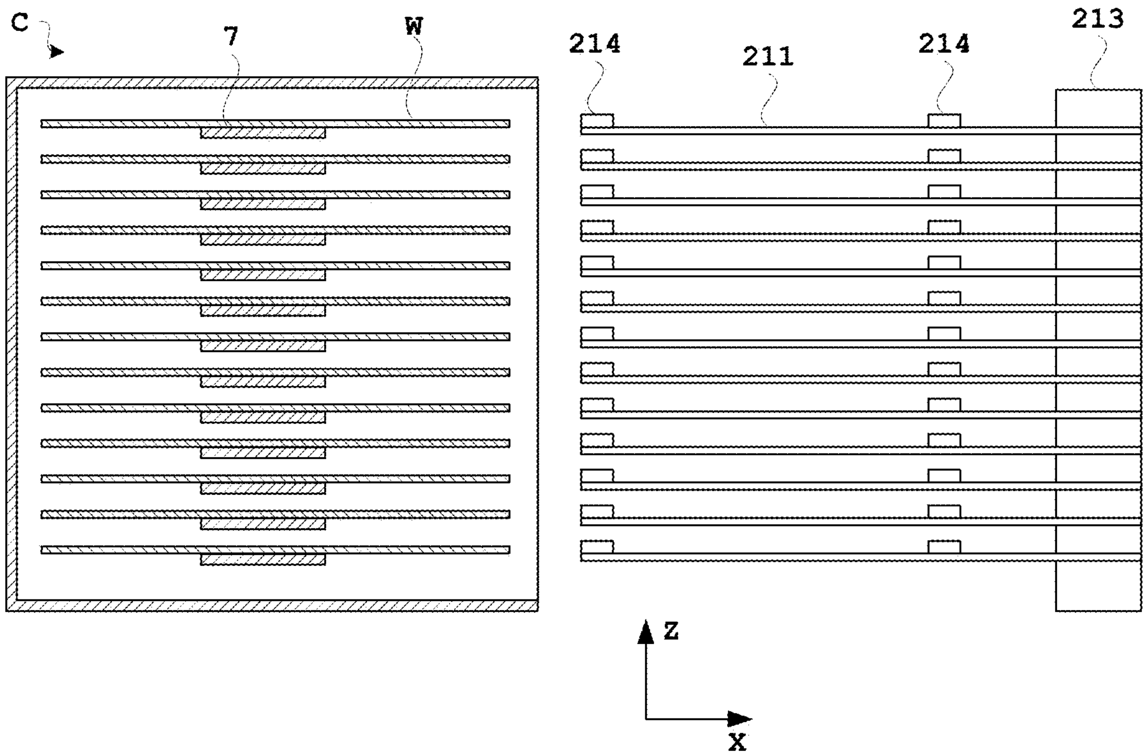


Fig.16A

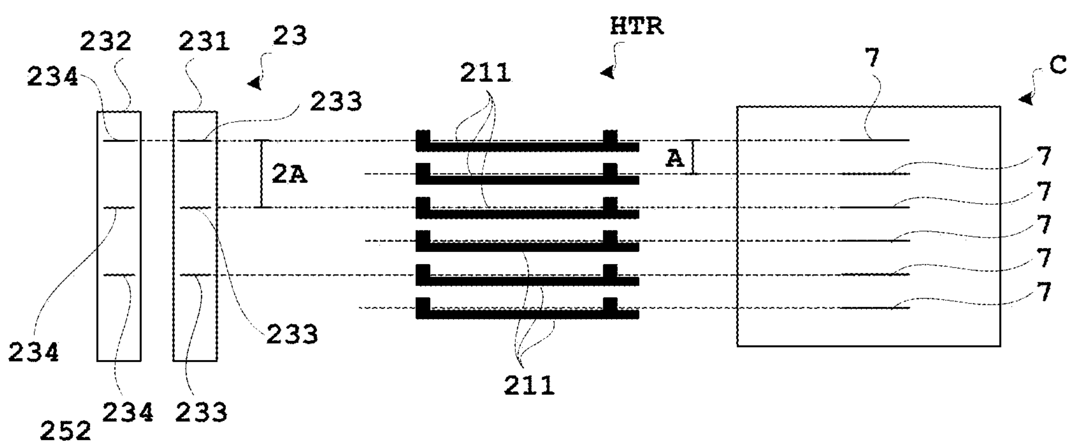


Fig.16B

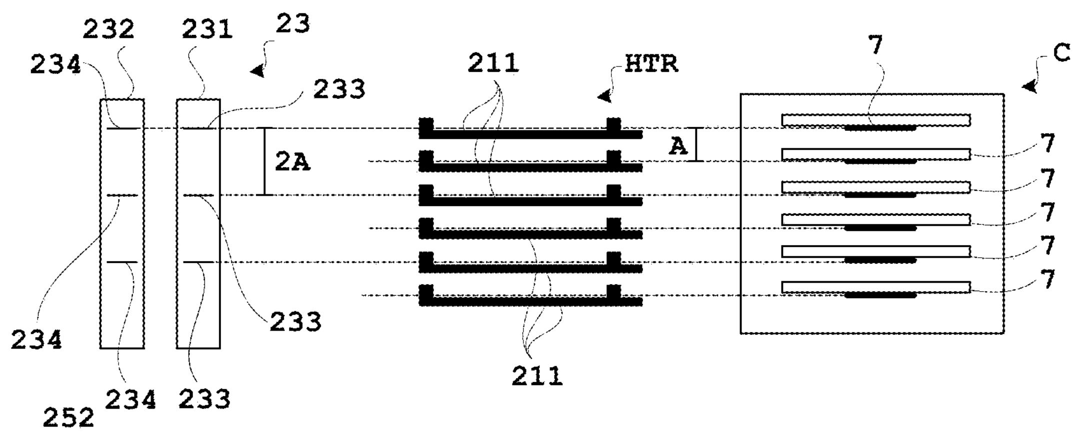


Fig.16C

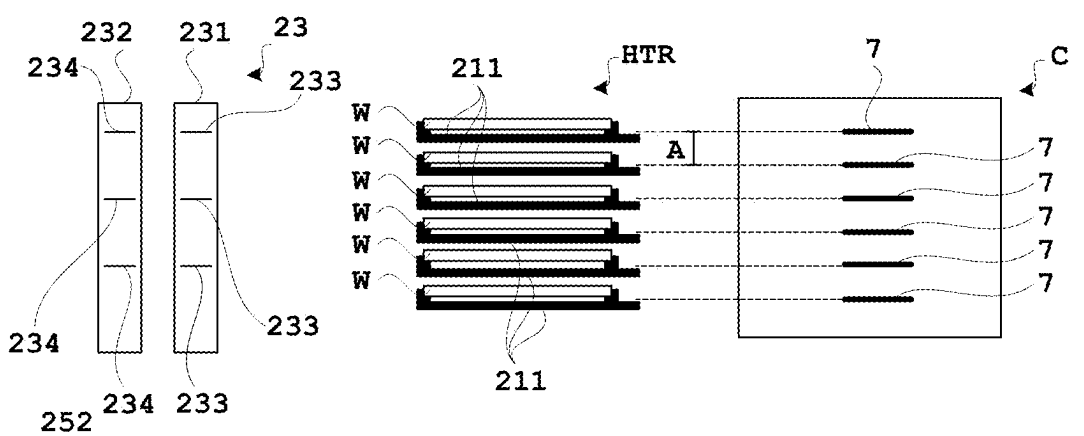


Fig.16D

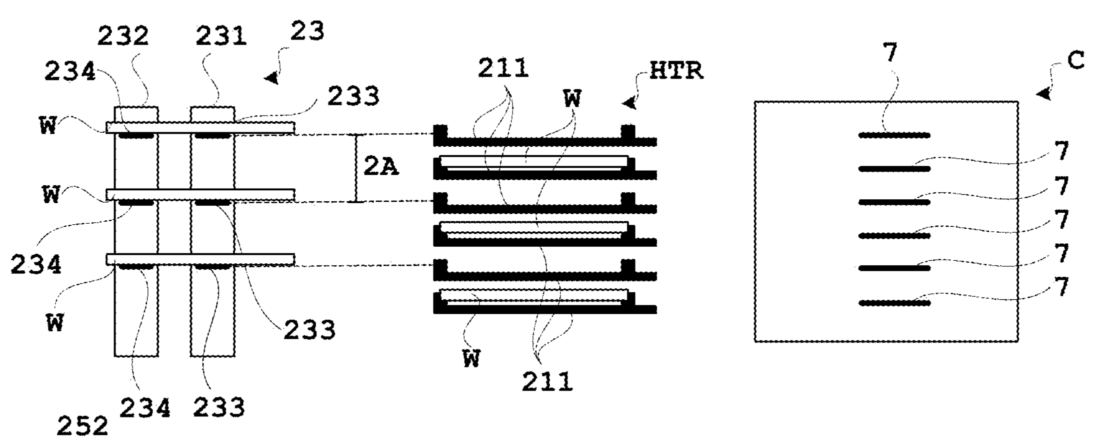


Fig.16E

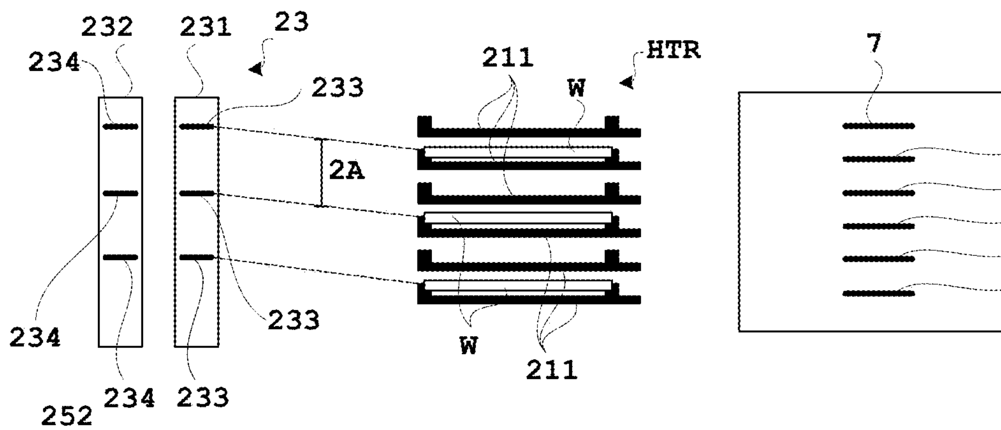
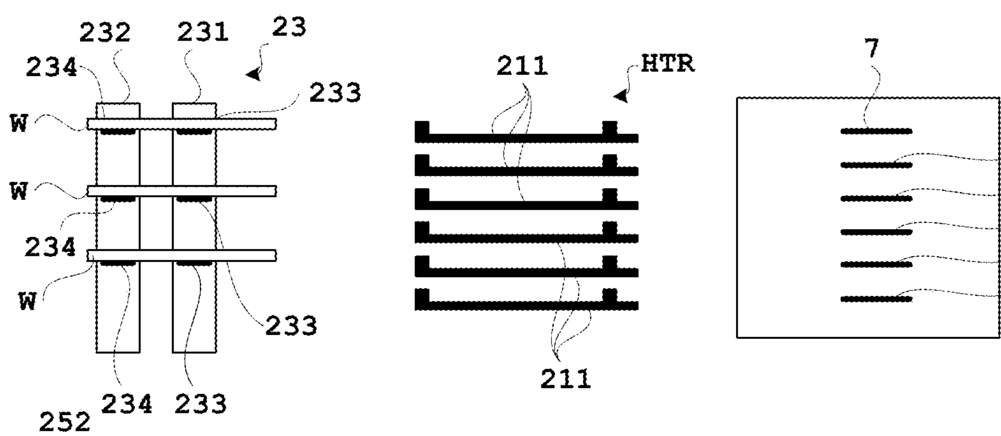


Fig.16F



SUBSTRATE PROCESSING METHOD

[0001] This application claims priority to Japanese Patent Application No. 2024-18102 filed Feb. 8, 2024, the subject matter of which is incorporated herein by reference in entirety.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to a substrate processing method for a semiconductor substrate, a substrate for a flat panel display (FPD) such as a liquid crystal display or an organic electroluminescence (EL) display device, a glass substrate for a photomask, a substrate for an optical disk, and the like.

DESCRIPTION OF THE RELATED ART

[0003] JP H5-175179 A describes a substrate processing apparatus that takes out the same number of substrates from each of two carriers, forms a first substrate group and a second substrate group, inserts the second substrate group into a gap between the respective substrates of the first substrate group to convert the pitch to ½, forms a substrate group of twice the number of substrates, and collectively processes the substrates.

