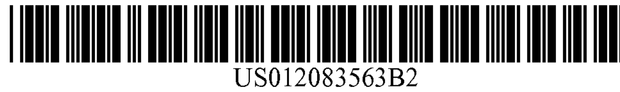


(12) **United States Patent**
Nakazawa et al.

(10) **Patent No.: US 12,083,563 B2**
(45) **Date of Patent: Sep. 10, 2024**

(54) **SUBSTRATE TREATING APPARATUS**

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

(72) Inventors: **Kazuhiko Nakazawa**, Kyoto (JP); **Yuichi Takayama**, Kyoto (JP); **Toshihito Morioka**, Kyoto (JP); **Hiromichi Kaba**, Kyoto (JP); **Takuya Sato**, Kyoto (JP)

(73) Assignee: **SCREEN Holdings Co., Ltd.** (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 908 days.

(21) Appl. No.: **17/016,438**

(22) Filed: **Sep. 10, 2020**

(65) **Prior Publication Data**

US 2021/0086236 A1 Mar. 25, 2021

(30) **Foreign Application Priority Data**

Sep. 20, 2019 (JP) 2019-171517

(51) **Int. Cl.**

B08B 3/04	(2006.01)
B08B 3/08	(2006.01)
B08B 3/10	(2006.01)
B08B 5/02	(2006.01)
B08B 13/00	(2006.01)
H01L 21/67	(2006.01)

(Continued)

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

CPC ***B08B 3/041*** (2013.01); ***B08B 3/08*** (2013.01); ***B08B 3/10*** (2013.01); ***B08B 5/023*** (2013.01); ***B08B 13/00*** (2013.01); ***H01L 21/67051*** (2013.01); ***H01L 21/6838*** (2013.01); ***H01L 21/68742*** (2013.01); ***H01L 21/68764*** (2013.01)

(58) **Field of Classification Search**

CPC H01L 21/68742

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,306,455 B1	10/2001	Takamori et al.	....	427/8
10,410,887 B2	9/2019	Nakano		

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1674247 A	9/2005
JP	H07-263324 A	10/1995

(Continued)

OTHER PUBLICATIONS

JP2019046985—Machine Translation (Year: 2019).*

(Continued)

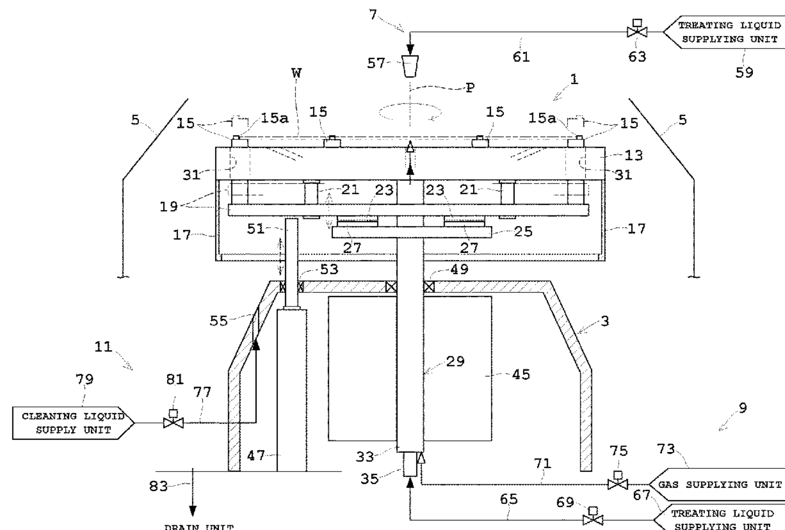
Primary Examiner — Marc Lorenzi

(74) *Attorney, Agent, or Firm* — OSTROLENK FABER LLP

(57) **ABSTRACT**

Disclosed is a substrate treating apparatus for treating a substrate with a treating liquid, the apparatus including the following: a rotating member including a plurality of through-holes formed therein; a plurality of support pins attached to the through-holes with a non-sealing structure, and configured to support a substrate in such a manner that the substrate is spaced apart; a supply nozzle configured to supply a treating liquid to the substrate; a cover spaced apart below the rotating member; a rotational drive device configured to drive the rotating member rotationally in a horizontal plane; and a drive device configured to drive the support pins.

8 Claims, 5 Drawing Sheets



(51) **Int. Cl.**
H01L 21/683 (2006.01)
H01L 21/687 (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0139228	A1	6/2005	Wilk et al.	134/1
2005/0215073	A1	9/2005	Nakamura et al.	438/778
2005/0253285	A1	11/2005	Kuibira et al.	257/787
2009/0101181	A1	4/2009	Morisawa et al.	134/94.1
2011/0222038	A1	9/2011	Yamashita	355/53
2013/0233361	A1*	9/2013	Egashira	H01L 21/67051 134/153
2016/0236239	A1	8/2016	Nishiyama	
2017/0358480	A1*	12/2017	Zhang	H01L 21/6875
2018/0226277	A1*	8/2018	Wakiyama	H01L 21/68792
2019/0252214	A1	8/2019	Okita et al.	

FOREIGN PATENT DOCUMENTS

JP	H11-102882	A	4/1999
JP	2001-308162	A	11/2001
JP	2002-086048	A	3/2002
JP	2002-313892	A	10/2002
JP	2005-019701	A	1/2005
JP	2005-135940	A	5/2005
JP	2005-260088	A	9/2005
JP	2008-130948	A	6/2008
JP	2009-117794	A	5/2009
JP	2010-073751	A	4/2010
JP	2010-080583	A	4/2010
JP	2013-105867	A	5/2013
JP	2016-149420	A	8/2016
JP	2018-067683	A	4/2018
JP	2018-107388	A	7/2018
JP	2019-046985	A	3/2019
KR	10-2009-0039629	A	4/2009
KR	10-2011-0039495	A	4/2011
TW	201705250	A	2/2017
TW	201935594	A	9/2019

OTHER PUBLICATIONS

Office Action dated Dec. 16, 2021 for corresponding Korean Patent Application No. 10-2020-0110974.
Office Action dated Apr. 16, 2021 for corresponding Taiwan Patent Application No. 109128498.
Japanese Notice of Allowance dated Oct. 3, 2023 for corresponding Japanese Patent Application No. 2019-171517.
Notice of Allowance dated Jan. 31, 2024 for corresponding Chinese Patent Application No. 202010848063.8.

