US 20250256406A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2025/0256406 A1**

MITSUYOSHI et al. (43) **Pub. Date: Aug. 14, 2025**

(54) **SUBSTRATE PROCESSING APPARATUS**

(71) Applicant: **SCREEN Holdings Co., Ltd.**, Kyoto (JP)

(72) Inventors: **Ichiro MITSUYOSHI**, Kyoto (JP); **Hidehiko OZAKI**, Kyoto (JP); **Tadashi MAEGAWA**, Kyoto (JP); **Nozomu NAKAGAWA**, Kyoto (JP)

(21) Appl. No.: **19/047,026**

(22) Filed: **Feb. 6, 2025**

(30) **Foreign Application Priority Data**

Feb. 8, 2024 (JP) 2024-018104

Publication Classification

(51) **Int. Cl.**

B25J 11/00	(2006.01)
H01L 21/677	(2006.01)
H01L 21/68	(2006.01)

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

CPC ***B25J 11/0095*** (2013.01); ***H01L 21/67718*** (2013.01); ***H01L 21/68*** (2013.01)

(57) **ABSTRACT**

An orientation changing unit of a substrate processing apparatus includes a vertical holding unit having reference pitch holding grooves and ⅔ pitch holding grooves, and a holding groove switching drive unit. The reference pitch holding grooves are disposed at a reference pitch. The ⅔ pitch holding groove are disposed at a ⅔ pitch that is ⅔ times the reference pitch. The holding groove switching drive unit switches to a state in which the reference pitch holding grooves are usable when 50 substrates aligned in a face-to-back manner are formed on a pusher member, and switches to a state in which the ⅔ pitch holding grooves are usable when the 50 substrates held by the pusher member is rearranged into a face-to-face manner.

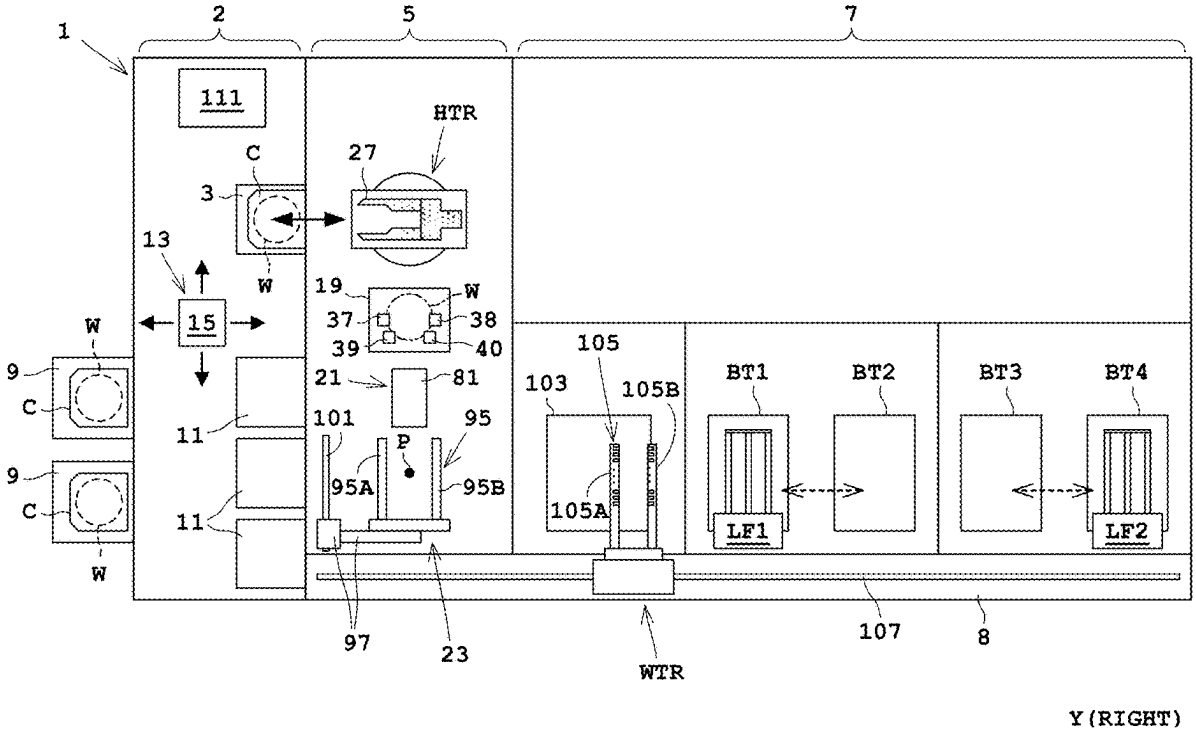


FIG. 1

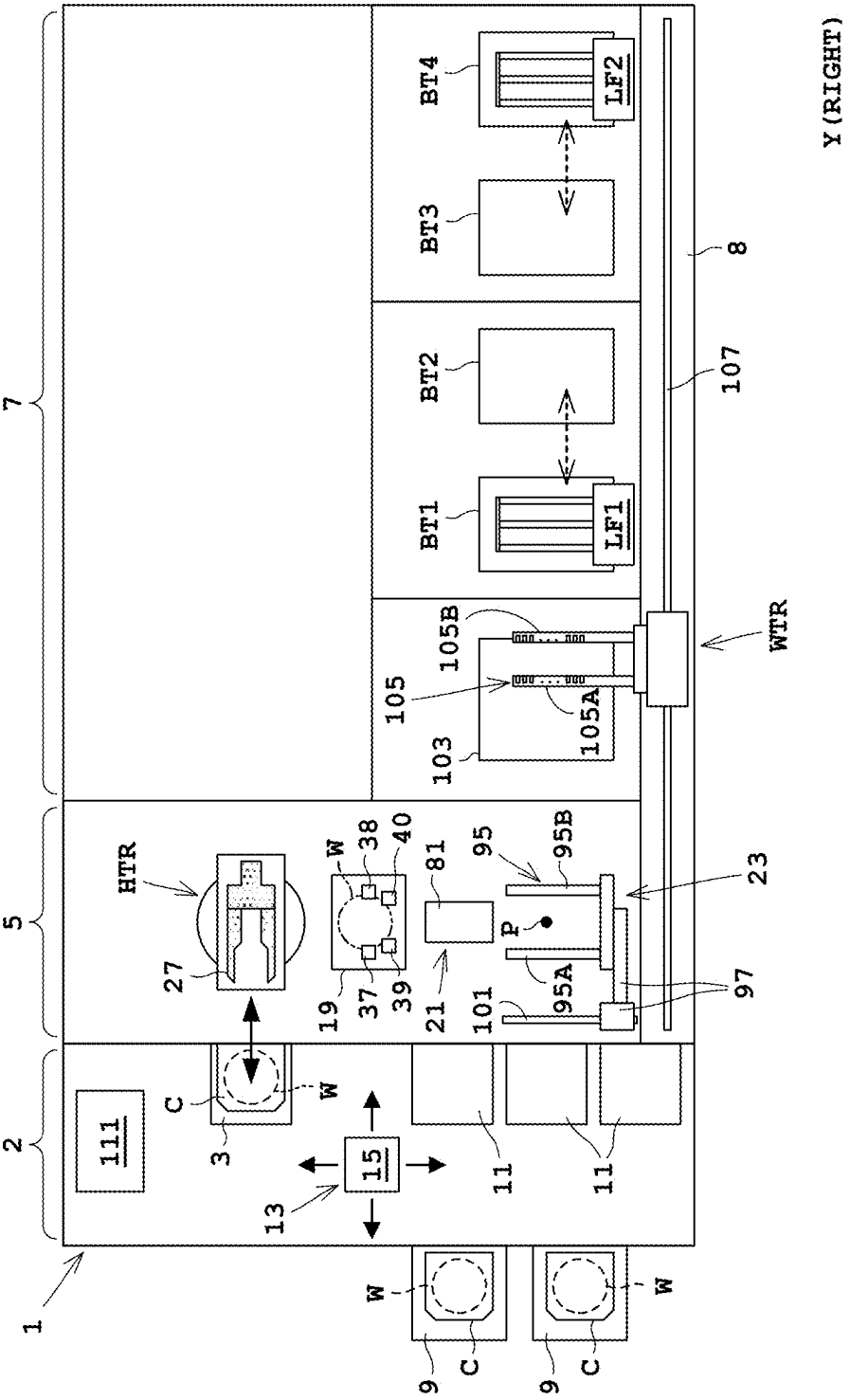

Y (RIGHT)
1
2
3
5
7
8
9
11
13
15
19
21
23
27
37
38
39
40
81
95
95A
95B
97
101
103
105
105A
105B
107
111
BT1
BT2
BT3
BT4
LF1
LF2
HTR
WTR
C
P
W

FIG. 2

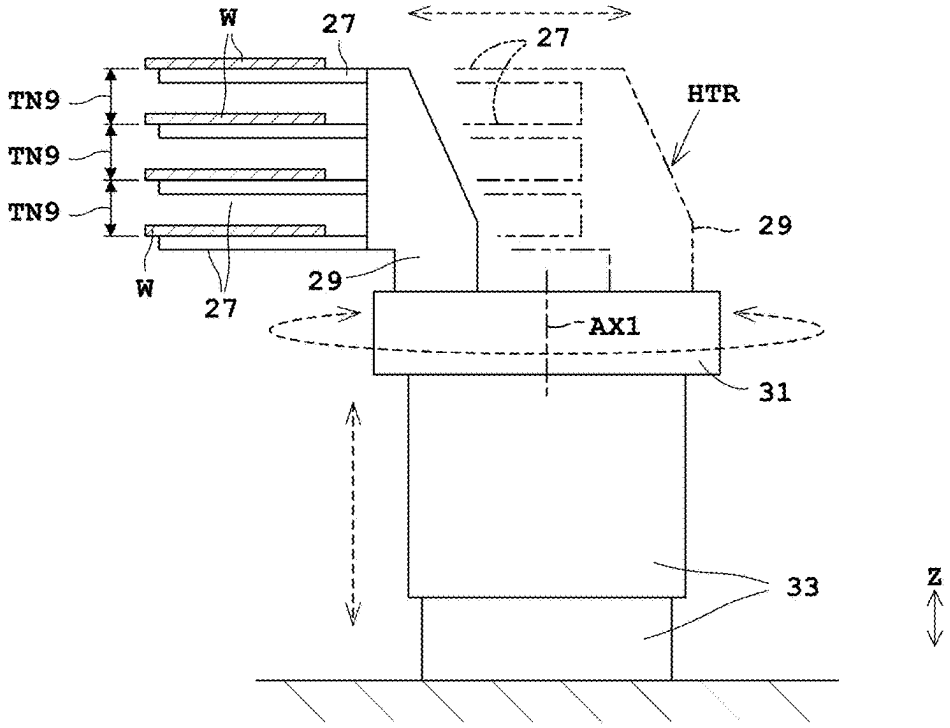

W
27
27
HTR
TN9
TN9
TN9
29
W
27
29
AX1
31
33
Z

FIG. 3

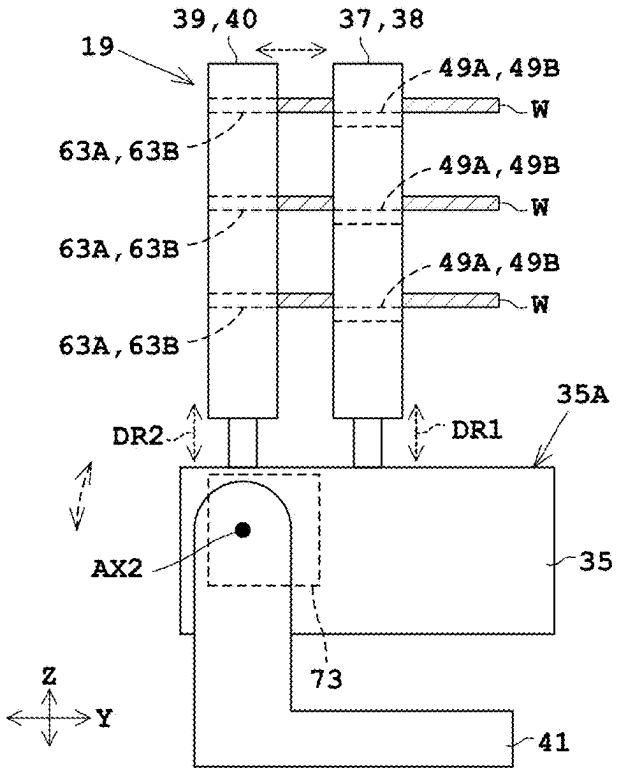

39,40
37,38
19
49A,49B
W
63A,63B
49A,49B
W
63A,63B
49A,49B
W
63A,63B
35A
DR2
DR1
AX2
35
73
Z
Y
41

FIG. 4

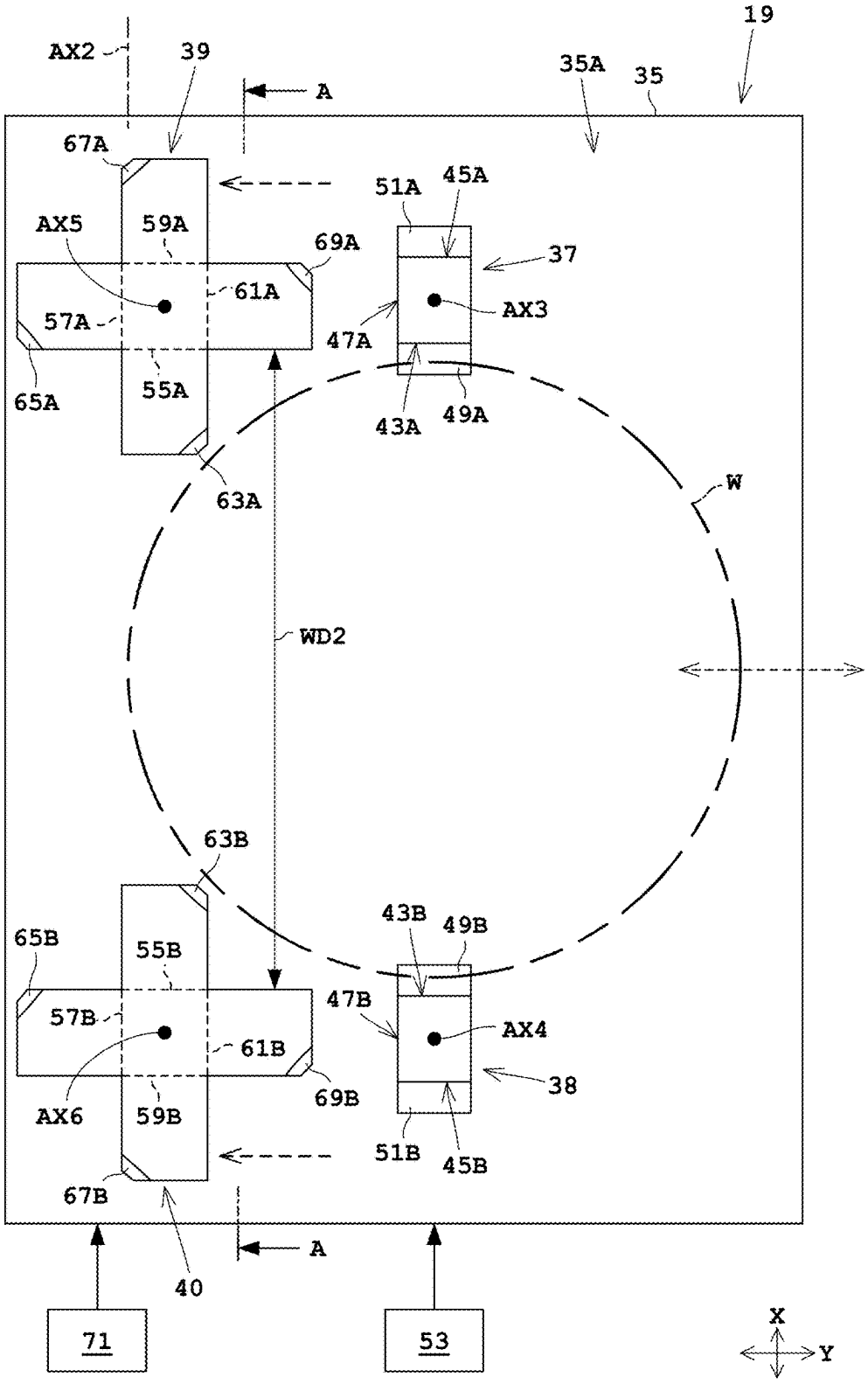

19
AX2
39
A
35A
35
67A
51A
45A
AX5
59A
69A
37
61A
AX3
57A
47A
65A
55A
43A
49A
63A
W
WD2
63B
43B
49B
65B
55B
47B
57B
AX4
61B
38
AX6
59B
69B
51B
45B
67B
A
40
71
53
X
Y

FIG. 5

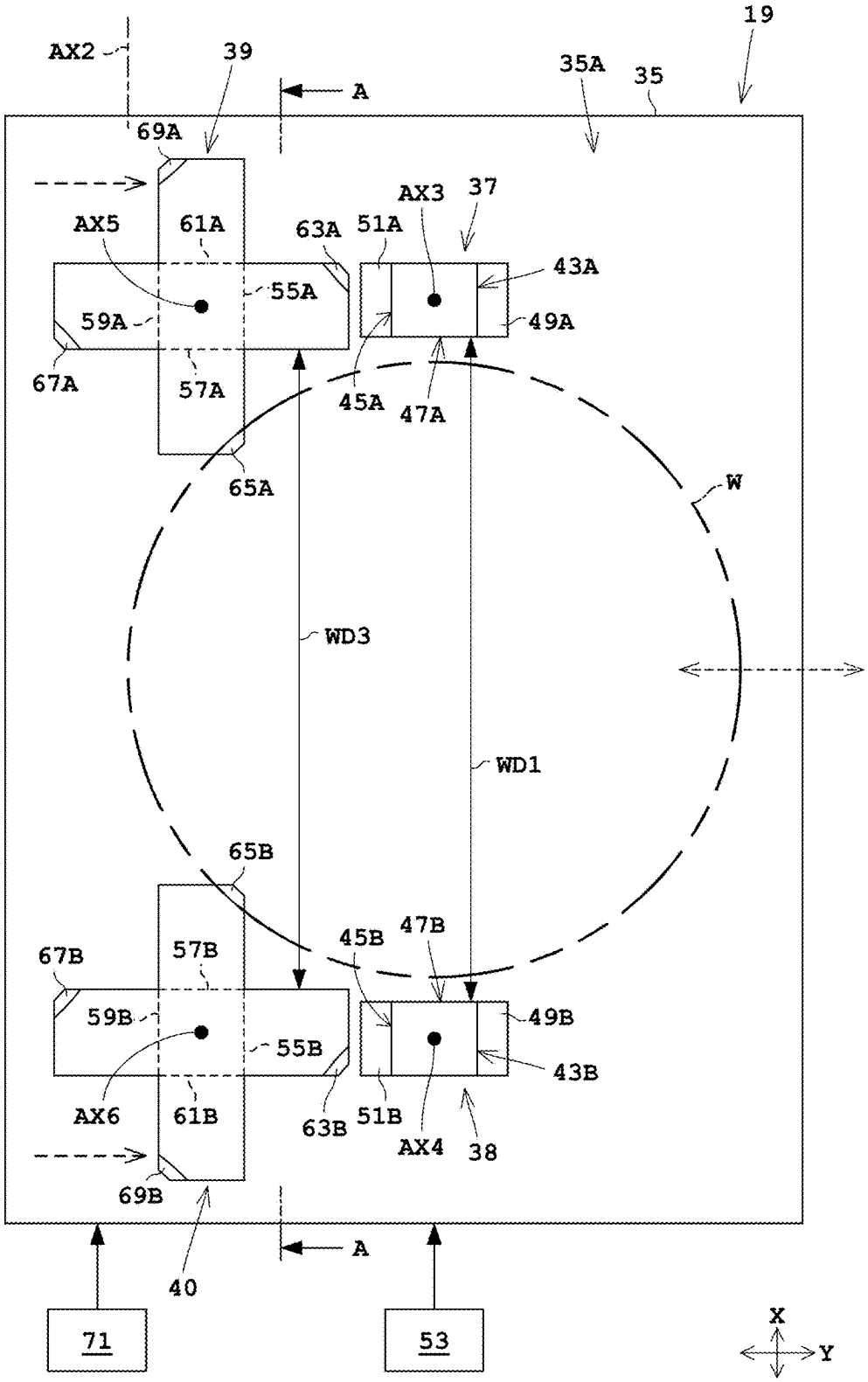

19
AX2
39
A
35A
35
69A
AX3
37
AX5
61A
63A
51A
43A
55A
59A
49A
67A
57A
45A
47A
65A
W
WD3
WD1
65B
67B
57B
45B
47B
59B
49B
55B
43B
AX6
61B
63B
51B
AX4
38
69B
40
A
71
53
X
Y

FIG. 6

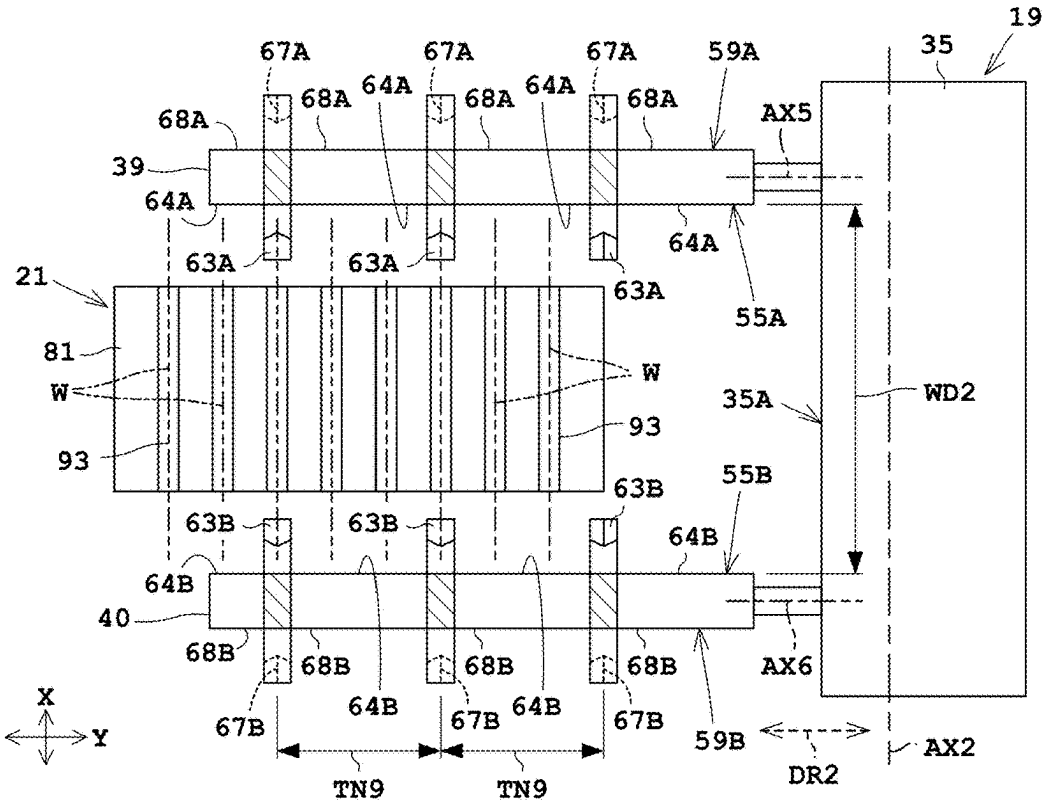

19
35
67A
67A
67A
59A
68A
64A
68A
64A
68A
68A
AX5
39
64A
64A
63A
63A
63A
21
55A
81
W
W
35A
WD2
93
93
63B
55B
63B
63B
64B
64B
64B
40
68B
68B
68B
68B
AX6
X
Y
67B
64B
67B
64B
67B
59B
DR2
AX2
TN9
TN9