LIST OF DOCUMENTS

[0004] JP H5-175179A

[0005] In recent years, there has been a demand for further improvement in efficiency of a substrate processing apparatus. In order to increase the number of substrates to be processed at one time by batch processing, it is necessary to further narrow the arrangement pitch of the substrates. A problem in this case is the orientation of the substrates. That is, for batch processing, it is more suitable from the viewpoint of preventing contamination of the device surface to form a batch lot by arranging substrates by a face-to-face method. In order to arrange the substrates by the face-to-face method with the device surfaces of the substrates facing each other, there is no choice but to combine the substrate arrangement acquired from a first carrier with the substrate arrangement acquired from a second carrier and rotated halfway. Therefore, according to the conventional configuration, although the arrangement pitch of the substrates can be halved, the arrangement pitch of the substrates cannot be further narrowed. When the substrates acquired from the second carrier are inserted into the gap of the substrate arrangement acquired from the first carrier to generate a batch lot, the arrangement pitch of the substrates in the batch lot is naturally determined to be half the original pitch.

[0006] The present invention has been made in view of such circumstances, and an object of the present invention is to provide a substrate processing method for efficiently performing substrate processing by narrowing an arrangement pitch of substrates.

SUMMARY OF THE INVENTION

[0007] In order to solve the above problems, the present invention has the following configurations.

[0008] That is, according to the present invention, there is provided a substrate processing method for collectively processing a plurality of substrates, the method including: a substrate group generation process of extracting a plurality of substrates from a carrier in which substrates defined on a front surface and a back surface are arranged at a specific pitch, and generating a substrate group in which the substrates are arranged in one direction at a pitch twice the specific pitch; and

[0009] a processing process of immersing a batch lot in a processing liquid after generating the batch lot by performing, in an arbitrary order, each of assembly processes including

[0010] a first assembly process of positioning a first substrate at a first position among the first position, a second position, a third position, a fourth position, and a fifth position that divide the predetermined interval in the substrate group into six by combining a first arrangement in which the first substrate oriented in an opposite direction to the one direction is arranged at a predetermined interval that is twice the specific pitch with the substrate group,

[0011] a second assembly process of positioning a second substrate at the second position by combining a second arrangement in which the second substrate oriented in the one direction is arranged at the predetermined interval with the substrate group,

[0012] a third assembly process of positioning a third substrate at the third position by combining a third arrangement in which the third substrate oriented in the opposite direction is arranged at the predetermined interval with the substrate group,

[0013] a fourth assembly process of positioning a fourth substrate at the fourth position by combining a fourth arrangement in which the fourth substrate oriented in the one direction is arranged at the predetermined interval with the substrate group, and

[0014] a fifth assembly process of positioning a fifth substrate at the fifth position by combining a fifth arrangement in which the fifth substrate oriented in the opposite direction is arranged at the predetermined interval with the substrate group.

OPERATION AND EFFECT

[0015] According to the above-described configuration, the substrate group arranged at the wide arrangement pitch is generated, and the substrates of the first arrangement, the second arrangement, the third arrangement, the fourth arrangement, and the fifth arrangement are inserted into the gap of the substrate group, whereby the arrangement pitch of the substrate group is narrowed. With this configuration, since the opposing relationship between the substrate group and the substrates to be inserted can be freely changed, a new substrate arrangement can be generated by combining the substrate group oriented in one direction, the first arrangement including the substrates oriented in the opposite direction, the second arrangement including the substrates oriented in one direction, the third arrangement including the substrates oriented in the opposite direction, the fourth arrangement including the substrates oriented in one direction, and the fifth arrangement including the substrates oriented in the opposite direction. Therefore, the arrangement pitch of the substrates can be narrowed, and the arrangement direction of the substrates can be made desired.

[0016] Furthermore, it is preferable in the above-described configuration that

[0017] a front surface of the first substrate in the first assembly process faces a front surface of the substrate group,

[0018] a back surface of the second substrate in the second assembly process faces a back surface of the first substrate,

[0019] a front surface of the third substrate in the third assembly process faces a front surface of the second substrate,

[0020] a back surface of the fourth substrate in the fourth assembly process faces a back surface of the third substrate, and

[0021] a front surface of the fifth substrate in the fifth assembly process faces a front surface of the fourth substrate, and a back surface of the fifth substrate faces a back surface of the substrate group.

OPERATION AND EFFECT

[0022] Furthermore, according to the above-described configuration, a front surface of the first substrate in the first assembly process faces a front surface of the substrate group, a back surface of the second substrate in the second assembly process faces a back surface of the first substrate, a front surface of the third substrate in the third assembly process faces a front surface of the second substrate, a back surface of the fourth substrate in the fourth assembly process faces a back surface of the third substrate, and a front surface of the fifth substrate in the fifth assembly process faces a front surface of the fourth substrate, and a back surface of the fifth substrate faces a back surface of the substrate group. According to the present invention, it is possible to generate a substrate arrangement in which the front surface and the back surface are arranged in this manner.

[0023] Furthermore, it is preferable in the above-described configuration that,

[0024] the first assembly process is performed after half-rotating the first arrangement in which the first substrate oriented in the one direction is arranged at the predetermined interval,

[0025] the third assembly process is performed after half-rotating the third arrangement in which the third substrate oriented in the one direction is arranged at the predetermined interval, and

[0026] the fifth assembly process is performed after half-rotating the fifth arrangement in which the fifth substrate oriented in the one direction is formed at the predetermined interval.

OPERATION AND EFFECT

[0027] According to the above-described configuration, the first assembly process is performed after half-rotating the first arrangement in which the first substrate oriented in one direction is arranged at a predetermined interval, the third assembly process is performed after half-rotating the third arrangement in which the third substrate oriented in one direction is arranged at a predetermined interval, and the fifth assembly process is performed after half-rotating the fifth arrangement in which the fifth substrate oriented in one direction is arranged at a predetermined interval. In this way, the generation of the substrate arrangement can be completed by receiving the substrate group arranged in one direction from the carrier.

[0028] Furthermore, it is preferable in the above-described configuration that,

[0029] a first process of collectively acquiring each substrate from a carrier that houses substrates in which substrates in a horizontal posture are arranged in a vertical direction, and

[0030] a second process of collectively converting the posture of each substrate from a horizontal posture to a vertical posture are provided, and

[0031] the first process and the second process are performed before each assembly process.

OPERATION AND EFFECT

[0032] According to the above-described configuration,

[0033] a first process of collectively acquiring each substrate from a carrier that houses substrates in which substrates in a horizontal posture are arranged in a vertical direction, and

[0034] a second process of collectively converting the posture of each substrate from a horizontal posture to a vertical posture are performed before each assembly process. With this configuration, the generation of the substrate arrangement can be completed by receiving the substrate group arranged in one direction from the carrier.

[0035] Furthermore, it is preferable in the above-described configuration that,

[0036] the distance from the first position to the second position is preferably ⅓ of the specific pitch in the carrier.

OPERATION AND EFFECT

[0037] According to the above-described configuration, the distance from the first position to the second position is ⅓ of the specific pitch in the carrier. With this configuration, the pitch of the substrate arrangement to be generated can be ½ or less of the arrangement pitch of the substrates housed in the carrier.

[0038] Furthermore, it is preferable in the above-described configuration that,

[0039] each assembly process is performed in the order of the first assembly process, the second assembly process, the third assembly process, the fourth assembly process, and the fifth assembly process.

OPERATION AND EFFECT

[0040] According to the above-described configuration, each assembly process is performed in the order of the first assembly process, the second assembly process, the third assembly process, the fourth assembly process, and the fifth assembly process. With this configuration, the substrate arrangement can be easily generated.

[0041] Furthermore, it is preferable in the above-described configuration that,

[0042] the substrate group is acquired from a first carrier that houses substrates in which substrates in a horizontal posture are arranged in a vertical direction,

[0043] the first arrangement is acquired from the first carrier,

[0044] the second arrangement is acquired from a second carrier that houses substrates in which substrates in the horizontal posture are arranged in the vertical direction,

[0045] the third arrangement is acquired from the second carrier,

[0046] the fourth arrangement is acquired from a third carrier that houses substrates in which substrates in the horizontal posture are arranged in the vertical direction, and

[0047] the fifth arrangement is preferably acquired from the third carrier.

OPERATION AND EFFECT

[0048] According to the above configuration, the substrate group is acquired from the first carrier, the first arrangement is acquired from the first carrier, the second arrangement is acquired from the second carrier, the third arrangement is acquired from the second carrier, the fourth arrangement is acquired from the third carrier, and the fifth arrangement is acquired from the third carrier. With this configuration, the substrate arrangement can be easily generated from the plurality of carriers.

[0049] Furthermore, it is preferable in the above-described configuration that the predetermined interval is equally divided into six by the first position, the second position, the third position, the fourth position, and the fifth position.

OPERATION AND EFFECT

[0050] According to the above configuration, the predetermined interval is equally divided into six by the first position, the second position, the third position, the fourth position, and the fifth position. With this configuration, it is possible to generate a substrate arrangement in which the substrates are arranged more orderly.

[0051] Furthermore, it is preferable in the above-described configuration that,

[0052] the substrate group generation process extracts every other substrate from the carrier to generate the substrate group.

OPERATION AND EFFECT

[0053] According to the above configuration, every other substrate is extracted from the carrier to generate the substrate group. With this configuration, the substrate group can be easily generated.

[0054] Furthermore, it is preferable in the above-described configuration that, in the substrate group generation process, the substrate group is generated by extracting every other substrate in a process of converting the substrates from the horizontal posture to the vertical posture after extracting all the substrates from the carrier.

OPERATION AND EFFECT

[0055] According to the above-described configuration, the substrate group is generated by extracting every other substrate in a subsequent process of converting the substrates from the horizontal posture to the vertical posture after extracting all the substrates from the carrier. With this configuration, the substrate group can be easily generated.

[0056] According to the present invention, it is possible to provide a substrate processing method capable of narrowing the arrangement pitch of substrates and efficiently performing substrate processing.

BRIEF OF DESCRIPTION OF THE DRAWINGS

[0057] FIG. **1** is a plan view for explaining an overall configuration of a substrate processing apparatus according to an embodiment;

[0058] FIG. **2** is a schematic diagram illustrating a configuration of a carrier according to the embodiment;

[0059] FIG. **3** is a perspective view for explaining each unit constituting a transfer block according to the embodiment;

[0060] FIG. **4** is a comparative view of a configuration of a carrier and a configuration of a handling robot according to the embodiment;

[0061] FIG. **5** is a perspective view illustrating a configuration of an HVC posture converter according to the embodiment;

[0062] FIG. **6** is a plan view for explaining a configuration of each rod according to the embodiment;

[0063] FIG. **7** is a plan view for explaining the configuration of each rod according to the embodiment;

[0064] FIG. **8** is a cross-sectional view for explaining a groove included in a clamping rod according to the embodiment;

[0065] FIG. **9** is a schematic diagram illustrating a pusher according to the embodiment;

[0066] FIG. **10** is a schematic diagram illustrating a pusher according to the embodiment;

[0067] FIG. **11**A is a schematic diagram illustrating a batch assembly according to the embodiment;

[0068] FIG. **11**B is a schematic diagram illustrating a batch assembly according to the embodiment;

[0069] FIG. **11**C is a schematic diagram illustrating a batch assembly according to the embodiment;

[0070] FIG. **11**D is a schematic diagram illustrating a batch assembly according to the embodiment;

[0071] FIG. **11**E is a schematic diagram illustrating a batch assembly according to the embodiment;

[0072] FIG. **11**F is a schematic diagram illustrating a batch assembly according to the embodiment;

[0073] FIG. **11**G is a schematic diagram illustrating a batch assembly according to the embodiment;

[0074] FIG. **11**H is a schematic diagram illustrating a batch assembly according to the embodiment;

[0075] FIG. **11**I is a schematic diagram illustrating a batch assembly according to the embodiment;

[0076] FIG. **11**J is a schematic diagram illustrating a batch assembly according to the embodiment;

[0077] FIG. **11**K is a schematic diagram illustrating a batch assembly according to the embodiment;

[0078] FIG. **11**L is a schematic diagram illustrating a batch assembly according to the embodiment;

[0079] FIG. **11**M is a schematic diagram illustrating a batch assembly according to the embodiment;

[0080] FIG. **11**N is a schematic diagram illustrating a batch assembly according to the embodiment;

[0081] FIG. **11**O is a schematic diagram illustrating a batch assembly according to the embodiment;

[0082] FIG. **11**P is a schematic diagram illustrating a batch assembly according to the embodiment;

[0083] FIG. **12** is a schematic diagram illustrating a direction of a substrate according to the embodiment;

[0084] FIG. **13** is a flowchart illustrating a flow of a substrate according to the embodiment;

[0085] FIG. **14** is a flowchart illustrating a flow of a substrate according to the embodiment;

[0086] FIG. **15** is a schematic view for explaining a modification of the handling robot according to the embodiment;

[0087] FIG. **16**A is a schematic diagram illustrating a modification of the batch assembly according to the embodiment;

[0088] FIG. **16**B is a schematic diagram illustrating a modification of the batch assembly according to the embodiment;

[0089] FIG. **16**C is a schematic diagram illustrating a modification of the batch assembly according to the embodiment;

[0090] FIG. **16**D is a schematic diagram for illustrating a modification of the batch assembly according to the embodiment;

[0091] FIG. **16**E is a schematic diagram illustrating a modification of the batch assembly according to the embodiment; and

[0092] FIG. **16**F is a schematic diagram illustrating a modification of the batch assembly according to the embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0093] Hereinafter, embodiments of the present invention will be described with reference to the drawings. In the substrate processing apparatus of the embodiment, substrates arranged at a pitch of 10 mm are converted to an arrangement pitch of ⅓ (10/3 mm) to form a batch lot. The formed batch lot is subjected to so-called batch processing in which various substrate processing such as chemical solution immersion processing are collectively performed. When the substrate processing is performed by narrowing the arrangement pitch of the substrates in this manner, a required amount of chemical solution is reduced, so that it is possible to reduce the running cost and perform the substrate processing in consideration of the environment.