* cited by examiner

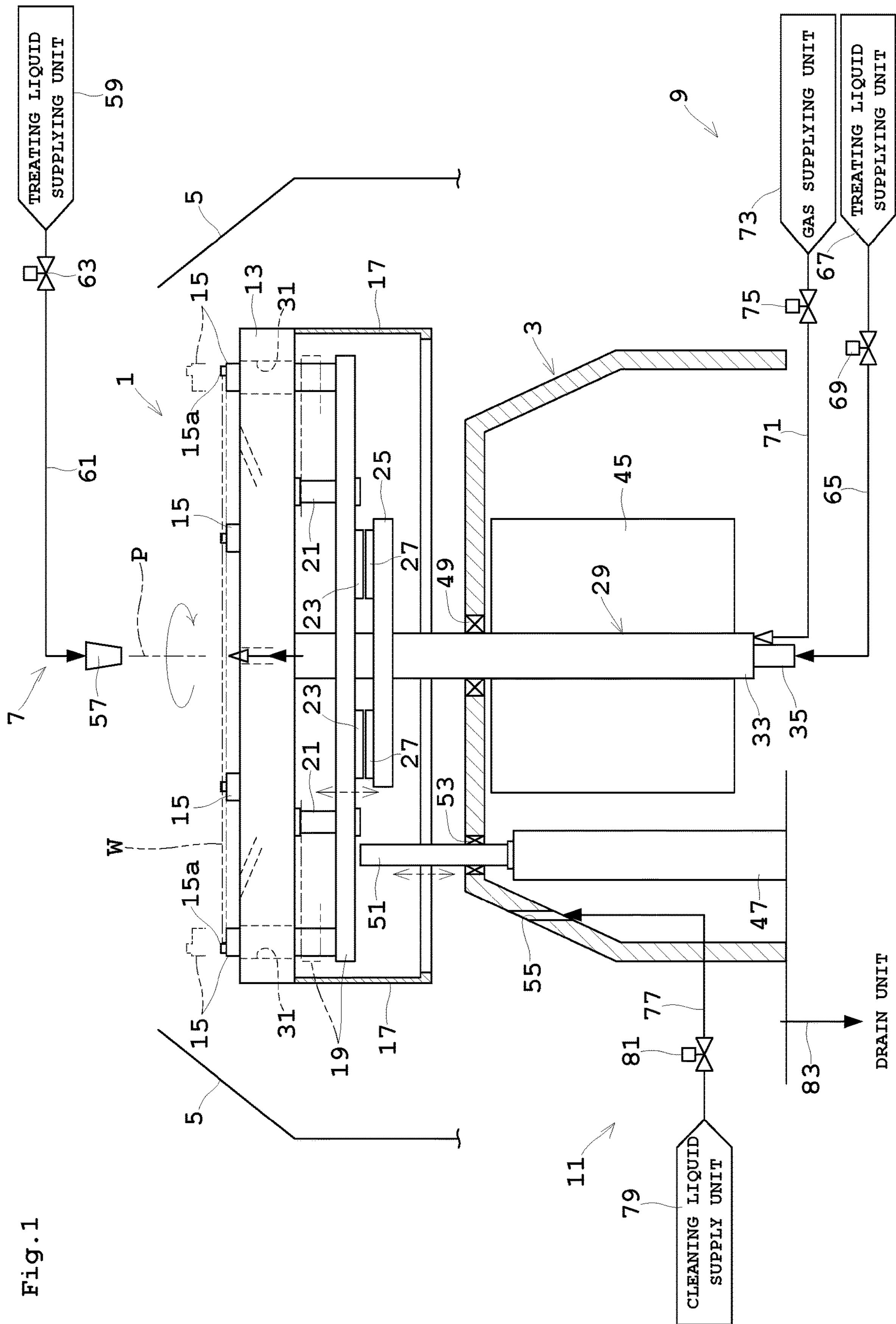


Fig.1
TREATING LIQUID SUPPLYING UNIT
GAS SUPPLYING UNIT
TREATING LIQUID SUPPLYING UNIT
CLEANING LIQUID SUPPLY UNIT
DRAIN UNIT
1
3
5
7
9
11
13
15
15a
17
19
21
23
25
27
29
31
33
35
45
47
49
51
53
55
57
59
61
63
65
67
69
71
73
75
77
79
81
83
P
W

