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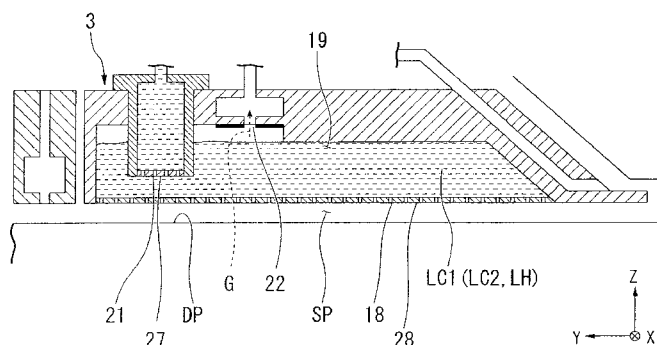
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FIG. 9



(57) Abstract: An immersion exposure apparatus exposes a substrate with exposure light that transits an exposure liquid. A liquid immersion member has a first recovery port, which is capable of recovering the exposure liquid, and is disposed at least partly around an optical member and an optical path of the exposure light that passes through the exposure liquid between the optical member and the substrate. A cleaning method comprises: supplying a cleaning liquid to a recovery passageway, where through the exposure liquid recovered via the first recovery port from a space, which the first recovery port faces, flows; and recovering the cleaning liquid from the recovery passageway. The liquid immersion member has a first discharge port, which is for discharging the exposure liquid from the recovery passageway, and a second discharge port, which hinders the discharge of the exposure liquid more than the first discharge port does and is for discharging a gas from the recovery passageway; and the cleaning liquid is not supplied to the space, which the first recovery port faces, via the first recovery port.

DESCRIPTION

CLEANING METHOD, IMMERSION EXPOSURE APPARATUS, DEVICE
FABRICATING METHOD, PROGRAM, AND STORAGE MEDIUM

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BACKGROUND

The present invention relates to a cleaning method, an immersion exposure apparatus, a device fabricating method, a program, and a storage medium.

Priority is claimed on U.S. Provisional Application No. 61/367,104, filed July 23, 2010, and U.S. Patent Application No. 13/184,244, filed July 15, 2011, the contents of which are incorporated herein by reference.

In the process of fabricating microdevices, such as semiconductor devices and electronic devices, using an immersion exposure apparatus that exposes a substrate with exposure light through an exposure liquid is known, as disclosed in, for example, U.S. Patent Application Publication No. 2008/0273181 and U.S. Patent Application Publication No. 2009/0195761.

SUMMARY

In an immersion exposure apparatus, if a member that contacts the exposure liquid becomes contaminated, then, for example, exposure failures might occur and, as a result, defective devices might be produced. Consequently, it is preferable to satisfactorily clean any member that contacts the exposure liquid.

An object of aspects of the present invention is to provide a cleaning method that can satisfactorily clean, for example, a member that contacts an exposure liquid.

Another object of aspects of the present invention is to provide an immersion exposure

apparatus that can prevent exposure failures. Yet another object of aspects of the present invention is to provide a device fabricating method, a program, and a storage medium that can prevent defective devices from being produced.

A first aspect of the invention provides a method of cleaning a liquid immersion member in an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, that has a first recovery port, which is capable of recovering the exposure liquid and that is disposed at least partly around an optical member and an optical path of the exposure light that passes through the exposure liquid between the optical member and the substrate, the method comprises: supplying a cleaning liquid to a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from a space, which the first recovery port faces, flows; and recovering the cleaning liquid from the recovery passageway; wherein, the liquid immersion member has a first discharge port, which is for discharging the exposure liquid from the recovery passageway, and a second discharge port, which hinders the discharge of the exposure liquid more than the first discharge port does and is for discharging a gas from the recovery passageway; and the cleaning liquid is not supplied to the space, which the first recovery port faces, via the first recovery port.

A second aspect of the invention provides a method of cleaning a liquid immersion member in an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, that has a first recovery port, which is capable of recovering the exposure liquid and that is disposed at least partly around an optical member and an optical path of the exposure light that passes through the exposure liquid between the optical member and the substrate, the method comprises: supplying a cleaning liquid to a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from a space, which the first recovery port faces, flows; and

recovering the cleaning liquid from the recovery passageway; wherein, the liquid immersion member has a first discharge port, which is for discharging from the recovery passageway a fluid that includes the exposure liquid and that has a higher percentage of the exposure liquid than of the gas, and a second discharge port, which is for discharging from the recovery passageway a fluid that includes the gas and that has a lower percentage of the exposure liquid than of the gas; and the cleaning liquid is not supplied to the space, which the first recovery port faces, via the first recovery port.

A third aspect of the invention provides a method of cleaning a liquid immersion member in an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, that has a first recovery port, which is capable of recovering the exposure liquid and that is disposed at least partly around an optical member and an optical path of the exposure light that passes through the exposure liquid between the optical member and the substrate, the method comprises: supplying a cleaning liquid to a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from a space, which the first recovery port faces, flows; and recovering the cleaning liquid from the recovery passageway; wherein, the liquid immersion member comprises a discharge part, which separately discharges the exposure liquid and a gas from the recovery passageway; the discharge part has a first discharge port, which is for discharging the exposure liquid from the recovery passageway, and a second discharge port, which is for discharging the gas from the recovery passageway; and the cleaning liquid is not supplied to the space, which the first recovery port faces, via the first recovery port.

A fourth aspect of the invention provides a device fabricating method that comprises: cleaning at least part of the liquid immersion member using a cleaning method according to any one aspect of the first through third aspects; exposing the

substrate with the exposure light that transits the exposure liquid; and developing the exposed substrate.

A fifth aspect of the invention provides an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, that comprises:

- 5 an optical member, which has an emergent surface wherefrom the exposure light emerges; a liquid immersion member that has a first recovery port, which is capable of recovering the exposure liquid, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from a space that the first recovery port faces flows, a first discharge port, which is for discharging the exposure liquid from the recovery
- 10 passageway, and a second discharge port, which is for discharging a gas from the recovery passageway and hinders the discharge of the exposure liquid more than the first discharge port does, and that is disposed at least partly around an optical path of the exposure light that passes through the exposure liquid between the optical member and the substrate; and a pressure adjusting apparatus, which adjusts the difference between a
- 15 pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

A sixth aspect of the invention provides an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, that comprises:

- 20 an optical member, which has an emergent surface wherefrom the exposure light emerges; a liquid immersion member that has a first recovery port, which is capable of recovering the exposure liquid, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from a space that the first recovery port faces flows, a first discharge port, which is for discharging, from the recovery passageway, a fluid that
- 25 includes the exposure liquid and has a higher percentage of the exposure liquid than of a

gas, and a second discharge port, which is for discharging, from the recovery passageway, a fluid that includes the gas and has a lower percentage of the exposure liquid than of the gas, and that is disposed at least partly around an optical path of the exposure light that passes through the exposure liquid between the optical member and the substrate; and a
5 pressure adjusting apparatus, which adjusts the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

A seventh aspect of the invention provides an immersion exposure apparatus,
10 which exposes a substrate with exposure light that transits an exposure liquid, that comprises: an optical member, which has an emergent surface wherefrom the exposure light emerges; a liquid immersion member that has a first recovery port, which is capable of recovering the exposure liquid, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from the space that the first recovery port
15 faces flows, and a discharge part, which has a first discharge port for discharging the exposure liquid from the recovery passageway and a second discharge port for discharging a gas from the recovery passageway, that separately discharges the exposure liquid and the gas from the recovery passageway, and that is disposed at least partly around an optical path of the exposure light that passes through the exposure liquid
20 between the optical member and the substrate; and a pressure adjusting apparatus, which adjusts the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

An eighth aspect of the invention provides a device fabricating method that
25 comprises: exposing a substrate with exposure light using an immersion exposure

apparatus according to any one aspect of the fifth through seventh aspects; and developing the exposed substrate.

A ninth aspect of the invention provides a program that causes a computer to control an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, and that comprises: forming an immersion space with the exposure liquid between the substrate and a liquid immersion member that has a first recovery port, which is capable of recovering at least some of the exposure liquid from a space above the substrate, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port flows, a first discharge port, which is for discharging the exposure liquid from the recovery passageway, and a second discharge port, which is for discharging a gas from the recovery passageway and hinders the discharge of the exposure liquid more than the first discharge port does, such that an optical path of the exposure light between the substrate and an optical member, wherefrom the exposure light can emerge, is filled with the exposure liquid; exposing the substrate with the exposure light, which transits the exposure liquid in the immersion space; recovering at least some of the exposure liquid from the space above the substrate via the first recovery port of the liquid immersion member; when an exposure is not being performed, supplying a cleaning liquid to the recovery passageway; and adjusting the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

A tenth aspect of the invention provides a program that causes a computer to control an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, and that comprises: forming an immersion space with the exposure liquid between the substrate and a liquid immersion member that has a first

recovery port, which is capable of recovering at least some of the exposure liquid from a space above the substrate, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port flows, a first discharge port, which is for discharging, from the recovery passageway, a fluid that includes the exposure liquid and that has a higher percentage of the exposure liquid than of the gas, and a second discharge port, which is for discharging, from the recovery passageway, a fluid that includes the gas and that has a lower percentage of the exposure liquid than of the gas, such that an optical path of the exposure light between the substrate and an optical member, wherefrom the exposure light can emerge, is filled with the exposure liquid; exposing the substrate with the exposure light, which transits the exposure liquid in the immersion space; recovering at least some of the exposure liquid from the space above the substrate via the first recovery port of the liquid immersion member; when an exposure is not being performed, supplying a cleaning liquid to the recovery passageway; and adjusting the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

An eleventh aspect of the invention provides a program that causes a computer to control an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, and that comprises: forming an immersion space with the exposure liquid between the substrate and a liquid immersion member that has a first recovery port, which is capable of recovering at least some of the exposure liquid from a space above the substrate, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port flows, and a discharge part, which has a first discharge port for discharging the exposure liquid from the recovery passageway and a second discharge port for discharging a gas from the recovery passageway, that

separately discharges the exposure liquid and the gas from the recovery passageway, such that an optical path of the exposure light between the substrate and an optical member, wherefrom the exposure light can emerge, is filled with the exposure liquid; exposing the substrate with the exposure light, which transits the exposure liquid in the immersion space; recovering at least some of the exposure liquid from the space above the substrate via the first recovery port of the liquid immersion member; when an exposure is not being performed, supplying a cleaning liquid to the recovery passageway; and adjusting the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

A twelfth aspect of the invention provides a computer readable storage medium whereon a program according to any one aspect of the ninth through eleventh aspects is stored.

According to the aspects of the present invention, any member that contacts an exposure liquid and the like can be cleaned satisfactorily. In addition, according to the aspects of the present invention, it is possible to prevent exposure failures from occurring and thereby to prevent defective devices from being produced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic block diagram that shows one example of an exposure apparatus according to a first embodiment.

FIG. 2 is a side cross sectional view that shows one example of a liquid immersion member according to the first embodiment.

FIG. 3 is a partial side cross sectional view of the liquid immersion member according to the first embodiment.

FIG. 4 is a schematic drawing for explaining one example of the operation of the liquid immersion member according to the first embodiment.

FIG. 5 is a schematic drawing for explaining one example of the operation of the liquid immersion member according to the first embodiment.

5 FIG. 6 is a flow chart for explaining one example of the operation of the exposure apparatus according to the first embodiment.

FIG. 7 is a flow chart for explaining one example of a cleaning sequence according to the first embodiment.

10 FIG. 8 is a diagram for explaining one example of the cleaning sequence according to the first embodiment.

FIG. 9 is a diagram for explaining one example of the cleaning sequence according to the first embodiment.

FIG. 10 is a diagram for explaining one example of the cleaning sequence according to the first embodiment.

15 FIG. 11 is a diagram for explaining one example of the cleaning sequence according to the first embodiment.

FIG. 12 is a diagram for explaining one example of the cleaning sequence according to the first embodiment.

20 FIG. 13 is a partial side cross sectional view of the liquid immersion member according to a second embodiment.

FIG. 14 is a partial side cross sectional view of the liquid immersion member according to a third embodiment.

FIGS. 15A and 15B are diagrams for explaining one example of the cleaning sequence according to a fourth embodiment.

25 FIGS. 16A and 16B are diagrams for explaining one example of the cleaning

sequence according to the fourth embodiment.

FIG. 17 is a partial side cross sectional view of the liquid immersion member according to a fifth embodiment.

FIG. 18 is a flow chart for explaining one example of a microdevice fabricating
5 process.

FIG. 19 is a schematic drawing for explaining one example of the operation of discharging a liquid via a first discharge port according to the first embodiment.

DESCRIPTION OF THE REFERENCE SYMBOLS

10	2P	Substrate stage
	3	Liquid immersion member
	4	Control apparatus
	5	Storage apparatus
	7	Emergent surface
15	8	Last optical element
	17	Supply port
	18	Recovery port
	19	Recovery passageway
	20	Discharge part
20	21	First discharge port
	22	Second discharge port
	27	Second member
	27A	Upper surface
	27B	Lower surface
25	27H	Hole

28	First member
28A	Upper surface
28B	Lower surface
300	Liquid supply port
5 310	Liquid recovery port
401	Recovery port
EL	Exposure light
EX	Exposure apparatus
IL	Illumination system
10 K	Optical path
LC	Cleaning liquid
LH	Rinsing liquid
LQ	Exposure liquid
LS	Immersion space
15 P	Substrate

DESCRIPTION OF EMBODIMENTS

The embodiments of the present invention will now be explained, referencing the drawings; however, the present invention is not limited thereto. The explanation below

20 defines an XYZ orthogonal coordinate system, and the positional relationships among parts are explained referencing this system. Prescribed directions within the horizontal plane are the X axial directions, directions orthogonal to the X axial directions in the horizontal plane are the Y axial directions, and directions orthogonal to the X axial directions and the Y axial directions (i.e., the vertical directions) are the Z axial directions.

25 In addition, the rotational directions (i.e., the tilting directions) around the X, Y, and Z

axes are the θX , θY , and θZ directions, respectively.

<First Embodiment>

A first embodiment will now be explained. FIG. 1 is a schematic block diagram that shows one example of an exposure apparatus EX according to a first embodiment.

5 The exposure apparatus EX of the present embodiment is an immersion exposure apparatus that exposes a substrate P with exposure light EL that transits an exposure liquid LQ. In the present embodiment, an immersion space LS is formed so that at least part of an optical path K of the exposure light EL is filled with the exposure liquid LQ. The immersion space LS refers to a portion (i.e., a space or an area) that is filled with the
10 exposure liquid LQ. The substrate P is exposed with the exposure light EL, which transits the exposure liquid LQ in the immersion space LS. In the present embodiment, water (pure water) is used as the exposure liquid LQ.

In addition, the exposure apparatus EX of the present embodiment comprises a substrate stage and a measurement stage as disclosed in, for example, U.S. Patent No.
15 6,897,963 and European Patent Application Publication No. 1713113.

In FIG. 1, the exposure apparatus EX comprises: a movable mask stage 1 that holds a mask M; a movable substrate stage 2P that holds the substrate P; a movable measurement stage 2C that does not hold the substrate P and whereon a measuring member C (i.e., a measuring instrument) that measures the exposure light EL is mounted;
20 an illumination system IL that illuminates the mask M with the exposure light EL; a projection optical system PL that projects an image of a pattern of the mask M, which is illuminated by the exposure light EL, to the substrate P; a liquid immersion member 3, which forms the immersion space LS by holding the exposure liquid LQ between itself and the substrate P such that the optical path K of the exposure light EL radiated to the
25 substrate P is filled with the exposure liquid LQ; a recovery member 400, which is

disposed at least partly around the liquid immersion member 3 and is capable of recovering the exposure liquid LQ; a control apparatus 4, which controls the operation of the entire exposure apparatus EX; and a storage apparatus 5, which is connected to the control apparatus 4 and stores various exposure-related information. The storage apparatus 5 comprises a storage medium such as memory (e.g., RAM), a hard disk, a CD-ROM, and the like. In the storage apparatus 5, an operating system (OS) that controls a computer system is installed and a program for controlling the exposure apparatus EX is stored.

In addition, the exposure apparatus EX comprises: a chamber member 101, which forms an internal space CS wherein at least the projection optical system PL, the liquid immersion member 3, the recovery member 400, the substrate stage 2P, and the measurement stage 2C are disposed; and a chamber apparatus 100 that comprises air conditioning apparatuses 102, which adjust the environment (i.e., the temperature, the humidity, the pressure, and the cleanliness level) of the internal space CS, and open-close mechanisms 103, which open and close openings 101K that are formed in the chamber member 101.

The mask M may be a reticle on which a device pattern to be projected to the substrate P is formed. The mask M may be a transmissive mask comprising a transparent plate, such as a glass plate, and the pattern, which is formed on the transparent plate using a shielding material, such as chrome. Furthermore, a reflective mask can also be used as the mask M.

The substrate P is a substrate for fabricating devices. The substrate P comprises, for example, a base material, such as a semiconductor wafer, and a photosensitive film, which is formed on the base material. The photosensitive film comprises a photosensitive material (e.g., photoresist). In addition to the photosensitive film, the

substrate P may comprise a separate film. For example, the substrate P may comprise an antireflection film or a protective film (i.e., a topcoat film) that protects the photosensitive film.

The illumination system IL radiates the exposure light EL to a prescribed illumination area IR. The illumination area IR includes a position whereto the exposure light EL that emerges from the illumination system IL can be radiated. The illumination system IL illuminates at least part of the mask M disposed in the illumination area IR with the exposure light EL, which has a uniform luminous flux intensity distribution. Examples of light that can be used as the exposure light EL that emerges from the illumination system IL include: deep ultraviolet (DUV) light, such as a bright line (i.e., g-line, h-line, or i-line) light emitted from, for example, a mercury lamp, and KrF excimer laser light (with a wavelength of 248 nm); and vacuum ultraviolet (VUV) light, such as ArF excimer laser light (with a wavelength of 193 nm) and F₂ laser light (with a wavelength of 157 nm). In the present embodiment, ArF excimer laser light, which is ultraviolet light (e.g., vacuum ultraviolet light), is used as the exposure light EL.

In the state wherein it holds the mask M, the mask stage 1 is capable of moving on a guide surface 6G of a base member 6 that includes the illumination area IR. The mask stage 1 moves by the operation of a drive system, which comprises a planar motor as disclosed in, for example, U.S. Patent No. 6,452,292. The planar motor comprises a slider, which is disposed on the mask stage 1, and a stator, which is disposed on the base member 6. In the present embodiment, the mask stage 1 is capable of moving in six directions along the guide surface 6G, namely, the X axial, Y axial, Z axial, θ X, θ Y, and θ Z directions, by the operation of the drive system.

The projection optical system PL radiates the exposure light EL to a prescribed projection area PR. The projection area PR includes a position whereto the exposure

light EL that emerges from the projection optical system PL can be radiated. The projection optical system PL projects with a prescribed projection magnification an image of the pattern of the mask M to at least part of the substrate P, which is disposed in the projection area PR. The projection optical system PL of the present embodiment is a reduction system that has a projection magnification of, for example, 1/4, 1/5, or 1/8. Furthermore, the projection optical system PL may be a unity magnification system or an enlargement system. In the present embodiment, an optical axis AX of the projection optical system PL is parallel to the Z axis. In addition, the projection optical system PL may be a dioptric system that does not include catoptric elements, a catoptric system that does not include dioptric elements, or a catadioptric system that includes both catoptric and dioptric elements. In addition, the projection optical system PL may form either an inverted or an erect image.

The projection optical system PL has an emergent surface 7 wherefrom the exposure light EL emerges and travels toward an image plane of the projection optical system PL. The emergent surface 7 belongs to a last optical element 8, which is the optical element of the plurality of optical elements of the projection optical system PL that is closest to the image plane of the projection optical system PL. The projection area PR includes a position whereto the exposure light EL that emerges from the emergent surface 7 can be radiated. In the present embodiment, the emergent surface 7 faces the $-Z$ direction and is parallel to the XY plane. Furthermore, the emergent surface 7, which faces the $-Z$ direction, may be a convex or a concave surface. The optical axis of the last optical element 8 is parallel to the Z axis. In the present embodiment, the exposure light EL that emerges from the emergent surface 7 proceeds in the $-Z$ direction.

In the state wherein it holds the substrate P, the substrate stage 2P is capable of

moving on a guide surface 9G of a base member 9, which includes the projection area PR.

In the state wherein the measuring member C (i.e., the measuring instrument) is mounted

thereon, the measurement stage 2C is capable of moving on the guide surface 9G of the

base member 9, which includes the projection area PR. The substrate stage 2P and the

5 measurement stage 2C each move by the operation of a drive system, which comprises a

planar motor as disclosed in, for example, U.S. Patent No. 6,452,292. Each planar

motor comprises a slider, which is disposed on the corresponding stage, namely, the

substrate stage 2P or the measurement stage 2C, and a stator, which is disposed on the

base member 9. In the present embodiment, the substrate stage 2P and the measurement

10 stage 2C are each capable of moving in six directions on the guide surface 9G, namely,

the X axial, Y axial, Z axial, θX , θY , and θZ directions, by the operation of its

corresponding drive system. Furthermore, the drive systems that move the substrate

stage 2P and the measurement stage 2C do not have to comprise planar motors. For

example, the drive systems may comprise linear motors.

15 The substrate stage 2P comprises a substrate holding part 10, which releasably

holds the substrate P. In the present embodiment, the front surface (i.e., the upper

surface) of the substrate P held by the substrate holding part 10 and an upper surface 2PF

of the substrate stage 2P disposed around the substrate P are disposed within the same

plane (i.e., they are flush with one another). The upper surface 2PF is flat. In the

20 present embodiment, the front surface (i.e., the upper surface) of the substrate P, which is

held by the substrate holding part 10, and the upper surface 2PF of the substrate stage 2P

are substantially parallel to the XY plane.

Furthermore, the upper surface 2PF of the substrate stage 2P and the front surface

(i.e., the upper surface) of the substrate P held by the substrate holding part 10 do not

25 have to be disposed within the same plane; furthermore, the front surface of the substrate

P or the upper surface 2PF, or both, may be nonparallel to the XY plane. In addition, the upper surface 2PF does not have to be flat. For example, the upper surface 2PF may include a curved surface.

In the present embodiment, the substrate stage 2P comprises a cover member holding part 11, which releasably holds a cover member T, as disclosed in, for example, U.S. Patent Application Publication No. 2007/0177125 and U.S. Patent Application Publication No. 2008/0049209. In the present embodiment, the upper surface 2PF of the substrate stage 2P includes an upper surface of the cover member T held by the cover member holding part 11.

Furthermore, the cover member T does not have to be releasable. In such a case, the cover member holding part 11 could be omitted. In addition, the upper surface 2PF of the substrate stage 2P may include the front surface of any sensor, measuring member, or the like installed on the substrate stage 2P.

The measurement stage 2C comprises a measuring member holding part 12, which releasably holds the measuring member C. In the present embodiment, the front surface (i.e., the upper surface) of the measuring member C held by the measuring member holding part 12 and an upper surface 2CF of the measurement stage 2C disposed around the measuring member C are disposed within the same plane (i.e., they are flush with one another). The upper surface 2CF is flat. In the present embodiment, the front surface (i.e., the upper surface) of the measuring member C held by the measuring member holding part 12 and the upper surface 2CF of the measurement stage 2C are substantially parallel to the XY plane.

In the present embodiment, the measuring member C installed on the measurement stage 2C may be a member that constitutes a part of, for example, an aerial image measuring system as disclosed in U.S. Patent Application Publication No.