[0094] The substrate processed by the substrate processing apparatus of the present embodiment has directions defined by the front surface and the back surface. The front surface of the substrate is a device surface to be subjected to film formation processing and exposure processing. The back surface is a surface opposite to the device surface. When the substrate is held in a horizontal posture, the front surface of the substrate faces upward.

Embodiment

1. Overall Configuration

[0095] The substrate processing apparatus **1** according to the present invention is configured to perform batch processing. The substrate processing apparatus **1** includes a housing **1**A that houses each block. The housing **1**A has a substantially rectangular shape in plan view. The housing **1**A horizontally arranges and houses a stocker block **3**, a transfer block **5**, and a processing block **6** from one end side. A load port **9** is provided to protrude from a wall surface on one end side of the housing **1**A.

[0096] In the present specification, for convenience, a direction in which the stocker block **3**, the transfer block **5**, and the processing block **6** in the substrate processing apparatus **1** are arranged is referred to as a “front-back direction X”. The front-back direction X extends horizontally. Of the front-back direction X, the direction from the transfer block **5** toward the stocker block **3** in the substrate processing apparatus **1** is referred to as “front side”. A direction opposite to the front is referred to as “back side”. A direction extending horizontally and orthogonal to the front-back direction X is referred to as a “width direction Y”. One direction of the “width direction Y” is referred to as a “right side” for convenience, and the other direction is referred to as a “left side” for convenience. A direction (height direction) orthogonal to the front-back direction X and the width direction Y is referred to as a “vertical direction Z” for convenience. In each drawing, front, back, upper, lower, right, and left are appropriately shown for reference.

2. Stocker Block

[0097] As illustrated in FIG. **1**, the stocker block **3** includes a load port **9** which is an entrance when a carrier C for housing a plurality of substrates W in a horizontal posture at predetermined intervals in a vertical direction is input into the block. The load port **9** protrudes from the outer wall of the stocker block **3** extending in the width direction (Y direction).

[0098] A plurality of substrates W (for example, 25 sheets) are stacked and housed in one carrier C at regular intervals in the horizontal posture. The carrier C storing the unprocessed substrates W carried into the substrate processing apparatus **1** is first placed on the load port **9**.

[0099] FIG. **2** illustrates a configuration of the carrier C. The carrier C is formed with a plurality of slots S extending in the horizontal direction to hold the surfaces of the substrates W in a state of being separated from each other. The slots S are arranged in the vertical direction at a specific pitch (for example, 10 mm), and the substrates W are accommodated in each of the slots S. 25 slots S are provided in one carrier C. Therefore, in the carrier C, 25 substrates W are arranged in the vertical direction at a specific pitch. A placement plate **7** is positioned to partition each slot S and, together with its paired placement plate **7**, supports both ends of each of the substrates W. Therefore, the placement plates **7** are arranged one by one on the side surface of the carrier C and the surface parallel to the side surface. As the carrier C, for example, there is a sealed front opening unify pod (FOUP). In the present invention, an open type container may be employed as the carrier C.

[0100] The internal structure of the stocker block **3** will be described. The stocker block **3** includes a conveyance/storage unit ACB that stocks and manages the carrier C. The conveyance/storage unit ACB includes a carrier conveyance mechanism **11** that conveys the carrier C and a shelf **13** on which the carrier C is placed. The number of carriers C that can be stocked by the stocker block **3** is one or more.

[0101] The stocker block **3** has a plurality of shelves **13** on which the carrier Cis placed. The shelf **13** is provided on a partition wall separating the stocker block **3** and the transfer block **5**. The shelf **13** includes a stock shelf **13***b* on which the carrier C is simply temporarily placed and a carrier placement shelf **13***a* on which a first handling robot HTR of the transfer block **5** accesses and from which the substrate is taken out.

[0102] The carrier placement shelf **13***a* has a configuration on which the carrier C can be placed. The carrier placement shelf **13***a* is configured to place the carrier C, from which the substrates W are to be taken out. In the present embodiment, one carrier placement shelf **13***a* is provided, but a plurality of carrier placement shelves **13***a* may be provided. The carrier conveyance mechanism **11** takes in the carrier C housing the unprocessed substrates W from the load port **9** and places the carrier C on the carrier placement shelf **13***a* for substrate extraction. At this time, the carrier conveyance mechanism **11** can also temporarily place the carrier C on the stock shelf **13***b* before placing the carrier C on the carrier placement shelf **13***a*. The number of carrier placement shelves **13***a* included in the stocker block **3** is 1 or more.

[0103] Note that the carrier placement shelf **13***a* is also configured to place an empty carrier C for housing the processed substrates W. The processed substrates W are housed in the carrier C waiting on the carrier placement shelf **13***a*. The carrier conveyance mechanism **11** obtains the carrier C storing the processed substrates W from the carrier placement shelf **13***a* and conveys the carrier C to the load port **9**. When the carrier C is conveyed to the load port **9**, the carrier conveyance mechanism **11** may temporarily place the carrier C on the shelf **13***b* for stock.

3. Transfer Block

[0104] The transfer block **5** is adjacent to the carrier placement shelf **13***a*. The transfer block **5** is disposed adjacent to the back side of the stocker block **3**. The transfer block **5** includes a handling robot HTR that can access the carrier C placed on the carrier placement shelf **13***a* for substrate extraction, an HVC posture converter **23** that collectively converts the posture of the plurality of substrates W from the horizontal posture to the vertical posture, and a pusher mechanism **25**. The HVC posture converter **23** collectively converts the plurality of substrates W from the horizontal posture to the vertical posture. Further, in the transfer block **5**, a substrate transfer position PP for transferring a plurality of substrates W to an advance/retract conveyance mechanism WTR provided in a collective conveyance region R**2** is set.

[0105] As illustrated in FIG. **3**, the handling robot HTR, the HVC posture converter **23**, and the pusher mechanism **25** are arranged in this order in the Y direction. The handling robot HTR includes hands **211** capable of gripping substrates W in the horizontal posture. The hand **211** can grip one substrate W. In the handling robot HTR, the hands **211** are arranged in the vertical direction. The handling robot HTR can convey a plurality of substrates W at one time by gripping the substrates with each of the hands **211**. The movement support mechanism **213** is a mechanism constituting the handling robot HTR, and is configured to rotate the hands **211** around the vertical axis, raise and lower the hands **211**, advance and retract the hands **211** in the front-back direction X, or traverse in the left-right direction Y.

[0106] FIG. **4** illustrates a state where the handling robot HTR receives the substrates W in the carrier C using the hands **211**. As illustrated in FIG. **4**, the hands **211** are arranged in the vertical direction at a pitch twice the arrangement pitch of the slots S provided in the carrier C. That is, the hands **211** are arranged at a pitch of 20 mm. 20 mm corresponds to a predetermined interval of the present invention. The handling robot HTR cannot convey all of the substrates W arranged at intervals of 10 mm on the carrier C at one time. The handling robot HTR is configured to generate a group of substrates arranged with a 20 mm interval by extracting every other substrate W, which is initially arranged at a 10 mm pitch. Since the front surfaces of the substrates W housed in the carrier C all face upward, the substrates W extracted by the handling robot HTR all face upward. Note that each of the hands **211** is provided with a guide **214** that brings a peripheral portion of the substrate into contact with the guide **214**. The guide **214** is provided at the distal end portion and the proximal end portion of the pair of blades constituting the hands **211**. Therefore, four guides **214** are provided in the hands **211**.

[0107] The handling robot HTR has 13 hands **211**. The handling robot HTR conveys the 25 substrates housed in the carrier C in two separate operations. The handling robot HTR can first convey 12 substrates W and then transport 13 substrates W. Similarly, the handling robot HTR can also convey 13 substrates W first and then 12 substrates W.

[0108] The HVC posture converter **23** illustrated in FIG. **3** is configured to convert the substrate W taken out from the carrier C from a horizontal posture to a vertical posture by the handling robot HTR. The HVC posture converter **23** includes a pair of placing rods **231** and a pair of clamping rods **232** extending in the vertical direction (Z direction). The support base **237** has a support surface extending in an XY plane that supports the placing rods **231** and the clamping rods **232**. A rotary drive mechanism **239** is configured to rotate the placing rods **231** and the clamping rods **232** together with the support base **237** by 90°. This rotation causes the placing rods **231** and the clamping rods **232** to extend in the left-right direction (Y direction).

[0109] The placing rod **231** each includes a rod driving mechanism **235** that rotates about a rotation axis along the extending direction. The pair of placing rods **231** can be synchronously rotated by a pair of rod driving mechanisms **235**. The rod driving mechanism **235** can extend and contract the placing rod **231**. A specific example when the placing rod **231** is driven by the rod driving mechanism **235** will be described later.

[0110] The clamping rod **232** each includes a rod rotary mechanism **236** that rotates about a rotation axis along the extending direction. The pair of clamping rods **232** can be synchronously rotated by a pair of rod rotary mechanisms **236**.

[0111] FIG. **5** illustrates flat plates **233** of the placing rod **231**. The flat plates **233** are arranged on the placing rod **231** at a pitch of 20 mm in an extending direction of the placing rod **231**. Each of the flat plates **233** is a plate extending on a plane orthogonal to the arrangement direction of the flat plates **233**, and the substrate W is supported by the placing rod **231** when the end of the substrate W is placed on the upper surface of the flat plate **233**. Since it is not possible to hold the entire substrate W only by holding one end portion of the substrate W, two placing rods **231** are provided in the HVC posture converter **23**. One end of the substrate W is held by the flat plate **233** of one placing rod **231**, and the other end of the substrate W is held by the flat plate **233** of the other placing rod **231**. One end and the other end are separated by a distance of the diameter of the substrate W. Therefore, the pair of placing rods **231** is separated by a distance of the diameter of the substrate Was illustrated in FIG. **6**. In this way, the substrate W held by the flat plate **233** does not float from the flat plate **233**. This is because the weight of the substrate W is symmetrically applied to the flat plate **233**, so that the weight of the substrate W in the flat plate **233** is balanced between the left and right. The pair of placing rods **231** is parallel to each other.

[0112] FIG. **5** illustrates clamping plates **234** of the clamping rod **232**. The clamping plate **234** has an arcuate side **234***a* along the curve of the substrate W, and the arcuate side **234***a* is provided with a V groove **234***b* for clamping the substrate W. Since the substrate W has a shape along the curve of the arcuate side **234***a*, the substrate W is clamped in the V groove **234***b* of the arcuate side **234***a*. The clamping plates **234** are arranged on the clamping rod **232** at a pitch of 20 mm in the extending direction of the clamping rod **232**. Each of the clamping plates **234** is a plate extending on a plane orthogonal to the arrangement direction of the clamping plates **234**, and a part of the substrate W is fitted into the V groove **234***b* of the arcuate side **234***a*, so that the substrate W is clamped by the clamping rod **232**.