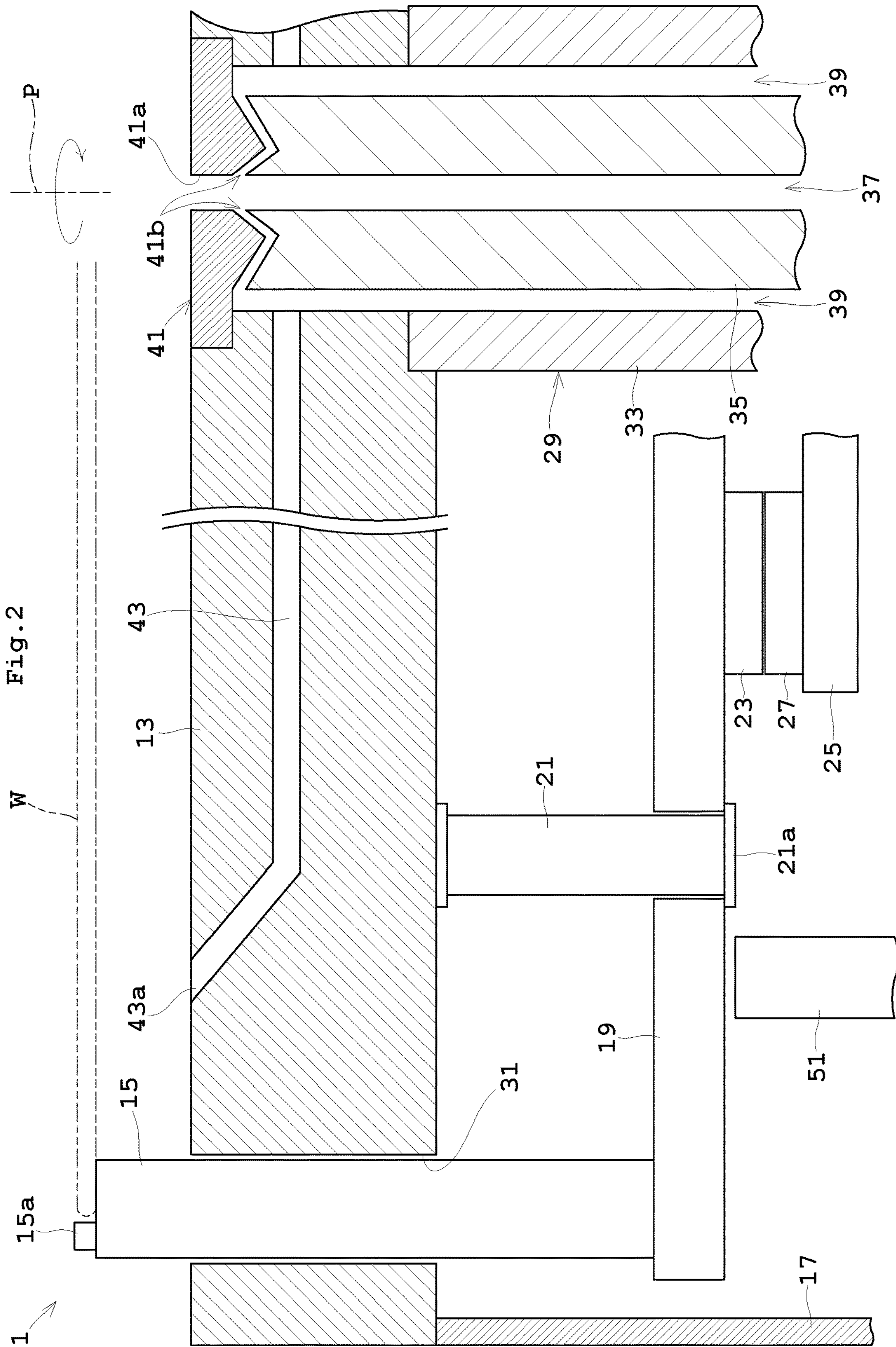


Fig.2
P
41a
41b
41
39
37
39
35
33
29
43
13
W
21
21a
23
27
25
43a
19
51
15
31
15a
17
1

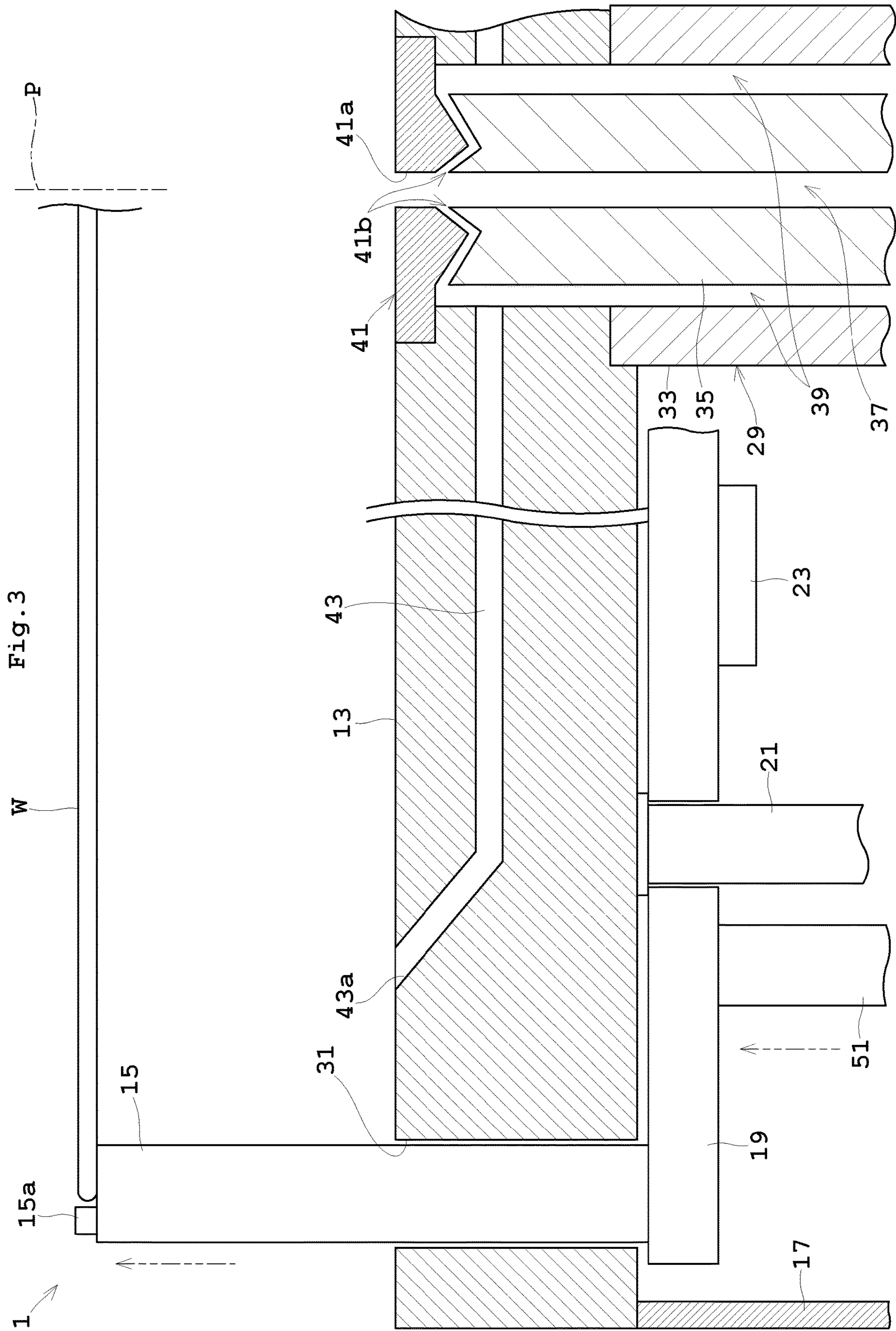


Fig.3
P
W
1
15a
15
31
13
43
43a
41
41a
41b
33
35
29
39
37
23
21
51
19
17

Fig. 4

Fig.5

TREATING LIQUID SUPPLYING UNIT

DRAIN UNIT

SUBSTRATE TREATING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a substrate treating apparatus for performing a treatment with a treating liquid on a substrate, such as a semiconductor wafer, a substrate for a liquid crystal display or for an organic electroluminescence (EL) display device, a glass substrate for photomask, a substrate for an optical disk, a substrate for a magnetic disk, a ceramic substrate, a substrate for a solar cell substrate, or the like (hereinafter, simply referred to as a substrate).

Description of the Related Art

Such currently-used types of devices include one having a platform, a plurality of support pins, and a supply nozzle. See, for example, Japanese Unexamined Patent Application Publication No. 2019-46985A (FIG. **6**). The platform rotatably supports a substrate. The support pins are erected on an outer peripheral portion of an upper surface of the platform. The support pins support an outer peripheral edge of a substrate. The supply nozzle supplies a treating liquid to a substrate supported by the platform.