FIG. 7

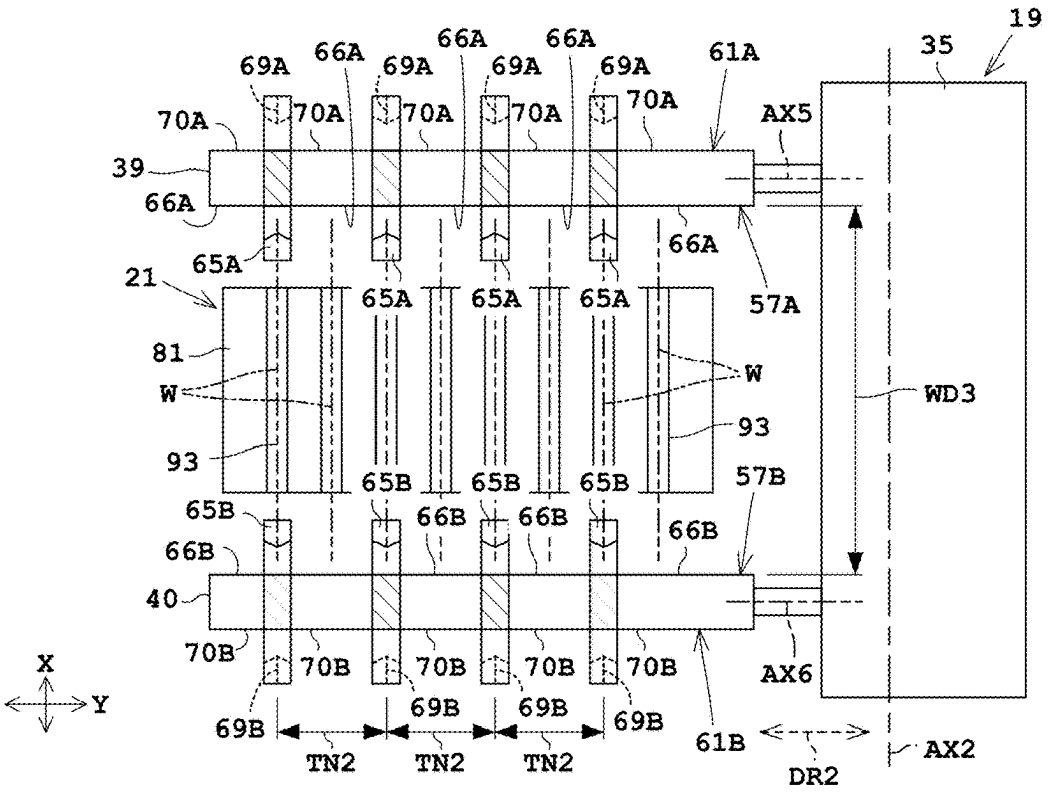

19
35
69A
66A
69A
66A
69A
66A
69A
61A
70A
70A
70A
70A
70A
AX5
39
66A
66A
65A
65A
65A
65A
21
57A
81
W
W
WD3
93
93
65B
65B
65B
65B
57B
65B
66B
66B
66B
66B
40
70B
70B
70B
70B
70B
AX6
X
Y
69B
69B
69B
69B
61B
DR2
AX2
TN2
TN2
TN2

FIG. 8

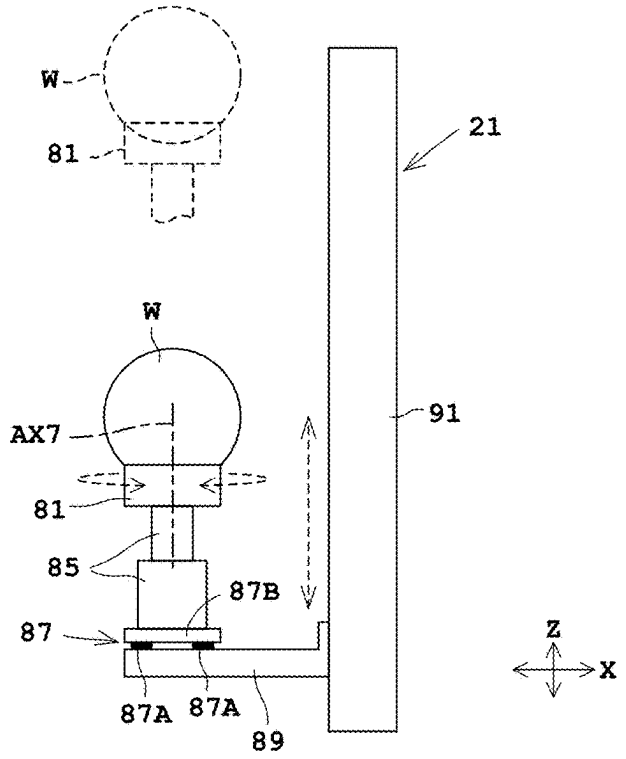

W
81
21
W
AX7
81
85
87B
87
91
87A
87A
89
Z
X

FIG. 9

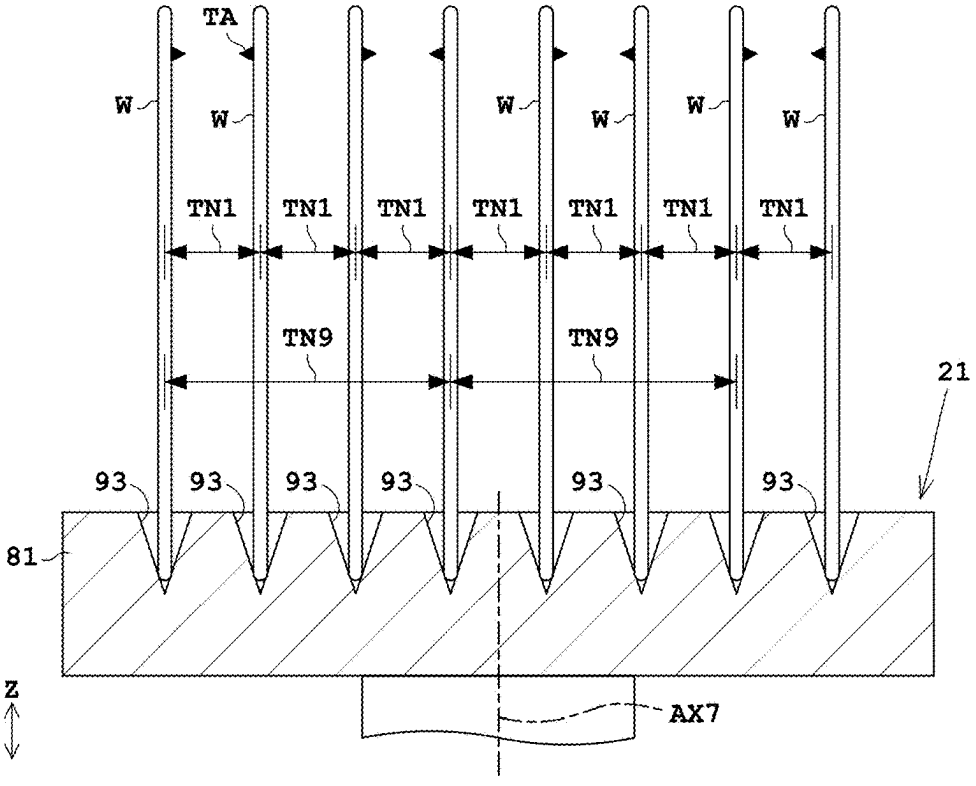

TA
W
W
W
W
W
W
TN1
TN1
TN1
TN1
TN1
TN1
TN1
TN9
TN9
21
93
93
93
93
93
93
81
Z
AX7

FIG. 10

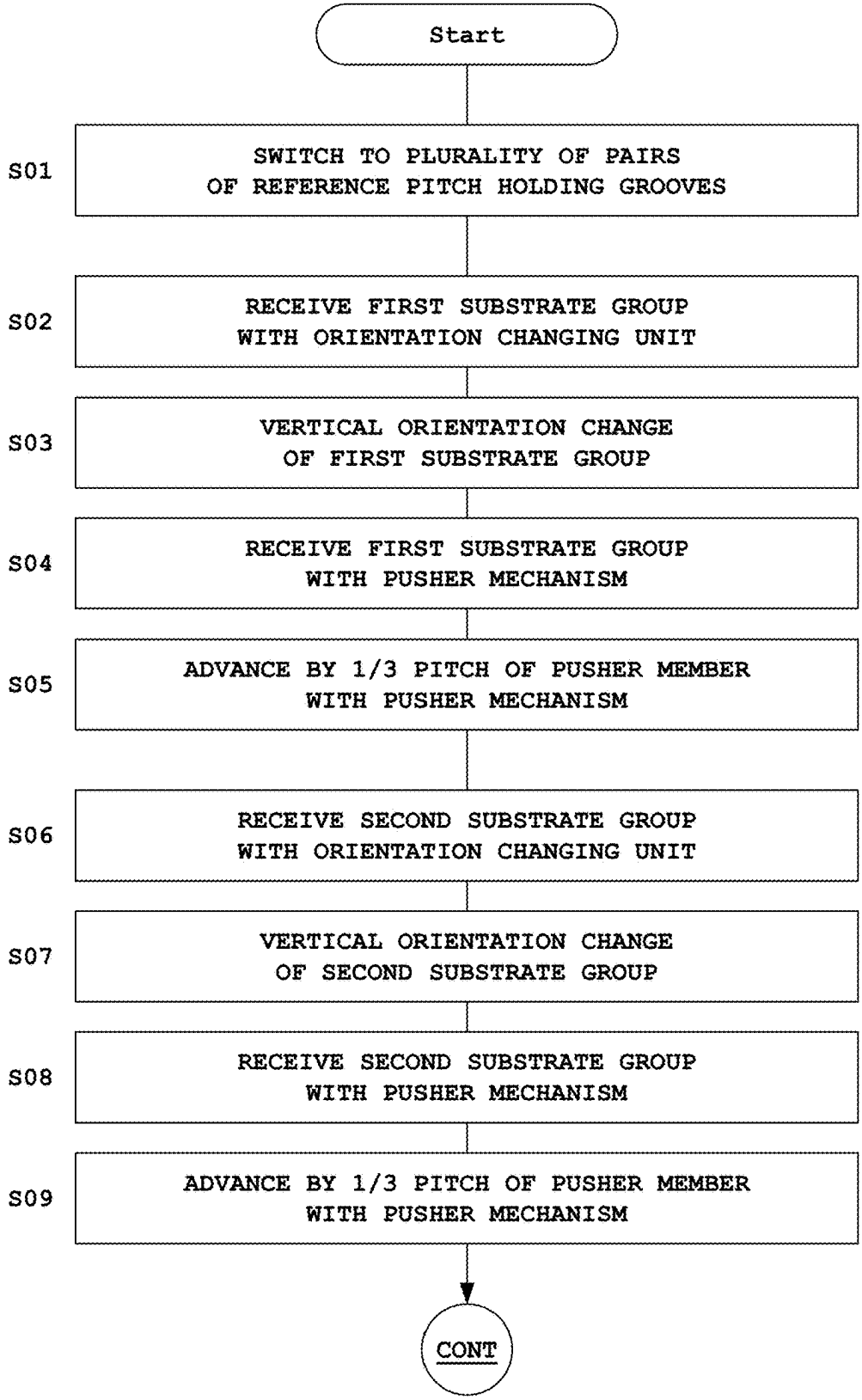

Start
S01
SWITCH TO PLURALITY OF PAIRS OF REFERENCE PITCH HOLDING GROOVES
S02
RECEIVE FIRST SUBSTRATE GROUP WITH ORIENTATION CHANGING UNIT
S03
VERTICAL ORIENTATION CHANGE OF FIRST SUBSTRATE GROUP
S04
RECEIVE FIRST SUBSTRATE GROUP WITH PUSHER MECHANISM
S05
ADVANCE BY 1/3 PITCH OF PUSHER MEMBER WITH PUSHER MECHANISM
S06
RECEIVE SECOND SUBSTRATE GROUP WITH ORIENTATION CHANGING UNIT
S07
VERTICAL ORIENTATION CHANGE OF SECOND SUBSTRATE GROUP
S08
RECEIVE SECOND SUBSTRATE GROUP WITH PUSHER MECHANISM
S09
ADVANCE BY 1/3 PITCH OF PUSHER MEMBER WITH PUSHER MECHANISM
CONT

FIG. 11

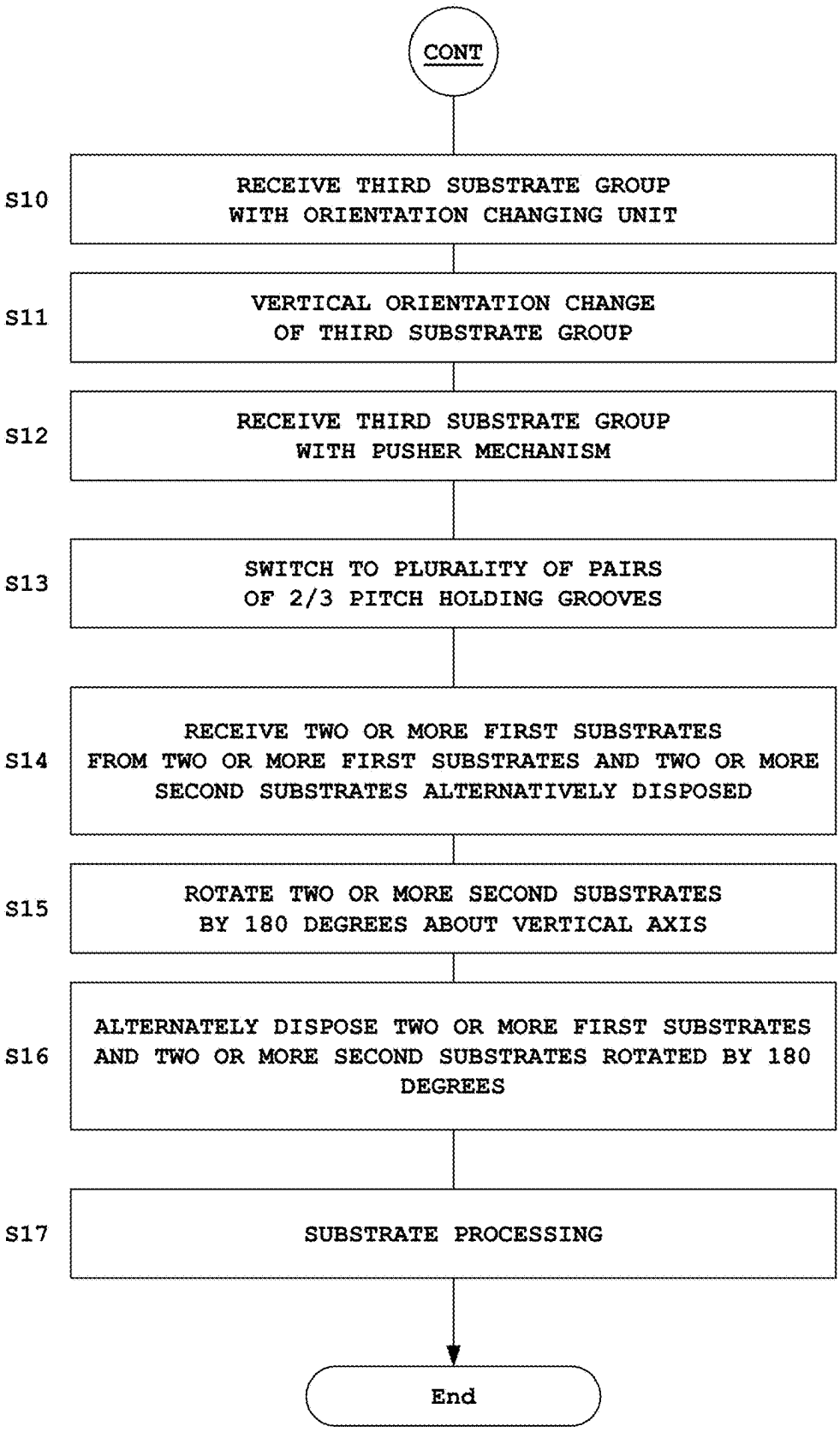

CONT
S10
RECEIVE THIRD SUBSTRATE GROUP WITH ORIENTATION CHANGING UNIT
S11
VERTICAL ORIENTATION CHANGE OF THIRD SUBSTRATE GROUP
S12
RECEIVE THIRD SUBSTRATE GROUP WITH PUSHER MECHANISM
S13
SWITCH TO PLURALITY OF PAIRS OF 2/3 PITCH HOLDING GROOVES
S14
RECEIVE TWO OR MORE FIRST SUBSTRATES FROM TWO OR MORE FIRST SUBSTRATES AND TWO OR MORE SECOND SUBSTRATES ALTERNATIVELY DISPOSED
S15
ROTATE TWO OR MORE SECOND SUBSTRATES BY 180 DEGREES ABOUT VERTICAL AXIS
S16
ALTERNATELY DISPOSE TWO OR MORE FIRST SUBSTRATES AND TWO OR MORE SECOND SUBSTRATES ROTATED BY 180 DEGREES
S17
SUBSTRATE PROCESSING
End