[0113] Note that, since it is not possible to realize the clamping of the entire substrate W only by clamping a part of the substrate W, two clamping rods **232** are provided in the HVC posture converter **23**. A part of the substrate W is clamped by the clamping plate **234** of one clamping rod **232**, and a part of the substrate W is clamped by the clamping plate **234** of the other clamping rod **232**. The pair of clamping rods **232** is separated by a distance shorter than the diameter of the substrate W. Since the pair of clamping rods **232** is configured to clamp the substrate W in the vertical posture, it is sufficient that the pair of clamping rods **232** is configured to clamp the lower side of the substrate W, and it is not necessary to separate the pair of clamping rods **232** by the diameter of the substrate W unlike the placing rod **231**. Nevertheless, as illustrated in FIG. **7**, since the clamping rod **232** is disposed at a position shifted from the bottom portion of the substrate W in the vertical posture, two of a rod for clamping a portion on the right side as viewed from the bottom portion of the substrate W and a rod for clamping a portion on the left side as viewed from the bottom portion of the substrate W are required. As illustrated in FIG. **8**, the two clamping rods **232** clamp the substrate W from both sides by the V groove **234***b* of the clamping plate **234**. The pair of clamping rods **232** is parallel to each other.

[0114] The pusher mechanism **25** in FIG. **3** includes a pusher **251** capable of horizontally arranging substrates W in a vertical posture. The pusher **251** is a half-pipe type along the curve of the bottom portion of the substrate W. In the pusher **251** in the initial state, the U groove **251***a* constituting the half-pipe extends in the left-right direction Y. The pusher **251** in this state can receive the substrate W from the HVC posture converter **23**.

[0115] FIG. **9** is a cross-sectional view for explaining the configuration of the pusher **251**. The pusher **251** has a plurality of V-shaped clamping grooves **252**. The clamping grooves **252** are arranged in the extending direction of the U groove described with reference to FIG. **7**. An arrangement pitch of the clamping grooves **252** is 10/3 mm. As illustrated in FIG. **9**, one substrate W is clamped by each of the clamping grooves **252**.

[0116] FIG. **10** illustrates a relationship between the pair of clamping rods **232** and the pusher **251**. Unlike the state of FIG. **3**, the pair of clamping rods **232** in FIG. **10** is tilted by 90° together with the support base **237** by the rotary drive mechanism **239**. Therefore, the clamping rod **232** in FIG. **10** extends in the horizontal direction. As can be seen with reference to FIG. **10**, the pusher **251** is at a position sandwiched between the pair of clamping rods **232** in the front-back direction X. Therefore, the pair of clamping rods **232** and the pusher **251** do not interfere with each other, and can cooperatively clamp the substrate W in the vertical posture.

[0117] The pusher rotation mechanism **253** in FIG. **3** can rotate the pusher **251** by at least 180°. The pusher rotation mechanism **253** can rotate the pusher **251** in the initial state to orient the pusher **251** in the opposite direction, or can rotate the pusher **251** oriented in the opposite direction to return the pusher **251** to the initial state. The pusher shift mechanism **254** can reciprocate the pusher **251** in the initial state in the left-right direction Y. The pusher shift mechanism **254** can bring the pusher **251** close to the HVC posture converter **23** or can bring the pusher **251** close to the advance/retract conveyance mechanism WTR.

[0118] A pusher lifting mechanism **255** can raise the pusher **251** at the initial position to the upper position. The pusher lifting mechanism **255** can also return the pusher **251** in the upper position to the initial position.

4. Pitch Change in Transfer Block

[0119] In the substrate processing apparatus of the present embodiment, since the arrangement pitch of the substrates W can be changed in the transfer block **5**, this point will be described. The substrates W arranged at a pitch of 10 mm in the carrier C are first arranged at a pitch of 20 mm in the transfer block **5**, and then rearranged at a pitch of 10/3 mm. Hereinafter, this configuration will be specifically described.

[0120] FIG. **11**A compares the arrangement pitch of the substrates in each configuration. In the carrier C, the placement plates **7** constituting the slots S are arranged at a pitch of 10 mm. The placement plates **7** are arranged in the vertical direction on one surface of the carrier C, and are arranged in the vertical direction on the other surface of the carrier C. Both ends of the substrate W are placed on the pair of placement plates **7** facing each other, so that the substrate W is held by the carrier C.

[0121] On the other hand, flat plates **233** are arranged at a pitch of 20 mm on the placing rod **231** in the HVC posture converter **23**. Therefore, assuming that the arrangement pitch of the placement plates **7** of the carriers C is A, the arrangement pitch of the flat plates **233** is 2 A. That is, the pair of placing rods **231** can hold only about half, that is, 13 substrates W out of 25 substrates housed in the carrier C at one time.

[0122] Similarly, the clamping plates **234** are arranged at a pitch of 20 mm on the clamping rod **232** in the HVC posture converter **23**. Therefore, assuming that the arrangement pitch of the placement plates **7** of the carriers C is A, the arrangement pitch of the clamping plates **234** is 2 A. That is, the pair of clamping rods **232** can hold only about half, that is, 13 substrates W out of 25 substrates housed in the carrier C at one time.

[0123] FIG. **11**B schematically illustrates a state in which 25 substrates W are arranged on the carrier C. Since three carriers C of different individuals appear in the following description, the carrier C in FIG. **11**B is referred to as a first carrier **C1**. In the first carrier **C1**, 25 substrates W are arranged at a pitch of 10 mm.

[0124] FIG. **11**C illustrates a state in which some of the substrates W housed in the first carrier C**1** are transferred to the HVC posture converter **23** by the handling robot HTR. The handling robot HTR has hands **211** arranged in the vertical direction at a pitch of 20 mm. Therefore, the handling robot HTR can hold only about half of the substrates W in the first carrier C1 at one time. The handling robot HTR extracts every other substrate W in the first carrier C1 and transfers the substrate W to the HVC posture converter **23**. Then, as illustrated in FIG. **6**, both ends of the substrate W are supported by the pair of placing rods **231**.

[0125] At this time, the peripheral edge portion of the substrate W is in contact with each of the clamping plates **234** of the pair of clamping rods **232**. Specifically, the peripheral edge portion of the substrate W is fitted into the V groove of the clamping plate **234**. Therefore, even if the support base **237** is rotated by 90° in this state, since the substrate W is clamped by the V groove **234***b* of the clamping plate **234**, the substrate W does not slide down from the HVC posture converter **23**.

[0126] FIG. **11**C also illustrates a state in which the placing rod **231** supports the substrate W by the flat plate **233**. Similarly, FIG. **11**C illustrates a state in which the clamping rod **232** clamps the substrate W with the clamping plate **234**.

[0127] FIG. **11**D illustrates a state when the rotary drive mechanism **239** in the HVC posture converter **23** operates. By this operation, the support base **237** is rotated by 90°, and the placing rod **231** and the clamping rod **232** are in a state of extending horizontally. Then, the load of the substrate W is transferred from the placing rod **231** to the clamping rod **232**, and the flat plate **233** of the placing rod **231** is brought into a state of only being in contact with the substrate W. FIG. **11**D illustrates a state where placing rod **231** is contracted by rod driving mechanism **235**. When the placing rod **231** contracts (slightly displaces and moves so as to be retracted into the support base **237**), the flat plate **233** separates from the substrate W. Even when such an operation is performed, since the substrate W is supported by the clamping rod **232**, the substrate W does not move along with the movement of the flat plate **233**.

[0128] By separating the flat plate **233** from the substrate W, even if the substrate W clamped by the clamping rod **232** is lifted by the pusher **251**, the flat plate **233** does not damage the back surface of the substrate W.

[0129] FIG. **11**E illustrates a state when the placing rod **231** is rotated by 90° by rod driving mechanism **235**. The flat plate **233** of the placing rod **231** faces upward by the rotation of the placing rod **231**. This movement of the flat plate **233** is performed above the pusher **251**. The placing rod **231** approaches the pusher **251** together with the substrate W clamped by the clamping rod **232**, but at that time, the flat plate **233** does not collide with the substrate W held by the pusher **251**. Since the pusher **251** in FIG. **11**E does not clamp the substrate W, the rotation operation of the flat plate **233** can be omitted.

[0130] FIG. **11**F illustrates a state when the pusher **251** subsequently rises. Then, the bottom portion of the substrate W clamped by the clamping rod **232** is fitted into the clamping groove **252** of the pusher **251**. When the pusher **251** further rises in this state, the substrate W is removed from the clamping plate **234** of the clamping rod **232**. In this manner, the substrate W is transferred from the HVC posture converter **23** to the pusher mechanism **25**.

[0131] Thereafter, the pusher **251** rises to an upper position UR set above the placing rod **231**. The pusher **251** located in the upper position UR does not collide with the placing rod **231** returned to the upright state. FIG. **11**F also illustrates a state in which the placing rod **231** and the clamping rod **232** are moved to a virtual position IR indicated by broken lines by the rotary drive mechanism **239**. At this time, the placing rod **231** that has contracted returns to the original stretched state. In addition, placing rod **231** reversely rotates to return to the original state described in FIG. **11**C.

[0132] In this way, the substrates W arranged at a pitch of 20 mm are transferred from the HVC posture converter **23** to the pusher mechanism **25**. The clamping groove **252** in the pusher **251** at this time includes a groove that clamps the substrate W and an empty groove that does not clamp the substrate W. The grooves that clamp the substrate W are separated from each other by 6 times the arrangement pitch of the clamping grooves **252**. This is because the arrangement pitch of the clamping grooves **252** is 10/3 mm. 20 mm, which is the arrangement pitch of the substrates W, corresponds to exactly 6 times the arrangement pitch of the clamping groove **252**. At this time, the substrates W arranged in the pusher **251** are referred to as an initial substrate group or simply as an initial substrate W**0** for convenience of description. The initial substrate group corresponds to the substrate group of the present invention.

[0133] FIG. **11**G illustrates a state when the pusher **251** that has moved down and returned to the initial position is half-rotated by the pusher rotation mechanism **253**. The pusher **251** facing the left is referred to as an L state. On the other hand, the pusher **251** in FIG. **11**F is in an R state facing the right. The half rotation in FIG. **11**G is referred to as a first half rotation r**1**. FIG. **11**G also illustrates a state in which the substrates W arranged at a pitch of 20 mm remaining in the first carrier C1 are conveyed to the HVC posture converter **23** by broken lines. This conveyance is realized by the handling robot HTR having hands **211** arranged at a pitch of 20 mm.

[0134] FIG. **11**H illustrates a state in which the substrate W held by the HVC posture converter **23** is then transferred to the pusher **251**. At this time, the tilting of the placing rod **231** and the clamping rod **232** and the contraction of the placing rod **231** described with reference to FIG. **11**D are executed, which have already been specifically described. Similarly, in FIG. **11**H, the rotation of the placing rod **231** described with reference to FIG. **11**E, the fitting of the substrate W into the pusher **251** described with reference to FIG. **11**F, the rising and lowering of the pusher **251**, the rising operation of the placing rod **231** and the clamping rod **232**, the extending operation of the placing rod **231**, and the reverse rotation operation of the placing rod **231** are also omitted.

[0135] As can be seen with reference to FIG. **11**H, also in this case, the substrates W arranged at a pitch of 20 mm are transferred to the pusher **251** without changing the pitch. When the substrate W is transferred from the HVC posture converter **23** to the pusher mechanism **25**, the substrate W is transferred to one of the clamping grooves **252** of the pusher **251**. Among the clamping grooves **252**, the clamping groove **252** in which the initial substrate group has been already fitted cannot clamp the substrate W any more. Therefore, the substrates W held by the HVC posture converter **23** are conveyed to a position shifted by one pitch in the arrangement of the clamping grooves **252** from the initial substrate group, and are fitted into the clamping grooves **252** on that spot. Such positioning of the substrates W and the pusher **251** is realized by the pusher shift mechanism **254**.

[0136] In this way, the substrates W arranged at a pitch of 20 mm are transferred from the HVC posture converter **23**

to the pusher mechanism **25**. In the pusher **251** at this time, a region in which two clamping grooves **252** that clamp the substrate W are continuous and a region in which four empty grooves that do not clamp the substrate W are continuous are alternately arranged. The substrates W newly arranged in the pusher **251** in FIG. **11**H are referred to as a first arrangement or simply as a first substrate W**1** for convenience of description.

[0137] FIG. **11**I illustrates a state in which the pusher **251** is then half-rotated by the pusher rotation mechanism **253**. The pusher **251** at this time is in the R state. The half rotation in FIG. **11**I is referred to as a second half rotation r**2**. FIG. **11**G also illustrates a state in which the substrates W are conveyed from the second carrier C**2** to the HVC posture converter **23** by broken lines. The second carrier C**2** is a new carrier that the carrier conveyance mechanism **11** has transported to the carrier placement shelf **13***a* instead of the empty first carrier C**1**. 25 substrates W arranged at a pitch of 10 mm are housed in the second carrier C**2**. The substrates W arranged at a pitch of 20 mm are extracted from the second carrier C**2** and conveyed to the HVC posture converter **23**. This conveyance is realized by the handling robot HTR having hands **211** arranged at a pitch of 20 mm.