The support pins are inserted into through-holes formed in the platform. The support pins include lifting pins. The lifting pins each move upward/downward between a transfer position apart from the upper surface of the platform and a holding position closer to the upper surface of the platform than the transfer position. The treating liquid is supplied from the supply nozzle to the platform while the substrate is held thereon. The treating liquid flowing down to the platform enters inside the platform through the gaps between the support pins and the through-holes. Then, drive components for lifting/lowering the support pins may be damaged by the treating liquid. Accordingly, a sealing member such as an O-ring is attached to each of the through-holes of the platform in which the support pins are inserted.

SUMMARY OF THE INVENTION

However, the conventional example with such a configuration as above possesses the following drawbacks.

That is, in the currently-used apparatus, the support pin has extremely high sliding resistance against the sealing member. Therefore, the drive components driving the support pins need to produce a larger driving force. The number of the drive components for driving the support pins need to be increased. Moreover, enhanced strength of a connecting member moved upward/downward by the drive component is needed by connecting the plurality of support pins. This causes prevention of a reduction in cost of the substrate treating apparatus.

The present disclosure has been made regarding the state of the art noted above, and its one object is to provide a substrate treating apparatus that enables a reduction in cost by making support pins with a non-sealing structure.

The present invention is constituted as stated below to achieve the above object.

One aspect of the present invention provides a substrate treating apparatus for treating a substrate with a treating liquid. The substrate treating apparatus includes a rotating member resistant to the treating liquid, having a diameter larger than a diameter of a substrate, and including a plurality of through-holes formed therein and configured to

be in communication with an upper surface and a lower surface thereof on an outer peripheral side; a plurality of support pins resistant to the treating liquid, attached to the through-holes with a non-sealing structure, and configured to support a substrate in such a manner that a lower surface of the substrate is spaced apart from the upper surface of the rotating member; a supply nozzle configured to supply a treating liquid to the substrate supported by the support pins on the upper surface of the rotating member; a cover resistant to the treating liquid and spaced apart below from the lower surface of the rotating member; a rotational drive device disposed within the cover and configured to drive the rotating member rotationally in a horizontal plane; and a drive device disposed within the cover and configured to drive the support pins.

According to the present invention, the support pins are attached to the through-holes of the rotating member with a non-sealing structure. Accordingly, the treating liquid supplied from the supply nozzle enters the lower surface of the rotation member through the gaps between the through-holes of the rotating member and the plurality of support pins. However, areas above the cover are resistant to the treating liquid, and the rotational drive device and the drive device are covered with the cover, leading to prevention of adverse effects by the treating liquid. Moreover, the non-sealing structure can lower sliding resistance and drive load. Consequently, the drive member does not need to increase the driving force and rigidity of the member for driving, leading to a reduction in cost of the substrate treating apparatus.

Moreover, it is preferable in the present invention that some of the support pins work as lifting pins, the substrate treating apparatus includes a connecting member configured to connect the lifting pins below the rotating member, and the drive device drives to lift and lower the lifting pins via the connecting member between a transfer position where the substrate is transported and a support position lower than the transfer position.

The drive device lifts and lowers the lifting pins via the connecting member. However, since the drive load is small due to the non-sealing structure, the rigidity of the connecting member can be lower than that of the currently-used connecting member.

Moreover, it is also preferable in the present invention that the drive device includes an actuation shaft configured to move forward and backward, an upper end of the actuation shaft abuts against the connecting member when the connecting member moves to the transfer position, the upper end of the actuation shaft is spaced apart from the connecting member when the connecting member moves to the support position, and the substrate treating apparatus includes magnets for attracting the connecting member downward with a magnetic force thereof when the connecting member moves from the transfer position to the support position.

The actuation shaft pushes the connecting member upward when the connecting member moves to the transfer position, and the actuation shaft is spaced apart from the connecting member when the connecting member moves to the support position. Accordingly, the support pins and the connecting member move downward by their own weights. At that time, the connecting member is attracted downward by the magnets. Consequently, the connecting member can move quickly from the transfer position to the support position.

Moreover, it is also preferable in the present invention that the rotating member includes a peripheral surface member

extending downward from an outer peripheral surface of the rotating member, and including a lower end portion spaced apart upward from an upper surface of the cover, and an opened lower surface.

The treating liquid that entered below the rotation member through the through-holes of the rotating member can be prevented from scattering laterally. Moreover, since the lower surface of the peripheral surface member is open, the rotating member can be maintained easily.

Moreover, it is also preferable in the present invention that the substrate treating apparatus further includes a cleaning nozzle configured to supply a cleaning liquid toward an inside of the peripheral surface member.

The cleaning nozzle supplies the cleaning liquid to remove a treating liquid that has entered a lower part of the rotating member. This achieves cleaning within a space formed by the lower surface of the rotating member and the inside of the peripheral surface member can be cleaned.

Moreover, it is preferable in the present invention that the substrate treating apparatus further includes a gas supply mechanism configured to supply gas between the rotation member and a lower surface of a substrate supported by the support pins, and a suction force is generated on the substrate supported by the support pins toward the rotating member.

The gas supply mechanism supplies gas, thereby working as a Bernoulli chuck. Consequently, in addition to a holding force by the plurality of support pins, the suction force toward the rotating member can hold a substrate reliably.

BRIEF DESCRIPTION OF THE DRAWINGS

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.

FIG. **1** is an overall diagram showing a schematic configuration of a substrate treating apparatus according to one embodiment.

FIG. **2** is a longitudinal sectional view showing a part of a holding unit.

FIG. **3** is a longitudinal sectional view showing the part of the holding unit in a state where a support pin is in a transfer position.

FIG. **4** is a longitudinal sectional view showing the part of the holding unit in a state where the support pin is rotated in a support position.

FIG. **5** is a diagram showing a state where the inside of the holding unit is being washed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following describes one embodiment of the present invention with reference to drawings.

FIG. **1** is an overall diagram showing a schematic configuration of a substrate treating apparatus according to one embodiment. FIG. **2** is a longitudinal sectional view showing a part of a holding unit.

A substrate treating apparatus according to this embodiment performs a treatment with a treating liquid while holding a substrate W in a horizontal posture, for example. The substrate treating apparatus includes a holding unit **1**, a cover **3**, a scattering prevention cup **5**, a treating liquid supply system **7**, a lower supply system **9**, and a cleaning liquid supply system **11**.