FIG. 12A

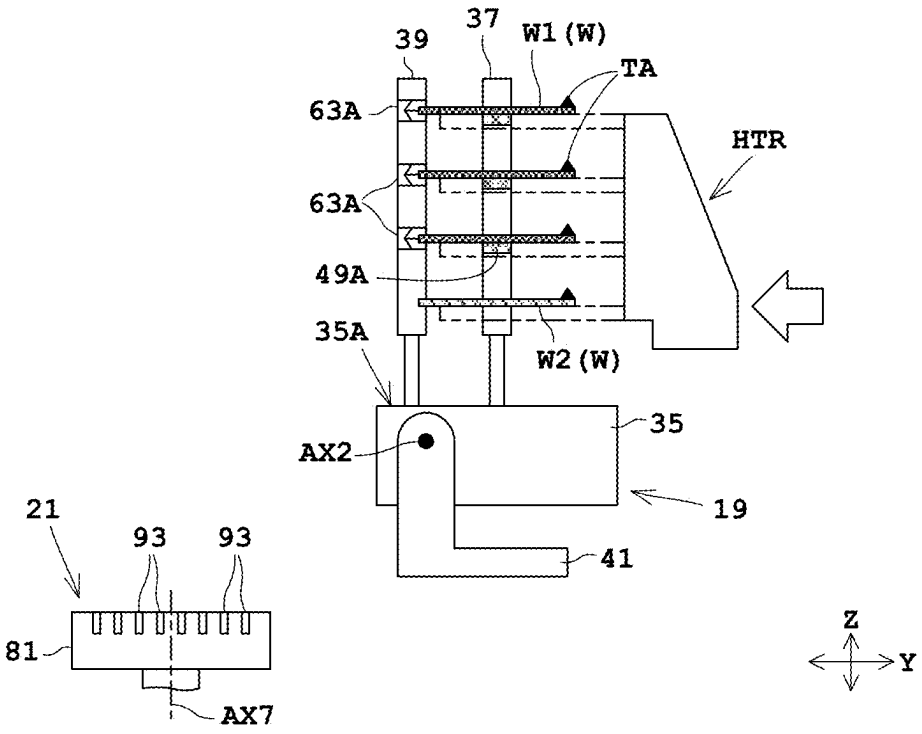


FIG. 12B

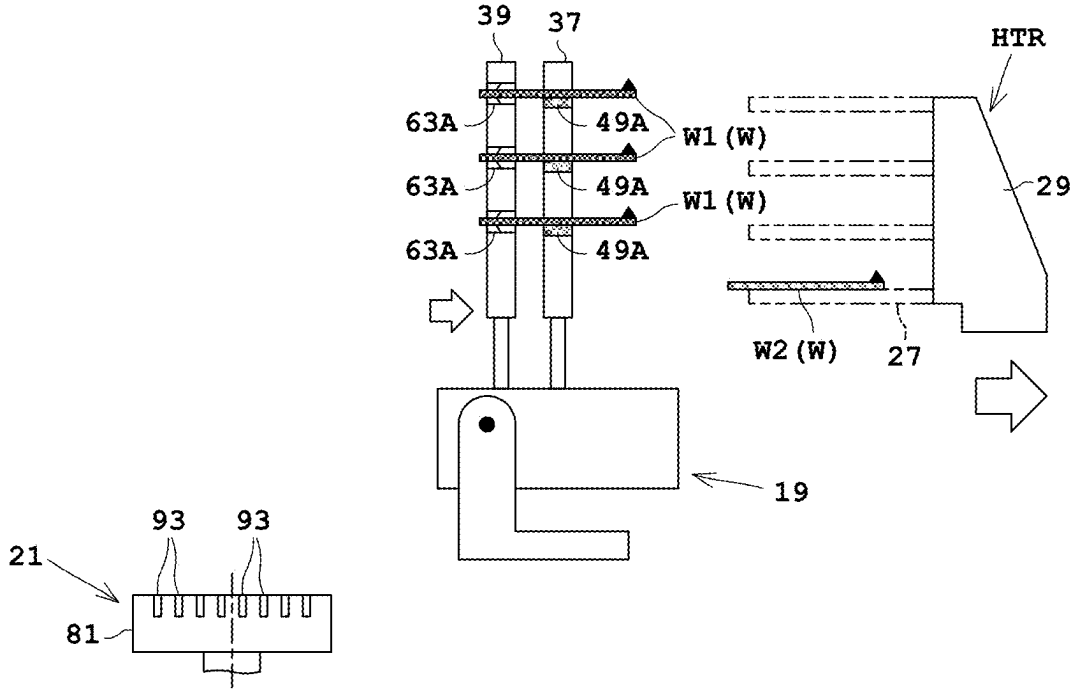


FIG. 13A

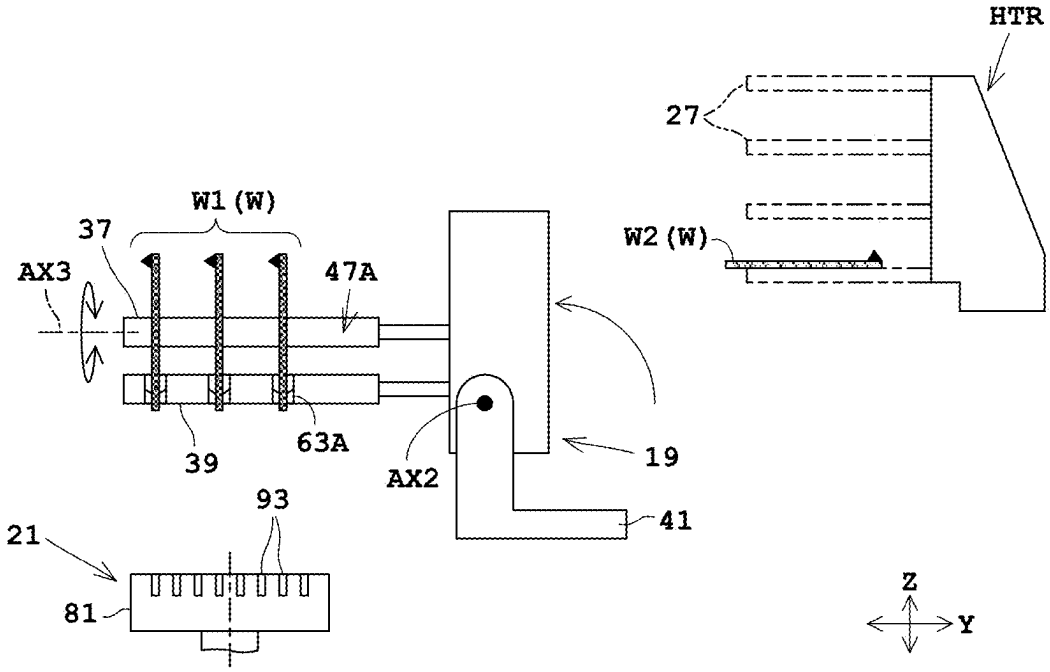


FIG. 13B

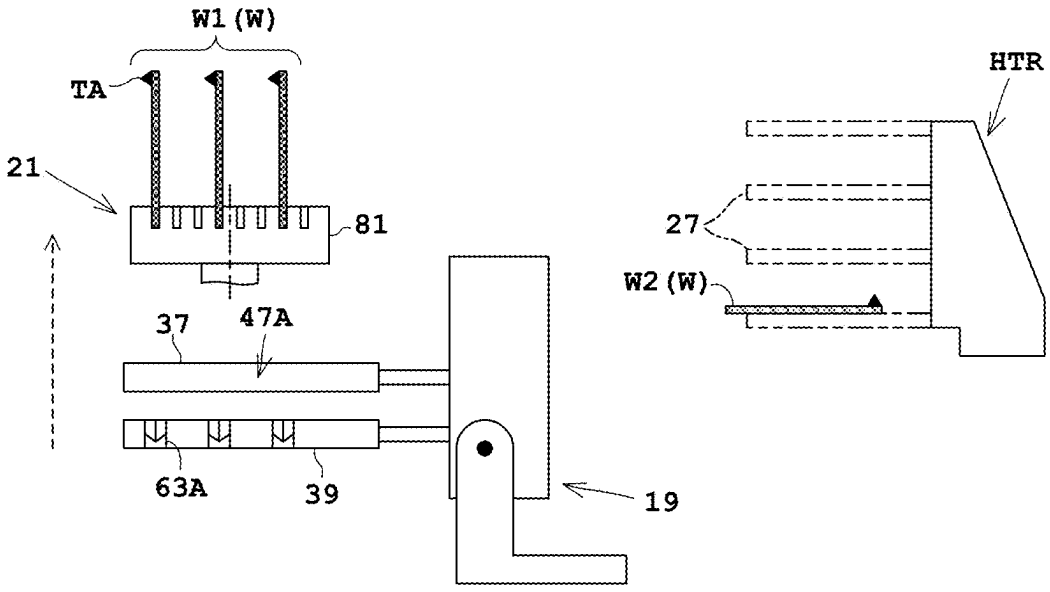


FIG. 14A

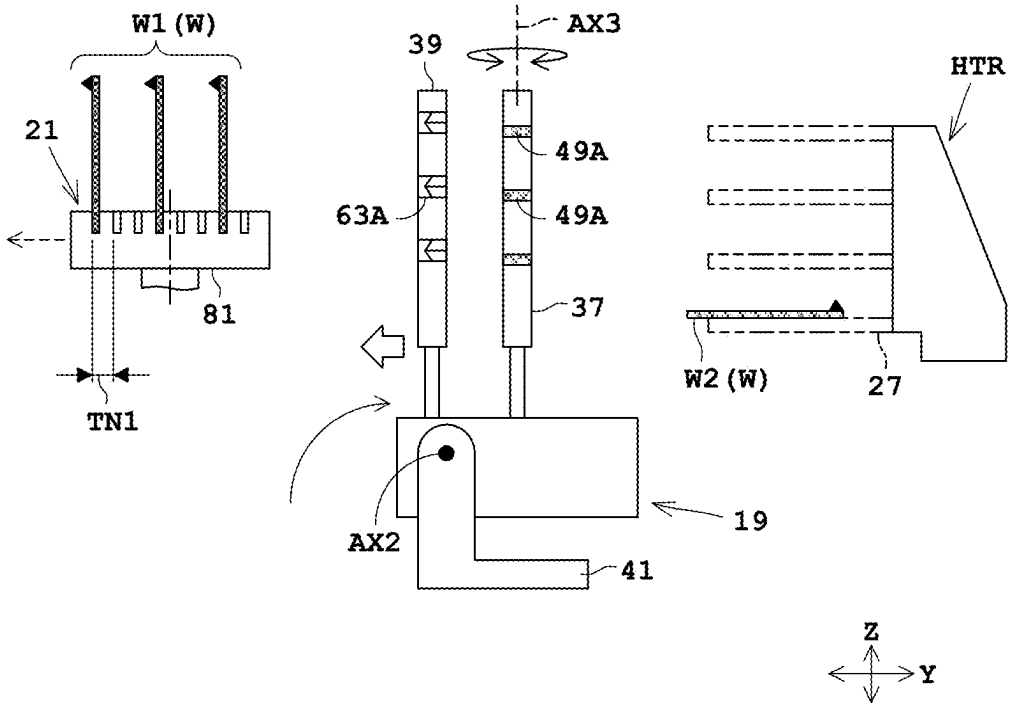


FIG. 14B

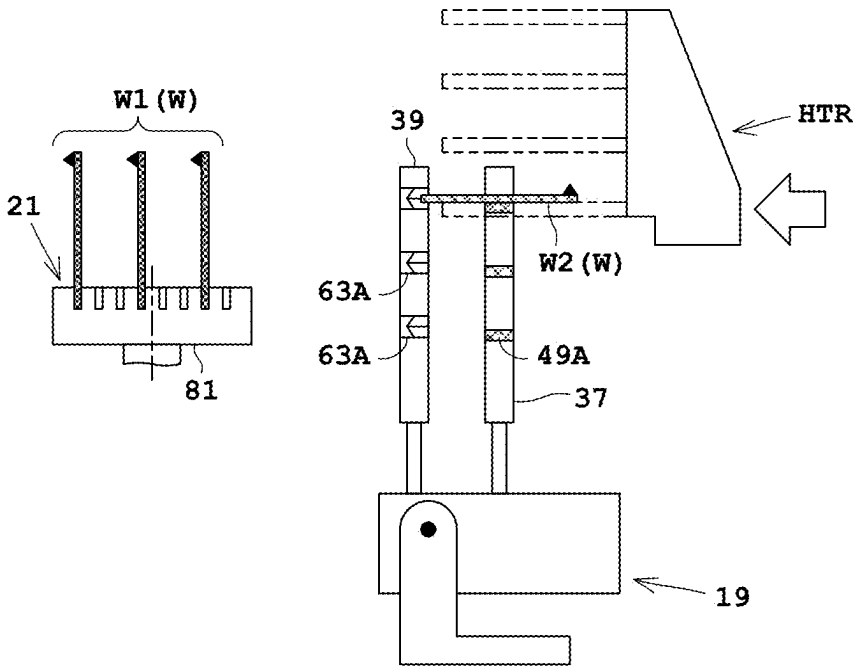


FIG. 15A

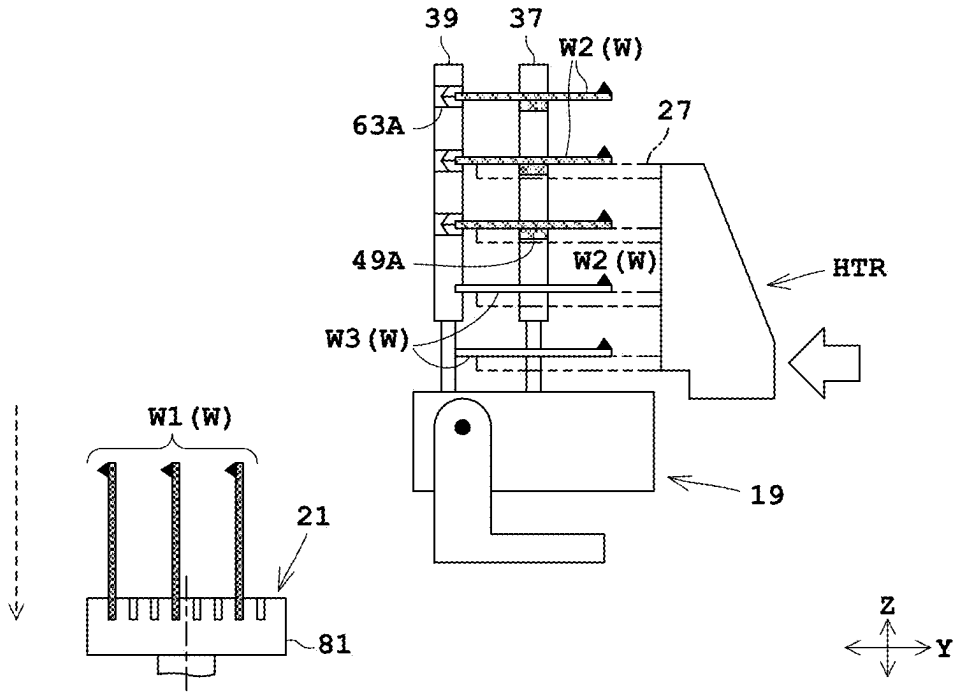


FIG. 15B

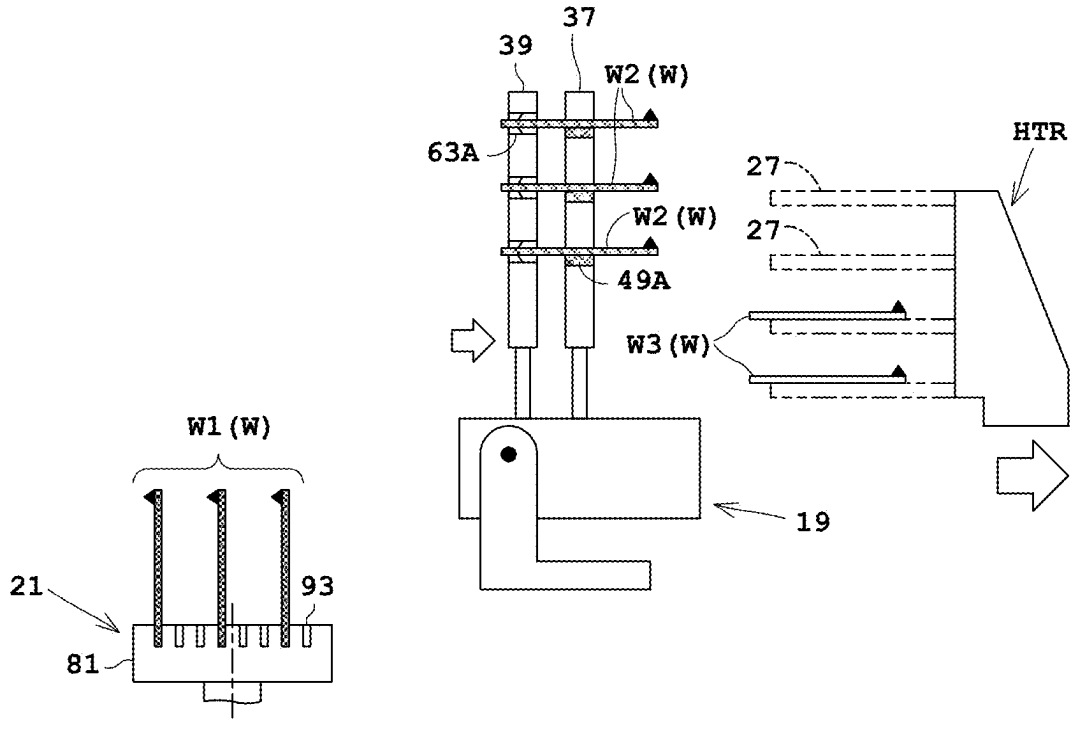


FIG. 16A

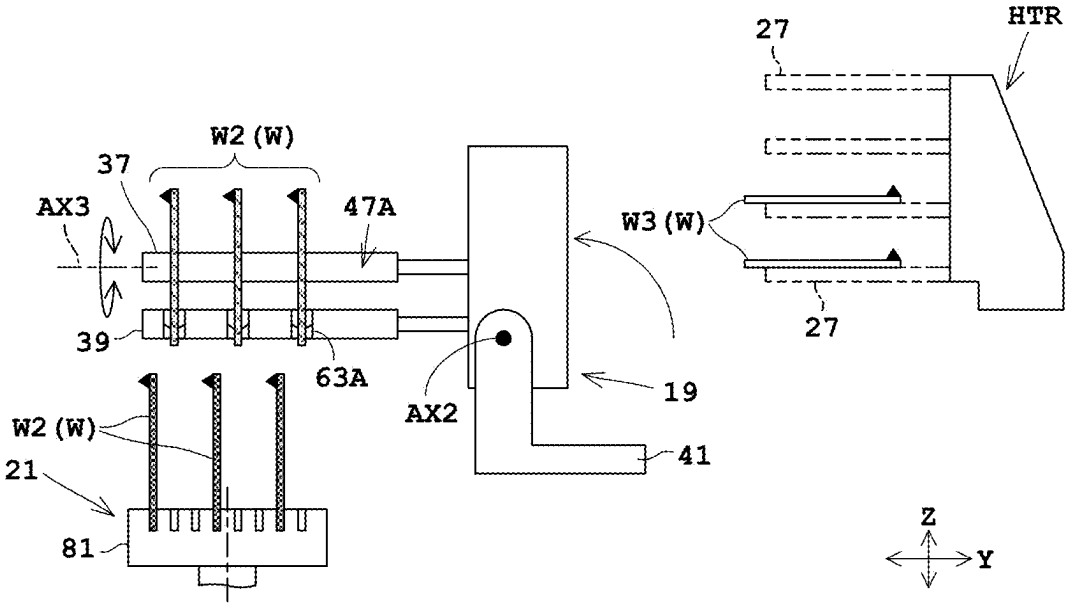


FIG. 16B

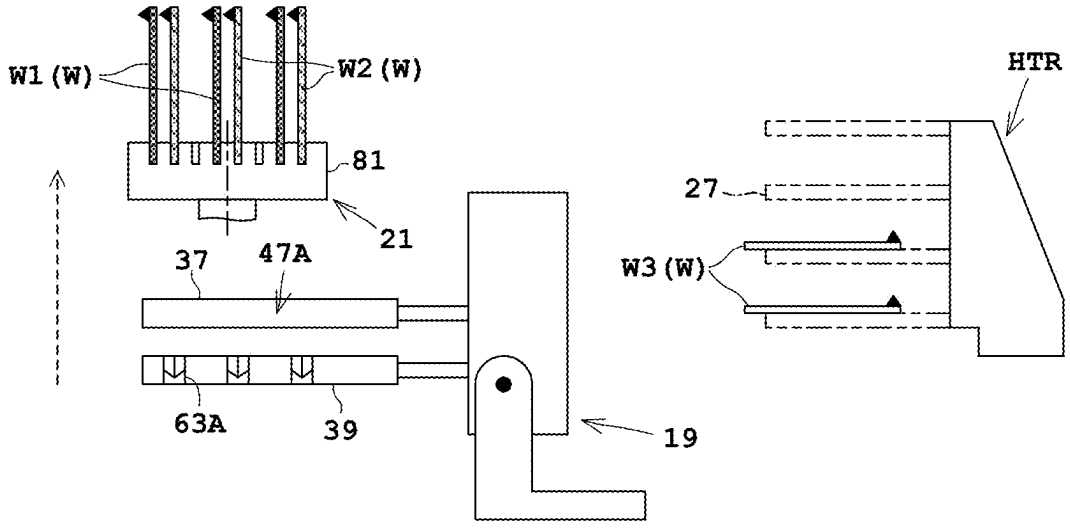


FIG. 17A

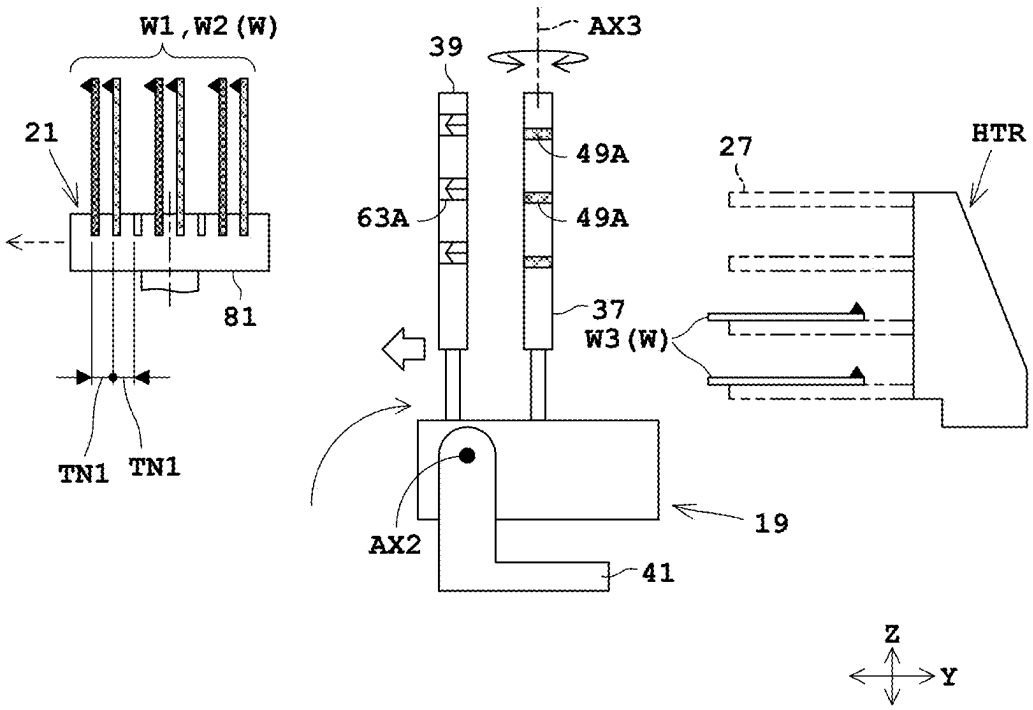


FIG. 17B

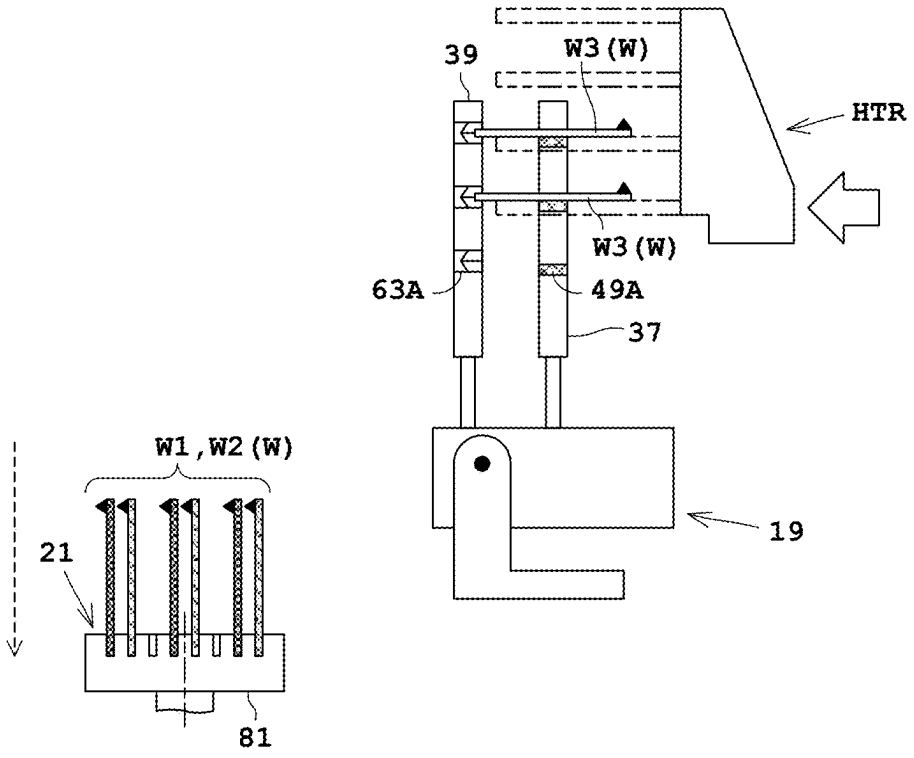


FIG. 18A

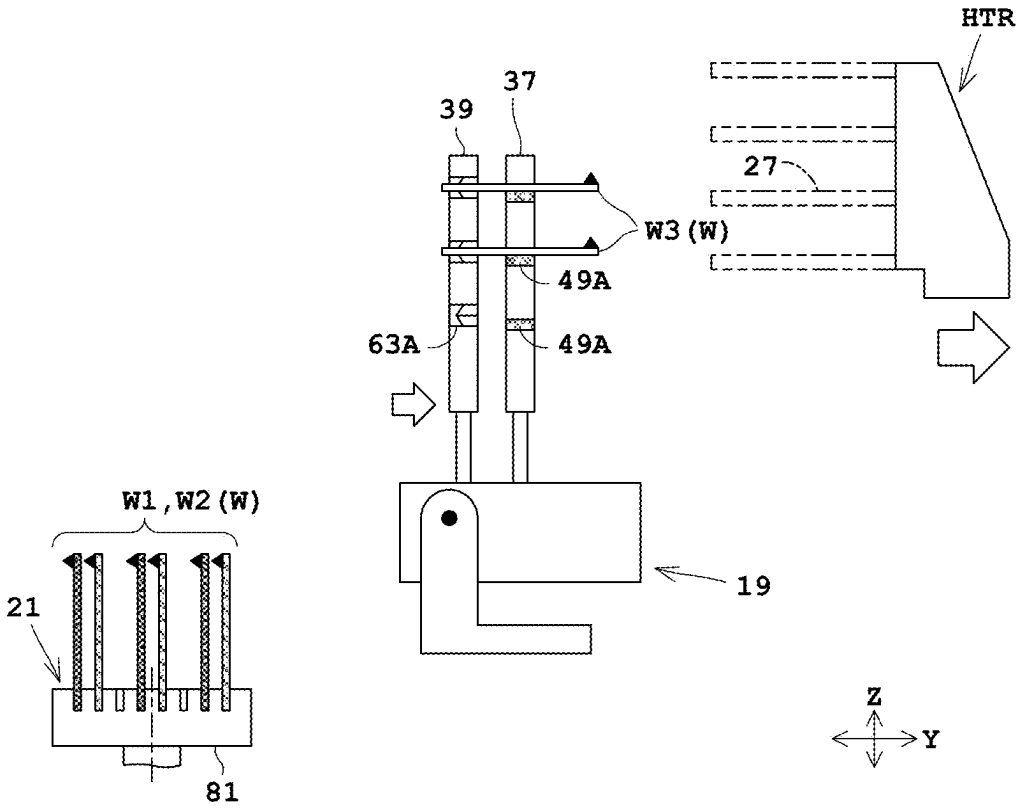


FIG. 18B

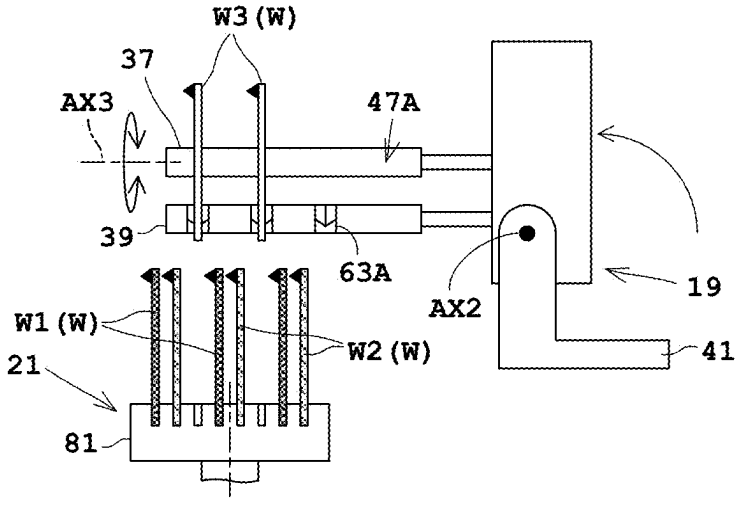


FIG. 19A

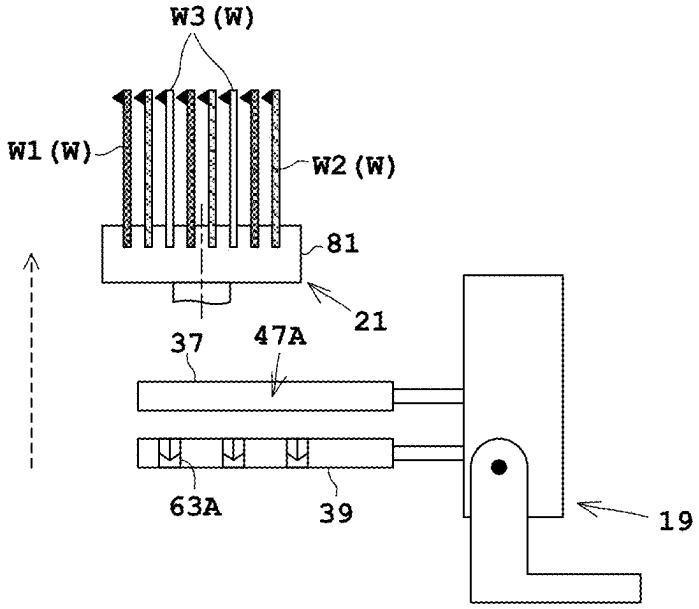


FIG. 19B

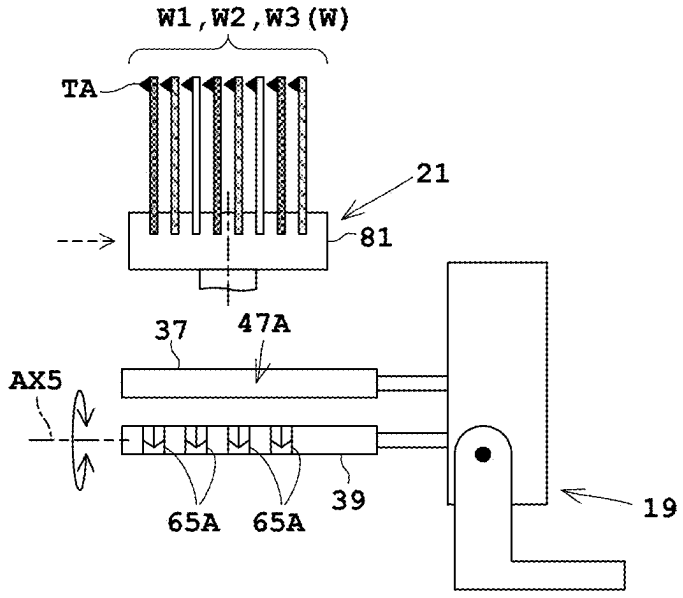