[0138] FIG. **11**J illustrates a state in which the substrate W held by the HVC posture converter **23** is then transferred to the pusher **251**. Specific operations such as tilting of the placing rod **231** and the clamping rod **232** described with reference to FIG. **11**D executed at that time will be omitted as in FIG. **11**H.

[0139] As can be seen with reference to FIG. **11**J, also in this case, the substrates W arranged at a pitch of 20 mm are transferred to the pusher **251** without changing the pitch. Among the clamping grooves **252** included in the pusher **251**, the clamping grooves **252** in which the substrates W of the initial substrate group and the first arrangement are already fitted cannot clamp the substrates W any more. Therefore, the substrates W held by the HVC posture converter **23** are conveyed from the substrate W in the first arrangement to a position shifted by one pitch in the arrangement of the clamping grooves **252**, and are fitted into the clamping grooves **252** on the spot. Such positioning of the substrates W and the pusher **251** is realized by the pusher shift mechanism **254**.

[0140] In this way, the substrates W arranged at a pitch of 20 mm are transferred from the HVC posture converter **23** to the pusher mechanism **25**. In the pusher **251** at this time, a region in which three clamping grooves **252** that clamp the substrate W are continuous and a region in which three empty grooves that do not clamp the substrate W are continuous are alternately arranged. The substrates W newly arranged in the pusher **251** in FIG. **11**J are referred to as a second arrangement or simply as a second substrate W**2** for convenience of description.

[0141] FIG. **11**K illustrates a state in which the pusher **251** is then half-rotated by the pusher rotation mechanism **253**. The pusher **251** at this time is in the L state. The half rotation in FIG. **11**K is referred to as a third half rotation r**3**. FIG. **11**K also illustrates a state in which the substrates W remaining in the second carrier C**2** are conveyed to the HVC posture converter **23** by broken lines. The substrates W remaining in the second carrier C**2** are arranged at a pitch of 20 mm. This conveyance is realized by the handling robot HTR having hands **211** arranged at a pitch of 20 mm.

[0142] FIG. **11**L illustrates a state in which the substrates W held by the HVC posture converter **23** are then transferred to the pusher **251**. Specific operations such as tilting of the placing rod **231** and the clamping rod **232** described with reference to FIG. **11**D executed at that time will be omitted as in FIG. **11**H.

[0143] As can be seen with reference to FIG. **11**L, also in this case, the substrates W arranged at a pitch of 20 mm are transferred to the pusher **251** without changing the pitch. Among the clamping grooves **252** included in the pusher **251**, the clamping grooves **252** in which the substrates W of the initial substrate group, the first arrangement, and the second arrangement are already fitted cannot clamp the substrates W any more. Therefore, the substrates W held by the HVC posture converter **23** are conveyed from the substrates W in the second arrangement to a position shifted by one pitch in the arrangement of the clamping grooves **252**, and are fitted into the clamping grooves **252** on the spot. Such positioning of the substrates W and the pusher **251** is realized by the pusher shift mechanism **254**.

[0144] In this way, the substrates W arranged at a pitch of 20 mm are transferred from the HVC posture converter **23** to the pusher mechanism **25**. In the pusher **251** at this time, a region in which four clamping grooves **252** that clamp the substrates W are continuous and a region in which two empty grooves that do not clamp the substrates W are continuous are alternately arranged. The substrates W newly arranged in the pusher **251** in FIG. **11**L are referred to as a third arrangement or simply as a third substrate W**3** for convenience of description.

[0145] FIG. **11**M illustrates a state in which the pusher **251** is then half-rotated by the pusher rotation mechanism **253**. The pusher **251** at this time is in the R state. The half rotation in FIG. **11**M is referred to as a fourth half rotation r**4**. FIG. **11**M also illustrates a state in which the substrates W are conveyed from the third carrier C**3** to the HVC posture converter **23** by broken lines. The third carrier C**3** is a new carrier that the carrier conveyance mechanism **11** has transported to the carrier placement shelf **13***a* instead of the empty second carrier C**2**. 25 substrates W arranged at a pitch of 10 mm are housed in the third carrier C**3**. The substrates W arranged at a pitch of 20 mm are extracted from the third carrier C**3** and conveyed to the HVC posture converter **23**. This conveyance is realized by the handling robot HTR having hands **211** arranged at a pitch of 20 mm.

[0146] FIG. **11**N illustrates a state in which the substrates W held by the HVC posture converter **23** are then transferred to the pusher **251**. Specific operations such as tilting of the placing rod **231** and the clamping rod **232** described with reference to FIG. **11**D executed at that time will be omitted as in FIG. **11**H.

[0147] As can be seen with reference to FIG. **11**N, also in this case, the substrates W arranged at a pitch of 20 mm are transferred to the pusher **251** without changing the pitch. Among the clamping grooves **252** included in the pusher **251**, the clamping grooves **252** in which the substrates W of the initial substrate group, the first arrangement, the second arrangement, and the third arrangement are already fitted cannot clamp the substrates W any more. Therefore, the substrates W held by the HVC posture converter **23** are conveyed from the substrates W in the third arrangement to a position shifted by one pitch in the arrangement of the clamping grooves **252**, and are fitted into the clamping grooves **252** on the spot. Such positioning of the substrates W and the pusher **251** is realized by the pusher shift mechanism **254**.

[0148] In this way, the substrates W arranged at a pitch of 20 mm are transferred from the HVC posture converter **23** to the pusher mechanism **25**. The clamping groove **252** in the pusher **251** at this time includes a groove that clamps the substrate W and an empty groove that does not clamp the substrate W. The empty grooves are separated from each other by 6 times the arrangement pitch of the clamping grooves **252**. The substrates W newly arranged in the pusher **251** in FIG. **11**N are referred to as a fourth arrangement or simply as a fourth substrate W**4** for convenience of description.

[0149] FIG. **11**O illustrates a state in which the pusher **251** is then half-rotated by the pusher rotation mechanism **253**. The pusher **251** at this time is in the L state. The half rotation in FIG. **11**O is referred to as a fifth half rotation r**5**. FIG. **11**O also illustrates a state in which the substrates W remaining in the third carrier C**3** is conveyed to the HVC posture converter **23** by broken lines. The substrates W remaining in the third carrier C**3** are arranged at a pitch of 20 mm. This conveyance is realized by the handling robot HTR having hands **211** arranged at a pitch of 20 mm.

[0150] FIG. **11**P illustrates a state in which the substrates W held by the HVC posture converter **23** are then transferred to the pusher **251**. Specific operations such as tilting of the placing rod **231** and the clamping rod **232** described with reference to FIG. **11**D executed at that time will be omitted as in FIG. **11**H.

[0151] As can be seen with reference to FIG. **11**P, also in this case, the substrates W arranged at a pitch of 20 mm are transferred to the pusher **251** without changing the pitch. Among the clamping grooves **252** included in the pusher **251**, the clamping grooves **252** in which the substrates W of the initial substrate group, the first arrangement, the second arrangement, the third arrangement, and the fourth arrangement are already fitted cannot clamp the substrates W any more. Therefore, the substrates W held by the HVC posture converter **23** are conveyed from the substrates W in the fourth arrangement to a position shifted by one pitch in the arrangement of the clamping grooves **252**, and are fitted into the clamping grooves **252** on the spot. Such positioning of the substrates W and the pusher **251** is realized by the pusher shift mechanism **254**.

[0152] In this way, the substrates W arranged at a pitch of 20 mm are transferred from the HVC posture converter **23** to the pusher mechanism **25**. The clamping grooves **252** in the pusher **251** at this time all clamp the substrates W. The substrates W newly arranged in the pusher **251** in FIG. **11**P are referred to as a fifth arrangement or simply as a fifth substrate W**5** for convenience of description.

[0153] In this way, 75 substrates W are arranged on the pusher **251** at a pitch of 10/3 mm. A substrate array thus produced is referred to as a batch lot BL.

5. Batch Lot Composed of Transfer Block

[0154] FIG. **12** illustrates the orientation of the substrates W in the batch lot BL. In the batch lot BL, the initial substrate W**0** derived from the first carrier C**1**, the first substrate W**1** derived from the first carrier C**1**, the second substrate W**2** derived from the second carrier C**2**, the third substrate W**3** derived from the second carrier C**2**, the fourth substrate W**4** derived from the third carrier C**3**, and the fifth substrate W**5** derived from the third carrier C**3** are repeatedly arranged in this order at a 10/3 mm pitch. Among them, the initial substrate W**0**, the second substrate W**2**, and the fourth substrate W**4** are received by the pusher **251** in the R state facing the right from the HVC posture converter **23**, and thus, the directions of these substrates W are aligned in one direction. On the other hand, the first substrate W**1**, the third substrate W**3**, and the fifth substrate W**5** are received by the pusher **251** in the L state facing the left from the HVC posture converter **23**, and thus, the directions of these substrates are aligned in the opposite direction.

[0155] That is, the device surface of the first substrate W**1** faces the front surface of the initial substrate W**0**, the back surface of the second substrate W**2** faces the back surface of the first substrate W**1**, the device surface of the third substrate W**3** faces the device surface of the second substrate W**2**, the back surface of the fourth substrate W**4** faces the back surface of the third substrate W**3**, the device surface of the fifth substrate W**5** faces the device surface of the fourth substrate W**4**, and the back surface of the fifth substrate W**5** faces the back surface of the initial substrate W**0**. In this manner, the batch lot BL completed in the pusher **251** is formed by arranging the substrates W in a face-to-face manner.

[0156] When the transfer of the substrates W is performed while rotating the pusher **251** as in the present example, the substrates W can be arranged by the face-to-face method based on the initial substrate W**0**, the first substrate W**1**, the second substrate W**2**, the third substrate W**3**, the fourth substrate W**4**, and the fifth substrate W**5** in which the orientation of the substrates W are all aligned in one direction, and the batch lot BL can be generated.

[0157] Next, a relationship between the clamping groove **252** of the pusher **251** and the substrate W will be described. There are six types of positions at which the clamping groove **252** is provided: a reference position P at which the initial substrate W**0** is positioned; a first position P**1** at which the first substrate W**1** is positioned; a second position P**2** at which the second substrate W**2** is positioned; a third position P**3** at which the third substrate W**3** is positioned; a fourth position P**4** at which the fourth substrate W**4** is positioned; and a fifth position P**5** at which the fifth substrate W**5** is positioned. The reference positions P are arranged at a pitch of 20 mm in the pusher **251**, and the first position P**1**, the second position P**2**, the third position P**3**, the fourth position P**4**, and the fifth position P**5** divide 20 mm between the reference positions P into six. Specifically, 20 mm between the reference positions P is equally divided into six by the first position P**1**, the second position P**2**, the third position P**3**, the fourth position P**4**, and the fifth position P**5**. Therefore, the distance from the reference position P to the first position P**1** is 10/3 mm, which is ⅓ of the arrangement pitch of the substrates W in the carrier C, 10 mm. Similarly, the distance from the first position P**1** to the second position P**2**, the distance from the second position P**2** to the third position P**3**, the distance from the third position P**3** to the fourth position P**4**, the distance from the fourth position P**4** to the fifth position P**5**, and the distance from the fifth position P**5** to the reference position P are all 10/3 mm.

[0158] The substrate W oriented in one direction is located at the reference position P, the substrate W oriented in the opposite direction is located at the first position P**1**, the substrate W oriented in one direction is located at the second position P**2**, the substrate W oriented in the opposite direction is located at the third position P**3**, the substrate W oriented in one direction is located at the fourth position P**4**, and the substrate W oriented in the opposite direction is located at the fifth position P**5**.

6. Holding Batch Lot in Transfer Block

[0159] The transfer block **5** has two sites capable of holding the batch lot BL. One of them is the pusher **251**. The pusher **251** can reciprocate between an initial position where the substrate W can be transferred to and from the HVC posture converter **23** and a transfer position PP where the batch lot BL can be transferred to the advance/retract conveyance mechanism WTR. This reciprocating movement is realized by the pusher shift mechanism **254**.

[0160] The transfer block **5** includes a lot support **33** as a portion capable of holding the batch lot BL separately from the pusher **251**. The lot support **33** serves as a batch lot holding part for temporarily retracting the batch lot BL when congestion of the batch lot BL occurs between the transfer block **5** and the processing block **6**.

7. Processing Block

[0161] Hereinafter, the configuration of the processing block **6** described with reference to FIG. **1** will be described. The processing block **6** is adjacent to the transfer block **5**. The processing block **6** performs batch processing on the above-described batch lot BL. The processing block **6** is divided into a batch processing region R**1** and the collective conveyance region R**2** arranged in the width direction (Y direction). Each region extends in the front-back direction (X direction). Specifically, the batch processing region R**1** is disposed inside the processing block **6**. The collective conveyance region R**2** is adjacent to the batch processing region R**1** and is disposed on the leftmost side of the processing block **6**.