A substrate W held by the holding unit **1** to be treated is in a circular shape in plan view, for example. The holding unit **1** includes a rotating member **13**, a plurality of (e.g., six) support pins **15**, a peripheral surface member **17**, a connecting member **19**, guide pins **21**, upper magnets **23**, a magnet holding member **25**, lower magnets **27**, and a rotary shaft **29**.

The rotating member **13** is in a circular shape and has a diameter larger than that of a substrate W. Specifically, the diameter of the rotating member **13** is preferably about 1.05 to 1.2 times of that of a substrate W. The rotating member **13** is rotationally driven by an electric motor **45**. The rotating member **13** is surrounded by the scattering prevention cup **5**. Accordingly, when the rotating member **13** is too large, the driving force of the electric motor **45** needs to be larger, and thus the scattering prevention cup **5** also needs to be larger in size, leading to increase in cost of the apparatus. The rotating member **13** has a plurality of through-holes **31** formed on an outer peripheral side thereof. The through-holes **31** are in communication with an upper surface and a lower surface of the rotating member **13**. The through-holes **31** are formed at a plurality of (e.g., six) positions of the rotating member **13**. No sealing member such as an O-ring is interposed in the through-holes **31**. In other words, the support pins **15** are inserted in the through-holes **31** with a non-sealing structure. The support pins **15** are each made of a resin material that is resistant to a treating liquid. Examples of the resin material include fluorine-based resins such as polytetrafluoroethylene (PTFE), a copolymer of tetrafluoroethylene and perfluoroalkyl vinyl ether (PFA), and polychlorotrifluoroethylene (PCTFE). Such a resin material is not limited to a fluorine-based resin. Any material that is resistant to the treating liquid supplied from a treating liquid supply system **7**, to be mentioned later, may be used. Each support pin **15** is in a cylindrical shape with a longitudinal axis longer than the thickness of the rotating member **13**. Each support pin **15** includes a projection **15*a*** on the upper surface thereof for restricting horizontal movement of a substrate W. Each support pin **15** is formed to have an outer diameter slightly smaller than an inner diameter of the through-hole **31**.

The support pins **15** each have a lower end portion connected to the connecting member **19**. The connecting member **19** is in an annular shape in plan view. The plurality of guide pins **21** are inserted into the connecting member **19** at a part of an area where the support pins **15** are not present in plan view. The upper portions of the guide pins **21** are attached to the lower surface of the rotating member **13**, and the lower portions of the guide pins **21** have flanges **21*a*** formed thereon. Consequently, a lowered position of the connecting member **19** is restricted by the flanges **21*a*** of the guide pins **21**. The connecting member **19** and the guide pins **21** are made by molding a metallic material such as stainless steel with fluoroplastic described above. Accordingly, the connecting member **19** and the guide pins **21** have a chemical resistance. Moreover, the rotating member **13** is made of a metallic material such as stainless steel. The lower surface and the inner peripheral surface of the rotating member **13** are coated with fluoroplastic or the like described above. Accordingly, the rotating member **13** has a chemical resistance.

The upper magnets **23** are attached to a part of the lower surface of the connecting member **19**. The magnet holding member **25** is attached below the connecting member **19**, apart from the upper magnets **23**. The magnet holding member **25** has a fixed position in level. The lower magnets **27** are attached to the upper surface of the magnet holding member **25**. The upper surfaces of the lower magnets **27** face

the upper magnets **23**. The upper magnets **23** and the lower magnets **27** are attached in such a manner that opposite polarities thereof attracting each other face each other. That is, if a lower surface of an upper magnet **23** has an S pole, the lower magnet **27** is attached in such a manner that an upper surface thereof has an N pole. The upper magnets **23**, the lower magnets **27**, and the magnet holding member **25** are molded with fluoroplastic described above. Accordingly, the upper magnets **23**, the lower magnets **27**, and the magnet holding member **25** have a chemical resistance.

The plurality of support pins **15** are moved upward/downward through the connecting member **19**, and the support pins **15** are attached to the rotating member **13** with a non-sealing structure. Thus, drive load of the support pins **15** through the connecting member **19** is reduced. Accordingly, the connecting member **19** can be configured to have lower rigidity compared with that of a currently-used connecting member.

A front end portion of the rotary shaft **29** is attached to the rotating member **13**. The rotary shaft **29** has a double cylindrical structure. The rotary shaft **29** includes an inner cylinder **35** and an outer cylinder **33** into which the inner cylinder **35** is inserted. An inner peripheral surface of the outer cylinder **33** is spaced apart from an outer peripheral surface of the inner cylinder **35**. Accordingly, the rotary shaft **29** includes a first flow path **37** and a second flow path **39** formed therein. The first flow path **37** is provided at the center of the inner cylinder **35**. The second flow path **39** is formed by the outer peripheral surface of the inner cylinder **35** and the inner peripheral surface of the outer cylinder **33**. An opening lid **41** is attached to the rotation center of the rotating member **13** above the rotary shaft **29**. A discharge port **41***a* is formed at a center of the opening lid **41**. A lower portion of the opening lid **41** protrudes downward in a triangular shape. The inner cylinder **35** facing the lower portion has an upper surface recessed downward to form a triangular shape. The triangular shape conforms to the triangular shape of the opening lid **41**. These triangular portions are spaced apart from each other, forming a labyrinth structure **41***b*. The rotary shaft **29** is made by coating fluoroplastic described above to a metallic material such as a stainless-steel alloy. Accordingly, the rotary shaft **29** has a chemical resistance.

A flow path **43** is formed inside the rotating member **13**. One end of the flow path **43** is in communication with the second flow path **39**. The other end of the flow path **43** is in communication with the upper surface of the rotating member **13** at the peripheral side. The opening at the peripheral side is an edge opening **43***a*. The edge opening **43***a* is formed so as to be inclined upward. This causes the edge opening **43***a* to blow gas toward the upper end portion of the support pin **15** positioned at the level in the support position.

Here, the discharge port **41***a* and the edge opening **43***a* described above correspond to the "gas supply mechanism" in the present disclosure.

The rotating member **13** includes the peripheral surface member **17**. The peripheral surface member **17** is in an annular shape in plan view. The peripheral surface member **17** extends downward from the outer peripheral surface side of the rotating member **13**. A lower end portion of the peripheral surface member **17** is spaced upward from an upper surface of the cover **3**. A lower surface of the peripheral surface member **17** has an opening in a substantially circular shape when viewed from below. The peripheral surface member **17** prevents lateral scattering of the treating liquid that entered below the rotating member **13** through the through-holes **31** of the rotating member **13**. Moreover, the lower surface of the peripheral surface member **17** is open. This achieves easy maintenance of the inside of the holding unit **1**.