2002/0041377 and the like, a luminous flux intensity nonuniformity measuring system as disclosed in U.S. Patent No. 4,465,368 and the like, a fiducial member as disclosed in U.S. Patent No. 5,493,403 and the like, an irradiance measuring system as disclosed in U.S. Patent Application Publication No. 2002/0061469 and the like, or a wavefront
5 aberration measuring system as disclosed in European Patent No. 1079223 and the like.

Furthermore, the front surface (i.e., the upper surface) of the measuring member C held by the measuring member holding part 12 and the upper surface 2CF of the measurement stage 2C do not have to be disposed within the same plane; furthermore, the front surface of the measuring member C or the upper surface 2CF, or both, may be
10 nonparallel to the XY plane. In addition, the upper surface 2CF does not have to be flat. For example, the upper surface 2CF may include a curved surface. In addition, the measuring member C does not have to be releasable. In this case, the measuring member holding part 12 could be omitted.

In the present embodiment, the measurement stage 2C comprises an ultrasonic
15 wave generating apparatus 13, which is capable of generating ultrasonic vibration, as disclosed in, for example, U.S. Patent Application Publication No. 2009/0251672. The ultrasonic wave generating apparatus 13 comprises a rod member and an oscillator, which vibrates the rod member.

In the present embodiment, an interferometer system 130, which comprises laser
20 interferometer units 130A, 130B, measures the positions of the mask stage 1, the substrate stage 2P, and the measurement stage 2C. The laser interferometer unit 130A is capable of measuring the position of the mask stage 1 using measurement mirrors, which are disposed on the mask stage 1. The laser interferometer unit 130B is capable of measuring the position of the substrate stage 2P using measurement mirrors, which are
25 disposed on the substrate stage 2P. In addition, the laser interferometer unit 130B is

capable of measuring the position of the measurement stage 2C using measurement mirrors, which are disposed on the measurement stage 2C. When an exposing process or a prescribed measurement process is performed on the substrate P, the control apparatus 4 controls, based on the measurement results of the interferometer system 130, the positions of the mask stage 1 (i.e., the mask M), the substrate stage 2P (i.e., the substrate P), or the measurement stage 2C (i.e., the measuring instrument C), or any combination thereof.

The exposure apparatus EX of the present embodiment is a scanning type exposure apparatus (i.e., a so-called scanning stepper) that projects the image of the pattern of the mask M to the substrate P while synchronously moving the mask M and the substrate P in prescribed scanning directions. In the present embodiment, the scanning directions (i.e., the synchronous movement directions) of both the substrate P and the mask M are the Y axial directions. The control apparatus 4 radiates the exposure light EL to the substrate P through the projection optical system PL and the exposure liquid LQ in the immersion space LS above the substrate P while moving the substrate P in one of the Y axial directions with respect to the projection area PR of the projection optical system PL and moving the mask M, synchronized to the movement of the substrate P, in the other Y axial direction with respect to the illumination area IR of the illumination system IL.

The liquid immersion member 3 forms the immersion space LS such that the optical path K of the exposure light EL radiated to the projection area PR is filled with the exposure liquid LQ. The liquid immersion member 3 forms the immersion space LS by holding the exposure liquid LQ between itself and an object such that the optical path K of the exposure light EL between the last optical element 8, wherefrom the exposure light EL can emerge, and the object, which is disposed at a position where to the

exposure light EL emerging from the emergent surface 7 of the last optical element 8 can be radiated, is filled with the exposure liquid LQ.

In the present embodiment, the position whereto the exposure light EL emerging from the emergent surface 7 can be radiated includes the projection area PR. In addition, the position whereto the exposure light EL that emerges from the emergent surface 7 can be radiated includes the position at which the object opposes the emergent surface 7. In the present embodiment, the object that is capable of being disposed at the position at which the object opposes the emergent surface 7, in other words, the object that is capable of being disposed in the projection area PR, may be the substrate stage 2P (i.e., the cover member T), the substrate P held by the substrate stage 2P (i.e., the substrate holding part 10), or the measurement stage 2C (i.e., the measuring member C and the ultrasonic wave generating apparatus 13), or any combination thereof. In the exposure of the substrate P, the liquid immersion member 3 forms the immersion space LS by holding the exposure liquid LQ between itself and the substrate P such that the optical path K of the exposure light EL radiated to the substrate P is filled with the exposure liquid LQ.

In the present embodiment, the liquid immersion member 3 is disposed at least partly around the last optical element 8 and the optical path K of the exposure light EL that passes through the exposure liquid LQ between the last optical element 8 and the object disposed in the projection area PR. In the present embodiment, the liquid immersion member 3 is annular. In the present embodiment, part of the liquid immersion member 3 is disposed around the last optical element 8 and part of the liquid immersion member 3 is disposed around the optical path K of the exposure light EL between the last optical element 8 and the object. The immersion space LS is formed such that the optical path K of the exposure light EL between the last optical element 8

and the object disposed in the projection area PR is filled with the exposure liquid LQ.

Furthermore, the liquid immersion member 3 does not have to be annular. For example, the liquid immersion member 3 may be disposed partly around the last optical element 8 and the optical path K. In addition, the liquid immersion member 3 does not
5 have to be disposed at least partly around the last optical element 8. For example, the liquid immersion member 3 may be disposed at least partly around the optical path K between the emergent surface 7 and the object and not around the last optical element 8. In addition, the liquid immersion member 3 does not have to be disposed at least partly around the optical path K between the emergent surface 7 and the object. For example,
10 the liquid immersion member 3 may be disposed at least partly around the last optical element 8 and not around the optical path K between the emergent surface 7 and the object.

The liquid immersion member 3 has a lower surface 14, which the front surface (i.e., the upper surface) of the object disposed in the projection area PR is capable of
15 opposing. The lower surface 14 of the liquid immersion member 3 can hold the exposure liquid LQ between itself and the front surface of the object. In the present embodiment, some of the exposure liquid LQ in the immersion space LS is held between the last optical element 8 and the object disposed such that the object opposes the emergent surface 7 of the last optical element 8. In addition, some of the exposure
20 liquid LQ in the immersion space LS is held between the liquid immersion member 3 and the object disposed such that the object opposes the lower surface 14 of the liquid immersion member 3. Holding the exposure liquid LQ between the emergent surface 7 and the lower surface 14 on one side and the front surface (i.e., the upper surface) of the object on the other side forms the immersion space LS such that the optical path K of the
25 exposure light EL between the last optical element 8 and the object is filled with the

exposure liquid LQ.

In the present embodiment, when the substrate P is being irradiated with the exposure light EL, the immersion space LS is formed such that part of the area of the front surface of the substrate P that includes the projection area PR is covered with the exposure liquid LQ. At least part of an interface LG (i.e., a meniscus or edge) of the exposure liquid LQ is formed between the lower surface 14 of the liquid immersion member 3 and the front surface of the substrate P. Namely, the exposure apparatus EX of the present embodiment adopts a local liquid immersion system. The outer side of the immersion space LS (i.e., the outer side of the interface LG) is a gas space GS.

FIG. 2 is a side cross sectional view that shows one example of the liquid immersion member 3 and the recovery member 400 according to the present embodiment, and FIG. 3 shows a partial enlarged view of FIG. 2. The text below explains an exemplary case, referencing FIG. 2 and FIG. 3, wherein the substrate P is disposed in the projection area PR, but the substrate stage 2P (i.e., the cover member T) and the measurement stage 2C (i.e., the measuring member C and the ultrasonic wave generating apparatus 13) can also be disposed in the projection area PR as discussed above.

In the present embodiment, the liquid immersion member 3 comprises a plate part 31, at least part of which is disposed such that the plate part 31 opposes the emergent surface 7, a main body part 32, at least part of which is disposed such that the main body part 32 opposes a side surface 8F of the last optical element 8, and a passageway forming member 33. In the present embodiment, the plate part 31 and the main body part 32 are one body. In the present embodiment, the passageway forming member 33 is different from the plate part 31 and the main body part 32. In the present embodiment, the passageway forming member 33 is supported by the main body part 32. Furthermore, the passageway forming member 33, the plate part 31, and the main body part 32 may be

one body. Furthermore, the passageway forming member 33 may be replaceable and may be capable of separating from the main body part 32.

Furthermore, the side surface 8F is disposed around the emergent surface 7. In the present embodiment, the side surface 8F is inclined upward toward the outer side in radial directions with respect to the optical path K. Furthermore, the radial directions with respect to the optical path K include the radial directions with respect to the optical axis AX of the projection optical system PL as well as the directions perpendicular to the Z axis.

The liquid immersion member 3 has an opening 15, which is formed at a position at which the opening 15 faces the emergent surface 7. The exposure light EL that emerges from the emergent surface 7 can be radiated through the opening 15 to the substrate P. In the present embodiment, the plate part 31 has an upper surface 16A, which opposes at least part of the emergent surface 7, and a lower surface 16B, which is capable of opposing the front surface of the substrate P. The opening 15 is a hole that is formed such that the opening 15 connects the upper surface 16A and the lower surface 16B. The upper surface 16A is disposed around an upper end of the opening 15 and the lower surface 16B is disposed around a lower end of the opening 15.

In the present embodiment, the upper surface 16A is flat. The upper surface 16A is substantially parallel to the XY plane. Furthermore, at least part of the upper surface 16A may be tilted with respect to the XY plane and may include a curved surface. In the present embodiment, the lower surface 16B is flat. The lower surface 16B is substantially parallel to the XY plane. Furthermore, at least part of the lower surface 16B may be tilted with respect to the XY plane and may include a curved surface. The lower surface 16B holds the exposure liquid LQ between itself and the front surface of the substrate P.

The liquid immersion member 3 has: supply ports 17, which are capable of supplying the exposure liquid LQ; recovery ports 18, which are capable of recovering the exposure liquid LQ; a recovery passageway 19, where through the exposure liquid LQ recovered from the space SP, which the recovery ports 18 face, via the recovery ports 18
5 flows; and discharge parts 20, which separately discharge the exposure liquid LQ and a gas G from the recovery passageway 19.

The supply ports 17 are capable of supplying the exposure liquid LQ to the optical path K. In the present embodiment, the supply ports 17 supply the exposure liquid LQ to the optical path K during at least part of the exposure of the substrate P.
10 The supply ports 17 are disposed in the vicinity of the optical path K such that they face the optical path K. In the present embodiment, the supply ports 17 supply the exposure liquid LQ to a space SR between the emergent surface 7 and the upper surface 16A. At least some of the exposure liquid LQ supplied to the space SR via the supply ports 17 is supplied to the space above the substrate P via the opening 15 as well as to the optical
15 path K. Furthermore, at least part of at least one of the supply ports 17 may face the side surface 8F.

The liquid immersion member 3 comprises supply passageways 29, which are connected to the supply ports 17. At least part of each of the supply passageways 29 is formed inside the liquid immersion member 3. In the present embodiment, each of the
20 supply ports 17 includes an opening, which is formed at one end of the corresponding supply passageway 29. The other end of each of the supply passageways 29 is connected to a liquid supply apparatus 35 via a passageway 34 formed by a piping member 34P.

The liquid supply apparatus 35 is capable of delivering the exposure liquid LQ,
25 which is clean and temperature adjusted. The exposure liquid LQ that is delivered from

the liquid supply apparatus 35 is supplied to the supply ports 17 via passageways 30 and the supply passageways 29. The supply ports 17 supply the exposure liquid LQ from the supply passageways 29 to the optical path K (i.e., the space SR).

The recovery ports 18 are capable of recovering at least some of the exposure liquid LQ from the space above the substrate P (i.e., the object). The recovery ports 18 recover at least some of the exposure liquid LQ from the space above the substrate P during the exposure of the substrate P. The recovery ports 18 face the $-Z$ direction. The front surface of the substrate P faces the recovery ports 18 during at least part of the exposure of the substrate P.

In the present embodiment, the liquid immersion member 3 comprises a first member 28, which has the recovery ports 18. The first member 28 has: a first surface 28B; a second surface 28A, which faces a direction other than that faced by the first surface 28B; and a plurality of holes 28H, which connect the first surface 28B and the second surface 28A. In the present embodiment, the recovery ports 18 include the holes 28H of the first member 28. In the present embodiment, the first member 28 is a porous member that has the plurality of holes 28H (i.e., openings or pores). Furthermore, the first member 28 may be a mesh filter, which is a porous member wherein numerous small holes are formed as a mesh. Namely, a variety of members that have holes capable of recovering the exposure liquid LQ can serve as the first member 28.

At least part of the recovery passageway 19 is formed inside the liquid immersion member 3. In the present embodiment, an opening 32K is formed in a lower end of the recovery passageway 19. The opening 32K is disposed at least partly around the lower surface 16B. The opening 32K is formed at the lower end of the main body part 32. The opening 32K faces downward (i.e., the $-Z$ direction). In the present embodiment, the first member 28 is disposed in the opening 32K. The recovery passageway 19

includes a space between the main body part 32 and the first member 28. The exposure liquid LQ recovered via the recovery ports 18 flows through the recovery passageway 19.

The first member 28 is disposed at least partly around the optical path K (i.e., the lower surface 16B). In the present embodiment, the first member 28 is disposed around the optical path K. Furthermore, the annular first member 28 may be disposed around the optical path K (i.e., the lower surface 16B) or a plurality of the first members 28 may be disposed such that the first members 28 are distributed around the optical path K (i.e., the lower surface 16B).

In the present embodiment, the first member 28 is a plate shaped member. The first surface 28B is one surface of the first member 28 and the second surface 28A is the other surface of the first member 28. In the present embodiment, the first surface 28B faces the space SP, which is on the lower side (i.e., the $-Z$ side) of the liquid immersion member 3. The space SP includes, for example, the space between the lower surface 14 of the liquid immersion member 3 and the front surface of the object (i.e., the substrate P and the like) that opposes the lower surface 14 of the liquid immersion member 3. If the immersion space LS is formed above the object (i.e., the substrate P and the like) opposing the lower surface 14 of the liquid immersion member 3, then the space SP includes the immersion space LS (i.e., a liquid space) and the gas space GS. In the present embodiment, the first member 28 is disposed in the opening 32K such that the first surface 28B faces the space SP and the second surface 28A faces the recovery passageway 19. In the present embodiment, the first surface 28B and the second surface 28A are substantially parallel. The first member 28 is disposed in the opening 32K such that the second surface 28A faces the $+Z$ direction and the first surface 28B faces the opposite direction (i.e., the $-Z$ direction) to that faced by the second surface 28A. In addition, in the present embodiment, the first member 28 is disposed in the

opening 32K such that the first surface 28B and the second surface 28A are substantially parallel to the XY plane.

In the explanation below, the first surface 28B is called the lower surface 28B where appropriate, and the second surface 28A is called the upper surface 28A where
5 appropriate.

Furthermore, the first member 28 does not have to be plate shaped. In addition, the lower surface 28B and the upper surface 28A may be nonparallel. In addition, at least part of the lower surface 28B may be tilted with respect to the XY plane and may include a curved surface. In addition, at least part of the upper surface 28A may be
10 tilted with respect to the XY plane and may include a curved surface.

The holes 28H are formed such that they connect the lower surface 28B and the upper surface 28A. The fluid (i.e., the fluid containing the gas G or the exposure liquid LQ, or both) is capable of passing through the holes 28H of the first member 28. In the present embodiment, the recovery ports 18 include the openings at the lower ends of the
15 holes 28H on the lower surface 28B side. The lower surface 28B is disposed around the lower ends of the holes 28H, and the upper surface 28A is disposed around the upper ends of the holes 28H. The exposure liquid LQ recovered via the recovery ports 18 from the space SP, which the recovery ports 18 face, flows through the recovery passageway 19.

20 The recovery passageway 19 is connected to the holes 28H (i.e., the recovery ports 18) of the first member 28. The first member 28 recovers at least some of the exposure liquid LQ from the space above the substrate P (i.e., the object) opposing the lower surface 28B via the holes 28H (i.e., the recovery ports 18). The exposure liquid LQ recovered via the holes 28H of the first member 28 flows through the recovery
25 passageway 19.

In the present embodiment, the lower surface 14 of the liquid immersion member 3 includes the lower surface 16B and the lower surface 28B. In the present embodiment, the lower surface 28B is disposed at least partly around the lower surface 16B. In the present embodiment, the annular lower surface 28B is disposed around the lower surface 16B. Furthermore, a plurality of the lower surfaces 28B may be disposed such that the lower surfaces 28B are distributed around the lower surface 16B (i.e., the optical path K).

In the present embodiment, the first member 28 comprises a first portion 281 and a second portion 282. In the present embodiment, the second portion 282 is disposed on the outer side of the first portion 281 in radial directions with respect to the optical path K. In the present embodiment, the second portion 282 hinders the flow of the gas G from the space SP into the recovery passageway 19 via the holes 28H more than the first portion 281 does.

In the present embodiment, the inflow resistance of the gas G from the space SP into the recovery passageway 19 via the holes 28H is greater at the second portion 282 than at the first portion 281.

The first portion 281 and the second portion 282 each have a plurality of the holes 28H. For example, in the state wherein the immersion space LS is being formed in the space SP, some of the holes 28H among the plurality of the holes 28H of the first portion 281 might contact the exposure liquid LQ in the immersion space LS and some might not. In addition, some of the holes 28H among the plurality of the holes 28H of the second portion 282 might contact the exposure liquid LQ in the immersion space LS and some might not.

In the present embodiment, the first portion 281 is capable of recovering the exposure liquid LQ to the recovery passageway 19 via the holes 28H that contact the exposure liquid LQ in the space SP (i.e., the exposure liquid LQ in the space above the

substrate P). In addition, the first portion 281 suctions the gas G into the recovery passageway 19 via the holes 28H that do not contact the exposure liquid LQ.

Namely, the first portion 281 is capable of recovering the exposure liquid LQ from the immersion space LS to the recovery passageway 19 via the holes 28H that face the immersion space LS, and the first portion 281 suctions the gas G into the recovery passageway 19 via the holes 28H that face the gas space GS, which is disposed on the outer side of the immersion space LS.

In other words, the first portion 281 is capable of recovering the exposure liquid LQ from the immersion space LS to the recovery passageway 19 via the holes 28H that face the immersion space LS, and the first portion 281 suctions the gas G into the recovery passageway 19 via the holes 28H that do not face the immersion space LS.

Namely, if the interface LG of the exposure liquid LQ in the immersion space LS is present between the first portion 281 and the substrate P, then the first portion 281 recovers to the recovery passageway 19 the exposure liquid LQ together with the gas G. Furthermore, at the interface LG, both the exposure liquid LQ and the gas G may be suctioned via the holes 28H that face both the immersion space LS and the gas space GS.

The second portion 282 is capable of recovering the exposure liquid LQ to the recovery passageway 19 via the holes 28H that contact the exposure liquid LQ in the space SP (i.e., the exposure liquid LQ in the space above the substrate P). In addition, the second portion 282 hinders the flow of the gas G into the recovery passageway 19 via the holes 28H that do not contact the exposure liquid LQ.

Namely, the second portion 282 is capable of recovering the exposure liquid LQ from the immersion space LS to the recovery passageway 19 via the holes 28H that face the immersion space LS, and the second portion 282 hinders the flow of the gas G into the recovery passageway 19 via the holes 28H that face the gas space GS, which is

disposed on the outer side of the immersion space LS.

In the present embodiment, the second portion 282 recovers substantially only the exposure liquid LQ, and not the gas G, to the recovery passageway 19.

FIG. 4 is a partial enlarged cross sectional view of the second portion 282 of the first member 28 and serves as a schematic drawing for explaining one example of the state wherein the second portion 282 is recovering only the exposure liquid LQ.

In FIG. 4, there is a difference between a pressure P_a in the space SP (i.e., the gas space GS) and a pressure P_b in the recovery passageway 19. In the present embodiment, the pressure P_b in the recovery passageway 19 is lower than the pressure P_a in the space SP. When the exposure liquid LQ is being recovered from the space above the substrate P (i.e., the object) via the first member 28, the exposure liquid LQ is recovered from the space above the substrate P to the recovery passageway 19 via a hole 28Hb of the second portion 282, and the flow of the gas G into the recovery passageway 19 via a hole 28Ha of the second portion 282 is hindered.

In FIG. 4, the immersion space LS (i.e., the liquid space) and the gas space GS are formed in the space SP between the lower surface 28B of the second portion 282 and the front surface of the substrate P. In FIG. 4, the space that the lower end of the hole 28Ha of the second portion 282 faces is the gas space GS, and the space that the lower end of the hole 28Hb of the second portion 282 faces is the immersion space LS (i.e., the liquid space). In addition, in FIG. 4, the exposure liquid LQ in the recovery passageway 19 (i.e., a liquid space) is present on the upper side of the second portion 282.

In the present embodiment, the exposure liquid LQ is recovered from the space above the substrate P to the recovery passageway 19 via the hole 28Hb of the second portion 282, which contacts the exposure liquid LQ, and the flow of the gas G into the recovery passageway 19 via the hole 28Ha of the second portion 282, which does not

contact the exposure liquid LQ, is hindered.

In FIG. 4, the condition below is satisfied.

$$(4 \times \gamma \times \cos\theta_2)/d_2 \geq (P_b - P_a) \quad (1)$$

Therein, P_a is the pressure in the gas space GS that the lower end of the hole 28Ha faces (i.e., the pressure on the lower surface 28B side), P_b is the pressure in the recovery passageway 19 (i.e., the liquid space) on the upper side of the first member 28 (i.e., the pressure on the upper surface 28A side), d_2 is the dimension (i.e., the pore size or diameter) of each of the holes 28Ha, 28Hb, θ_2 is the contact angle of the exposure liquid LQ with respect to the surface (i.e., the inner surface) of each of the holes 28H of the second portion 282, and γ is the surface tension of the exposure liquid LQ.

Furthermore, to simplify the explanation, the condition expressed in the abovementioned equation (1) does not take the hydrostatic pressure of the exposure liquid LQ on the upper side of the first member 28 into consideration.

Furthermore, in the present embodiment, the dimension d_2 of each of the holes 28H of the second portion 282 indicates the minimum value thereof of all of the holes 28H between the upper surface 28A and the lower surface 28B. Furthermore, the dimension d_2 does not have to be the minimum dimension of all of the holes 28H between the upper surface 28A and the lower surface 28B, and may be, for example, the average value or the maximum value thereof.

In this case, the contact angle θ_2 of the exposure liquid LQ with respect to the surface of each of the holes 28H of the second portion 282 satisfies the condition below.

$$\theta_2 \leq 90^\circ \quad (2)$$

If the above condition holds, then, even if the gas space GS is formed on the lower side (i.e., on the space SP side) of the hole 28Ha of the first member 28, the gas G in the gas space GS on the lower side of the first member 28 is hindered from moving to

(i.e., flowing into) the recovery passageway 19 (i.e., the liquid space) on the upper side of the first member 28 via the hole 28Ha. Namely, if the dimension $d2$ (i.e., the pore size or diameter) of each of the holes 28H of the second portion 282, the contact angle $\theta2$ (i.e., the affinity) of the exposure liquid LQ with respect to the surface of each of the

5 holes 28H of the second portion 282, the surface tension γ of the exposure liquid LQ, and the pressures Pa , Pb satisfy the above condition, then the interface between the exposure liquid LQ and the gas G is kept on the inner side of the hole 28Ha and the flow of the gas G from the space SP into the recovery passageway 19 via the hole 28Ha of the second

10 portion 282 is hindered. Moreover, because the immersion space LS (i.e., the liquid space) is formed on the lower side (i.e., on the space SP side) of the hole 28Hb, only the exposure liquid LQ is recovered via the hole 28Hb.

In the present embodiment, the above condition is satisfied for all of the holes 28H of the second portion 282, and substantially only the exposure liquid LQ is recovered via the holes 28H of the second portion 282.