[0162] The batch processing region R**1** in the processing block **6** is a rectangular region extending in the front-back direction (X direction). One end side (front side) of the batch processing region R**1** is adjacent to the transfer block **5**. The other end side of the batch processing region R**1** extends in a direction away from the transfer block **5** (backward side). When the batch lot BL is conveyed from the transfer block **5** to the processing block **6**, the advance/retract conveyance mechanism WTR included in the processing block **6** is used.

[0163] The advance/retract conveyance mechanism WTR collectively conveys a plurality of substrates W in a vertical posture among the transfer block **5**, the batch processing units BPU**1** to BPU**6**, and a batch drying chamber DC. The advance/retract conveyance mechanism WTR can hold the batch lot BL including the substrates W arranged at a pitch of 10/3 mm.

[0164] The batch processing region R**1** includes a batch-type processing unit that performs batch-type processing. Specifically, in the batch processing region R**1**, the batch drying chamber DC for collectively drying a plurality of substrates W, and a plurality of batch processing units BPU**1** to BPU**6** for collectively immersing the plurality of substrates W in a direction in which the batch processing region R**1** extends are arranged. The batch processing units BPU**1** to BPU**6** collectively immerse a plurality of substrates in a vertical posture. The arrangement of the batch drying chamber DC and the batch processing units BPU**1** to BPU**6** will be specifically described. The batch drying chamber DC is adjacent to the transfer block **5** from the rear. The first batch processing unit BPU**1** is adjacent to the batch drying chamber DC from the rear. The second batch processing unit BPU**2** is adjacent to the first batch processing unit BPU**1** from the rear. The third batch processing unit BPU**3** is adjacent to the second batch processing unit BPU**2** from the rear. The fourth batch processing unit BPU**4** is adjacent to the third batch processing unit BPU**3** from the rear. The fifth batch processing unit BPU**5** is adjacent to the fourth batch processing unit BPU**4** from the rear. The sixth batch processing unit BPU**6** is adjacent to the fifth batch processing unit BPU**5** from the rear. Therefore, the batch drying chamber DC, the first batch processing unit BPU**1**, the second batch processing unit BPU**2**, the third batch processing unit BPU**3**, the fourth batch processing unit BPU**4**, the fifth batch processing unit BPU**5**, and the sixth batch processing unit BPU**6** are arranged so as to be separated from the transfer block **5** in this order.

[0165] Each of the batch processing units BPU**1** to BPU**6** includes a batch processing tank capable of holding liquid. The batch processing tank is a liquid tank that holds a chemical solution or pure water. The chemical solution is an acidic aqueous solution, for example, a phosphoric acid aqueous solution. In the present specification, the chemical solution and pure water are collectively referred to as a processing liquid. A batch processing tank for holding a chemical solution is referred to as batch chemical solution processing tanks CHB**2** to CHB**6**, and a batch processing tank for holding pure water is referred to as batch rinse processing tank ONB.

[0166] Specifically, the second batch processing unit BPU**2** includes a batch chemical solution processing tank CHB**2** that collectively performs chemical solution processing on the batch lot BL, and a lifter LF**2** that raises and lowers the batch lot BL between the substrate transfer position and the chemical solution processing position (see FIG. **2**). The substrate transfer position is a position set above the batch chemical solution processing tank CHB**2** accessible by the advance/retract conveyance mechanism WTR, and the chemical solution processing position is a position set in the tank of the batch chemical solution processing tank CHB**2** capable of immersing the batch lot BL in the chemical solution. The batch chemical solution processing tank CHB**2** performs acid processing on the batch lot BL. The acid processing may be a phosphoric acid processing, but may be a processing using another acid. In the phosphoric acid processing, etching processing is performed on a plurality of substrates W constituting the batch lot BL. In the etching processing, for example, the nitride film on the front surface of the substrate W is chemically etched.

[0167] The lifter LF**2** can hold the batch lot BL including the substrates W arranged at a 10/3 mm pitch. Like the lifter LF**2**, lifters provided in other processing tanks can also hold the batch lot BL. The batch drying chamber DC can house the batch lot BL.

[0168] The batch chemical solution processing tank CHB**2** houses an acid solution such as a phosphoric acid solution. The batch chemical solution processing tank CHB**2** is provided with a lifter LF**2** for moving the batch lot BL up and down. The lifter LF**2** moves up and down in the vertical direction (Z direction). Specifically, the lifter LF**2** moves up and down between a processing position corresponding to the inside of the batch chemical solution processing tank

CHB**2** and a delivery position corresponding to the upper side of the batch chemical solution processing tank CHB**2**. The lifter LF**2** holds the batch lot BL including the substrate W in a vertical posture. The lifter LF**2** delivers the batch lot BL to and from the advance/retract conveyance mechanism WTR at the delivery position. When the lifter LF**2** descends from the delivery position to the processing position in a state of holding the batch lot BL, the entire region of the substrate W is located below the liquid level of the chemical solution. When the lifter LF**2** rises from the processing position to the delivery position in a state of holding the batch lot BL, the entire region of the substrate W is located on the liquid level of the chemical solution. The lifter LF**2** can collectively immerse the batch lot BL in the batch processing tank. At this time, the lifter LF**2** descends from the delivery position to the processing position.

[0169] Specifically, the third batch processing unit BPU**3** includes a batch chemical solution processing tank CHB**3** and a lifter LF**3** that raises and lowers the batch lot BL between the substrate transfer position and the chemical solution processing position. The batch chemical solution processing tank CHB**3** has the same configuration as the batch chemical solution processing tank CHB**2** described above. That is, the batch chemical solution processing tank CHB**3** houses the chemical solution described above, and is provided with the lifter LF**3**. The batch chemical solution processing tank CHB**3** performs the same processing as the batch chemical solution processing tank CHB**2** on the batch lot BL. The substrate processing apparatus **1** of the present example includes a plurality of processing tanks capable of performing the same chemical solution processing. This is because the phosphoric acid processing takes more time than other processing. The phosphoric acid processing requires a long time (for example, **60** minutes). Therefore, in the apparatus of the present example, the acid processing can be concurrently performed by a plurality of batch chemical solution processing tanks.

[0170] The fourth batch processing unit BPU**4** to the sixth batch processing unit BPU**6** have the same configuration as the second batch processing unit BPU**2** and the third batch processing unit BPU**3**. That is, the fourth batch processing unit BPU**4** includes the batch chemical solution processing tank CHB**4** and the lifter LF**4** that raises and lowers the batch lot BL between the substrate transfer position and the chemical solution processing position. Similarly, the fifth batch processing unit BPU**5** includes a batch chemical solution processing tank CHB**5** and a lifter LF**5** that raises and lowers the batch lot BL between the substrate transfer position and the chemical solution processing position. The sixth batch processing unit BPU**6** includes a batch chemical solution processing tank CHB**6** and a lifter LF**6** that raises and lowers the batch lot BL between the substrate transfer position and the chemical solution processing position. Therefore, the batch lot BL is acid-processed in any one of the batch chemical solution processing tank CHB**2** to the batch chemical solution processing tank CHB**6**. When the chemical solution processing is concurrently performed by the five processing units in this manner, the throughput of the apparatus is increased.

[0171] Specifically, the first batch processing unit BPU**1** includes a batch rinse processing tank ONB that houses a rinse solution, and a lifter LF**1** that raises and lowers the batch lot BL between the substrate transfer position and the rinse position. The substrate transfer position is a position set above the batch rinse processing tank ONB accessible by the advance/retract conveyance mechanism WTR, and the rinse position is a position set in a tank of the batch rinse processing tank ONB capable of immersing the batch lot BL in the rinse solution. The batch rinse processing tank ONB has the same configuration as the batch chemical solution processing tank CHB**2** described above. That is, the batch rinse processing tank ONB houses the rinse solution and is provided with the lifter LF**1**. Unlike other processing tanks, the batch rinse processing tank ONB houses pure water, and is provided for the purpose of cleaning the chemical solution attached to the plurality of substrates W. In the batch rinse processing tank ONB, when the specific resistance of the pure water in the tank increases to a predetermined value, the cleaning processing ends.

[0172] As described above, the batch rinse processing tank ONB in the present embodiment is located closer to the transfer block **5** than the batch chemical solution processing tanks CHB**2** to CHB**6**. With this configuration, the mechanisms constituting the transfer block **5** and the batch chemical solution processing tanks CHB**2** to CHB**6** are separated as much as possible, and the pusher mechanism **25** and the like are not adversely affected by an acid such as phosphoric acid. In addition, by arranging the transfer block **5** and the batch drying chamber DC close to each other, the batch lot BL for which the rinse processing has been finished is conveyed by a short distance and immediately returned to the transfer block **5**.

8. Collective Conveyance Region in Processing Block

[0173] The collective conveyance region R**2** in the processing block **6** is a rectangular region extending in the front-back direction (X direction). The collective conveyance region R**2** is provided along the outer edge of the batch processing region R**1**, and has one end side extending to the transfer block **5** and the other end side extending in a direction away from the transfer block **5**.

[0174] The collective conveyance region R**2** is provided with an advance/retract conveyance mechanism WTR that collectively conveys a plurality of substrates W. The advance/retract conveyance mechanism WTR collectively conveys a plurality of substrates W (specifically, batch lots BL) between the substrate transfer position PP defined in the transfer block **5**, the lot support **33**, the batch drying chamber DC, and each of the batch processing units BPU**1** to BPU**6**. The advance/retract conveyance mechanism WTR is configured to be able to reciprocate in the front-back direction (X direction) across the transfer block **5** and the processing block **6**. The advance/retract conveyance mechanism WTR can also enter the substrate transfer position PP and the lot support **33** in the transfer block **5** in addition to the collective conveyance region R**2** in the processing block **6**.

[0175] The advance/retract conveyance mechanism WTR includes a pair of chucks **29** for conveying the batch lot BL. The pair of chucks **29** can be changed to a closed state in which they are close to each other and an open state in which they are separated from each other. The chuck **29** is a member extending in the Y direction in which grooves for gripping the substrate W are arranged at a pitch of 10/3 mm. The pair of chucks **29** is closed to receive the plurality of substrates W constituting the batch lot BL. Then, the pair of chucks **29** is opened to transfer the plurality of substrates W constituting the batch lot BL to another member (the lifter

LF**1** or the like). The advance/retract conveyance mechanism WTR transfers the batch lot BL between the substrate transfer position PP in the transfer block **5** and the lot support **33**. In addition, the advance/retract conveyance mechanism WTR transfers the batch lot BL to and from each of the lifters LF**1** to LF**6** belonging to the batch processing units BPU**1** to BPU**6** in the processing block **6** and the batch drying chamber DC.

[0176] In the collective conveyance region R**2**, a guide rail **31** extending in the X direction for guiding the advance/retract conveyance mechanism WTR is provided. The advance/retract conveyance mechanism WTR can advance and retract in the X direction along the guide rail **31**. Therefore, the guide rail **31** extends from the processing block **6** to the transfer block **5**. More specifically, the guide rail **31** faces the substrate transfer position PP in the transfer block **5** from the Y direction, and faces the sixth batch processing unit BPU**6** in the processing block **6** from the Y direction. Besides, the guide rail **31** faces the lot support **33** in the transfer block **5**, the batch drying chamber DC in the processing block **6**, and the first batch processing unit BPU**1** to the sixth batch processing unit BPU**6** from the Y direction.

9. Other Configurations in Processing Block

[0177] The batch drying chamber DC is disposed at a position sandwiched between the first batch processing unit BPU**1** and the transfer block **5**. The batch drying chamber DC has a drying chamber that accommodates the batch lot BL in which the substrates W in the vertical posture are arranged. The drying chamber includes an inert gas supply nozzle that supplies an inert gas into the chamber, and a vapor supply nozzle that supplies vapor of an organic solvent into the tank. The batch drying chamber DC first supplies an inert gas to the batch lot BL supported in the chamber to replace the atmosphere in the chamber with the inert gas. Then, pressure reduction in the chamber is started. In a state where the inside of the chamber is depressurized, vapor of the organic solvent is supplied into the chamber. The organic solvent is discharged to the outside of the chamber together with moisture adhering to the substrate W. In this way, the batch drying chamber DC performs the drying of the batch lot BL. The inert gas at this time may be, for example, nitrogen, and the organic solvent may be, for example, isopropyl alcohol (IPA).

[0178] The carrier placement shelf **13***a*, the batch drying chamber DC, and the batch processing units BPU**1** to BPU**6** in the substrate processing apparatus **1** are arranged in the front-back direction. That is, the carrier placement shelf **13***a* is arranged in front, and the batch drying chamber DC is arranged behind the carrier placement shelf **13***a*. The batch processing units BPU**1** to BPU**6** are disposed further behind the batch processing units BPU**1** to BPU**6**. In the substrate processing apparatus **1** of the present embodiment, the layout in the apparatus is optimized so that the moving distance of the advance/retract conveyance mechanism WTR decreases.