The upper surface of the cover **3** is spaced apart downward from the lower end portion of the peripheral surface member **17**. At least the upper surface of the cover **3** is made of, for example, fluoroplastic described above. Accordingly, the cover **3** is resistant to the treating liquid supplied from the treating liquid supply system **7**, which is to be mentioned later. The cover **3** includes an electric motor **45** and a lifting/lowering driving unit **47** therein. The rotary shaft **29** is inserted in the central portion of the cover **3** via a sealing member **49**. The rotary shaft **29** is connected to the electric motor **45** while protruding downward from a lower end portion of the electric motor **45**. When the electric motor **45** is actuated, the rotary shaft **29** is rotated about a shaft axis P. A lifting/lowering driving unit **47** is disposed on an outer peripheral side of the upper surface of the cover **3**. The lifting/lowering driving unit **47** is formed by an actuator such as an air cylinder, for example. The lifting/lowering driving unit **47** includes an actuation shaft **51**. The actuation shaft **51** has a longitudinal axis oriented vertically. The actuation shaft **51** is inserted into the cover **3** via the sealing member **53**. When the lifting/lowering driving unit **47** is actuated, the actuation shaft **51** expands in such a manner that the upper end of the operation shaft **51** is separated from the lifting/lowering driving unit **47**. When the lifting/lowering driving unit **47** is in a non-actuated state, the actuation shaft **51** contracts in such a manner that the upper end approaches the lifting/lowering driving unit **47**. While the lifting/lowering driving unit **47** is in a non-actuated state, the upper end of the actuation shaft **51** is slightly spaced apart from the lower surface of the connecting member **19**. When the lifting/lowering driving unit **47** is in the non-actuated state, the connecting member **19** is movable downward, and the support pins **15** is movable into the support position. Moreover, while the lifting/lowering driving unit **47** is activated, the upper end of the actuation shaft **51** abuts against the lower surface of the connecting member **19** to push the connecting member **19** upward. This causes the actuation shaft **51** to push the support pins **15** upward to the transfer position.

The actuation shaft **51** described above is made of stainless steel, for example. The actuation shaft **51** is coated with fluoroplastic described above, such as polybenzimidazole (PBI), a copolymer of tetrafluoroethylene and ethylene (EFEP). Accordingly, the actuation shaft **51** has a chemical resistance. Moreover, the actuation shaft **51** may be made of polyether ether ketone (PEEK). In this case, the actuation shaft **51** is coated with fluoroplastic or the like described above.

A cleaning nozzle **55** is disposed on a side surface of the cover **3**. The side surface is inclined downward from the upper surface of the cover **3**. The cleaning nozzle **55** has a longitudinal axis oriented toward an opening of the peripheral surface member **17**. The scattering prevention cup **5** is disposed laterally to the cover **3** and the holding unit **1**. The scattering prevention cup **5** collects a treating liquid scattered from the holding unit **1** to the periphery thereof. Moreover, the scattering prevention cup **5** collects a treating liquid that has entered inside of the holding unit **1**. Moreover, the scattering prevention cup **5** collects the scattered cleaning liquid supplied from the cleaning nozzle **55** to the holding unit **1**.

The treating liquid supply system **7** includes a supply nozzle **57**, a treating liquid supplying unit **59**, a pipe **61**, and a control valve **63**. The supply nozzle **57** is disposed above

the holding unit **1**, along the shaft axis P. The supply nozzle **57** is configured to be movable between a standby position (not shown) and a supply position shown in FIG. **1**. The treating liquid supplying unit **59** stores a cleaning liquid for cleaning substrates W. Examples of the cleaning liquid include deionized water, a mixed solution of aqueous ammonia and aqueous hydrogen peroxide (SC1), a mixed solution of hydrochloric acid, aqueous hydrogen peroxide, and pure water (SC2), and diluted hydrofluoric acid (DHF). The supply nozzle **57** is in fluid communication with the treating liquid supplying unit **59** via the pipe **61**. The control valve **63** is attached to the pipe **61**. The control valve **63** regulates a flow rate or permits or shuts off supply of the treating liquid at a predetermined flow rate.

The lower supply system **9** is configured as follows. One end of the pipe **65** is in fluid communication with the first flow path **37** of the rotary shaft **29**. The other end of the pipe **65** is in fluid communication with a treating liquid supplying unit **67**. The pipe **65** includes a control valve **69**. The control valve **69** adjusts the flow rate of the treating liquid or controls the supply/shut-off of the treating liquid. The treating liquid supplying unit **67** is capable of supplying a treating liquid similar to that supplied by the treating liquid supplying unit **59** described above, for example. Moreover, one end of a pipe **71** is in fluid communication with the second flow path **39** of the rotary shaft **29**. The other end of the pipe **71** is in fluid communication with a gas supplying unit **73**. The pipe **71** includes a control valve **69**. The control valve **69** adjusts a flow rate of gas or controls supply/shut-off of gas. The gas supplying unit **73** supplies gas. The gas is preferably an inert gas, and a nitrogen gas is suitable, for example. The control valves **69** and **75** may be opened simultaneously. In this case, a treating liquid and gas is supplied from the discharge port **41***a* toward a lower surface of a substrate W at the same time. Moreover, in this case, only gas is supplied from the edge opening **43***a* toward a peripheral edge of the lower surface of the substrate W.

Moreover, the rotary shaft **29** employs the labyrinth structure **41***b*. Accordingly, the treating liquid does not enter the second flow path **39** after the treating liquid is supplied from the discharge port **41***a*. Consequently, even in the case where only gas is supplied from the discharge port **41***a*, no treating liquid previously supplied is supplied from the discharge **41***a* to a substrate W. As a result, an appropriate fluid supply is achievable.

One end of a pipe **77** is in fluid communication with the cleaning nozzle **55** of the cleaning liquid supply system **11**. The other end of the pipe **77** is in fluid communication with a cleaning liquid supply unit **79**. A control valve **81** is attached to the pipe **77**. The control valve **81** adjusts a flow rate of the cleaning liquid, or controls the supply/shut-off of the cleaning liquid. The cleaning liquid supply unit **79** supplies, for example, deionized water or the like as the cleaning liquid.

The substrate treating apparatus includes, for example, a drain pipe **83** at the bottom thereof. The drain pipe **83** is in fluid communication with a drain unit provided in a clean room or the like. The drain pipe **83** discharges a treating liquid supplied from the treating liquid supply system **7**, the lower supply system **9**, the cleaning liquid supply system **11**, and the like.