15 In the explanation below, the state wherein only the exposure liquid LQ is recovered via the holes of the porous member (e.g., the holes 28H of the first member 28) is called a liquid selective recovery state where appropriate, and the condition wherein only the exposure liquid LQ is recovered via the holes of the porous member is called a liquid selective recovery condition.

20 FIG. 5 is a partial enlarged cross sectional view of the first portion 281 of the first member 28 and serves as a schematic drawing for explaining one example of the state wherein the first portion 281 is recovering the exposure liquid LQ and the gas G.

In FIG. 5, there is a difference between the pressure Pa in the space SP (i.e., the gas space GS) and the pressure Pb in the recovery passageway 19. In the present

25 embodiment, the pressure Pb in the recovery passageway 19 is lower than the pressure

P_a in the space SP. When the exposure liquid LQ is being recovered from the space above the substrate P (i.e., the object) via the first member 28, the gas G is suctioned into the recovery passageway 19 via a hole 28Hc in the first portion 281.

In FIG. 5, the immersion space LS (i.e., the liquid space) and the gas space GS are formed in the space SP. In FIG. 5, the space that the lower end of the hole 28Hc of the first portion 281 faces is the gas space GS, and the space that the lower end of a hole 28Hd of the first portion 281 faces is the immersion space LS (i.e., the liquid space). In addition, in FIG. 5, the exposure liquid LQ in the recovery passageway 19 (i.e., the liquid space) is present on the upper side of the first portion 281.

In the present embodiment, the exposure liquid LQ is recovered from the space above the substrate P to the recovery passageway 19 via the hole 28Hd of the first portion 281, which contacts the exposure liquid LQ, and the gas G is suctioned into the recovery passageway 19 via the hole 28Hc of the first portion 281, which does not contact the exposure liquid LQ.

In the present embodiment, the dimension (i.e., the pore size or diameter) of each of the holes 28H or the contact angle of the exposure liquid LQ with respect to the surface (i.e., the inner surface) of each of the holes 28H, or both, is different at the first portion 281 than it is at the second portion 282. Owing to the difference between the pressure P_a in the space SP (i.e., the gas space GS) and the pressure P_b in the recovery passageway 19, the exposure liquid LQ is recovered from the space above the substrate P to the recovery passageway 19 via the hole 28Hd of the first portion 281, which contacts the exposure liquid LQ, and the gas G is suctioned into the recovery passageway 19 via the hole 28Hc of the first portion 281, which does not contact the exposure liquid LQ.

Furthermore, in the present embodiment, a dimension d_l of each of the holes 28H of the first portion 281 indicates the minimum value thereof of all of the holes 28H

between the upper surface 28A and the lower surface 28B. Furthermore, the dimension $d1$ does not have to be the minimum dimension of all of the holes 28H between the upper surface 28A and the lower surface 28B, and may be, for example, the average value or the maximum value thereof.

5 In the present embodiment, the surface of each of the holes 28H of the second portion 282 is more lyophilic with respect to the exposure liquid LQ than the surface of each of the holes 28H of the first portion 281 is. Namely, the contact angle $\theta 2$ of the exposure liquid LQ with respect to the surface (i.e., the inner surface) of each of the holes 28H of the second portion 282 is smaller than a contact angle $\theta 1$ of the exposure liquid
10 LQ with respect to the surface (i.e., the inner surface) of each of the holes 28H of the first portion 281. Thereby, the first portion 281 recovers the exposure liquid LQ together with the gas G, and the second portion 282 recovers the exposure liquid LQ while hindering the flow of the gas G into the recovery passageway 19.

 In the present embodiment, the contact angle $\theta 2$ of the exposure liquid LQ with
15 respect to the surface of each of the holes 28H of the second portion 282 is less than 90° . For example, the contact angle $\theta 2$ of the exposure liquid LQ with respect to the surface of each of the holes 28H of the second portion 282 may be less than 50° , less than 40° , less than 30° , or less than 20° .

 Furthermore, the dimension $d1$ of each of the holes 28H of the first portion 281
20 may be different from the dimension $d2$ of each of the holes 28H of the second portion 282. For example, by making the dimension $d2$ of each of the holes 28H of the second portion 282 smaller than the dimension $d1$ of each of the holes 28H of the first portion 281, the first portion 281 recovers the exposure liquid LQ together with the gas G, and the second portion 282 recovers the exposure liquid LQ while hindering the flow of the
25 gas G into the recovery passageway 19.

The text below explains the discharge parts 20, referencing FIG. 2 and FIG. 3.

Each of the discharge parts 20 has first discharge ports 21, which face the recovery passageway 19 and are for discharging the exposure liquid LQ from the recovery passageway 19, and a second discharge port 22, which faces the recovery passageway 19 and is for discharging the gas G from the recovery passageway 19.

In the present embodiment, the first discharge ports 21 are disposed above (i.e., in the +Z direction of) the recovery ports 18 such that the first discharge ports 21 face the recovery passageway 19. The second discharge ports 22 are disposed above (i.e., in the +Z direction of) the recovery ports 18 such that the second discharge ports 22 face the recovery passageway 19.

In the present embodiment, the first discharge ports 21 or the second discharge ports 22, or both, face downward (i.e., in the -Z direction). In the present embodiment, the first discharge ports 21 and the second discharge ports 22 each face downward.

In the present embodiment, the first discharge ports 21 are disposed on the outer side of the second discharge ports 22 in radial directions with respect to the optical path K. Namely, in the present embodiment, the first discharge ports 21 are farther from the optical path K than the second discharge ports 22 are.

In the present embodiment, at least part of at least one of the first discharge ports 21 opposes the upper surface 28A of the second portion 282 of the first member 28. In the present embodiment, all of each of the first discharge ports 21 opposes the upper surface 28A of the second portion 282. The first discharge ports 21, which oppose the first member 28, oppose the recovery ports 18.

In the present embodiment, at least part of at least one of the second discharge ports 22 oppose the upper surface 28A of the second portion 282 of the first member 28.

In the present embodiment, all of the second discharge ports 22 oppose the upper surface

28A of the second portion 282. The second discharge ports 22, which oppose the first member 28, oppose the recovery ports 18.

In the present embodiment, the first discharge ports 21 are disposed below the second discharge ports 22.

5 In addition, in the present embodiment, the second discharge ports 22 are disposed more spaced apart from the upper surface 28A of the first member 28 than the first discharge ports 21 are.

In addition, in the present embodiment, at least part of the second portion 282 is disposed on the outer side of the first discharge ports 21 and the second discharge ports
10 22 in the radial directions with respect to the optical path K. Namely, in the present embodiment, at least part of the second portion 282 is farther from the optical path K than the first discharge ports 21 and the second discharge ports 22 are. In the example shown in FIG. 2 and FIG. 3, an outer edge of the second portion 282 is disposed on the outer side of the first discharge ports 21 and the second discharge ports 22 in the radial
15 directions with respect to the optical path K.

In addition, in the present embodiment, at least part of the first portion 281 of the first member 28 is disposed on the inner side of the first discharge ports 21 and the second discharge ports 22 in the radial directions with respect to the optical path K. Namely, in the present embodiment, at least part of the first portion 281 is closer to the
20 optical path K than the first discharge ports 21 and the second discharge ports 22 are. In the example shown in FIG. 2 and FIG. 3, substantially the entire first portion 281 is disposed on the inner side of the first discharge ports 21 and the second discharge ports 22 in the radial directions with respect to the optical path K.

As discussed above, the first member 28 (i.e., the first portion 281) recovers the
25 exposure liquid LQ together with the gas G from the space SP to the recovery

passageway 19. The exposure liquid LQ and the gas G in the space SP between the substrate P and the first member 28 flow to the recovery passageway 19 via the first member 28. As shown in FIG. 2 and FIG. 3, a gas space and the liquid space are formed in the recovery passageway 19. The first discharge ports 21 discharge the exposure liquid LQ from the recovery passageway 19, and the second discharge ports 22 discharge the gas G from the recovery passageway 19.

In the present embodiment, the first discharge ports 21 hinder the inflow of the gas G more than the second discharge ports 22 do. The second discharge ports 22 hinder the discharge of the exposure liquid LQ more than the first discharge ports 21 do.

In other words, the second discharge ports 22 hinder the inflow of the exposure liquid LQ more than the first discharge ports 21 do.

In the present embodiment, the first discharge ports 21 discharge the fluid, which includes the exposure liquid LQ and wherein the percentage of the exposure liquid LQ is higher than the percentage of the gas G, from the recovery passageway 19. The second discharge ports 22 discharge the fluid, which includes the gas G and wherein the percentage of the exposure liquid LQ is lower than the percentage of the gas G, from the recovery passageway 19. Namely, in the present embodiment, the percentage of the exposure liquid LQ in the fluid discharged via the first discharge ports 21 is higher than the percentage of the exposure liquid LQ in the fluid discharged via the second discharge ports 22. In the present embodiment, the percentage of the gas G in the fluid discharged via the first discharge ports 21 is lower than the percentage of the gas G in the fluid discharged via the second discharge ports 22.

In the present embodiment, the first discharge ports 21 discharge substantially only the exposure liquid LQ from the recovery passageway 19. The second discharge ports 22 discharge substantially only the gas G from the recovery passageway 19.

In the present embodiment, the liquid immersion member 3 comprises second members 27, which have the first discharge ports 21. Each of the second members 27 has: a third surface 27B, which faces the recovery passageway 19; a fourth surface 27A, which faces a direction other than that faced by the third surface 27B; and multiple holes 27H, which connect the third surface 27B and the fourth surface 27A. In the present embodiment, the first discharge ports 21 include the holes 27H of the second members 27. In the present embodiment, each of the second members 27 is a porous member that has the multiple holes 27H. Furthermore, each of the second members 27 may be a mesh filter, which is a porous member wherein numerous small holes are formed as a mesh. Namely, a variety of members that have holes capable of hindering the inflow of the gas G can serve as each of the second members 27.

In the present embodiment, openings 33K are formed at the lower end of the passageway forming member 33. The openings 33K face downward (i.e., the $-Z$ direction). In the present embodiment, the second members 27 are disposed in the openings 33K.

In the present embodiment, the second members 27 are plate shaped members. Each of the third surfaces 27B is one surface of the corresponding second member 27, and each of the fourth surfaces 27A is the other surface of the corresponding second member 27. In the present embodiment, the second members 27 are disposed in the openings 33K such that the third surfaces 27B face the recovery passageway 19 and the fourth surfaces 27A face the passageways 30 of the passageway forming member 33. In the present embodiment, the third surfaces 27B and the fourth surfaces 27A are substantially parallel. The second members 27 are disposed in the openings 33K such that the fourth surfaces 27A face the $+Z$ direction and the third surfaces 27B face the opposite direction (i.e., the $-Z$ direction) to that faced by the fourth surfaces 27A. In

addition, in the present embodiment, the second members 27 are disposed in the openings 33K such that the third surfaces 27B and the fourth surfaces 27A are substantially parallel to the XY plane.

In the explanation below, the third surfaces 27B are called the lower surfaces 27B where appropriate, and the fourth surfaces 27A are called the upper surfaces 27A where appropriate.

Furthermore, the second members 27 do not have to be plate shaped members. In addition, the lower surface 27B and the upper surface 27A may be nonparallel. In addition, at least part of the lower surface 27B may be tilted with respect to the XY plane and may include a curved surface. In addition, at least part of the upper surface 27A may be tilted with respect to the XY plane and may include a curved surface.

The holes 27H are disposed such that they connect each of the lower surfaces 27B to the corresponding upper surface 27A. The fluid (i.e., the fluid containing the exposure liquid LQ or the gas G, or both) can flow through the holes 27H of the second members 27. In the present embodiment, each of the first discharge ports 21 is disposed at the lower ends of the holes 27H on the corresponding lower surface 27B side. In other words, the first discharge ports 21 are the openings at the lower ends of the holes 27H. Each of the lower surfaces 27B is disposed around the lower ends of the corresponding holes 27H, and each of the upper surfaces 27A is disposed around the upper ends of the corresponding holes 27H.

Each of the passageways 30 are connected to the holes 27H (i.e., the first discharge ports 21) of the corresponding second member 27. The second members 27 discharge at least some of the exposure liquid LQ from the recovery passageway 19 via the holes 27H (i.e., the first discharge ports 21). The exposure liquid LQ discharged via the holes 27H of the second members 27 flows through the passageways 30.

In the present embodiment, the pressure differential between the recovery passageway 19 that the lower surfaces 27B face and the passageways 30 (i.e., the spaces) that the upper surfaces 27A face is adjusted such that the discharge of the gas G via the first discharge ports 21 is hindered.

5 In the present embodiment, the second members 27 discharge substantially only the exposure liquid LQ, and not the gas G, to the passageways 30.

In the present embodiment, the recovery condition (i.e., the discharge condition) of the exposure liquid LQ via the holes 27H of the second members 27 satisfies the liquid selective recovery condition, as explained referencing FIG. 4 and the like. Namely, as
10 shown in FIG. 19, by making a dimension $d3$ (i.e., the pore size or diameter) of each of the holes 27H of the second members 27, a contact angle $\theta3$ (i.e., the affinity) of the exposure liquid LQ with respect to the surface of each of the holes 27H of the second members 27, the surface tension γ of the exposure liquid LQ, the pressure Pb in the recovery passageway 19 that the lower surfaces 27B face, and a pressure Pc in the
15 passageways 30 that the upper surfaces 27A face satisfy the liquid selective recovery condition, the interface between the exposure liquid LQ and the gas G is kept on the inner side of the holes 27H and the flow of the gas G from the recovery passageway 19 into the passageways 30 via the holes 27H of the second members 27 is hindered. Thereby, the second members 27 (i.e., the first discharge ports 21) can discharge
20 substantially only the exposure liquid LQ.

In the present embodiment, the difference between the pressure Pb in the recovery passageway 19 and the pressure Pc in the passageways 30 is adjusted such that the recovery condition (i.e., the discharge condition) of the exposure liquid LQ via the holes 27H of the second members 27 is the liquid selective recovery condition. The
25 pressure Pc is lower than the pressure Pb . Namely, the difference between the pressure

P_b in the recovery passageway 19 and the pressure P_c in the passageways 30 is prescribed such that the exposure liquid LQ is discharged from the recovery passageway 19 to the passageways 30 via the holes 27H of the second members 27 and the gas G is hindered from flowing into the passageways 30 via the holes 27H of the second members

5 27. By adjusting the pressure P_b or the pressure P_c , or both, the second members 27 discharge substantially only the exposure liquid LQ, and not the gas G, to the passageways 30 via the holes 27H.

In the present embodiment, at least part of the surface of each of the second members 27 is lyophilic with respect to the exposure liquid LQ. In the present
10 embodiment, at least the surfaces (i.e., the inner surfaces) of the holes 27H of the second members 27 are lyophilic with respect to the exposure liquid LQ. In the present embodiment, the contact angle of the exposure liquid LQ with respect to the surface of each of the holes 27H is less than 90° . Furthermore, the contact angle of the exposure liquid LQ with respect to the surface of each of the holes 27H may be less than 50° , less
15 than 40° , less than 30° , or less than 20° .

In the present embodiment, the liquid immersion member 3 comprises a hindering part 40, which is disposed in the recovery passageway 19 and hinders the exposure liquid LQ in the recovery passageway 19 from contacting the second discharge ports 22. The hindering part 40 is provided in the recovery passageway 19 such that the
20 second discharge ports 22 are disposed in the gas space of the recovery passageway 19. Namely, the hindering part 40 is provided in the recovery passageway 19 such that the peripheral space of each of the second discharge ports 22 in the recovery passageway 19 is the gas space. For example, the hindering part 40 adjusts the interface (i.e., the surface) of the liquid space in the recovery passageway 19 such that the exposure liquid
25 LQ does not contact the second discharge ports 22. Thereby, the second discharge ports

22 disposed in the gas space discharge substantially only the gas G from the recovery passageway 19.

In the present embodiment, the hindering part 40 comprises a projection 41, which is disposed at least partly around the second discharge ports 22. The projection 41 is provided inside the recovery passageway 19 such that the second discharge ports 22 are disposed in the gas space in the recovery passageway 19. The projection 41 limits the movement of the interface of the liquid space in the recovery passageway 19 such that the second discharge ports 22 are disposed in the gas space in the recovery passageway 19. Namely, the projection 41 hinders the interface of the liquid space in the recovery passageway 19 from approaching the second discharge ports 22.

In addition, in the present embodiment, the hindering part 40 comprises a liquid repellent part 42, which is disposed inside the recovery passageway 19 at least partly around the second discharge ports 22 and whose surface is liquid repellent with respect to the exposure liquid LQ. The liquid repellent part 42 hinders contact between the second discharge ports 22 and the exposure liquid LQ in the recovery passageway 19. The liquid repellent part 42 is provided inside the recovery passageway 19 such that the second discharge ports 22 are disposed in the gas space in the recovery passageway 19. The liquid repellent part 42 hinders the interface of the liquid space in the recovery passageway 19 from approaching the second discharge ports 22 such that the peripheral space of each of the second discharge ports 22 inside the recovery passageway 19 is the gas space.

In the present embodiment, the second discharge ports 22 are disposed on the outer side of the projection 41 in radial directions with respect to the optical path K. Namely, the second discharge ports 22 are farther from the optical path K than the projection 41 is. In addition, at least part of the liquid repellent part 42 is disposed

between the second discharge ports 22 and the projection 41.

In the present embodiment, the projection 41 is disposed between the second discharge ports 22 and at least some of the recovery ports 18 in the radial directions with respect to the optical path K. In the present embodiment, the projection 41 is disposed
5 between the recovery ports 18 of the first portion 281 and the second discharge ports 22 in the radial directions with respect to the optical path K.

The projection 41 projects downward at least partly around the second discharge ports 22. In the present embodiment, the projection 41 is formed by at least part of the inner surface of the recovery passageway 19. In the present embodiment, the surfaces
10 of the projection 41 include a side surface 41S, which extends downward at least partly around the second discharge ports 22, and a lower surface 41K, which extends from a lower end part of the side surface 41S such that it approaches the optical path K proceeding from the inner sides of the second discharge ports 22. The side surface 41S faces the outer side in the radial directions with respect to the optical path K. The side
15 surface 41S is substantially parallel to the optical path K. The side surface 41S is substantially parallel to the Z axis. Furthermore, the side surface 41S does not have to be parallel to the Z axis. The lower surface 41K faces the $-Z$ direction. In the present embodiment, the lower surface 41K is substantially parallel to the XY plane. The side surface 41S and the lower surface 41K are part of the inner surface of the recovery
20 passageway 19. In the present embodiment, the angle formed between the lower surface 41K and the side surface 41S is substantially 90° . Furthermore, the angle formed between the lower surface 41K and the side surface 41S may be less than or greater than 90° . In the present embodiment, the tip (i.e., the lower end) of the projection 41 is disposed at a position that is lower than the second discharge ports 22.

25 In the present embodiment, the lower surface 41K and the side surface 41S of the

inner surface of the recovery passageway 19, which form the projection 41, are lyophilic with respect to the exposure liquid LQ. In the present embodiment, the lyophilic lower surface 41K and the lyophilic side surface 41S are adjacent to the liquid repellent part 42. At least part of the liquid repellent part 42 is disposed between the lyophilic lower
5 surface 41K and the lyophilic side surface 41S on one side and the second discharge ports 22 on the other side.

In the present embodiment, the contact angle of the exposure liquid LQ with respect to the lyophilic inner surface (i.e., the lower surface 41K and the side surface 41S) of the recovery passageway 19 is less than 90° . The contact angle of the exposure
10 liquid LQ with respect to the surface of the liquid repellent part 42 is 90° or greater. In the present embodiment, the contact angle of the exposure liquid LQ with respect to the surface of the liquid repellent part 42 may be, for example, 100° or greater or 110° or greater.

In the present embodiment, the liquid repellent part 42 is formed with films Fr
15 that are liquid repellent with respect to the exposure liquid LQ. The material used to form the films Fr is fluorine based. In the present embodiment, the films Fr are tetrafluoroethylene-perfluoro (alkyl vinyl ether) copolymer (PFA) films. Furthermore, the films Fr may also be, for example, polytetrafluoroethylene (PTFE) films, polyetheretherketone (PEEK) films, or Teflon[®] films. In addition, the films Fr may also
20 be Cytop[™] (made by Asahi Glass Co.) or Novec EGC[™] (made by 3M Company) films.

In the present embodiment, the first discharge ports 21 and the second discharge ports 22 are disposed at least partly around the optical path K. In the present embodiment, the second members 27, which each have the first discharge ports 21, are disposed at prescribed intervals around the optical path K. In the present embodiment,
25 the second members 27 are disposed at four locations around the optical path K. The

second discharge ports 22 are disposed at prescribed intervals around the optical path K. Furthermore, the number of the first discharge ports 21 and the number of the second discharge ports 22 may be the same. In addition, the first discharge ports 21 may be provided continuously around the optical path K, the second discharge ports 22 may be provided continuously around the optical path K, or both may be so provided.

As shown in FIG. 2, each of the first discharge ports 21 is connected to a first discharge apparatus 24 via the corresponding passageway 30 and a passageway 23, which is formed by a piping member 23P. The second discharge ports 22 are connected to a second discharge apparatus 26 via a passageway 36, which is formed inside the main body part 32, and a passageway 25, which is formed by a piping member 25P. Each of the first and second discharge apparatuses 24, 26 comprises, for example, a vacuum system and is capable of suctioning the fluid (i.e., the fluid containing the gas G or the exposure liquid LQ, or both).

In the present embodiment, a discharge operation is performed via the first discharge ports 21 by the operation of the first discharge apparatus 24. In addition, in the present embodiment, a discharge operation is performed via the second discharge ports 22 by the operation of the second discharge apparatus 26.

In the present embodiment, the first discharge apparatus 24 is capable of adjusting the pressure P_c in the passageways 30 that the upper surfaces 27A of the second members 27 face. In addition, the second discharge apparatus 26 is capable of adjusting the pressure P_b in the recovery passageway 19 that the lower surfaces 27B of the second members 27 and the upper surface 28A of the first member 28 face. In addition, the internal space CS includes the space SP, and the chamber apparatus 100 is capable of adjusting the pressure P_a in the space SP that the lower surface 28B of the first member 28 faces. The control apparatus 4 uses the chamber apparatus 100 or the

second discharge apparatus 26, or both, to adjust the pressure P_a or the pressure P_b , or both, such that the first portion 281 of the first member 28 recovers the exposure liquid LQ together with the gas G from the space SP and such that the second portion 282 recovers the exposure liquid LQ while hindering the inflow of the gas G. In addition, the control apparatus 4 uses the first discharge apparatus 24 or the second discharge apparatus 26, or both, to set the pressure P_b or the pressure P_c , or both, such that the second members 27 discharge the exposure liquid LQ from the recovery passageway 19 while hindering the inflow of the gas G. Furthermore, the second discharge apparatus 26 does not have to be capable of adjusting the pressure P_b .

Furthermore, the exposure apparatus EX may comprise the first discharge apparatus 24 or the second discharge apparatus 26, or both. Furthermore, the first discharge apparatus 24 or the second discharge apparatus 26, or both, may be an apparatus that is external to the exposure apparatus EX. Furthermore, the first discharge apparatus 24 or the second discharge apparatus 26, or both, may be equipment in the factory wherein the exposure apparatus EX is installed.

In the present embodiment, the first discharge ports 21 are capable of supplying a liquid to the recovery passageway 19. Namely, in the present embodiment, the first discharge ports 21 can function as liquid supply ports that are capable of supplying the liquid.