FIG. 20A

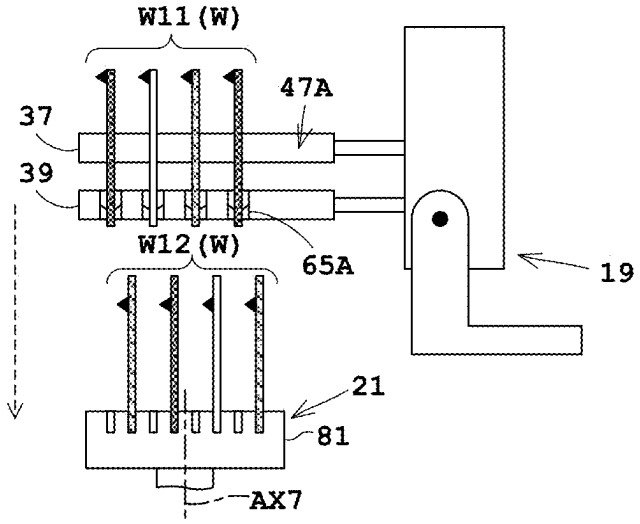


FIG. 20B

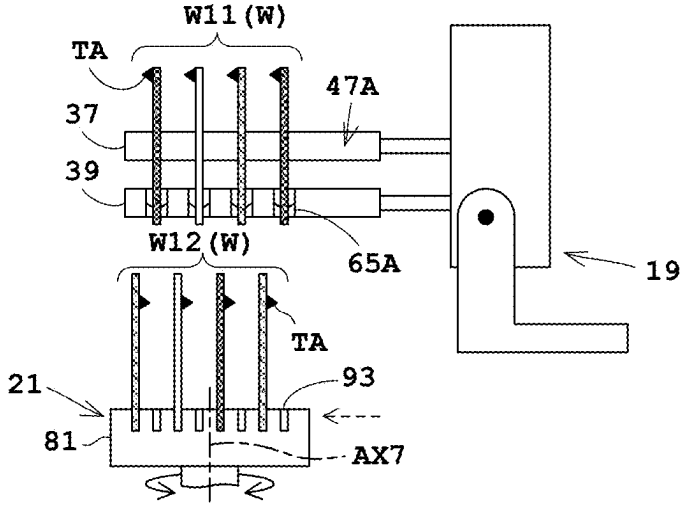


FIG. 21A

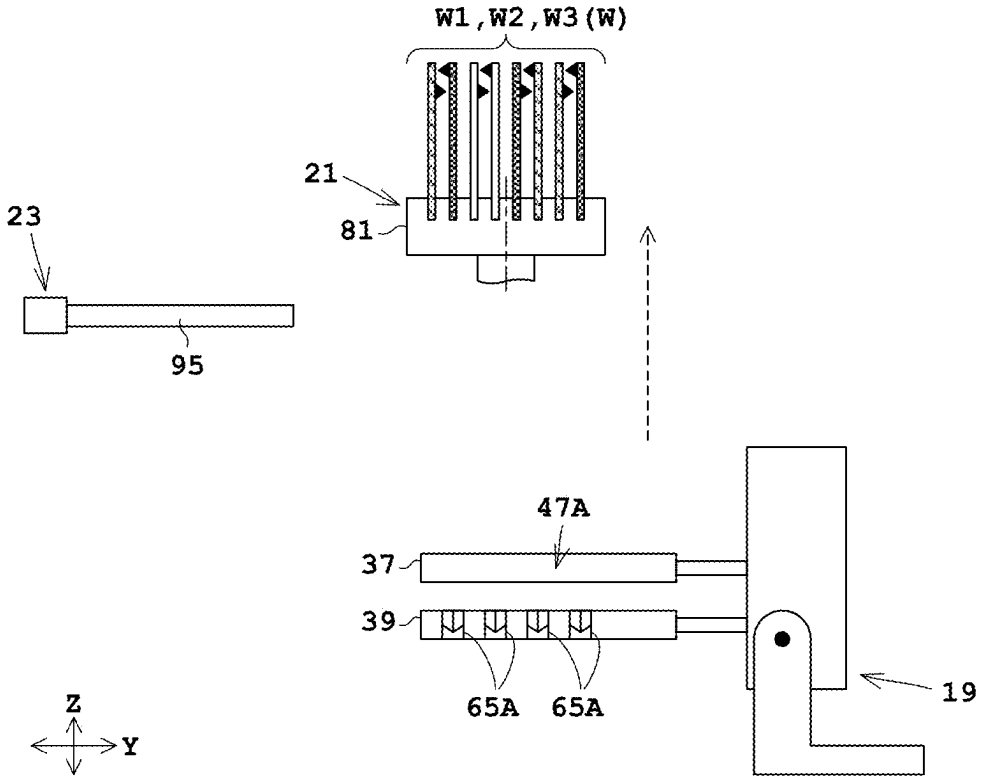


FIG. 21B

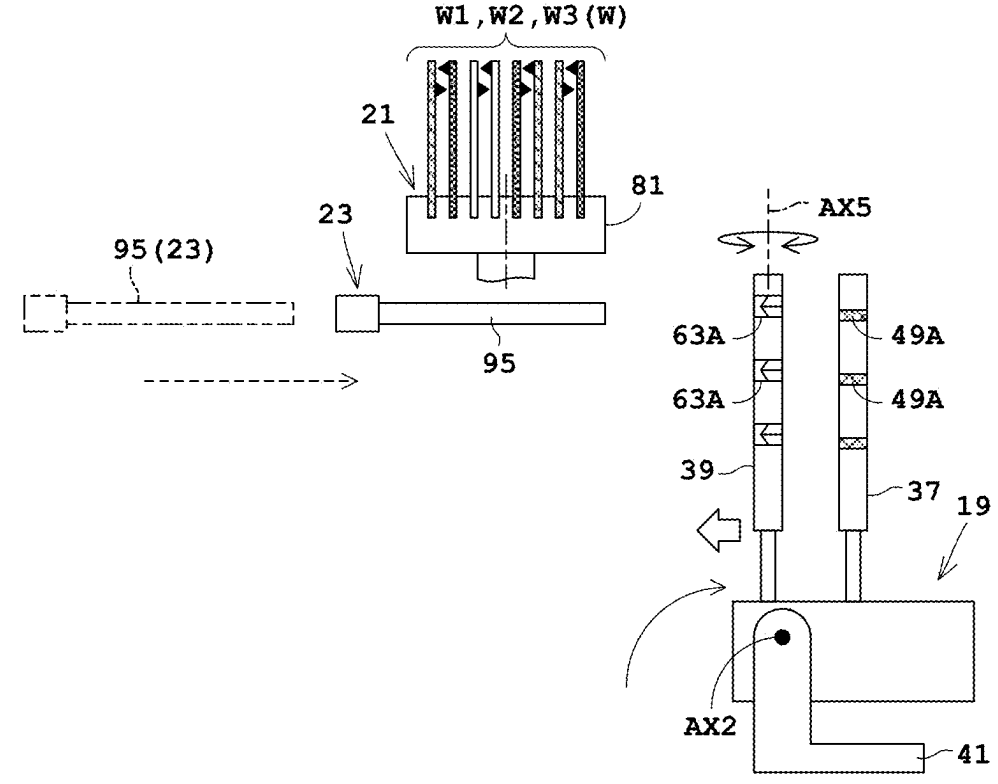


FIG. 22A

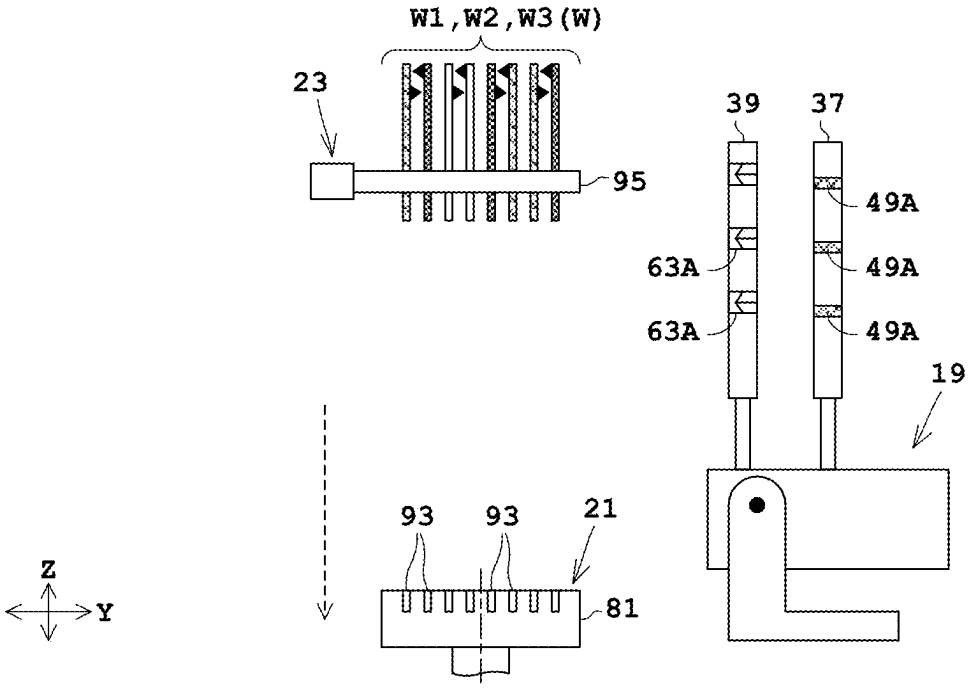


FIG. 22B

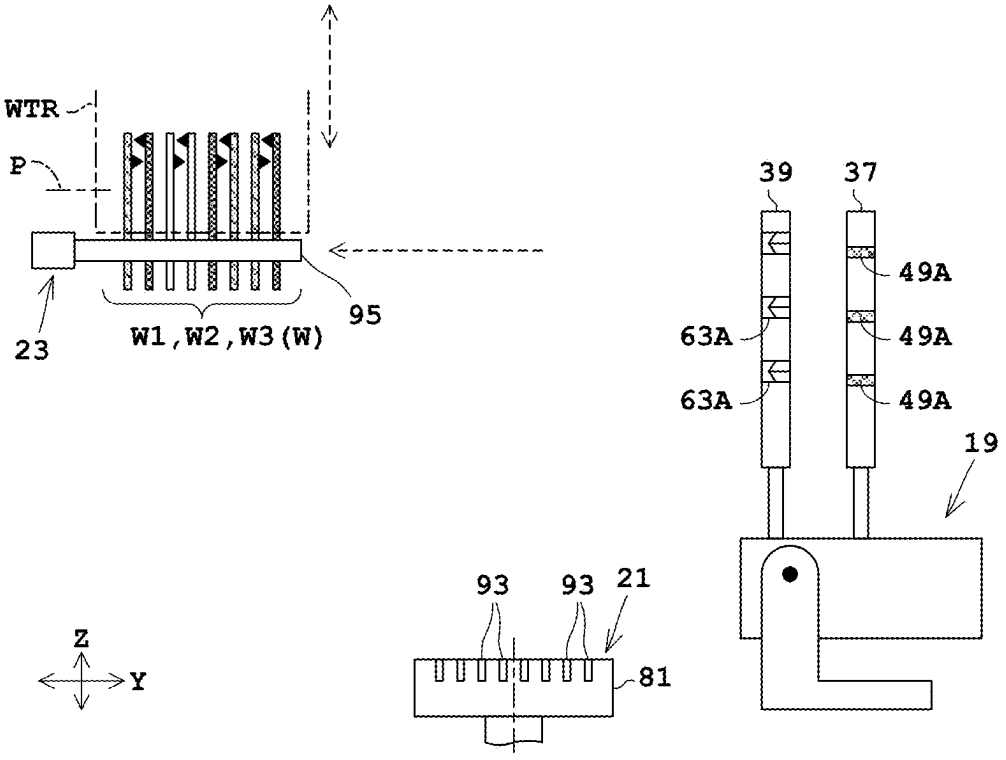


FIG. 23

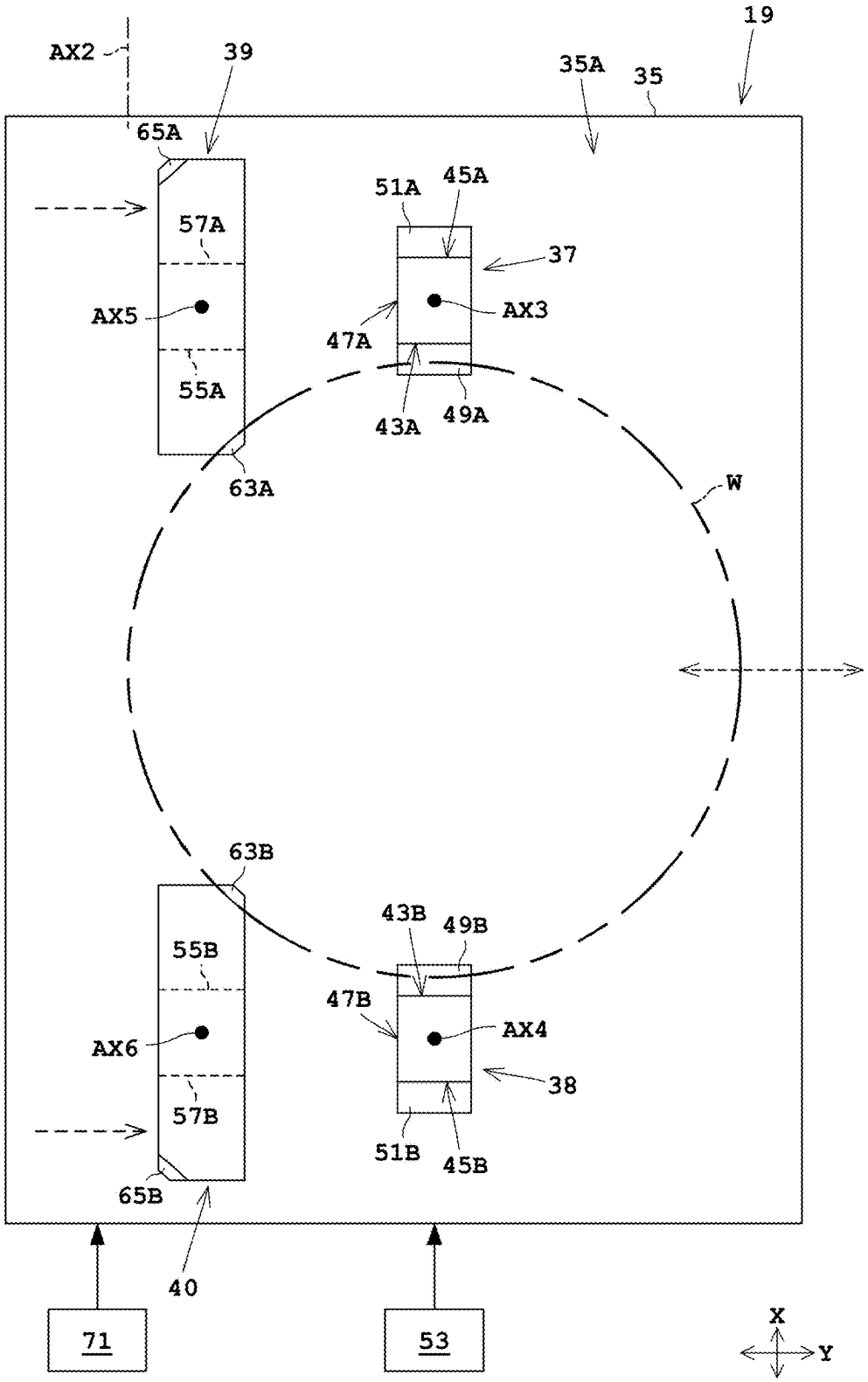

AX2
39
19
35A
35
65A
57A
AX5
55A
63A
51A
45A
37
AX3
47A
43A
49A
W
63B
55B
AX6
57B
65B
43B
49B
47B
AX4
38
51B
45B
40
71
53
X
Y

FIG. 24A

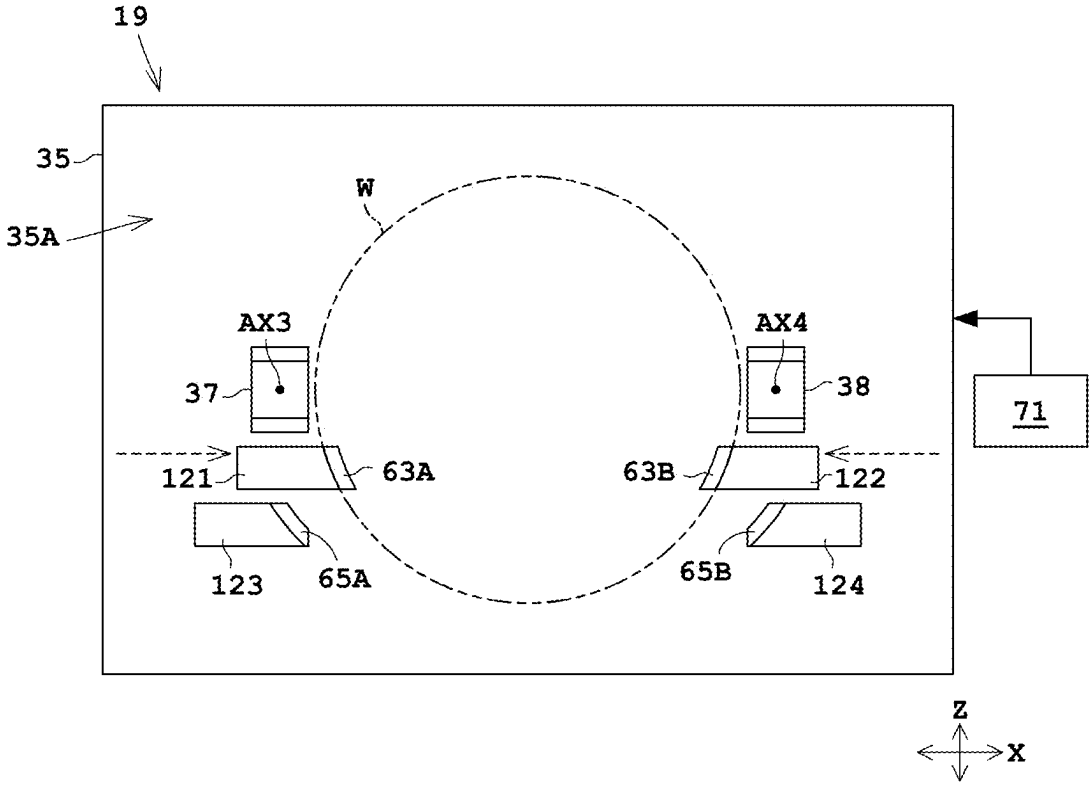
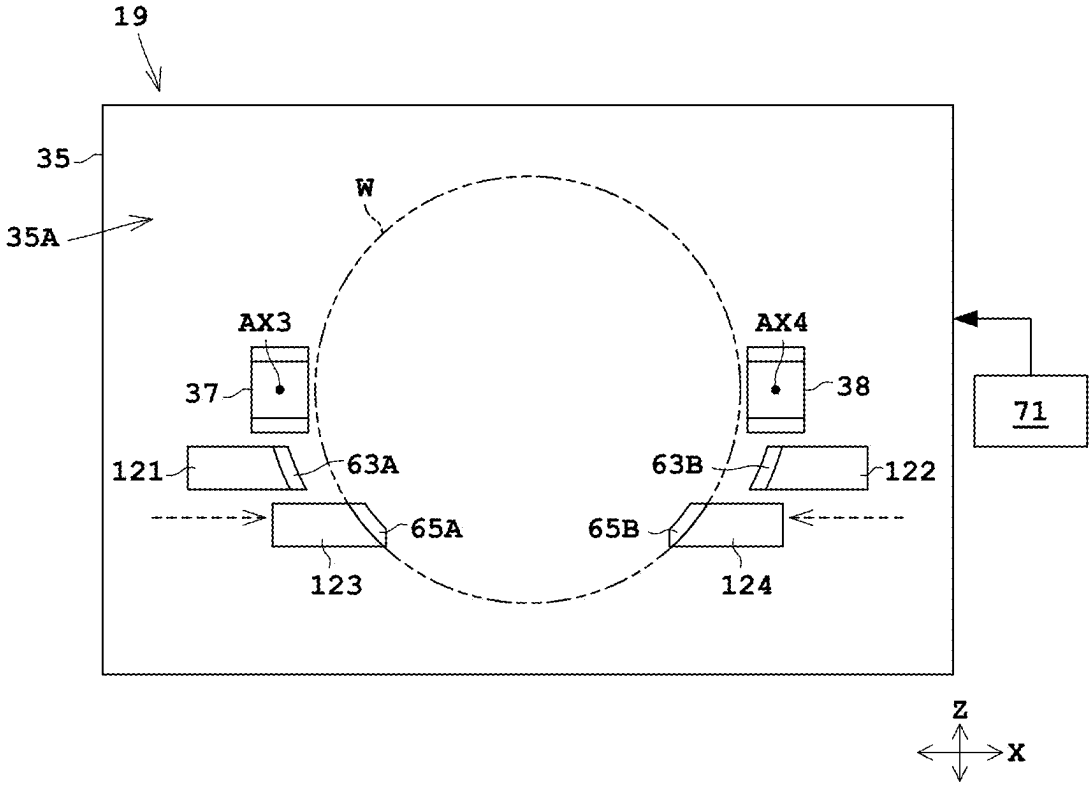


FIG. 24B



SUBSTRATE PROCESSING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Japanese Patent Application No. 2024-018104 filed Feb. 8, 2024, the subject matter of which is incorporated herein by reference in entirety.

