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(54) **SUBSTRATE PROCESSING APPARATUS**

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B08B 3/04	(2006.01)
H01L 21/677	(2006.01)

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

CPC ***H01L 21/68*** (2013.01); ***B08B 3/04*** (2013.01); ***H01L 21/67718*** (2013.01)

(57) **ABSTRACT**

A substrate processing apparatus including: an attitude changing mechanism configured to change attitudes of the substrates between a horizontal holding attitude and a vertical holding attitude; a pusher mechanism including a pusher member configured to combine a second substrate group and a first substrate group to hold a plurality of the substrates aligned at a narrow interval; a pitch converter configured to receive the plurality of the substrates aligned at the narrow interval and align, at a narrow pitch, the plurality of the substrates aligned; a substrate processor configured to collectively process the plurality of the substrates aligned at the narrow pitch; and a main transport mechanism configured to collectively transport the plurality of the substrates aligned at the narrow pitch to the substrate processor, in which the pitch converter is disposed on the main transport mechanism side of the pusher mechanism.

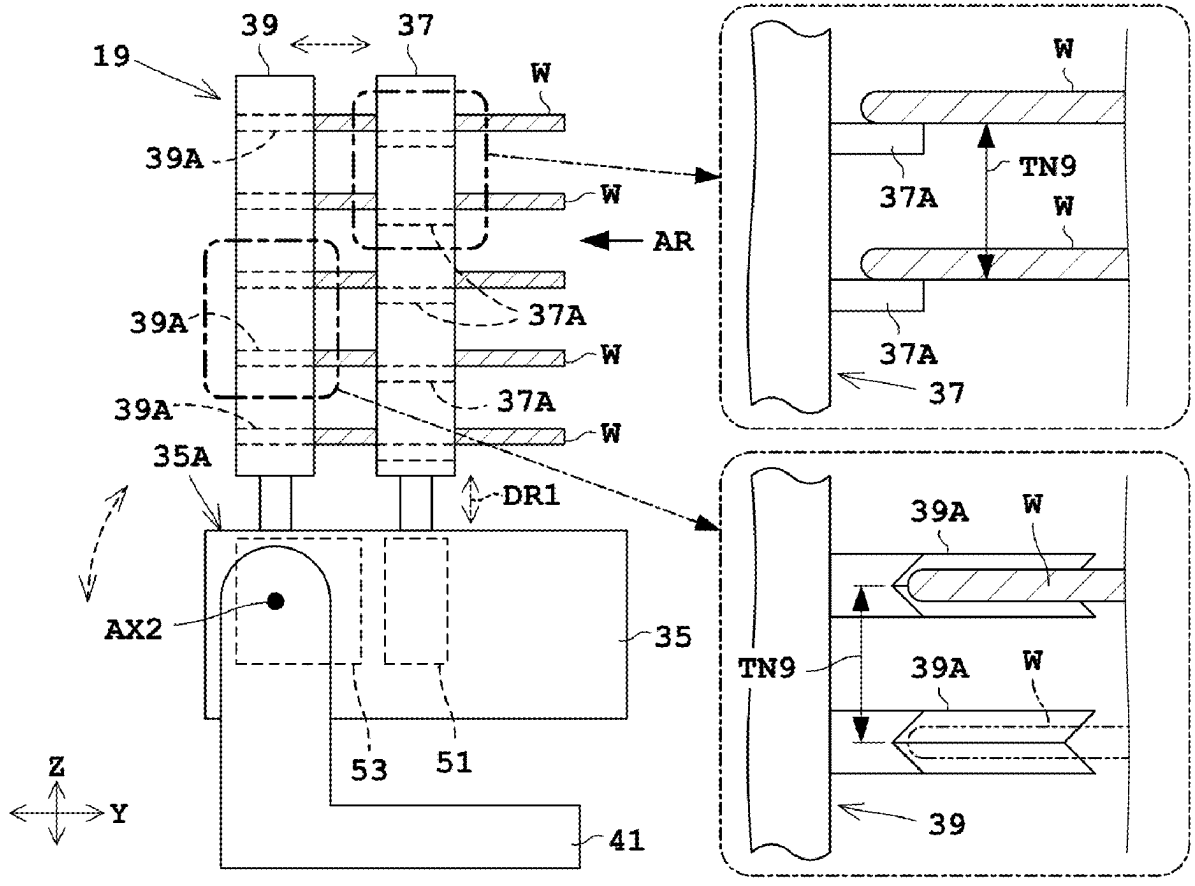


FIG. 1

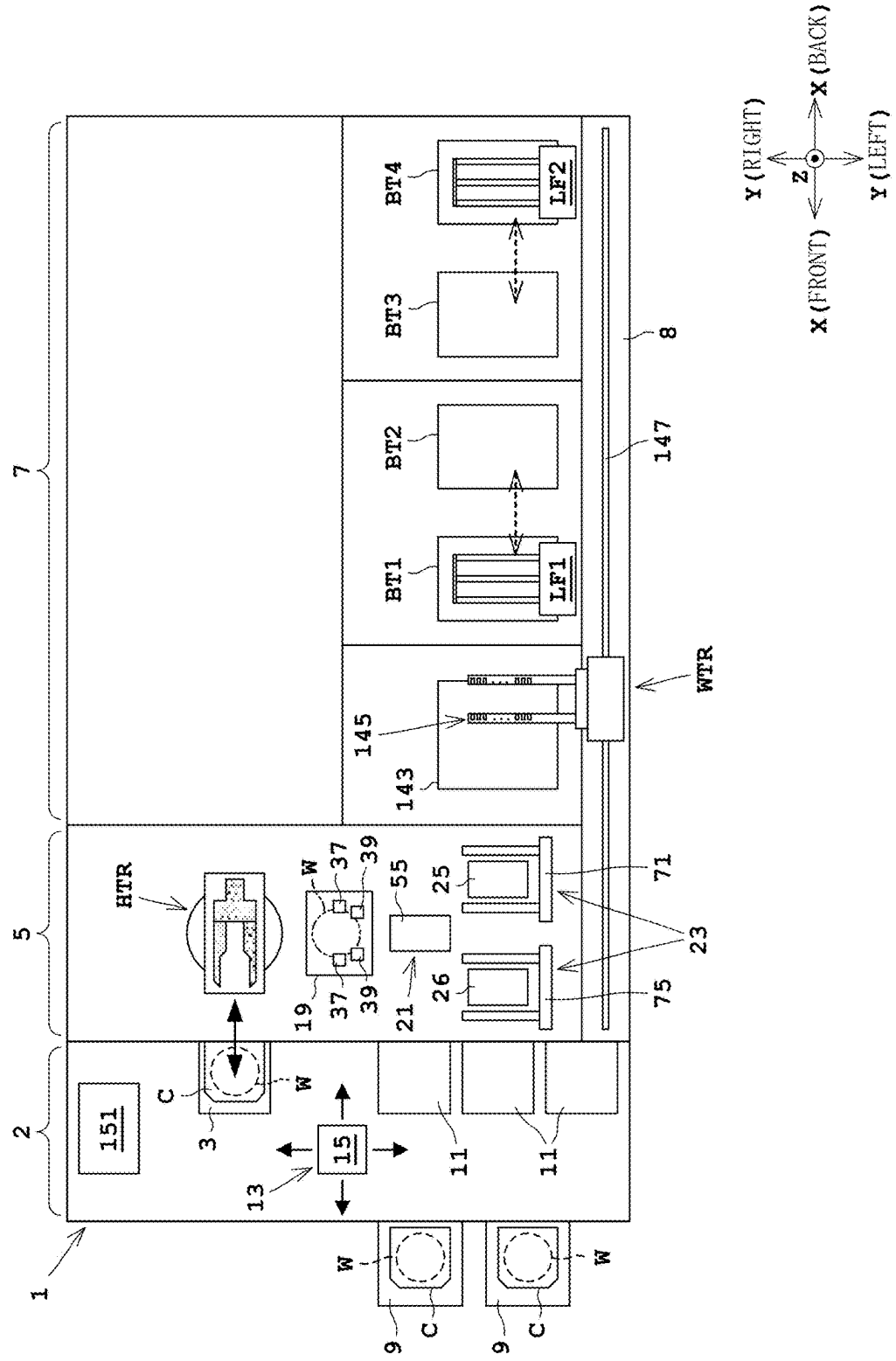

Y (RIGHT)
X (BACK)
Z
X (FRONT)
Y (LEFT)
1
2
3
5
7
8
9
11
13
15
19
21
23
25
26
37
39
55
71
75
143
145
147
151
BT1
BT2
BT3
BT4
LF1
LF2
HTR
WTR
W
C

FIG. 2

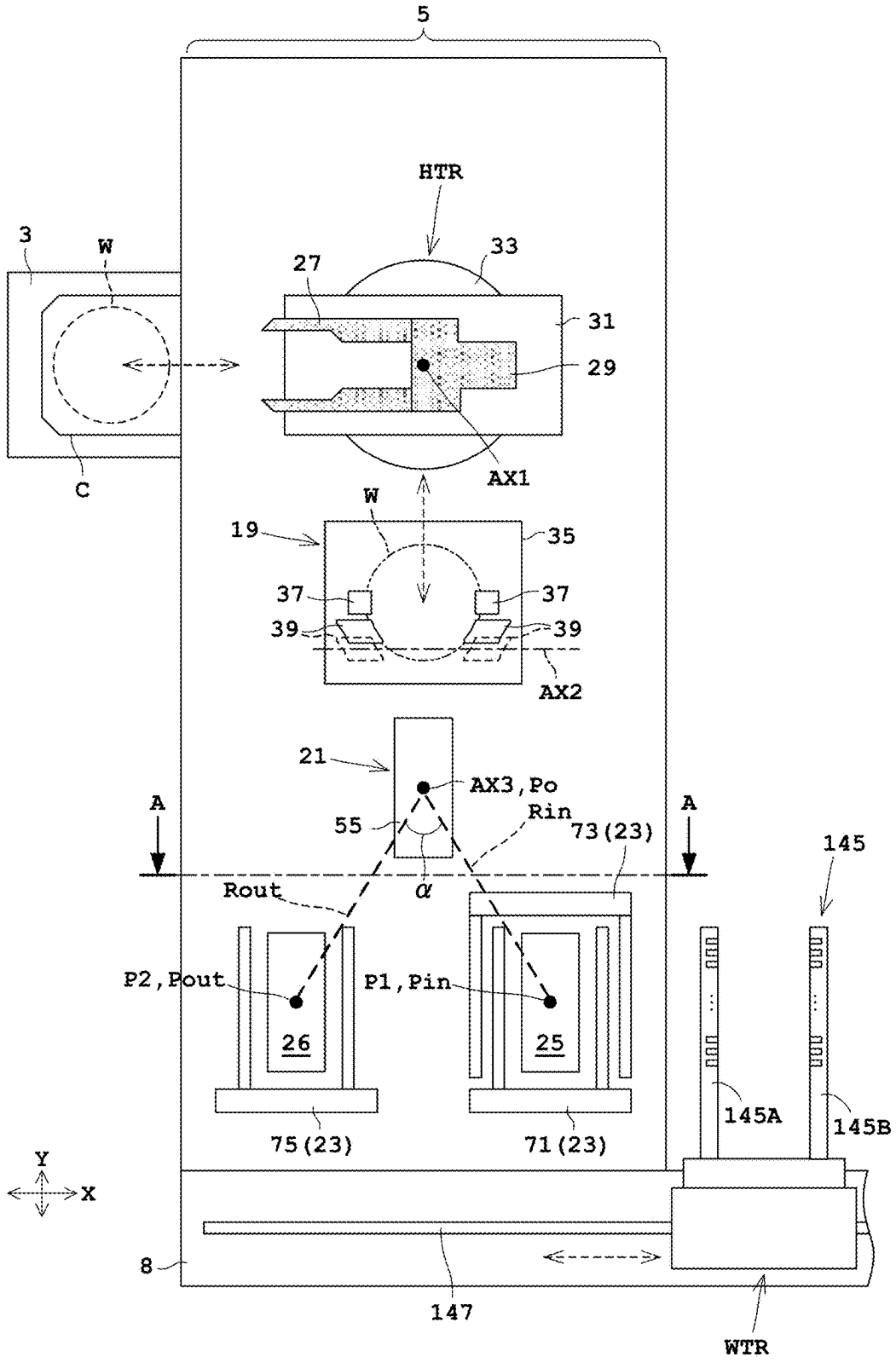

5
HTR
3
W
27
33
31
29
AX1
C
W
19
35
37
37
39
39
AX2
21
AX3, Po
A
55
Rin
73(23)
A
145
Rout
α
P2, Pout
P1, Pin
26
25
145A
145B
75(23)
71(23)
Y
X
8
147
WTR

FIG. 3

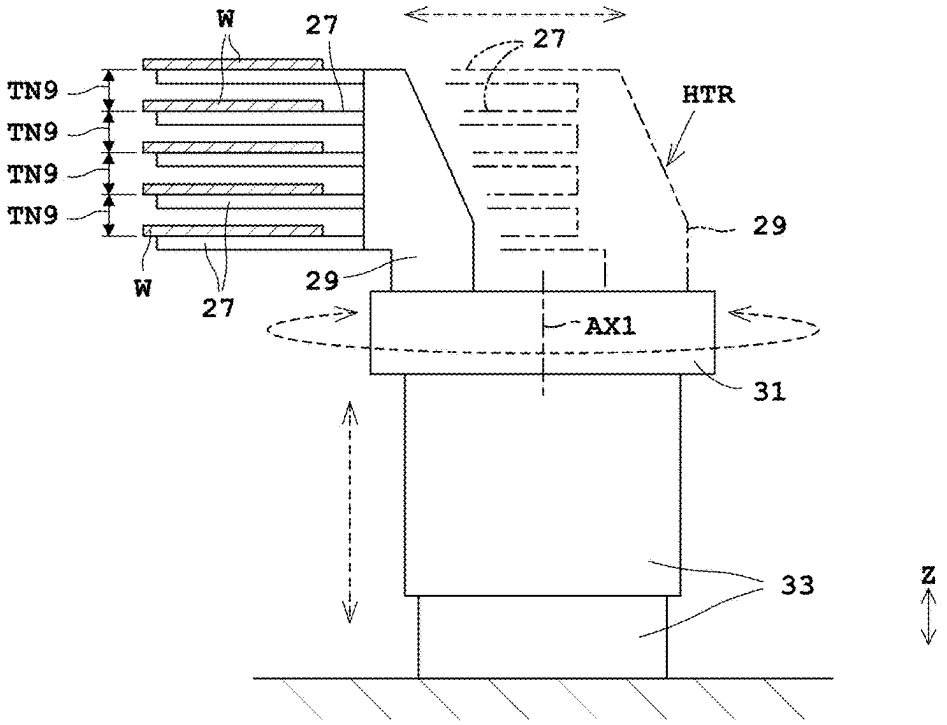

W
27
27
HTR
TN9
TN9
TN9
TN9
29
W
27
29
AX1
31
33
Z

FIG. 4

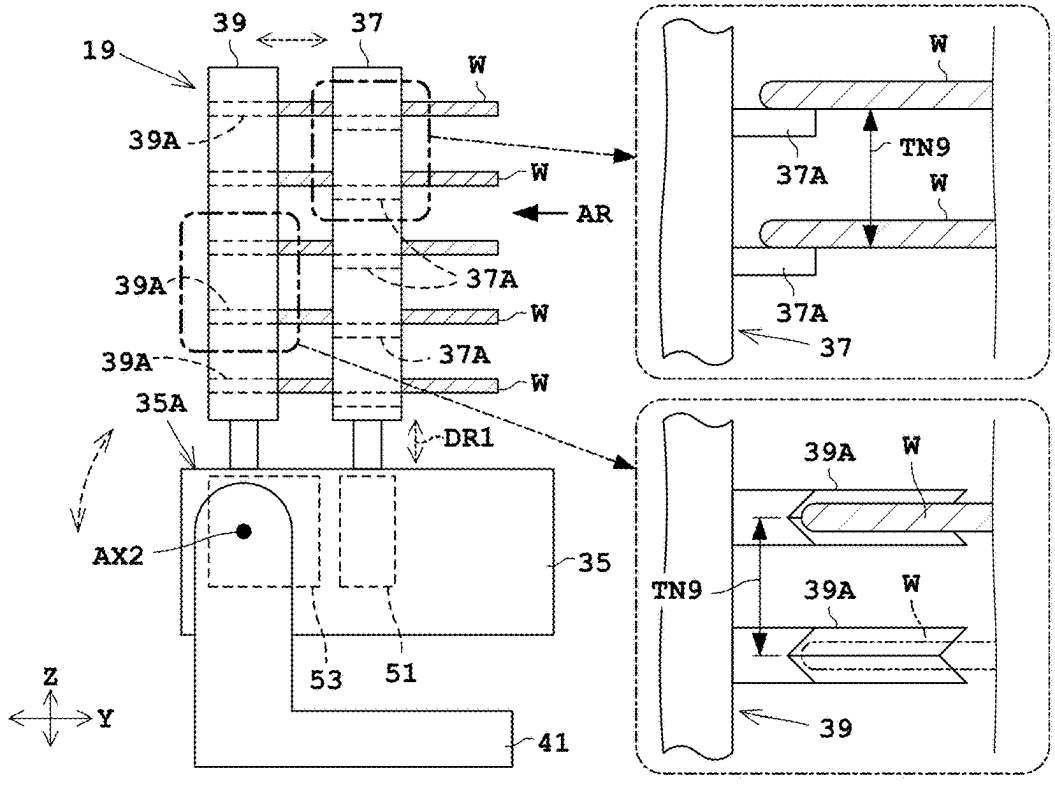

39
37
19
W
39A
W
AR
37A
39A
W
37A
39A
W
35A
DR1
AX2
35
53
51
41
Z
Y
W
TN9
37A
W
37A
37
39A
W
TN9
39A
W
39

FIG. 5

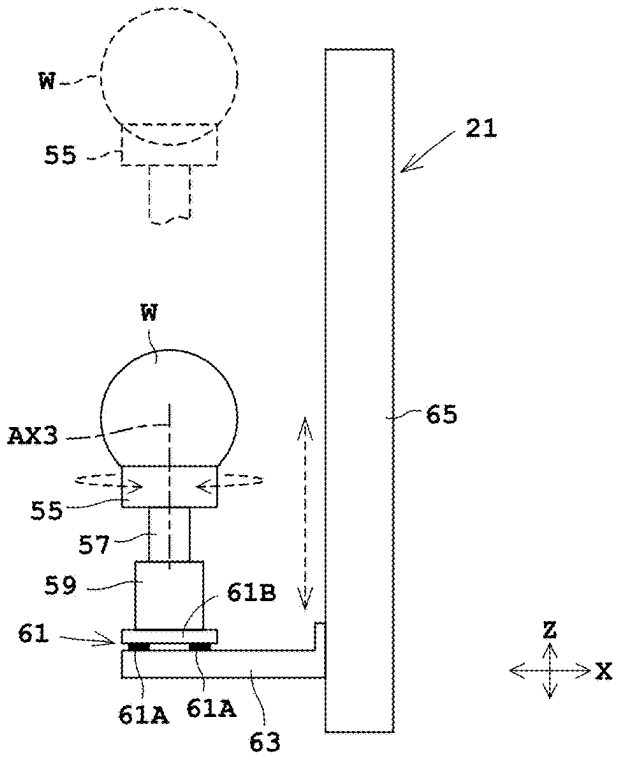

W
55
21
W
AX3
55
57
59
61B
61
65
61A
61A
63
Z
X

FIG. 6

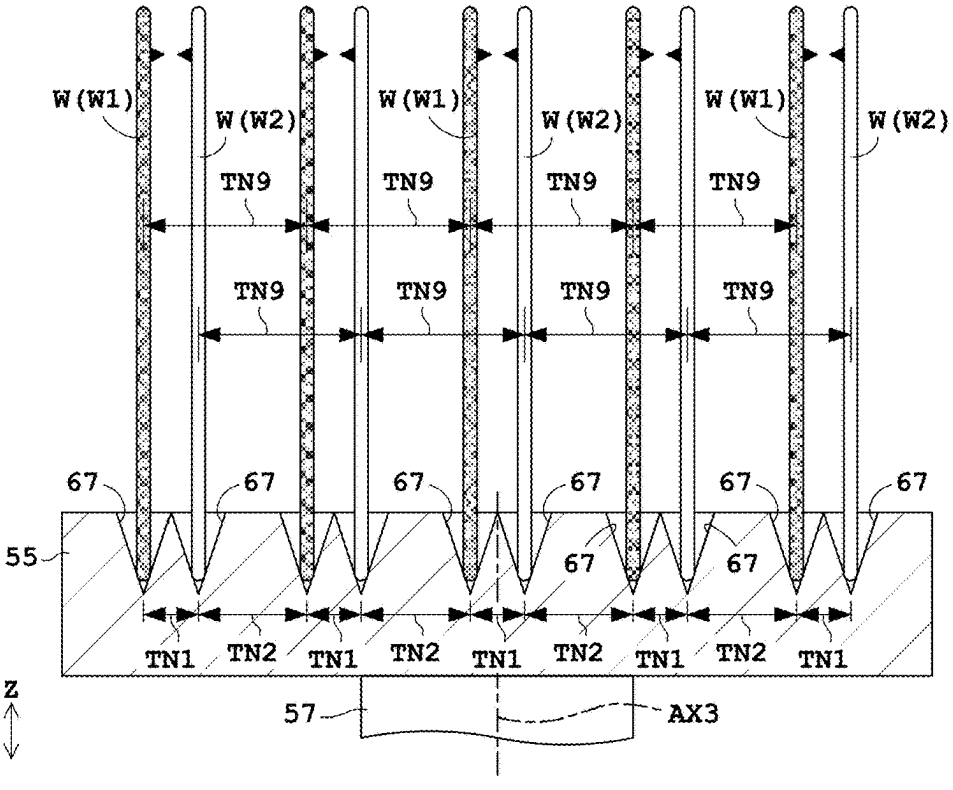

W(W1)
W(W2)
W(W1)
W(W2)
W(W1)
W(W2)
TN9
TN9
TN9
TN9
TN9
TN9
TN9
TN9
67
67
67
67
67
67
55
67
67
TN1
TN2
TN1
TN2
TN1
TN2
TN1
TN2
TN1
Z
57
AX3

FIG. 7

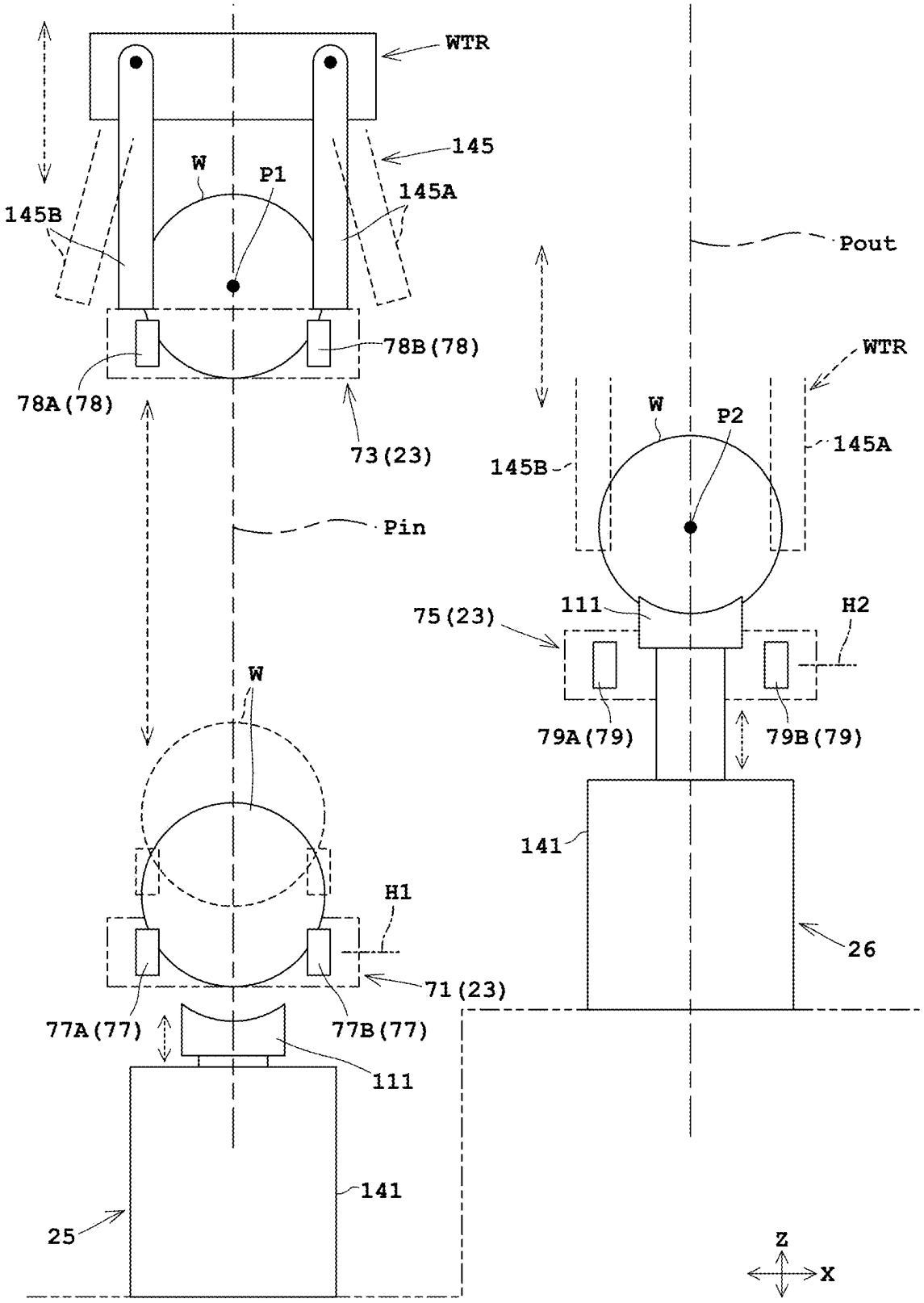

WTR
145
W
P1
145A
145B
78B(78)
78A(78)
73(23)
Pin
Pout
WTR
W
P2
145A
145B
111
H2
75(23)
79A(79)
79B(79)
141
26
W
H1
71(23)
77A(77)
77B(77)
111
141
25
Z
X

FIG. 8

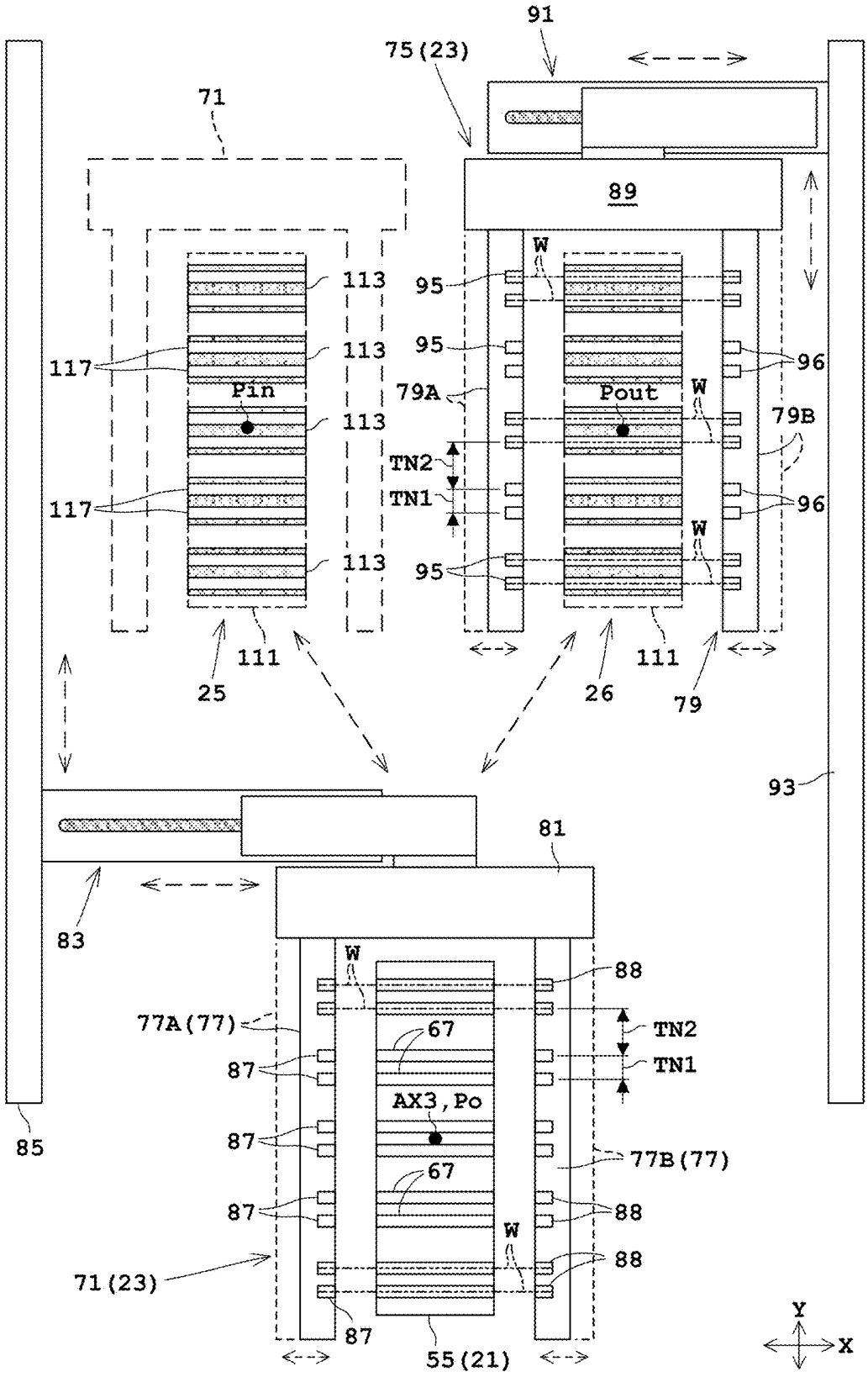

91
75(23)
71
89
W
113
95
117
Pin
79A
Pout
79B
96
TN2
TN1
25
111
26
79
93
81
83
88
77A(77)
67
87
AX3,Po
77B(77)
85
71(23)
55(21)
Y
X