10. Controller

[0179] FIG. **1** can be referred to for the controller **131** included in the substrate processing apparatus **1**. Although not illustrated in FIG. **1**, the controller **131** is provided with a corresponding storage unit. The controller **131** includes, for example, a central processing unit (CPU). A specific configuration of the controller is not limited, and for example, each controller may be configured by a single processor, or each controller may be configured by an individual processor.

[0180] Examples of the control related to the controller **131** include control related to the carrier conveyance mechanism **11**, the handling robot HTR, the HVC posture converter **23**, the pusher mechanism **25**, the advance/retract conveyance mechanism WTR, the batch processing units BPU**1** to BPU**6**, and the batch drying chamber DC. The storage unit houses programs, parameters, and the like related to control. The storage unit may be configured by a single device or may be configured by individual devices corresponding to the respective controllers. In addition, the substrate processing system of the present embodiment has no particular limitation on the configuration of the device that realizes the storage unit.

11. Flow of Substrate Processing

[0181] Hereinafter, the flow of the substrate processing of the present example will be described with reference to the flowcharts of FIGS. **13** and **14**.

[0182] Step S**10**: Every other initial substrate W**0** is extracted by the handling robot HTR from the first carrier C**1**. The extracted initial substrate W**0** is arranged at a pitch of 20 mm. The posture of the initial substrate W**0** is converted from a horizontal posture to a vertical posture. The initial substrate W**0** in the vertical posture is acquired by the pusher **251**. The first carrier C**1** corresponds to the first carrier of the present invention.

[0183] Step S**11**: The remaining first substrate W**1** is extracted from the first carrier C**1** by the handling robot HTR. The first substrate W**1** is also arranged at a pitch of 20 mm. The first substrate W**1** is acquired by the HVC posture converter **23**.

[0184] Step S**12**: A half rotation of the pusher **251** holding the initial substrate group in the vertical posture is executed. As a result, the initial substrate group faces one direction.

[0185] Step S**13**: In the pusher **251**, a batch assembly of the initial substrate W**0** and the first substrate W**1** is performed. The first substrate W**1** is positioned at the first position P**1** of the pusher **251** by combining the first arrangement in which the first substrate W**1** oriented in the opposite direction to one direction are arranged at an interval of 20 mm with the initial substrate group. As a result, the initial substrate W**0** and the first substrate W**1** are arranged at an interval of 10/3 mm in a state where the device surfaces face each other. Step S**13** corresponds to the first assembly process of the present invention.

[0186] Step S**14**: Every other second substrate W**2** is extracted from the second carrier C**2** by the handling robot HTR. The extracted second substrate W**2** is arranged at a pitch of 20 mm. The second substrate W**2** is acquired by the HVC posture converter **23**. The second carrier C**2** corresponds to the second carrier of the present invention. Step S**15**: A half rotation of the pusher **251** holding the initial substrate W**0** and the first substrate W**1** is executed.

[0187] Step S**16**: In the pusher **251**, a batch assembly of the substrate array including the initial substrate W**0** and the first substrate W**1** and the second substrate W**2** is performed. The second substrate W**2** is positioned at the second position P**2** of the pusher **251** by combining the second arrangement in which the second substrate W**2** oriented in one direction at an interval of 20 mm with the substrate array in the pusher

251. As a result, the first substrate W**1** and the second substrate W**2** are arranged at an interval of 10/3 mm in a state where the back surfaces face each other. Step S**16** corresponds to the second assembly process of the present invention.

[0188] Step S**17**: The remaining third substrate W**3** is extracted from the second carrier C**2** by the handling robot HTR. The third substrate W**3** is arranged at a pitch of 20 mm. The HVC posture converter **23** acquires the third substrate W**3**.

[0189] Step S**18**: A half rotation of the pusher **251** holding the initial substrate W**0**, the first substrate W**1**, and the second substrate **2** is executed.

[0190] Step S**19**: In the pusher **251**, a batch assembly of the substrate array including the initial substrate W**0**, the first substrate W**1**, and the second substrate W**2** and the third substrate W**3** is performed. The third substrate W**3** is positioned at the third position P**3** of the pusher **251** in combination with the third arrangement in which the third substrate W**3** oriented in the opposite direction is arranged at an interval of 20 mm and the substrate array in the pusher **251**. As a result, the second substrate W**2** and the third substrate W**3** are arranged at an interval of 10/3 mm in a state where the device surfaces face each other. Step S**19** corresponds to the third assembly process of the present invention.

[0191] Step S**20**: Every other fourth substrate W**4** is extracted from the third carrier C**3** by the handling robot HTR. The extracted fourth substrate W**4** is arranged at a pitch of 20 mm. The fourth substrate W**4** is acquired by the HVC posture converter **23**. The third carrier C**3** corresponds to the third carrier of the present invention.

[0192] Step S**21**: A half rotation of the pusher **251** holding the initial substrate W**0**, the first substrate W**1**, the second substrate W**2**, and the third substrate W**3** is executed.

[0193] Step S**22**: In the pusher **251**, a batch assembly of the substrate array including the initial substrate W**0**, the first substrate W**1**, the second substrate W**2**, and the third substrate W**3** and the fourth substrate W**4** is performed. The fourth substrate W**4** is positioned at the fourth position P**4** of the pusher **251** by combining the fourth arrangement in which the fourth substrate W**4** oriented in one direction at an interval of 20 mm with the substrate array in the pusher **251**. As a result, the third substrate W**3** and the fourth substrate W**4** are arranged at an interval of 10/3 mm in a state where the back surfaces face each other. Step S**22** corresponds to the fourth assembly process of the present invention.

[0194] Step S**23**: The remaining fifth substrate W**5** is extracted from the third carrier C**3** by the handling robot HTR. The fifth substrate W**5** is arranged at a pitch of 20 mm. The fifth substrate W**5** is acquired by the HVC posture converter **23**.

[0195] Step S**24**: A half rotation of the pusher **251** holding the initial substrate W**0**, the first substrate W**1**, the second substrate W**2**, the third substrate W**3**, and the fourth substrate W**4** is executed.

[0196] Step S**25**: In the pusher **251**, a batch assembly of the substrate array including the initial substrate W**0**, the first substrate W**1**, the second substrate W**2**, the third substrate W**3**, and the fourth substrate W**4** and the fifth substrate W**5** is performed. The fifth substrate W**5** is positioned at the fifth position P**5** of the pusher **251** in combination with the fifth arrangement in which the fifth substrate W**5** oriented in the opposite direction at an interval of 20 mm and the substrate array in the pusher **251**. As a result, the fourth substrate W**4** and the fifth substrate W**5** are arranged at an interval of 10/3 mm in a state where the device surfaces face each other. Step S**25** corresponds to the fifth assembly process of the present invention.

[0197] Step S**31**: The generated batch lot BL is conveyed from the transfer block **5** to the processing block **6** by the advance/retract conveyance mechanism WTR.

[0198] Step S**32**: The batch lot BL is subjected to a chemical solution processing. Step S**32** corresponds to a processing process of the present invention.

[0199] Step S**33**: The batch lot BL is subjected to a rinse processing. Step S**33** corresponds to a processing process of the present invention.

[0200] Step S**34**: The batch lot BL is subjected to a drying processing.

[0201] In this way, the substrate processing is realized in batch lot units.

[0202] FIG. **14** illustrates a flowchart when the batch lot BL for which the substrate processing has been completed is returned to the carrier C. The returning operation of the substrate W is basically obtained by reversing the above-described method over time.

[0203] Step S**41**: The batch lot BL subjected to the substrate processing is conveyed from the processing block **6** to the transfer block **5** by the advance/retract conveyance mechanism WTR.

[0204] Step S**42**: The pusher **251** is half-rotated after acquiring the batch lot BL. With this operation, the fifth substrate W**5** that has been oriented in the opposite direction is oriented in one direction.

[0205] Step S**43**: The HVC posture converter **23** receives the fifth substrate W**5** from the batch lot BL in the pusher **251**, and disassembles the batch lot BL.

[0206] Step S**44**: After the posture of the fifth substrate W**5** is converted by the HVC posture converter **23**, the fifth substrate W**5** is returned to the third carrier C**3** by the handling robot HTR.

[0207] Step S**45**: The pusher **251** is half-rotated. With this operation, the fourth substrate W**4** that has been oriented in the opposite direction is oriented in one direction.

[0208] Step S**46**: The HVC posture converter **23** receives the fourth substrate W**4** from the batch lot BL in the pusher **251**, and disassembles the batch lot BL.

[0209] Step S**47**: After the posture of the fourth substrate W**4** is converted by the HVC posture converter **23**, the fourth substrate W**4** is returned to the third carrier C**3** by the handling robot HTR.

[0210] Step S**48**: The pusher **251** is half-rotated. With this operation, the third substrate W**3** that has been oriented in the opposite direction is oriented in one direction.

[0211] Step S**49**: The HVC posture converter **23** receives the third substrate W**3** from the batch lot BL in the pusher **251**, and disassembles the batch lot BL.

[0212] Step S**50**: After the posture of the third substrate W**3** is converted by the HVC posture converter **23**, the third substrate W**3** is returned to the second carrier C**2** by the handling robot HTR.

[0213] Step S**51**: The pusher **251** is half-rotated. By this operation, the second substrate W**2** that has been oriented in the opposite direction is oriented in one direction.

[0214] Step S**52**: The HVC posture converter **23** receives the second substrate W**2** from the batch lot BL in the pusher **251**, and disassembles the batch lot BL.

[0215] Step S**53**: After the posture of the second substrate W**2** is changed by the HVC posture converter **23**, the second substrate W**2** is returned to the second carrier C**2** by the handling robot HTR.

[0216] Step S**54**: The pusher **251** is half-rotated. By this operation, the first substrate W**1** that has been oriented in the opposite direction is oriented in one direction.

[0217] Step S**55**: The HVC posture converter **23** receives the first substrate W**1** from the batch lot BL in the pusher **251**, and disassembles the batch lot BL.

[0218] Step S**56**: After the posture of the first substrate W**1** is converted by the HVC posture converter **23**, the first substrate W**1** is returned to the first carrier C**1** by the handling robot HTR.

[0219] Step S**57**: The pusher **251** is half-rotated. By this operation, the initial substrate W**0** that has been oriented in the opposite direction is oriented in one direction.

[0220] Step S**58**: The HVC posture converter **23** receives the initial substrate W**0** from the batch lot BL in the pusher **251**. The initial substrate W**0** is returned to the first carrier C**1** by the handling robot HTR after being posture-converted by the HVC posture converter **23**.

12. Effects of Present Example

[0221] As described above, according to the configuration of the present example, the arrangement pitch of the substrate group is narrowed by acquiring the substrate group arranged at a wide arrangement pitch and inserting the substrates W of the first arrangement, the second arrangement, the third arrangement, the fourth arrangement, and the fifth arrangement into the gap of the substrate groups. With this configuration, since the opposing relationship between the substrate group and the substrate to be inserted can be freely changed, a new batch lot BL can be generated by combining the substrate group oriented in one direction, the first arrangement including the first substrate W**1** oriented in the opposite direction, the second arrangement including the second substrate W**2** oriented in one direction, the third arrangement including the third substrate W**3** oriented in the opposite direction, the fourth arrangement including the fourth substrate W**4** oriented in one direction, and the fifth arrangement including the fifth substrate W**5** oriented in the opposite direction. Therefore, the arrangement pitch of the substrates W can be narrowed, and the arrangement direction of the substrates W can be made desired.

[0222] According to the configuration of the present example, the front surface of the first substrate W**1** in step S**13** is opposed to the front surface of the initial substrate group, the back surface of the second substrate W**2** in step S**16** is opposed to the back surface of the first substrate W**1**, the front surface of the third substrate W**3** in step S**18** is opposed to the front surface of the second substrate W**2**, the back surface of the fourth substrate W**4** in step S**22** is opposed to the back surface of the third substrate W**3**, the front surface of the fifth substrate W**5** in step S**25** is opposed to the front surface of the fourth substrate W**4**, and the back surface of the fifth substrate W**5** is opposed to the back surface of the initial substrate group. According to the present example, it is possible to generate the batch lot BL in which the front surface and the back surface are arranged in this manner.

[0223] According to the configuration of the present example, step S**13** is performed after half-rotating the first arrangement in which the first substrate oriented in one direction is arranged at a predetermined interval, step S**18** is performed after half-rotating the third arrangement in which the third substrate oriented in one direction is arranged at a predetermined interval, and step S**25** is performed after half-rotating the fifth arrangement in which the fifth substrate oriented in one direction is arranged a predetermined interval. In this way, the generation of the batch lot BL row can be completed by receiving the substrate group arranged in one direction from the carrier C.