BACKGROUND

Technical Field

[0002] The present invention relates to a substrate processing apparatus that processes a substrate. Examples of the substrate 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 magneto-optical disk, a ceramic substrate, and substrate for a solar cell. Examples of the FPD include a liquid crystal display device and an organic electroluminescence (EL) display device.

Related Art

[0003] Conventionally, a substrate processing apparatus that collectively immerses and processes a plurality of substrates in a processing liquid is known. The substrate processing apparatus includes an orientation changing mechanism (orientation changing unit) and a pusher (pusher mechanism) (see, for example, JP 2010-093230 A). The orientation changing mechanism changes the orientation of the substrate between a horizontal orientation and a vertical orientation. The pusher can deliver and receive a plurality of substrates in a vertical orientation to and from the orientation changing mechanism with an up-down movement of a lifting and holding unit (pusher member).

[0004] After 25 substrates are delivered from the orientation changing mechanism to the lifting and holding unit, the lifting and holding unit turns 180 degrees about a vertical axis. With the turning of 180 degrees, the held 25 substrates move by a half pitch. In this state, another 25 substrates are delivered from the orientation changing mechanism to the lifting and holding unit. As a result, the 25 substrates delivered later enter between the 25 substrates delivered earlier, and a substrate group of a total of 50 substrates is formed on the lifting and holding unit. At this time, two adjacent substrates are in a face-to-face state in which their front surfaces (or the back surfaces) face each other. The 50 substrates held by the lifting and holding unit are aligned at a half pitch that is half the substrate holding pitch in a carrier.

SUMMARY

[0005] To reduce the amount of processing liquid (chemical liquid and cleaning liquid) used in the substrate processing apparatus, there is a demand for aligning a plurality of substrates at a pitch narrower than the half pitch and collectively processing the plurality of substrates aligned at the narrow pitch. In this case, it may be difficult to bring the plurality of substrates aligned at a narrow pitch narrower than the half pitch into a face-to-face state.

[0006] The present invention has been made in view of such circumstances, and an object thereof is to provide a substrate processing apparatus capable of easily aligning a plurality of substrates at a narrow pitch narrower than a half pitch in a face-to-face manner.

[0007] To achieve such an object, the present invention has the following configurations. That is, a substrate processing apparatus according to the present invention is a substrate processing apparatus that collectively processes a plurality of substrates, the substrate processing apparatus including a substrate handling mechanism including a plurality of hands disposed in a vertical direction at a reference pitch, each of which holds one substrate in a horizontal orientation, an orientation changing unit that individually changes an orientation of N substrate groups each including two or more substrates aligned at the reference pitch from the horizontal orientation to a vertical orientation, wherein N is a natural number of three or more, the N substrate groups being sequentially received from the substrate handling mechanism, and a pusher mechanism including a pusher member that holds the plurality of substrates aligned in the vertical orientation at a 1/N pitch that is 1/N times the reference pitch, the pusher mechanism forming the plurality of substrates on the pusher member by aligning the N substrate groups received from the orientation changing unit in one row with the pusher member while shifting the pusher member by the 1/N pitch in an alignment direction in which the plurality of substrates are aligned, wherein the orientation changing unit includes a support base, a pair of horizontal holding units that holds one substrate group of the N substrate groups in the horizontal orientation, the pair of horizontal holding units being provided in such a manner as to extend at a right angle with respect to a support surface of the support base, a pair of vertical holding units including a plurality of pairs of reference pitch holding grooves and a plurality of pairs of 2/N pitch holding grooves, the pair of vertical holding units being provided in such a manner as to extend at the right angle with respect to the support surface of the support base, a rotation drive unit that rotates the support base about a horizontal axis, and a switching drive unit that switches between a state in which the plurality of pairs of reference pitch holding grooves are usable and a state in which the plurality of pairs of 2/N pitch holding grooves are usable, the plurality of pairs of reference pitch holding grooves are disposed at the reference pitch in an extending direction in which the pair of vertical holding units extends, the plurality of pairs of 2/N pitch holding grooves are disposed at a 2/N pitch that is 2/N times the reference pitch in the extending direction, and the switching drive unit switches to the state in which the plurality of pairs of reference pitch holding grooves are usable when the plurality of substrates aligned in a face-to-back manner are formed in the pusher member, and switches to the state in which the plurality of pairs of 2/N pitch holding grooves are usable when the plurality of substrates held by the pusher member are rearranged into a face-to-face manner.

[0008] According to the substrate processing apparatus of the present invention, the pair of vertical holding units of the orientation changing unit includes a plurality of pairs of reference pitch holding grooves and a plurality of pairs of 2/N pitch holding grooves. The plurality of pairs of reference pitch holding grooves are disposed at a reference pitch. The plurality of pairs of 2/N pitch holding grooves are disposed at a 2/N pitch that is 2/N times the reference pitch. The switching drive unit switches to a state in which the plurality of pairs of reference pitch holding grooves are usable. With this operation, the pusher mechanism can cause

the pusher member to hold the plurality of substrate groups each aligned at the reference pitch while moving them by the 1/N pitch. Thus, a plurality of substrates aligned at the 1/N pitch in a face-to-back manner are once held by the pusher member.

[0009] The switching drive unit of the orientation changing unit switches to a state in which the plurality of pairs of 2/N pitch holding grooves are usable. As a result, the orientation changing unit can extract two or more first substrates out of the plurality of substrates in which two or more first substrates and two or more second substrates are alternately disposed from the plurality of substrates held by the pusher member. Thereafter, the pusher mechanism rotates the two or more second substrates remaining on the pusher member by 180 degrees about a vertical axis. Thereafter, the two or more first substrates extracted by the orientation changing unit are returned to the pusher member. With this operation, a plurality of substrates aligned at the 1/N pitch in a face-to-face manner are held by the pusher member. Thus, a plurality of substrates can be easily aligned at the 1/N pitch narrower than a half pitch in a face-to-face manner.

[0010] In the substrate processing apparatus described above, it is preferable that a first vertical holding unit of the pair of vertical holding unit is rotatable about a first rotation axis passing through the first vertical holding unit and extending at a right angle with respect to the support surface, the first vertical holding unit includes a first outer peripheral surface and a second outer peripheral surface provided around the first rotation axis, a second vertical holding unit of the pair of vertical holding unit is rotatable about a second rotation axis passing through the second vertical holding unit and extending at a right angle with respect to the support surface, the second vertical holding unit includes a third outer peripheral surface and a fourth outer peripheral surface provided around the second rotation axis, the first outer peripheral surface and the third outer peripheral surface are provided with the plurality of pairs of reference pitch holding grooves, the second outer peripheral surface and the fourth outer peripheral surface are provided with the plurality of pairs of 2/N pitch holding grooves, and the switching drive unit rotates the first vertical holding unit about the first rotation axis and rotates the second vertical holding unit about the second rotation axis to switch between the state in which the plurality of pairs of reference pitch holding grooves are usable and the state in which the plurality of pairs of 2/N pitch holding grooves are usable.

[0011] The switching drive unit rotates the first vertical holding unit about the first rotation axis and rotates the second vertical holding unit about the second rotation axis. This allows the switching drive unit to switch between a state in which the plurality of pairs of reference pitch holding grooves are usable and a state in which the plurality of pairs of 2/N pitch holding grooves are usable.

[0012] In the substrate processing apparatus described above, it is preferable that the first vertical holding unit includes a fifth outer peripheral surface and a sixth outer peripheral surface provided around the first rotation axis in addition to the first outer peripheral surface and the second outer peripheral surface, the second vertical holding unit includes a seventh outer peripheral surface and an eighth outer peripheral surface provided around the second rotation axis in addition to the third outer peripheral surface and the fourth outer peripheral surface, the fifth outer peripheral surface and the seventh outer peripheral surface are provided with a plurality of pairs of post-processing reference pitch holding grooves disposed at the reference pitch in the extending direction, the sixth outer peripheral surface and the eighth outer peripheral surface are provided with a plurality of pairs of post-processing 2/N pitch holding grooves disposed at the 2/N pitch in the extending direction, the switching drive unit rotates the first vertical holding unit about the first rotation axis and rotates the second vertical holding unit about the second rotation axis to switch between the state in which the plurality of pairs of reference pitch holding grooves are usable, the state in which the plurality of pairs of 2/N pitch holding grooves are usable, a state in which the plurality of pairs of post-processing reference pitch holding grooves are usable, and a state in which the plurality of pairs of post-processing 2/N pitch holding grooves are usable, and the switching drive unit switches to the state in which the plurality of pairs of post-processing 2/N pitch holding grooves are usable when the plurality of substrates held by the pusher member are rearranged into a face-to-back manner, and switches to the state in which the plurality of pairs of post-processing reference pitch holding grooves are usable when the plurality of substrates held by the pusher member are divided into the N substrate groups.

[0013] The switching drive unit rotates the first vertical holding unit about the first rotation axis and rotates the second vertical holding unit about the second rotation axis. With this operation, the switching drive unit can switch between four states, that is, between a state in which the plurality of pairs of reference pitch holding grooves are usable, a state in which the plurality of pairs of 2/N pitch holding grooves are usable, a state in which the plurality of pairs of post-processing reference pitch holding grooves are usable, and a state in which the plurality of pairs of post-processing 2/N pitch holding grooves are usable.

[0014] It is preferable that the substrate processing apparatus described above includes a controller, wherein the controller causes the switching drive unit to switch to the state in which the plurality of pairs of reference pitch holding grooves are usable, causes the orientation changing unit to sequentially receive the N substrate groups from the substrate handling mechanism, causes the orientation changing unit to individually change the orientation of the N substrate groups from a horizontal orientation to a vertical orientation, causes the pusher mechanism to hold the plurality of substrates aligned at the 1/N pitch in a face-to-back manner with the pusher member, the plurality of substrates being formed from the N substrate groups by the pusher member sequentially receiving the N substrate groups while the pusher member is shifted in the alignment direction by the 1/N pitch, causes the switching drive unit to switch to the state in which the plurality of pairs of 2/N pitch holding grooves are usable, causes the pair of vertical holding units to receive, from the pusher member, two or more first substrates aligned at the 2/N pitch among the plurality of substrates in which the two or more first substrates and two or more second substrates are alternately disposed, causes the pusher mechanism to rotate the pusher member holding the two or more second substrates in a vertical orientation by 180 degrees about a vertical axis, and causes the pusher member to receive the two or more first substrates from the pair of vertical holding units while alternately disposing the

two or more first substrates and the two or more second substrates rotated by 180 degrees.

[0015] It is preferable that the substrate processing apparatus described above further includes a substrate processing unit that collectively processes the plurality of substrates aligned at the 1/N pitch in a face-to-face manner, and a main conveyance mechanism that conveys the plurality of substrates aligned at the 1/N pitch in a face-to-face manner to the substrate processing unit.

[0016] The plurality of substrates to be collectively processed are aligned at a pitch narrower than the half pitch. Thus, the size of the substrate processing unit for accommodating the plurality of substrates can be reduced. For example, when the substrate processing unit is a batch processing tank, the use amount of the processing liquid (chemical liquid and cleaning liquid) can be reduced.

[0017] In the substrate processing apparatus described above, for example, the N substrate groups are three substrate groups, the 1/N pitch is a ⅓ pitch that is ⅓ times the reference pitch, and the plurality of pairs of 2/N pitch holding grooves are a plurality of pairs of ⅔ pitch holding grooves disposed at a ⅔ pitch that is ⅔ times the reference pitch in the extending direction.

[0018] In the substrate processing apparatus described above, for example, the N substrate groups are three substrate groups, the 1/N pitch is a ⅓ pitch that is ⅓ times the reference pitch, the plurality of pairs of 2/N pitch holding grooves are a plurality of pairs of ⅔ pitch holding grooves disposed at a ⅔ pitch that is ⅔ times the reference pitch in the extending direction, and the plurality of pairs of post-processing 2/N pitch holding grooves are a plurality of pairs of post-processing ⅔ pitch holding grooves disposed at the ⅔ pitch in the extending direction.

[0019] The substrate processing apparatus according to the present invention can easily align a plurality of substrates at a pitch narrower than a half pitch in a face-to-face manner.

BRIEF DESCRIPTION OF DRAWINGS

[0020] 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.

[0021] FIG. **1** is a plan view illustrating a schematic configuration of a substrate processing apparatus according to a first embodiment;

[0022] FIG. **2** is a side view of a substrate handling mechanism;

[0023] FIG. **3** is a side view of an orientation changing unit;

[0024] FIG. **4** is a plan view illustrating the orientation changing unit in a state where a pair of vertical holding units is separated from a pair of horizontal holding units;

[0025] FIG. **5** is a plan view illustrating the orientation changing unit in a state where the pair of vertical holding units has approached the pair of horizontal holding units;

[0026] FIG. **6** is a plan view mainly illustrating the pair of vertical holding units in a horizontal orientation in a first state in which a plurality of pairs of reference pitch holding grooves are usable when viewed as indicated by the arrows A-A in FIGS. **4** and **5**;

[0027] FIG. **7** is a plan view mainly illustrating the pair of vertical holding units in a horizontal orientation in a second state in which a plurality of pairs of ⅔ pitch holding grooves are usable when viewed as indicated by the arrows A-A in FIGS. **4** and **5**;

[0028] FIG. **8** is a side view of a pusher mechanism;

[0029] FIG. **9** is a longitudinal sectional view illustrating a pusher member that holds a plurality of substrates aligned at ⅓ pitch in a face-to-face manner in a vertical orientation;

[0030] FIG. **10** is a flowchart for describing a first half operation of the substrate processing apparatus;

[0031] FIG. **11** is a flowchart for describing a later half operation of the substrate processing apparatus;

[0032] FIGS. **12**A and **12**B are diagrams for describing an operation of the substrate processing apparatus;

[0033] FIGS. **13**A and **13**B are diagrams for describing an operation of the substrate processing apparatus;

[0034] FIGS. **14**A and **14**B are diagrams for describing an operation of the substrate processing apparatus;

[0035] FIGS. **15**A and **15**B are diagrams for describing an operation of the substrate processing apparatus;

[0036] FIGS. **16**A and **16**B are diagrams for describing an operation of the substrate processing apparatus;

[0037] FIGS. **17**A and **17**B are diagrams for describing an operation of the substrate processing apparatus;

[0038] FIGS. **18**A and **18**B are diagrams for describing an operation of the substrate processing apparatus;

[0039] FIGS. **19**A and **19**B are diagrams for describing an operation of the substrate processing apparatus;

[0040] FIGS. **20**A and **20**B are diagrams for describing an operation of the substrate processing apparatus;

[0041] FIGS. **21**A and **21**B are diagrams for describing an operation of the substrate processing apparatus;

[0042] FIGS. **22**A and **22**B are diagrams for describing an operation of the substrate processing apparatus;

[0043] FIG. **23** is a plan view illustrating an orientation changing unit according to a second embodiment; and

[0044] FIGS. **24**A and **24**B are side views illustrating an orientation changing unit according to a modification.

DETAILED DESCRIPTION

[0045] Hereinafter, various embodiments of the present invention will be described.

First Embodiment

[0046] Hereinafter, a first embodiment 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 the first embodiment.

[0047] In the present specification, for convenience, the directions in which a transfer block **5** and a processing block **7** are arranged are referred to as "front-back directions X". The front-back directions X are horizontal. Of the front-back directions X, for example, the direction from the processing block **7** toward the transfer block **5** is referred to as "front direction". The direction opposite to the front direction is referred to as "back direction". The horizontal directions orthogonal to the front-back directions X are referred to as "width directions Y". One direction in the "width directions Y" is appropriately referred to as "right direction". The direction opposite to the right direction is referred to as "left direction". The directions perpendicular to the horizontal

directions are referred to as "vertical directions Z". In each drawing, front, back, right, left, top, and bottom are appropriately shown for reference.

<1. Configuration of Substrate Processing Apparatus>

[0048] See FIG. **1**. The substrate processing apparatus **1** processes a substrate 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. In the present embodiment, a case where 50 substrates W are collectively processed will be described. Substrates W**1**, W**2**, W**3**, W**11**, W**12**, and the like are referred to as substrates W unless otherwise distinguished.

[0049] The substrate processing apparatus **1** performs, for example, chemical liquid processing, cleaning processing, drying processing, and the like on the substrate 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 conveyance region **8**.

<1-1. Stocker>

[0050] The stocker **2** accommodates at least one carrier C. The stocker **2** is adjacent to the front 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 orientation. In other words, the carrier C stores a plurality of substrates W in a horizontal orientation aligned in the vertical directions Z and at a reference pitch (for example, 10 mm pitch). The plurality of substrates W in the carrier C are aligned in the thickness directions of each substrate W. As the carrier C, for example, a front opening unified pod (FOUP) is used, but the carrier C is not limited to this.

[0051] The stocker **2** includes a plurality of (for example, two) load ports **9**. The two load ports **9** are disposed in the width directions Y. In the present embodiment, the two load ports **9** are used for loading and unloading the carrier C. The stocker **2** includes at least one storage shelf **11** and a carrier conveyance robot **13**. The carrier C is placed on the storage shelf **11**.

[0052] The carrier conveyance robot **13** conveys the carrier C between the two load ports **9**, the storage shelf **11**, and the placement shelf **3**. The carrier conveyance robot **13** includes, for example, a gripping unit **15** (gripper) that grips a protrusion provided on the upper surface of the carrier C. The carrier conveyance robot **13** can move the gripping unit **15** in horizontal directions (the front-back directions X and the width directions Y) and the vertical directions Z. The carrier conveyance robot **13** is driven by one or more electric motors.

[0053] The placement shelf **3** is disposed in a region of the stocker **2**. The placement shelf **3** is adjacent to the front of the transfer block **5**. The carrier C is placed on the placement shelf **3**.

<1-2. Transfer Block>

[0054] See FIG. **1**. The transfer block **5** includes a substrate handling mechanism (robot) HTR, an orientation changing unit **19**, a pusher mechanism **21**, and a delivery mechanism **23**.

[0055] The substrate handling mechanism HTR is disposed behind the placement shelf **3**. The substrate handling mechanism HTR conveys a plurality of (for example, 17 or 16) substrates W in a horizontal orientation between the carrier C placed on the placement shelf **3** and the orientation changing unit **19**. As illustrated in FIG. **2**, the substrate handling mechanism HTR includes a plurality of (for example, 25 or 17) hands **27**. Each hand **27** holds one substrate W in a horizontal orientation. The plurality of hands **27** is disposed in the vertical directions Z at a reference pitch (for example, 10 mm pitch). Thus, for example, the 25 substrates W held by the 25 hands **27** are aligned at the reference pitch. The reference pitch repeats a reference interval TN**9** (for example, 10 mm).

[0056] In FIG. **2** and the like, for convenience of illustration, the substrate handling mechanism HTR includes four hands **27**. A pair of horizontal holding unit **37** and **38** and a pair of vertical holding units **39** and **40** described later hold three substrates W. A pusher member **81** (see FIG. **9**) to be described later supports eight substrates W.

[0057] The substrate handling mechanism HTR further includes a hand support **29**, a reciprocating unit **31**, and a lifting and rotating unit **33**. The hand support **29** supports the plurality of hands **27**. The reciprocating unit **31** moves the plurality of hands **27** forward and backward via the hand support **29**. The lifting and rotating unit **33** rotates the reciprocating unit **31** about a vertical axis AX**1** to change the direction of the hands **27**. The lifting and rotating unit **33** is fixed to a floor surface. The reciprocating unit **31** and the lifting and rotating unit **33** each include an electric motor. The substrate handling mechanism HTR may include a movable hand (not illustrated) for conveying only one substrate W, separately from the hands **27**.

[0058] The orientation changing unit **19** changes the orientation of a plurality of (for example, 17 or 16) substrates W between a horizontal orientation and a vertical orientation. Specifically, the orientation changing unit **19** individually changes the orientation of three substrate groups (first substrate group, second substrate group, and third substrate group) sequentially received from the substrate handling mechanism HTR from a horizontal orientation to a vertical orientation. Each of the three substrate groups includes two or more (for example, 17 or 16) substrates W aligned at a reference pitch (for example, 10 mm pitch).

[0059] The orientation changing unit **19** is disposed on the left side of the substrate handling mechanism HTR. As illustrated in FIGS. **3** to **5**, the orientation changing unit **19** includes a support base **35**, a pair of horizontal holding units **37** and **38**, a pair of vertical holding units **39** and **40**, and a rotation drive unit **41**.