In the present embodiment, a supply apparatus 241, which is capable of supplying the liquid, is connected to the passageway 23 via a passageway 231 formed by a piping member 231P. The passageway 231 is connected to the passageway 23 via a passageway switching mechanism 23B, which comprises, for example, a valve mechanism. The supply apparatus 241 is capable of supplying the liquid to the first discharge ports 21 via the passageway 231 and the passageway 23. The first discharge

ports 21 are capable of supplying the liquid from the supply apparatus 241 to the recovery passageway 19. When the exposure liquid LQ is discharged from the recovery passageway 19 via the first discharge ports 21, the control apparatus 4 controls the passageway switching mechanism 23B such that the first discharge ports 21 are

5 connected to the first discharge apparatus 24 via the passageway 23 and not to the supply apparatus 241. In the state wherein the passageway switching mechanism 23B connects the first discharge ports 21 and the first discharge apparatus 24 via the passageway 23, the fluid is discharged from the recovery passageway 19 via the first discharge ports 21 by the operation of the first discharge apparatus 24. Moreover, when the liquid is

10 supplied to the recovery passageway 19 via the first discharge ports 21, the control apparatus 4 controls the passageway switching mechanism 23B such that the first discharge ports 21 are connected to the supply apparatus 241 via the passageway 23 and the passageway 231 and not to the first discharge apparatus 24. In the state wherein the passageway switching mechanism 23B connects the first discharge ports 21 and the

15 supply apparatus 241 via the passageway 23 and the passageway 231, the liquid is supplied to the recovery passageway 19 via the first discharge ports 21 by the operation of the supply apparatus 241.

In the present embodiment, the liquid that is capable of being supplied via the first discharge ports 21 includes at least one of the following liquids: cleaning liquids LC

20 (LC1, LC2) for cleaning, for example, at least some of the members of the exposure apparatus EX; and a rinsing liquid LH for eliminating any of the cleaning liquids LC that remain on those members. In the present embodiment, the cleaning liquids LC include the first cleaning liquid LC1 and the second cleaning liquid LC2. The supply apparatus 241 is capable of delivering the cleaning liquids LC or the rinsing liquid LH, or both.

25 The recovery member 400 is disposed at least partly around the liquid immersion

member 3. In the present embodiment, the recovery member 400 is annular. The recovery member 400 is disposed such that it surrounds the liquid immersion member 3. Furthermore, a plurality of the recovery members 400 may be disposed such that the recovery members 400 are distributed around the liquid immersion member 3.

5 The recovery member 400 has a recovery port 401, which is capable of recovering at least some of the liquid from the space above the substrate P (i.e., the object). The substrate P is capable of opposing the recovery port 401. The recovery member 400 has a lower surface 402, which is disposed around the recovery port 401 and which the substrate P (i.e., the object) is capable of opposing. The recovery port 401 is
10 capable of recovering the liquid from a space SQ between the lower surface 402 and the upper surface of the substrate P (i.e., the object) opposing the lower surface 402. In addition, the recovery member 400 has a recovery passageway 403, wherethrough the liquid recovered via the recovery port 401 flows.

 The recovery port 401 is connected to a recovery apparatus 405 via the recovery
15 passageway 403 and a passageway 404 formed by a piping member 404P. The recovery apparatus 405 comprises, for example, a vacuum system and is capable of suctioning a fluid (i.e., a fluid containing the liquid or the gas G, or both).

 In the present embodiment, the recovery operation via the recovery port 401 is performed by the operation of the recovery apparatus 405.

20 Furthermore, the exposure apparatus EX may comprise the recovery apparatus 405. Furthermore, the recovery apparatus 405 may be an apparatus that is external to the exposure apparatus EX. Furthermore, the recovery apparatus 405 may be equipment in the factory wherein the exposure apparatus EX is installed.

 In addition, in the present embodiment, the supply ports 17 can supply the
25 cleaning liquids LC (LC1, LC2). The liquid supply apparatus 35 can deliver not only

the exposure liquid LQ but also the cleaning liquids LC.

In the present embodiment, at least part of the surface of the liquid immersion member 3 includes a surface of an amorphous carbon film. The amorphous carbon film may be a tetrahedral amorphous carbon film. In the present embodiment, at least part of the surface of the liquid immersion member 3 includes a surface of a tetrahedral amorphous carbon film. In the present embodiment, at least part of the surface of the liquid immersion member 3 that contacts the exposure liquid LQ in the immersion space LS during an exposure of the substrate P includes a surface of an amorphous carbon film (i.e., a tetrahedral amorphous carbon film). In the present embodiment, the base material of the plate part 31 and the main body part 32 may be titanium, and the amorphous carbon film is formed on the surface of that base material. In the present embodiment, the base material of the first member 28 and the second members 27 may be titanium, and the amorphous carbon film is formed on the surface of that base material.

Furthermore, the base material of the liquid immersion member 3, which comprises the plate part 31, the main body part 32, the first member 28, or the second members 27, or any combination thereof, may be a metal, such as stainless steel or aluminum, or a ceramic material.

Furthermore, the amorphous carbon film may be formed on the base material using, for example, chemical vapor deposition (CVD), physical vapor deposition (PVD), and the like. Furthermore, at least part of the surface of the liquid immersion member 3 does not have to include the surface of the amorphous carbon film.

Furthermore, at least part of the liquid immersion member 3 may include a material other than titanium, for example, stainless steel or magnesium. In addition, at least part of the liquid immersion member 3 may even be formed from a ceramic

material.

Furthermore, at least part of the surface of the liquid immersion member 400 may include a surface of an amorphous carbon film or a surface of a tetrahedral amorphous carbon film. In addition, the base material of the recovery member 400 may be a metal
5 such as titanium, stainless steel, or aluminum, or may be a ceramic material.

The text below explains one example of the operation of the exposure apparatus EX, which has the configuration discussed above. As in the flow chart shown in FIG. 6, in the present embodiment, an exposure sequence (i.e., a step SP1), which includes the exposing process that is performed on the substrate P, and a cleaning sequence (i.e., a
10 step SP2), which includes a cleaning process that is performed on the liquid immersion member 3, are performed. Furthermore, the exposure sequence may be performed after the cleaning sequence, and the exposure sequence and the cleaning sequence may be performed repeatedly. In addition, the cleaning sequence may be performed at prescribed intervals and/or in a case that it is determined that the liquid immersion
15 member 3 has become contaminated.

First, the exposure sequence (i.e., the step SP1) will be explained. To load the unexposed substrate P onto the substrate stage 2P (i.e., the substrate holding part 10), the control apparatus 4 moves the substrate stage 2P to a substrate exchange position. The substrate exchange position is a position spaced apart from the liquid immersion member
20 3 (i.e., the projection area PR) and is where the substrate P exchanging process can be performed. The substrate P exchanging process includes at least one of the following processes, using a prescribed transport apparatus (not shown), a process that unloads the exposed substrate P, which is held by the substrate stage 2P (i.e., the substrate holding part 10), from the substrate stage 2P; and a process that loads the unexposed substrate P
25 onto the substrate stage 2P (i.e., the substrate holding part 10). The control apparatus 4

moves the substrate stage 2P to the substrate exchange position and performs the substrate P exchanging process.

During at least part of the interval during which the substrate stage 2P is spaced apart from the liquid immersion member 3, the control apparatus 4 disposes the

5 measurement stage 2C at a position at which it opposes the last optical element 8 and the liquid immersion member 3 and forms the immersion space LS by holding the exposure liquid LQ between the last optical element 8 and the liquid immersion member 3 on one side and the measurement stage 2C on the other side.

In addition, during at least part of the interval during which the substrate stage 2P
10 is spaced apart from the liquid immersion member 3, the measuring process may be performed, as needed, using the measurement stage 2C. When the measuring process using the measurement stage 2C is to be performed, the control apparatus 4 causes the last optical element 8 and the liquid immersion member 3 on one side and the measurement stage 2C on the other side to oppose one another and forms the immersion
15 space LS such that the optical path K of the exposure light EL between the last optical element 8 and the measuring member C is filled with the exposure liquid LQ. The control apparatus 4 performs the exposure light EL measuring process by radiating the exposure light EL through the projection optical system PL and the exposure liquid LQ to the measuring member C (i.e., the measuring instrument) held by the measurement stage
20 2C. The result of that measuring process may be subsequently reflected in the exposing process to be performed on the substrate P.

After the unexposed substrate P is loaded onto the substrate stage 2P and the measuring process that uses the measurement stage 2C has ended, the control apparatus 4 moves the substrate stage 2P to the projection area PR and forms the immersion space LS
25 between the last optical element 8 and the liquid immersion member 3 on one side and

the substrate stage 2P (i.e., the substrate P) on the other side.

In the present embodiment, the immersion space LS is formed with the exposure liquid LQ between the last optical element 8 and the liquid immersion member 3 on one side and the substrate P (i.e., the object) on the other side by recovering the exposure liquid LQ via the recovery ports 18 in parallel with supplying the exposure liquid LQ via the supply ports 17.

Furthermore, in the present embodiment, as shown in FIG. 2 and FIG. 3, in the state wherein the object (i.e., the substrate P) opposing the last optical element 8 and the liquid immersion member 3 is substantially stationary, the interface LG of the exposure liquid LQ in the immersion space LS is formed between the first portion 281 and the object.

Furthermore, in the state wherein the object is substantially stationary, the interface LG of the exposure liquid LQ in the immersion space LS is formed between the second portion 282 and the object.

The control apparatus 4 starts the process of exposing the substrate P. The control apparatus 4 radiates the exposure light EL, which emerges from the mask M illuminated with the exposure light EL from the illumination system IL, to the substrate P through the projection optical system PL and the exposure liquid LQ in the immersion space LS. Thereby, the substrate P is exposed with the exposure light EL, which transits the exposure liquid LQ in the immersion space LS and emerges from the emergent surface 7, and thus the image of the pattern of the mask M is projected to the substrate P.

When recovering the exposure liquid LQ via the recovery ports 18, the control apparatus 4 operates the second discharge apparatus 26 to discharge the gas G from the recovery passageway 19 via the second discharge ports 22. Thereby, the pressure Pb in the recovery passageway 19 decreases. In the present embodiment, the control

apparatus 4 controls the second discharge apparatus 26 such that the pressure Pb in the recovery passageway 19 is lower than the pressure Pa in the space SP. By making the pressure Pb lower than the pressure Pa , at least some of the exposure liquid LQ is recovered from the space above the substrate P to the recovery passageway 19 via the holes 28H of the first portion 281 of the first member 28 or the holes 28H of the second portion 282 of the first member 28, or both. In addition, at least some of the gas G is recovered from the space SP to the recovery passageway 19 via the holes 28H. The exposure liquid LQ and the gas G are separately discharged from the recovery passageway 19 via the discharge parts 20.

In the present embodiment, the discharge operation via the second discharge ports 22 is performed in the state wherein the hindering part 40, which comprises the projection 41 and the liquid repellent part 42, is disposed at least partly around the second discharge ports 22. The gas G is discharged from the recovery passageway 19 via the second discharge ports 22 while the hindering part 40 hinders the exposure liquid LQ in the recovery passageway 19 from contacting the second discharge ports 22. Furthermore, the hindering part 40 may have either just the projection 41 or just the liquid repellent part 42.

In the present embodiment, the exposure liquid LQ and the gas G flow in the recovery passageway 19 such that the exposure liquid LQ in the recovery passageway 19 contacts the first discharge ports 21 but not the second discharge ports 22. In the present embodiment, the arrangement of the first discharge ports 21, the second discharge ports 22, the recovery ports 18, and the like, and, for example, the shape of the inner surface of the recovery passageway 19, a characteristic (c.g., the contact angle) of the inner surface of the recovery passageway 19 with respect to the exposure liquid LQ, the shape of the surface of each of the members that faces the recovery passageway 19, and a

characteristic (e.g., the contact angle) of the surface of the members that face the recovery passageway 19 with respect to the exposure liquid LQ are prescribed such that the exposure liquid LQ recovered to the recovery passageway 19 via the holes 28H of the first member 28 flows toward the first discharge ports 21 without contacting the second
5 discharge ports 22.

In the present embodiment, the exposure liquid LQ, together with the gas G, is recovered to the recovery passageway 19 via the first portion 281 of the first member 28, and the exposure liquid LQ is recovered to the recovery passageway 19 via the second portion 282 of the first member 28 while the flow of the gas G into the recovery
10 passageway 19 via the second portion 282 is hindered.

By virtue of the pressure Pb in the recovery passageway 19 being made lower than the pressure Pa in the space SP between the liquid immersion member 3 and the substrate P, the exposure liquid LQ in the space above the substrate P flows into the recovery passageway 19 via the recovery ports 18 (i.e., the first member 28). Namely,
15 because a pressure differential is generated between the upper surface 28A and the lower surface 28B of the first member 28, the exposure liquid LQ in the space above the substrate P flows into the recovery passageway 19 via the recovery ports 18 (i.e., the first member 28).

In addition, the control apparatus 4 both controls the passageway switching
20 mechanism 23B such that the first discharge apparatus 24 and the first discharge ports 21 are connected and operates the first discharge apparatus 24 to discharge the exposure liquid LQ from the recovery passageway 19 via the first discharge ports 21. The operation of the first discharge apparatus 24 lowers the pressure in the passageways 30. In the present embodiment, the control apparatus 4 controls the first discharge apparatus
25 24 such that the pressure Pc in the passageways 30 becomes lower than the pressure Pb

in the recovery passageway 19.

The control apparatus 4 controls the first discharge apparatus 24 and thereby controls the pressure P_c in the passageways 30 such that only the exposure liquid LQ is discharged to the passageways 30 via the second members 27.

5 By virtue of the pressure P_c in the passageways 30 becoming lower than the pressure P_b in the recovery passageway 19, the exposure liquid LQ in the recovery passageway 19 flows into the passageways 30 via the first discharge ports 21 (i.e., the second members 27). Namely, by virtue of a pressure differential being generated between the upper surfaces 27A and the lower surfaces 27B of the second members 27,
10 the exposure liquid LQ in the recovery passageway 19 flows into the passageways 30 via the first discharge ports 21 (i.e., the second members 27).

During the recovery of the exposure liquid LQ via the recovery ports 18, the exposure liquid LQ continues to be discharged from the recovery passageway 19 via the first discharge ports 21. To recover the exposure liquid LQ via the recovery ports 18,
15 the second discharge ports 22 continue to discharge the gas G from the recovery passageway 19.

To discharge only the gas G from the recovery passageway 19, the second discharge ports 22 hinder the pressure P_b in the recovery passageway 19 from fluctuating greatly. Namely, the pressure P_b in the recovery passageway 19 is held substantially
20 constant by ensuring a continuous gas passageway between the second discharge apparatus 26 and the gas space at the upper part of the recovery passageway 19 and by the second discharge ports 22 continuing to discharge the gas G from the recovery passageway 19. Because the pressure P_b in the recovery passageway 19 is substantially constant, fluctuations in the amount of the exposure liquid LQ recovered per unit of time
25 from the space above the substrate P (i.e., in the immersion space LS) via the recovery

ports 18 are hindered.

In the present embodiment, to form the immersion space LS, the supply ports 17 supply a prescribed amount of the exposure liquid LQ per unit of time. In the present embodiment, the supply ports 17 continue to supply a substantially constant amount of the exposure liquid LQ. In addition, the recovery ports 18 recover a prescribed amount of the exposure liquid LQ per unit of time. In the present embodiment, the recovery ports 18 continue to recover a substantially constant amount of the exposure liquid LQ. Accordingly, large fluctuations in the immersion space LS are hindered.

In the present embodiment, the exposure liquid LQ recovered to the recovery passageway 19 via the recovery ports 18 flows toward the first discharge ports 21 (i.e., the second members 27) while contacting at least part of the inner surface of the recovery passageway 19. The exposure liquid LQ in the recovery passageway 19 that contacts any of the first discharge ports 21 (i.e., the second members 27) is discharged via those first discharge ports 21. For example, the exposure liquid LQ recovered via the holes 28H of the first portion 281 flows on the upper surface 28A of the first member 28 toward the first discharge ports 21 (i.e., the second members 27). The exposure liquid LQ is discharged from the recovery passageway 19 via the first discharge ports 21 such that the flow of the gas G from the recovery passageway 19 into the second discharge ports 22 is maintained. The control apparatus 4 controls the first discharge apparatus 24 or the second discharge apparatus 26, or both, such that the discharge of the gas G via the second discharge ports 22 continues and such that the exposure liquid LQ is discharged via the first discharge ports 21.

In the present embodiment, when the exposure liquid LQ is being recovered from the space above the substrate P via the first member 28, at least the upper surface 28A of the second portion 282 is covered by the exposure liquid LQ in the recovery passageway

19. In the present embodiment as shown in FIG. 2 and FIG. 3, in the recovery passageway 19, substantially the entire area of the upper surface 28A of the first member 28 is covered by the exposure liquid LQ in the recovery passageway 19. Namely, in the recovery passageway 19, substantially the entire upper surface 28A contacts the exposure liquid LQ. Thereby, the liquid selective recovery condition is satisfied for the majority of the holes 28H of the second portion 282, and substantially only the exposure liquid LQ is recovered via the second portion 282.

In addition, in the present embodiment, if the exposure liquid LQ in the immersion space LS flows out of the space SP, then the recovery port 401 of the recovery member 400 recovers that exposure liquid LQ. Thereby, the exposure liquid LQ is hindered from flowing out to the outer side of the space SQ. In addition, if the exposure liquid LQ remains in the space above the substrate P (i.e., the object), then the recovery port 401 recovers that residual exposure liquid LQ. Furthermore, the suctioning operation via the recovery port 401 does not have to be performed during the process of exposing the substrate P. Namely, the exposure liquid LQ does not have to be recovered via the recovery port 401 during the substrate P exposing process.

After the substrate P exposing process is complete, the control apparatus 4 moves the substrate stage 2P to the substrate exchange position. The measurement stage 2C is disposed such that it opposes, for example, the last optical element 8 and the liquid immersion member 3. The exposed substrate P is unloaded from the substrate stage 2P, which has moved to the substrate exchange position, and the unexposed substrate P is loaded onto the substrate stage 2P.

Below, the control apparatus 4 performs the processes discussed above repetitively to sequentially expose a plurality of the substrates P.

Furthermore, in the present embodiment, during at least part of the interval of the

exposure sequence, which includes the substrate P exchanging process, the measuring process using the measurement stage 2C, and the substrate P exposing process, the exposure liquid LQ is supplied via the supply ports 17 to the space between the last optical element 8 and the liquid immersion member 3 on one side and the object (i.e., the substrate P, the substrate stage 2P, or the measurement stage 2C, or any combination thereof), which is disposed opposing the last optical element 8 and the liquid immersion member 3, on the other side, and at least some of the exposure liquid LQ supplied via the supply ports 17 is recovered via the recovery ports 18. The exposure liquid LQ in the recovery passageway 19 recovered via the recovery ports 18 during the exposure sequence is discharged via the first discharge ports 21, and the gas G in the recovery passageway 19 is discharged via the second discharge ports 22.

Incidentally, during an exposure of the substrate P, there is a possibility that, for example, a substance (e.g., an organic substance such as the photosensitive material) produced by the substrate P will intermix with the exposure liquid LQ in the immersion space LS, or that a substance of the substrate P will elute into the exposure liquid LQ. That substance will function as foreign matter. In addition, along with the substance produced by the substrate P, foreign matter suspended in midair and the like might intermix with the exposure liquid LQ of the immersion space LS.

The liquid immersion member 3 is a member that contacts the exposure liquid LQ. In addition, because the first member 28 continues to contact the exposure liquid LQ at least during the exposure of the substrate P, if foreign matter intermixes with the exposure liquid LQ, then that foreign matter might adhere to the first member 28. For example, foreign matter might adhere to the lower surface 28B of the first member 28.

In addition, by virtue of the exposure liquid LQ in the immersion space LS, which is contaminated by foreign matter, being recovered via the recovery ports 18 and

flowing through the recovery passageway 19, at least part of, for example, the upper surface 28A and the surfaces (i.e., the inner surfaces) of the holes 28H of the first member 28, the inner surface of the recovery passageway 19, and the surfaces (i.e., the upper surfaces 27A, the lower surfaces 27B, and the inner surfaces of the holes 27H) of the second members 27 will contact the exposure liquid LQ and thereby the foreign matter might adhere to those surfaces.

If the state wherein foreign matter is adhered to at least part of the surfaces of the liquid immersion member 3—including the lower surface 14, the inner surface of the recovery passageway 19, the surfaces of the first member 28, and the surfaces of the second members 27—is left as is, then, for example, that foreign matter might adhere to the substrate P during an exposure, or the exposure liquid LQ supplied via the supply ports 17 might become contaminated. In addition, if the lower surface 14 becomes contaminated, then there is also a possibility that, for example, the immersion space LS will no longer be able to be formed satisfactorily. As a result, exposure failures might occur.

Accordingly, in the present embodiment, the cleaning sequence (i.e., the step SP2) is performed wherein at least part of the liquid immersion member 3 is cleaned with a prescribed timing.

The text below explains one example of the cleaning sequence for cleaning the liquid immersion member 3.

FIG. 7 is a flow chart that shows one example of the cleaning sequence according to the present embodiment, and FIG. 8 through FIG. 11 are schematic drawings that show one example of the cleaning sequence according to the present embodiment.

The cleaning sequence according to the present embodiment comprises: a process (i.e., a step SC1) wherein the object is disposed at a position at which it opposes the

recovery ports 18 of the liquid immersion member 3; a process (i.e., a step SC2) wherein the first cleaning liquid LC1 is supplied to the recovery passageway 19 of the liquid immersion member 3 and thereby at least part of the liquid immersion member 3 is cleaned; a process (i.e., a step SC3) wherein the rinsing liquid LH is supplied to the recovery passageway 19; a process (i.e., a step SC4) wherein the second cleaning liquid LC2 is supplied to the recovery passageway 19 and thereby at least part of the liquid immersion member 3 is cleaned; a process (i.e., a step SC5) wherein the rinsing liquid LH is supplied to the recovery passageway 19; and a process (i.e., a step SC6) wherein the rinsing liquid LH is furthermore supplied to the recovery passageway 19.

10 In the explanation below, the cleaning process that uses the first cleaning liquid LC1 (i.e., the step SC2) is called a first cleaning process where appropriate, and the cleaning process that uses the second cleaning liquid LC2 (i.e., the step SC4) is called a second cleaning process where appropriate.

In addition, in the explanation below, the process wherein the rinsing liquid LH is supplied to a member, such as the liquid immersion member 3, that was cleaned using the cleaning liquids LC (LC1, LC2) is called a rinsing process where appropriate. The rinsing process includes a process that supplies the rinsing liquid LH to a member and then eliminates the cleaning liquids LC (LC1, LC2) remaining on that member by rinsing that member.

20 In addition, in the explanation below, the rinsing process that is performed after the first cleaning process (i.e., the step SC3) is called a first rinsing process where appropriate, the rinsing process that is performed after the second cleaning process (i.e., the step SC5) is called a second rinsing process where appropriate, and the rinsing process that is performed after the second rinsing process (i.e., the step SC6) is called a
25 third rinsing process where appropriate.

An alkaline liquid, for example, may be used as the first cleaning liquid LC1. Namely, an alkaline solution that contains a prescribed substance may be used as the first cleaning liquid LC1. For example, the prescribed substance that the first cleaning liquid LC1 contains may be, for example, tetramethylammonium hydroxide (TMAH). In addition, an alkaline aqueous solution may be used as the first cleaning liquid LC1.

An acidic liquid, for example, may be used as the second cleaning liquid LC2. Namely, an acidic solution that contains a prescribed substance may be used as the second cleaning liquid LC2. The prescribed substance that the second cleaning liquid LC2 contains may be, for example, hydrogen peroxide. In addition, an acidic aqueous solution may be used as the second cleaning liquid LC2.