FIG. 9

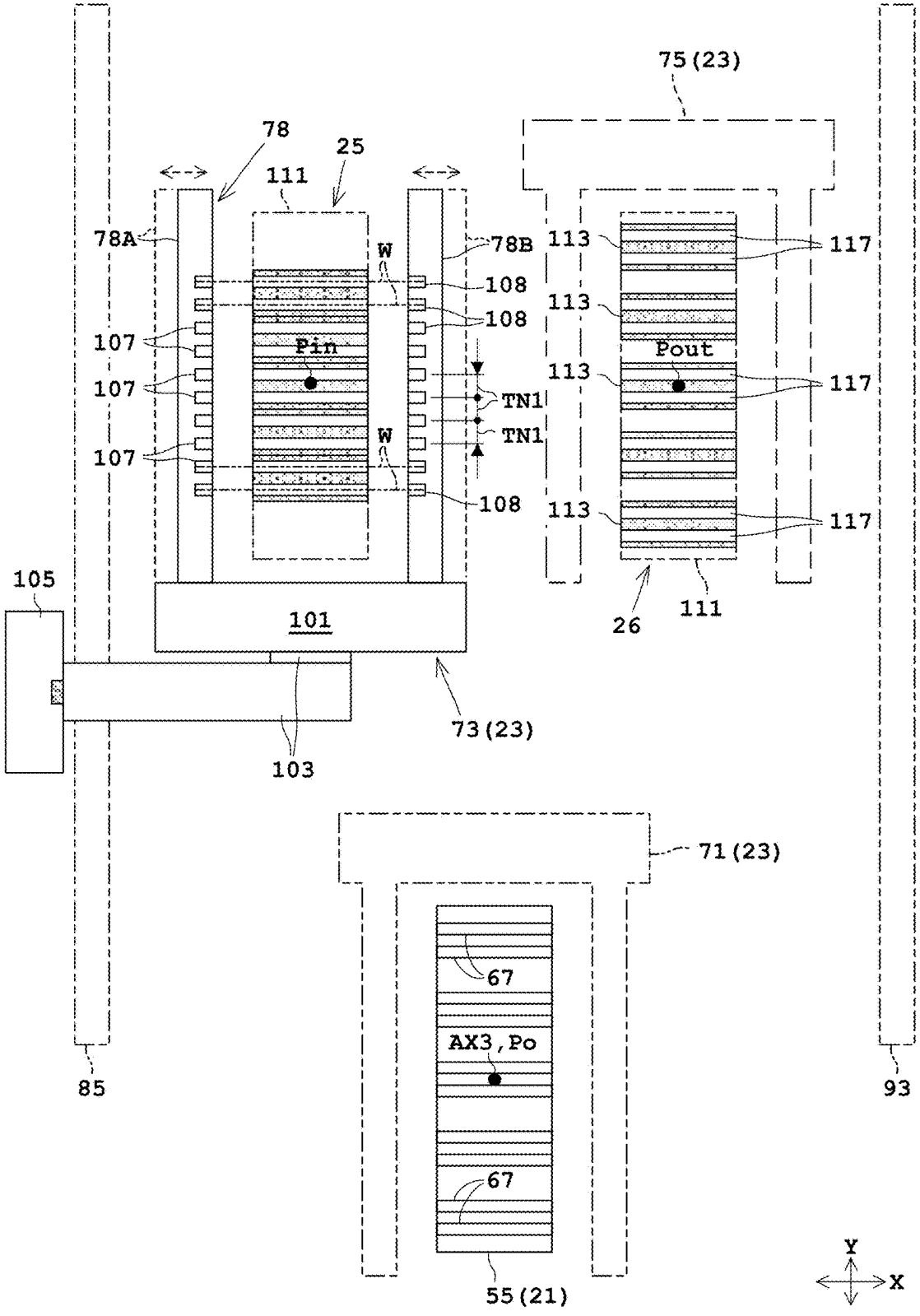

75(23)
78
25
111
78A
78B
W
108
108
107
107
107
Pin
TN1
TN1
W
108
113
113
113
113
Pout
117
117
117
105
101
26
111
73(23)
103
71(23)
67
AX3,Po
67
55(21)
85
93
Y
X

FIG. 10

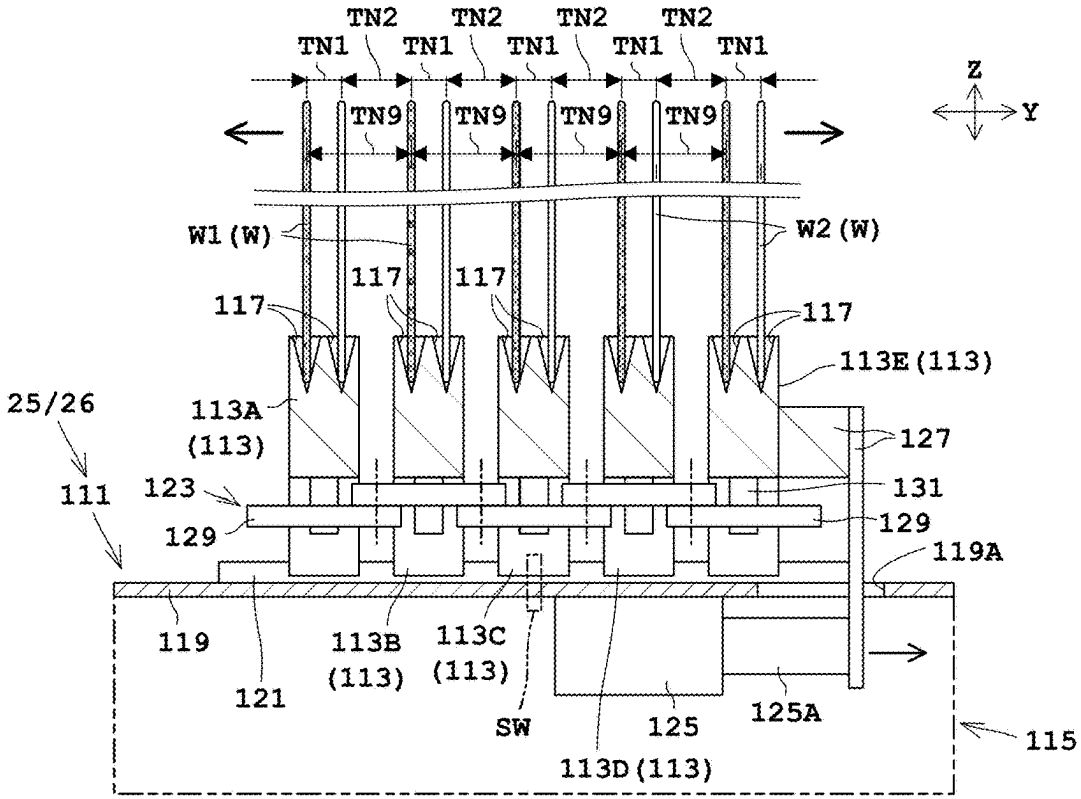

TN2
TN1
TN9
Z
Y
W1 (W)
W2 (W)
117
113E (113)
25/26
113A
(113)
127
111
123
131
129
119A
119
121
113B
(113)
113C
(113)
SW
125
125A
115
113D (113)

FIG. 11

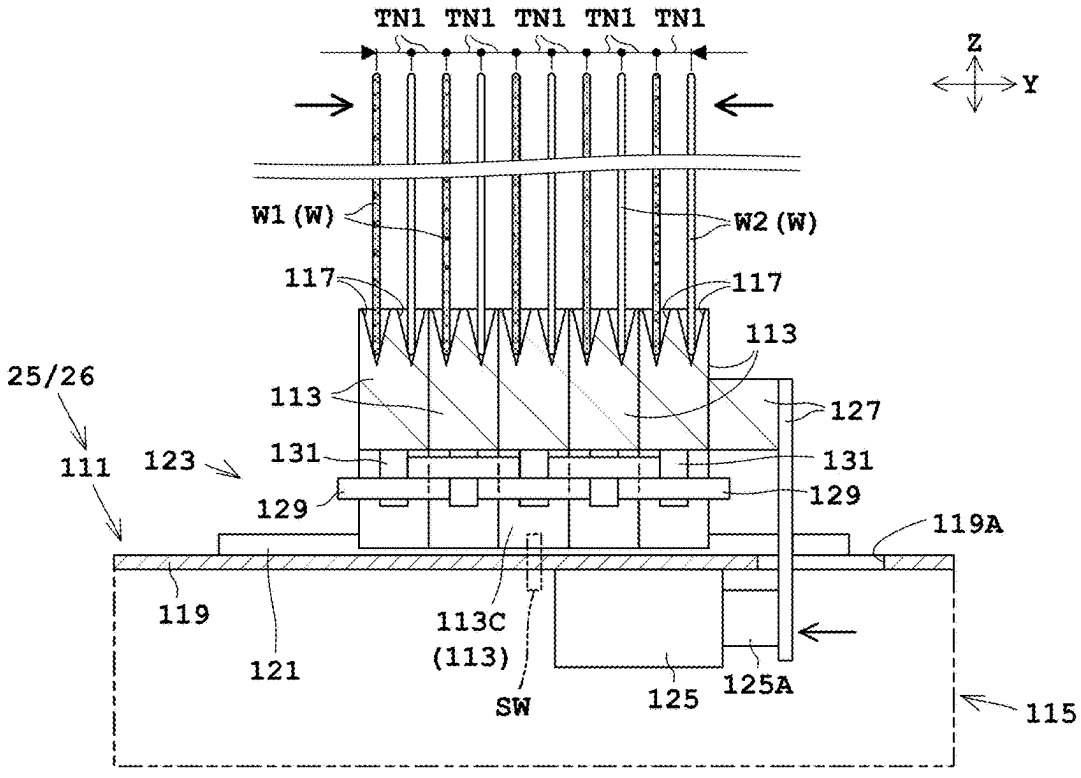

TN1
Z
Y
W1 (W)
W2 (W)
117
113
25/26
127
111
123
131
129
119A
119
121
113C
(113)
SW
125
125A
115

FIG. 12

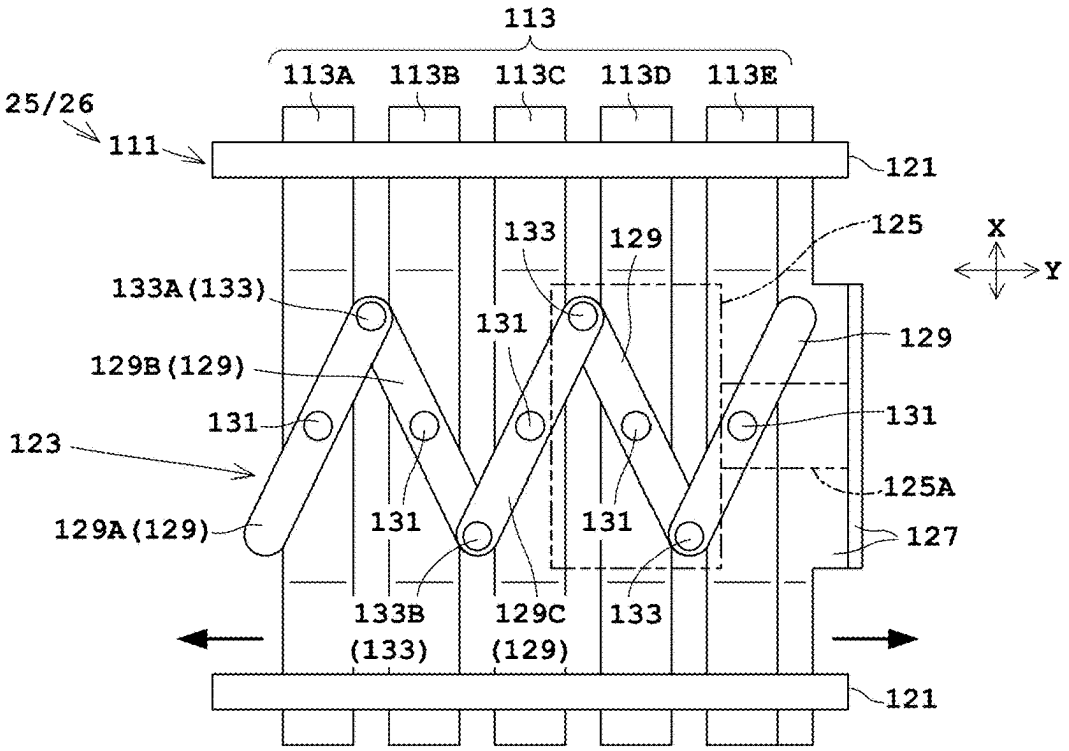

113
113A
113B
113C
113D
113E
25/26
111
121
133
129
125
X
Y
133A(133)
131
129
129B(129)
131
131
123
125A
129A(129)
131
131
127
133B
(133)
129C
(129)
133
121

FIG. 13

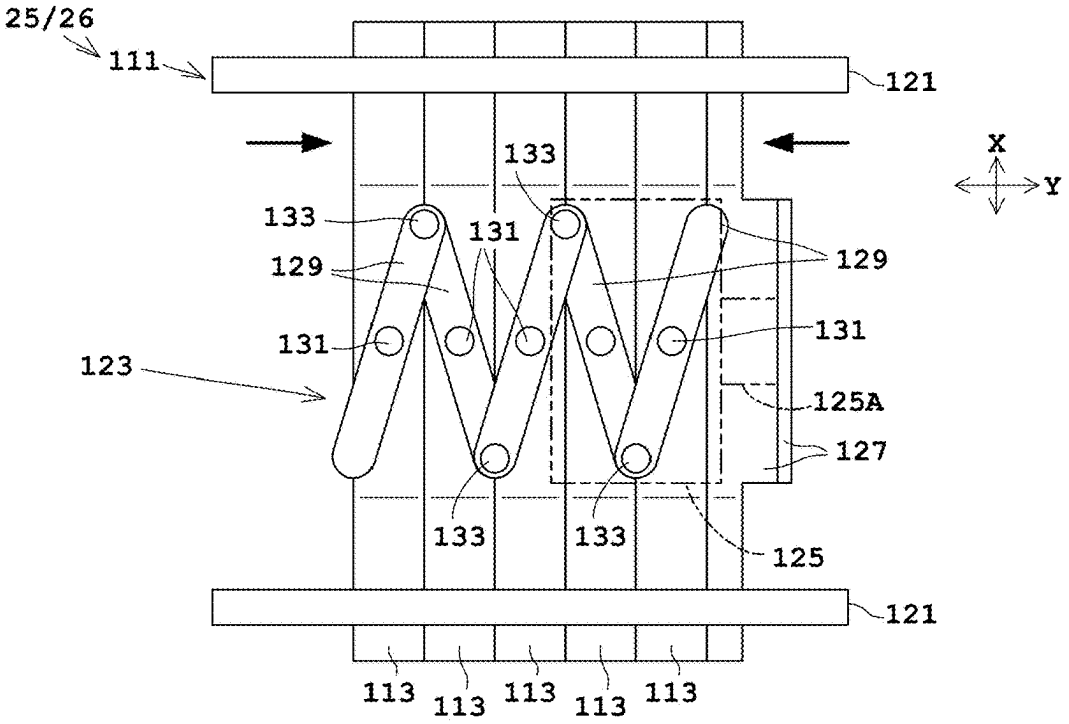

25/26
111
121
133
X
Y
133
131
129
129
131
131
123
125A
127
133
133
125
121
113
113
113
113
113

FIG. 14

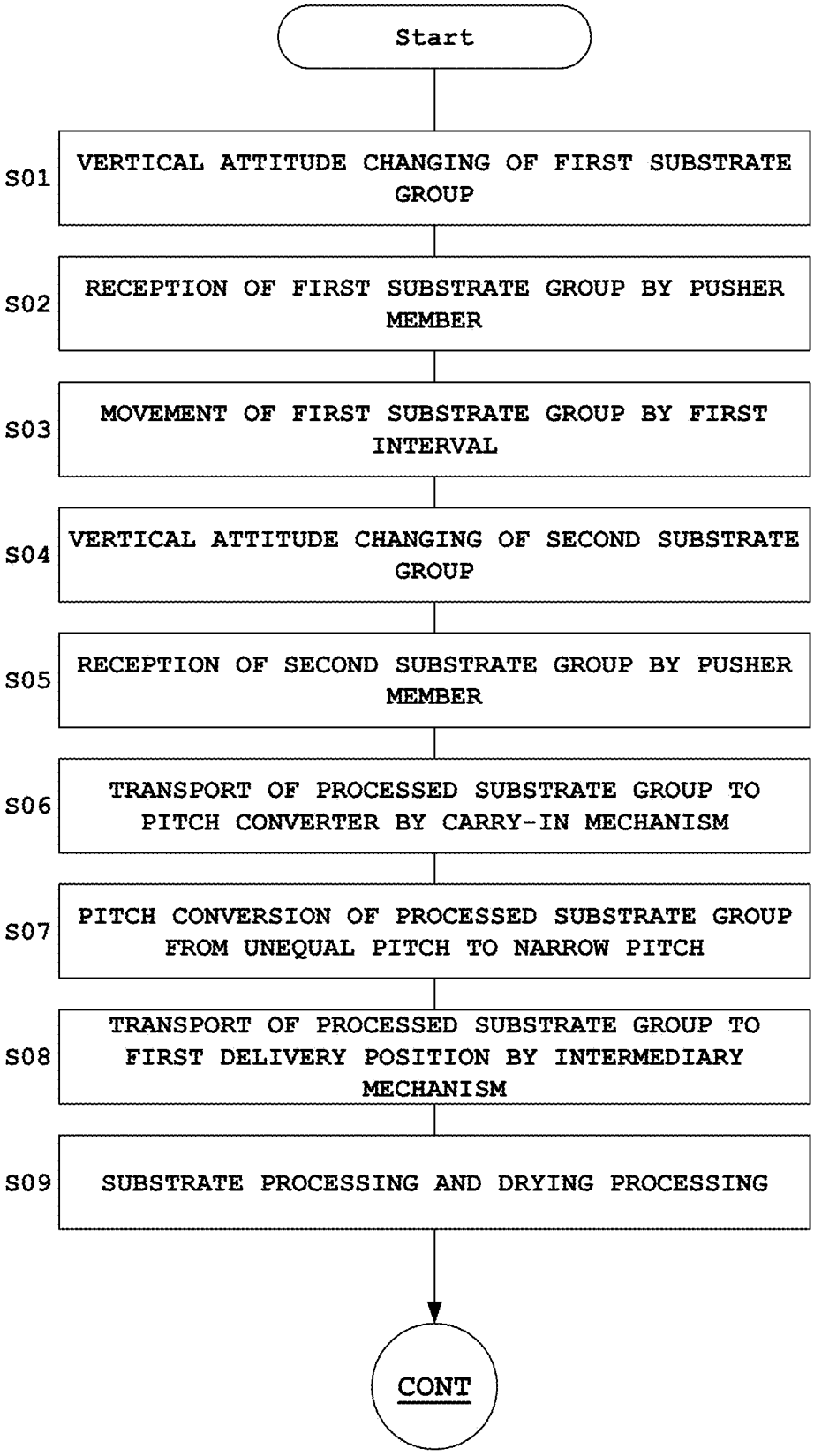

Start
S01
VERTICAL ATTITUDE CHANGING OF FIRST SUBSTRATE GROUP
S02
RECEPTION OF FIRST SUBSTRATE GROUP BY PUSHER MEMBER
S03
MOVEMENT OF FIRST SUBSTRATE GROUP BY FIRST INTERVAL
S04
VERTICAL ATTITUDE CHANGING OF SECOND SUBSTRATE GROUP
S05
RECEPTION OF SECOND SUBSTRATE GROUP BY PUSHER MEMBER
S06
TRANSPORT OF PROCESSED SUBSTRATE GROUP TO PITCH CONVERTER BY CARRY-IN MECHANISM
S07
PITCH CONVERSION OF PROCESSED SUBSTRATE GROUP FROM UNEQUAL PITCH TO NARROW PITCH
S08
TRANSPORT OF PROCESSED SUBSTRATE GROUP TO FIRST DELIVERY POSITION BY INTERMEDIARY MECHANISM
S09
SUBSTRATE PROCESSING AND DRYING PROCESSING
CONT