[0060] The support base **35** is rotatably supported about a horizontal axis AX**2** extending in the front-back directions X. Each of the pair of horizontal holding units **37** and **38** and the pair of vertical holding units **39** and **40** is provided so as to extend at a right angle with respect to a support surface **35**A. The pair of horizontal holding units **37** and **38** holds, for example, 17 or 16 substrates W of one substrate group in a horizontal orientation. That is, the pair of horizontal holding units **37** and **38** holds the peripheral edge portions of, for example, 17 or 16 substrates W in a horizontal orientation. The pair of vertical holding units **39** and **40** holds, for example, 17 or 16 substrates W of one substrate group in a vertical orientation.

[0061] The rotation drive unit **41** rotates the support base **35** about the horizontal axis AX**2**. This can change the orientation of the plurality of substrates W held by the pair of horizontal holding units **37** and **38** and the pair of vertical

holding units **39** and **40** between a horizontal orientation and a vertical orientation. The rotation drive unit **41** includes, for example, an electric motor.

[0062] Next, details of the pair of horizontal holding units **37** and **38** will be described. The pair of horizontal holding units **37** and **38** is disposed in the front-back directions X. A first horizontal holding unit **37** is rotatable about a rotation axis AX**3** passing through the first horizontal holding unit **37** and extending at a right angle with respect to the support surface **35**A. The first horizontal holding units **37** includes a first surface **43**A, a second surface **45**A, and a first retraction surface **47**A provided around the rotation axis AX**3**. The first surface **43**A is provided on the opposite side of the second surface **45**A.

[0063] A second horizontal holding unit **38** is rotatable about a rotation axis AX**4** passing through the second horizontal holding unit **38** and extending at a right angle with respect to the support surface **35**A. The second horizontal holding units **38** includes a third surface **43**B, a fourth surface **45**B, and a second retraction surface **47**B provided around the rotation axis AX**4**. The third surface **43**B is provided on the opposite side of the fourth surface **45**B.

[0064] The pair of horizontal holding units **37** and **38** includes a plurality of pairs (for example, 17 pairs) of pre-processing shelves **49**A and **49**B and a plurality of pairs (for example, 17 pairs) of post-processing shelves **51**A and **51**B. The plurality of pairs of pre-processing shelves **49**A and **49**B and the plurality of pairs of post-processing shelves **51**A and **51**B are both disposed at a reference pitch (for example, 10 mm pitch) in a direction DR**1** (see FIG. **3**) in which the pair of horizontal holding units **37** and **38** (each of the horizontal holding units **37** and **38**) extends.

[0065] The plurality of pairs of pre-processing shelves **49**A and **49**B are provided on the first surface **43**A and the third surface **43**B. On the other hand, the plurality of pairs of post-processing shelves **51**A and **51**B are provided on the second surface **45**A and the fourth surface **45**B. A shelf such as the shelf **49**A is not provided on the first retraction surface **47**A or the second retraction surface **47**B. When the first retraction surface **47**A and the second retraction surface **47**B face each other (that is, in a state where the first retraction surface **47**A and the second retraction surface **47**B are usable), a width WD**1** between the first retraction surface **47**A and the second retraction surface **47**B is larger than the diameter of the substrate W (see FIG. **5**).

[0066] The orientation changing unit **19** further includes a shelf switching drive unit **53**. The shelf switching drive unit **53** includes at least one electric motor. The shelf switching drive unit **53** rotates the first horizontal holding unit **37** about the rotation axis AX**3** and rotates the second horizontal holding unit **38** about the rotation axis AX**4**. This can switch between a state in which the plurality of pairs of pre-processing shelves **49**A and **49**B are usable, a state in which the plurality of pairs of post-processing shelves **51**A and **51**B are usable, and a state in which the first retraction surface **47**A and the second retraction surface **47**B are usable. That is, the shelf switching drive unit **53** can switch three states.

[0067] When the plurality of pairs of pre-processing shelves **49**A and **49**B are in a usable state, the plurality of pairs of pre-processing shelves **49**A and **49**B face each other (see FIG. **4**). When the plurality of pairs of post-processing shelves **51**A and **51**B are in a usable state, the plurality of pairs of post-processing shelves **51**A and **51**B face each other.

[0068] For example, when receiving a plurality of substrates before processing from the substrate handling mechanism HTR, the shelf switching drive unit **53** switches to the state in which the plurality of pairs of pre-processing shelves **49**A and **49**B are usable. When individually holding three substrate groups of the plurality of substrates W after processing in a horizontal orientation, the shelf switching drive unit **53** switches to the state in which the plurality of pairs of post-processing shelves **51**A and **51**B are usable. When delivering a plurality of substrates W between the pair of vertical holding units **39** and **40** (orientation changing unit **19**) and the pusher member **81** (pusher mechanism **21**), the shelf switching drive unit **53** switches to the state in which the first retraction surface **47**A and the second retraction surface **47**B are usable. This can prevent the pair of horizontal holding units **37** and **38** from being rubbed against the plurality of substrates W.

[0069] The orientation changing unit **19** may include a drive unit that brings the pair of horizontal holding units **37** and **38** close to the support surface **35**A and separates the pair of horizontal holding units **37** and **38** from the support surface **35**A along the rotation axes AX**3** and AX**4**. The drive unit includes, for example, an electric actuator or an air cylinder.

[0070] Next, details of the pair of vertical holding units **39** and **40** will be described. The pair of vertical holding units **39** and **40** is disposed in the front-back directions X. The first vertical holding unit **39** is rotatable about a rotation axis AX**5** passing through the first vertical holding unit **39** and extending at a right angle with respect to the support surface **35**A. The first vertical holding unit **39** includes four outer peripheral surfaces **55**A, **57**A, **59**A, and **61**A provided around the rotation axis AX**5**. The outer peripheral surface **55**A is provided on the opposite side of the outer peripheral surface **59**A. The outer peripheral surface **57**A is provided on the opposite side of the outer peripheral surface **61**A. The arrangement of the four outer peripheral surfaces **55**A, **57**A, **59**A, and **61**A is not particularly limited.

[0071] The second vertical holding unit **40** is rotatable about a rotation axis AX**6** passing through the second vertical holding unit **40** and extending at a right angle with respect to the support surface **35**A. The second vertical holding unit **40** includes four outer peripheral surfaces **55**B, **57**B, **59**B, and **61**B provided around the rotation axis AX**6**. The outer peripheral surface **55**B is provided on the opposite side of the outer peripheral surface **59**B. The outer peripheral surface **57**B is provided on the opposite side of the outer peripheral surface **61**B. The arrangement of the four outer peripheral surfaces **55**B, **57**B, **59**B, and **61**B is not particularly limited.

[0072] FIGS. **6** and **7** are plan views mainly illustrating the pair of vertical holding units **39** and **40** in a horizontal orientation when viewed as indicated by the arrows A-A in FIGS. **4** and **5**. The pair of vertical holding units **39** and **40** includes a plurality of pairs (for example, 17 pairs) of reference pitch holding grooves **63**A and **63**B and a plurality of pairs (for example, 25 pairs) of ⅔ pitch holding grooves **65**A and **65**B to handle the substrates W before processing.

[0073] As illustrated in FIG. **6**, the plurality of pairs of reference pitch holding grooves **63**A and **63**B are disposed at a reference pitch (for example, 10 mm pitch) in the

extending directions DR**2** in which the pair of vertical holding units **39** and **40** (the vertical holding units **39** and **40**) extends. On the other hand, as illustrated in FIG. **7**, the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B are disposed at a ⅔ pitch (for example, 6.666 mm pitch) that is ⅔ times the reference pitch in the extending directions DR**2**. The ⅔ pitch repeats a second interval TN**2** (for example, 6.666 mm) that is twice the first interval TN**1** (for example, 3.333 mm).

[0074] A plurality of pairs (for example, 17 pairs) of reference pitch holding grooves **63**A and **63**B are provided on the two outer peripheral surfaces **55**A and **55**B. A plurality of pairs (for example, 25 pairs) of ⅔ pitch holding grooves **65**A and **65**B are provided on the two outer peripheral surfaces **57**A and **57**B.

[0075] The pair of vertical holding units **39** and **40** further includes a plurality of pairs (for example, 17 pairs) of reference pitch holding grooves **67**A and **67**B and a plurality of pairs (for example, 25 pairs) of ⅔ pitch holding grooves **69**A and **69**B to handle the substrates W after processing. The two outer peripheral surfaces **59**A and **59**B are provided with the plurality of pairs of reference pitch holding grooves **67**A and **67**B disposed at a reference pitch in the extending directions DR**2**. The two outer peripheral surfaces **61**A and **61**B are provided with the plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B disposed at a ⅔ pitch (for example, 6.666 mm pitch) in the extending directions DR**2**.

[0076] The reference pitch holding grooves **67**A and **67**B are used to hold, for example, one substrate group (for example, 17 or 16 substrates W) that have been processed in a chemical liquid processing tank BT**1** (described later). The ⅔ pitch holding grooves **69**A and **69**B are used to hold two or more (25) first substrates W**11** (second substrates W**12**) among a plurality of (for example, 50) substrates W (W**11** and W**12**) in which two or more (for example, 25) first substrates W**11** and two or more (for example, 25) second substrates W**12** that have been processed, for example, in the chemical liquid processing tank BT**1** are alternately disposed.

[0077] The orientation changing unit **19** further includes a holding groove switching drive unit **71**. The holding groove switching drive unit **71** includes at least one electric motor. The holding groove switching drive unit **71** rotates the first vertical holding unit **39** about the rotation axis AX**5** and rotates the second vertical holding unit **40** about the rotation axis AX**6**. This can switch between a first state in which the plurality of pairs of reference pitch holding grooves **63**A and **63**B are usable, a second state in which the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B are usable, a third state in which the plurality of pairs of reference pitch holding grooves **67**A and **67**B are usable, and a fourth state in which the plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B are usable. That is, the holding groove switching drive unit **71** can switch four states.

[0078] In the first state in which the plurality of pairs of reference pitch holding grooves **63**A and **63**B are usable, the plurality of pairs of reference pitch holding grooves **63**A and **63**B face each other (see FIG. **4**). In the second state in which the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B are usable, the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B face each other (see FIG. **5**). In the third state in which the plurality of pairs of reference pitch holding grooves **67**A and **67**B are usable, the plurality of pairs of reference pitch holding grooves **67**A and **67**B face each other. In the fourth state in which the plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B are usable, the plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B face each other.

[0079] In FIG. **6**, the pair of vertical holding units **39** and **40** includes a plurality of pairs (for example, 18 pairs) of passage grooves **64**A and **64**B in addition to the plurality of pairs (for example, 17 pairs) of reference pitch holding grooves **63**A and **63**B. The plurality of pairs of reference pitch holding grooves **63**A and **63**B and the plurality of pairs of passage grooves **64**A and **64**B are alternately disposed. The plurality of pairs of passage grooves **64**A and **64**B are provided on the two outer peripheral **20** surfaces **55**A and **55**B. Similarly, the pair of vertical holding units **39** and includes a plurality of pairs (for example, 18 pairs) of passage grooves **68**A and **68**B in addition to the plurality of pairs (for example, 17 pairs) of reference pitch holding grooves **67**A and **67**B. The plurality of pairs of reference pitch holding grooves **67**A and **67**B and the plurality of pairs of passage grooves **68**A and **68**B are alternately disposed.

[0080] For example, in FIG. **6**, for convenience of illustration, the pair of vertical holding units **39** and **40** includes three pairs of reference pitch holding grooves **63**A and **63**B and four pairs of passage grooves **64**A and **64**B. The three pairs of reference pitch holding grooves **63**A and **63**B and the four pairs of passage grooves **64**A and **64**B are alternately disposed. The width WD**2** between the passage grooves **64**A and **64**B of each pair is set to be larger than the diameter of the substrate W. Thus, the passage grooves **64**A and **64**B of each pair can allow the two substrates W held by the pusher member **81** to pass therethrough. Similarly, when the passage grooves **68**A and **68**B of each pair face each other, the width of each pair of the passage grooves **68**A and **68**B is also set to be larger than the diameter of the substrate W.

[0081] In FIG. **7**, the pair of vertical holding units **39** and **40** includes a plurality of pairs (for example, 26 pairs) of passage grooves **66**A and **66**B in addition to the plurality of pairs (for example, 25 pairs) of ⅔ pitch holding grooves **65**A and **65**B. The plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B and the plurality of pairs of passage grooves **66**A and **66**B are alternately disposed. The plurality of pairs of passage grooves **66**A and **66**B are provided on the two outer peripheral surfaces **57**A and **57**B. Similarly, the pair of vertical holding units **39** and **40** includes a plurality of pairs (for example, 26 pairs) of passage grooves **70**A and **70**B in addition to the plurality of pairs (for example, 25 pairs) of ⅔ pitch holding grooves **69**A and **69**B. The plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B and the plurality of pairs of passage grooves **70**A and **70**B are alternately disposed.

[0082] For example, in FIG. **7**, for convenience of illustration, the pair of vertical holding units **39** and **40** includes four pairs of ⅔ pitch holding grooves **65**A and **65**B and five pairs of passage grooves **66**A and **66**B. The four pairs of ⅔ pitch holding grooves **65**A and **65**B and the five pairs of passage grooves **66**A and **66**B are alternately disposed. The width WD**3** between the passage grooves **66**A and **66**B of each pair is also set to be larger than the diameter of the substrate W. Thus, the passage grooves **66**A and **66**B of each pair can allow one substrate W held by the pusher member **81** to pass therethrough. Similarly, when the passage grooves **70**A and **70**B of each pair face each other, the width

of the passage grooves **70**A and **70**B of each pair is also set to be larger than the diameter of the substrate W.

[0083] When a plurality of substrates W aligned in a face-to-back manner are formed on the pusher member **81**, the holding groove switching drive unit **71** switches to the first state in which the plurality of pairs of reference pitch holding grooves **63**A and **63**B are usable. When the plurality of substrates W held by the pusher member **81** are rearranged into a face to face manner, the holding groove switching drive unit **71** switches to the second state in which the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B are usable.

[0084] "Face-to-back" refers to an alignment state in which all front surfaces (front surface, main surface, or device surface) of a plurality of (for example, 50) substrates W face the same direction. "Face-to-face" refers to an alignment state in which the back surface or the front surface of two adjacent substrates W face each other. In other words, the face-to-face refers to an alignment state in which, when two or more first substrates W**11** and two or more second substrates W**12** are alternately disposed, the front surfaces of the two or more first substrates W**11** face in a direction opposite to the front surfaces of the two or more second substrates W**12**. The device surface is a surface on which a device is to be formed or a surface on which a device is being formed.

[0085] When the plurality of substrates W held by the pusher member **81** are rearranged from the face-to-face manner to the face-to-back manner, the holding groove switching drive unit **71** switches to the fourth state in which the plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B are usable. When the plurality of substrates W held by the pusher member **81** are divided into the three substrate groups, the holding groove switching drive unit **71** switches to the third state in which the plurality of pairs of reference pitch holding grooves **67**A and **67**B are usable.

[0086] As illustrated in FIG. **3**, the orientation changing unit **19** further includes an accommodation moving unit **73**. The accommodation moving unit **73** moves the pair of vertical holding units **39** and **40** close to or away from the pair of horizontal holding units **37** and **38**. For example, when the pair of horizontal holding units **37** and **38** hold a plurality of substrates W in a horizontal orientation, the accommodation moving unit **73** can move the pair of vertical holding units **39** and **40** in the width directions Y. The accommodation moving unit **73** includes, for example, an electric actuator or an air cylinder. The electric actuator includes an electric motor.

[0087] See FIG. **4**. When the accommodation moving unit **73** moves the vertical holding units **39** and **40** away from the horizontal holding units **37** and **38**, the plurality of substrates W in a horizontal orientation are held only by the horizontal holding units **37** and **38** without using the vertical holding units **39** and **40**. See FIG. **5**. When the accommodation moving unit **73** moves the vertical holding units **39** and **40** close to the horizontal holding units **37** and **38**, the peripheral edge portions of the plurality of substrates W can be accommodated by the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B at the position of the substrate W illustrated in FIG. **4**, for example.

[0088] The rotation axis AX**5** corresponds to a first rotation axis of the present invention. The rotation axis AX**6** corresponds to a second rotation axis of the present invention. The outer peripheral surface **55**A corresponds to a first outer peripheral surface of the present invention. The outer peripheral surface **57**A corresponds to a second outer peripheral surface of the present invention. The outer peripheral surface **59**A corresponds to a fifth outer peripheral surface of the present invention. The outer peripheral surface **61**A corresponds to a sixth outer peripheral surface of the present invention. The outer peripheral surface **55**B corresponds to a third outer peripheral surface of the present invention. The outer peripheral surface **57**B corresponds to a fourth outer peripheral surface of the present invention. The outer peripheral surface **59**B corresponds to a seventh outer peripheral surface of the present invention. The outer peripheral surface **61**B corresponds to an eighth outer peripheral surface of the present invention.

[0089] The plurality of pairs of reference pitch holding grooves **67**A and **67**B correspond to a plurality of pairs of post-processing reference pitch holding grooves of the present invention. The plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B correspond to a plurality of pairs of post-processing ⅔ pitch holding grooves of the present invention. The holding groove switching drive unit **71** corresponds to a switching drive unit of the present invention.

[0090] Next, details of the pusher mechanism **21** will be described. See FIGS. **8** and **9**. The pusher mechanism **21** includes the pusher member **81** that holds a plurality of substrates W (for example, 50 substrates) aligned at a ⅓ pitch (for example, 3.333 mm pitch) that is ⅓ times a reference pitch (for example, 10 mm pitch) in a vertical orientation. The pusher mechanism **21** aligns the three substrate groups received from the orientation changing unit **19** in a row with the pusher member **81** while shifting the pusher member **81** by ⅓ pitch in the alignment direction (width direction Y) in which the plurality of substrates W is aligned. As a result, a plurality of (for example, 50) substrates W are formed on the pusher member **81**. For the ⅓ pitch, the first interval TN**1** (3.333 mm) is repeated.

[0091] The pusher mechanism **21** is disposed on the left side of the orientation changing unit **19** (see FIG. **1**). As illustrated in FIG. **8**, the pusher mechanism **21** includes the pusher member **81**, a pusher rotating unit **85**, a pusher horizontal moving unit **87**, a lifting stage **89**, and a pusher lifting unit **91**. The pusher member **81** includes a plurality of (for example, 50 or 51) vertical holding grooves **93** disposed at a ⅓ pitch to hold a plurality of substrates W in a vertical orientation aligned at the ⅓ pitch.

[0092] The pusher rotating unit **85** rotates the pusher member **81** about a vertical axis AX**7** passing through the center of the pusher member **81**. This causes the plurality of substrates W supported in the vertical orientation by the pusher member **81** to rotate about the vertical axis AX**7**. The pusher rotating unit **85** includes, for example, an electric motor. The pusher rotating unit **85** is connected to the lower surface of the pusher member **81**. The pusher rotating unit **85** is attached to the upper surface of the lifting stage **89** via the pusher horizontal moving unit **87**.

[0093] The pusher horizontal moving unit **87** includes two guide rails **87**A extending in the width directions Y, a slider **87**B, and an electric motor (not illustrated). The two guide rails **87**A are provided on the upper surface of the lifting stage **89**. The slider **87**B moves in the width directions Y along the two guide rails **87**A. The slider **87**B is driven by the electric motor. The pusher lifting unit **91** lifts and lowers the lifting stage **89** in the vertical directions Z. This causes

the pusher member **81** to be lifted and lowered. The pusher lifting unit **91** includes, for example, an electric actuator.

[0094] See FIG. **1**. The delivery mechanism **23** receives the plurality of substrates W aligned at a ⅓ pitch from the pusher member **81**, and conveys the received plurality of substrates W to a delivery position P. At the delivery position P, the plurality of substrates W held by the delivery mechanism **23** are transferred to the main conveyance mechanism WTR. The delivery mechanism **23** includes a chuck **95**, a width direction moving unit **97**, and a guide rail **101**. The width direction moving unit **97** can horizontally move the chuck **95** along the guide rail **101** extending in the width directions Y. The width direction moving unit **97** includes, for example, an electric actuator.

[0095] The chuck **95** holds a plurality of substrates W aligned at a ⅓ pitch in the width directions Y in a vertical orientation. The chuck **95** includes a pair of chuck members **95**A and **95**B extending in the width directions Y. The pair of chuck members **95**A and **95**B includes a plurality of pairs (for example, 50 pairs) of holding grooves disposed at a ⅓ pitch in the width directions Y.

[0096] When the plurality of vertical holding grooves **93** are disposed in the width directions Y, the pusher member **81** can pass between the pair of chuck members **95**A and **95**B in the vertical directions Z. The pair of chuck members **95**A and **95**B may be opened and closed in the front-back directions X.

<1-4. Processing Block>

[0097] The processing block **7** includes a plurality of (for example, four) batch processing tanks BT**1** to BT**4** and a drying unit **103**. The four batch processing tanks BT**1** to BT**4** and the drying unit **103** are disposed in the front-back directions X in which the substrate processing apparatus **1** extends. Each of the four batch processing tanks BT**1** to BT**4** collectively immerses and processes a plurality of (for example, 50) substrates W. Each of the four batch processing tanks BT**1** to BT**4** stores a processing liquid (for example, chemical liquid or pure water) for immersing the plurality of substrates W.

[0098] The four batch processing tanks BT**1** to BT**4** are formed of, for example, two chemical liquid processing tanks BT**1** and BT**3** and two cleaning processing tanks BT**2** and BT**4**. The chemical liquid processing tank BT**1** and the cleaning processing tank BT**2** constitute one set, and the chemical liquid processing tank BT**3** and the cleaning processing tank BT**4** constitute the other set. The combination of the chemical liquid processing tank and the cleaning processing tank is not limited to this example. The number of batch processing tanks is not limited to four as long as it is one or more. At least one of the four batch processing tanks BT**1** to BT**4** corresponds to a substrate processing unit of the present invention.

[0099] Each of the two chemical liquid processing tanks BT**1** and BT**3** performs etching processing using a chemical liquid. For example, a phosphoric acid solution is used as the chemical liquid, but the chemical liquid 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 the inner bottom of each of the chemical liquid processing tanks BT**1** and BT**3**. Each of the chemical liquid processing tanks BT**1** and BT**3** stores the chemical liquid supplied from the chemical liquid ejection pipe.

[0100] Each of the two cleaning processing tanks BT**2** and BT**4** performs a cleaning processing of washing away the chemical liquid adhering to the plurality of substrates W with a cleaning liquid (rinse liquid). As the cleaning liquid, for example, pure water such as deionized water (DIW) is used. Each of the cleaning processing tanks BT**2** and BT**4** stores pure water supplied from a pure water ejection pipe (not illustrated).

[0101] The processing block **7** includes a lifter LF**1** as a dedicated conveyance mechanism for transferring the substrate W subjected to the chemical liquid processing 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 subjected to the chemical liquid processing in the chemical liquid processing tank BT**3** to the cleaning processing tank BT**4**. Each of the two lifters LF**1** and LF**2** includes a substrate holding unit that holds a plurality of substrates W aligned at a ⅓ pitch in the width directions Y in a vertical orientation, a lift unit that lifts and lowers the substrate holding unit, and a horizontal moving unit that moves the substrate holding unit in the front-back directions X.