Reference is now made to FIGS. **3** and **4**. FIG. **3** is a longitudinal sectional view showing the part of the holding unit in a state where a support pin is in a transfer position. FIG. **4** is a longitudinal sectional view showing the part of the holding unit in a state where the support pin is rotated in a support position.

When a substrate W to be treated is received from a transport mechanism (not shown), the lifting/lowering driving unit **47** is activated. This causes the actuation shaft **51** to raise as shown in FIG. **3**, thereby pushing the connecting member **19** upward to move the support pins **15** upward to the transfer position. The support pins **15** each have an extremely smaller sliding resistance at the time of upward movement in comparison with the currently-used support pins since there is no sealing member such as a currently-used O-ring. Consequently, a drive load at the upward movement of the support pins **15** is just the sum of a force to raise the support pins **15** and the connecting member **19** and the like, and a force to release an attraction force due to the magnetic force of the magnets **23** and **27**. However, such drive load is extremely smaller compared with that of a conventional configuration with a sealing member such as an O-ring. Thus, in a state where the support pins **15** are moved upward to the transfer position, a substrate W is transferred from a transport mechanism (not shown) and is placed on the support pins **15**. At this time, an edge of the substrate W in the horizontal position is restricted by the projections **15***a*.

The lifting/lowering driving unit **47** is then in a non-actuated state. Accordingly, the actuation shaft **51** is contracted toward the lifting/lowering driving unit **47**. Then, as shown in FIG. **4**, the upper end of the actuation shaft **51** pushing the lower surface of the connecting member **19** upward is spaced apart downward from the lower surface of the connecting member **19**. Accordingly, the support pins **15** start to move downward by their own weights combined with those of the connecting member **19** and the magnets **23**, or the like. At the same time, the support pins **15** are rapidly lowered by attraction due to the magnetic force between the upper magnets **23** and the lower magnets **27**. Such lowering is stopped when the connecting member **19** reaches the flange **21***a* of the guide pin **21**. This causes a part of the support pins **15** to enter the upper surface of the rotating member **13**, and to move the lower surface of the substrate W to the support position close to the upper surface of the rotating member **13**. Since the connecting member **19** is attracted downward by the upper magnets **23** and the lower magnets **27**, the support pins **15** can be moved quickly from the transfer position to the support position.

At this time, a centering pin (not shown) provided in the rotating member **13** may perform centering operation to match a center of a substrate W to a rotation center of the rotating member **13**. Here, for easy understanding of the invention, it is assumed that a substrate W and the rotating member **13** are placed in such a manner that the center of substrate W and the center of the rotating member **13** are substantially coincident.

When the substrate W is moved to the support position, the control valve **75** is opened. Then, as indicated by a white triangle arrow line in FIG. **4**, a nitrogen gas is discharged from the discharge port **41***a* and the edge opening **43***a*. The nitrogen gas discharged from the discharge port **41***a* is oriented laterally at a lower surface of the substrate W. Then, the nitrogen gas flows out at a high speed toward the outer periphery of the substrate W through a narrow space between the upper surface of the rotating table **13** and the lower surface of the substrate W. Moreover, the nitrogen gas discharged from the edge opening **43***a* is oriented laterally at the outer peripheral edge of the lower surface of substrate W. Then, the nitrogen gas flows out at a high speed through a narrow space between the rotating table **13** and the outer peripheral edge of the lower surface of the substrate W. Such flow of the nitrogen-gas produces a Bernoulli effect, gener-

ating a negative pressure on the lower surface of the substrate W. The negative pressure generates a suction force toward the upper surface of the rotating member **13** with respect to the substrate W, and the substrate W is sucked toward the rotating member **13**. Consequently, the substrate W can be held stably by the holding unit **1**.

After the substrate W is sucked toward the rotating member **13**, the electric motor **45** is operated to start to rotate the rotary shaft **29** to a cleaning rotation rate. After the rotation rate of substrate W reaches the cleaning rotation rate, the supply nozzle **57** is moved above the shaft axis P. At the same time, the control valve **63** is opened. Then, the treating liquid is supplied from the supply nozzle **57** toward the upper surface of the substrate W, and the treating liquid flows out toward the outer peripheral surface at the upper surface of the substrate W by a centrifugal force. This cleans the upper surface of the substrate W with the treating liquid. When a predetermined treatment time elapses, the control valve **63** is closed to stop the supply of the treating liquid from the supply nozzle **57**. Then, the rotation rate of the electric motor **45** is increased to a drying rotation rate higher than the cleaning rotation rate. Accordingly, the treating liquid adhering to the substrate W or the rotating table **13** or the like is scattered around, and a drying process is performed on the substrate W. The treating liquid scattered around is collected into the scattering prevention cup **5**. After the drying process for a predetermined time, the electric motor **45** is stopped.

When the drying process is completed, the control valve **75** is closed to stop the supply of the nitrogen gas. This eliminates the negative pressure generated on the lower surface of the substrate W. Then, when the lifting/lowering driving unit **47** is actuated, the actuation shaft **51** is moved upward as shown in FIG. **3**, thereby pushing the connecting member **19** upward to move the support pins **15** upward to the transfer position. Then, the transport mechanism (not shown) transfers the cleaned substrate W from the support pins **15**.

Moreover, while repeatedly performing the cleaning process described above, the treating liquid flows down through the gaps between the support pins **15** and the through-hole **31**. The treating liquid flowing downward from the rotating member **13** and the peripheral surface member **17** is discharged to the drain unit through the drain pipe **83** in a lower portion of the substrate treating apparatus. The treating liquid that not discharged from the drain pipe **83** adheres to the components in the space surrounded by the rotating member **13** and the peripheral surface member **17**. Then, as illustrated in FIG. **2**, the control valve **81** is opened to supply the cleaning liquid from the cleaning nozzle **55** while the electric motor **45** rotates periodically. Accordingly, the cleaning liquid is sprayed on the components in the space surrounded by the rotating member **13** and the peripheral surface member **17**, and the treating liquid also flows down on the upper surface of the cover **3**. Thus, the treating liquid is removable that adheres to the components of the space surrounded by the rotating member **13** and the peripheral surface member **17**, and the upper surface of the cover **3** is removable. Consequently, such a situation is preventable in advance that the adhering treating liquid is stuck and dried, and then is peeled off to become particles, thereby contaminating a substrate W.