FIG. 15A

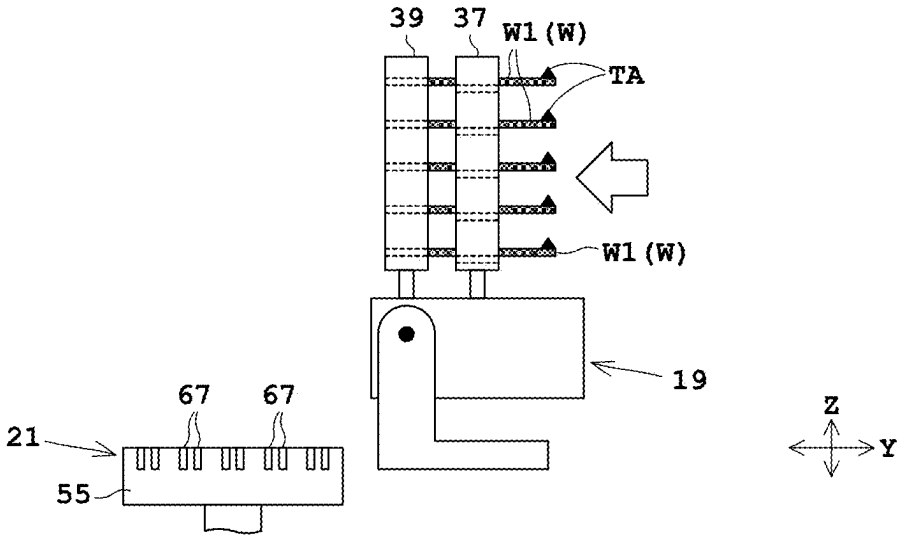


FIG. 15B

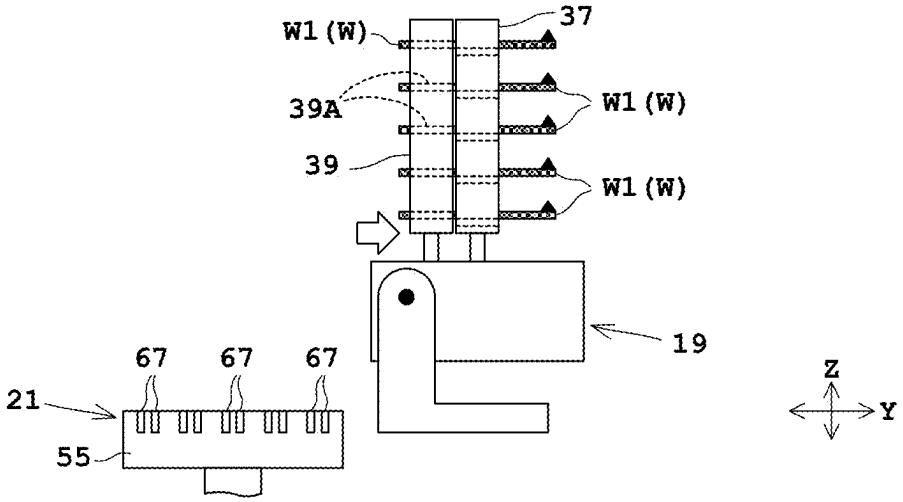


FIG. 15C

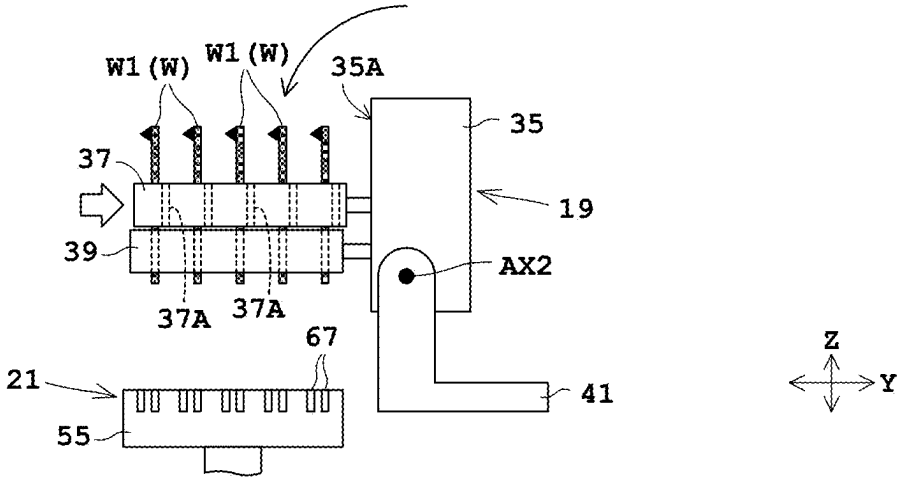


FIG. 16A

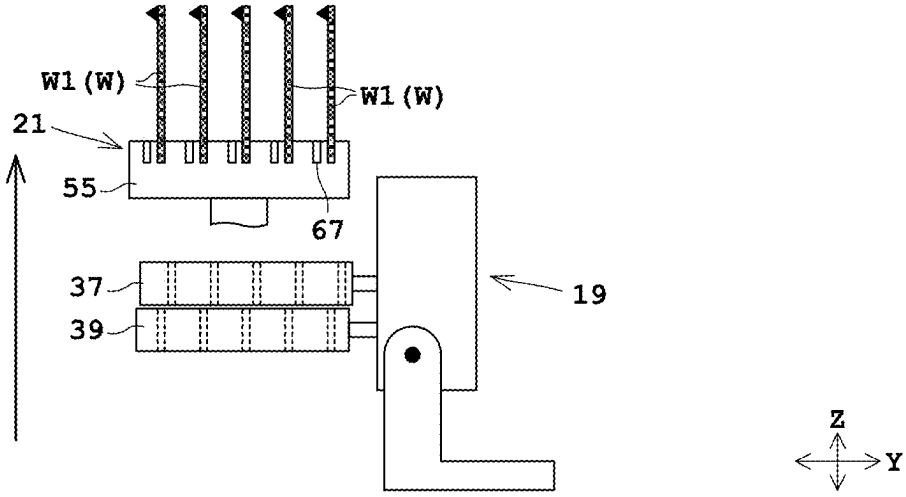


FIG. 16B

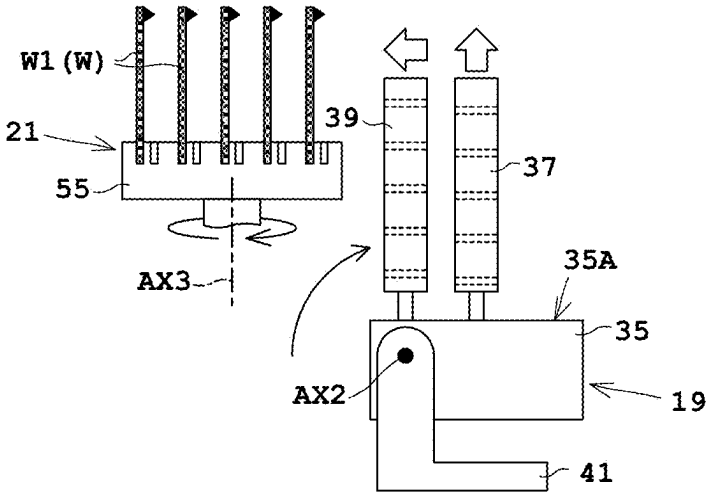


FIG. 16C

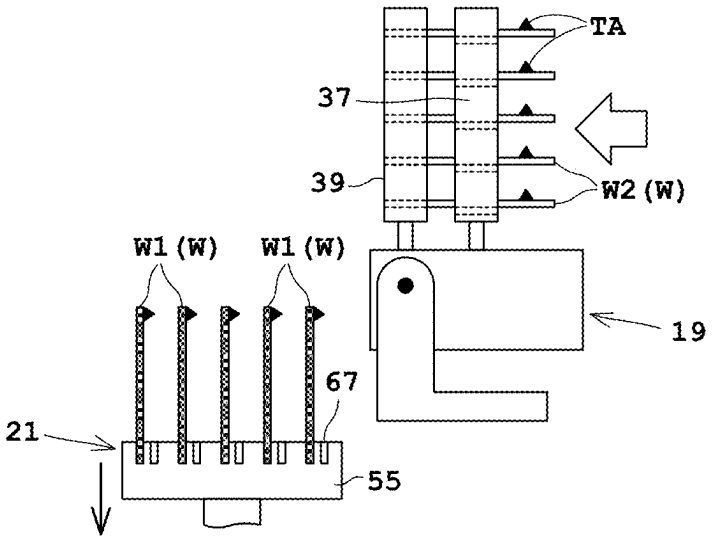


FIG. 17A

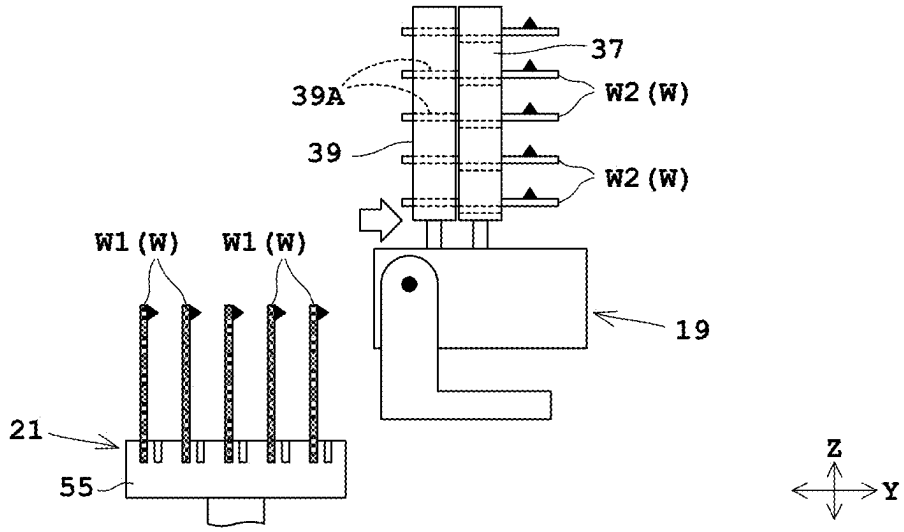


FIG. 17B

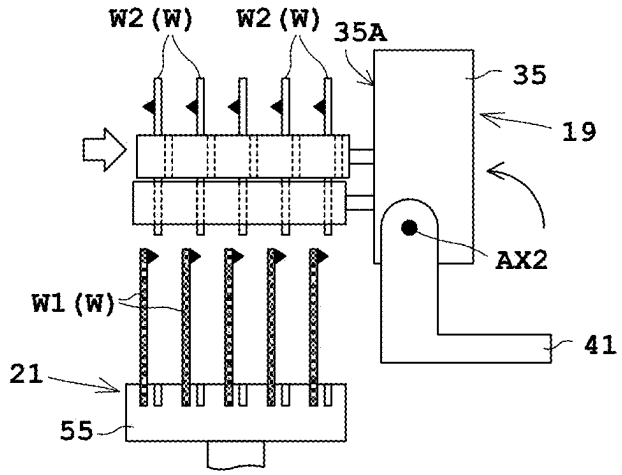


FIG. 17C

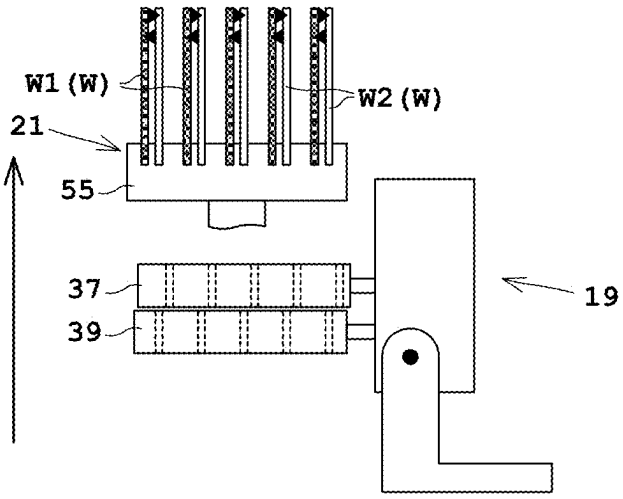


FIG. 18A

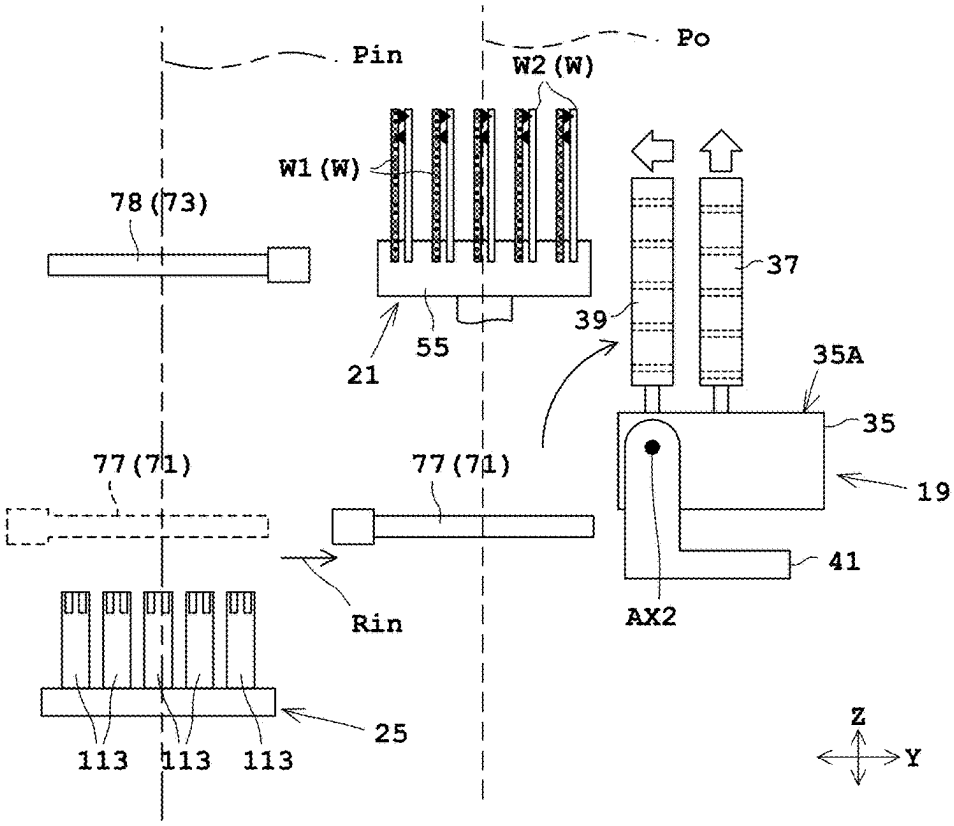


FIG. 18B

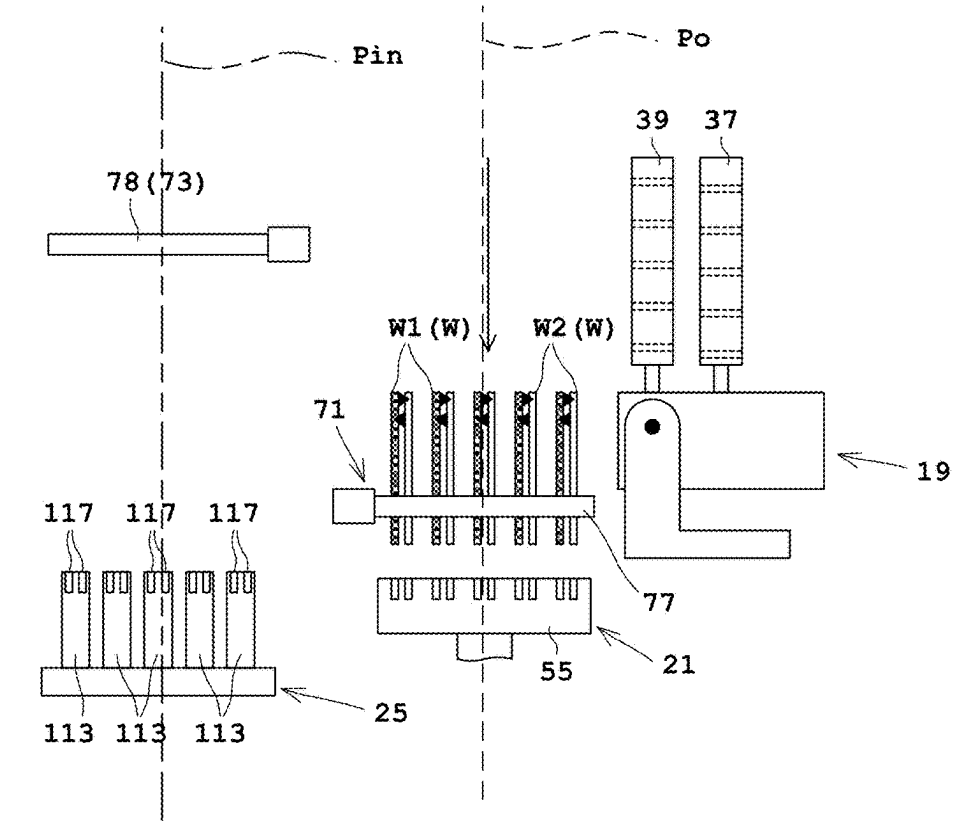


FIG. 19A

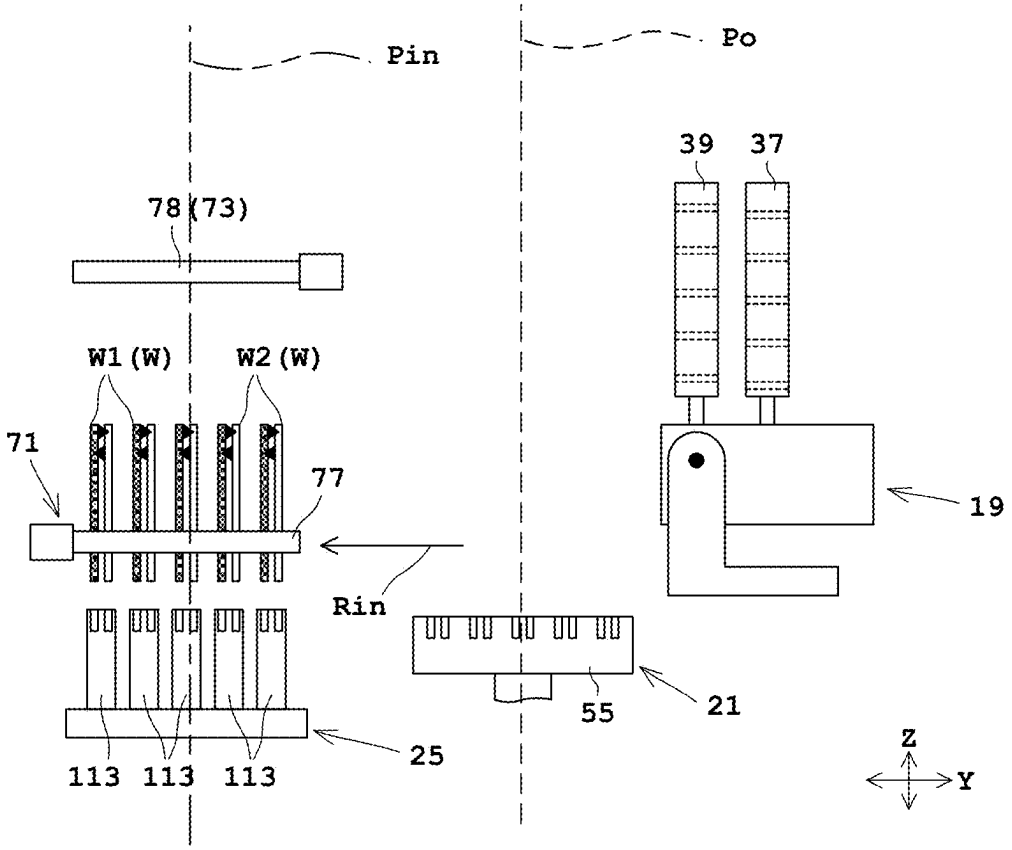


FIG. 19B

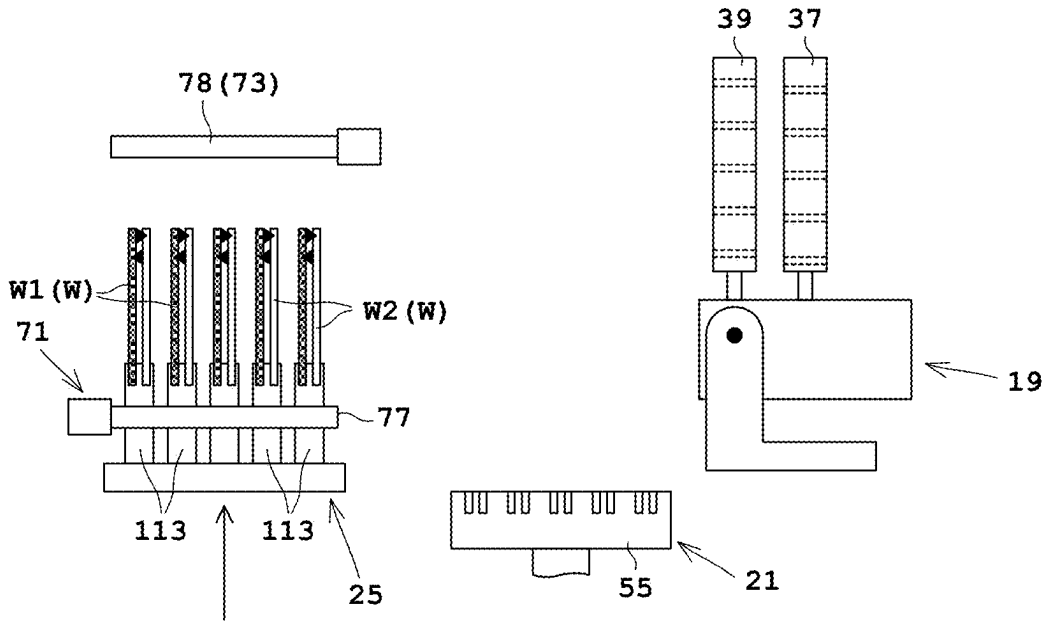


FIG. 20A

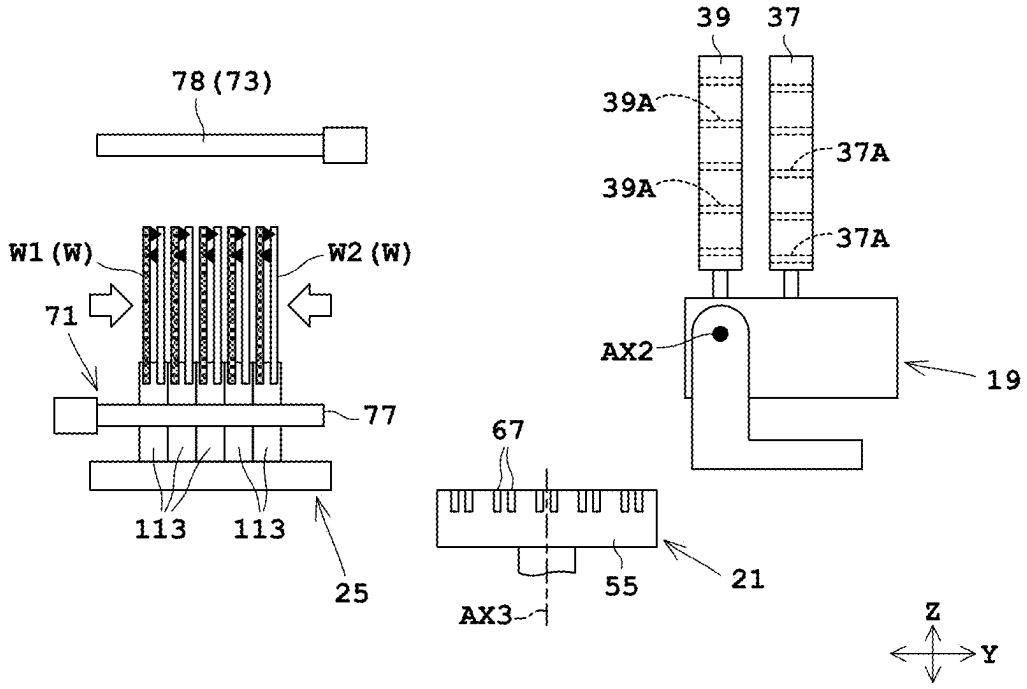


FIG. 20B

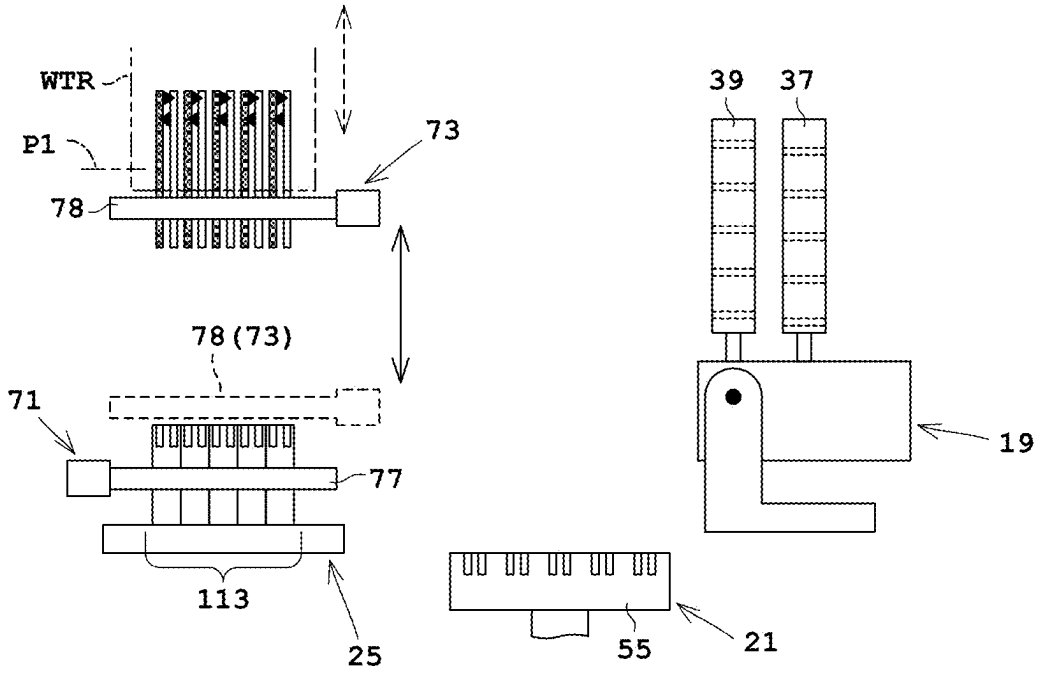


FIG. 21

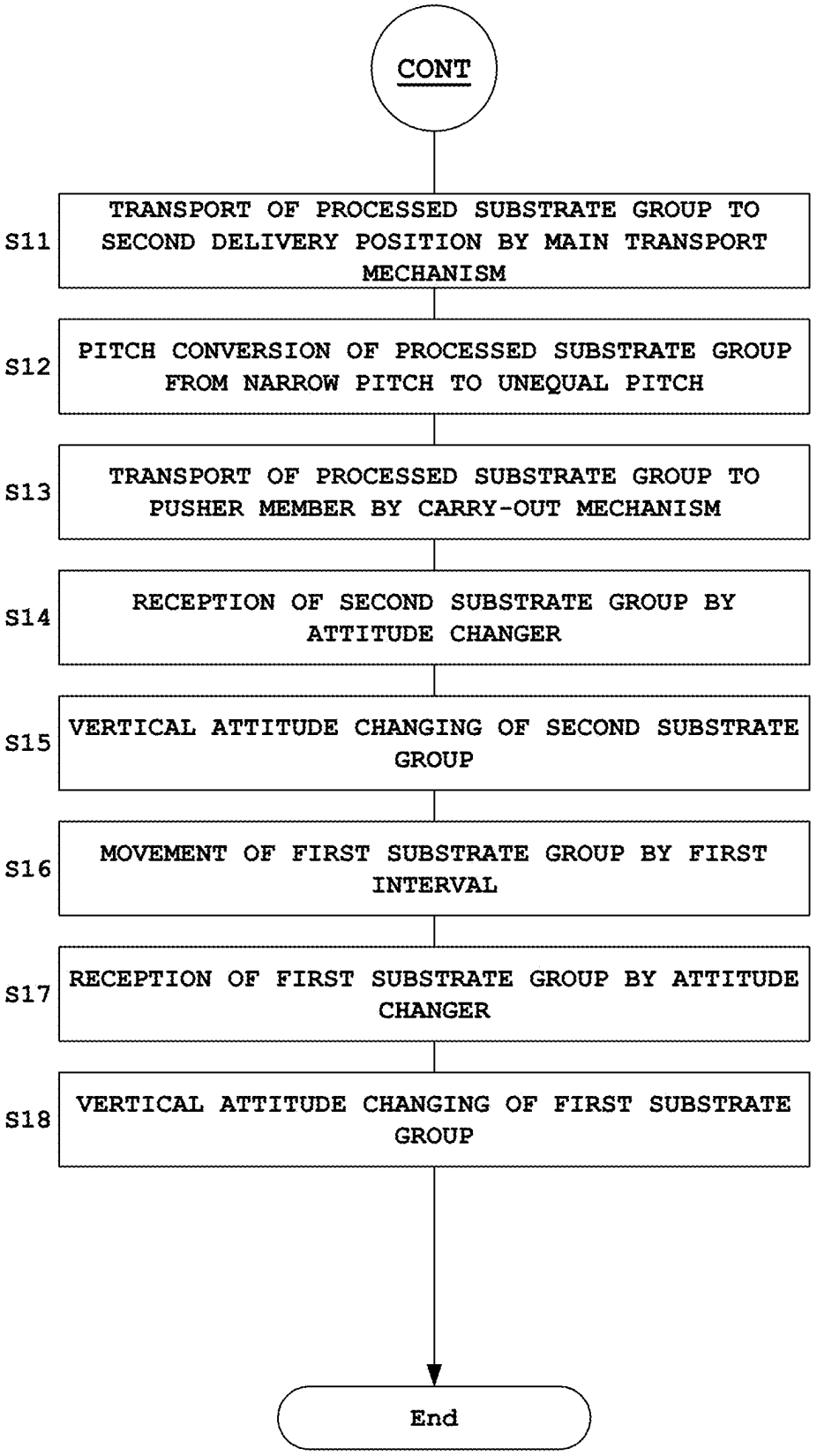

CONT
S11
TRANSPORT OF PROCESSED SUBSTRATE GROUP TO SECOND DELIVERY POSITION BY MAIN TRANSPORT MECHANISM
S12
PITCH CONVERSION OF PROCESSED SUBSTRATE GROUP FROM NARROW PITCH TO UNEQUAL PITCH
S13
TRANSPORT OF PROCESSED SUBSTRATE GROUP TO PUSHER MEMBER BY CARRY-OUT MECHANISM
S14
RECEPTION OF SECOND SUBSTRATE GROUP BY ATTITUDE CHANGER
S15
VERTICAL ATTITUDE CHANGING OF SECOND SUBSTRATE GROUP
S16
MOVEMENT OF FIRST SUBSTRATE GROUP BY FIRST INTERVAL
S17
RECEPTION OF FIRST SUBSTRATE GROUP BY ATTITUDE CHANGER
S18
VERTICAL ATTITUDE CHANGING OF FIRST SUBSTRATE GROUP
End