[0102] The drying unit **103** includes a substrate holding mechanism that holds a plurality of (for example, 50) substrates W aligned at a ⅓ pitch in the width directions Y in a vertical orientation, and a processing chamber that accommodates the plurality of substrates W held by the substrate holding mechanism. The drying unit **103** 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 the surface of the substrates W using centrifugal force.

<1-5. Batch Substrate Conveyance Region>

[0103] The batch substrate conveyance region **8** is disposed behind the stocker **2** and is adjacent to the transfer block **5** and the processing block **7** on the left side. The batch substrate conveyance region **8** extends in the front-back directions X. The batch substrate conveyance region **8** includes a main conveyance mechanism WTR (main conveyance robot). The main conveyance mechanism WTR conveys a plurality of (for example, 50) substrates W in a vertical orientation aligned at a ⅓ pitch in the width directions Y in the front-back directions X. The main conveyance mechanism WTR conveys the plurality of substrates W between the delivery position P, the plurality of (for example, four) batch processing tanks BT**1** to BT**4**, and the drying unit **103**.

[0104] The main conveyance mechanism WTR includes a chuck **105**, a chuck lifting unit (not illustrated), a chuck horizontal moving unit (not illustrated), and a guide rail **107**. The chuck **105** holds a plurality of substrates W aligned at a ⅓ pitch in the width directions Y in a vertical orientation. The chuck **105** includes a pair of chuck members **105**A and **105**B extending in the width directions Y. The pair of chuck members **105**A and **105**B includes a plurality of pairs (for example, 50 or 51 pairs) of holding grooves disposed at a ⅓ pitch in the width directions Y. The pair of chuck members **105**A and **105**B is opened and closed by a chuck opening and closing unit (not illustrated).

[0105] The chuck **105** is movable in the front-back directions X along the guide rail **107**. The chuck **105** is moved in the front-back directions X by the chuck horizontal moving unit. The chuck **105** is lifted and lowered in the vertical

directions Z by the chuck lifting unit. The chuck horizontal moving unit and the chuck lifting unit include, for example, an electric actuator. The chuck opening and closing unit includes, for example, an electric actuator or an air cylinder.

<1-6. Controller>

[0106] The substrate processing apparatus **1** includes a controller **111** and a storage unit (not illustrated). The controller **111** controls each configuration of the substrate processing apparatus **1**. The controller **111** includes one or more processors such as a central processing unit (CPU). The storage unit includes, for example, at least one of a read-only memory (ROM), a random-access memory (RAM), and a hard disk. The storage unit stores a computer program necessary for controlling each configuration of the substrate processing apparatus **1**.

<2. Operation of Substrate Processing Apparatus>

[0107] Next, the operation of the substrate processing apparatus **1** will be described with reference to the flowcharts of FIGS. **10** and **11**.

[0108] In FIG. **12**A and the like, a reference sign TA indicates a front surface (front surface, device surface, or main surface) of the substrate W (W**1**, W**2**, W**3**). In FIG. **12**A and the like, for convenience of illustration, 17 substrates W**1** are illustrated by three substrates W**1**, and 17 substrates W**2** are illustrated by three substrates W**2**. In addition, 16 substrates W**3** are illustrated by two substrates W**3**.

[0109] The substrate handling mechanism HTR includes 25 hands **27**. The pair of horizontal holding units **37** and **38** includes 17 pairs of pre-processing shelves **49**A and **49**B and 17 pairs of post-processing shelves **51**A and **51**B. The pusher member **81** includes 51 vertical holding grooves **93**.

[0110] The pair of vertical holding units **39** and **40** includes 17 pairs of reference pitch holding grooves **63**A and **63**B and 25 pairs of ⅔ pitch holding grooves **65**A and **65**B to handle the substrates W before processing. The pair of vertical holding units **39** and **40** includes 17 pairs of reference pitch holding grooves **67**A and **67**B and 25 pairs of ⅔ pitch holding grooves **69**A and **69**B to handle the substrates W after processing.

[0111] See FIG. **1**. An external conveyance robot (not illustrated) sequentially conveys two carriers C to the load port **9**. The carrier conveyance robot **13** conveys the first carrier C from the load port **9** to the placement shelf **3**. It is assumed that 25 substrates W**1** and W**2** (17 substrates W**1** and 8 substrates W**2**) aligned at a reference pitch (for example, 10 mm) are stored in a first carrier C.

[Step S**01**] Switching to Plurality of Pairs of Reference Pitch Holding Grooves

[0112] First, the holding groove switching drive unit **71** of the orientation changing unit **19** rotates the first vertical holding unit **39** about the rotation axis AX**5** and rotates the second vertical holding unit **40** about the rotation axis AX**6**. With this operation, the holding groove switching drive unit **71** switches to the first state in which the 17 pairs of reference pitch holding grooves **63**A and **63**B are usable. The shelf switching drive unit **53** of the orientation changing unit **19** switches to the state in which the 17 pairs of pre-processing shelves **49**A and **49**B are usable.

[0113] Here, an outline of operations in steps S**02** to S**12** will be described. The orientation changing unit **19** sequentially receives three substrate groups (first substrate group, second substrate group, and third substrate group) from the substrate handling mechanism HTR. The orientation changing unit **19** individually changes the orientation of the three substrate groups from a horizontal orientation to a vertical orientation. The pusher mechanism **21** causes the pusher member **81** to sequentially receive the three substrate groups while shifting the pusher member **81** by ⅓ pitch in the alignment direction (width direction Y) of the 50 substrates W (W**1**, W**2**, W**3**). As a result, the pusher member **81** holds 50 substrates W formed from the three substrate groups and aligned in a face-to-back manner at a ⅓ pitch. These operations will be described in order.

[Step S**02**] Reception of First Substrate Group with Orientation Changing Unit

[0114] See FIGS. **1** and **12**A. The substrate handling mechanism HTR takes out 25 substrates W**1** and W**2** from the first carrier C placed on the placement shelf **3**. Thereafter, the substrate handling mechanism HTR conveys 17 substrates W**1** out of the taken out 25 substrates W**1** and W**2** to the orientation changing unit **19**. The orientation changing unit **19** receives 17 substrates W**1** (first substrate group) from the substrate handling mechanism HTR using 17 pairs of pre-processing shelves **49**A and **49**B of the horizontal holding units **37** and **38**.

[0115] The carrier conveyance robot **13** moves the empty first carrier C from which the 25 substrates W**1** and W**2** have been taken out from the placement shelf **3** to the storage shelf **11**. The carrier conveyance robot **13** also conveys a second carrier C from the load port **9** to the placement shelf **3**. It is assumed that 25 substrates W**2** and W**3** (9 substrates W**2** and 16 substrates W**3**) are stored in the second carrier C.

[0116] See FIG. **12**B. The pair of horizontal holding units **37** and **38** holds 17 substrates W**1** in a horizontal orientation. At this time, the front surfaces of the 17 substrates W**1** are upward as indicated by the reference sign TA. The substrate handling mechanism HTR holds the remaining eight substrates W**2** with eight hands **27** among the 25 hands **27**.

[0117] Thereafter, the accommodation moving unit **73** (see FIG. **3**) of the orientation changing unit **19** moves the vertical holding units **39** and **40** close to the horizontal holding units **37** and **38**. As a result, the 17 pairs of reference pitch holding grooves **63**A and **63**B of the vertical holding units **39** and **40** accommodate the peripheral edge portions of the 17 substrates W**1** in a horizontal orientation held (placed) by the horizontal holding units **37** and **38**.

[Step S**03**] Vertical Orientation Change of First Substrate Group

[0118] See FIG. **13**A. The rotation drive unit **41** of the orientation changing unit **19** rotates the horizontal holding units **37** and **38** and the vertical holding units **39** and **40** by 90 degrees about the horizontal axis AX**2**. As a result, the orientation of the 17 substrates W**1** (first substrate group) held by the horizontal holding units **37** and **38** and the vertical holding units **39** and **40** are changed from a horizontal orientation to a vertical orientation.

[0119] Thereafter, the shelf switching drive unit **53** rotates the first horizontal holding unit **37** about the rotation axis AX**3** and rotates the second horizontal holding unit **38** about the rotation axis AX**4**. With this operation, the shelf switching drive unit **53** switches from the state in which the 17

pairs of pre-processing shelves **49**A and **49**B are usable to the state in which the first retraction surface **47**A and the second retraction surface **47**B are usable. That is, the shelf switching drive unit **53** retracts each of the 17 pairs of pre-processing shelves **49**A and **49**B from the position on the back surface side of the 17 substrates W**1**.

[Step S**04**] Reception of First Substrate Group with Pusher Mechanism

[0120] See FIG. **13**B. Thereafter, the pusher mechanism **21** lifts the pusher member **81** that does not hold a substrate to a position higher than the horizontal holding units **37** and **38**. With this operation, the pusher member **81** receives the 17 substrates W**1** (first substrate group) from the 17 pairs of reference pitch holding grooves **63**A and **63**B of the vertical holding units **39** and **40**. The pusher member **81** holds 17 substrates W**1** aligned at a reference pitch (10 mm pitch) in a vertical orientation. At this time, the front surfaces of the 17 substrates W**1** face leftward.

[Step S**05**] ⅓ Pitch Advance of Pusher Member with Pusher Mechanism

[0121] See FIG. **14**A. The pusher horizontal moving unit **87** (see FIG. **8**) of the pusher mechanism **21** moves the pusher member **81** leftward by the first interval TN**1** (for example, 3.333 mm). The first interval TN**1** is an interval of ⅓ times the reference interval TN**9** constituting the reference pitch. With such movement, the pusher member **81** can receive the next 17 substrates W**2** (second substrate group) at a position separated from the 17 substrates W**1** by the first interval TN**1**. In addition, 17 substrates W**1** (first substrate group) and 17 substrates W**2** (second substrate group) can be alternately disposed.

[0122] The rotation drive unit **41** of the orientation changing unit **19** rotates the horizontal holding units **37** and **38** and the vertical holding units **39** and by 90 degrees about the horizontal axis AX**2**. The horizontal holding units **37** and **38** and the like thus rise. The accommodation moving unit **73** (see FIG. **3**) of the orientation changing unit **19** moves the vertical holding units **39** and **40** away from the horizontal holding units **37** and **38**. The shelf switching drive unit **53** rotates the first horizontal holding unit **37** about the rotation axis AX**3** and rotates the second horizontal holding unit **38** about the rotation axis AX**4**. With this operation, the shelf switching drive unit **53** switches from the state in which the first retraction surface **47**A and the second retraction surface **47**B are usable to the state in which the 17 pairs of pre-processing shelves **49**A and **49**B are usable. This allows the 17 pairs of pre-processing shelves **49**A and **49**B to receive the next 17 substrates W**2**.

[Step S**06**] Reception of Second Substrate Group with Orientation Changing Unit

[0123] See FIG. **14**B. The substrate handling mechanism HTR conveys the remaining eight substrates W**2** held by eight hands **27** among the 25 hands **27** in the first carrier C to the orientation changing unit **19**. The orientation changing unit **19** receives eight substrates W**2** from the substrate handling mechanism HTR using eight pairs of pre-processing shelves **49**A and **49**B out of the 17 pairs of pre-processing shelves **49**A and **49**B.

[0124] See FIG. **15**A. Thereafter, the substrate handling mechanism HTR takes out 25 substrates W**2** and W**3** from the second carrier C placed on the placement shelf **3**. Thereafter, the substrate handling mechanism HTR conveys nine substrates W**2** out of the taken out 25 substrates W**2** and W**3** to the orientation changing unit **19**. The orientation changing unit **19** receives nine substrates W**2** from the substrate handling mechanism HTR using nine pairs of pre-processing shelves **49**A and **49**B out of the 17 pairs of pre-processing shelves **49**A and **49**B. The horizontal holding units **37** and **38** of the orientation changing unit **19** hold 17 substrates W**2** (second substrate group) including eight substrates W**2** of the first carrier C and nine substrates W**2** of the second carrier C in a horizontal orientation.

[0125] The pusher mechanism **21** lowers the pusher member **81** holding the 17 substrates W**1** in a vertical orientation to a height position at which the next 17 substrates W**2** can be received.

[0126] See FIG. **15**B. Thereafter, the accommodation moving unit **73** (see FIG. **3**) of the orientation changing unit **19** moves the vertical holding units **39** and **40** close to the horizontal holding units **37** and **38**. As a result, the 17 pairs of reference pitch holding grooves **63**A and **63**B accommodate the peripheral edge portions of the 17 substrates W**2** in the horizontal orientation held (placed) by the horizontal holding units **37** and **38**.

[Step S**07**] Vertical Orientation Change of Second Substrate Group

[0127] See FIG. **16**A. After moving the vertical holding units **39** and **40** close to the horizontal holding unit **37** and **38**, the orientation changing unit **19** rotates the horizontal holding units **37** and **38** and the vertical holding units **39** and **40** by 90 degrees about the horizontal axis AX**2**. This causes the orientation changing unit **19** to change the orientation of the 17 substrates W**2** (second substrate group) from a horizontal orientation to a vertical orientation. Thereafter, the shelf switching drive unit **53** switches from the state in which the 17 pairs of pre-processing shelves **49**A and **49**B are usable to the state in which the first retraction surface **47**A and the second retraction surface **47**B are usable.

[Step S**08**] Reception of Second Substrate Group with Pusher Mechanism

[0128] See FIG. **16**B. Thereafter, the pusher mechanism **21** lifts the pusher member **81**. With this operation, the pusher member **81** receives the 17 substrates W**2** (second substrate group) from the vertical holding units **39** and **40**. Further, the pusher member **81** holds the 17 substrates W**2** aligned at a reference pitch (10 mm pitch) in a vertical orientation. In other words, the pusher member **81** holds the 17 substrates W**1** and the 17 substrates W**2** alternately disposed. At this time, the front surfaces of the 17 substrates W**2** face leftward.

[Step S**09**] ⅓ Pitch Advance of Pusher Member with Pusher Mechanism

[0129] See FIG. **17**A. The pusher mechanism **21** further moves the pusher member **81** leftward by the first interval TN**1** (3.333 mm). With such movement, the pusher member **81** can receive the next 16 substrates W**3** (third substrate group) at a position separated from the 17 substrates W**2** by the first interval TN**1**. In addition, the pusher member **81** can sequentially and repeatedly dispose 17 substrates W**1**, 17 substrates W**2**, and 16 substrates W**3** one by one.

[0130] The orientation changing unit **19** rotates the horizontal holding units **37** and **38** and the vertical holding units **39** and **40** by 90 degrees about the horizontal axis AX**2**. The horizontal holding units **37** and **38** and the like thus rise. The accommodation moving unit **73** (see FIG. **3**) moves the vertical holding units **39** and **40** away from the horizontal holding units **37** and **38**. The shelf switching drive unit **53**

switches from the state in which the first retraction surface **47**A and the second retraction surface **47**B are usable to the state in which the 17 pairs of pre-processing shelves **49**A and **49**B are usable. This allows the 17 pairs of pre-processing shelves **49**A and **49**B to receive the next 16 substrates W**3**.

[Step S**10**] Reception of Third Substrate Group with Orientation Changing Unit

[0131] See FIG. **17**B. The substrate handling mechanism HTR conveys the remaining 16 substrates W**3** in the second carrier C held by 16 hands **27** among the 25 hands **27** to the orientation changing unit **19**. The orientation changing unit **19** receives the 16 substrates W**3** (third substrate group) from the substrate handling mechanism HTR using 16 pairs of pre-processing shelves **49**A and **49**B out of the 17 pairs of pre-processing shelves **49**A and **49**B. The horizontal holding units **37** and **38** hold the 16 substrates W**3** (third substrate group) of the second carrier C in a horizontal orientation.

[0132] The pusher mechanism **21** lowers the pusher member **81** holding the 34 substrates W**1** and W**2** in a vertical orientation to a height position at which the next 16 substrates W**3** can be received.

[0133] See FIG. **18**A. Thereafter, the accommodation moving unit **73** (see FIG. **3**) moves the vertical holding units **39** and **40** close to the horizontal holding units **37** and **38**.

[Step S**11**] Vertical Orientation Change of Third Substrate Group

[0134] See FIG. **18**B. Thereafter, the orientation changing unit **19** rotates the horizontal holding units **37** and **38** and the vertical holding units **39** and by 90 degrees about the horizontal axis AX**2**. This causes the orientation changing unit **19** to change the orientation of the 16 substrates W**3** (third substrate group) from a horizontal orientation to a vertical orientation. Thereafter, the shelf switching drive unit **53** switches from the state in which the 17 pairs of pre-processing shelves **49**A and **49**B are usable to the state in which the first retraction surface **47**A and the second retraction surface **47**B are usable.

[Step S**12**] Reception of Third Substrate Group with Pusher Mechanism

[0135] See FIG. **19**A. Thereafter, the pusher mechanism **21** lifts the pusher member **81**. With this operation, the pusher member **81** receives the 16 substrates W**3** (third substrate group) from the vertical holding units **39** and **40**. Further, the pusher member **81** holds 16 substrates W**3** aligned at a reference pitch (10 mm pitch) in a vertical orientation. The pusher member **81** holds 50 substrates W (processing substrate group) in which 17 substrates W**1**, 17 substrates W**2**, and 16 substrates W**3** are sequentially disposed one by one. At this time, the front surfaces of the 16 substrates W**3** face leftward. That is, all the front surfaces of the 50 substrates W face leftward. Thus, the pusher member **81** holds 50 substrates W aligned in a face-to-back manner. The pusher member **81** holds the 50 substrates W aligned at a ⅓ pitch.

[Step S**13**] Switching to Plurality of Pairs of ⅔ Pitch Holding Grooves

[0136] See FIG. **19**B. The holding groove switching drive unit **71** rotates the first vertical holding unit **39** about the rotation axis AX**5** and rotates the second vertical holding unit **40** about the rotation axis AX**6**. With this operation, the holding groove switching drive unit **71** switches from the first state in which the 17 pairs of reference pitch holding grooves **63**A and **63**B are usable to the second state in which the 25 pairs of ⅔ pitch holding grooves **65**A and **65**B are usable.

[0137] The pusher mechanism **21** horizontally moves the pusher member **81** holding the 50 substrates W in a vertical orientation in the alignment direction (width direction Y) of the 50 substrates W. At this time, the pusher member **81** is moved rightward, for example. As a result, as illustrated in FIG. **20**A, 25 pairs of ⅔ pitch holding grooves **65**A and **65**B of the vertical holding unit **39** and **40** can extract, for example, 25 first substrates W**11** from 50 substrates W (W**1**, W**2**, W**3**). It is assumed that the 50 substrates W (W**1**, W**2**, W**3**) include 25 first substrates W**11** and 25 second substrates W**12** alternately disposed. In other words, the 50 substrates W including the substrates W**1**, W**2**, and W**3** are grouped into 25 first substrates W**11** and 25 second substrates W**12**.

[Step S**14**] Reception of Two or More First Substrates from Two or More First Substrates and Two or More Second Substrates Alternatively Disposed

[0138] See FIG. **20**A. The pusher mechanism **21** lowers the pusher member **81** holding the 50 substrates W in a vertical orientation to a height position lower than the vertical holding units **39** and **40**. The vertical holding units **39** and **40** are in the second state in which the 25 pairs of ⅔ pitch holding grooves **65**A and **65**B face each other, and the 25 pairs of ⅔ pitch holding grooves **65**A and **65**B are usable.

[0139] Thus, the vertical holding units **39** and **40** receive, from the pusher member **81**, 25 first substrates W**11** aligned at a ⅔ pitch (for example, 6.666 mm pitch) among the 50 substrates W in which 25 first substrates W**11** and 25 second substrates W**12** are alternately disposed. At this time, the 25 first substrates W**11** are held by 25 pairs of ⅔ pitch holding grooves **65**A and **65**B. The 25 second substrates W**12** are passed through, for example, 26 pairs of passage grooves **66**A and **66**B illustrated in FIG. **7**. The 25 first substrates W**11** are aligned at ⅔ pitch, and the 25 second substrates W**12** are also aligned at ⅔ pitch. For the ⅔ pitch, the second interval TN**2** (6.666 mm) is repeated.

[0140] In this description, the vertical holding units **39** and **40** receive 25 first substrates W**11** out of 50 substrates W from the pusher member **81**. In this regard, the vertical holding units **39** and **40** may receive 25 second substrates W**12** out of 50 substrates W from the pusher member **81**.

[Step S**15**] Rotation of Two or More Second Substrates by 180 Degrees About Vertical Axis

[0141] See FIG. **20**B. The pusher rotating unit **85** (see FIG. **8**) of the pusher mechanism **21** rotates the pusher member **81** holding 25 second substrates W**12** in a vertical orientation by 180 degrees about the vertical axis AX**7**. As a result, the front surfaces of the 25 second substrates W**12** face from the left to the right. The pusher horizontal moving unit **87** of the pusher mechanism **21** may horizontally move the pusher member **81** holding the 25 second substrates W**12** leftward. This allows 25 vertical holding grooves **93** that do not hold the substrates W to receive the 25 first substrates W**11** held by the vertical holding units **39** and **40**.

[Step S16] Alternate Disposition of Two or More First Substrates and Two or More Second Substrates Rotated by 180 Degrees

[0142] See FIG. **21**A. The pusher mechanism **21** lifts the pusher member **81** holding the 25 second substrates W**12** that have been rotated by 180 degrees. With this operation, the pusher member **81** receives the 25 first substrates W**11** from the vertical holding units **39** and **40**. The reception of the 25 first substrates W**11** is performed while the 25 first substrates W**11** and the 25 second substrates W**12** rotated by 180 degrees are alternately disposed.

[0143] As illustrated in FIG. **20**B, the front surfaces of the 25 first substrates W**11** that are not rotated by 180 degrees face leftward. On the other hand, the 25 second substrates W**12** rotated by 180 degrees face rightward. Thus, the pusher member **81** illustrated in FIG. **21**A holds 50 substrates W aligned in a face-to-face manner. The pusher member **81** holds the 50 substrates W aligned at a ⅓ pitch.

[Step S17] Substrate Processing

[0144] See FIG. **21**B. The delivery mechanism **23** horizontally moves the chuck **95** below the pusher member **81** that holds the 50 substrates W in a vertical orientation. See FIG. **22**A. Thereafter, the pusher mechanism **21** lowers the pusher member **81**. With this operation, the chuck **95** receives 50 substrates W in a vertical orientation, which are aligned in a face-to-face manner at a ⅓ pitch, from the pusher member **81**. See FIG. **22**B. Thereafter, the delivery mechanism **23** moves the chuck **95** holding the 50 substrates W to the delivery position P.