In addition, the first cleaning liquid LC1 and the rinsing liquid LH may be the same type of liquid. In addition, the second cleaning liquid LC2 and the rinsing liquid LH may be the same type of liquid.

In the present embodiment, an alkali aqueous solution is used as the first cleaning liquid LC1. An aqueous solution of hydrogen peroxide is used as the second cleaning liquid LC2. The exposure liquid LQ is used as the rinsing liquid LH. Namely, in the present embodiment, water (i.e., pure water) is used as the rinsing liquid LH. In the present embodiment, the abovementioned same type of liquid that is used as the first cleaning liquid LC1, the second cleaning liquid LC2, and the rinsing liquid LH may be water.

In the present embodiment, an aqueous solution of tetramethylammonium hydroxide (TMAH) is used as the first cleaning liquid LC1. An aqueous solution of hydrogen peroxide (i.e., aqueous hydrogen peroxide) is used as the second cleaning liquid LC2.

Furthermore, the alkaline solution used as the first cleaning liquid LC1 is not

limited to tetramethylammonium hydroxide, and may be an inorganic alkaline solution of sodium hydroxide, potassium hydroxide, and the like, or may be an organic alkaline solution of trimethyl(2-hydroxyethyl) ammonium hydroxide and the like. Furthermore, aqueous ammonia may be used as the first cleaning liquid LC1.

5 Furthermore, the second cleaning liquid LC2 may be a solution of buffered hydrofluoric acid. In addition, the second cleaning liquid LC2 may be a solution that contains buffered hydrofluoric acid and hydrogen peroxide. Buffered hydrofluoric acid is a mixture of hydrofluoric acid and ammonium fluoride. The mixing ratio may be in the range of 5:1 to 2000:1 as calculated by the volumetric ratio of a 40 wt% solution of
10 ammonium fluoride to 50 wt% of hydrofluoric acid. In addition, the mixing ratio of the buffered hydrofluoric acid to the hydrogen peroxide may be in the range of 0.8:1 to 55:1 as calculated by the weight ratio of the hydrogen peroxide to the hydrofluoric acid. The second cleaning liquid LC2 may even be an ozone liquid that contains ozone. Of course, it may be a solution that contains hydrogen peroxide and ozone.

15 Furthermore, the first cleaning liquid LC1 or the second cleaning liquid LC2, or both, may be an alcohol. For example, the first cleaning liquid LC1 or the second cleaning liquid LC2, or both, may be ethanol, isopropyl alcohol (IPA), or pentanol, or any combination thereof.

 In addition, the abovementioned same type of liquid used as the first cleaning
20 liquid LC1 and the second cleaning liquid LC2 may be, for example, an alcohol.

 In addition, a rinsing liquid other than the rinsing liquid LH may be used in at least one of the following processes: the first rinsing process, the second rinsing process, and the third rinsing process.

 In the present embodiment, at least part of the cleaning sequence is performed in
25 the state wherein the recovery ports 18 of the liquid immersion member 3 and the object

are opposed. In the cleaning sequence, first, the object is disposed such that it opposes the recovery ports 18 of the liquid immersion member 3 (i.e., the step SC1). In the present embodiment, the object that is disposed at the position at which it opposes the recovery ports 18 is a dummy substrate DP, which is held by the substrate stage 2P (i.e., the substrate holding part 10). In the present embodiment, the dummy substrate DP held by the substrate stage 2P is disposed such that it opposes the liquid immersion member 3. The dummy substrate DP is a substrate that tends not to release foreign matter more than the substrate P tends to. The dummy substrate DP is not used in the formation of the device pattern. In addition, there may be a function that traps foreign matter on the front surface of the dummy substrate DP. In such a case, the dummy substrate DP preferably tends not to release the foreign matter trapped on (i.e., adhered to) its front surface. In addition, in the present embodiment, the external shape and size of the dummy substrate DP are substantially the same as those of the substrate P. The substrate holding part 10 is capable of holding the dummy substrate DP. Furthermore, the external shape and size of the dummy substrate DP do not have to be the same as those of the substrate P.

In the state wherein the liquid immersion member 3 and the dummy substrate DP are opposed, the control apparatus 4 starts the first cleaning process (i.e., the step SC2). The first cleaning process includes the process wherein the first cleaning liquid LC1 is supplied to the recovery passageway 19. In the present embodiment, the supply of the first cleaning liquid LC1 to the recovery passageway 19 is started in the state wherein the recovery ports 18 of the liquid immersion member 3 and the dummy substrate DP are opposed across the space SP. Furthermore, when the first cleaning process is to be started, the supply of the first cleaning liquid LC1 may be started in the state wherein the exposure liquid LQ remains in the recovery passageway 19.

In the present embodiment, as shown in FIG. 8, the first cleaning liquid LC1 is supplied to the recovery passageway 19 via the first discharge ports 21. As discussed above, in the present embodiment, the supply apparatus 241, which is capable of supplying the cleaning liquids LC (LC1, LC2) and the rinsing liquid LH, is connected to the passageway 23. Furthermore, a supply apparatus that supplies the cleaning liquids LC (LC1, LC2) and a supply apparatus that supplies the rinsing liquid LH may be separately provided. In addition, a supply apparatus that supplies the first cleaning liquid LC1 and a supply apparatus that supplies the second cleaning liquid LC2 may be separately provided. In the first cleaning process, the control apparatus 4 delivers the first cleaning liquid LC1 from the supply apparatus 241. The control apparatus 4 controls the passageway switching mechanism 23B such that the first cleaning liquid LC1 delivered from the supply apparatus 241 is supplied to the first discharge ports 21. Thereby, the first cleaning liquid LC1 delivered from the supply apparatus 241 is supplied to the first discharge ports 21 via the passageway 231 and the passageway 23. The first discharge ports 21, which are disposed such that they face the recovery passageway 19, supply the first cleaning liquid LC1 from the supply apparatus 241 to the recovery passageway 19.

The first cleaning liquid LC1 from the supply apparatus 241 contacts at least part of the surfaces of the second members 27. Namely, the first cleaning liquid LC1 from the supply apparatus 241 contacts at least part of the upper surfaces 27A, the inner surfaces of the holes 27H, and the lower surfaces 27B of the second members 27. Thereby, the second members 27 are cleaned by the first cleaning liquid LC1.

In addition, at least some of the first cleaning liquid LC1 supplied to the recovery passageway 19 via the first discharge ports 21 contacts the inner surface of the recovery passageway 19. Thereby, at least part of the inner surface of the recovery passageway

19 is cleaned by the first cleaning liquid LC1.

In addition, at least some of the first cleaning liquid LC1 supplied to the recovery passageway 19 via the first discharge ports 21 contacts at least part of the surfaces of the first member 28. Namely, the first cleaning liquid LC1 from the first discharge ports 21
5 contacts at least part of the upper surface 28A, the inner surfaces of the holes 28H, and the lower surface 28B of the first member 28. Thereby, the first member 28 is cleaned by the first cleaning liquid LC1.

In the present embodiment, the first cleaning liquid LC1 is not discharged to the space SP, which the recovery ports 18 face, via the recovery ports 18 (i.e., the holes
10 28H).

In the present embodiment, the control apparatus 4 controls the difference between the pressure Pb in the recovery passageway 19 and the pressure Pa in the space SP such that the first cleaning liquid LC1 does not flow out of the recovery passageway 19 to the space SP via the recovery ports 18 (i.e., the holes 28H).

15 As discussed above, in the present embodiment, the second discharge apparatus 26 is capable of adjusting the pressure Pb in the recovery passageway 19. In addition, the chamber apparatus 100 is capable of adjusting the pressure Pa in the space SP. The control apparatus 4 uses the chamber apparatus 100 or the second discharge apparatus 26, or both, to control the difference between the pressure Pb in the recovery passageway 19
20 and the pressure Pa in the space SP such that the first cleaning liquid LC1 in the recovery passageway 19 is not supplied to the space SP via the recovery ports 18.

In the present embodiment, the control apparatus 4 controls the difference between the pressure Pb and the pressure Pa by discharging the gas G from the recovery passageway 19 via the second discharge port 22. Furthermore, the first cleaning liquid
25 LC1 may be discharged together with the gas G from the recovery passageway 19 via the

second discharge port 22.

Namely, in the present embodiment, when the first cleaning liquid LC1 is being supplied to the recovery passageway 19 via the first discharge ports 21, a fluid discharge operation is performed via the second discharge port 22 such that the first cleaning liquid LC1 in the recovery passageway 19 is not supplied to the space SP via the recovery ports 18. The fluid includes the gas G and the first cleaning liquid LC1, or both.

In the present embodiment, the first cleaning liquid LC1 in the recovery passageway 19 contacts the second member 27, the inner surface of the recovery passageway 19, and the first member 28.

For example, the difference between the pressure Pb and the pressure Pa may be controlled such that the liquid selective recovery condition is satisfied in relation to the first member 28.

As shown in FIG. 9, in the present embodiment, the control apparatus 4 supplies a prescribed amount of the first cleaning liquid LC1 to the recovery passageway 19 via the first discharge ports 21, after which the control apparatus 4 stops the supply of the first cleaning liquid LC1 via the first discharge ports 21. The control apparatus 4 supplies the first cleaning liquid LC1 to the recovery passageway 19 via the first discharge ports 21 such that, for example, the first cleaning liquid LC1 in the recovery passageway 19 contacts at least the second member 27. Namely, in the recovery passageway 19, the first cleaning liquid LC1 is supplied to the recovery passageway 19 via the first discharge ports 21 such that the surface (i.e., the liquid level) of the first cleaning liquid LC1 is disposed above the lower surface 27B of the second member 27.

In the present embodiment, the control apparatus 4 supplies the first cleaning liquid LC1 to the recovery passageway 19 via the first discharge ports 21 such that the first cleaning liquid LC1 covers substantially the entire upper surface 28A of the first

member 28. Furthermore, the first cleaning liquid LC1 does not have to cover substantially the entire upper surface 28A of the first member 28. In addition, the recovery passageway 19 may be filled, but does not have to be filled, with the first cleaning liquid LC1.

5 In the present embodiment, after the supply of the first cleaning liquid LC1 via the first discharge ports 21 is stopped, the supply of the first cleaning liquid LC1 to the recovery passageway 19 and the recovery (i.e., the discharge) of the first cleaning liquid LC1 from the recovery passageway 19 are not performed for a prescribed time. The state wherein the first cleaning liquid LC1 in the recovery passageway 19 is in contact
10 with the second member 27 and the like is maintained for the prescribed time. Furthermore, the prescribed time includes the time sufficient for foreign matter from the second member 27 that contacts the first cleaning liquid LC1 to be eliminated. Furthermore, during at least part of the interval during which the supply of the first cleaning liquid LC1 via the first discharge ports 21 is stopped, the fluid discharge
15 operation (i.e., the suction operation) via the second discharge port 22 may be stopped.

After the prescribed time has elapsed since the supply of the first cleaning liquid LC1 via the first discharge ports 21 was stopped, the control apparatus 4 discharges (i.e., recovers) the first cleaning liquid LC1 from the recovery passageway 19. In the present embodiment, the first cleaning liquid LC1 is discharged together with the gas G.

20 As shown in FIG. 10, in the present embodiment, the first cleaning liquid LC1 is discharged (i.e., recovered) from the recovery passageway 19 via the first discharge ports 21.

The discharge of the first cleaning liquid LC1 from the recovery passageway 19 via the first discharge ports 21 ends the first cleaning process (i.e., the step SC2).

25 Furthermore, in the first cleaning process, if the first cleaning liquid LC1 is discharged

from the recovery passageway 19, then the first cleaning liquid LC1 may be discharged not only via the first discharge ports 21 but also via the second discharge ports 22.

Next, the first rinsing process (i.e., the step SC3) is started. The first rinsing process includes the process of supplying of the rinsing liquid LH to the recovery passageway 19. In the present embodiment, the rinsing liquid LH is supplied to the recovery passageway 19 via the first discharge ports 21. Furthermore, the supply of the rinsing liquid LH may be started in the state wherein the first cleaning liquid LC1 remains in the recovery passageway 19.

By supplying the rinsing liquid LH to the recovery passageway 19, the first cleaning liquid LC1 remaining on, for example, at least part of the surfaces of the second members 27, the inner surface of the recovery passageway 19, and the surfaces of the first member 28 is eliminated.

In the present embodiment, the rinsing liquid LH does not flow out to the space SP, which the recovery ports 18 face, via the recovery ports 18 (i.e., the holes 28H). The control apparatus 4 controls the difference between the pressure P_b in the recovery passageway 19 and the pressure P_a in the space SP such that the rinsing liquid LH is not discharged from the recovery passageway 19 to the space SP via the recovery ports 18.

In the present embodiment, the first rinsing process can be performed using the same sequence of steps as that of the first cleaning process. A detailed explanation of the first rinsing process is omitted.

After the first rinsing process has ended, the second cleaning process, which uses the second cleaning liquid LC2, is started (i.e., the step SC4). The second cleaning process includes the process wherein the second cleaning liquid LC2 is supplied to the recovery passageway 19. In the present embodiment, the second cleaning liquid LC2 is supplied to the recovery passageway 19 via the first discharge ports 21. Furthermore,

the supply of the second cleaning liquid LC2 may be started in the state wherein the rinsing liquid LH remains in the recovery passageway 19.

Supplying the second cleaning liquid LC2 to the recovery passageway 19 cleans, for example, at least part of the surfaces of the second members 27, the inner surface of the recovery passageway 19, and the front surface of the first member 28.

In the present embodiment, the second cleaning liquid LC2 does not flow out to the space SP, which the recovery ports 18 face, via the recovery ports 18 (i.e., the holes 28H). The control apparatus 4 controls the difference between the pressure Pb in the recovery passageway 19 and the pressure Pa in the space SP such that the second cleaning liquid LC2 is not discharged from the recovery passageway 19 to the space SP via the recovery ports 18.

In the present embodiment, the second cleaning process can be performed using the same sequence of steps as that of the first cleaning process. A detailed explanation of the second cleaning process is omitted.

After the second cleaning process has ended, the second rinsing process (i.e., the step SC5) is started. In the present embodiment, the rinsing liquid LH is supplied to the recovery passageway 19 via the first discharge ports 21. Furthermore, the supply of the rinsing liquid LH may be started in the state wherein the second cleaning liquid LC2 remains in the recovery passageway 19.

The second rinsing process can be performed using the same sequence of steps as that of the first rinsing process. A detailed explanation of the second rinsing process is omitted.

After the second rinsing process has ended, the third rinsing process is started in the state wherein the liquid immersion member 3 and the dummy substrate DP are opposed (i.e., the step SC6). Furthermore, the third rinsing process may be started in

the state wherein the rinsing liquid LH remains in the recovery passageway 19.

As shown in FIG. 11, the third rinsing process includes the operation of supplying the rinsing liquid LH (i.e., the exposure liquid LQ) via the supply ports 17 of the liquid immersion member 3 in the state wherein the dummy substrate DP is disposed such that it opposes the liquid immersion member 3, and the operation of recovering, in parallel with the operation of supplying, the rinsing liquid LH via the recovery ports 18.

Thereby, the liquid immersion member 3 is rinsed.

Furthermore, in the state wherein the immersion space LS of the rinsing liquid LH is formed between the last optical element 8 and the liquid immersion member 3 on one side and the dummy substrate DP on the other side, the dummy substrate DP may be, but does not have to be, moved within the XY plane by controlling the substrate stage 2P.

Furthermore, the range of movement of the dummy substrate DP (i.e., the substrate stage 2P) with respect to the liquid immersion member 3 may be controlled such that the immersion space LS of the rinsing liquid LH is formed only above the dummy substrate DP and such that the rinsing liquid LH in the immersion space LS does not contact the upper surface 2PF of the substrate stage 2P on the outer side of the dummy substrate DP; furthermore, the dummy substrate DP (i.e., the substrate stage 2P) may be moved such that the rinsing liquid LH contacts the upper surface 2PF of the substrate stage 2P.

Furthermore, the third rinsing process may be omitted.

The above step completes the cleaning sequence. After the cleaning sequence has ended, the exposure sequence discussed above, for example, may be started.

According to the present embodiment as explained above, the liquid immersion member 3, which has contacted the exposure liquid LQ, can be cleaned satisfactorily.

Accordingly, it is possible to prevent exposure failures from occurring and defective

devices from being produced.

In addition, according to the present embodiment, at least part of the surfaces of the liquid immersion member 3—including the lower surface 14 of the liquid immersion member 3, the surfaces (i.e., the upper surface 28A, the lower surface 28B, or the inner surfaces of the holes 28H, or any combination thereof) of the first member 28, the inner surface of the recovery passageway 19, and the surfaces (i.e., the upper surfaces 27A, the lower surfaces 27B, or the inner surfaces of the holes 27H, or any combination thereof) of the second members 27—can be cleaned satisfactorily.

Furthermore, in the present embodiment, after the liquid (i.e., the first cleaning liquid LC1, the second cleaning liquid LC2, or the rinsing liquid LH, or any combination thereof) has been supplied to the recovery passageway 19 via the first discharge ports 21, the supply of the liquid via the first discharge ports 21 is stopped and, after the prescribed time has elapsed, the liquid is discharged via the first discharge ports 21 or the second discharge port 22, or both; however, during the first cleaning process, the first rinsing process, the second cleaning process, or the second rinsing process, or any combination thereof, for example, as shown in FIG. 12, the discharge of the liquid from the recovery passageway 19 via the second discharge port 22 may be continued for the prescribed time in parallel with the supply of the liquid to the recovery passageway 19 via the first discharge ports 21. In this case, after the supply of the liquid via the first discharge ports 21 and the discharge of the liquid via the second discharge port 22 has continued for the prescribed time, the supply of the liquid via the first discharge ports 21 should be stopped and the liquid should be discharged from the recovery passageway 19 via the first discharge ports 21 or the second discharge port 22, or both.

Furthermore, in the embodiment shown in FIG. 12, all of the recovery passageway 19 may be filled, but does not have to be filled, with the liquid supplied via

the first discharge ports 21. Namely, when the liquid is being supplied via the first discharge ports 21 and the liquid is being discharged via the second discharge port 22, all of the recovery passageway 19 may be a liquid space, or the recovery passageway 19 may include both a liquid space and a gas space.

5 <Second Embodiment>

A second embodiment will now be explained. In the explanation below, constituent parts that are identical or equivalent to those in the embodiment discussed above are assigned identical symbols, and the explanations thereof are therefore abbreviated or omitted.

10 In the first embodiment discussed above, the cleaning liquids LC (the rinsing liquid LH) are supplied to the recovery passageway 19 via the first discharge ports 21, and the cleaning liquids LC (the rinsing liquid LH) are recovered from the recovery passageway 19 via the first discharge ports 21. In the second embodiment, liquid supply ports 300, which are separate from the first discharge ports 21 and the second
15 discharge ports 22, are provided such that they face the recovery passageway 19, and the cleaning liquids LC (the rinsing liquid LH) are supplied to the recovery passageway 19 via the liquid supply ports 300.

FIG. 13 is a view that shows one example of a liquid immersion member 3B according to the second embodiment. In FIG. 13, the liquid immersion member 3B has
20 the liquid supply port 300, which faces the recovery passageway 19. In the present embodiment, the liquid supply port 300 is disposed in at least part of the inner surface of the recovery passageway 19. In the present embodiment, the liquid supply port 300 faces downward. Furthermore, the liquid supply port 300 does not have to face downward. For example, the liquid supply port 300 may face toward the outer side or
25 the inner side in the radial directions with respect to the optical path K.

In the present embodiment, the liquid supply port 300 is disposed on the inner side of the first discharge ports 21 in the radial directions with respect to the optical path K. In addition, the liquid supply port 300 is disposed on the inner side of the second discharge port 22 in the radial directions with respect to the optical path K.

5 Furthermore, the liquid supply port 300 may be disposed on the outer side of the second discharge port 22 or the outer side of the first discharge ports 21 in the radial directions with respect to the optical path K. In addition, the second discharge port 22 may be disposed on the inner side of the liquid supply port 300, and the first discharge ports 21 may be disposed on the outer side of the liquid supply port 300 in the radial directions
10 with respect to the optical path K. In addition, the first discharge ports 21 may be disposed on the inner side of the liquid supply port 300, and the second discharge port 22 may be disposed on the outer side of the liquid supply port 300 in the radial directions with respect to the optical path K.

For example, when the first cleaning process is performed, the first cleaning
15 liquid LC1 is supplied to the recovery passageway 19 via the liquid supply port 300, which faces the recovery passageway 19. The first cleaning liquid LC1 supplied to the recovery passageway 19 contacts, for example, at least part of the surfaces of the first member 28, the inner surface of the recovery passageway 19, and the surfaces of the second members 27. Thereby, at least part of the surfaces of the first member 28, the
20 inner surface of the recovery passageway 19, and the surfaces of the second members 27 are cleaned.

In the present embodiment, too, the first cleaning liquid LC1 does not flow out of the recovery passageway 19 to the space SP via the recovery ports 18. In the present embodiment, when the first cleaning liquid LC1 is being supplied to the recovery
25 passageway 19 via the liquid supply ports 300, the fluid discharge operation via the

second discharge ports 22 is performed. By performing the fluid discharge operation via the second discharge ports 22, the difference between the pressure P_a in the space SP and the pressure P_b in the recovery passageway 19 is adjusted such that the first cleaning liquid LC1 is not discharged from the recovery passageway 19 to the space SP via the
5 recovery ports 18.

In the present embodiment, the first cleaning liquid LC1 is discharged from the recovery passageway 19 via the first discharge ports 21. Namely, the first cleaning liquid LC1 is recovered from the recovery passageway 19 via the first discharge ports 21.

In the present embodiment, the control apparatus 4 controls the difference
10 between the pressure P_b and the pressure P_a by both discharging the first cleaning liquid LC1 via the first discharge ports 21 and discharging the gas G via the second discharge ports 22. For example, the difference between the pressure P_b and the pressure P_a may be controlled such that the liquid selective recovery condition is satisfied in relation to the first member 28. In the present embodiment, the supply and the recovery of the first
15 cleaning liquid LC1 are performed such that substantially the entire upper surface 28A of the first member 28 is covered with the first cleaning liquid LC1. Furthermore, substantially the entire upper surface 28A of the first member 28 does not have to be covered with the first cleaning liquid LC1. In addition, the recovery passageway 19 may be filled, but does not have to be filled, with the first cleaning liquid LC1.

20 In the present embodiment, the first cleaning liquid LC1 is recovered from the recovery passageway 19 via the first discharge ports 21 while the first cleaning liquid LC1 is supplied via the liquid supply ports 300. Namely, the control apparatus 4 performs the operation of recovering (i.e., discharging) the first cleaning liquid LC1 via the first discharge ports 21 in parallel with supplying the first cleaning liquid LC1 via the
25 liquid supply ports 300.

After the supply and the recovery of the first cleaning liquid LC1 has continued for the prescribed time, the supply of the first cleaning liquid LC1 via the liquid supply ports 300 is stopped and the first cleaning liquid LC1 is discharged from the recovery passageway 19 via the first discharge ports 21. In the present embodiment, the first
5 cleaning liquid LC1 is discharged together with the gas G via the first discharge ports 21. Thereby, the first cleaning process ends. Furthermore, during at least part of the first cleaning process, the first cleaning liquid LC1 may be discharged via the second discharge ports 22.

In addition, if it is possible to adopt a configuration wherein the first cleaning
10 liquid LC1 is not discharged from the recovery passageway 19 to the space SP via the recovery ports 18, then the fluid discharge operation (i.e., the suction operation) via the second discharge ports 22 does not have to be performed during at least part of the first cleaning process.