FIG. 22A

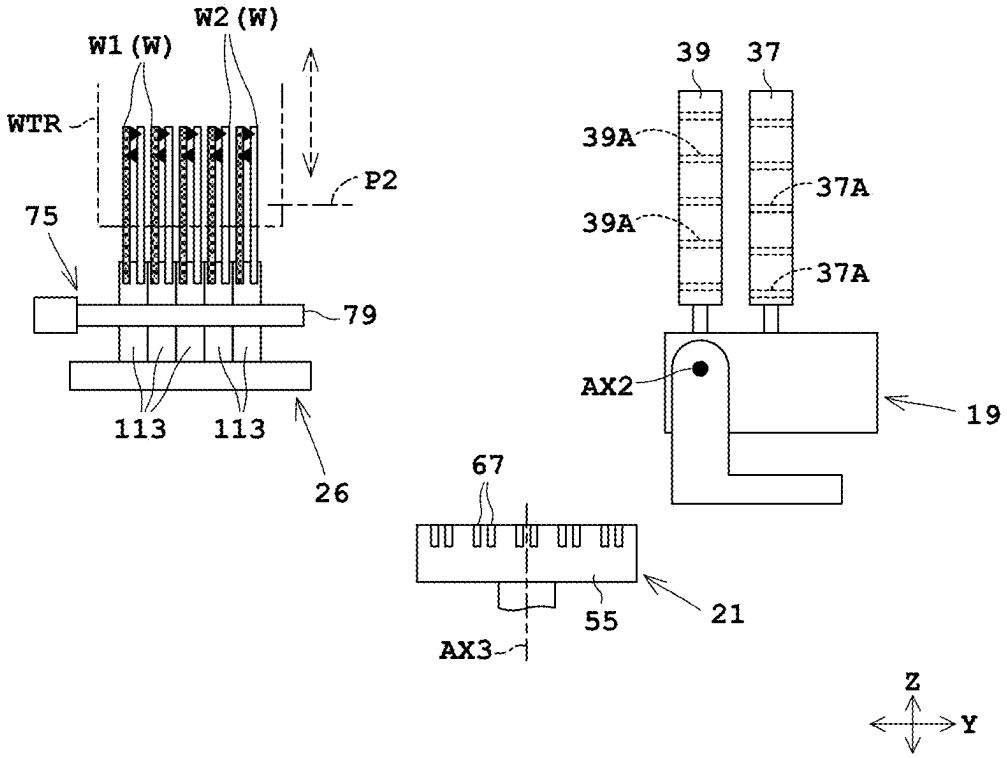


FIG. 22B

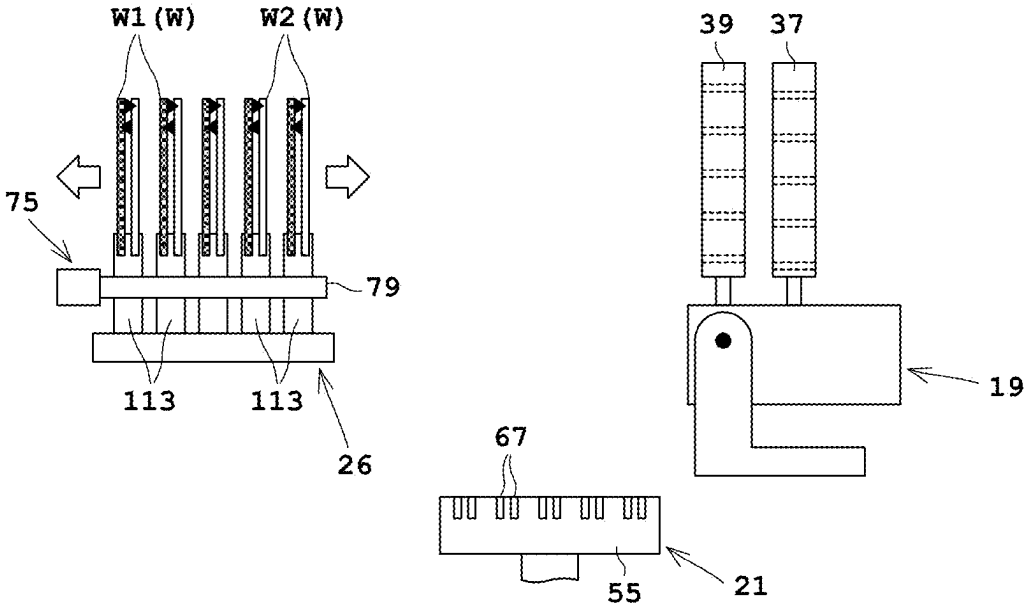


FIG. 23A

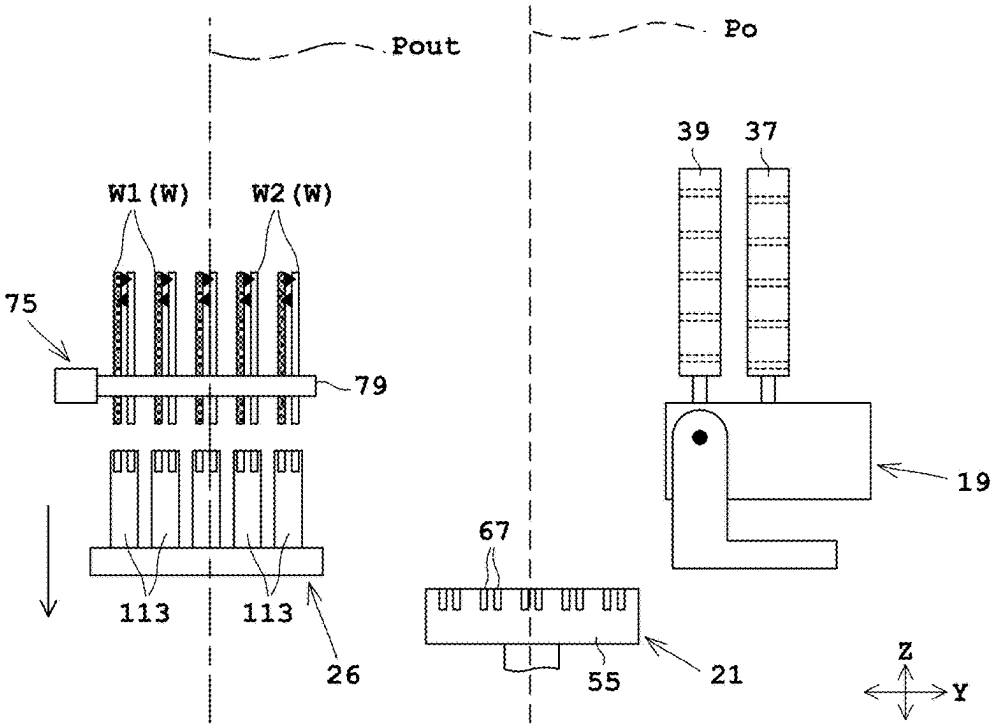


FIG. 23B

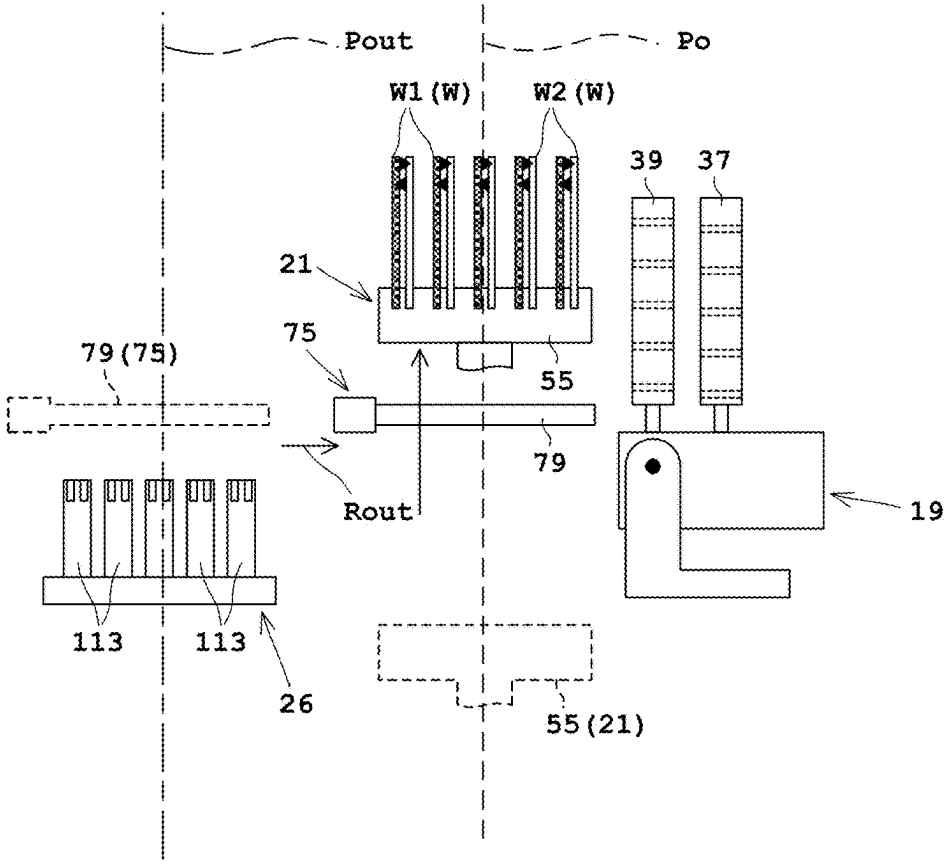


FIG. 24A

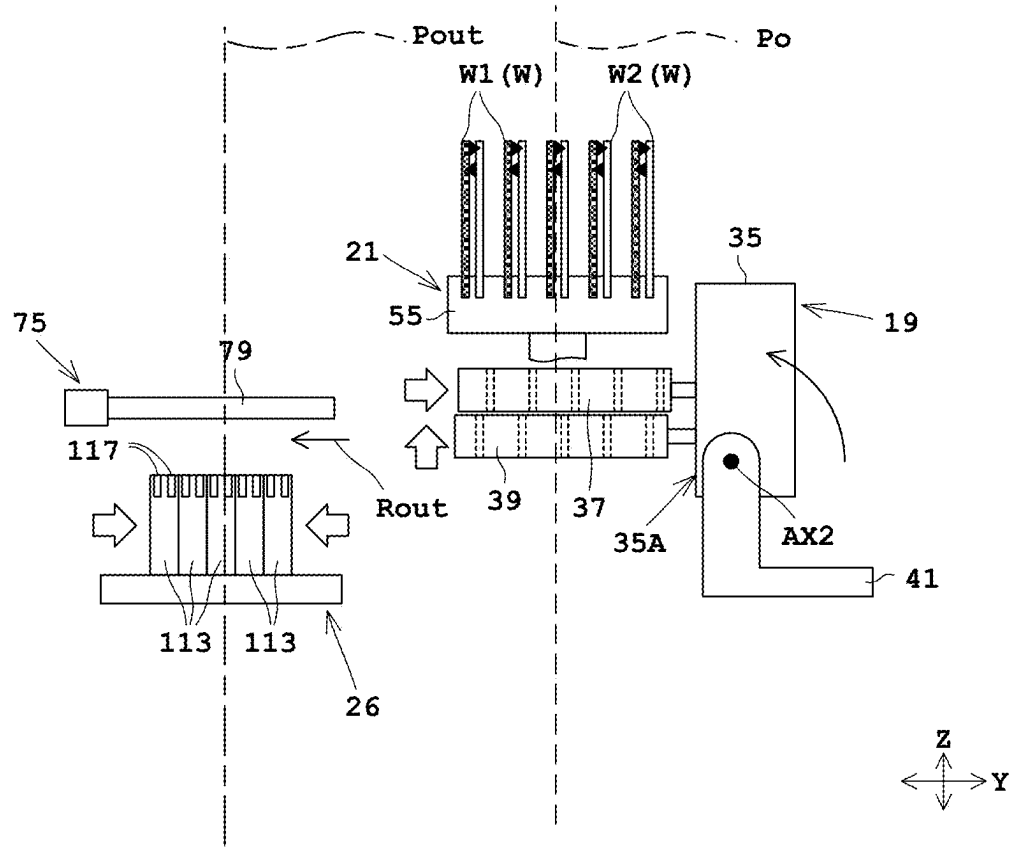


FIG. 24B

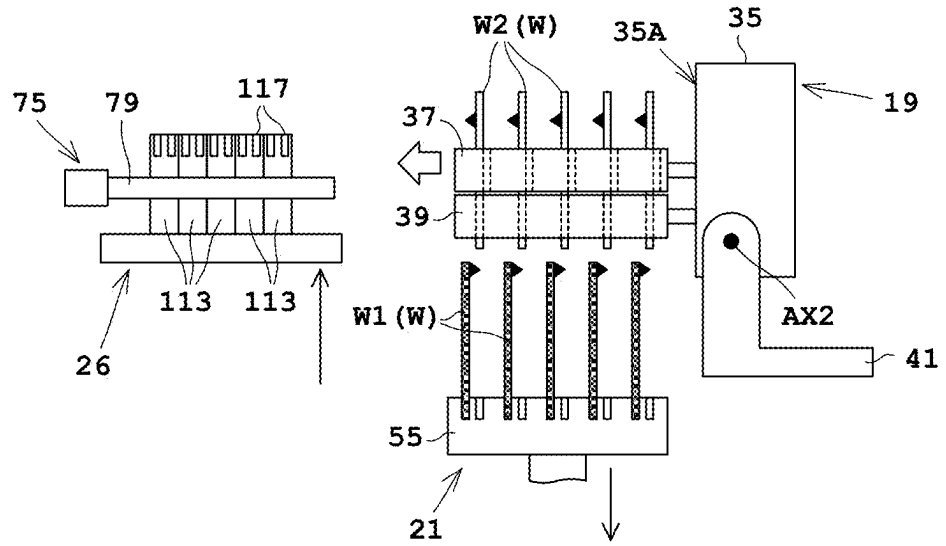


FIG. 25A

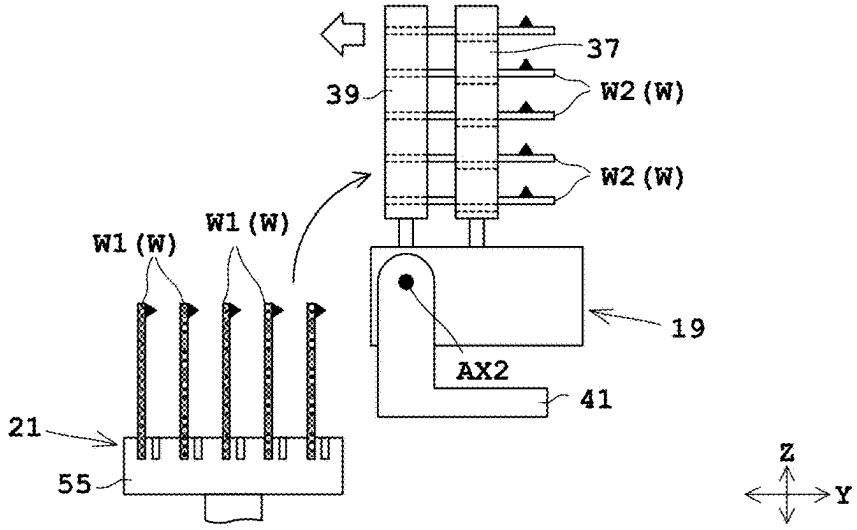


FIG. 25B

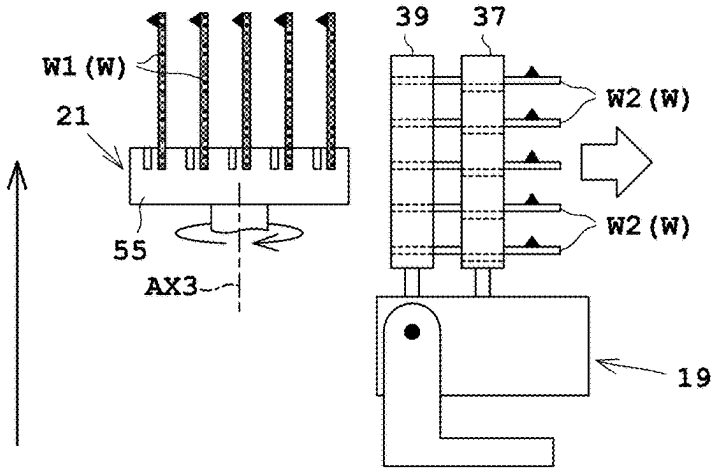


FIG. 25C

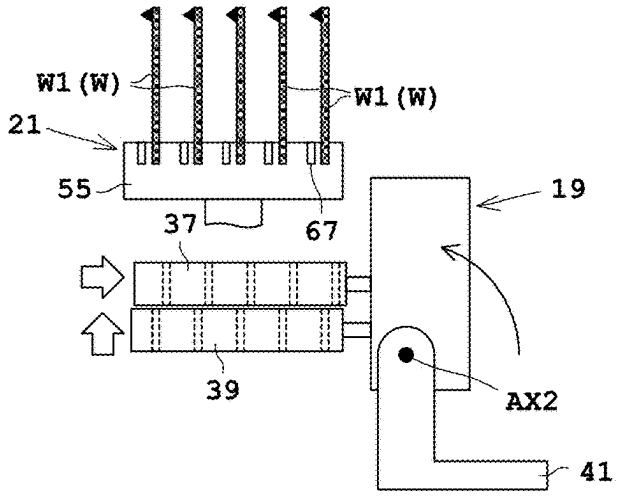


FIG. 26A

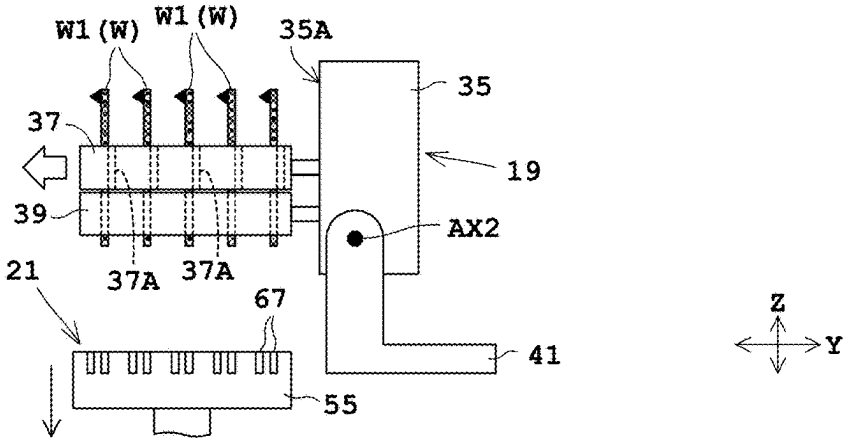


FIG. 26B

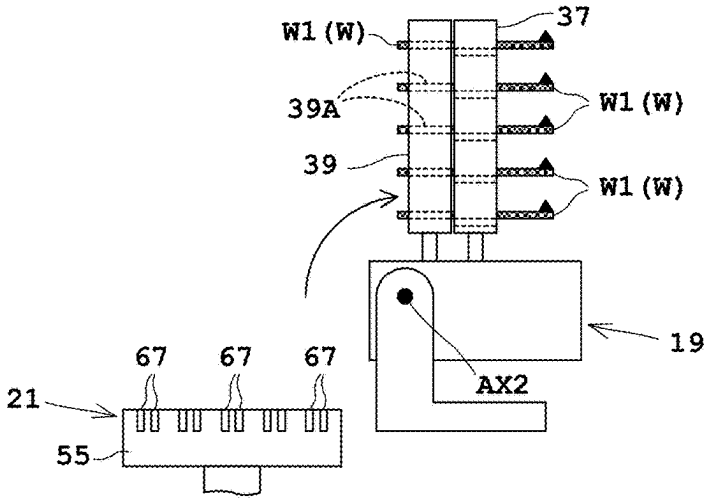


FIG. 26C

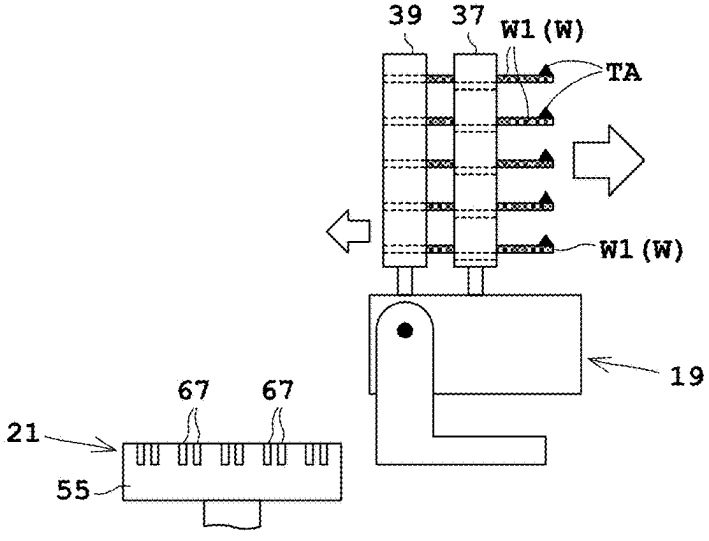
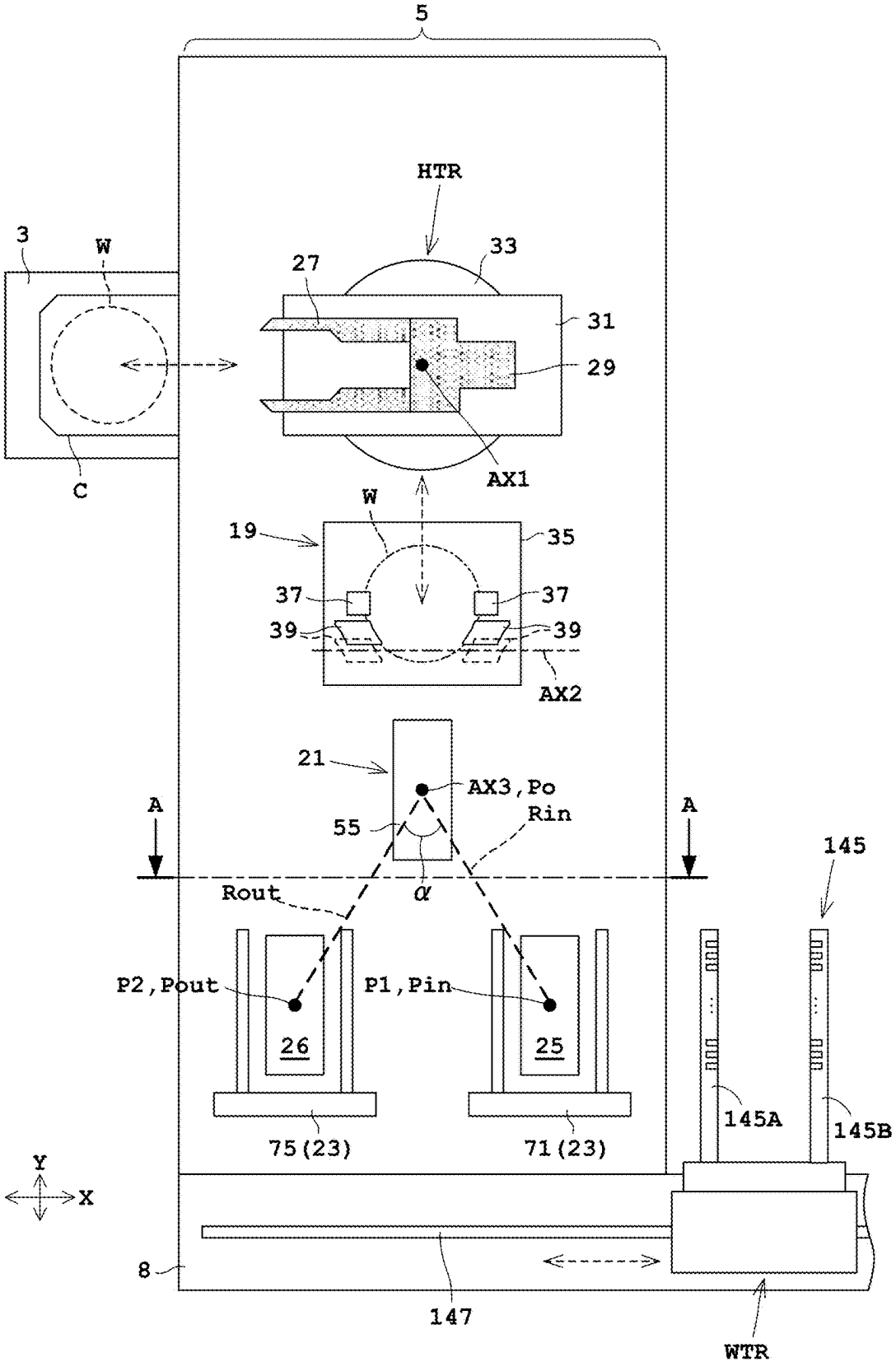


FIG. 27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HTR
3
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27
33
31
29
AX1
C
W
19
35
37
37
39
39
AX2
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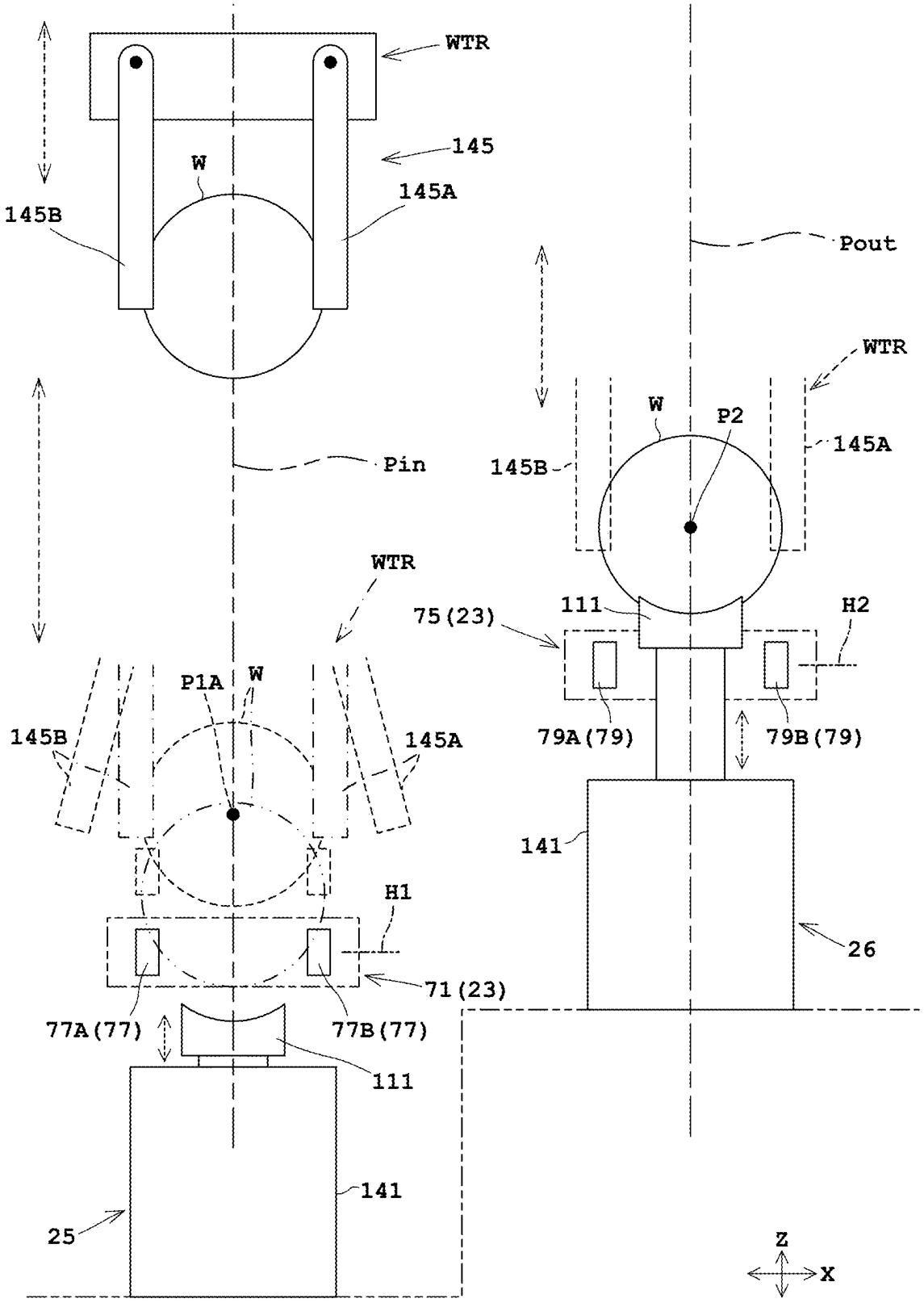
AX3, Po
Rin
55
A
A
145
Rout
α
P2, Pout
P1, Pin
26
25
145A
145B
75 (23)
71 (23)
Y
X
8
147
WTR

FIG. 28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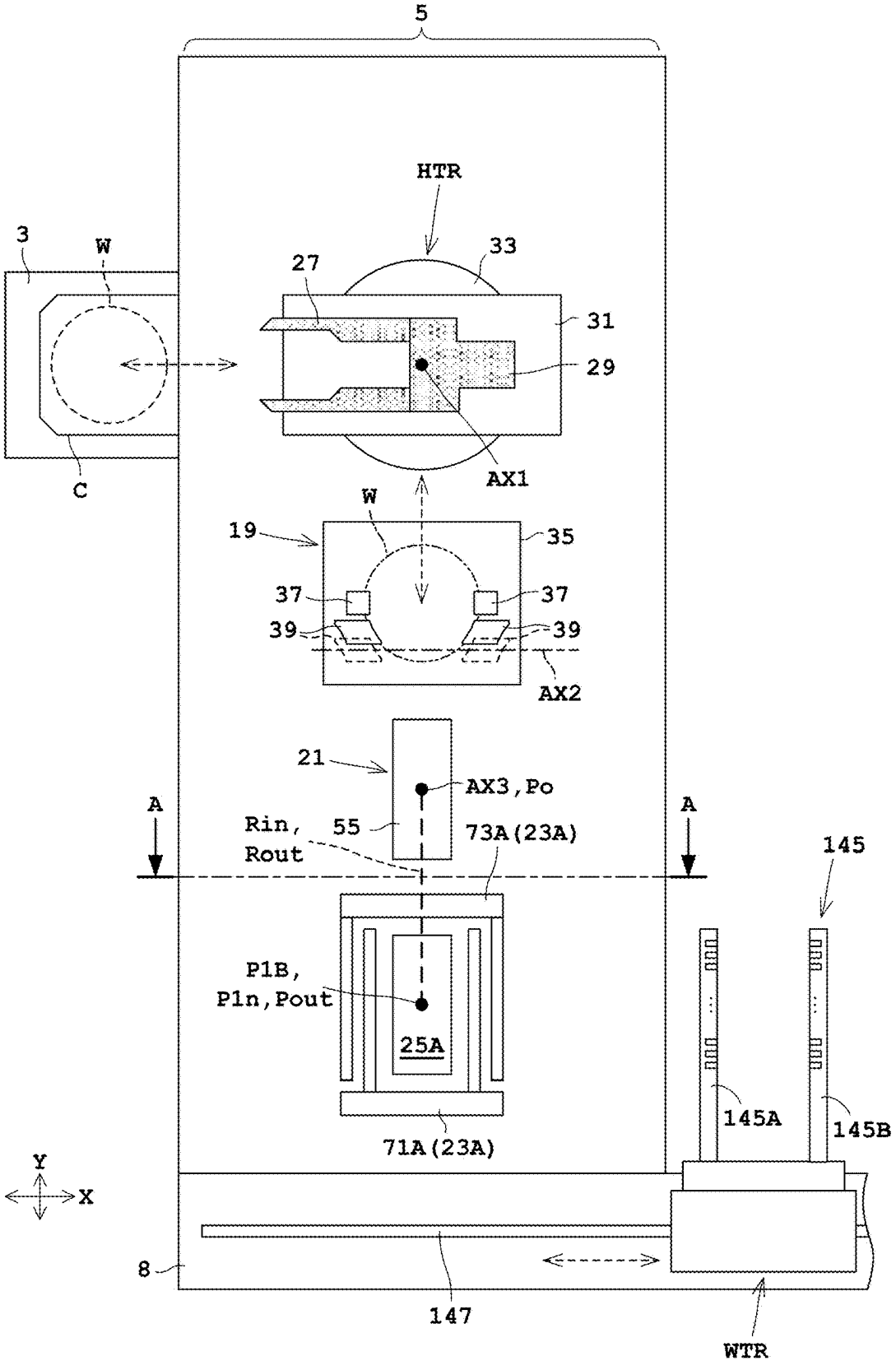
145
W
145A
145B
Pout
WTR
W
P2
145A
145B
Pin
WTR
111
H2
75(23)
P1A
W
145B
145A
79A(79)
79B(79)
141
H1
26
71(23)
77A(77)
77B(77)
111
141
25
Z
X

FIG. 29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27
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29
AX1
C
W
19
35
37
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39
39
AX2
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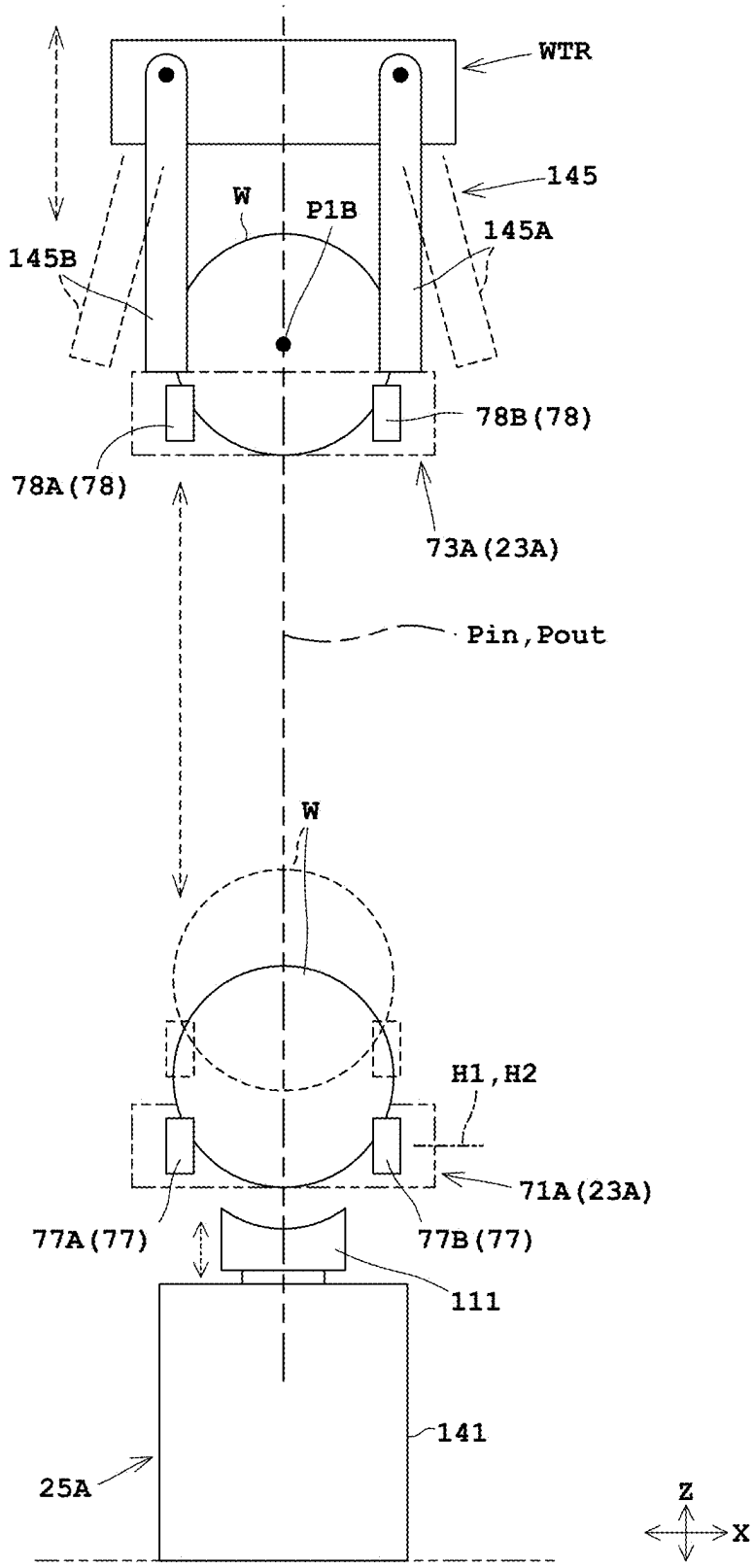
AX3, Po
A
A
Rin,
Rout
55
73A(23A)
145
P1B,
P1n, Pout
25A
145A
145B
71A(23A)
Y
X
8
147
WTR

FIG. 30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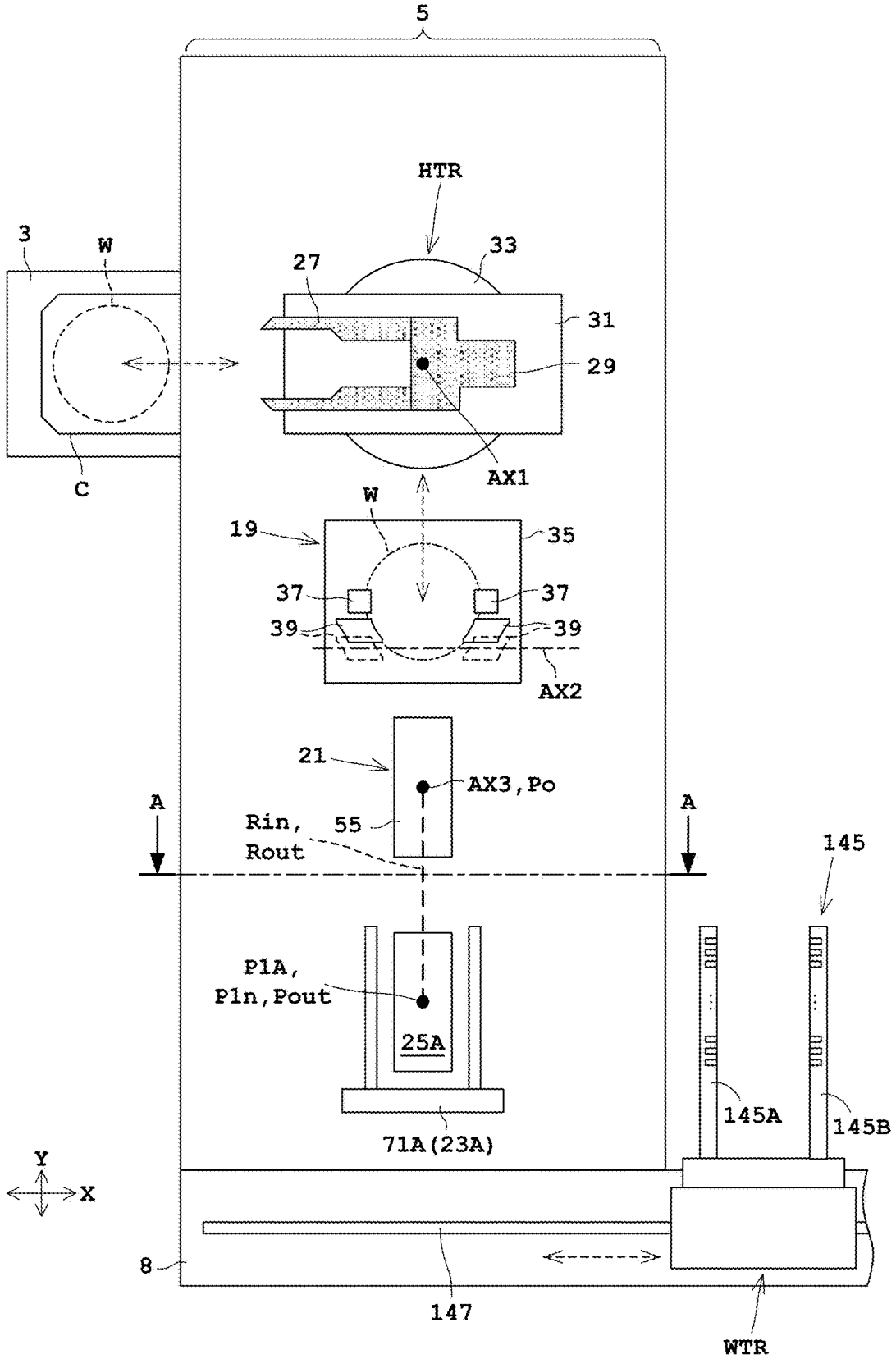
145
W
P1B
145A
145B
78B(78)
78A(78)
73A(23A)
Pin,Pout
W
H1,H2
71A(23A)
77A(77)
77B(77)
111
141
25A
Z
X