[0224] According to the configuration of the present example, a first process of collectively acquiring the substrates W from the carrier C housing the substrates W in which the substrates in the horizontal posture are arranged in the vertical direction, and a second process of collectively converting the posture of the substrates W from the horizontal posture to the vertical posture are performed before each assembly process. With this configuration, the generation of the batch lot BL can be completed by receiving the substrate group arranged in one direction from the carrier C.

[0225] According to the configuration of the present example, the distance from the first position P**1** to the second position P**2** is ⅓ of the specific pitch of 10 mm in the carrier C. With this configuration, the pitch of the substrate arrangement to be generated can be ½ or less of the arrangement pitch of the substrates W housed in the carrier C.

[0226] According to the configuration of the present example, steps related to the batch assembly is performed in the order of step S**13** related to the first substrate W**1**, step S**16** related to the second substrate W**2**, step S**18** related to the third substrate W**3**, step S**22** related to the fourth substrate W**4**, and step S**25** related to the fifth substrate W**5**. With this configuration, it is easy to generate the batch lot BL.

[0227] According to the configuration of the present example, the initial substrate group is acquired from the first carrier C, the first arrangement is acquired from the first carrier C, the second arrangement is acquired from the second carrier C, the third arrangement is acquired from the second carrier C, the fourth arrangement is acquired from the third carrier C, and the fifth arrangement is acquired from the third carrier C. With this configuration, the batch lot BL can be easily generated from the plurality of carriers C.

[0228] According to the configuration of the present example, the predetermined interval, 20 mm, is equally divided into six by the first position P**1**, the second position P**2**, the third position P**3**, the fourth position P**4**, and the fifth position P**5**. With this configuration, it is possible to generate the batch lot BL in which the substrates W are arranged more orderly.

[0229] According to the configuration of the present example, every other substrate W is extracted from the first carrier C**1** to generate the initial substrate group. With this configuration, it is easy to generate the initial substrate group.

13. Modified Example

[0230] The present invention is not limited to the configuration of the above-described embodiment, and modifications can be made as follows.

Modification 1

[0231] According to the above configuration, the batch assembly is performed in the order of the first substrate W**1**, the second substrate W**2**, the third substrate W**3**, the fourth substrate W**4**, and the fifth substrate W**5**, but this order can be arbitrary. In particular, if the order is changed so that the batch assembly is correctively performed for the first substrate W**1**, the third substrate W**3**, and the fifth substrate W**5**, the half-rotating operation of the pusher **251** can be partially omitted.

Modification 2

[0232] The handling robot HTR having the above-described configuration is configured to acquire only about half of the number of substrates W in the carrier C at one time, but the present invention is not limited to this configuration. As shown in FIG. **15**, the present invention can also be applied to a substrate processing apparatus having a handling robot HTR in which hands **211** are arranged at a pitch of 10 mm.

[0233] Hereinafter, a method of conveying the substrate W in the present modification will be described. FIG. **16**A compares the arrangement pitch of the substrates in each configuration. In the carrier C, the placement plates **7** constituting the slots S are arranged at a pitch of 10 mm.

[0234] On the other hand, the HVC posture converter **23** can hold only about half, that is, 13 substrates W out of 25 substrates housed in the carrier C at one time. This is because the flat plates **233** of the placing rod **231** are arranged at a pitch of 20 mm. This is also because the clamping plates **234** of the clamping rods **232** are arranged at a pitch of 20 mm.

[0235] The handling robot HTR of the present modification can hold 25 substrates W housed in the carrier C at one time. This is because the hands **211** in the handling robot HTR are arranged at a pitch of 10 mm.

[0236] According to the present modification, although the handling robot HTR can hold 25 substrates housed in the carrier C at a time, the handling robot HTR cannot transfer the held substrates W to the HVC posture converter **23** at one time. Therefore, the handling robot HTR of the present modification has a configuration in which about half of the substrates W housed in the carrier C is transferred to the HVC posture converter **23**, and the remaining half is temporarily held. The remaining substrates W held by the handling robot HTR is transferred to the HVC posture converter **23** at another coming opportunity.

[0237] FIG. **16**B schematically illustrates a state in which 25 substrates W are arranged on the carrier C. In the carrier C, 25 substrates W are arranged at a pitch of 10 mm.

[0238] FIG. **16**C illustrates a state in which the handling robot HTR extracts all of the substrates W housed in the carrier C from the carrier C. The handling robot HTR has hands **211** arranged in the vertical direction at a pitch of 10 mm. Therefore, the handling robot HTR can grip all of the substrates W in the carrier C**1** at one time.

[0239] FIG. **16**D illustrates a state when about half of the substrates W gripped by the handling robot HTR is transferred to the HVC posture converter **23**. The handling robot HTR causes the hands **211** to enter between the pair of placing rods **231** in the HVC posture converter **23**. Then, the placing rod **231** supports a part of the substrates W conveyed by the flat plate **233**. Specifically, the placing rod **231** selectively supports the substrates W conveyed by the handling robot HTR such that the substrates W to be supported and the substrates W not to be supported are alternately arranged. The substrates W to be supported are arranged at a pitch of 20 mm. The substrates W not to be supported are also arranged at a pitch of 20 mm. The substrates W to be supported and the substrates W not to be supported adjacent to each other are separated by 10 mm.

[0240] The handling robot HTR partially releases the gripping of the substrates W. That is, the gripping of the substrates W by the handling robot HTR is released with respect to the substrates W to be supported on the placing rod **231**. In this way, the substrates W arranged at a pitch of 20 mm are transferred from the handling robot HTR to the HVC posture converter **23**.

[0241] On the other hand, the gripping of the substrate W by the handling robot HTR is not released with respect to the substrate W not to be supported on the placing rod **321**.

[0242] FIG. **16**D illustrates a state in which the handling robot HTR then retracts the hands **211** from the HVC posture converter **23**. Such a measure is performed to ensure that the hands **211** does not hinder the upright positioning of the substrates W during the upcoming posture conversion of the substrates W. The handling robot HTR retracts the hands **211** from the HVC posture converter **23** while gripping the substrates W not to be supported. On the other hand, the substrate W to be supported is left behind in the HVC posture converter **23** by the movement of the hands **211**. Among them, since the substrates W transferred to the HVC posture converter **23** are arranged at a pitch of 20 mm, it can be handled equivalently to the substrates W supported by the HVC posture converter **23** described with reference to FIGS. **11**A to **11**P. That is, the same operation as the batch assembly described in the embodiment can be performed using these substrates W.

[0243] In FIG. **16**D, the substrate W not to be supported left behind in the handling robot HTR is transferred to the HVC posture converter **23** at another opportunity when the substrate W comes.

[0244] FIG. **16**E illustrates a state in which the HVC posture converter **23** in the state of FIG. **16**D has finished transferring the substrates W to the pusher **251**. Since all of the flat plates **233** of the placing rod **231** are in an empty state not supporting the substrates W, it is possible to receive the substrates W left behind in the handling robot HTR at present.

[0245] FIG. **16**F illustrates a state when the remaining substrate W gripped by the handling robot HTR is transferred to the HVC posture converter **23**. The handling robot HTR causes the hands **211** to enter between the pair of placing rods **231** in the HVC posture converter **23**. The remaining substrates W are arranged at a pitch of 20 mm in the handling robot HTR, and the flat plates **233** are arranged at a pitch of 20 mm in the placing rod **231**. Therefore, the handling robot HTR can transfer all of the remaining substrates W to the HVC posture converter **23**. Since the substrates W transferred to the HVC posture converter **23** are arranged at a pitch of 20 mm, it can be handled equivalently to the substrates W supported by the HVC posture converter **23** described with reference to FIGS. **11**A to **11**P. That is, the same operation as the batch assembly described in the embodiment can be performed using these substrates W.

[0246] At the time of the second transfer of the substrates W described with reference to FIG. **16**E, the hands **211** is moved to a position higher by 10 mm than the height at the time of the first transfer of the substrates W described with reference to FIG. **16**D. Then, the hands **211** horizontally moves from the place and enters the HVC posture converter **23**. In this way, when the substrate W is transferred, the transfer of the substrate W can be reliably performed without the standby placing rod **231** holding an empty space.

[0247] As described above, according to the present modification, in the process of once extracting all the substrates W from the carrier C and converting the substrates from the horizontal posture to the vertical posture, every other substrate is extracted. In this way, the substrates W to be supported in which the substrates W arranged at a pitch of 10 mm are arranged at a pitch of 20 mm and the substrates W not to be supported in which the substrates W are arranged at a pitch of 20 mm are separated. Incidentally, the initial substrate W**0**, the second substrate W**2**, and the fourth substrate W**4** are the substrates W to be supported, and the first substrate W**1**, the third substrate W**3**, and the fifth substrate W**5** are the substrates W not to be supported. With such a configuration, each substrate can be reliably produced.

What is claimed is:

1. A substrate processing method for collectively processing a plurality of substrates, the substrate processing method comprising:
- a substrate group generation process of extracting a plurality of substrates from a carrier in which substrates defined on a front surface and a back surface are arranged at a specific pitch, and generating a substrate group in which the substrates are arranged in one direction at a pitch twice the specific pitch; and
- a processing process of immersing a batch lot in a processing liquid after generating the batch lot by performing, in an arbitrary order, each of assembly processes including
- a first assembly process of positioning a first substrate at a first position among the first position, a second position, a third position, a fourth position, and a fifth position that divide the predetermined interval in the substrate group into six by combining a first arrangement in which the first substrate oriented in an opposite direction to the one direction is arranged at a predetermined interval that is twice the specific pitch with the substrate group,
- a second assembly process of positioning a second substrate at the second position by combining a second arrangement in which the second substrate oriented in the one direction is arranged at the predetermined interval with the substrate group,
- a third assembly process of positioning a third substrate at the third position by combining a third arrangement in which the third substrate oriented in the opposite direction is arranged at the predetermined interval with the substrate group,
- a fourth assembly process of positioning a fourth substrate at the fourth position by combining a fourth arrangement in which the fourth substrate oriented in the one direction is arranged at the predetermined interval with the substrate group, and
- a fifth assembly process of positioning a fifth substrate at the fifth position by combining a fifth arrangement in which the fifth substrate oriented in the opposite direction is arranged at the predetermined interval with the substrate group.

2. The substrate processing method according to claim **1**, wherein
- a front surface of the first substrate in the first assembly process faces a front surface of the substrate group,
- a back surface of the second substrate in the second assembly process faces a back surface of the first substrate,
- a front surface of the third substrate in the third assembly process faces a front surface of the second substrate,
- a back surface of the fourth substrate in the fourth assembly process faces a back surface of the third substrate, and
- a front surface of the fifth substrate in the fifth assembly process faces a front surface of the fourth substrate, and a back surface of the fifth substrate faces a back surface of the substrate group.

3. The substrate processing method according to claim **1**, wherein
- the first assembly process is performed after half-rotating the first arrangement in which the first substrate oriented in the one direction is arranged at the predetermined interval,
- the third assembly process is performed after half-rotating the third arrangement in which the third substrate oriented in the one direction is arranged at the predetermined interval, and
- the fifth assembly process is performed after half-rotating the fifth arrangement in which the fifth substrate oriented in the one direction is arranged at the predetermined interval.

4. The substrate processing method according to claim **1**, wherein a distance from the first position to the second position is ⅓ of the specific pitch in the carrier.

5. The substrate processing method according to claim **1**, wherein each assembly process is performed in the order of the first assembly process, the second assembly process, the third assembly process, the fourth assembly process, and the fifth assembly process.

6. The substrate processing method according to claim **5**, wherein
- the substrate group is acquired from a first carrier that houses substrates in which substrates in a horizontal posture are arranged in a vertical direction,
- the first arrangement is acquired from the first carrier,
- the second arrangement is acquired from a second carrier that houses substrates in which substrates in the horizontal posture are arranged in the vertical direction,
- the third arrangement is acquired from the second carrier,
- the fourth arrangement is acquired from a third carrier that houses substrates in which substrates in the horizontal posture are arranged in the vertical direction, and
- the fifth arrangement is preferably acquired from the third carrier.

7. The substrate processing method according to claim **1**, wherein the predetermined interval is equally divided into six by the first position, the second position, the third position, the fourth position, and the fifth position.

8. The substrate processing method according to claim **1**, wherein the substrate group generation process extracts every other substrate from the carrier to generate the substrate group.

9. The substrate processing method according to claim **1**, wherein in the substrate group generation process, the substrate group is generated by extracting every other substrate in a process of converting the substrates from a horizontal posture to a vertical posture after extracting all the substrates from the carrier.

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