After the first cleaning process has ended, the first rinsing process is performed.
15 In the present embodiment, the first rinsing process includes the process of supplying the rinsing liquid LH via the liquid supply ports 300. Furthermore, the supply of the rinsing liquid LH may be started in the state wherein the first cleaning liquid LC1 remains in the recovery passageway 19. In the present embodiment, the rinsing liquid LH is supplied via the liquid supply ports 300 and, in parallel, the rinsing liquid LH is recovered from
20 the recovery passageway 19 via the first discharge ports 21. Thereby, at least some of the first cleaning liquid LC1 remaining on the surfaces of the first member 28, the inner surface of the recovery passageway 19, and the surfaces of the second members 27 is eliminated. In the first rinsing process, too, the rinsing liquid LH does not flow out of the recovery passageway 19 to the space SP via the recovery ports 18.

25 After the first rinsing process has ended, the second cleaning process is

performed. The second cleaning process includes the process of supplying the second cleaning liquid LC2 via the liquid supply ports 300. The second cleaning process includes the same sequence of steps as that of the first cleaning process. A detailed explanation of the second cleaning process is omitted.

5 After the second cleaning process has ended, the second rinsing process is performed. The second rinsing process includes the same sequence of steps as that of the first rinsing process. A detailed explanation of the second rinsing process is omitted.

 After the second rinsing process has ended, the third rinsing process may be
10 performed.

 In the present embodiment as explained above, too, at least part of the liquid immersion member 3B, which contacts the exposure liquid LQ, can be cleaned satisfactorily.

 Furthermore, in the present embodiment, the liquid (i.e., the first cleaning liquid
15 LC1, the second cleaning liquid LC2, or the rinsing liquid LH, or any combination thereof) may be supplied to the recovery passageway 19 via the second discharge ports 22 as long as it is possible to ensure that the liquid is not discharged from the recovery passageway 19 to the space SP via the recovery ports 18 by the fluid discharge operation (i.e., the suction operation) performed via the first discharge ports 21.

20 <Third Embodiment>

 A third embodiment will now be explained. In the explanation below, constituent parts that are identical or equivalent to those in the embodiments discussed above are assigned identical symbols, and the explanations thereof are therefore abbreviated or omitted.

25 In the third embodiment, liquid recovery ports 310, which are separate from the

first discharge ports 21 and the second discharge ports 22, are provided such that they face the recovery passageway 19, and the cleaning liquids LC (the rinsing liquid LH) are recovered from the recovery passageway 19 via the liquid recovery ports 310.

FIG. 14 is a view that shows one example of a liquid immersion member 3C according to the third embodiment. In FIG. 14, the liquid immersion member 3C has the liquid recovery port 310, which faces the recovery passageway 19. In the present embodiment, the liquid recovery port 310 is disposed in at least part of the inner surface of the recovery passageway 19. In the present embodiment, the liquid recovery port 310 faces downward. Furthermore, the liquid recovery port 310 does not have to face downward. For example, the liquid recovery port 310 may face toward the outer side or the inner side in the radial directions with respect to the optical path K.

In the present embodiment, the liquid recovery port 310 is disposed on the inner side of the first discharge ports 21 in the radial directions with respect to the optical path K. In addition, the liquid recovery port 310 is disposed on the inner side of the second discharge port 22 in the radial directions with respect to the optical path K.

Furthermore, the liquid recovery port 310 may be disposed on the outer side of the second discharge port 22 or the outer side of the first discharge ports 21 in the radial directions with respect to the optical path K. In addition, the second discharge port 22 may be disposed on the inner side of the liquid recovery port 310, and the first discharge ports 21 may be disposed on the outer side of the liquid recovery port 310 in the radial directions with respect to the optical path K. In addition, the first discharge ports 21 may be disposed on the inner side of the liquid recovery port 310, and the second discharge port 22 may be disposed on the outer side of the liquid recovery port 310 in the radial directions with respect to the optical path K.

For example, when the first cleaning process is performed, the first cleaning

liquid LC1 is supplied to the recovery passageway 19 via the first discharge ports 21.

The first cleaning liquid LC1 supplied to the recovery passageway 19 contacts, for example, at least part of the surfaces of the first member 28, the inner surface of the recovery passageway 19, and the surfaces of the second members 27. Thereby, at least
5 part of the surfaces of the first member 28, the inner surface of the recovery passageway 19, and the surfaces of the second members 27 are cleaned.

In the present embodiment, too, the first cleaning liquid LC1 does not flow out of the recovery passageway 19 to the space SP via the recovery ports 18. In the present embodiment, when the first cleaning liquid LC1 is being supplied to the recovery
10 passageway 19 via the first discharge ports 21, the fluid discharge operation via the second discharge ports 22 is performed. By performing the fluid discharge operation via the second discharge ports 22, the difference between the pressure P_a in the space SP and the pressure P_b in the recovery passageway 19 is adjusted such that the first cleaning liquid LC1 is not discharged from the recovery passageway 19 to the space SP via the
15 recovery ports 18.

In the present embodiment, the first cleaning liquid LC1 is recovered from the recovery passageway 19 via the liquid recovery ports 310.

In the present embodiment, the control apparatus 4 controls the difference between the pressure P_b and the pressure P_a by both discharging the first cleaning liquid
20 LC1 via the liquid recovery port 310 and discharging the gas G via the second discharge ports 22. For example, the difference between the pressure P_b and the pressure P_a may be controlled such that the liquid selective recovery condition is satisfied in relation to the first member 28. In the present embodiment, the control apparatus 4 performs the operation of supplying and recovering the first cleaning liquid LC1 such that
25 substantially the entire upper surface 28A of the first member 28 is covered with the first

cleaning liquid LC1. Furthermore, substantially the entire upper surface 28A of the first member 28 does not have to be covered with the first cleaning liquid LC1. In addition, the recovery passageway 19 may be filled, but does not have to be filled, with the first cleaning liquid LC1.

5 In the present embodiment, the first cleaning liquid LC1 is recovered from the recovery passageway 19 via the liquid recovery ports 310 while the first cleaning liquid LC1 is supplied via the first discharge ports 21. Namely, the control apparatus 4 performs the operation of recovering (i.e., discharging) the first cleaning liquid LC1 via the liquid recovery ports 310 in parallel with supplying the first cleaning liquid LC1 via
10 the first discharge ports 21.

After the supply and the recovery of the first cleaning liquid LC1 has continued for the prescribed time, the supply of the first cleaning liquid LC1 via the first discharge ports 21 is stopped and the first cleaning liquid LC1 is recovered from the recovery passageway 19 via the liquid recovery ports 310. Thereby, the first cleaning process ends.

15 Furthermore, the first cleaning liquid LC1 may be discharged via the first discharge ports 21 in parallel with the recovery of the liquid via the liquid recovery ports 310. In addition, during at least part of the first cleaning process, the first cleaning liquid LC1 may be discharged via the second discharge ports 22.

In addition, if it is possible to adopt a configuration wherein the first cleaning
20 liquid LC1 is not discharged from the recovery passageway 19 to the space SP via the recovery ports 18, then the fluid discharge operation (i.e., the suction operation) via the second discharge ports 22 does not have to be performed during at least part of the first cleaning process.

After the first cleaning process has ended, the first rinsing process is performed.

25 In the present embodiment, the first rinsing process includes the process of supplying the

rinsing liquid LH via the first discharge ports 21. Furthermore, the supply of the rinsing liquid LH may be started in the state wherein the first cleaning liquid LC1 remains in the recovery passageway 19. In the present embodiment, the rinsing liquid LH is supplied via the first discharge ports 21 and, in parallel, the rinsing liquid LH is recovered from the recovery passageway 19 via the liquid recovery ports 310. Thereby, at least some of the first cleaning liquid LC1 remaining on the surfaces of the first member 28, the inner surface of the recovery passageway 19, and the surfaces of the second members 27 is eliminated. In the first rinsing process, the rinsing liquid LH is not supplied from the recovery passageway 19 to the space SP via the recovery ports 18.

Furthermore, after the supply of the rinsing liquid LH via the first discharge ports 21 has been stopped, the discharge of the rinsing liquid LH via the first discharge ports 21 is performed in parallel with the recovery (i.e., discharge) of the rinsing liquid LH via the liquid recovery ports 310.

After the first rinsing process ends, the second cleaning process is performed.

The second cleaning process includes the process wherein the second cleaning liquid LC2 is supplied to the recovery passageway 19 via the first discharge ports 21 and the second cleaning liquid LC2 is recovered from the recovery passageway 19 via the liquid recovery ports 310. The second cleaning process includes the same sequence of steps as that of the first cleaning process. A detailed explanation of the second cleaning process is omitted.

After the second cleaning process has ended, the second rinsing process is performed. The second rinsing process includes the same sequence of steps as that of the first rinsing process. A detailed explanation of the second rinsing process is omitted.

After the second rinsing process has ended, the third rinsing process may be

performed.

In the present embodiment as explained above, too, at least part of the liquid immersion member 3C, which contacts the exposure liquid LQ, can be cleaned satisfactorily.

5 Furthermore, in the present embodiment, the liquid (i.e., the first cleaning liquid LC1, the second cleaning liquid LC2, or the rinsing liquid LH, or any combination thereof) may be supplied to the recovery passageway 19 via the second discharge ports 22 as long as it is possible to ensure that the liquid is not discharged from the recovery passageway 19 to the space SP via the recovery ports 18 by the fluid discharge operation
10 (i.e., the suction operation) performed via the liquid recovery ports 310.

<Fourth Embodiment>

A fourth embodiment will now be explained. In the explanation below, constituent parts that are identical or equivalent to those in the embodiments discussed above are assigned identical symbols, and the explanations thereof are therefore
15 abbreviated or omitted.

FIG. 15A shows the state wherein, for example, during the exposure sequence, the exposure liquid LQ is recovered from the space SP via the recovery ports 18 in parallel with the supply of the exposure liquid LQ via the supply port 17. In FIG. 15A, the exposure liquid LQ is present in the space SP below the liquid immersion member 3B.
20 The control apparatus 4 adjusts the difference between the pressure P_a in the space SP and the pressure P_b in the recovery passageway 19 such that the exposure liquid LQ is not supplied from the recovery passageway 19 to the space SP via the recovery ports 18.

When the cleaning sequence is performed, the supply of the exposure liquid LQ via the supply ports 17 is stopped. Moreover, after the supply of the exposure liquid LQ
25 via the supply ports 17 is stopped, too, the recovery of the exposure liquid LQ from the

space SP via the recovery ports 18 continues. Thereby, as shown in FIG. 15B, the exposure liquid LQ is eliminated from the space SP below the liquid immersion member 3B, which includes the space that the recovery ports 18 oppose.

After the exposure liquid LQ has been eliminated from the space SP, the control
5 apparatus 4 supplies the first cleaning liquid LC1 to the recovery passageway 19. The liquid immersion member 3B has the liquid supply ports 300, which face the recovery passageway 19.

As shown in FIG. 16A, the control apparatus 4 supplies the first cleaning liquid LC1 to the recovery passageway 19 via the liquid supply port 300. Thereby, the liquid,
10 which is a mixture of the exposure liquid LQ and the first cleaning liquid LC1, is present in the recovery passageway 19.

The liquid is discharged from the recovery passageway 19 via the first discharge ports 21. The control apparatus 4 discharges (i.e., recovers) the liquid from the recovery passageway 19 via the first discharge ports 21 in parallel with the supply of the
15 first cleaning liquid LC1 to the recovery passageway 19 via the liquid supply port 300. The control apparatus 4 supplies the first cleaning liquid LC1 to the recovery passageway 19 via the liquid supply port 300 and discharges (i.e., recovers) the liquid from the recovery passageway 19 via the first discharge ports 21 while adjusting the difference between the pressure P_a and the pressure P_b such that the liquid is not supplied from the
20 recovery passageway 19 to the space SP via the recovery ports 18.

Thereby, as shown in FIG. 16B, the exposure liquid LQ in the recovery passageway 19 is replaced by the first cleaning liquid LC1. Filling the recovery passageway 19 with the first cleaning liquid LC1 cleans, for example, at least part of the surfaces of the first member 28, the inner surface of the recovery passageway 19, and the
25 surfaces of the second member 27.

After the first cleaning process that uses the first cleaning liquid LC1 has ended, the first rinsing process, the second cleaning process, the second rinsing process, the third rinsing process, and the like are performed as in the embodiments discussed above.

In the present embodiment as explained above, too, at least part of the liquid immersion member 3B, which contacts the exposure liquid LQ, can be cleaned satisfactorily.

<Fifth Embodiment>

A fifth embodiment will now be explained. In the explanation below, constituent parts that are identical or equivalent to those in the embodiments discussed above are assigned identical symbols, and the explanations thereof are therefore abbreviated or omitted.

FIG. 17 is a partial view of the exposure apparatus EX according to the fifth embodiment. In the present embodiment, an ultrasonic wave generating apparatus 550, which comprises an oscillator that imparts ultrasonic waves to the liquid (i.e., the first cleaning liquid LC1, the second cleaning liquid LC2, or the rinsing liquid LH, or any combination thereof), is provided. As shown in FIG. 17, the ultrasonic wave generating apparatus 550 that comprises an oscillator capable of generating ultrasonic vibration is disposed, for example, in the passageway 23 (i.e., the piping member 23P). If the liquid is supplied to the recovery passageway 19 via the first discharge ports 21, then the control apparatus 4 operates the ultrasonic wave generating apparatus 550. Thereby, ultrasonic waves are imparted to the liquid that is delivered from the supply apparatus 241 and flows through the passageway 23.

Furthermore, as shown in FIG. 17, an ultrasonic wave generating apparatus 560, which comprises an oscillator capable of generating ultrasonic vibration, may be disposed in, for example, the recovery passageway 19. The ultrasonic wave generating

apparatus 560 can impart ultrasonic waves to the liquid supplied to the recovery passageway 19.

Furthermore, in each of the embodiments discussed above, during the first cleaning process, the first rinsing process, the second cleaning process, the second
5 rinsing process, or the third rinsing process, or any combination thereof, both the ultrasonic wave generating apparatus 550 and the ultrasonic wave generating apparatus 560, or just one of them, may be used.

Furthermore, in FIG. 17, both the ultrasonic wave generating apparatus 550 and the ultrasonic wave generating apparatus 560 are provided, but just one of them may be
10 provided.

A strong cleaning effect or a strong rinsing effect, or both, can be obtained by virtue of the liquid, to which the ultrasonic waves are imparted, contacting at least part of the liquid immersion member 3D.

Furthermore, in the first through fifth embodiments discussed above, during the
15 first cleaning process, the first rinsing process, the second cleaning process, and the second rinsing process, the dummy substrate DP does not have to be disposed at the position at which it opposes the liquid immersion member 3 (3B, 3C, 3D) (i.e., the recovery ports 18). Namely, during at least part of the first cleaning process, the first rinsing process, the second cleaning process, and the second rinsing process, wherein the
20 liquid does not flow out to the space SP, the stage (i.e., the substrate stage 2P or the measurement stage 2C, or both) does not have to be disposed below the liquid immersion member 3.

Furthermore, in the first through fifth embodiments discussed above, not all of the lower surface 14 of the liquid immersion member 3, the surfaces of the first member
25 28, the inner surface of the recovery passageway 19, and the surfaces of the second

members 27 have to be cleaned. For example, at least part of the second members 27, which have the first discharge ports 21, do not have to be cleaned.

Furthermore, in each of the embodiments discussed above, the liquid immersion member 3 may be capable of moving with respect to the last optical element 8. For example, the liquid immersion member 3 may be capable of moving in the Z axial directions with respect to the last optical element 8. In addition, the liquid immersion member 3 may be capable of moving in the θX directions or the θY directions, or both, with respect to the last optical element 8. In other words, the liquid immersion member 3 may be capable of tilting. Of course, the liquid immersion member 3 may be capable of moving in the X axial directions, the Y axial directions, the θZ directions, or any combination thereof, with respect to the last optical element 8. Furthermore, the liquid immersion member 3 may be capable of moving by an actuator, such as a voice coil motor. In addition, the liquid immersion member 3 may be capable of moving by being supported by an elastic member that comprises, for example, a spring, or by a flexible member that comprises, for example, a bellows.

Furthermore, in each of the embodiments discussed above, the lower surface 28B of the first member 28 (i.e., the lower surface 14 of the liquid immersion member 3) and the lower surface 402 of the recovery member 400 are disposed at substantially the same position (i.e., height) in the Z axial directions; however, for example, the lower surface 402 may be disposed below (i.e., in the $-Z$ direction of) or above (i.e., in the $+Z$ direction of) the lower surface 28B. In other words, the distance between the lower surface 402 (i.e., the recovery port 401) of the recovery member 400 and the upper surface of the object (i.e., the front surface of the substrate P, the front surface of the dummy substrate DP, and the like) may be less than, or greater than, the distance between the lower surface 28B of the first member 28 and the upper surface of the object. In addition, if the lower

surface 28B of the first member 28 is tilted, then just part of the lower surface 28B of the first member 28 may be lower than, or higher than, the lower surface 402 (i.e., the recovery port 401).

Furthermore, in the embodiments discussed above, the lower surface 402 (i.e., the recovery port 401) of the recovery member 400 is disposed below the emergent surface 7 of the last optical element 8, but it may be disposed thereabove or at substantially the same height.

Furthermore, in each of the embodiments discussed above, the emergent surface 7 is disposed above the lower surface 28B. In that case, the lower surface 402 may be disposed between the emergent surface 7 and the lower surface 28B in the Z axial directions. In other words, the lower surface 402 may be disposed above the lower surface 28B and below the emergent surface 7.

Furthermore, in each of the embodiments discussed above, the recovery member 400 may be capable of moving with respect to the liquid immersion member 3. For example, the recovery member 400 may be capable of moving in the Z axial directions with respect to the liquid immersion member 3. In addition, the recovery member 400 may be capable of moving in the θX directions or the θY directions, or both, with respect to the liquid immersion member 3. In other words, the recovery member 400 may be capable of tilting. Of course, the recovery member 400 may be capable of moving in the X axial directions, the Y axial directions, the θZ directions, or any combination thereof, with respect to the liquid immersion member 3. Furthermore, the recovery member 400 may be capable of moving by an actuator, such as a voice coil motor. In addition, the recovery member 400 may be capable of moving by being supported by an elastic member that comprises, for example, a spring, or by a flexible member that comprises, for example, a bellows.

In addition, if the recovery member 400 is moved in the Z axial directions relative to the liquid immersion member 3, then, during at least part of the cleaning sequence, the recovery member 400 may be moved in the Z axial directions such that at least part of the lower surface 28B of the first member 28 is lower than (i.e., disposed on
5 the -Z side of) the lower surface 402 (i.e., the recovery port 401).

Furthermore, in each of the embodiments discussed above, the member (i.e., the liquid immersion member 3) that has the recovery ports 18 and the member (i.e., the recovery member 400) that has the recovery port 401 disposed at least partly around the recovery ports 18 are separate members; however, the recovery ports 18 and the recovery
10 port 401 may be disposed in a single member (i.e., the liquid immersion member 3 (3B, 3C, 3D)). In addition, the recovery member 400 (i.e., the recovery port 401) does not have to be provided.

Furthermore, in each of the embodiments discussed above, the hindering part (40 and the like), which hinders contact between the second discharge ports 22 and the
15 exposure liquid LQ, is provided, but it does not have to be provided.

Furthermore, in each of the embodiments discussed above, the cleaning sequence is performed using the first cleaning liquid LC1 and the second cleaning liquid LC2; however, the cleaning sequence may be performed using a single cleaning liquid or using three or more cleaning liquids.

20 Furthermore, in each of the embodiments discussed above, the rinsing processes that are performed after the cleaning processes wherein the cleaning liquids LC are used may be omitted. For example, the first rinsing process may be omitted.

In addition, in each of the embodiments discussed above, during the first rinsing process or the second rinsing process, or both, the rinsing liquid LH (i.e., the exposure
25 liquid LQ) may be supplied via the supply ports 17 and recovered via the recovery ports

18.

Furthermore, in each of the embodiments discussed above, the third rinsing process (i.e., the step SC6) may be performed above the measurement stage 2C.

Furthermore, in each of the embodiments discussed above, the first member 28
5 comprises the first portion 281 and the second portion 282, which are provided such that their resistances to the inflow of the gas G are different; however, the first member 28 does not have to be provided with multiple portions that have different resistances to the inflow of the gas G.

Furthermore, in each of the embodiments discussed above, the upper surface 28A
10 or the lower surface 28B, or both, of the first member 28 may be tilted with respect to the horizontal plane (i.e., the XY plane).

Furthermore, in each of the embodiments discussed above, the first discharge
ports 21 or the second discharge ports 22, or both, do not have to oppose the upper
surface 28A of the first member 28. For example, the first discharge ports 21 or the
15 second discharge ports 22, or both, may be disposed on the outer side of an outer side end part of the first member 28 in the radial directions with respect to the optical path K. Namely, the first discharge ports 21 or the second discharge ports 22, or both, may be disposed farther from the optical path K in the radial directions with respect to the optical path K than the first member 28 is.

20 In addition, in each of the embodiments discussed above, too, the first discharge ports 21 may be disposed on the inner side of the second discharge ports 22 in radial directions with respect to the optical path K. Namely, the first discharge ports 21 may be nearer to the optical path K than the second discharge ports 22 are.

In addition, in each of the embodiments discussed above, the first discharge ports
25 21 face the -Z direction, but they may face a different direction. For example, they may

face the +Z direction, or a direction parallel to the Y axial directions; furthermore, the third surfaces 27B of the second members 27 may be tilted with respect to the horizontal plane (i.e., the XY plane).

In addition, in each of the embodiments discussed above, the second discharge
5 ports 22 face the -Z direction, but they may face a different direction. For example, they may face the +Z direction. Alternatively, they may face a direction parallel to the Y axial directions.

In addition, the direction in which the first discharge ports 21 face and the direction in which the second discharge ports 22 face may be different.

10 Furthermore, in each of the embodiments discussed above, the "radial directions with respect to the optical path K" may be regarded as the radial directions with respect to the optical axis AX of the projection optical system PL in the vicinity of the projection area PR.

Furthermore, as discussed above, the control apparatus 4 comprises a computer
15 system, which comprises a CPU and the like. In addition, the control apparatus 4 comprises an interface, which is capable of conducting communication between the computer system and the external apparatus. The storage apparatus 5 comprises a storage medium such as memory (e.g., RAM), a hard disk, a CD-ROM, and the like. In the storage apparatus 5, an operating system (OS) that controls a computer system is
20 installed and a program for controlling the exposure apparatus EX is stored.

Furthermore, the control apparatus 4 may be connected to an input apparatus that is capable of inputting an input signal. The input apparatus comprises input equipment, such as a keyboard and a mouse, or a communication apparatus, which is capable of inputting data from the external apparatus. In addition, a display apparatus, such as a
25 liquid crystal display, may be provided.

Various information, including the program stored in the storage apparatus 5, can be read by the control apparatus 4 (i.e., the computer system). In the storage apparatus 5, a program is stored that causes the control apparatus 4 to control the exposure apparatus EX such that the substrate P is exposed with the exposure light EL, which
5 transits the exposure liquid LQ.