FIG. 31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33
31
29
AX1
C
W
19
35
37
37
39
39
AX2
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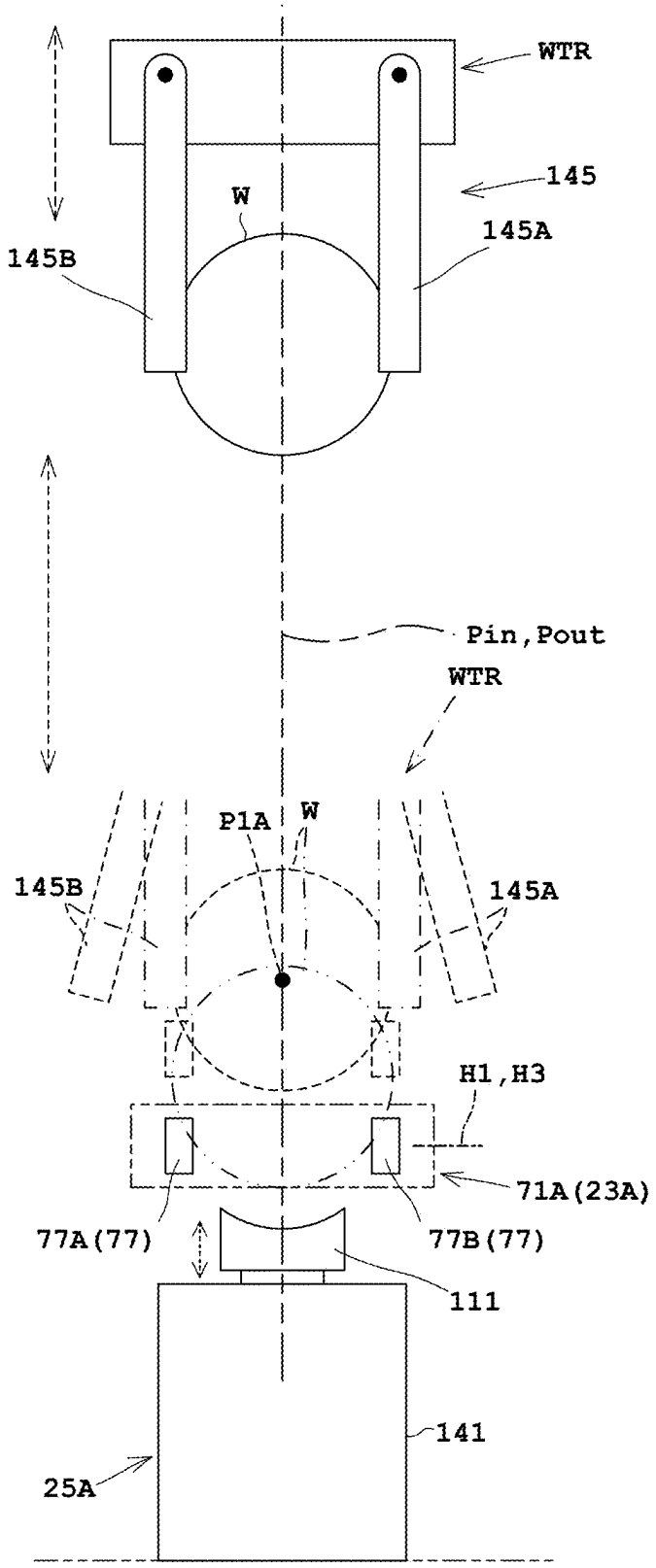
AX3, Po
A
A
Rin,
Rout
55
145
P1A,
P1n, Pout
25A
145A
145B
71A(23A)
Y
X
8
147
WTR

FIG. 32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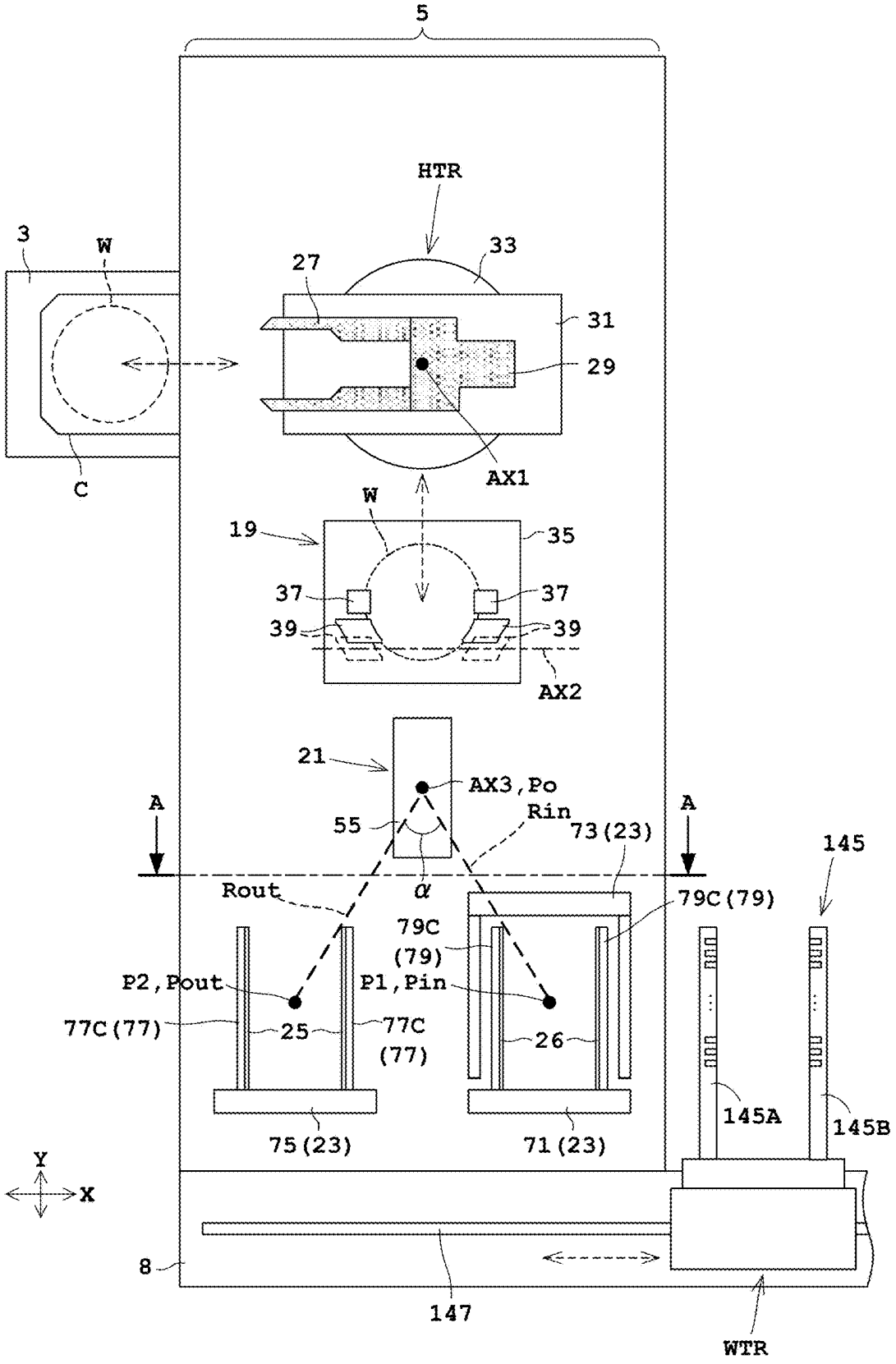
W
145A
145B
Pin,Pout
WTR
P1A
W
145B
145A
H1,H3
71A(23A)
77A(77)
77B(77)
111
141
25A

FIG. 33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27
33
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29
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C
W
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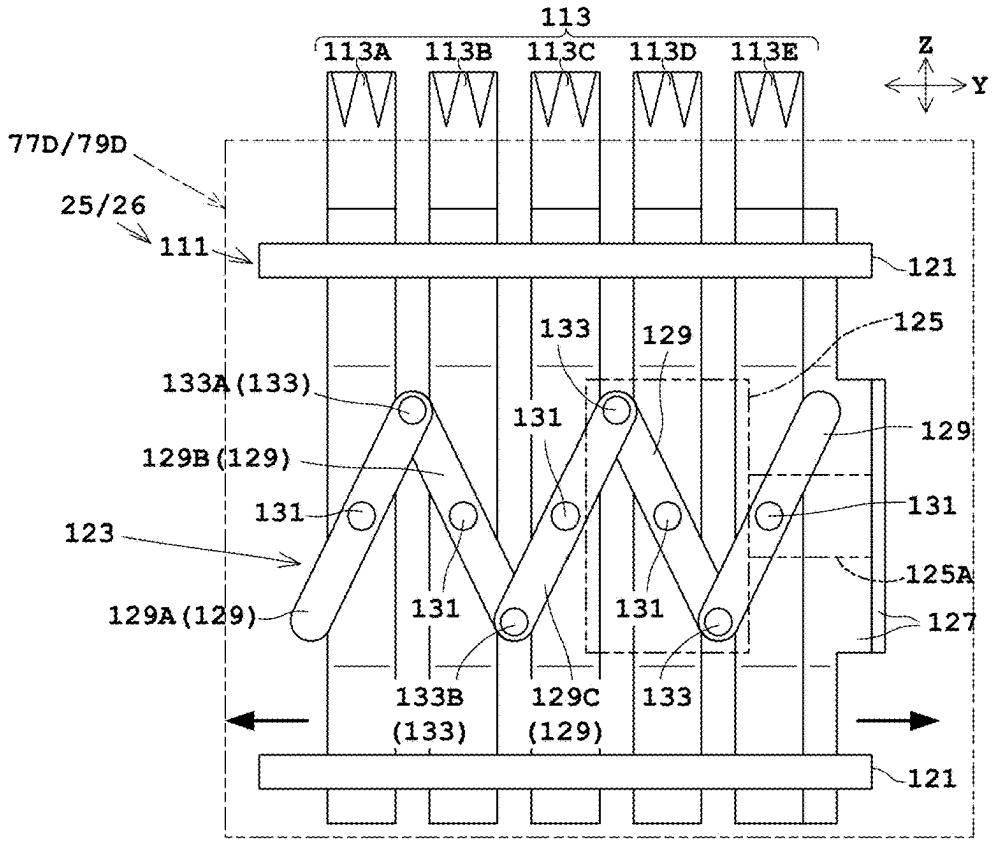
37
37
39
39
AX2
21
AX3, Po
A
55
Rin
73(23)
A
145
Rout
α
79C(79)
79C
(79)
P2, Pout
P1, Pin
77C(77)
25
77C
(77)
26
145A
145B
75(23)
71(23)
Y
X
8
147
WTR

FIG. 34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113A
113B
113C
113D
113E
Z
Y
77D/79D
25/26
111
121
133
129
125
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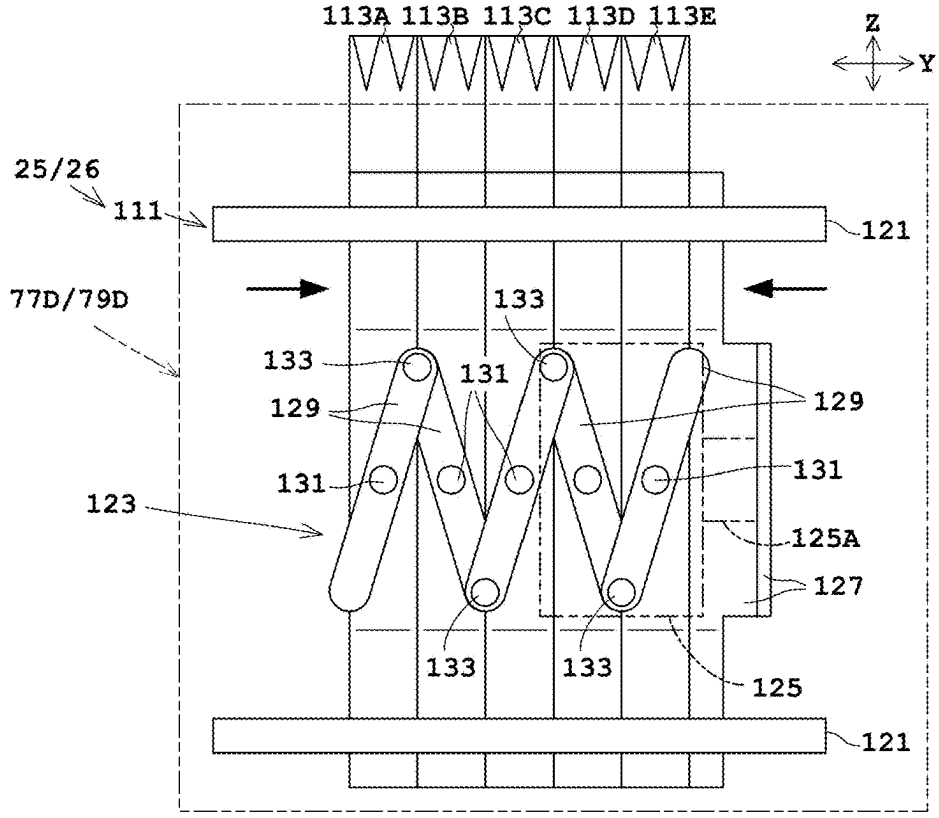
131
129
129B(129)
131
131
123
125A
129A(129)
131
131
127
133B
(133)
129C
(129)
133
121

FIG. 35


113A 113B 113C 113D 113E
Z
Y
25/26
111
121
77D/79D
133
133
131
129
129
131
131
123
125A
127
133
133
125
121

SUBSTRATE PROCESSING APPARATUS

BACKGROUND OF THE INVENTION

(1) Field of the Invention

[0001] The present invention relates to a substrate processing apparatus processing substrates. Examples of the substrates include a semiconductor substrate, a substrate for a flat panel display (FPD), a glass substrate for a photomask, a substrate for an optical disk, a substrate for a magnetic disk, a ceramic substrate, and a substrate for a solar cell. Examples of the FPD include a liquid crystal display and an organic electroluminescence (EL) display.

(2) Description of the Related Art

[0002] Conventionally, there has been known a substrate processing apparatus that collectively immerses a plurality of substrates in a vertical attitude in a processing liquid for processing. The substrate processing apparatus includes an attitude changing mechanism and a pusher (see, for example, JP 2010-93230 A). The attitude changing mechanism changes attitudes of the substrates between a horizontal attitude and a vertical attitude. The pusher can deliver the plurality of substrates in the vertical attitude to and from the attitude changing mechanism by vertical movement of a lifting retainer.

[0003] The pusher combines a substrate group held by the attitude changing mechanism and a substrate group delivered in advance from the attitude changing mechanism to hold the plurality of substrates by the lifting retainer. The combination of the substrate groups performed by the lifting retainer is one kind of pitch conversion. The plurality of substrates held by the lifting retainer is aligned, for example, at a half pitch that is half a substrate holding pitch in a carrier. A used amount of the processing liquid can be reduced by collectively processing the substrates aligned at the half pitch.

SUMMARY OF THE INVENTION

[0004] In order to further reduce the used amount of the processing liquid (a chemical liquid and a cleaning liquid) in the substrate processing apparatus, there is a demand for aligning the plurality of substrates at a narrow pitch narrower than the half pitch and collectively processing the plurality of substrates aligned at the narrow pitch.

[0005] In such case, it is necessary to combine the substrate group held by the attitude changing mechanism and the substrate group delivered in advance from the attitude changing mechanism to hold the plurality of substrates by the lifting retainer, and then further perform the pitch conversion. Therefore, the time required for the pitch conversion becomes further longer. Accordingly, the conventional apparatus has a problem that the substrates cannot be efficiently processed.

[0006] The present invention has been made in view of such circumstances, and an object thereof is to provide a substrate processing apparatus that can efficiently process substrates.

[0007] In order to achieve such object, the present invention has the following configuration.

[0008] In other words, the substrate processing apparatus according to the present invention is a substrate processing apparatus processing substrates, the substrate processing apparatus including:

[0009] an attitude changing mechanism configured to perform attitude changing between a horizontal holding attitude in which a substrate group of the substrates in a horizontal attitude aligned at an equal pitch in a vertical direction is held and a vertical holding attitude in which a substrate group of the substrates in a vertical attitude aligned at the equal pitch in a horizontal direction is held;

[0010] a pusher mechanism including a pusher member configured to combine a second substrate group in the vertical holding attitude held by the attitude changing mechanism and a first substrate group in the vertical holding attitude delivered in advance from the attitude changing mechanism to hold a plurality of the substrates aligned at a narrow interval narrower than the equal pitch;

[0011] a pitch converter configured to receive the plurality of the substrates aligned at the narrow interval, and align, at a narrow pitch narrower than the equal pitch, the plurality of the substrates aligned at the narrow interval;

[0012] a substrate processor configured to collectively process the plurality of the substrates aligned at the narrow pitch; and

[0013] a main transport mechanism configured to collectively transport the plurality of the substrates aligned at the narrow pitch to the substrate processor, in which

[0014] the pitch converter is disposed on the main transport mechanism side of the pusher mechanism.

[0015] In the substrate processing apparatus according to the present invention, the pusher mechanism combines the second substrate group in the vertical holding attitude held by the attitude changing mechanism and the first substrate group in the vertical holding attitude delivered in advance from the attitude changing mechanism to hold the plurality of the substrates aligned at the narrow interval narrower than the equal pitch. A process of making the plurality of the substrates aligned at the narrow interval from the substrate group at the equal pitch is referred to as first-stage pitch conversion. The pitch converter receives the plurality of the substrates aligned at the narrow interval, and aligns, at the narrow pitch narrower than the equal pitch, the plurality of the substrates aligned at the narrow interval. A process of making the plurality of the substrates aligned at the narrow pitch from the plurality of the substrates aligned at the narrow interval is referred to as second-stage pitch conversion. In the present invention, the second-stage pitch conversion is not performed by the pusher mechanism, but is performed by the pitch converter disposed on the main transport mechanism side of the pusher mechanism. In other words, the second-stage pitch conversion is performed at a position where throughput is not reduced. This makes it possible to efficiently process the substrates.

[0016] Further, in the substrate processing apparatus according to the present invention,

[0017] it is preferable that the plurality of the substrates aligned at the narrow interval is a plurality of the substrates aligned at an unequal pitch where a first interval narrower than the equal pitch and a second

interval narrower than the equal pitch and wider than the first interval are alternately repeated,

[0018] the equal pitch is equal to a sum of the first interval and the second interval, and

[0019] the plurality of the substrates aligned at the narrow pitch is a plurality of the substrates aligned at the first interval repeated. In this way, the second-stage pitch conversion is performed slowly because the second interval at the unequal pitch formed by the first-stage pitch conversion is narrowed to the first interval. Accordingly, the second-stage pitch conversion can be slowly performed at a position where throughput of the first-stage pitch conversion is not reduced.

[0020] Further, in the substrate processing apparatus according to the present invention,

[0021] it is preferable that the plurality of the substrates aligned at the narrow interval is a plurality of the substrates aligned at a first narrow pitch narrower than the equal pitch, and

[0022] the plurality of the substrates aligned at the narrow pitch is a plurality of the substrates aligned at a second narrow pitch narrower than the first narrow pitch. In this way, the second-stage pitch conversion is performed slowly because the first narrow pitch formed by the first-stage pitch conversion is narrowed to the second narrow pitch. However, the second-stage pitch conversion is performed at the position where the throughput is not reduced. This makes it possible to efficiently process the substrates.

[0023] Further, in the substrate processing apparatus according to the present invention,

[0024] it is preferable that the substrate processing apparatus includes:

[0025] a traverse mechanism configured to cause a traverse holder collectively holding the plurality of the substrates aligned at the narrow interval and received from the pusher member to traverse along a traverse path between a substrate transfer position and a substrate delivery position, in which

[0026] the substrate transfer position is a position where the plurality of the substrates aligned at the narrow interval is collectively delivered between the pusher member and the traverse holder,

[0027] the substrate delivery position is a position where the plurality of the substrates aligned at the narrow pitch is collectively delivered between the pitch converter and the main transport mechanism,

[0028] the pitch converter moves up and down along the substrate delivery position to deliver the plurality of the substrates aligned at the narrow interval to and from the traverse holder, and

[0029] the pitch converter is disposed at the substrate delivery position. This makes it possible to separate a position of the pitch converter that performs the second-stage pitch conversion from the pusher mechanism that performs the first-stage pitch conversion. In other words, the second-stage pitch conversion is performed at the position where the throughput of the first-stage pitch conversion is not reduced. This makes it possible to efficiently process the substrates.

[0030] Further, in the substrate processing apparatus according to the present invention,

[0031] the pitch converter is preferably disposed below the traverse path. This makes it possible to perform an operation in the traverse holder and an operation in the pitch converter at the same time, partially at the same time, or at approximately the same timing.

[0032] Further, in the substrate processing apparatus according to the present invention,

[0033] it is preferable that the substrate processing apparatus includes:

[0034] a traverse mechanism configured to cause a traverse holder collectively holding the plurality of the substrates aligned at the narrow interval and received from the pusher member to traverse along a traverse path between a substrate transfer position and a substrate delivery position; and

[0035] an intermediary mechanism configured to raise and lower, along the substrate delivery position, an intermediary holder collectively holding the plurality of the substrates aligned at the narrow pitch, in which

[0036] the substrate transfer position is a position where the plurality of the substrates aligned at the narrow interval is collectively delivered between the pusher member and the traverse holder,

[0037] the substrate delivery position is a position where the plurality of the substrates aligned at the narrow pitch is collectively delivered between the intermediary holder and the main transport mechanism,

[0038] the pitch converter moves up and down along the substrate delivery position to deliver the plurality of the substrates aligned at the narrow interval to and from the traverse holder,

[0039] the intermediary holder moves up and down along the substrate delivery position to deliver the plurality of the substrates aligned at the narrow pitch to and from the pitch converter, and

[0040] the pitch converter is disposed at the substrate delivery position. This makes it possible to separate the position of the pitch converter that performs the second-stage pitch conversion from the pusher mechanism that performs the first-stage pitch conversion. In other words, the second-stage pitch conversion is performed at the position where the throughput of the first-stage pitch conversion is not reduced. This makes it possible to efficiently process the substrates.

[0041] Further, in the substrate processing apparatus according to the present invention,

[0042] the pitch converter is preferably disposed at a position below the intermediary holder. This makes it possible to perform an operation in the pitch converter and an operation in the intermediary holder at the same time, partially at the same time, or at approximately the same timing.

[0043] Further, in the substrate processing apparatus according to the present invention,

[0044] the pitch converter is preferably disposed below the traverse path. This makes it possible to perform the operation in the traverse holder, the operation in the pitch converter, and the operation in the intermediary holder at the same time, partially at the same time, or at approximately the same timing.

[0045] Further, in the substrate processing apparatus according to the present invention,

[0046] it is preferable that the substrate processing apparatus includes:

[0047] a first traverse mechanism configured to cause, to traverse along a first traverse path, a first traverse holder collectively holding the plurality of the substrates aligned at the narrow interval and received from the pusher member; and

[0048] a second traverse mechanism configured to cause, to traverse along a second traverse path, a second traverse holder collectively holding the plurality of the substrates aligned at the narrow interval and to be delivered to the pusher member, in which

[0049] the pitch converter includes:

[0050] a first pitch converter configured to receive the plurality of the substrates aligned at the narrow interval, and align, at the narrow pitch, the plurality of the substrates aligned at the narrow interval; and

[0051] a second pitch converter configured to receive the plurality of the substrates aligned at the narrow pitch, and align, at the narrow interval, the plurality of the substrates aligned at the narrow pitch. The two-stage pitch conversion is performed separately for the pusher mechanism and the pitch converter. In addition, the pitch conversion is performed separately for the first pitch converter and the second pitch converter before and after the processing in the substrate processor. In this way, the throughput is not reduced. This makes it possible to efficiently process the substrates.

[0052] Further, in the substrate processing apparatus according to the present invention,

[0053] it is preferable that the first traverse path is a path between a substrate transfer position and a substrate carry-in position,

[0054] the second traverse path is a path between a substrate carry-out position and a substrate transfer position,

[0055] the first traverse path and the second traverse path are provided at positions apart from each other in a lateral direction,

[0056] the first pitch converter is disposed at the substrate carry-in position, and

[0057] the second pitch converter is disposed at the substrate carry-out position. The first traverse path and the second traverse path are provided at positions apart from each other in the lateral direction. Therefore, a height of the substrate processing apparatus is suppressed. The first pitch converter and the second pitch converter perform the pitch conversion at positions apart from each other in the lateral direction. In this way, since the first pitch converter and the second pitch converter do not interfere with each other, respective pitch conversion can be performed at the same time, partially at the same time, or at approximately the same timing. Therefore, the throughput can be improved. As a result, the substrates can be efficiently processed.

[0058] Further, in the substrate processing apparatus according to the present invention,

[0059] it is preferable that the first pitch converter

[0060] receives the plurality of the substrates aligned at the narrow interval from the first traverse holder to carry the plurality of the substrates aligned at the narrow pitch into the main transport mechanism. This makes it possible to efficiently carry the substrates into the first traverse holder, the first pitch converter, and the main transport mechanism.

[0061] Further, it is preferable that the substrate processing apparatus according to the present invention includes:

[0062] an intermediary mechanism configured to raise, along the substrate carry-in position, an intermediary holder collectively holding the plurality of the substrates aligned at the narrow pitch, in which

[0063] the substrate transfer position is a position where the plurality of the substrates aligned at the narrow interval is collectively carried from the pusher member to the first traverse holder,

[0064] the substrate carry-in position is a position where the plurality of the substrates aligned at the narrow pitch is collectively carried from the intermediary holder to the main transport mechanism,

[0065] the first pitch converter moves up along the substrate carry-in position to carry in the plurality of the substrates aligned at the narrow interval from the first traverse holder,

[0066] the intermediary holder moves up along the substrate carry-in position to carry in the plurality of the substrates aligned at the narrow pitch from the pitch converter, and

[0067] the first pitch converter is disposed at the substrate carry-in position. This makes it possible to efficiently perform the pitch conversion by the first pitch converter during substrate carry-in processing performed in the first traverse holder, the first pitch converter, the intermediary holder, and the main transport mechanism.

[0068] Further, in the substrate processing apparatus according to the present invention,

[0069] the first pitch converter is preferably disposed below the intermediary holder. This makes it possible to perform an operation in the first pitch converter and an operation in the intermediary holder at the same time, partially at the same time, or at approximately the same timing.

[0070] Further, in the substrate processing apparatus according to the present invention,

[0071] the first pitch converter is preferably disposed below the first traverse path. This makes it possible to perform an operation in the first traverse holder, an operation in the first pitch converter and an operation in the intermediary holder at the same time, partially at the same time, or at approximately the same timing.

[0072] Further, in the substrate processing apparatus according to the present invention,

[0073] it is preferable that the second pitch converter

[0074] receives the plurality of the substrates aligned at the narrow pitch from the main transport mechanism to carry out the plurality of the substrates aligned at the narrow interval to the second traverse holder, and

[0075] is disposed at the substrate carry-out position. This makes it possible to efficiently perform the pitch conversion by the second pitch converter during substrate carry-out processing.

[0076] Further, in the substrate processing apparatus according to the present invention,

[0077] the second pitch converter is preferably disposed below the second traverse path. This make it possible to perform an operation in the second pitch converter and

an operation in the second traverse holder at the same time, partially at the same time, or at approximately the same timing.

[0078] Further, in the substrate processing apparatus according to the present invention,

[0079] the second pitch converter is preferably disposed above the first pitch converter. This makes it possible to perform the operation in the first pitch converter and the operation in the second pitch converter at the same time, partially at the same time, or at approximately the same timing.

[0080] Further, in the substrate processing apparatus according to the present invention,

[0081] the second pitch converter is preferably disposed above the intermediary holder. This makes it possible to perform the operation in the first pitch converter, the operation in the intermediary holder, and the operation in the second pitch converter at the same time, partially at the same time, or at approximately the same timing.

[0082] Further, in the substrate processing apparatus according to the present invention,

[0083] it is preferable that the first traverse path and the second traverse path cross each other at a predetermined angle,

[0084] the pusher mechanism is disposed at a position where the first traverse path and the second traverse path cross each other at the predetermined angle, and

[0085] the first pitch converter and the second pitch converter are disposed apart from each other at the predetermined angle. This makes it possible to separate the first pitch converter and the second pitch converter from each other at positions where interference is less likely to occur.

[0086] Further, in the substrate processing apparatus according to the present invention,

[0087] it is preferable that the substrate processing apparatus includes:

[0088] a traverse mechanism configured to cause a traverse holder collectively holding the plurality of the substrates aligned at the narrow interval and received from the pusher member to traverse along a traverse path between a substrate transfer position and a substrate delivery position, in which

[0089] the pitch converter is included in the traverse mechanism. This makes it possible to suppress the height of the substrate processing apparatus as the pitch converter is integrated with the traverse mechanism.

[0090] Further, in the substrate processing apparatus according to the present invention,

[0091] it is preferable that the first pitch converter is included in the first traverse mechanism, and

[0092] the second pitch converter is included in the second traverse mechanism. This makes it possible to suppress the height of the substrate processing apparatus as the first pitch converter is integrated with the first traverse mechanism and the second pitch converter is integrated with the second traverse mechanism.

[0093] With the substrate processing apparatus according to the present invention, it is possible to perform other processing before or after the processing in the substrate processor while performing the pitch conversion. This makes it possible to efficiently process the substrates.

BRIEF DESCRIPTION OF THE DRAWINGS

[0094] For the purpose of illustrating the invention, there are shown in the drawings several forms which are presently preferred, it being understood, however, that the invention is not limited to the precise arrangement and instrumentalities shown.