With this embodiment, the support pins **15** are attached to the through-holes **31** of the rotating member **13** with a non-sealing structure. Accordingly, the treating liquid supplied from the supply nozzle **57** enters the lower surface of the rotation member **13** through the gaps between the through-holes **31** of the rotating member **13** and the support pins **15**. However, the electric motor **45** and the lifting/lowering driving unit **47** are covered with the cover **3**, leading to prevention of adverse effects by the treating liquid. Moreover, since the non-sealing structure is adopted, lowered sliding resistance and drive load can be obtained. Consequently, the lifting/lowering driving unit **47** does not need to increase the driving force and rigidity of the member for driving, leading to a reduction in cost of the substrate treating apparatus.

The present invention is not limited to the foregoing examples, but may be modified as follows.

(1) In the embodiment described above, a target to be treated is only a substrate W. However, the present invention is also applicable to a substrate treating apparatus for treating a substrate W thinned by grinding only the inside of its inner circumference without grinding its edge portion (for several millimeters) at the outermost periphery (also referred to as a TAIKO substrate), or a substrate W thinned over the entire surface, for example.

(2) In the embodiment described above, such a substrate treating apparatus has been described as an example that includes only the support pins **15** in the rotating member **13**. However, the present invention is also applicable to the substrate treating apparatus that includes a centering pin between the support pins **15** described above, for example. Specifically, a substrate treating apparatus with a centering mechanism is exemplified. The centering mechanism pivots the centering pin. The centering mechanism pivots the centering pin while a substrate W is supported on the support pins **15** and is moved to the support position. Then, the rotation center of the substrate W is matched with the rotation center of the rotating member **13**. The centering pin is pivotally attached to the rotating member **13** be pivoted around the vertical axis, and includes an alignment projection in a position decentered from the vertical axis. In this case, magnets are attached to the lower end portion of the centering pin in such a manner that magnetic poles of the magnets are different horizontally. Moreover, a centering pin driving unit for switching the polarity of the magnets is disposed inside the cover **3**. When the centering pin driving unit is actuated, a magnetic force caused by switching the magnetic poles affects the magnets at the lower end portion of the centering pin over the upper surface of the cover **3**. Consequently, the centering pin rotates around its vertical axis. It is preferred that the centering pin has such a configuration as to be coated with an above-described fluoroplastic, and to be rotatable with a non-sealing structure.

(3) In the embodiment described above, the connecting member **19** drives to lift and lower the support pins **15** collectively. However, the present invention is not limitative to this configuration. For example, such a configuration may be employed that six support pins **15** are divided into two groups, and the separated groups of three support pins **15** are driven to move up or down collectively.

(4) The embodiment described above employs the configuration in which the actuation shaft **51** is not connected to the connecting member **19**. However, the present invention is not limitative to this configuration. For example, such a configuration may be employed in which the upper end of the actuation shaft **51** is connected to the lower surface of the connecting member **19**. In this case, the upper magnets **23**, the lower magnets **27**, and the magnet holding member **25** can be omitted, leading to a reduction in cost.

(5) In the embodiment described above, the cover **3** includes the cleaning nozzle **55**. However, this configuration is not essential in the present invention. Moreover, instead of

providing the cleaning nozzle **55** to the cover **3** itself, the cleaning nozzle **55** may be disposed at a position where the cleaning liquid can be supplied to the inside of the peripheral surface member **17**. For example, the cleaning nozzle **55** may be disposed at a position inside the scattering prevention cup **5** and outside the cover **3**.

(6) In the embodiment described above, a negative pressure is generated by ejecting gas at the high speed into the gap between the lower surface of the substrate W supported by the support pins **15** and the surface of the rotating member **13**, thereby generating a suction force on the substrate W toward the rotating member **13**. However, the present invention is not limited to such a Bernoulli chuck. Specifically, the present invention is applicable to a substrate treating apparatus including a holding unit for abutting against to support an outer peripheral edge of a lower surface of a substrate W simply by the support pins **15**.

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 treating apparatus for treating a substrate with a treating liquid, the apparatus comprising:

a rotating member resistant to the treating liquid, having a diameter larger than a diameter of the substrate, and including a plurality of through-holes formed therein and configured to be in communication with an upper surface and a lower surface of the rotating member on an outer peripheral side;

a plurality of support pins resistant to the treating liquid, attached to the through-holes with a non-sealing structure, and configured to support the substrate in such a manner that a lower surface of the substrate is spaced apart from the upper surface of the rotating member,

a supply nozzle configured to supply a treating liquid to the substrate supported by the support pins on the upper surface of the rotating member,

a cover resistant to the treating liquid and spaced apart below from the lower surface of the rotating member;

a rotational drive device disposed within the cover and configured to drive the rotating member rotationally in a horizontal plane; and

a drive device disposed within the cover and configured to drive the support pins, wherein

some of the support pins work as lifting pins,

the substrate treating apparatus includes a connecting member configured to connect the lifting pins below the rotating member,

the drive device drives to lift and lower the lifting pins via the connecting member between a transfer position where the substrate is transported and a support position lower than the transfer position,

the drive device includes an actuation shaft configured to move forward and backward, an upper end of the actuation shaft abuts against the connecting member when the connecting member moves to the transfer position, the upper end of the actuation shaft is spaced apart from the connecting member when the connecting member moves to the support position, and

the substrate treating apparatus includes magnets for attracting the connecting member downward with a magnetic force thereof when the connecting member moves from the transfer position to the support position.

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

the rotating member includes a peripheral surface member extending downward from an outer peripheral surface of the rotating member, and including a lower end portion spaced apart upwardly from an upper surface of the cover, and an opened lower surface.

3. The substrate treating apparatus according to claim **2**, further comprising:

a cleaning nozzle configured to supply a cleaning liquid toward an inside of the peripheral surface member.

4. The substrate treating apparatus according to claim **1**, further comprising:

a gas supply mechanism configured to supply gas between the rotation member and a lower surface of the substrate supported by the support pins,

wherein a suction force is generated on the substrate supported by the support pins toward the rotating member.

5. The substrate treating apparatus according to claim **2**, further comprising:

a gas supply mechanism configured to supply gas between the rotation member and a lower surface of the substrate supported by the support pins,

wherein a suction force is generated on the substrate supported by the support pins toward the rotating member.

6. The substrate treating apparatus according to claim **3**, further comprising:

a gas supply mechanism configured to supply gas between the rotation member and a lower surface of the substrate supported by the support pins,

wherein a suction force is generated on the substrate supported by the support pins toward the rotating member.

7. The substrate treating apparatus according to claim **1**, wherein:

the plurality of support pins are inserted into the plurality of through-holes.

8. The substrate treating apparatus according to claim **1**, wherein:

the cover has an upper surface, and a side surface inclined downwardly from the upper surface.

* * * * *