The program stored in the storage apparatus 5 may cause the control apparatus 4 to execute the following processes according to the embodiments discussed above: a process that forms the immersion space LS with the exposure liquid LQ between the substrate P and the liquid immersion member 3 that has the recovery ports 18, which are
10 capable of recovering at least some of the exposure liquid LQ from the space above the substrate P, the recovery passageway 19, wherethrough the exposure liquid LQ recovered via the recovery ports 18 flows, the first discharge ports 21, which are for discharging the exposure liquid LQ from the recovery passageway 19, and the second discharge ports 22, which are for discharging the gas G from the recovery passageway 19 and hinder the
15 discharge of the exposure liquid LQ more than the first discharge ports 21 do, such that the optical path K of the exposure light EL between the substrate P and the last optical element 8, wherefrom the exposure light EL can emerge, is filled with the exposure liquid LQ; a process that exposes the substrate P with the exposure light EL, which transits the exposure liquid LQ in the immersion space LS; a process that recovers at
20 least some of the exposure liquid LQ from the space above the substrate P via the recovery ports 18 of the liquid immersion member 3; a process that, when an exposure is not being performed, supplies the cleaning liquids LC to the recovery passageway 19; and a process that adjusts the difference between the pressure Pb in the recovery passageway 19 and the pressure Pa in the space SP, which the recovery ports 18 face,
25 such that the cleaning liquids LC supplied to the recovery passageway 19 are not

supplied to the space SP, which the recovery ports 18 face.

In addition, the program stored in the storage apparatus 5 may cause the control apparatus 4 to execute the following processes according to the embodiments discussed above: a process that forms the immersion space LS with the exposure liquid LQ

5 between the substrate P and the liquid immersion member 3 that has the recovery ports 18, which are capable of recovering at least some of the exposure liquid LQ from the space above the substrate P, the recovery passageway 19, wherethrough the exposure liquid LQ recovered via the recovery ports 18 flows, the first discharge ports 21 for discharging from the recovery passageway 19 the fluid that includes the exposure liquid
10 LQ and that has a higher percentage of the exposure liquid LQ than of the gas G, and the second discharge ports 22 for discharging from the recovery passageway 19 the fluid that includes the gas G and that has a lower percentage of the exposure liquid LQ than of the gas G, such that the optical path K of the exposure light EL between the substrate P and the last optical element 8, wherefrom the exposure light EL can emerge, is filled with the
15 exposure liquid LQ; a process that exposes the substrate P with the exposure light EL, which transits the exposure liquid LQ in the immersion space LS; a process that recovers at least some of the exposure liquid LQ from the space above the substrate P via the recovery ports 18 of the liquid immersion member 3; a process that, when an exposure is not being performed, supplies the cleaning liquids LC to the recovery passageway 19;
20 and a process that adjusts the difference between the pressure Pb in the recovery passageway 19 and the pressure Pa in the space SP, which the recovery ports 18 face, such that the cleaning liquids LC supplied to the recovery passageway 19 are not supplied to the space SP, which the recovery ports 18 face.

In addition, the program stored in the storage apparatus 5 may cause the control
25 apparatus 4 to execute the following processes according to the embodiments discussed

above: a process that forms the immersion space LS with the exposure liquid LQ between the substrate P and the liquid immersion member 3 that has the recovery ports 18, which are capable of recovering at least some of the exposure liquid LQ from the space above the substrate P, the recovery passageway 19, wherethrough the exposure liquid LQ recovered via the recovery ports 18 flows, and the discharge parts 20, which separately discharge the exposure liquid LQ and the gas G from the recovery passageway 19 and have the first discharge ports 21 for discharging the exposure liquid LQ from the recovery passageway 19 and the second discharge ports 22 for discharging the gas G from the recovery passageway 19, such that the optical path K of the exposure light EL between the substrate P and the last optical element 8, wherefrom the exposure light EL can emerge, is filled with the exposure liquid LQ; a process that exposes the substrate P with the exposure light EL, which transits the exposure liquid LQ in the immersion space LS; a process that recovers at least some of the exposure liquid LQ from the space above the substrate P via the recovery ports 18 of the liquid immersion member 3; a process that, when an exposure is not being performed, supplies the cleaning liquids LC to the recovery passageway 19; and a process that adjusts the difference between the pressure Pb in the recovery passageway 19 and the pressure Pa in the space SP, which the recovery ports 18 face, such that cleaning liquids LC supplied to the recovery passageway 19 are not supplied to the space SP, which the recovery ports 18 face.

The program stored in the storage apparatus 5 is read by the control apparatus 4, and thereby the various processes, such as the immersion exposure of the substrate P in the state wherein the immersion space LS is formed, are executed in cooperation with the various apparatuses of the exposure apparatus EX, such as the substrate stage 2P, the liquid immersion member 3, the liquid supply apparatus 35, the first discharge apparatus 24, and the second discharge apparatus 26.

Furthermore, in each of the embodiments discussed above, the optical path K on the emergent (i.e., the image plane) side of the last optical element 8 of the projection optical system PL is filled with the exposure liquid LQ; however, the projection optical system PL may be a projection optical system wherein the optical path K on the incident
5 (i.e., the object plane) side of the last optical element 8 is also filled with the exposure liquid LQ, as disclosed in, for example, PCT International Publication No. WO2004/019128.

Furthermore, in each of the embodiments discussed above, the exposure liquid LQ is water but may be a liquid other than water. Preferably, the exposure liquid LQ is
10 a liquid that is transparent with respect to the exposure light EL, has a high refractive index with respect to the exposure light EL, and is stable with respect to the projection optical system PL or the film of, for example, the photosensitive material (i.e., the photoresist) that forms the front surface of the substrate P. For example, the exposure liquid LQ may be a fluorine-based liquid such as hydro-fluoro-ether (HFE),
15 perfluorinated polyether (PFPE), or Fomblin[®] oil. In addition, the exposure liquid LQ may be any of various fluids, for example, a supercritical fluid.

Furthermore, the substrate P in each of the embodiments discussed above is a semiconductor wafer for fabricating semiconductor devices, but it may be, for example, a glass substrate for display devices, a ceramic wafer for thin film magnetic heads, or the
20 original plate of a mask or a reticle (e.g., synthetic quartz or a silicon wafer) used by an exposure apparatus.

Furthermore, the exposure apparatus EX in each of the embodiments discussed above is a step-and-scan type scanning exposure apparatus (i.e., a scanning stepper), which scans and exposes the pattern of the mask M by synchronously moving the mask
25 M and the substrate P, but the exposure apparatus EX may be, for example, a

step-and-repeat type projection exposure apparatus (i.e., a stepper), which performs a full field exposure of the pattern of the mask M—with the mask M and the substrate P in a stationary state—and then sequentially steps the substrate P.

In addition, the exposure apparatus EX may be a full-field exposure apparatus (i.e., a stitching type full-field exposure apparatus), which performs a full-field exposure of the substrate P; in this case, a step-and-repeat type exposure is performed using the projection optical system PL to transfer a reduced image of a first pattern onto the substrate P in a state wherein the first pattern and the substrate P are substantially stationary, after which the projection optical system PL is used to partially superpose a reduced image of a second pattern onto the transferred first pattern in the state wherein the second pattern and the substrate P are substantially stationary. In addition, the stitching type exposure apparatus may be a step-and-stitch type exposure apparatus that successively transfers at least two patterns onto the substrate P such that they are partially superposed and steps the substrate P.

In addition, the exposure apparatus EX may be an exposure apparatus that combines on the substrate P the patterns of two masks through a projection optical system and double exposes, substantially simultaneously, a single shot region on the substrate P using a single scanning exposure, as disclosed in, for example, U.S. Patent No. 6,611,316. In addition, the exposure apparatus EX may be a proximity type exposure apparatus, a mirror projection aligner, or the like.

Furthermore, the exposure apparatus EX does not have to comprise the measurement stage 2C.

In addition, the exposure apparatus EX may be a twin stage type exposure apparatus, which comprises a plurality of substrate stages, as disclosed in, for example, U.S. Patent Nos. 6,341,007, 6,208,407, and 6,262,796. For example, if the exposure

apparatus EX comprises two of the substrate stages, then the object that is capable of being disposed such that it opposes the emergent surface 7 is one of the substrate stages, a substrate held by a substrate holding part on that substrate stage, the other of the substrate stages, the substrate held by a substrate holding part on that other substrate stage, or any combination thereof.

In addition, the exposure apparatus EX may be an exposure apparatus that comprises a plurality of the substrate stages and the measurement stages.

The exposure apparatus EX may be a semiconductor device fabrication exposure apparatus that exposes the substrate P with the pattern of a semiconductor device, an exposure apparatus used for fabricating, for example, liquid crystal devices or displays, or an exposure apparatus for fabricating thin film magnetic heads, image capturing devices (e.g., CCDs), micromachines, MEMS, DNA chips, or reticles and masks.

Furthermore, in each of the embodiments discussed above, the position of each of the stages (i.e., the mask stage 1, the measurement stage 2C, and the substrate stage 2P) is measured using the interferometer system 130, but the present invention is not limited thereto; for example, an encoder system that detects a scale (i.e., a diffraction grating) provided to each of the stages (i.e., the mask stage 1, the measurement stage 2C, and the substrate stage 2P) may be used, or the interferometer system 130 may be used in parallel with the encoder system.

Furthermore, in the embodiments discussed above, the optically transmissive mask M wherein a prescribed shielding pattern (or phase pattern or dimming pattern) is formed on an optically transmissive substrate is used; however, instead of such a mask, a variable shaped mask (also called an electronic mask, an active mask, or an image generator), wherein a transmissive pattern, a reflective pattern, or a light emitting pattern is formed based on electronic data of the pattern to be exposed, as disclosed in, for

example, U.S. Patent No. 6,778,257, may be used. In addition, instead of a variable shaped mask that comprises a non-emissive type image display device, a pattern forming apparatus that comprises a self-luminous type image display device may be provided.

In each of the embodiments discussed above, the exposure apparatus EX
5 comprises the projection optical system PL; however, the constituent elements explained in each of the embodiments discussed above may be adapted to an exposure apparatus and an exposing method that does not use the projection optical system PL. For example, the constituent elements explained in each of the embodiments discussed above may be adapted to an exposure apparatus and an exposing method wherein the
10 immersion space LS is formed between the substrate P and an optical member such as a lens, and the exposure light EL is radiated to the substrate P via that optical member.

In addition, the exposure apparatus EX may be an exposure apparatus (i.e., a lithographic system) that exposes the substrate P with a line-and-space pattern by forming interference fringes on the substrate P, as disclosed in, for example, PCT
15 International Publication No. WO2001/035168.

The exposure apparatus EX according to the embodiments discussed above is manufactured by assembling various subsystems, including each constituent element discussed above, so that prescribed mechanical, electrical, and optical accuracies are maintained. To ensure these various accuracies, adjustments are performed before and
20 after this assembly, including an adjustment to achieve optical accuracy for the various optical systems, an adjustment to achieve mechanical accuracy for the various mechanical systems, and an adjustment to achieve electrical accuracy for the various electrical systems. The process of assembling the exposure apparatus EX from the various subsystems includes, for example, the connection of mechanical components, the
25 wiring and connection of electrical circuits, and the piping and connection of the

pneumatic circuits among the various subsystems. Naturally, prior to performing the process of assembling the exposure apparatus EX from these various subsystems, there are also the processes of assembling each individual subsystem. After the process of assembling the exposure apparatus EX from the various subsystems is complete, a

5 comprehensive adjustment is performed to ensure the various accuracies of the exposure apparatus EX as a whole. Furthermore, it is preferable to manufacture the exposure apparatus EX in a clean room, wherein the temperature, the cleanliness level, and the like are controlled.

As shown in FIG. 18, a microdevice, such as a semiconductor device, is

10 manufactured by: a step 201 that designs the functions and performance of the microdevice; a step 202 that fabricates the mask M (i.e., the reticle) based on this designing step; a step 203 that manufactures the substrate P, which is the base material of the device; a substrate processing step 204 that comprises a substrate process (i.e., an exposure process) that includes, in accordance with the embodiments discussed above,

15 exposing the substrate P with the exposure light EL that emerges from the pattern of the mask M and developing the exposed substrate P; a device assembling step 205 (which includes fabrication processes such as dicing, bonding, and packaging processes); an inspecting step 206; and the like.

Furthermore, the features of each of the embodiments discussed above can be

20 combined as appropriate. In addition, there are also cases wherein some of the constituent elements are not used. In addition, each disclosure of every Japanese published patent application and U.S. patent related to the exposure apparatus EX recited in each of the embodiments discussed above, the modified examples, and the like is hereby incorporated by reference in its entirety to the extent permitted by the national

25 laws and regulations.

CLAIMS

1. A method of cleaning a liquid immersion member in an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid,
5 that has a first recovery port, which is capable of recovering the exposure liquid and that is disposed at least partly around an optical member and an optical path of the exposure light that passes through the exposure liquid between the optical member and the substrate, the method comprising:

supplying a cleaning liquid to a recovery passageway, wherethrough the exposure
10 liquid recovered via the first recovery port from a space, which the first recovery port faces, flows; and

recovering the cleaning liquid from the recovery passageway;

wherein,

the liquid immersion member has a first discharge port, which is for discharging
15 the exposure liquid from the recovery passageway, and a second discharge port, which hinders the discharge of the exposure liquid more than the first discharge port does and is for discharging a gas from the recovery passageway; and

the cleaning liquid is not supplied to the space, which the first recovery port faces, via the first recovery port.

20

2. A method of cleaning a liquid immersion member in an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, that has a first recovery port, which is capable of recovering the exposure liquid and that is disposed at least partly around an optical member and an optical path of the exposure
25 light that passes through the exposure liquid between the optical member and the

substrate, the method comprising:

supplying a cleaning liquid to a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from a space, which the first recovery port faces, flows; and

5 recovering the cleaning liquid from the recovery passageway;
wherein,

the liquid immersion member has a first discharge port, which is for discharging from the recovery passageway a fluid that includes the exposure liquid and that has a higher percentage of the exposure liquid than of the gas, and a second discharge port,
10 which is for discharging from the recovery passageway a fluid that includes the gas and that has a lower percentage of the exposure liquid than of the gas; and

the cleaning liquid is not supplied to the space, which the first recovery port faces, via the first recovery port.

15 3. A method of cleaning a liquid immersion member in an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, that has a first recovery port, which is capable of recovering the exposure liquid and that is disposed at least partly around an optical member and an optical path of the exposure light that passes through the exposure liquid between the optical member and the
20 substrate, the method comprising:

supplying a cleaning liquid to a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from a space, which the first recovery port faces, flows; and

recovering the cleaning liquid from the recovery passageway;
25 wherein,

the liquid immersion member comprises a discharge part, which separately discharges the exposure liquid and a gas from the recovery passageway; the discharge part has a first discharge port, which is for discharging the exposure liquid from the recovery passageway, and a second discharge port, which is for discharging the gas from the recovery passageway; and

the cleaning liquid is not supplied to the space, which the first recovery port faces, via the first recovery port.

4. The cleaning method according to any one claim of claim 1 through claim 3,

comprising the step of:

controlling the difference between a pressure in the recovery passageway and a pressure in the space such that the cleaning liquid is not supplied from the recovery passageway to the space, which the first recovery port faces, via the first recovery port.

5. The cleaning method according to claim 4, comprising the step of:

controlling the difference between the pressures by discharging the gas from the recovery passageway via the second discharge port.

6. The cleaning method according to claim 4 or claim 5, comprising the step of:

controlling the difference between the pressures by recovering the cleaning liquid via the recovery passageway.

7. The cleaning method according to claim 6, wherein

the recovery passageway is filled with the cleaning liquid.

8. The cleaning method according to any one claim of claim 1 through claim 7, wherein
the cleaning liquid is recovered via a second recovery port, which faces the
recovery passageway.

5 9. The cleaning method according to any one claim of claim 1 through claim 8, wherein
the cleaning liquid is recovered via the first discharge port.

10. The cleaning method according to any one claim of claim 1 through claim 8,
wherein
10 the cleaning liquid is supplied to the recovery passageway via the first discharge
port.

11. The cleaning method according to claim 10, wherein
the cleaning liquid is recovered via the first discharge port.

15

12. The cleaning method according to claim 11, comprising:
supplying a prescribed amount of the cleaning liquid via the first discharge port;
and
after this supplying stops, recovering the cleaning liquid from the recovery
20 passageway via the first discharge port.

13. The cleaning method according to claim 12, wherein
after a prescribed time has elapsed since the stopping of the supply, the cleaning
liquid is recovered from the recovery passageway via the first discharge port.

25

14. The cleaning method according to any one claim of claim 1 through claim 13,
wherein

the cleaning liquid is supplied to the recovery passageway via a supply port,
which faces the recovery passageway.

5

15. The cleaning method according to claim 14, wherein

the cleaning liquid is recovered from the recovery passageway via the first
discharge port while the cleaning liquid is supplied via the supply port.

10 16. The cleaning method according to any one claim of claim 1 through claim 15,
wherein

the first discharge port includes a hole of a porous member.

15 17. The cleaning method according to any one claim of claim 1 through claim 16,
wherein

the first recovery port includes a hole of a porous member.

18. The cleaning method according to any one claim of claim 1 through claim 17,
comprising the step of:

20 imparting ultrasonic waves to the cleaning liquid.

19. The cleaning method according to claim 18, wherein

the cleaning liquid whereto the ultrasonic waves have been imparted is supplied
to the recovery passageway.

25

20. The cleaning method according to claim 18 or claim 19, wherein

ultrasonic waves are imparted to the cleaning liquid supplied to the recovery passageway.

5 21. The cleaning method according to any one claim of claim 1 through claim 20, comprising:

eliminating the exposure liquid from a lower space of the liquid immersion member, which includes the space that the first recovery port opposes; and

10 after the exposure liquid has been eliminated from the lower space, supplying the exposure liquid to the recovery passageway.

22. The cleaning method according to claim 21, comprising the step of:

substituting the exposure liquid in the recovery passageway with the cleaning liquid.

15

23. The cleaning method according to any one claim of claim 1 through claim 22, wherein

the cleaning liquid is supplied to the recovery passageway in the state wherein the first recovery port and an object oppose one another across the space.

20

24. A device fabricating method, comprising:

cleaning at least part of the liquid immersion member using a cleaning method according to any one claim of claim 1 through claim 23;

exposing the substrate with the exposure light that transits the exposure liquid;

25 and

developing the exposed substrate.

25. An immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, comprising:

5 an optical member, which has an emergent surface wherefrom the exposure light emerges;

a liquid immersion member that has a first recovery port, which is capable of recovering the exposure liquid, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from a space that the first recovery port faces flows,

10 a first discharge port, which is for discharging the exposure liquid from the recovery passageway, and a second discharge port, which is for discharging a gas from the recovery passageway and hinders the discharge of the exposure liquid more than the first discharge port does, and that is disposed at least partly around an optical path of the exposure light that passes through the exposure liquid between the optical member and
15 the substrate; and

a pressure adjusting apparatus, which adjusts the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

20

26. An immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, comprising:

an optical member, which has an emergent surface wherefrom the exposure light emerges;

25 a liquid immersion member that has a first recovery port, which is capable of

recovering the exposure liquid, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from a space that the first recovery port faces flows, a first discharge port, which is for discharging, from the recovery passageway, a fluid that includes the exposure liquid and has a higher percentage of the exposure liquid than of a gas, and a second discharge port, which is for discharging, from the recovery passageway, a fluid that includes the gas and has a lower percentage of the exposure liquid than of the gas, and that is disposed at least partly around an optical path of the exposure light that passes through the exposure liquid between the optical member and the substrate; and

a pressure adjusting apparatus, which adjusts the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

27. An immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, comprising:

an optical member, which has an emergent surface wherefrom the exposure light emerges;

a liquid immersion member that has a first recovery port, which is capable of recovering the exposure liquid, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port from the space that the first recovery port faces flows, and a discharge part, which has a first discharge port for discharging the exposure liquid from the recovery passageway and a second discharge port for discharging a gas from the recovery passageway, that separately discharges the exposure liquid and the gas from the recovery passageway, and that is disposed at least partly around an optical path of the exposure light that passes through the exposure liquid between the optical member

and the substrate; and

a pressure adjusting apparatus, which adjusts the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

28. The immersion exposure apparatus according to any one claim of claim 25 through claim 27, wherein

the liquid immersion member has a second recovery port, which faces the recovery passageway and recovers the cleaning liquid from the recovery passageway.

29. The immersion exposure apparatus according to any one claim of claim 25 through claim 28, wherein

the cleaning liquid is recovered from the recovery passageway via the first discharge port.

30. The immersion exposure apparatus according to any one claim of claim 25 through claim 29, wherein

the liquid immersion member has a supply port, which faces the recovery passageway and supplies the cleaning liquid to the recovery passageway.

31. The immersion exposure apparatus according to any one claim of claim 25 through claim 30, wherein

the cleaning liquid is supplied to the recovery passageway via the first discharge port.

32. The immersion exposure apparatus according to any one claim of claim 25 through claim 31, wherein

the first discharge port includes a hole of a porous member.

5

33. The immersion exposure apparatus according to any one claim of claim 25 through claim 32, wherein

the first recovery port includes a hole of a porous member.

10 34. The immersion exposure apparatus according to any one claim of claim 25 through claim 33, further comprising:

an oscillator that imparts ultrasonic waves to the cleaning liquid.

35. A device fabricating method, comprising:

15 exposing a substrate with exposure light using an immersion exposure apparatus according to any one claim of claim 25 through claim 34; and
developing the exposed substrate.