[0095] FIG. **1** is a plan view illustrating a schematic configuration of a substrate processing apparatus according to Example 1;

[0096] FIG. **2** is a plan view illustrating configurations of a transfer block and a periphery thereof;

[0097] FIG. **3** is a side view illustrating a substrate handling mechanism;

[0098] FIG. **4** is a side view illustrating an attitude changer;

[0099] FIG. **5** is a side view illustrating a pusher mechanism;

[0100] FIG. **6** is a side view illustrating a pusher member in a longitudinal cross section;

[0101] FIG. **7** is a side view illustrating a delivery mechanism, two pitch converters, and the like when viewed as indicated by arrows A-A in FIG. **2**;

[0102] FIG. **8** is a plan view mainly illustrating a carry-in mechanism and a carry-out mechanism;

[0103] FIG. **9** is a plan view mainly illustrating an intermediary mechanism;

[0104] FIG. **10** is a side view illustrating a schematic configuration of a pitch converter that holds a plurality of substrates aligned at an unequal pitch;

[0105] FIG. **11** is a side view illustrating a schematic configuration of a pitch converter that holds the plurality of substrates aligned at a narrow pitch;

[0106] FIG. **12** is a bottom view mainly illustrating an expansion/contraction mechanism of the pitch converter that holds the plurality of substrates aligned at the unequal pitch;

[0107] FIG. **13** is a bottom view mainly illustrating an expansion/contraction mechanism of the pitch converter that holds the plurality of substrates aligned at the narrow pitch;

[0108] FIG. **14** is a flowchart for explaining an operation of a first half of the substrate processing apparatus;

[0109] FIGS. **15**A, **15**B, and **15**C are side views for explaining operations of the substrate processing apparatus;

[0110] FIGS. **16**A, **16**B, and **16**C are side views for explaining operations of the substrate processing apparatus;

[0111] FIGS. **17**A, **17**B, and **17**C are side views for explaining operations of the substrate processing apparatus;

[0112] FIGS. **18**A and **18**B are side views for explaining operations of the substrate processing apparatus;

[0113] FIGS. **19**A and **19**B are side views for explaining operations of the substrate processing apparatus;

[0114] FIGS. **20**A and **20**B are side views for explaining operations of the substrate processing apparatus;

[0115] FIG. **21** is a flowchart for explaining an operation of a second half of the substrate processing apparatus;

[0116] FIGS. **22**A and **22**B are side views for explaining operations of the substrate processing apparatus;

[0117] FIGS. **23**A and **23**B are side views for explaining operations of the substrate processing apparatus;

[0118] FIGS. **24**A and **24**B are side views for explaining operations of the substrate processing apparatus;

[0119] FIGS. **25**A, **25**B, and **25**C are side views for explaining operations of the substrate processing apparatus;

[0120] FIGS. **26**A, **26**B, and **26**C are side views for explaining operations of the substrate processing apparatus;

[0121] FIG. **27** is a plan view illustrating configurations of a transfer block and a periphery thereof according to Example 2;

[0122] FIG. **28** is a side view illustrating the delivery mechanism, the two pitch converters, and the like when viewed as indicated by arrows A-A in FIG. **27**;

[0123] FIG. **29** is a plan view illustrating configurations of a transfer block and a periphery thereof according to Example 3;

[0124] FIG. **30** is a side view illustrating the delivery mechanism, the two pitch converters, and the like when viewed as indicated by arrows A-A in FIG. **29**;

[0125] FIG. **31** is a plan view illustrating configurations of a transfer block and a periphery thereof according to Example 4;

[0126] FIG. **32** is a side view illustrating the delivery mechanism, the two pitch converters, and the like when viewed as indicated by arrows A-A in FIG. **31**;

[0127] FIG. **33** is a plan view illustrating configurations of a transfer block and a periphery thereof according to Example 5;

[0128] FIG. **34** is a side view illustrating an expansion/contraction mechanism of the pitch converter included in a pair of chuck members of the carry-in mechanism and a pair of chuck members of the carry-out mechanism; and

[0129] FIG. **35** is a side view illustrating the expansion/contraction mechanism of the pitch converter included in the pair of chuck members of the carry-in mechanism and the pair of chuck members of the carry-out mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS DETAILED DESCRIPTION

Example 1

[0130] Hereinafter, Example 1 of the present invention will be described with reference to the drawings. FIG. **1** is a plan view illustrating a schematic configuration of a substrate processing apparatus **1** according to Example 1. FIG. **2** is a plan view illustrating configurations of a transfer block **5** and a periphery thereof.

[0131] In the present description, for convenience, a direction where the transfer block **5** and a processing block **7** are arranged is referred to as a "front-back direction X". The front-back direction X is horizontal. In the front-back direction X, for example, a direction from the processing block **7** toward the transfer block **5** is referred to as "front". A direction opposite to the front is referred to as "back". A horizontal direction orthogonal to the front-back direction X is referred to as a "width direction Y". One side in the "width direction Y" is appropriately referred to as a "right side". A side opposite to the right side is referred to as a "left side". A direction perpendicular to the horizontal direction is referred to as a "vertical direction Z". In each of the drawings, front, back, right, left, top, and bottom are appropriately illustrated for reference.

<1. Configuration of Substrate Processing Apparatus>

[0132] Refer to FIG. **1**. The substrate processing apparatus **1** processes substrates W. The substrate processing apparatus **1** is a batch-type substrate processing apparatus that collectively processes a plurality of (for example, 50, 75, or 100) substrates W. The substrate processing apparatus **1** performs, for example, chemical liquid processing, cleaning processing, drying processing, and the like on the substrates W. The substrate processing apparatus **1** includes a stocker **2**, a placement shelf **3**, a transfer block **5**, a processing block **7**, and a batch substrate transport region **8**.

<1-1. Stocker>

[0133] The stocker **2** accommodates at least one carrier C. The stocker **2** is adjacent to a front side of the transfer block **5**. The carrier C stores a plurality of (for example, 25) substrates W at a predetermined interval (for example, 10 mm) in a horizontal attitude. In other words, the carrier C stores N (for example, 25) substrates W aligned at a reference pitch in the horizontal attitude. Note that N is a natural number of 2 or more. Note that, at the reference pitch, a reference interval TN**9** (for example, 10 millimeters (mm)) is repeated. In other words, in a case where the reference interval TN**9** is 10 mm, the reference pitch is 10 mm. The N substrates W in the carrier C are aligned in the vertical direction Z or a thickness direction of each of the substrates W. As the carrier C, for example, a front opening unify pod (FOUP) is used, but the carrier C is not limited thereto.

[0134] The stocker **2** includes a plurality of (for example, two) load ports **9**. The two load ports **9** are disposed in the width direction Y. In the present example, the two load ports **9** are used for carrying in and carrying out the carrier C. Further, the stocker **2** includes at least one storage shelf **11** and a carrier transport robot **13**. The carrier C is placed on the storage shelf **11**.

[0135] The carrier transport robot **13** transports the carrier C among the two load ports **9**, the storage shelf **11**, and the placement shelf **3**. The carrier transport robot **13** includes, for example, a grip **15** that grips a protrusion provided on an upper face of the carrier C. The carrier transport robot **13** can move the grip **15** in the horizontal direction (the front-back direction X and the width direction Y) and the vertical direction Z. The carrier transport robot **13** is driven by one or more electric motors.

[0136] The placement shelf **3** is disposed in a region of the stocker **2**. The placement shelf **3** is adjacent to the front side of the transfer block **5**. The carrier C is placed on the placement shelf **3**.

<1-2. Transfer Block>

[0137] Refer to FIGS. **1** and **2**. The transfer block **5** includes a substrate handling mechanism (robot) HTR, an attitude changer **19**, a pusher mechanism **21**, a delivery mechanism **23**, and two pitch converters **25**, **26**.

[0138] The substrate handling mechanism HTR is disposed behind the placement shelf **3**. The substrate handling mechanism HTR transports the plurality of (for example, 25) substrates W in the horizontal attitude between the carrier C placed on the placement shelf **3** and the attitude changer **19**. As illustrated in FIG. **3**, the substrate handling mechanism HTR includes a plurality of (for example, 25 or 13) hands **27**. Each of the hands **27** holds one substrate W. The plurality of (**25**) hands **27** is arranged at the reference pitch in the vertical direction Z. Therefore, for example, the 25 substrates W held by the 25 hands **27** are aligned at the reference pitch. Note that, at the reference pitch, the reference interval TN**9** (for example, 10 mm) is repeated.

[0139] Note that, in FIG. **3** and the like, for convenience of illustration, the substrate handling mechanism HTR includes 5 hands **27**. Further, a pair of horizontal holders **37**

and a pair of vertical holders **39** to be described later hold 5 substrates W. Further, a pusher member **55** to be described later supports 10 substrates W.

[0140] The substrate handling mechanism HTR further includes a hand support **29**, an advancing/retracting portion **31**, and a lifting rotator **33**. The hand support **29** supports the plurality of hands **27**. The advancing/retracting portion **31** causes the plurality of hands **27** to advance and retract via the hand support **29**. The lifting rotator **33** rotates the advancing/retracting portion **31** about a vertical axis AX**1** to change a direction of the hands **27**. The lifting rotator **33** is fixed to a floor face. Note that the advancing/retracting portion **31** and the lifting rotator **33** each include the electric motor. Further, the substrate handling mechanism HTR may include a movable hand (not illustrated) for transporting only one substrate W, separately from the hands **27**.

[0141] The attitude changer **19** changes the plurality of (for example, 25) substrates W between the horizontal attitude and a vertical attitude. The attitude changer **19** is disposed on a left side of the substrate handling mechanism HTR. As illustrated in FIG. **4**, the attitude changer **19** includes a support base **35**, the pair of horizontal holders **37**, the pair of vertical holders **39**, and a rotation driver **41**.

[0142] The support base **35** is rotatably supported about a horizontal axis AX**2** extending in the front-back direction X. The pair of horizontal holders **37** and the pair of vertical holders **39** are provided to extend at a right angle from a support face **35**A. When the plurality of substrates W is in the horizontal attitude, the pair of horizontal holders **37** holds the plurality of substrates W. In other words, when the plurality of substrates W is in the horizontal attitude, the plurality of substrates W is placed on the pair of horizontal holders **37**. Further, when the plurality of substrates W is in the vertical attitude, the pair of vertical holders **39** holds the plurality of substrates W.

[0143] The pair of horizontal holders **37** and the pair of vertical holders **39** are both disposed in the front-back direction X (see FIG. **2**). Further, when the pair of horizontal holders **37** holds the plurality of substrates W in the horizontal attitude, the pair of vertical holders **39** is disposed closer to the pusher mechanism **21** than the pair of horizontal holders **37**. The pair of horizontal holders **37** has a plurality of pairs (for example, 25 pairs, 38 pairs, or 50 pairs) of shelves **37**A arranged at the reference pitch in a direction DR**1** where the pair of horizontal holders **37** extends. The pair of vertical holders **39** has a plurality of pairs (for example, 25 pairs, 38 pairs, or 50 pairs) of holding grooves **39**A arranged at the reference pitch in the direction DR**1** where the pair of vertical holders **39** extends.

[0144] Further, the attitude changer **19** further includes an axial moving portion **51** and an accommodation moving portion **53**. The axial moving portion **51** moves the pair of horizontal holders **37** by a preset minute distance in the direction DR**1** where the pair of horizontal holders **37** extends. The accommodation moving portion **53** moves the pair of vertical holders **39** close to or away from the pair of horizontal holders **37**. For example, when the pair of horizontal holders **37** holds the plurality of substrates W in the horizontal attitude, the accommodation moving portion **53** can move the pair of vertical holders **39** in the width direction Y. The rotation driver **41** changes the plurality of substrates W held by the pair of horizontal holders **37** and the pair of vertical holders **39** between the horizontal attitude and the vertical attitude.

[0145] Note that the rotation driver **41** includes, for example, the electric motor. The axial moving portion **51** and the accommodation moving portion **53** each include an air cylinder or an electric actuator. The electric actuator includes the electric motor.

[0146] The pusher mechanism **21** is disposed on a left side of the attitude changer **19**. As illustrated in FIG. **5**, the pusher mechanism **21** includes a pusher member **55**, a rotation shaft **57**, a pusher rotator **59**, a pusher horizontal moving portion **61**, a lifting base **63**, and a pusher lifting portion **65**.

[0147] The pusher member **55** holds the plurality of substrates W arranged at a narrow interval narrower than the reference pitch at which the reference interval TN**9** is repeated. For example, as illustrated in FIG. **6**, the pusher member **55** holds, in the vertical attitude, the plurality of (for example, 50, 75, or 100) substrates W aligned at an unequal pitch where a first interval TN**1** (for example, 3.333 mm) and a second interval TN**2** (for example, 6.666 mm) are alternately repeated. As illustrated in FIG. **6**, the pusher member **55** holds, in the vertical attitude, the plurality of (for example, 50, 75, or 100) substrates W aligned at the unequal pitch where the first interval TN**1** (for example, 3.333 mm) and the second interval TN**2** (for example, 6.666 mm) are alternately repeated. The second interval TN**2** is an interval wider than the first interval TN**1** (second interval TN**2**>first interval TN**1**). Note that the first interval TN**1** is also referred to as the narrow interval, and the second interval TN**2** is also referred to as a wide interval.

[0148] As illustrated in FIG. **6**, the pusher member **55** includes a plurality of (for example, 50, 75, or 100) vertical holding grooves **67** for holding the plurality of substrates W in the vertical attitude. For example, the plurality of vertical holding grooves **67** is arranged at the unequal pitch where the first interval TN**1** and the second interval TN**2** are alternately repeated. A sum of the first interval TN**1** (for example, 3.333 mm) and the second interval TN**2** (for example, 6.666 mm) is the reference interval TN**9** (for example, 10 mm).

[0149] Refer to FIG. **5**. A lower face of the pusher member **55** is connected to an upper end of the rotation shaft **57**. The pusher rotator **59** rotates the pusher member **55** and the rotation shaft **57** about a vertical axis AX**3** passing through the rotation shaft **57**. Accordingly, the plurality of substrates W supported by the pusher member **55** in the vertical attitude is rotated about the vertical axis AX**3**. The pusher rotator **59** includes, for example, the electric motor. The pusher rotator **59** is provided below the pusher member **55**. Further, the pusher rotator **59** is attached to an upper face of the lifting base **63** via the pusher horizontal moving portion **61**.

[0150] The pusher horizontal moving portion **61** includes two guide rails **61**A each extending in the width direction Y, a slider **61**B, and the electric motor that is not illustrated. The two guide rails **61**A are provided on the upper face of the lifting base **63**. The slider **61**B is moved in the width direction Y along the two guide rails **61**A. The slider **61**B is driven by the electric motor. The pusher lifting portion **65** raises and lowers the lifting base **63** in the vertical direction Z. Accordingly, the pusher member **55** is raised and lowered. The pusher lifting portion **65** includes, for example, the electric actuator.

[0151] Refer to FIG. **2**. The two pitch converters **25**, **26** are disposed on a main transport mechanism WTR side of the pusher mechanism **21**, that is, on a left side of the pusher

mechanism **21**. Further, if the two pitch converters **25**, **26** are disposed in the vertical direction Z, the substrate processing apparatus **1** becomes unnecessarily high. In this regard, the two pitch converters **25**, **26** are disposed in the front-back direction X. In other words, the first pitch converter **25** is disposed behind the second pitch converter **26** in plan view. Therefore, it is possible to suppress the substrate processing apparatus **1** to be unnecessarily high. For example, the delivery mechanism **23** transports the plurality of substrates W aligned at the unequal pitch between the pusher member **55** and the two pitch converters **25**, **26**.

[0152] The first pitch converter **25** and the second pitch converter **26** are arranged apart from each other at a predetermined angle α around a substrate transfer position Po of the pusher mechanism **21**. In other words, the first pitch converter **25** is located at a substrate carry-in position Pin apart from the second pitch converter **26** by the predetermined angle α. The second pitch converter **26** is located at a substrate carry-out position Pout apart from the first pitch converter **25** by the predetermined angle α. Further, a first traverse path Rin along which the first pitch converter **25** to be described later traverses and a second traverse path Rout along which the second pitch converter **26** traverses cross each other at the predetermined angle α. The pusher mechanism **21** is disposed at a position where the first traverse path Rin and the second traverse path Rout cross each other at the predetermined angle α. In this way, the first pitch converter **25** and the second pitch converter **26** are separated from each other at positions where interference is less likely to occur. Note that the substrate transfer position Po, the substrate carry-in position Pin, and the second traverse path Rout are positions when the transfer block **5** is viewed in plan view as illustrated in FIG. **2**.

[0153] Refer to FIGS. **2** and **7**. FIG. **7** is a side view illustrating the delivery mechanism **23**, the two pitch converters **25**, **26**, and the like when viewed as indicated by arrows A-A in FIG. **2**. The delivery mechanism **23** includes a carry-in mechanism **71**, an intermediary mechanism **73**, and a carry-out mechanism **75**. The carry-in mechanism **71** transports the plurality of substrates W aligned at the unequal pitch from the pusher member **55** to the first pitch converter **25**. The intermediary mechanism **73** transports the plurality of substrates W aligned at a narrow pitch from the first pitch converter **25** to a first delivery position P**1**. The carry-out mechanism **75** transports the plurality of substrates W aligned at the unequal pitch from the second pitch converter **26** to the pusher member **55**. The carry-in mechanism **71**, the intermediary mechanism **73**, and the carry-out mechanism **75** include a chuck **77**, a chuck **78**, and a chuck **79**, respectively.

[0154] As illustrated in FIG. **7**, the carry-in mechanism **71** is disposed at a carry-in height position H**1** along the substrate carry-in position Pin. The carry-in mechanism **71** is disposed, for example, on a lifting portion **141** side of the second pitch converter **26** along the substrate carry-in position Pin. The chuck **78** of the intermediary mechanism **73** is provided at a position above the first pitch converter **25** along the substrate carry-in position Pin. Further, the chuck **78** of the intermediary mechanism **73** is disposed between the carry-in height position H**1** and the first delivery position P**1** along the substrate carry-in position Pin. The first delivery position P**1** is a position higher than the carry-in height position H**1** and a carry-out height position H**2** along the substrate carry-in position Pin. The carry-out mechanism **75** is disposed at the carry-out height position H**2** higher than the carry-in height position H**1** along the substrate carry-out position Pout. The carry-in mechanism **71** and the carry-out mechanism **75** each are configured such that the carry-out mechanism **75** and the plurality of substrates W held by the carry-out mechanism **75** do not interfere with the carry-in mechanism **71** and the plurality of other substrates W held by the carry-in mechanism **71**. The substrate carry-in position Pin and the substrate carry-out position Pout are provided at positions sufficiently separated in the front-back direction X. Note that, as illustrated in FIG. **7**, the substrate carry-in position Pin may be indicated by a two-dot chain line extending in the vertical direction Z. Further, the substrate carry-out position Pout may also be indicated by the one-dot chain line extending in the vertical direction Z.

[0155] FIG. **8** is a plan view mainly illustrating the carry-in mechanism **71** and the carry-out mechanism **75**. The carry-in mechanism **71** is disposed at the substrate carry-in position Pin behind the carry-out mechanism **75**. The carry-out mechanism **75** is disposed at the substrate carry-out position Pout before the carry-in mechanism **71**. In other words, the carry-in mechanism **71** is disposed at the substrate carry-in position Pin close to the processing block **7** side, and the carry-out mechanism **75** is disposed at the substrate carry-out position Pout close to the stocker **2** side. The carry-in mechanism **71** includes the chuck **77**, an opening/closing portion **81**, a front-back moving portion **83**, and a widthwise moving portion **85**.

[0156] The chuck **77** holds the plurality of substrates W aligned at the unequal pitch in the vertical attitude. The chuck **77** includes a pair of chuck members **77**A, **77**B each extending in the width direction Y. The pair of chuck members **77**A, **77**B includes a plurality of pairs (for example, 50 pairs, 75 pairs, or 100 pairs) of holding grooves **87**, **88** arranged at the unequal pitch. Note that, at the unequal pitch, the first interval TN**1** (for example, 3.333 mm) and the second interval TN**2** (for example, 6.666 mm) are alternately arranged. The first chuck member **77**A is provided with the plurality of holding grooves **87** arranged at the unequal pitch. Further, the second chuck member **77**B is provided with a plurality of holding grooves **88** arranged at the unequal pitch.

[0157] The opening/closing portion **81** supports two chuck members **77**A, **77**B to be movable in the front-back direction X. Further, the opening/closing portion **81** opens and closes the two chuck members **77**A, **77**B in the front-back direction X. Specifically, the opening/closing portion **81** brings the two chuck members **77**A, **77**B close to or away from each other. When the opening/closing portion **81** closes the chuck **77**, the chuck **77** can hold the plurality of substrates W in the vertical attitude. On the other hand, when the opening/closing portion **81** opens the chuck **77**, the chuck **77** can pass, in the vertical direction Z, the plurality of substrates W in the vertical attitude between the two chuck members **77**A, **77**B. The opening/closing portion **81** includes the air cylinder or the electric actuator that drives the two chuck members **77**A, **77**B.

[0158] The front-back moving portion **83** is disposed closer to two pitch converters **25**, **26** than the widthwise moving portion **85**. The front-back moving portion **83** horizontally moves the chuck **77** and the opening/closing portion **81** in the front-back direction X. The widthwise moving portion **85** horizontally moves the chuck **77**, the opening/closing portion **81**, and the front-back moving

portion **83** in the width direction Y. In other words, it is possible for the front-back moving portion **83** and the widthwise moving portion **85** to move the chuck **77** in the front-back direction X and the width direction Y (a two-dimensional direction). Accordingly, it is possible for the carry-in mechanism **71** to move the chuck **77** between the substrate transfer position Po and the substrate delivery position (the substrate carry-in position Pin and the substrate carry-out position Pout) to be described later. Movement in an oblique direction such as the first traverse path Rin and the second traverse path Rout described above is implemented by simultaneously performing movement in the front-back direction X and movement in the width direction Y. The front-back moving portion **83** includes, for example, the air cylinder or the electric actuator. The widthwise moving portion **85** includes the electric actuator.

[0159] The carry-out mechanism **75** includes the chuck **79**, an opening/closing portion **89**, a front-back moving portion **91**, and a widthwise moving portion **93**. The chuck **79** is configured similarly to the chuck **77**. Specifically, the chuck **79** includes a pair of chuck members **79**A, **79**B each extending in the width direction Y. The pair of chuck members **79**A, **79**B includes a plurality of pairs (for example, 50 pairs, 75 pairs, or 100 pairs) of holding grooves **95**, **96** arranged at the unequal pitch. The front-back moving portion **91** is disposed closer to the two pitch converters **25**, **26** than the widthwise moving portion **93**. In addition, the opening/closing portion **89**, the front-back moving portion **91**, and the widthwise moving portion **93** are configured similarly to the opening/closing portion **81**, the front-back moving portion **83**, and the widthwise moving portion **85**, respectively.

[0160] FIG. **9** is a plan view mainly illustrating the intermediary mechanism **73**. The intermediary mechanism **73** is disposed at the same substrate carry-in position Pin as the carry-in mechanism **71**. The intermediary mechanism **73** includes the chuck **78**, an opening/closing portion **101**, an arm **103**, and a lifting portion **105**. The chuck **78** includes a pair of chuck members **78**A, **78**B each extending in the width direction Y. The pair of chuck members **78**A, **78**B includes a plurality of pairs (for example, 50 pairs, 75 pairs, or 100 pairs) of holding grooves **107**, **108** arranged at the narrow pitch (for example, 3.333 mm (⅓ pitch)). Specifically, the first chuck member **78**A is provided with a plurality of holding grooves **107** arranged at the narrow pitch in the width direction Y. Further, the second chuck member **78**B is provided with a plurality of holding grooves **108** arranged at the narrow pitch.

[0161] The opening/closing portion **101** is provided on a right side (the pusher mechanism **21** side) of the chuck **78**. In addition, the opening/closing portion **101** is configured similarly to the opening/closing portion **81**. More specifically, the opening/closing portion **101** supports the pair of chuck members **78**A, **78**B to be movable in the front-back direction X. Further, the opening/closing portion **101** opens and closes the pair of chuck members **78**A, **78**B in the front-back direction X. When the opening/closing portion **101** closes the chuck **78**, the chuck **78** can hold the plurality of substrates W aligned at the narrow pitch in the vertical attitude. On the other hand, when the opening/closing portion **101** opens the chuck **78**, the chuck **78** can pass, in the vertical direction Z, the plurality of substrates W in the vertical attitude between the two chuck members **78**A, **78**B.

[0162] The opening/closing portion **101** is attached to the lifting portion **105** via the arm **103** to be movable up and down. The lifting portion **105** raises and lowers the chuck **78** and the opening/closing portion **101** in the vertical direction Z. The lifting portion **105** includes, for example, the electric actuator. This makes it possible for the intermediary mechanism **73** to receive the plurality of substrates W in the vertical attitude aligned at the narrow pitch from the first pitch converter **25** and move the plurality of substrates W to the first delivery position P**1** (see FIG. **7**) in order to transfer the plurality of substrates W to the main transport mechanism WTR.

[0163] Note that the transfer block **5** has two transport paths for transporting the plurality of substrates W between the pusher member **55** (the pusher mechanism **21**) and the main transport mechanism WTR. In other words, a first transport path is a path passing through the carry-in mechanism **71**, the first pitch converter **25**, and the intermediary mechanism **73**. Further, a second transport path is a path passing through the second pitch converter **26** and the carry-out mechanism **75**. For example, when 50 substrates W are held by the intermediary mechanism **73**, the carry-out mechanism **75** can transport 50 substrates W processed in a chemical liquid processing tank BT**1** or the like to the pusher member **55**. Therefore, 50 substrates W (a processed substrate group) can be smoothly transported.

<1-2-1. Pitch Converter>

[0164] Refer to FIGS. **7** and **10** to **13**. The two pitch converters **25**, **26** each convert the pitches of the plurality of substrates W between the unequal pitch and the narrow pitch. At the unequal pitch, the first interval TN**1** (for example, 3.333 mm) and the second interval TN**2** (for example, 6.666 mm) wider than the first interval TN**1** are alternately repeated. Note that, at the narrow pitch, the first interval TN**1** is repeated.

[0165] The first pitch converter **25** aligns, at the narrow pitch, the plurality of substrates W aligned at the unequal pitch. In other words, the first pitch converter **25** converts the pitches of the plurality of substrates W before being processed in the processing block **7** into the narrow pitch. On the other hand, the second pitch converter **26** aligns, at the unequal pitch, the plurality of substrates W aligned at the narrow pitch. In other words, the second pitch converter **26** converts the pitches of the plurality of substrates W processed in the processing block **7** into the unequal pitch.

[0166] The two pitch converters **25**, **26** each include a pitch conversion body **111**. The pitch conversion body **111** includes a plurality of (for example, 25, 38, or 50) holding members **113** (**113**A to **113**E) and a moving portion **115**.

[0167] The plurality of holding members **113** holds the plurality of substrates W aligned at the unequal pitch in the vertical attitude. The plurality of holding members **113** each has two holding grooves **117** that hold two substrates W out of the plurality of substrates W at the first interval TN**1** (for example, 3.333 mm). The two holding grooves **117** are separated by the first interval TN**1**. The two holding grooves **117** of each of the holding members **113** are disposed in the width direction Y. For example, in a case where the pitch converter **25** includes 25 holding members **113**, the 25 holding members **113** can hold 50 substrates W. Note that, in FIGS. **10** to **13**, for convenience of illustration, the two pitch converters **25**, **26** each include five holding members **113**.

[0168] The moving portion **115** moves the plurality of holding members **113** in an alignment direction (the width direction Y) of the plurality of substrates W to change between an unequal pitch state in which the plurality of substrates W is aligned at the unequal pitch and a narrow pitch state in which the plurality of substrates W is aligned at the narrow pitch. The moving portion **115** includes a base member **119**, two guide rails **121**, an expansion/contraction mechanism **123**, a driver **125**, and a connector **127**.

[0169] The two guide rails **121** support the plurality of holding members **113** to be movable in the alignment direction (the width direction Y). The two guide rails **121** each extend in the width direction Y. The two guide rails **121** are attached to an upper face of the base member **119**. Note that a central holding member **113**C out of the plurality of holding members **113** is fixed to the base member **119** with, for example, a screw SW. In other words, the central holding member **113**C does not move in the width direction Y. Note that the number of the guide rails **121** is not limited to two, and may be one or three or more. In other words, the moving portion **115** may include one or more guide rails **121**.

[0170] The expansion/contraction mechanism **123** causes the plurality of holding members **113** to expand and contract in the alignment direction (the width direction Y). The expansion/contraction mechanism **123** is connected to each of the holding members **113**. The expansion/contraction mechanism **123** includes, for example, a link mechanism. Specifically, the expansion/contraction mechanism **123** is configured in, for example, a lazy tongue type, a zigzag linear type, or a type close thereto. The expansion/contraction mechanism **123** includes, for example, a plurality of (five in FIG. **10** and the like) link members **129**, a plurality of (five in FIG. **10** and the like) pins **131**, and a plurality of (four in FIG. **10** and the like) joints **133**. In FIGS. **12** and **13**, for example, the five pins **131** are provided on bottom faces of the five holding members **113**. The five link members **129** each are attached to the five pins **131** to be rotatable about a vertical axis. The five pins **131** are respectively located at five central portions of the five link members **129**. The four joints **133** each connect ends of two adjacent link members **129**.

[0171] For example, a first end of a link member **129**B is connected to a second end of a link member **129**A with a joint **133**A. Further, the second end of the link member **129**B is connected to a first end of a link member **129**C with a joint **133**B.

[0172] The driver **125** drives the expansion/contraction mechanism **123**. The driver **125** is attached to a lower face of the base member **119**. The driver **125** causes a rod **125**A extending in the width direction Y to extend and contract. The driver **125** includes the air cylinder or the electric actuator. The connector **127** connects a holding member **113**E at the side out of the plurality of holding members **113** and a distal end of the rod **125**A of the driver **125**. Note that the connector **127** passes through an opening **119**A of the base member **119**.

[0173] In FIGS. **10** and **12**, for example, when the rod **125**A of the driver **125** extends, the holding member **113**E at the side is separated from the central holding member **113**C, and other three holding members **113**A, **113**B, **113**D are separated from the central holding member **113** C by the expansion/contraction mechanism **123**. Accordingly, the plurality of substrates W is aligned at the unequal pitch. Further, in FIGS. **11** and **13**, for example, when the rod of the driver **125** contracts, the holding member **113**E at the side approaches the central holding member **113**C, and the other three holding members **113**A, **113**B, **113**D are brought close to the central holding member **113**C by the expansion/contraction mechanism **123**. Accordingly, the plurality of substrates W is aligned at the narrow pitch (the first interval TN**1**).

[0174] As illustrated in FIG. **7**, the pitch converters **25**, **26** each include the lifting portion **141**. The lifting portion **141** raises and lowers the pitch conversion body **111** (the plurality of holding members **113** and the moving portion **115**). The lifting portion **141** includes the air cylinder or the electric actuator.

[0175] The lifting portion **141** of the first pitch converter **25** raises and lowers the plurality of holding members **113** between an upper position higher than (an upper face of) the chuck **77** of the carry-in mechanism **71** and a lower position lower than the chuck **77**. Further, the lifting portion **141** of the second pitch converter **26** raises and lowers the plurality of holding members **113** between an upper position higher than (an upper face of) the chuck **79** of the carry-out mechanism **75** and a lower position lower than the chuck **79**.