[0145] See FIG. **1**. Thereafter, the main conveyance mechanism WTR receives the 50 substrates W in a vertical orientation from the chuck **95** using the chuck **105** at the delivery position P. Thereafter, the main conveyance mechanism WTR conveys the 50 substrates W aligned at a ⅓ pitch in a face-to-face manner to one of the two chemical liquid processing tanks BT**1** and BT**3**. For example, when the main conveyance mechanism WTR conveys the 50 substrates W to the chemical liquid processing tank BT**1**, the lifter LF**1** receives the 50 substrates W aligned at a ⅓ pitch from the main conveyance mechanism WTR at a position above the chemical liquid processing tank BT**1**. The 50 substrates W are aligned in a face-to-face manner. 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. As a result, the 50 substrates W are collectively subjected to chemical liquid processing.

[0146] 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 lifting the 50 substrates W. Thereafter, the lifter LF**1** horizontally moves the 50 substrates W from the upper position of the chemical liquid processing tank BT**1** to the upper position of 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. As a result, the 50 substrates W are collectively subjected to cleaning processing. After a 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**.

[0147] When the main conveyance mechanism WTR conveys the 50 substrates W to the chemical liquid processing tank BT**3**, the lifter LF**2** receives the 50 substrates W from the main conveyance mechanism WTR. Then, the lifter LF**2** conveys the 50 substrates W in order of the chemical liquid processing tank BT**3** and the cleaning processing tank BT**4**.

[0148] The main conveyance mechanism WTR uses the chuck **105** to receive the 50 substrates W from one of the two lifters LF**1** and LF**2** and conveys the 50 substrates W to the drying unit **103**. The drying unit **103** dries the 50 substrates W. Thereafter, the main conveyance mechanism WTR receives the dried 50 substrates W from the drying unit **103**. The main conveyance mechanism WTR conveys the 50 substrates W subjected to the drying processing to the delivery position P.

[0149] Next, a conveyance operation for the 50 substrates W after processing will be described. This conveyance operation is performed in the reverse order of FIGS. **12**A to **22**B.

[0150] First, the delivery mechanism **23** uses the chuck **95** to receive the 50 substrates W after processing from the main conveyance mechanism WTR at the delivery position P. The 50 substrates W in a vertical orientation are aligned in a face-to-face manner at a ⅓ pitch. Thereafter, the delivery mechanism **23** moves the chuck **95** holding the 50 substrates W above the pusher member **81**. Thereafter, the pusher mechanism **21** lifts the pusher **30** member **81**. With this operation, the pusher member **81** receives the 50 substrates W from the chuck **95**.

[0151] Thereafter, the 50 substrates W aligned in a face-to-face manner are rearranged to be aligned in a face-to-back manner as illustrated in the order of FIGS. **21**A, **20**B, and **20**A. At this time, the horizontal holding units **37** and **38** and the like lie down (see FIG. **21**A). The vertical holding units **39** and **40** are brought close to the horizontal holding units **37** and **38**. The holding groove switching drive unit **71** switches to the fourth state in which the 25 pairs of ⅔ pitch holding grooves **69**A and **69**B for post processing are usable.

[0152] Thereafter, as illustrated in the order of FIG. **19**B, FIG. **19**A, FIG. **18**B, FIG. **18**A, FIG. **17**B, FIG. **17**A, FIG. **16**B, FIG. **16**A, FIG. **15**B, FIG. **15**A, FIG. **14**B, FIG. **14**A, FIG. **13**B, FIG. **13**A, FIG. **12**B, and FIG. **12**A, the 50 substrates W are divided into three substrate groups. The three substrate groups are the first substrate group (17 substrates W**1**), the second substrate group (17 substrates W**2**), and the third substrate group (16 substrates W**3**).

[0153] When the substrates W are divided into the three substrate groups held by the pusher member **81**, the holding groove switching drive unit **71** switches to the third state in which 17 pairs of reference pitch holding grooves **67**A and **67**B for post processing are usable. When individually holding three substrate groups of the 50 substrates W after processing in a horizontal orientation, the shelf switching drive unit **53** switches to the state **20**) in which the plurality of pairs of post-processing shelves **51**A and **51**B are usable. When delivering a plurality of substrates W between the pair of vertical holding units **39** and **40** (orientation changing unit **19**) and the pusher member **81** (pusher mechanism **21**), the shelf switching drive unit **53** switches to the state in which the first retraction surface **47**A and the second retraction surface **47**B are usable.

[0154] Thereafter, the substrate handling mechanism HTR stores the 25 substrates W**2** and W**3** (9 substrates W**2** and 16 substrates W**3**) after processing in the second carrier C placed on the placement shelf **3**. The substrate handling mechanism HTR stores the 25 substrates W**1** and W**2** (17

substrates W1 and 8 substrates W2) after processing in the first carrier C placed on the placement shelf **3**.

[0155] The carrier conveyance robot **13** conveys the first carrier C in which the 25 substrates W**1** and W**2** after processing from the placement shelf **3** to the load port **9**. The carrier conveyance robot **13** conveys the second carrier C in which the 25 substrates W**2** and W**3** after processing from the placement shelf **3** to the load port **9**. An external conveyance robot (not illustrated) sequentially conveys two carriers C from the load port **9** to the next destination.

[0156] According to the present embodiment, the pair of vertical holding units **39** and **40** of the orientation changing unit **19** includes the plurality of pairs of reference pitch holding grooves **63**A and **63**B and the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B. The plurality of pairs of reference pitch holding grooves **63**A and **63**B are disposed at a reference pitch. The plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B are disposed at a ⅔ pitch that is ⅔ times the reference pitch. The holding groove switching drive unit **71** switches to the state in which the plurality of pairs of reference pitch holding grooves **63**A and **63**B are usable. With this operation, the pusher mechanism **21** can cause the pusher member **81** to hold the first substrate group, the second substrate group, and the third substrate group aligned at the reference pitch while moving them by ⅓ pitch. Thus, a plurality of substrates W aligned at a ⅓ pitch in a face-to-back manner are once held by the pusher member **81**.

[0157] Then, the holding groove switching drive unit **71** of the orientation changing unit **19** switches to the state in which the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B are usable. As a result, the orientation changing unit **19** can extract two or more first substrates W**11** out of the plurality of substrates W in which two or more first substrates W**11** and two or more second substrates W**12** are alternately disposed from the plurality of substrates W held by the pusher member **81**. Thereafter, the pusher mechanism **21** rotates the two or more second substrates W**12** remaining on the pusher member **81** by 180 degrees about the vertical axis AX**7**. Thereafter, the two or more first substrates W**11** extracted by the orientation changing unit **19** are returned to the pusher member **81**. With this operation, a plurality of substrates W aligned at a ⅓ pitch in a face-to-face manner are held by the pusher member **81**. Thus, a plurality of substrates can be easily aligned at a ⅓ pitch narrower than a half pitch in a face-to-face manner.

[0158] The holding groove switching drive unit **71** rotates the first vertical holding unit **39** about the rotation axis AX**5** and rotates the second vertical holding unit **40** about the rotation axis AX**6**. With this operation, the holding groove switching drive unit **71** can switch between four states, that is, between a first state in which the plurality of pairs of reference pitch holding grooves **63**A and **63**B are usable, a second state in which the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B are usable, a third state in which the plurality of pairs of reference pitch holding grooves **67**A and **67**B are usable, and a fourth state in which the plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B are usable.

[0159] The plurality of substrates W to be collectively processed are aligned at a pitch (in the present embodiment, ⅓ pitch) narrower than the half pitch. Thus, for example, the size of the batch processing tank BT**1** for accommodating the plurality of substrates W can be reduced. As a result, the use amount of the processing liquid (chemical liquid and cleaning liquid) can be reduced.

Second Embodiment

[0160] Hereinafter, a second embodiment of the present invention will be described with reference to the drawings. Descriptions overlapping with the first embodiment will be omitted. FIG. **23** is a plan view illustrating the orientation changing unit **19** according to the second embodiment.

[0161] In the first embodiment, the vertical holding units **39** and **40** include the reference pitch holding grooves **63**A and **63**B and the ⅔ pitch holding grooves **65**A and **65**B to handle the substrates W before processing. The vertical holding units **39** and **40** also include a plurality of pairs of reference pitch holding grooves **67**A and **67**B and a plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B to handle the substrates W after processing. The four states were switched with this configuration.

[0162] In this regard, for example, when the substrate W before processing and the substrate W after processing are not distinguished, the vertical holding units **39** and **40** do not have to include the plurality of pairs of reference pitch holding grooves **67**A and **67**B and the plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B.

[0163] See FIG. **23**. The vertical holding units **39** and **40** do not include the plurality of pairs of reference pitch holding grooves **67**A and **67**B and the plurality of pairs of ⅔ pitch holding grooves **69**A and **69**B, but include the plurality of pairs of reference pitch holding grooves **63**A and **63**B and the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B.

[0164] The holding groove switching drive unit **71** switches between the first state in which the plurality of pairs of reference pitch holding grooves **63**A and **63**B are usable and the second state in which the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B are usable. That is, the holding groove switching drive unit **71** may be configured to switch between two states.

[0165] The present invention is not limited to the embodiments described above, and can be modified as follows.

[0166] (1) In each embodiment described above, the substrate processing apparatus **1** collectively processes 50 substrates W. In this regard, the substrate processing apparatus **1** may collectively process 75 substrates W. In this case, a processing substrate group in which a total of 75 substrates W of three carriers C are collectively processed is formed. That is, the 75 substrates W are aligned in a face-to-face manner at a ⅓ pitch.

[0167] The processing substrate group is formed based on the flowcharts of FIGS. **10** and **11**. The 25 substrates W**1** of the first carrier C are used as the first substrate group. The 25 substrates W**2** of the second carrier Care used as the second substrate group. The 25 substrates W**3** of the third carrier C are used as the third substrate group.

[0168] For example, the pair of horizontal holding units **37** and **38** includes pairs of pre-processing shelves **49**A and **49**B and 25 pairs of post-processing shelves **51**A and **51**B. The pusher member **81** includes 75 or 76 vertical holding grooves **93**.

[0169] The pair of vertical holding units **39** and **40** includes 25 pairs of reference pitch holding grooves **63**A and **63**B and 38 pairs of ⅔ pitch holding grooves **65**A and **65**B to handle the substrates W before processing. The pair of vertical holding units **39** and **40** includes 25 pairs of refer-

ence pitch holding grooves **67**A and **67**B and 38 pairs of ⅔ pitch holding grooves **69**A and **69**B to handle the substrates W after processing.

[0170] (2) In each embodiment described above, the substrate processing apparatus **1** collectively processes 50 substrates W. In this regard, the substrate processing apparatus **1** may collectively process 100 substrates W. In this case, a processing substrate group in which a total of 100 substrates W of four carriers C are collectively processed is formed. That is, the 100 substrates W are aligned in a face-to-face manner at a ⅓ pitch.

[0171] The processing substrate group is formed based on the flowcharts of FIGS. **10** and **11**. The 25 substrates W**1** of the first carrier C and the nine substrate W**1** of the second carrier C (34 substrate W**1**) are used as the first substrate group. The remaining 16 substrates W**2** of the second carrier C and the 17 substrate W**2** of the third carrier C (33 substrate W**2**) are used as the second substrate group. The remaining eight substrates W**3** of the third carrier C and the 25 substrate W**3** of the fourth carrier C (33 substrate W**3**) are used as the third substrate group.

[0172] For example, the pair of horizontal holding units **37** and **38** includes 34 pairs of pre-processing shelves **49**A and **49**B and 34 pairs of post-processing shelves **51**A and **51**B. The pusher member **81** includes 100 vertical holding grooves **93**.

[0173] The pair of vertical holding units **39** and **40** includes 34 pairs of reference pitch holding grooves **63**A and **63**B and 50 pairs of ⅔ pitch holding grooves **65**A and **65**B to handle the substrates W before processing. The pair of vertical holding units **39** and **40** includes 34 pairs of reference pitch holding grooves **67**A and **67**B and 50 pairs of ⅔ pitch holding grooves **69**A and **69**B to handle the substrates W after processing.

[0174] (3) In each embodiment and modification described above, the holding groove switching drive unit **71** of the orientation changing unit **19** rotates the first vertical holding unit **39** about the rotation axis AX**5** and rotates the second vertical holding unit **40** about the rotation axis AX**6**. With this operation, for example, the holding groove switching drive unit **71** switches from the first state in which the plurality of pairs of reference pitch holding grooves **63**A and **63**B are usable to the second state in which the plurality of pairs of ⅔ pitch holding grooves **65**A and **65**B are usable. This switching may be performed not by the rotation of each of the vertical holding units **39** and **40** but, for example, by horizontal movement.

[0175] For example, as illustrated in FIGS. **24**A and **24**B, the orientation changing unit **19** includes two pairs of vertical holding units **121**, **122**, **123**, and **124**. The pair of vertical holding units **121** and **122** includes, for example, 17 pairs of reference pitch holding grooves **63**A and **63**B. The other pair of vertical holding units **123** and **124** includes, for example, 25 pairs of ⅔ pitch holding grooves **65**A and **65**B. The pair of vertical holding units **121** and **122** can move in the front-back directions X. The other pair of vertical holding units **123** and **124** can also move in the front-back directions X.

[0176] The holding groove switching drive unit **71** includes, for example, an electric actuator or an air cylinder. As illustrated in FIG. **24**A, the holding groove switching drive unit **71** moves the pair of vertical holding units **121** and **122** close to each other. This allows the pair of vertical holding units **121** and **122** to hold the 17 substrates W in a vertical orientation aligned at the reference pitch. As illustrated in FIG. **24**B, the holding groove switching drive unit **71** moves the other pair of vertical holding units **123** and **124** close to each other. This allows the other pair of vertical holding units **123** and **124** to hold the 25 substrates W aligned at the ⅔ pitch.

[0177] (4) In each embodiment and modification described above, the delivery mechanism **23** conveys, for example, 50 substrates W between the pusher mechanism **21** and the main conveyance mechanism WTR. That is, the delivery mechanism **23** conveys 50 substrates W from the pusher member **81** to the delivery position P for the delivery to the main conveyance mechanism WTR. In this regard, the pusher mechanism **21** may directly convey the 50 substrates W to the delivery position P. In this case, the delivery mechanism **23** does not have to be provided.

[0178] (5) In each embodiment and modification described above, the transfer block **5** includes one delivery mechanism **23**. In this regard, the transfer block **5** may include a plurality of delivery mechanisms **23**. For example, when two delivery mechanisms **23** are provided, a first delivery mechanism **23** may convey 50 substrates W from the pusher member **81** to the delivery position P for the delivery to the main conveyance mechanism WTR. A second delivery mechanism **23** may convey 50 substrates W to the pusher member **81** from another substrate delivery position for the delivery from the main conveyance mechanism WTR.

[0179] (6) In each embodiment and modification described above, the pusher member **81** holds a plurality of substrates W formed of the three substrate groups. The plurality of substrates W are aligned at a ⅓ pitch. In this regard, the plurality of substrates W (processing substrate group) to be collectively processed may be aligned at a ¼ pitch or a ⅕ pitch.

[0180] For example, when the plurality of substrates W are aligned at a ¼ pitch (for example, 2.5 mm pitch), the plurality of substrates W are formed by four substrate groups. Accordingly, the vertical holding units **39** and may include, instead of the ⅔ pitch holding grooves **65**A and **65**B (**69**A and **69**B), a plurality of pairs of ½ pitch holding grooves aligned at a ½ pitch (¾ pitch) (for example, 5 mm pitch) in the extending directions DR**2**. When the plurality of substrates W are aligned at a ⅕ pitch (for example, 2 mm pitch), the plurality of substrates W are formed by five substrate groups. Accordingly, the vertical holding units **39** and **40** may include, instead of the ⅔ pitch holding grooves **65**A and **65**B (**69**A and **69**B), a plurality of pairs of ⅖ pitch holding grooves aligned at a ⅖ pitch (for example, 4 mm pitch) in the extending directions DR**2**.

[0181] That is, the plurality of substrates W to be collectively processed are aligned at a 1/N pitch. In this case, the plurality of substrates W are formed by N substrate groups. Accordingly, the vertical holding units **39** and **40** may include, instead of the ⅔ pitch holding grooves **65**A and **65**B (**69**A and **69**B), a plurality of pairs of 2/N pitch holding grooves aligned at a 2/N pitch in the extending directions DR**2**. "N" in the 1/N pitch, the 2/N pitch, and N is a natural number of 3 or more.

[0182] 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 that collectively processes a plurality of substrates, the substrate processing apparatus comprising:

a substrate handling mechanism including a plurality of hands disposed in a vertical direction at a reference pitch, each of which holds 5 one substrate in a horizontal orientation;

an orientation changing unit that individually changes an orientation of N substrate groups each including two or more substrates aligned at the reference pitch from the horizontal orientation to a vertical orientation, wherein N is a natural number of three or more, the N substrate groups being sequentially received from the substrate handling mechanism; and

a pusher mechanism including a pusher member that holds the plurality of substrates aligned in the vertical orientation at a 1/N pitch that is 1/N times the reference pitch, the pusher mechanism forming the plurality of substrates on the pusher member by aligning the N substrate groups received from the orientation changing unit in one row with the pusher member while shifting the pusher member by the 1/N pitch in an alignment direction in which the plurality of substrates are aligned, wherein

the orientation changing unit includes:

a support base;

a pair of horizontal holding units that holds one substrate group of the N substrate groups in the horizontal orientation, the pair of horizontal holding units being provided in such a manner as to extend at a right angle with respect to a support surface of the support base;

a pair of vertical holding units including a plurality of pairs of reference pitch holding grooves and a plurality of pairs of 2/N pitch holding grooves, the pair of vertical holding units being provided in such a manner as to extend at the right angle with respect to the support surface of the support base;

a rotation drive unit that rotates the support base about a horizontal axis; and

a switching drive unit that switches between a state in which the plurality of pairs of reference pitch holding grooves are usable and a state in which the plurality of pairs of 2/N pitch holding grooves are usable,

the plurality of pairs of reference pitch holding grooves are disposed at the reference pitch in an extending direction in which the pair of vertical holding units extends,

the plurality of pairs of 2/N pitch holding grooves are disposed at a 2/N pitch that is 2/N times the reference pitch in the extending direction, and

the switching drive unit:

switches to the state in which the plurality of pairs of reference pitch holding grooves are usable when the plurality of substrates aligned in a face-to-back manner are formed in the pusher member; and

switches to the state in which the plurality of pairs of 2/N pitch holding grooves are usable when the plurality of substrates held by the pusher member are rearranged into a face-to-face manner.

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

a first vertical holding unit of the pair of vertical holding unit is rotatable about a first rotation axis passing through the first vertical holding unit and extending at the right angle with respect to the support surface,

the first vertical holding unit includes a first outer peripheral surface and a second outer peripheral surface provided around the first rotation axis,

a second vertical holding unit of the pair of vertical holding unit is rotatable about a second rotation axis passing through the second vertical holding unit and extending at the right angle with respect to the support surface,

the second vertical holding unit includes a third outer peripheral surface and a fourth outer peripheral surface provided around the second rotation axis,

the first outer peripheral surface and the third outer peripheral surface are provided with the plurality of pairs of reference pitch holding grooves,

the second outer peripheral surface and the fourth outer peripheral surface are provided with the plurality of pairs of 2/N pitch holding grooves, and

the switching drive unit rotates the first vertical holding unit about the first rotation axis and rotates the second vertical holding unit about the second rotation axis to switch between the state in which the plurality of pairs of reference pitch holding grooves are usable and the state in which the plurality of pairs of 2/N pitch holding grooves are usable.

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

the first vertical holding unit includes a fifth outer peripheral surface and a sixth outer peripheral surface provided around the first rotation axis in addition to the first outer peripheral surface and the second outer peripheral surface,

the second vertical holding unit includes a seventh outer peripheral surface and an eighth outer peripheral surface provided around the second rotation axis in addition to the third outer peripheral surface and the fourth outer peripheral surface,

the fifth outer peripheral surface and the seventh outer peripheral surface are provided with a plurality of pairs of post-processing reference pitch holding grooves disposed at the reference pitch in the extending direction,

the sixth outer peripheral surface and the eighth outer peripheral surface are provided with a plurality of pairs of post-processing 2/N pitch holding grooves disposed at the 2/N pitch in the extending direction,

the switching drive unit rotates the first vertical holding unit about the first rotation axis and rotates the second vertical holding unit about the second rotation axis to switch between the state in which the plurality of pairs of reference pitch holding grooves are usable, the state in which the plurality of pairs of 2/N pitch holding grooves are usable, a state in which the plurality of pairs of post-processing reference pitch holding grooves are usable, and a state in which the plurality of pairs of post-processing 2/N pitch holding grooves are usable, and

the switching drive unit:

switches to the state in which the plurality of pairs of post-processing 2/N pitch holding grooves are usable

when the plurality of substrates held by the pusher member are rearranged into a face-to-back manner; and

switches to the state in which the plurality of pairs of post-processing reference pitch holding grooves are usable when the plurality of substrates held by the pusher member are divided into the N substrate groups.

4. The substrate processing apparatus according to claim **1**,

the substrate processing apparatus comprising a controller, wherein

the controller:

causes the switching drive unit to switch to the state in which the plurality of pairs of reference pitch holding grooves are usable;

causes the orientation changing unit to sequentially receive the N substrate groups from the substrate handling mechanism;

causes the orientation changing unit to individually change the orientation of the N substrate groups from the horizontal orientation to the vertical orientation;

causes the pusher mechanism to hold the plurality of substrates aligned at the 1/N pitch in the face-to-back manner with the pusher member, the plurality of substrates being formed from the N substrate groups by the pusher member sequentially receiving the N substrate groups while the pusher member is shifted in the alignment direction by the 1/N pitch;

causes the switching drive unit to switch to the state in which the plurality of pairs of 2/N pitch holding grooves are usable;

causes the pair of vertical holding units to receive, from the pusher member, two or more first substrates aligned at the 2/N pitch among the plurality of substrates in which the two or more first substrates and two or more second substrates are alternately disposed;

causes the pusher mechanism to rotate the pusher member holding the two or more second substrates in the vertical orientation by 180 degrees about a vertical axis; and

causes the pusher member to receive the two or more first substrates from the pair of vertical holding units while alternately disposing the two or more first substrates and the two or more second substrates rotated by 180 degrees.

5. The substrate processing apparatus according to claim **1**, the substrate processing apparatus further comprising:

a substrate processing unit that collectively processes the plurality of substrates aligned at the 1/N pitch in the face-to-face manner; and

a main conveyance mechanism that conveys the plurality of substrates aligned at the 1/N pitch in the face-to-face manner to the substrate processing unit.

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

the N substrate groups are three substrate groups,

the 1/N pitch is a ⅓ pitch that is ⅓ times the reference pitch, and

the plurality of pairs of 2/N pitch holding grooves are a plurality of pairs of ⅔ pitch holding grooves disposed at a ⅔ pitch that is ⅔ times the reference pitch in the extending direction.

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

the N substrate groups are three substrate groups,

the 1/N pitch is a ⅓ pitch that is ⅓ times the reference pitch,

the plurality of pairs of 2/N pitch holding grooves are a plurality of pairs of ⅔ pitch holding grooves disposed at a ⅔ pitch that is ⅔ times the reference pitch in the extending direction, and

the plurality of pairs of post-processing 2/N pitch holding grooves are a plurality of pairs of post-processing ⅔ pitch holding grooves disposed at the ⅔ pitch in the extending direction.

* * * * *