36. A program that causes a computer to control an immersion exposure apparatus,

20 which exposes a substrate with exposure light that transits an exposure liquid, comprising:

forming an immersion space with the exposure liquid between the substrate and a liquid immersion member that has a first recovery port, which is capable of recovering at least some of the exposure liquid from a space above the substrate, a recovery

25 passageway, wherethrough the exposure liquid recovered via the first recovery port flows,

a first discharge port, which is for discharging the exposure liquid from the recovery passageway, and a second discharge port, which is for discharging a gas from the recovery passageway and hinders the discharge of the exposure liquid more than the first discharge port does, such that an optical path of the exposure light between the substrate and an optical member, wherefrom the exposure light can emerge, is filled with the exposure liquid;

exposing the substrate with the exposure light, which transits the exposure liquid in the immersion space;

recovering at least some of the exposure liquid from the space above the substrate via the first recovery port of the liquid immersion member;

when an exposure is not being performed, supplying a cleaning liquid to the recovery passageway; and

adjusting the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid

supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

37. A program that causes a computer to control an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid,

comprising:

forming an immersion space with the exposure liquid between the substrate and a liquid immersion member that has a first recovery port, which is capable of recovering at least some of the exposure liquid from a space above the substrate, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port flows,

a first discharge port, which is for discharging, from the recovery passageway, a fluid that

includes the exposure liquid and that has a higher percentage of the exposure liquid than of the gas, and a second discharge port, which is for discharging, from the recovery passageway, a fluid that includes the gas and that has a lower percentage of the exposure liquid than of the gas, such that an optical path of the exposure light between the substrate and an optical member, wherefrom the exposure light can emerge, is filled with the exposure liquid;

exposing the substrate with the exposure light, which transits the exposure liquid in the immersion space;

recovering at least some of the exposure liquid from the space above the substrate via the first recovery port of the liquid immersion member;

when an exposure is not being performed, supplying a cleaning liquid to the recovery passageway; and

adjusting the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

38. A program that causes a computer to control an immersion exposure apparatus, which exposes a substrate with exposure light that transits an exposure liquid, comprising:

forming an immersion space with the exposure liquid between the substrate and a liquid immersion member that has a first recovery port, which is capable of recovering at least some of the exposure liquid from a space above the substrate, a recovery passageway, wherethrough the exposure liquid recovered via the first recovery port flows, and a discharge part, which has a first discharge port for discharging the exposure liquid

from the recovery passageway and a second discharge port for discharging a gas from the recovery passageway, that separately discharges the exposure liquid and the gas from the recovery passageway, such that an optical path of the exposure light between the substrate and an optical member, wherefrom the exposure light can emerge, is filled with the exposure liquid;

exposing the substrate with the exposure light, which transits the exposure liquid in the immersion space;

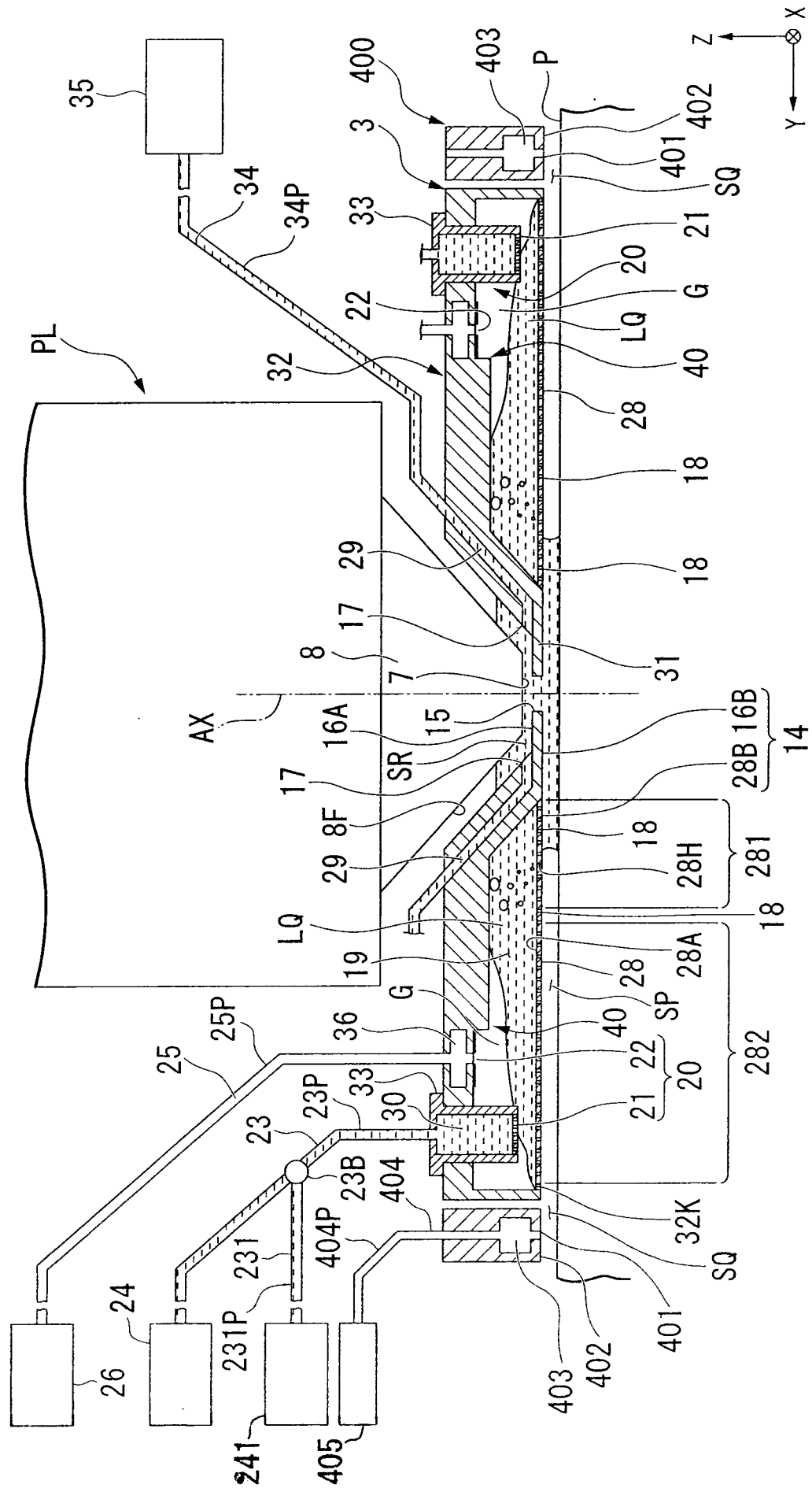
recovering at least some of the exposure liquid from the space above the substrate via the first recovery port of the liquid immersion member;

when an exposure is not being performed, supplying a cleaning liquid to the recovery passageway; and

adjusting the difference between a pressure in the recovery passageway and a pressure in the space that the first recovery port faces such that the cleaning liquid supplied to the recovery passageway is not supplied to the space that the first recovery port faces.

39. A computer readable storage medium whereon a program according to any one claim of claim 36 through claim 38 is stored.

FIG. 2



[illegible]

[illegible][illegible]

FIG. 6

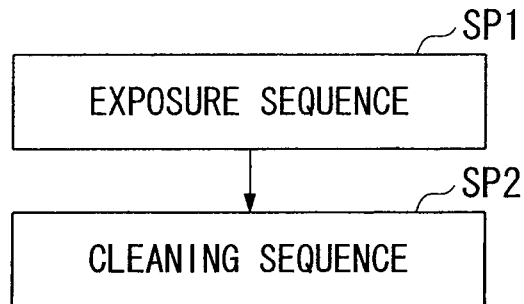


FIG. 7

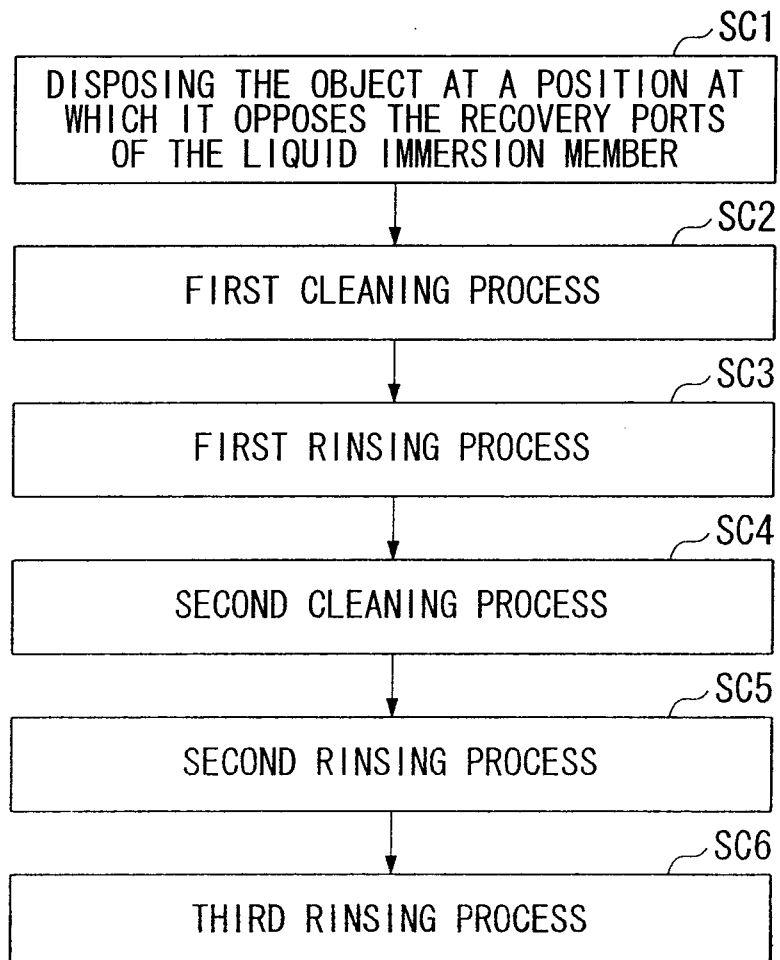


FIG. 8

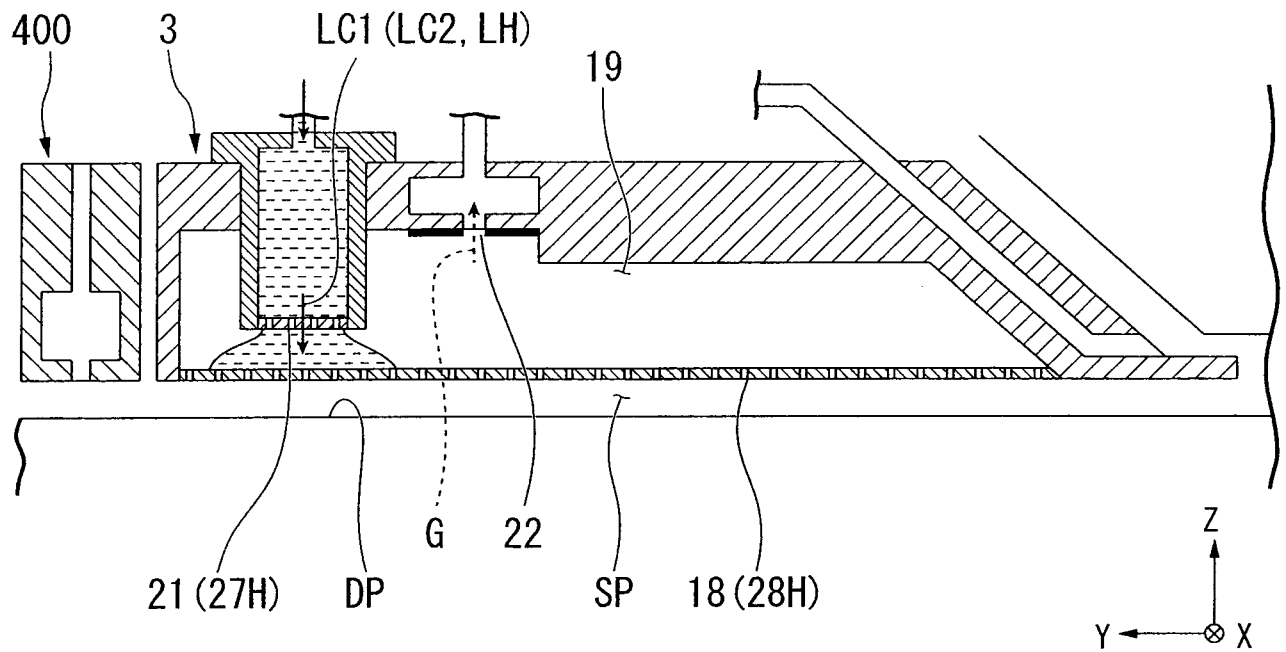


FIG. 9

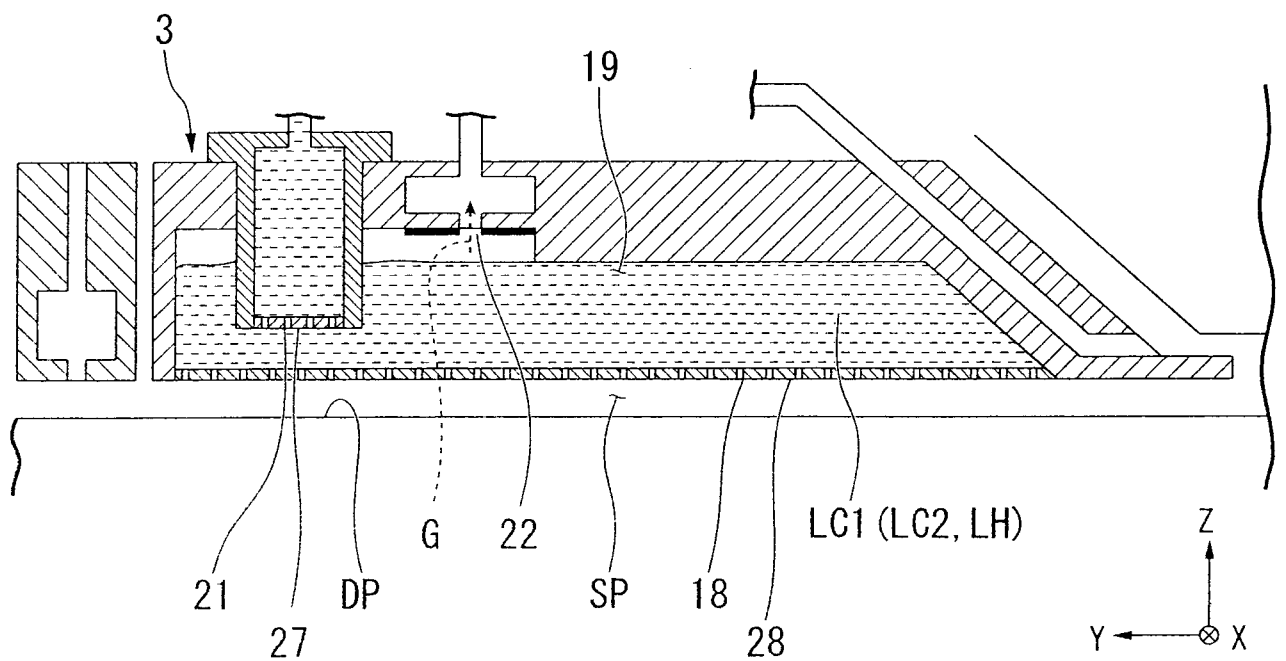


FIG. 10

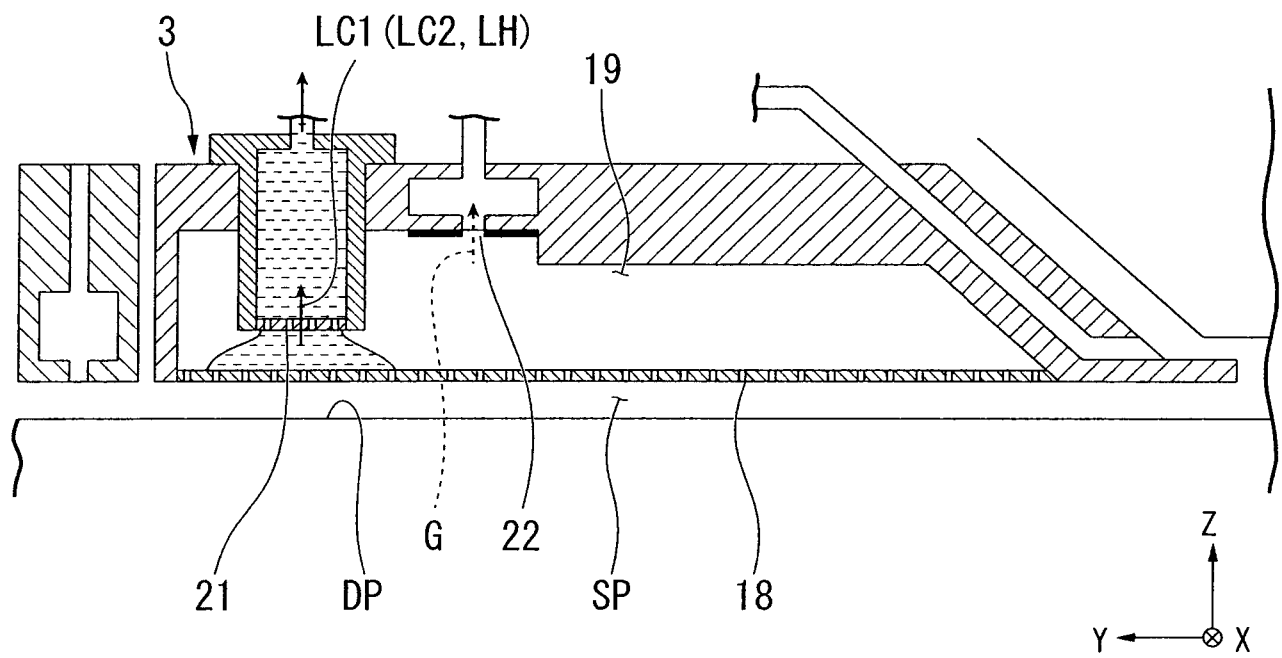
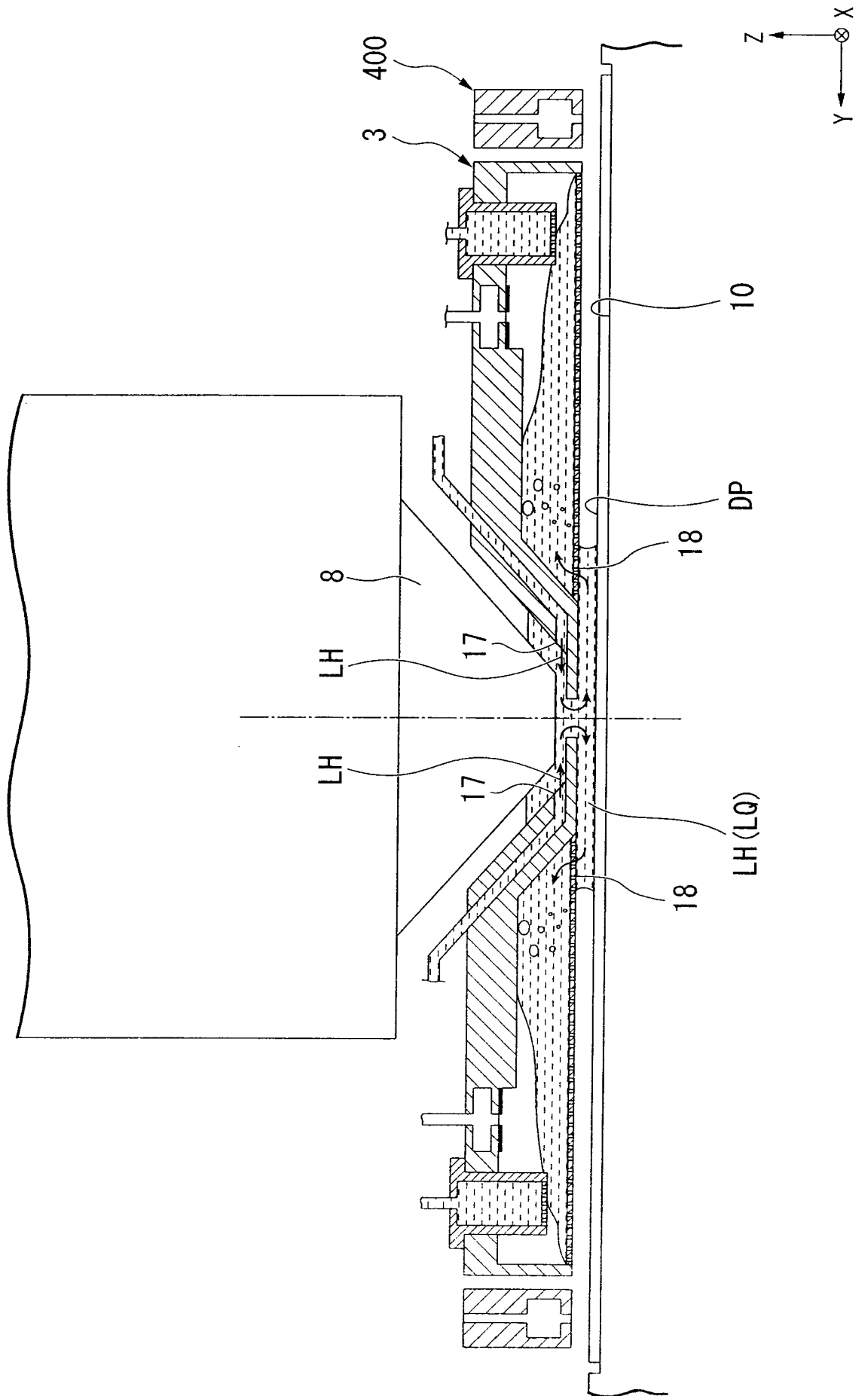


FIG. 11



[illegible]

[illegible]

21 27 3C LC1 (LC2, LH) 19 310 22 SP 18 (28H) 28

Z
Y ← ⊗ X

A detailed cross-sectional view of the liquid discharge device. The diagram shows a horizontal base with various internal chambers and passages. On the left, there are two vertical structures labeled 27 and 21. A central passage is labeled G. To its right is another vertical structure labeled 22. Further right is a chamber labeled SP. A long horizontal passage is labeled 18, with a section further down also labeled 18. A sloped channel on the far right is labeled 17, leading to an outlet labeled LQ. Above the main body, there are two valve-like mechanisms controlled by plungers; the one on the left is labeled 3B. A small vertical tube is labeled 19, and a larger vertical tube or nozzle is labeled 300. Arrows indicate the flow direction of the liquid. A coordinate system at the bottom right shows Z pointing up, Y pointing left, and X pointing out of the page.

This cross-sectional view shows a substrate with multiple layers. From top to bottom, there are several patterned layers: a top layer (19), a layer with openings (21), another patterned layer (22), a spacer or protective layer (SP), and a base layer (18). A liquid layer (LQ) is present beneath the main structure. On the left, a vertical structure (3B) is shown. A gap (G) is indicated between two central components. A large rectangular feature (300) is located on the right side. A coordinate system at the bottom right indicates X (horizontal), Y (vertical), and Z (depth).

[illegible]

FIG. 18

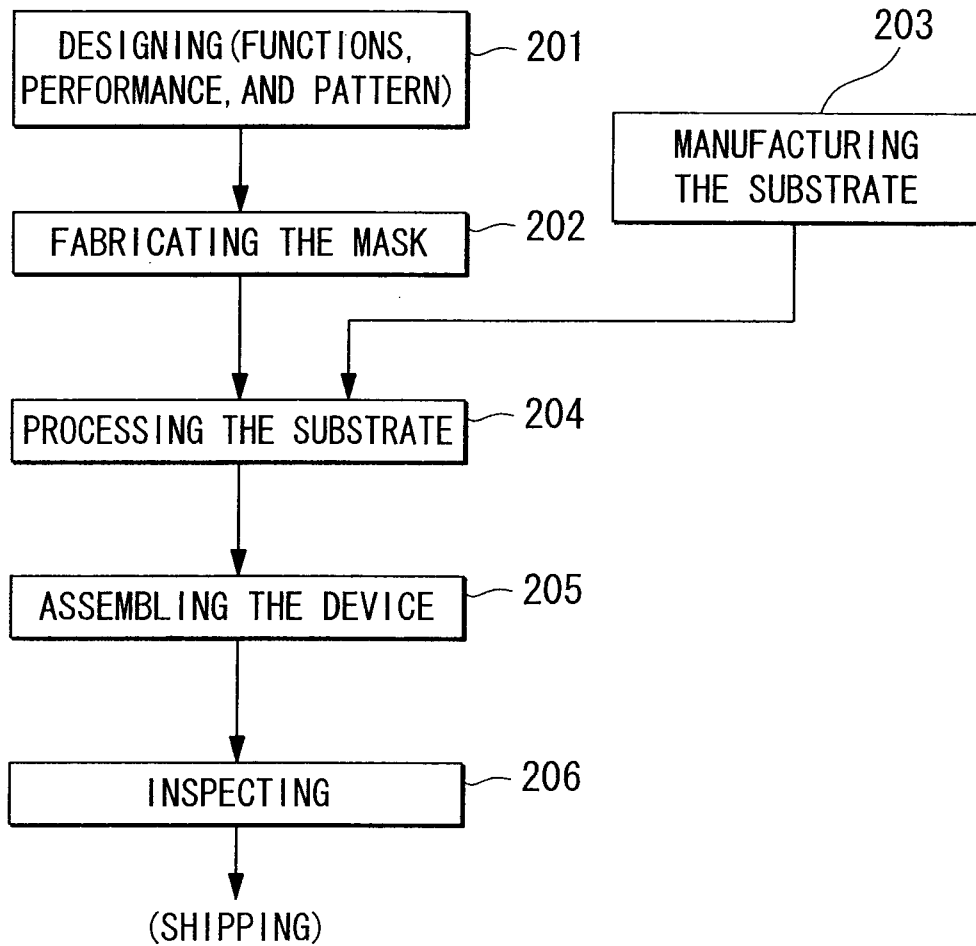


FIG. 19