<1-3. Processing Block>

[0176] Refer to FIG. **1**. The processing block **7** includes a plurality of (for example, four) batch processing tanks BT**1** to BT**4** and a dryer **143**. The four batch processing tanks BT**1** to BT**4** and the dryer **143** are disposed in the front-back direction X where the substrate processing apparatus **1** extends. In each of the four batch processing tanks BT**1** to BT**4**, the plurality of (for example, 50, 75, or 100) substrates W is collectively immersed for processing. The four batch processing tanks BT**1** to BT**4** each store a processing liquid (for example, a chemical liquid or pure water) in which the plurality of substrates W is immersed. Note that the processing block **7** corresponds to the "substrate processor" of the present invention.

[0177] The four batch processing tanks BT**1** to BT**4** include, for example, two chemical liquid processing tanks BT**1**, BT**3** and two cleaning processing tanks BT**2**, BT**4**. The chemical liquid processing tank BT**1** and the cleaning processing tank BT**2** are set as one group, and the chemical liquid processing tank BT**3** and the cleaning processing tank BT**4** are set as the other group. Note that combination of the chemical liquid processing tanks and the cleaning processing tanks is not limited to this example. Further, the number of the batch processing tanks is not limited to four, and may be one or more.

[0178] The two chemical liquid processing tanks BT**1**, BT**3** each perform etching processing using the chemical liquid. For example, the chemical liquid can be a phosphoric acid solution, and is not limited to the phosphoric acid solution. The chemical liquid is heated to a preset temperature. A chemical liquid ejection pipe not illustrated is provided at an inner bottom of each of the chemical liquid processing tanks BT**1**, BT**3**. Each of the chemical liquid processing tanks BT**1**, BT**3** stores the chemical liquid supplied from the chemical liquid ejection pipe.

[0179] The two cleaning processing tanks BT**2**, BT**4** each perform cleaning processing of washing away the chemical liquid adhering to the plurality of substrates W with a cleaning liquid (a rinse liquid). As the cleaning liquid, for example, pure water such as deionized water (DIW) is used.

The cleaning processing tanks BT**2**, BT**4** each store the pure water supplied from a pure water ejection pipe not illustrated.

[0180] The processing block **7** includes a lifter LF**1** as a dedicated transport mechanism for transferring the substrate W processed with the chemical liquid in the chemical liquid processing tank BT**1** to the cleaning processing tank BT**2**, and a lifter LF**2** for transferring the substrate W processed with the chemical liquid in the chemical liquid processing tank BT**3** to the cleaning processing tank BT**4**. Two lifters LF**1**, LF**2** each include a substrate holder that holds, in the vertical attitude, the plurality of substrates W aligned at the narrow pitch in the width direction Y, a lifting portion that raises and lowers the substrate holder, and a horizontal moving portion that moves the substrate holder in the front-back direction X.

[0181] The dryer **143** includes a substrate holding mechanism that holds, in the vertical attitude, the plurality of (for example, 50, 75, or 100) substrates W aligned at the narrow pitch in the width direction Y, and a processing chamber that accommodates the plurality of substrates W held by the substrate holding mechanism. The dryer **143** dries the substrates by supplying an organic solvent (for example, isopropyl alcohol) to the substrates W in a reduced-pressure atmosphere or removing liquid components on surfaces of the substrates W by centrifugal force.

<1-4. Batch Substrate Transport Region>

[0182] The batch substrate transport region **8** is disposed behind the stocker **2**, and is adjacent to left sides of the transfer block **5** and the processing block **7**. The batch substrate transport region **8** extends in the front-back direction X. The batch substrate transport region **8** includes the main transport mechanism WTR (a main transport robot). The main transport mechanism WTR transports, in the front-back direction X, the plurality of (for example, 50, 75, or 100) substrates W in the vertical attitude aligned at the narrow pitch in the width direction Y. Further, the main transport mechanism WTR transports the plurality of substrates W among the first delivery position P**1**, a second delivery position P**2**, the plurality of (for example, four) batch processing tanks BT**1** to BT**4**, and the dryer **143**.

[0183] The main transport mechanism WTR includes a chuck **145**, a chuck lifting portion (not illustrated), a chuck horizontal moving portion (not illustrated), and a guide rail **147**. The chuck **145** holds, in the vertical attitude, the plurality of substrates W in a vertical attitude aligned at the narrow pitch in the width direction Y. The chuck **145** includes a pair of chuck members **145**A, **145**B each extending in the width direction Y. The pair of chuck members **145**A, **145**B includes a plurality of pairs (for example, 50 pairs, 75 pairs, or 100 pairs) of holding grooves arranged at the narrow pitch in the width direction Y. The pair of chuck members **145**A, **145**B is opened and closed by a chuck opening/closing portion not illustrated.

[0184] The chuck **145** is movable in the front-back direction X along the guide rail **147**. The chuck **145** is moved in the front-back direction X by the chuck horizontal moving portion. The chuck **145** is raised and lowered in the vertical direction Z by the chuck lifting portion. The chuck horizontal moving portion and the chuck lifting portion include, for example, the electric actuator. The chuck opening/closing portion includes, for example, the air cylinder or the electric actuator.

<1-5. Controller>

[0185] The substrate processing apparatus **1** includes a controller **151** (see FIG. **1**) and a storage (not illustrated). The controller **151** controls each component of the substrate processing apparatus **1**. The controller **151** includes one or more processors such as a central processing unit (CPU). The storage includes, for example, at least one of a read-only memory (ROM), a random-access memory (RAM), and a hard disk. The storage stores a computer program necessary for controlling each component of the substrate processing apparatus **1**.

<2. Operation of Substrate Processing Apparatus>

[0186] Next, an operation of the substrate processing apparatus **1** will be described with reference to flowcharts in FIGS. **14** and **21**. First, the first half operation from transport of the carrier C to the load ports **9** to drying processing will be described with reference to FIG. **14**. Note that, in the present example, the substrate processing apparatus **1** collectively processes 50 substrates W taken out from two carriers C.

[0187] Note that, in FIG. **15**A and the like, a reference numeral TA denotes surfaces (device faces or main surfaces) of the substrates W (W**1**, W**2**). Note that back faces of the substrates W are faces opposite to front faces of the substrates W. The device faces are faces on which the device is formed or faces on which the device is being formed. Note that, in FIG. **15**A and the like, for convenience of illustration, 25 substrates W**1** are illustrated as 5 substrates W**1**, and 25 substrates W**2** are illustrated as 5 substrates W**2**.

[Step S**01**] Vertical Attitude Changing of First Substrate Group

[0188] Refer to FIG. **1**. An external transport robot not illustrated sequentially transports the two carriers C to the load ports **9**. The carrier transport robot **13** of the stocker **2** transports a first carrier C from one of the load ports **9** to the placement shelf **3**. In the first carrier C, for example, the 25 substrates W**1** (a first substrate group) aligned at the reference pitch (for example, 10 mm) at which the reference interval TN**9** is repeated are stored. The substrate handling mechanism HTR of the transfer block **5** takes out the 25 substrates W**1** in the horizontal attitude from the first carrier C placed on the placement shelf **3** with, for example, the 25 hands **27**. Then, the substrate handling mechanism HTR transports the 25 substrates W**1** taken out to the attitude changer **19**. Note that the carrier transport robot **13** moves the empty first carrier C from which the 25 substrates W**1** have been taken out from the placement shelf **3** to the storage shelf **11**.

[0189] Refer to FIG. **15**A. The attitude changer **19** receives the 25 substrates W**1** aligned at the reference pitch from the substrate handling mechanism HTR. In the attitude changer **19**, the 25 substrates W**1** are held (placed) on 25 pairs of shelves **37**A of the pair of horizontal holders **37**. Refer to FIG. **15**B. Thereafter, the accommodation moving portion **53** (see FIG. **4**) of the attitude changer **19** brings the pair of vertical holders **39** close to the pair of horizontal holders **37**. Accordingly, peripheral edges of the 25 substrates W**1** are accommodated and held in the 25 pairs of holding grooves **39**A of the pair of vertical holders **39**.

[0190] Refer to FIG. **15**C. Thereafter, the attitude changer **19** collectively changes the 25 substrates W**1** (the first

substrate group) held at the reference pitch from the horizontal attitude to the vertical attitude. Specifically, the rotation driver **41** of the attitude changer **19** changes the 25 substrates W**1** held by the pair of horizontal holders **37** and the pair of vertical holders **39** from the horizontal attitude to the vertical attitude. Thereafter, the axial moving portion **51** (see FIG. **4**) of the attitude changer **19** moves the pair of horizontal holders **37** in a direction where the pair of horizontal holders **37** approaches the support face **35**A such that the 25 pairs of shelves **37**A of the pair of horizontal holders **37** are separated from the 25 substrates W**1** in the vertical attitude.

[Step S**02**] Reception of First Substrate Group by Pusher Member

[0191] Refer to FIG. **16**A. Thereafter, the pusher lifting portion **65** (see FIG. **5**) of the pusher mechanism **21** raises the pusher member **55** to a position higher than the pair of horizontal holders **37** and the pair of vertical holders **39**. Accordingly, the pusher member **55** receives the 25 substrates W**1** (the first substrate group) changed into the vertical attitude. Further, the pusher member **55** holds the 25 substrates W**1** aligned at the reference pitch in the vertical attitude. Note that 50 vertical holding grooves **67** are arranged at the unequal pitch.

[Step S**03**] Movement of First Substrate Group by First Interval

[0192] Refer to FIG. **16**B. The pusher mechanism **21** moves the 25 substrates W**1** held by the pusher member **55** by the first interval TN**1** (3.333 mm) in an alignment direction of the 25 substrates W**1**. Specifically, the pusher rotator **59** (see FIG. **5**) of the pusher mechanism **21** rotates the pusher member **55** by 180 degrees about the vertical axis AX**3**. Accordingly, the 25 substrates W**1** held by the pusher member **55** are moved leftward by the first interval TN**1**. Note that the movement by the first interval TN**1** may be performed by rotation of the pusher member **55** by 180 degrees by the pusher rotator **59** and movement of the pusher member **55** in the width direction Y by the pusher horizontal moving portion **61** (see FIG. **5**).

[0193] Further, the attitude changer **19** rotates the pair of horizontal holders **37** and the like by 90 degrees about the horizontal axis AX**2**. Accordingly, the pair of horizontal holders **37** and the like are raised. The axial moving portion **51** (see FIG. **4**) of the attitude changer **19** moves the pair of horizontal holders **37** in a direction where the pair of horizontal holders **37** is separated from the support face **35**A. Further, the accommodation moving portion **53** (see FIG. **4**) of the attitude changer **19** moves the pair of vertical holders **39** away from the pair of horizontal holders **37**.

[Step S**04**] Vertical Attitude Changing of Second Substrate Group

[0194] The carrier transport robot **13** illustrated in FIG. **1** transports a second carrier C from one of the load ports **9** to the placement shelf **3**. Similarly to the first carrier C, for example, the 25 substrates W**2** aligned at the reference pitch (10 mm) are stored in the second carrier C. The substrate handling mechanism HTR takes out the 25 substrates W**2** in the horizontal attitude from the second carrier C placed on the placement shelf **3** using the 25 hands **27**. Then, the substrate handling mechanism HTR transports the 25 substrates W**2** taken out to the attitude changer **19**. Note that the carrier transport robot **13** moves the empty second carrier C from which the 25 substrates W**2** have been taken out from the placement shelf **3** to the storage shelf **11**.

[0195] Refer to FIG. **16**C. The attitude changer **19** receives the 25 substrates W**2** aligned at the reference pitch from the substrate handling mechanism HTR. In the attitude changer **19**, the 25 substrates W**2** are held on the 25 pairs of shelves **37**A of the pair of horizontal holders **37**. Refer to FIG. **17**A. Thereafter, the accommodation moving portion **53** (see FIG. **4**) of the attitude changer **19** brings the pair of vertical holders **39** close to the pair of horizontal holders **37**.

[0196] Refer to FIG. **17**B. Thereafter, the attitude changer **19** collectively changes the 25 substrates W**2** (a second substrate group) held at the reference pitch from the horizontal attitude to the vertical attitude. Thereafter, the axial moving portion **51** (see FIG. **4**) of the attitude changer **19** moves the pair of horizontal holders **37** in the direction where the pair of horizontal holders **37** approaches the support face **35**A such that the 25 pairs of shelves **37**A of the pair of horizontal holders **37** are separated from the 25 substrates W**1** in the vertical attitude.

[Step S**05**] Reception of Second Substrate Group by Pusher Member

[0197] Refer to FIG. **17**C. Thereafter, the pusher lifting portion **65** (see FIG. **5**) of the pusher mechanism **21** raises the pusher member **55** to the position higher than the pair of horizontal holders **37** and the pair of vertical holders **39**. Accordingly, the pusher member **55** receives the 25 substrates W**2** (the second substrate group) changed into the vertical attitude. Further, the pusher member **55** holds 50 substrates W (W**1**, W**2**) aligned at the unequal pitch. The 50 substrates W are configured by alternately arranging the 25 substrates W**1** and the 25 substrates W**2**.

[0198] Further, as illustrated in FIGS. **17**B and **17**C, the surfaces (the device surfaces or the main surfaces) of the 25 substrates W**1** face a predetermined direction (a right side). On the other hand, the surfaces of the 25 substrates W**2** face a direction (a left side) opposite to the predetermined direction. In other words, the 50 substrates W are arranged in a so-called face-to-face manner.

[Step S**06**] Transport of Processed Substrate Group to Pitch Converter by Carry-In Mechanism

[0199] Thereafter, the carry-in mechanism **71** transports the 50 substrates W (a processed substrate group) aligned at the unequal pitch from the pusher member **55** to the first pitch converter **25**. This operation will be described in details. Refer to FIG. **18**A. First, the attitude changer **19** rotates the pair of horizontal holders **37** and the like by 90 degrees about the horizontal axis AX**2**. Accordingly, the pair of horizontal holders **37** and the like are raised.

[0200] Refer to FIG. **18**B. Thereafter, the carry-in mechanism **71** horizontally moves the chuck **77** from the position above the first pitch converter **25** to a position below the pusher member **55**. In other words, the carry-in mechanism **71** causes the chuck **77** without holding the substrates W to traverse from the substrate carry-in position Pin to the substrate transfer position Po along the first traverse path Rin. Before the traverse, the first pitch converter **25** is located below the first traverse path Rin. The first pitch converter **25** is located at the substrate carry-in position Pin.

The first pitch converter **25** is located below the chuck **77**. Further, the pusher member **55** is located at the substrate transfer position Po. The chuck **77** is in a closed state in which the 50 substrates W are held. Thereafter, the pusher mechanism **21** lowers the pusher member **55** that holds the 50 substrates W in the vertical attitude. When the pusher member **55** passes between the pair of chuck members **77**A, **77**B of the chuck **77**, the 50 substrates W are delivered from the pusher member **55** to the chuck **77**. The chuck **77** holds the 50 substrates W aligned at the unequal pitch in the vertical attitude.

[0201] Refer to FIG. **19**A. Thereafter, the carry-in mechanism **71** moves the chuck **77** from a position above the pusher member **55** to the position above the first pitch converter **25**. In other words, the carry-in mechanism **71** causes the chuck **77** holding the 50 substrates W to traverse from the substrate transfer position Po to the substrate carry-in position Pin along the first traverse path Rin. After the traverse, the first pitch converter **25** is located below the first traverse path Rin. The first pitch converter **25** is located at the substrate carry-in position Pin. The first pitch converter **25** is located below the chuck **77**. Further, the pusher member **55** is located at the substrate transfer position Po. The substrate carry-in position is the position above the first pitch converter **25**. Refer to FIG. **19**B. Thereafter, the lifting portion **141** (see FIG. **7**) of the first pitch converter **25** raises the pitch conversion body **111** including 25 holding members **113**. Accordingly, the first pitch converter **25** receives the 50 substrates W from the carry-in mechanism **71**.

[Step S**07**] Pitch Conversion of Processed Substrate Group from Unequal Pitch to Narrow Pitch

[0202] Refer to FIG. **20**A. Thereafter, the first pitch converter **25** converts the pitches of the 50 substrates W from the unequal pitch to the narrow pitch (3.333 mm). In other words, the first pitch converter **25** aligns, at the narrow pitch, the 50 substrates W aligned at the unequal pitch. This operation will be described in details.

[0203] The 25 holding members **113** of the first pitch converter **25** each have the two holding grooves **117** separated by the first interval (3.333 mm). The first pitch converter **25** holds two substrates W**1**, W**2** out of the 50 substrates W using the two holding grooves **117** of each of the 25 holding members **113**, and holds the 50 substrates W aligned at the unequal pitch using the 25 holding members **113**.

[0204] Further, the moving portion **115** (see FIG. **10**) of the first pitch converter **25** moves the 25 holding members **113** in the alignment direction (a Y direction) of the 50 substrates W so as to change from an unequal pitch state in which the 50 substrates W are aligned at the unequal pitch to a narrow pitch state in which the 50 substrates W are aligned at the narrow pitch. Note that the intermediary mechanism **73** opens the chuck **78**.

[Step S**08**] Transport of Processed Substrate Group to First Delivery Position by Intermediary Mechanism

[0205] Refer to FIG. **20**B. Thereafter, the intermediary mechanism **73** lowers the chuck **78** as indicated by a broken line in order to receive the 50 substrates W aligned at the narrow pitch held by the first pitch converter **25**. Thereafter, the intermediary mechanism **73** closes the chuck **78**. Accordingly, the 50 substrates W can be held by the chuck **78**.

[0206] Thereafter, the intermediary mechanism **73** raises the chuck **78** to the first delivery position P**1**. This makes it possible for the intermediary mechanism **73** to receive the 50 substrates W from the first pitch converter **25** and deliver the 50 substrates W to the main transport mechanism WTR. Note that the chuck **78** holds the 50 substrates W aligned at the narrow pitch in the vertical attitude.

[Step S**09**] Substrate Processing and Drying Processing

[0207] Thereafter, the main transport mechanism WTR receives the 50 substrates W from the intermediary mechanism **73** using the chuck **145**, and transports the 50 substrates W to one of the two chemical liquid processing tanks BT**1**, BT**3**. For example, when the main transport mechanism WTR transports the 50 substrates W to the chemical liquid processing tank BT**1**, the lifter LF**1** receives the 50 substrates W aligned at the narrow pitch from the main transport mechanism WTR at a position above the chemical liquid processing tank BT**1**. Thereafter, the lifter LF**1** immerses the 50 substrates W in the chemical liquid stored in the chemical liquid processing tank BT**1** by lowering the 50 substrates W. Accordingly, the 50 substrates W are collectively processed with the chemical liquid.

[0208] Further, after a preset chemical liquid processing time has elapsed, the lifter LF**1** pulls up the 50 substrates W from the chemical liquid in the chemical liquid processing tank BT**1** by raising the 50 substrates W. Thereafter, the lifter LF**1** horizontally moves the 50 substrates W from the position above the chemical liquid processing tank BT**1** to a position above the cleaning processing tank BT**2**. Thereafter, the lifter LF**1** immerses the 50 substrates W in the pure water stored in the cleaning processing tank BT**2** by lowering the 50 substrates W. Accordingly, the 50 substrates W are collectively cleaned. After the preset cleaning processing time has elapsed, the lifter LF**1** pulls up the 50 substrates W from the pure water in the cleaning processing tank BT**2**.

[0209] Note that, when the main transport mechanism WTR transports the 50 substrates W to the chemical liquid processing tank BT**3**, the lifter LF**2** receives the 50 substrates W from the main transport mechanism WTR. Then, the lifter LF**2** transports the 50 substrates W in order of the chemical liquid processing tank BT**3** and the cleaning processing tank BT**4**.

[0210] The main transport mechanism WTR receives the 50 substrates W from one of two lifters LF**1**, LF**2** using the chuck **145** and transports the 50 substrates W to the dryer **143**. The dryer **143** dries the 50 substrates W. Thereafter, the main transport mechanism WTR receives the dried 50 substrates W from the dryer **143**.

[0211] Next, the second half operation from the drying process to the transport of the carriers C from the load ports **9** will be described with reference to FIG. **21**.

[Step S**11**] Transport of Processed Substrate Group to Second Delivery Position by Main Transport Mechanism

[0212] Refer to FIGS. **2** and **22**A. The main transport mechanism WTR transports the 50 substrates W in the vertical attitude, which are collectively processed in the chemical liquid processing tank BT**1** or the like and aligned at the narrow pitch, to a position above the second pitch converter **26**. In other words, the main transport mechanism WTR transports the 50 substrates W dried by the dryer **143** to the position above the second pitch converter **26**.

[0213] Thereafter, the main transport mechanism WTR lowers the 50 substrates W held by the chuck **145** to the delivery position P**2**. Accordingly, the main transport mechanism WTR transports the 50 substrates W in the vertical attitude aligned at the narrow pitch to the second pitch converter **26**. Further, the second pitch converter **26** receives the 50 substrates W in the vertical attitude aligned at the narrow pitch from the main transport mechanism WTR. Note that, when receiving the 50 substrates W, the second pitch converter **26** moves **25** holding members **113** such that 50 holding grooves **117** are arranged at the narrow pitch.

[Step S**12**] Pitch Conversion of Processed Substrate Group from Narrow Pitch to Unequal Pitch

[0214] Refer to FIG. **22**B. Thereafter, the second pitch converter **26** converts the pitches of the 50 substrates W from the narrow pitch to the unequal pitch. This operation will be described in details. The second pitch converter **26** holds the 50 substrates W aligned at the narrow pitch using the 25 holding members **113** while holding two substrates W at the first interval TN**1** using the two holding grooves **117** separated by the first interval TN**1**, the two holding grooves **117** being included in each of the 25 holding members **113**. The moving portion **115** (see FIG. **10**) moves the 25 holding members **113** in the alignment direction (the width direction Y) of the 50 substrates W to change from the narrow pitch state to the unequal pitch state.

[Step S**13**] Transport of Processed Substrate Group to Pusher Member by Carry-Out Mechanism

[0215] Refer to FIG. **23**A. Thereafter, the carry-out mechanism **75** of the delivery mechanism **23** transports the 50 substrates W aligned at the unequal pitch in the vertical attitude from the second pitch converter **26** to the pusher member **55**. This operation will be described in details. The chuck **79** of the carry-out mechanism **75** is closed. First, the lifting portion **141** (see FIG. **7**) of the second pitch converter **26** lowers the pitch conversion body **111** including the 25 holding members **113**. During the lowering, the carry-out mechanism **75** receives and holds the 50 substrates W in the vertical attitude aligned at the unequal pitch using the chuck **79**.

[0216] Refer to FIG. **23**B. Thereafter, the carry-out mechanism **75** transports the 50 substrates W held by the chuck **79** from the position above the second pitch converter **26** to the position above the pusher member **55**. In other words, the carry-out mechanism **75** causes the chuck **79** holding the 50 substrates W to traverse from the substrate carry-out position Pout to the substrate transfer position Po along the second traverse path Rout. Before the traverse of the chuck **79**, the second pitch converter **26** is located below the second traverse path Rout. The second pitch converter **26** is located at the substrate carrying-out position Pout. The second pitch converter **26** is located below the chuck **79**. Further, the pusher member **55** is located at the substrate transfer position Po. Thereafter, the pusher mechanism **21** raises the pusher member **55** to a position higher than the chuck **79**. During the raising, the pusher mechanism **21** receives and holds the 50 substrates W from the chuck **79** of the carry-out mechanism **75** using the pusher member **55**. The pusher member **55** holds the 50 substrates W aligned at the unequal pitch in the vertical attitude.

[Step S**14**] Reception of Second Substrate Group by Attitude Changer

[0217] Refer to FIG. **24**A. Thereafter, the carry-out mechanism **75** moves the chuck **79** to the position above the second pitch converter **26**. In other words, the carry-out mechanism **75** causes the chuck **79** without holding the substrates W to traverse from the substrate carry-out position Pout to the substrate transfer position Po along the second traverse path Rout. After the traverse of the chuck **79**, the second pitch converter **26** is located below the second traverse path Rout. The second pitch converter **26** is located at the substrate carrying-out position Pout. The second pitch converter **26** is located below the chuck **79**. Further, the pusher member **55** is located at the substrate transfer position Po. Thereafter, the rotation driver **41** of the attitude changer **19** rotates the pair of horizontal holders **37** and the like by 90 degrees about the horizontal axis AX**2** in order for the pair of vertical holders **39** to receive the 25 substrates W**2** (the second substrate group). Accordingly, the pair of horizontal holders **37** and the pair of vertical holders **39** are in a laid-down state. Further, the axial moving portion **51** brings the pair of horizontal holders **37** close to the support face **35**A, and the accommodation moving portion **53** brings the pair of vertical holders **39** close to the pair of horizontal holders **37**.

Refer to FIG. **24**B.

[0218] Thereafter, the pusher mechanism **21** lowers the pusher member **55** from a position above the pair of vertical holders **39** to a position below the pair of vertical holders **39**. During the lowering, the attitude changer **19** receives the 25 substrates W**2** (the second substrate group) out of the 50 substrates W (the processed substrate group) from the pusher member **55** using the pair of horizontal holders **37** and the pair of vertical holders **39**. The pair of vertical holders **39** holds the 25 substrates W**2** aligned at the reference pitch (10 mm). Thereafter, the axial moving portion **51** moves the pair of horizontal holders **37** away from the support face **35**A. Accordingly, the 25 pairs of shelves **37**A of the pair of horizontal holders **37** come into contact with back surfaces of the 25 substrates W**2**, respectively.

[0219] Note that, as illustrated in FIG. **24**A, the moving portion **115** of the second pitch converter **26** moves **25** (**24**) holding members **113** such that the 50 holding grooves **117** are arranged at the narrow pitch. As illustrated in FIG. **24**B, the lifting portion **141** of the second pitch converter **26** raises the pitch conversion body **111** including the 25 holding members **113** such that the 50 holding grooves **117** are disposed at positions higher than the chuck **79**.

[Step S**15**] Vertical Attitude Changing of Second Substrate Group

Refer to FIG. **25**A.

[0220] The attitude changer **19** rotates the pair of horizontal holders **37** and the like by 90 degrees about the horizontal axis AX**2**. Accordingly, the attitude changer **19** changes the 25 substrates W**2** from the vertical attitude to the horizontal attitude.

[0221] Thereafter, the accommodation moving portion **53** moves the pair of vertical holders **39** away from the pair of horizontal holders **37**. Accordingly, peripheral edges of the

25 substrates W2 are taken out from the 25 pairs of holding grooves 39A of the pair of vertical holders 39.

[0222] The carrier transport robot 13 illustrated in FIG. 1 transports the empty second carrier C from the storage shelf 11 to the placement shelf 3. The substrate handling mechanism HTR takes out, from the attitude changer 19, the 25 substrates W2 which are changed to the horizontal attitude by the attitude changer 19 and aligned at the reference pitch (see FIG. 25B). Thereafter, the substrate handling mechanism HTR transports the 25 substrates W2 into the second carrier C placed on the placement shelf 3. Thereafter, the carrier transport robot 13 transports the second carrier C storing the processed 25 substrates W2 from the placement shelf 3 to the load ports 9.

[Step S16] Movement of First Substrate Group by First Interval

[0223] Refer to FIG. 25B. After the attitude changer 19 changes the 25 substrates W2 to the horizontal attitude, the pusher mechanism 21 raises the pusher member 55 holding the 25 substrates W1 (the first substrate group).

[0224] Further, the pusher mechanism 21 moves the 25 substrates W1 held by the pusher member 55 by the first interval TN1 (3.333 mm) in the alignment direction of the 25 substrates W1. Specifically, the pusher rotator 59 (see FIG. 5) of the pusher mechanism 21 rotates the pusher member 55 by 180 degrees about the vertical axis AX3. Accordingly, the 25 substrates W1 held by the pusher member 55 are moved rightward by the first interval TN1. Note that the movement by the first interval TN1 may be performed by rotation of the pusher member 55 by 180 degrees by the pusher rotator 59 and movement of the pusher member 55 in the width direction Y by the pusher horizontal moving portion 61 (see FIG. 5).

[Step S17] Reception of First Substrate Group by Attitude Changer

[0225] Refer to FIG. 25C. The attitude changer 19 brings the pair of horizontal holders 37 and the pair of vertical holders 39 into the laid-down state. Further, the axial moving portion 51 brings the pair of horizontal holders 37 close to the support face 35A, and the accommodation moving portion 53 brings the pair of vertical holders 39 close to the pair of horizontal holders 37.

[0226] Refer to FIG. 26A. Thereafter, the pusher mechanism 21 lowers the pusher member 55 from the position above the pair of vertical holders 39 to the position below the pair of vertical holders 39. During the lowering, the attitude changer 19 receives the remaining 25 substrates W1 from the pusher member 55 using the pair of horizontal holders 37 and the pair of vertical holders 39. The pair of vertical holders 39 holds the 25 substrates W1 aligned at the reference pitch (for example, 10 mm). Thereafter, the axial moving portion 51 brings the 25 pairs of shelves 37A of the pair of horizontal holders 37 into contact with the back surfaces of the 25 substrates W1, respectively.

[Step S18] Vertical Attitude Changing of First Substrate Group

[0227] Refer to FIG. 26B. The attitude changer 19 rotates the pair of horizontal holders 37 and the like by 90 degrees about the horizontal axis AX2. Accordingly, the attitude changer 19 changes the 25 substrates W1 from the vertical attitude to the horizontal attitude. Refer to FIG. 26C. Thereafter, the accommodation moving portion 53 moves the pair of vertical holders 39 away from the pair of horizontal holders 37.

[0228] The carrier transport robot 13 illustrated in FIG. 1 transports the empty first carrier C from the storage shelf 11 to the placement shelf 3. The substrate handling mechanism HTR takes out, from the attitude changer 19, the 25 substrates W1 which are changed to the horizontal attitude by the attitude changer 19 and aligned at the reference pitch (10 mm) (see FIG. 26C). Thereafter, the substrate handling mechanism HTR transports the 25 substrates W1 into the first carrier C placed on the placement shelf 3. Thereafter, the carrier transport robot 13 transports the first carrier C storing the processed 25 substrates W1 from the placement shelf 3 to the load ports 9. Thereafter, the external transport robot not illustrated sequentially transports the two carriers C from the load ports 9 to the next destination.

[0229] The chuck 77 described above corresponds to the "first traverse holder" of the present invention. The carry-in mechanism 71 described above corresponds to the "first traverse mechanism" of the present invention. The chuck 79 described above corresponds to the "second traverse holder" of the present invention. The carry-out mechanism 75 described above corresponds to the "second traverse mechanism" of the present invention. The chuck 78 described above corresponds to the "intermediary holder" of the present invention.

[0230] According to Example 1, the attitude changer 19 changes the attitudes of the substrates to the horizontal holding attitude in which the substrate group of the substrates in the horizontal attitude aligned at the reference pitch in the vertical direction is held, and the vertical holding attitude in which the substrate group of the substrates in the vertical attitude aligned at the reference pitch in the horizontal direction is held. The pusher mechanism 21 includes the pusher member 55 that combines the substrates W2 (the second substrate group) in the vertical holding attitude held by the attitude changer 19 and the substrates W1 (the first substrate group) in the vertical holding attitude delivered in advance from the attitude changer 19 to hold the plurality of substrates aligned at the unequal pitch narrower than the reference pitch. The first pitch converter 25 receives the plurality of substrates aligned at the unequal pitch, and aligns, at the narrow pitch narrower than the reference pitch, the plurality of substrates aligned at the unequal pitch. The processing block 7 collectively processes the plurality of substrates aligned at the narrow pitch. The main transport mechanism WTR collectively transports the plurality of substrates aligned at the narrow pitch to the processing block 7. The first pitch converter 25 and the second pitch converter 26 are disposed on the main transport mechanism WTR side (a left side in a left-right direction Y) of the pusher mechanism 21.

[0231] In this way, the pusher mechanism 21 combines the substrates W2 (the second substrate group) in the vertical holding attitude held by the attitude changer 19 and the substrates W1 (the first substrate group) in the vertical holding attitude delivered in advance from the attitude changer 19 to hold the plurality of substrates aligned at the unequal pitch narrower than the reference pitch. A process of making the plurality of substrates aligned at the unequal pitch from the substrate group at the reference pitch is referred to as first-stage pitch conversion. The first pitch

converter **25** receives the plurality of substrates aligned at the unequal pitch, and aligns, at the narrow pitch narrower than the reference pitch, the plurality of substrates aligned at the unequal pitch. A process of making the plurality of the substrates aligned at the narrow pitch from the plurality of the substrates aligned at the unequal pitch is referred to as second-stage pitch conversion. In the present invention, the second-stage pitch conversion is not performed by the pusher mechanism **21**, but is performed by the first pitch converter **25** disposed on the main transport mechanism WTR side of the pusher mechanism **21**. In other words, the second-stage pitch conversion is performed at a position where throughput of the second-stage pitch conversion is not reduced. This makes it possible to efficiently process the substrates W.

[0232] Further, the plurality of substrates aligned at the unequal pitch is the plurality of substrates W aligned at the unequal pitch where the first interval TN**1** narrower than the reference pitch and the second interval TN**2** narrower than the reference pitch and wider than the first interval TN**1** are alternately repeated. The equal pitch is equal to the sum of the first interval TN**1** and the second interval TN**2**. The plurality of substrates W aligned at the narrow pitch is the plurality of substrates W aligned at the first interval TN**1** repeated. In this way, the second-stage pitch conversion is performed slowly because the second interval TN**2** at the unequal pitch formed by the first-stage pitch conversion is narrowed to the first interval TN**1**. Accordingly, the second-stage pitch conversion can be slowly performed at the position where the throughput of the first-stage pitch conversion is not reduced.

[0233] Further, the carry-in mechanism **71** causes the chuck **77** to traverse along the first traverse path, the chuck **77** collectively holding the plurality of substrates W aligned at the unequal pitch and received from the pusher member **55**. The carry-out mechanism **75** causes the chuck **79** to traverse along the second traverse path, the chunk **79** collectively holding the plurality of substrates W aligned at the unequal pitch to be delivered to the pusher member **55**. The first pitch converter **25** receives the plurality of substrates W aligned at the unequal pitch, and aligns, at the narrow pitch, the plurality of substrates W aligned at the unequal pitch. The second pitch converter **26** receives the plurality of substrates W aligned at the narrow pitch, and aligns, at the unequal pitch, the plurality of substrates W aligned at the narrow pitch. In this way, the two-stage pitch conversion is performed separately for the pusher mechanism **21**, the first pitch converter **25**, and the second pitch converter **26**. In addition, the pitch conversion is performed separately for the first pitch converter **25** and the second pitch converter **26** before and after the processing in the processing block **7**. Therefore, the throughput of the second-stage pitch conversion is not reduced. This makes it possible to efficiently process the Further, the intermediary mechanism **73** raises, along the substrate carry-in position, the chuck **78** that collectively holds the plurality of substrates W aligned at the narrow pitch. The substrate transfer position is a position where the plurality of substrates W aligned at the unequal pitch is collectively carried from the pusher member **55** to the chuck **78**. The substrate carry-in position is a position where the plurality of substrates W aligned at the narrow pitch is collectively carried from the chuck **78** to the main transport mechanism WTR. The first pitch converter **25** moves up along the substrate carry-in position to carry in the plurality of substrates W aligned at the unequal pitch from the chuck **77**. The chuck **78** moves up along the substrate carry-in position Pin to carry in the plurality of substrates W aligned at the narrow pitch from the first pitch converter **25**. The first pitch converter **25** is disposed at the substrate carry-in position Pin. This makes it possible to efficiently perform the pitch conversion by the first pitch converter **25** during the substrate carry-in processing performed among the chuck **77**, the first pitch converter **25**, the chuck **78**, and the main transport mechanism WTR.

[0234] Further, the first pitch converter **25** is disposed below the chuck **78**. This makes it possible to perform an operation in the first pitch converter **25** and an operation in the chuck **78** at the same time, partially at the same time, or at approximately the same timing.

[0235] Further, the first pitch converter **25** is disposed below the first traverse path Pin. This makes it possible to perform an operation in the chuck **77**, the operation in the first pitch converter **25**, and the operation in the chuck **78** at the same time, partially at the same time, or at approximately the same timing.

[0236] Further, the second pitch converter **26** receives the plurality of substrates W aligned at the narrow pitch from the main transport mechanism WTR to carry out the plurality of substrates W aligned at the unequal pitch to the chuck **79**. The second pitch converter **26** is disposed at the substrate carry-out position Pout. This makes it possible to efficiently perform the pitch conversion by the second pitch converter **26** during the substrate carry-out processing.

[0237] Further, the second pitch converter **26** is disposed below the second traverse path Pout. This makes it possible to perform an operation in the second pitch converter **26** and an operation in the chuck **79** at the same time, partially at the same time, or at approximately the same timing.

[0238] Further, the second pitch converter **26** is disposed above the first pitch converter **25**. This makes it possible to perform the operation in the first pitch converter **25** and the operation in the second pitch converter **26** at the same time, partially at the same time, or at approximately the same timing.

[0239] Further, the second pitch converter **26** is disposed above the chuck **78**. This makes it possible to perform the operation in the first pitch converter **25**, the operation in the chuck **79**, and the operation in the second pitch converter at the same time, partially at the same time, or at approximately the same timing.

[0240] Further, the first traverse path Pin and the second traverse path Pout cross each other at the predetermined angle α, the pusher mechanism **21** is disposed at the position (Po) where the first traverse path Pin and the second traverse path Pout cross each other at the predetermined angle α, and the first pitch converter **25** and the second pitch converter **26** are disposed apart from each other at a predetermined angle. This makes it possible to separate the first pitch converter **25** and the second pitch converter **26** from each other at the positions (substrate carry-in position Pin and substrate carry-out position Pout) where the interference is less likely to occur.

Example 2

[0241] Next, Example 2 of the present invention will be described with reference to the drawings. Note that description overlapping with that in Example 1 will be omitted.

[0242] FIG. **27** is a plan view illustrating configurations of the transfer block **5** and the periphery thereof according to Example 2. FIG. **28** is a side view illustrating the delivery mechanism **23**, the two pitch converters **25**, **26**, and the like when viewed as indicated by arrows A-A in FIG. **27**. The substrate processing apparatus **1** according to Example 2 is different from the substrate processing apparatus **1** according to Example 1 in that the intermediary mechanism **73** is not included.

[0243] In other words, the main transport mechanism WTR receives the 50 substrates W aligned at the narrow pitch held by the first pitch converter **25** without the intermediary mechanism **73**. For example, the main transport mechanism WTR moves down to a height (a first delivery position P**1**A in the present example) when the first pitch converter **25** performs the pitch conversion. The first pitch converter **25** carries, into the main transport mechanism WTR, the 50 substrates aligned at the narrow pitch at the height when the pitch conversion is performed. Note that the first delivery position PIA may be higher than the position illustrated in the present example as long as the first pitch converter **25** can move up to a position higher than the height when the pitch conversion is performed.

[0244] According to Example 2, the first pitch converter **25** receives the plurality of substrates W aligned at the unequal pitch from the chuck **77** to carry the plurality of substrates W aligned at the narrow pitch into the main transport mechanism WTR. This makes it possible to efficiently carry the substrates W among the chuck **77**, the first pitch converter **25**, and the main transport mechanism WTR.

Example 3

[0245] Next, Example 3 of the present invention will be described with reference to the drawings. Note that description overlapping with those in Examples 1 and 2 will be omitted.

[0246] FIG. **29** is a plan view illustrating configurations of the transfer block **5** and the periphery thereof according to Example 3. FIG. **28** is a side view illustrating a delivery mechanism **23**A, one pitch converter **25**A, and the like when viewed as indicated by arrows A-A in FIG. **30**.

[0247] The substrate processing apparatus **1** according to Example 1 includes the delivery mechanism **23** having two pitch converter **25**, **26**. In this regard, the substrate processing apparatus **1** according to Example 3 includes the delivery mechanism **23**A having one pitch converter **25**A.

[0248] In other words, the delivery mechanism **23**A includes a carry-in/carry-out mechanism **71**A and an intermediary mechanism **73**A. The carry-in/carry-out mechanism **71**A carries the plurality of substrates W aligned at the unequal pitch from the pusher member **55** to the pitch converter **25**A, and carries the plurality of substrates W aligned at the unequal pitch from the pitch converter **25**A to the pusher member **55**. The intermediary mechanism **73**A carries the plurality of substrates W aligned at the narrow pitch from the pitch converter **25**A to a delivery position P**1**B, and carries the plurality of substrates W aligned at the narrow pitch from the delivery position P**1**B to the pitch converter **25**A.

[0249] The carry-in/carry-out mechanism **71**A is disposed at a carry-in height position H**1** or a carry-in height position H**3**. The carry-in height position H**1** and the carry-in height position H**3** are at the same height.

[0250] The carry-in/carry-out mechanism **71**A includes the chuck **77**, the opening/closing portion **81**, the front-back moving portion **83**, and the widthwise moving portion **85**. The chuck **77**, the opening/closing portion **81**, the front-back moving portion **83**, and the widthwise moving portion **85** are used for both carrying in and out the plurality of substrates W aligned at the unequal pitch.

[0251] The intermediary mechanism **73**A includes the chuck **78**, the opening/closing portion **101**, the arm **103**, and the lifting portion **105**. The chuck **78**, the opening/closing portion **101**, the arm **103**, and the lifting portion **105** are used for both carrying in and out the plurality of substrates W aligned at the narrow pitch. Note that the intermediary mechanism **73**A may be used only for carrying in the substrates W.

[0252] The pitch converter **25** is used for both conversion of the plurality of substrates W from being aligned at the unequal pitch to being aligned at the narrow pitch and conversion of the plurality of substrates W from being aligned at the narrow pitch to being aligned at the unequal pitch.

[0253] The chuck **77** described above corresponds to the "traverse holder" of the present invention. The traverse mechanism **71**A described above corresponds to the "traverse mechanism" of the present invention. The chuck **78** described above corresponds to the "intermediary holder" of the present invention.

[0254] In the substrate processing apparatus **1** according to Example 3, a traverse carry-out mechanism **71**A causes the chuck **77** that collectively holds the plurality of substrates W aligned at the unequal pitch and received from the pusher member **55** to traverse along the traverse paths Rin, Rout between the substrate transfer position Po and the substrate delivery positions Pin, Pout. The intermediary mechanism **73**A raises and lowers the chuck **78** that collectively holds the plurality of substrates W aligned at the narrow pitch along the substrate delivery positions Pin, Pout. The substrate transfer position Po is a position where the plurality of substrates W aligned at the unequal pitch is collectively delivered between the pusher member **55** and the chuck **77**. The substrate delivery positions Pin, Pout are positions where the plurality of substrates W aligned at the narrow pitch is collectively delivered between the chuck **78** and the main transport mechanism WTR. The pitch converter **25**A moves up and down along the substrate delivery positions Pin, Pout to deliver the plurality of substrates W aligned at the unequal pitch to and from the chuck **77**. The chuck **77** moves up and down along the substrate delivery positions Pin, Pout to deliver the plurality of substrates W aligned at the narrow pitch to and from the pitch converter **25**A. The pitch converter **25**A is disposed at the substrate delivery positions Pin, Pout. This makes it possible to separate a position of the pitch converter **25** that performs the second-stage pitch conversion from the pusher mechanism **21** that performs the first-stage pitch conversion. In other words, the second-stage pitch conversion is performed at the position where the throughput of the first-stage pitch conversion is not reduced. This makes it possible to efficiently process the substrates W.

[0255] Further, the pitch converter **25**A is disposed below the chuck **78**.

[0256] This makes it possible to perform an operation in the pitch converter **25**A and the operation in the chuck **78** at the same time, partially at the same time, or at approximately the same timing.

[0257] Further, the pitch converter **25**A is disposed below the traverse path. This makes it possible to perform the operation in the chuck **77**, the operation in the pitch converter **25**A, and the operation in the chuck **78** at the same time, partially at the same time, or at approximately the same timing.

Example 4

[0258] Next, Example 4 of the present invention will be described with reference to the drawings. Note that description overlapping with those in Examples 1 to 3 will be omitted.

[0259] FIG. **31** is the plan view illustrating configurations of the transfer block and the periphery thereof according to Example 4. FIG. **32** is the side view illustrating the delivery mechanism, the two pitch converters, and the like when viewed as indicated by arrows A-A in FIG. **31**.

[0260] The substrate processing apparatus **1** according to Example 4 includes the delivery mechanism **23**A having one pitch converter **25**A as in Example 3. The substrate processing apparatus **1** according to Example 4 is different from the substrate processing apparatus **1** according to Example 3 in that the intermediary mechanism **73**A is not included.

[0261] In other words, the main transport mechanism WTR receives the 50 substrates W aligned at the narrow pitch held by the pitch converter **25**A without the intermediary mechanism **73**A. For example, the main transport mechanism WTR moves down to a height (the first delivery position P**1**A in the present example) when the pitch converter **25**A performs the pitch conversion. The pitch converter **25**A carries, into the main transport mechanism WTR, the 50 substrates aligned at the narrow pitch at the height when the pitch conversion is performed.

[0262] In the substrate processing apparatus **1** according to Example 4, a carry-in/carry-out mechanism **71**A causes the chuck **77** that collectively holds the plurality of substrates W aligned at the unequal pitch and received from the pusher member **55** to traverse along the traverse paths Rin, Rout between the substrate transfer position Po and the substrate delivery positions Pin, Pout. The substrate transfer position Po is a position where the plurality of substrates W aligned at the unequal pitch is collectively delivered between the pusher member **55** and the chuck **77**. The substrate delivery positions Pin, Pout are positions where the plurality of substrates aligned at the narrow pitch is collectively delivered between the pitch converter **25**A and the main transport mechanism WTR. The pitch converter **25**A moves up and down along the substrate delivery positions Pin, Pout to deliver the plurality of substrates W aligned at the unequal pitch to and from the chuck **77**. The pitch converter **25**A is disposed at the substrate delivery positions Pin, Pout. This makes it possible to separate a position of the pitch converter **25**A that performs the second-stage pitch conversion from the pusher mechanism **21** that performs the first-stage pitch conversion. In other words, the second-stage pitch conversion is performed at the position where the throughput of the first-stage pitch conversion is not reduced. This makes it possible to efficiently process the Further, the pitch converter **25**A is disposed below the traverse paths Rin, Rout. This makes it possible to perform the operation in the chuck **77** and the operation in the pitch converter **25**A at the same time, partially at the same time, or at approximately the same timing.

Example 5

[0263] Next, Example 5 of the present invention will be described with reference to the drawings. Note that description overlapping with those in Examples 1 to 4 will be omitted.

[0264] FIG. **33** is a plan view illustrating configurations of the transfer block **5** and the periphery thereof according to Example 5. FIG. **34** is a side view illustrating expansion/contraction mechanisms of the pitch converters **25**, **26** included in the pair of chuck members **77**C, **77**D of the carry-in mechanism **71** and the pair of chucks **79**C, **79**D of the carry-out mechanism **75**. FIG. **34** is the side view illustrating the expansion/contraction mechanisms of the pitch converters **25**, **26** included in the pair of chuck members **77**C, **77**D of the carry-in mechanism **71** and the pair of chucks **79**C, **79**D of the carry-out mechanism **75**.

[0265] In Example 5, the first pitch converter **25** is integrally attached to the pair of chuck members **77**C, **77**D of the carry-in mechanism **71**. The second pitch converter **26** is attached to the pair of chucks **79**C, **79**D of the carry-out mechanism **75**. Specifically, the first pitch converter **25** is integrally attached to a side face of the pair of chuck members **77**C, **77**D of the carry-in mechanism **71**. The second pitch converter **26** is attached to a side face of the pair of chucks **79**C, **79**D of the carry-out mechanism **75**.

[0266] Expansion/contraction structures of the first pitch converter **25** and the second pitch converter **26** are the same as those in Example 1. In Example 1, the pitch converters **25**, **26** are placed horizontally, while in Example 5, the pitch converters **25**, **26** are placed vertically.

[0267] The holding grooves **113** of the carry-in mechanism **71** are attached to upper sides of the chuck members **77**C, **77**D, respectively. The holding grooves **113** of the carry-out mechanism **75** are attached to upper sides of the chucks **79**C, **79**D, respectively. Accordingly, in the carry-in mechanism **71**, the substrates W are held on the upper sides of the chuck members **77**C, **77**D, respectively. In the carry-out mechanism **75**, the substrates W are held on the upper sides of the chucks **79**C, **79**D, respectively.

[0268] According to Example 5, the first pitch converter **25** is included in the carry-in mechanism **71**, and the second pitch converter **26** is included in the carry-out mechanism **75**. This makes it possible to suppress the height of the substrate processing apparatus **1** as the first pitch converter **25** is integrated with the carry-in mechanism **71** and the second pitch converter **26** is integrated with the carry-out mechanism **75**.

[0269] Note that this can also apply to the substrate processing apparatus **1** in which the carry-in mechanism **71** and the carry-out mechanism **75** are arranged vertically. This is because the height of the substrate processing apparatus **1** can be suppressed as the first pitch converter **25** is integrated with the carry-in mechanism **71** and the second pitch converter **26** is integrated with the carry-out mechanism **75**.

[0270] Note that the present example can also be applied to the substrate processing apparatus **1** in which the carry-in mechanism **71** and the carry-out mechanism **75** are used in one mechanism (the carry-in/carry-out mechanism **71**A). The present invention is not limited to the above examples, and can be implemented in a modified manner as follows.

[0271] (1) In the examples described above, in a case where the reference interval TN**9** is, for example, 10 mm, the first interval TN**1** is, for example, 3.333 mm, and the second interval TN**2** is, for example, 6.666 mm. In this case, the first interval TN**1** is equal to half of the second interval TN**2**. In this regard, the first interval TN**1** may be smaller than half of the second interval TN**2**. For example, in the case where the reference interval TN**9** is, for example, 10 mm, the first interval TN**1** may be 3 mm, and the second interval TN**2** may be 7 mm. Further, the first interval TN**1** may be 2.5 mm, and the second interval TN**2** may be 7.5 mm. Further, the second interval TN**2** is preferably 2 to 3 times the first interval TN**1**.

[0272] For example, the two holding grooves **117** of each of the holding members **113** may be configured to be separated by the first interval TN**1** (for example, 3 mm) that is smaller than half of the second interval TN**2** (for example, 7 mm) and is larger than 0 mm. Further, the two holding grooves **117** of each of the holding members **113** may be configured to be separated by the first interval TN**1** (for example, 3 mm) that is an interval larger than or equal to ⅓ times and smaller than or equal to ½ times the second interval TN**2** (for example, 7 mm). Further, the two holding grooves **117** of each of the holding members **113** may be configured to be separated by the first interval TN**1** (for example, 3.333 mm) that is an interval half of the second interval TN**2** (for example, 6.666 mm).

[0273] (2) In each of the examples and Modification (1) described above, in the case where the reference interval TN**9** is, for example, 10 mm, the first interval TN**1** is, for example, 3.333 mm, and the second interval TN**2** is, for example, 6.666 mm. In this regard, the first interval TN**1** may be larger than an interval ⅓ times the reference interval TN**9** (for example, 3.333 mm) and smaller than an interval ½ times the reference interval TN**9** (for example, 5 mm).

[0274] (3) In the examples described above, in the pitch converters **25**, **26**, one holding member **113** is provided with two holding grooves **117**, but one holding groove **117** may be configured to be provided for each of the holding members **113**. In such configuration, two-stage pitch conversion different from that in the examples described above can be adopted. In other words, the pusher mechanism **21** combines the substrates W**1** of the first substrate group and the substrates W**2** of the second substrate group to form the plurality of substrates W aligned at a first narrow pitch narrower than the reference pitch. The first pitch converter **25** converts the plurality of substrates W from being aligned at the first narrow pitch to being aligned at a second narrow pitch narrower than the first narrow pitch. Since one holding groove **117** is provided for each of the holding members **113**, the first pitch converter **25** can convert the first narrow pitch to the second narrow pitch.

[0275] According to this example, the plurality of substrates W aligned at the narrow interval is the plurality of substrates W aligned at the first narrow pitch narrower than the reference pitch. The plurality of substrates W aligned at the narrow pitch is the plurality of substrates W aligned at the second narrow pitch narrower than the first narrow pitch. In this way, the second-stage pitch conversion is performed slowly because the first narrow pitch formed by the first-stage pitch conversion is narrowed to the second narrow pitch. The second-stage pitch conversion is performed at the position where the throughput is not reduced. This makes it possible to efficiently process the substrates.

[0276] (4) In each of the examples and each of the modifications described above, the carry-in mechanism **71** is provided behind the carry-out mechanism **75**, but the carry-in mechanism **71** may be provided before the carry-out mechanism **75**. In other words, arrangements of the carry-in mechanism **71** and the carry-out mechanism **75** may be reversed. In this case, the carry-in mechanism **71** transports the plurality of substrates W from the pusher member **55** to the second pitch converter **26**, and the carry-out mechanism **73** transports the plurality of substrates W from the first pitch converter **25** to the pusher member **55**.

[0277] (5) In each of the examples and each of the modifications described above, the intermediary mechanism **73** transports the plurality of substrates W aligned at the narrow pitch from the first pitch converter **25** to the main transport mechanism WTR. In this regard, the intermediary mechanism **73** may transport the plurality of substrates W aligned at the narrow pitch from the main transport mechanism WTR to the second pitch converter **26**.

[0278] (6) In each of the examples and each of the modifications described above, the chuck **77** (the pair of chuck members **77**A, **77**B) of the carry-in mechanism **71** is opened and closed by the opening/closing portion **81**. In this regard, the chuck **77** may not be configured to be opened and closed.

[0279] (7) In each of the examples and each of the modifications described above, the chuck **79** (the pair of chuck members **79**A, **79**B) of the carry-out mechanism **75** is opened and closed by the opening/closing portion **89**. In this regard, the chuck **79** may not be configured to be opened and closed.

[0280] The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

What is claimed is:

1. A substrate processing apparatus processing substrates, the substrate processing apparatus comprising:

an attitude changing mechanism configured to change attitudes of the substrates between a horizontal holding attitude in which a substrate group of the substrates in a horizontal attitude aligned at an equal pitch in a vertical direction is held and a vertical holding attitude in which a substrate group of the substrates in a vertical attitude aligned at the equal pitch in a horizontal direction is held;

a pusher mechanism including a pusher member configured to combine a second substrate group in the vertical holding attitude held by the attitude changing mechanism and a first substrate group in the vertical holding attitude delivered in advance from the attitude changing mechanism to hold a plurality of the substrates aligned at a narrow interval narrower than the equal pitch;

a pitch converter configured to receive the plurality of the substrates aligned at the narrow interval, and align, at a narrow pitch narrower than the equal pitch, the plurality of the substrates aligned at the narrow interval;

a substrate processor configured to collectively process the plurality of the substrates aligned at the narrow pitch; and

a main transport mechanism configured to collectively transport the plurality of the substrates aligned at the narrow pitch to the substrate processor, wherein

the pitch converter is disposed on the main transport mechanism side of the pusher mechanism.

2. The substrate processing apparatus according to claim **1**, wherein

the plurality of the substrates aligned at the narrow interval is a plurality of the substrates aligned at an unequal pitch where a first interval narrower than the equal pitch and a second interval narrower than the equal pitch and wider than the first interval are alternately repeated,

the equal pitch is equal to a sum of the first interval and the second interval, and

the plurality of the substrates aligned at the narrow pitch is a plurality of the substrates aligned at the first interval repeated.

3. The substrate processing apparatus according to claim **1**, wherein

the plurality of the substrates aligned at the narrow interval is a plurality of the substrates aligned at a first narrow pitch narrower than the equal pitch, and

the plurality of the substrates aligned at the narrow pitch is a plurality of the substrates aligned at a second narrow pitch narrower than the first narrow pitch.

4. The substrate processing apparatus according to claim **1**, comprising a traverse mechanism configured to cause a traverse holder collectively holding the plurality of the substrates aligned at the narrow interval and received from the pusher member to traverse along a traverse path between a substrate transfer position and a substrate delivery position, wherein

the substrate transfer position is a position where the plurality of the substrates aligned at the narrow interval is collectively delivered between the pusher member and the traverse holder,

the substrate delivery position is a position where the plurality of the substrates aligned at the narrow pitch is collectively delivered between the pitch converter and the main transport mechanism,

the pitch converter moves up and down along the substrate delivery position to deliver the plurality of the substrates aligned at the narrow interval to and from the traverse holder, and

the pitch converter is disposed at the substrate delivery position.

5. The substrate processing apparatus according to claim **4**, wherein

the pitch converter is disposed below the traverse path.

6. The substrate processing apparatus according to claim **1**, comprising:

a traverse mechanism configured to cause a traverse holder collectively holding the plurality of the substrates aligned at the narrow interval and received from the pusher member to traverse along a traverse path between a substrate transfer position and a substrate delivery position; and

an intermediary mechanism configured to raise and lower, along the substrate delivery position, an intermediary holder collectively holding the plurality of the substrates aligned at the narrow pitch, wherein

the substrate transfer position is a position where the plurality of the substrates aligned at the narrow interval is collectively delivered between the pusher member and the traverse holder,

the substrate delivery position is a position where the plurality of the substrates aligned at the narrow pitch is collectively delivered between the intermediary holder and the main transport mechanism,

the pitch converter moves up and down along the substrate delivery position to deliver the plurality of the substrates aligned at the narrow interval to and from the traverse holder,

the intermediary holder moves up and down along the substrate delivery position to deliver the plurality of the substrates aligned at the narrow pitch to and from the pitch converter, and

the pitch converter is disposed at the substrate delivery position.

7. The substrate processing apparatus according to claim **6**, wherein

the pitch converter is disposed at a position below the intermediary holder.

8. The substrate processing apparatus according to claim **6**, wherein

the pitch converter is disposed below the traverse path.

9. The substrate processing apparatus according to claim **1**, comprising:

a first traverse mechanism configured to cause, to traverse along a first traverse path, a first traverse holder collectively holding the plurality of the substrates aligned at the narrow interval and received from the pusher member; and

a second traverse mechanism configured to cause, to traverse along a second traverse path, a second traverse holder collectively holding the plurality of the substrates aligned at the narrow interval and to be delivered to the pusher member, wherein

the pitch converter includes:

a first pitch converter configured to receive the plurality of the substrates aligned at the narrow interval, and align, at the narrow pitch, the plurality of the substrates aligned at the narrow interval; and

a second pitch converter configured to receive the plurality of the substrates aligned at the narrow pitch, and align, at the narrow interval, the plurality of the substrates aligned at the narrow pitch.

10. The substrate processing apparatus according to claim **9**, wherein

the first traverse path is a path between a substrate transfer position and a substrate carry-in position,

the second traverse path is a path between a substrate carry-out position and a substrate transfer position,

the first traverse path and the second traverse path are provided at positions apart from each other in a lateral direction,

the first pitch converter is disposed at the substrate carry-in position, and

the second pitch converter is disposed at the substrate carry-out position.

11. The substrate processing apparatus according to claim 10, wherein

the first pitch converter

receives the plurality of the substrates aligned at the narrow interval from the first traverse holder to carry the plurality of the substrates aligned at the narrow pitch into the main transport mechanism.

12. The substrate processing apparatus according to claim 10, comprising an intermediary mechanism configured to raise, along the substrate carry-in position, an intermediary holder collectively holding the plurality of the substrates aligned at the narrow pitch, wherein

the substrate transfer position is a position where the plurality of the substrates aligned at the narrow interval is collectively carried from the pusher member to the first traverse holder,

the substrate carry-in position is a position where the plurality of the substrates aligned at the narrow pitch is collectively carried from the intermediary holder to the main transport mechanism,

the first pitch converter moves up along the substrate carry-in position to carry in the plurality of the substrates aligned at the narrow interval from the first traverse holder,

the intermediary holder moves up along the substrate carry-in position to carry in the plurality of the substrates aligned at the narrow pitch from the pitch converter, and

the first pitch converter is disposed at the substrate carry-in position.

13. The substrate processing apparatus according to claim 12, wherein

the first pitch converter is disposed below the intermediary holder.

14. The substrate processing apparatus according to claim 13, wherein

the first pitch converter is disposed below the first traverse path.

15. The substrate processing apparatus according to claim 10, wherein

the second pitch converter

receives the plurality of the substrates aligned at the narrow pitch from the main transport mechanism to carry out the plurality of the substrates aligned at the narrow interval to the second traverse holder, and

is disposed at the substrate carry-out position.

16. The substrate processing apparatus according to claim 15, wherein

the second pitch converter is disposed below the second traverse path.

17. The substrate processing apparatus according to claim 9, wherein

the second pitch converter is disposed above the first pitch converter.

18. The substrate processing apparatus according to claim 10, wherein

the second pitch converter is disposed above the intermediary holder.

19. The substrate processing apparatus according to claim 9, wherein

the first traverse path and the second traverse path cross each other at a predetermined angle,

the pusher mechanism is disposed at a position where the first traverse path and the second traverse path cross each other at the predetermined angle, and

the first pitch converter and the second pitch converter are disposed apart from each other at the predetermined angle.

20. The substrate processing apparatus according to claim 1, comprising a traverse mechanism configured to cause a traverse holder collectively holding the plurality of the substrates aligned at the narrow interval and received from the pusher member to traverse along a traverse path between a substrate transfer position and a substrate delivery position, wherein

the pitch converter is included in the traverse mechanism.

21. The substrate processing apparatus according to claim 9, wherein

the first pitch converter is included in the first traverse mechanism, and

the second pitch converter is included in the second traverse mechanism.

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