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(54) **STAGE UNIT, EXPOSURE APPARATUS, AND EXPOSURE METHOD**

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(57) **ABSTRACT**

A power usage supply unit that supplies power usage to a stage which moves on a movement surface has a first axis section, first support sections, a second axis section, and a second support section. The first axis section is movably supported by the first support section in a direction of the first axis and around the first axis, and the second axis and around the second axis. And, by employing a mechanism in which the power usage supply unit has at least four degrees of freedom, the power usage supply unit does not interfere with the movement of a stage even when the stage moves in the first and second axis directions and in the rotational direction of each axis, therefore, decrease in position controllability of the stage caused by dragging a tube can be completely avoided.

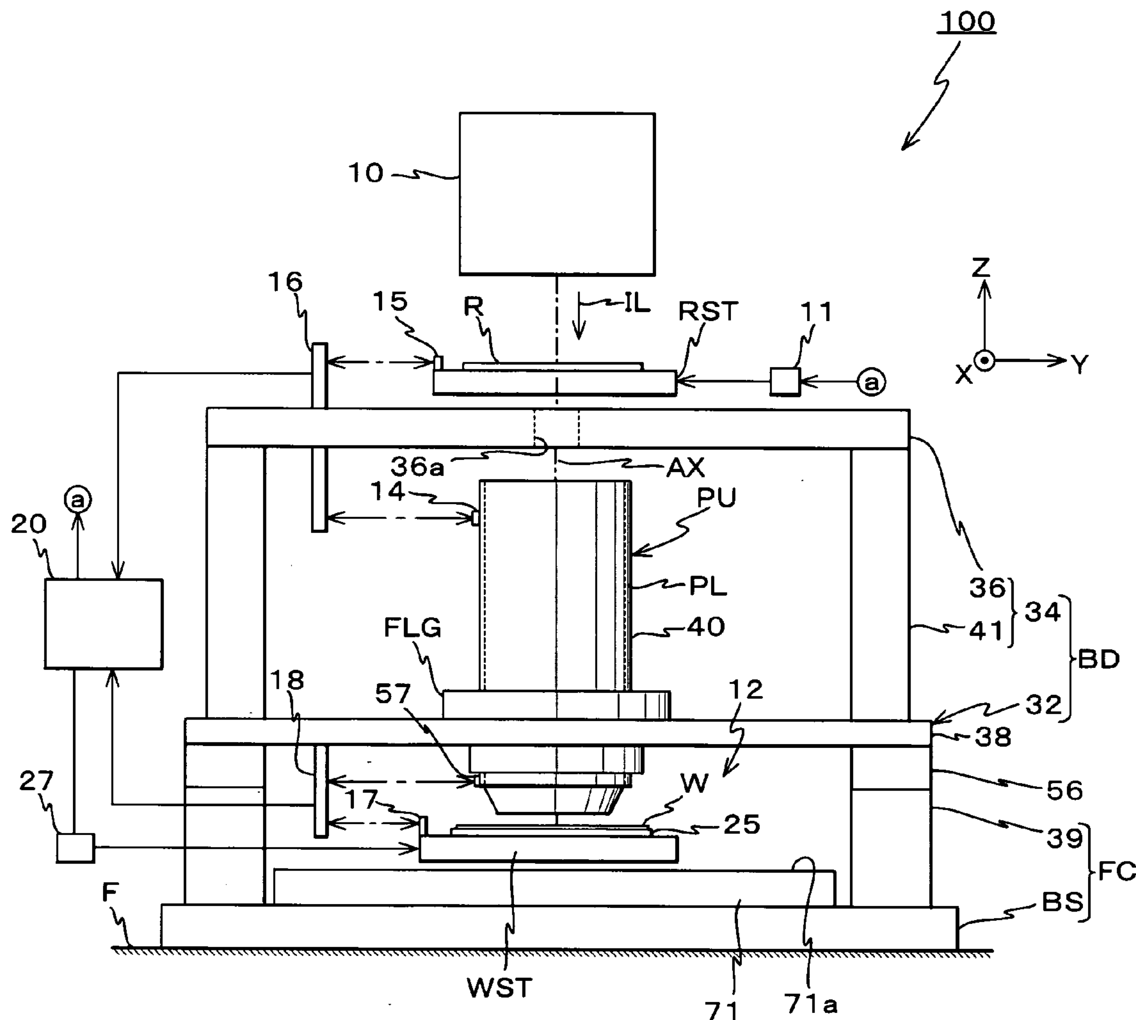


Fig. 1

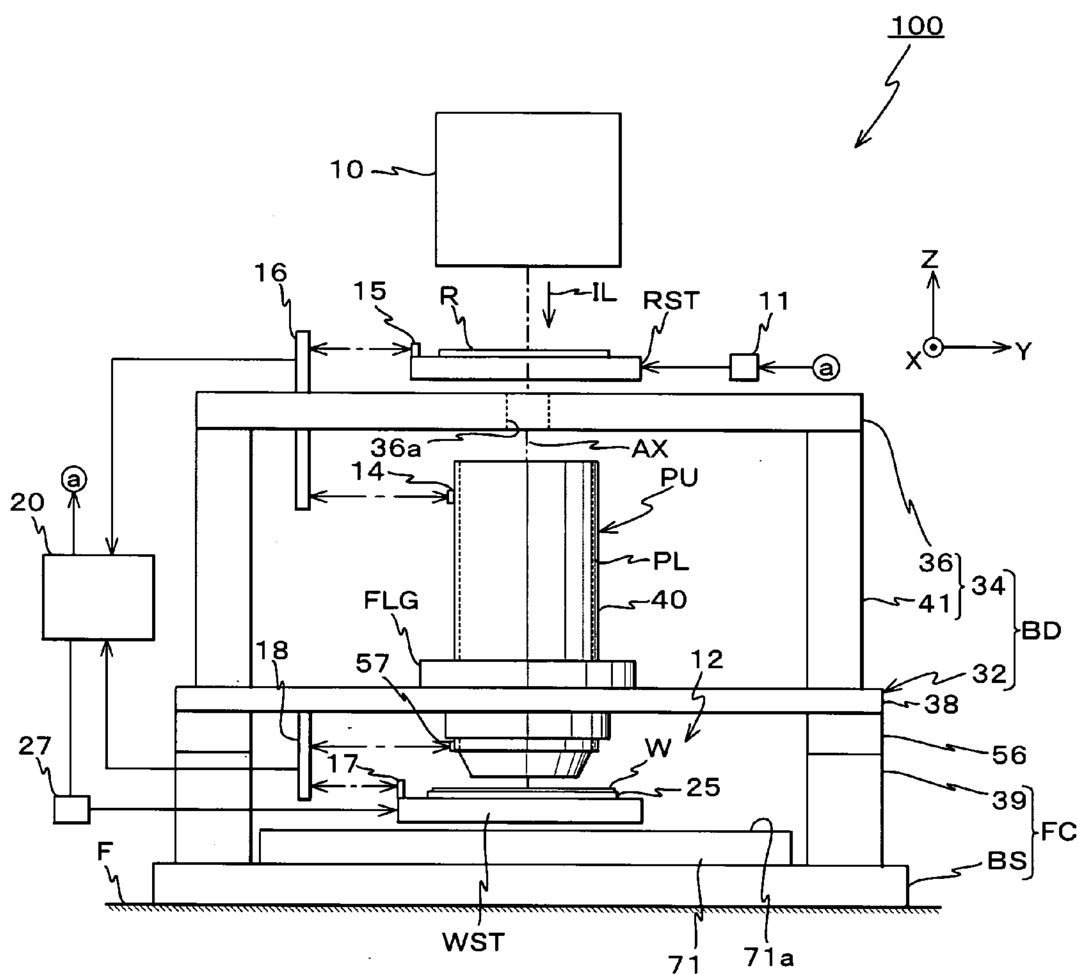


Fig. 2

Fig. 3A

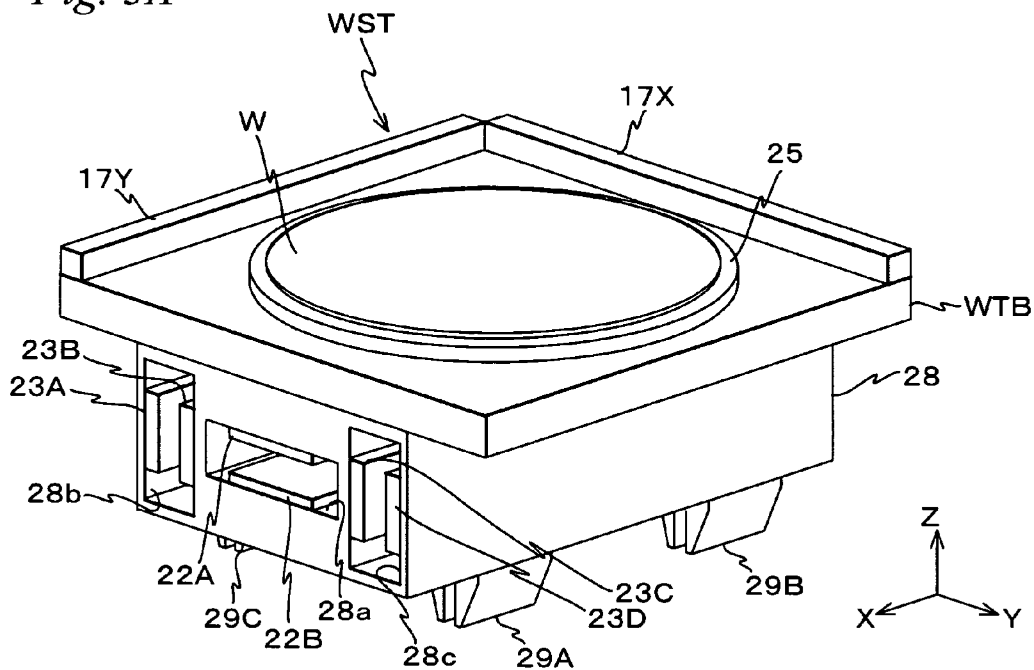


Fig. 3B

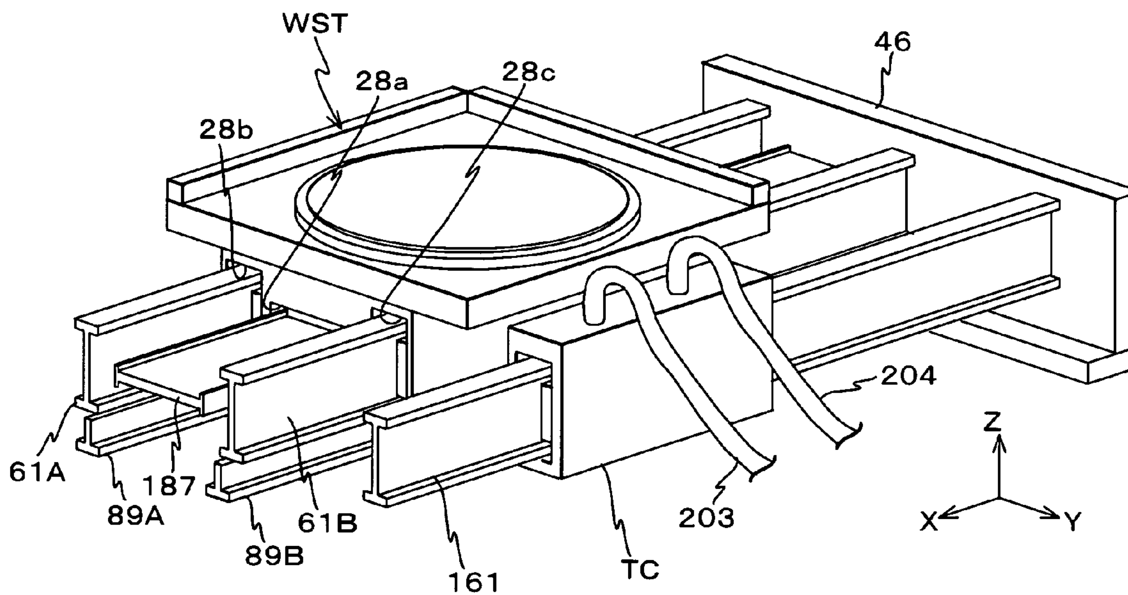


Fig. 4

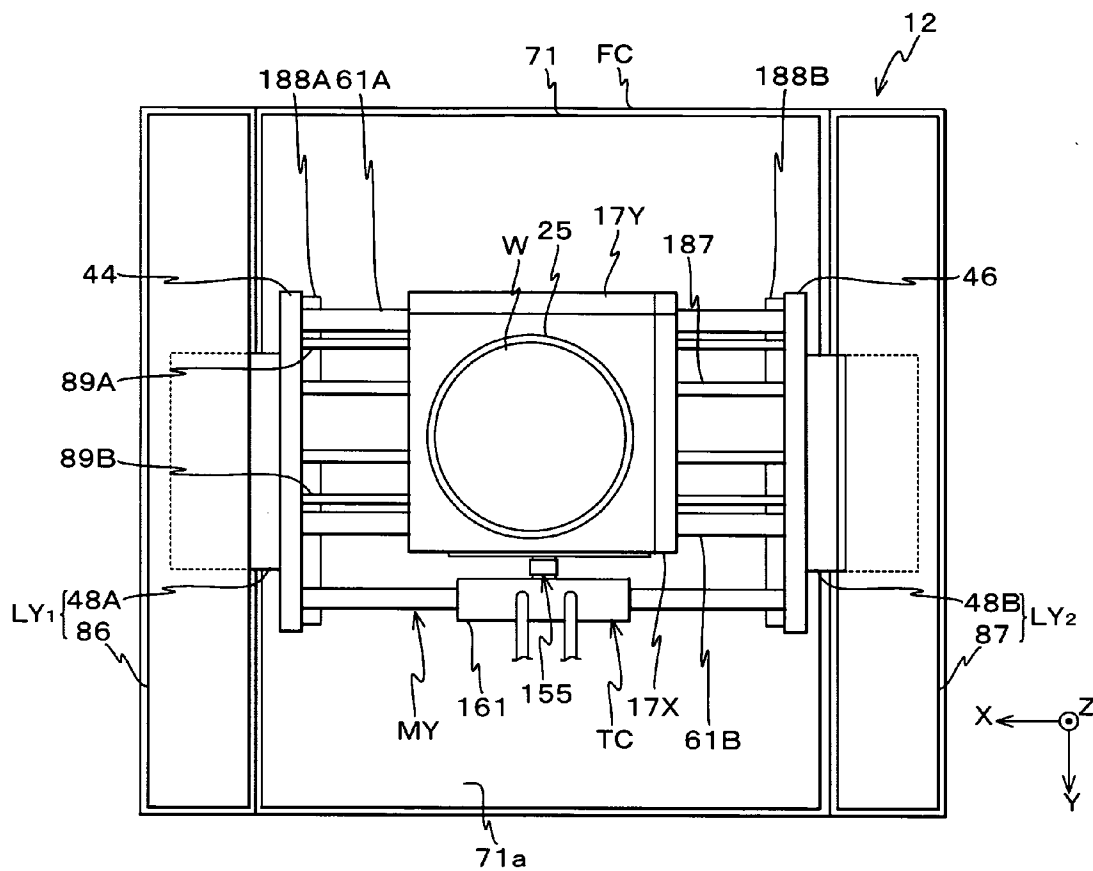


Fig. 5

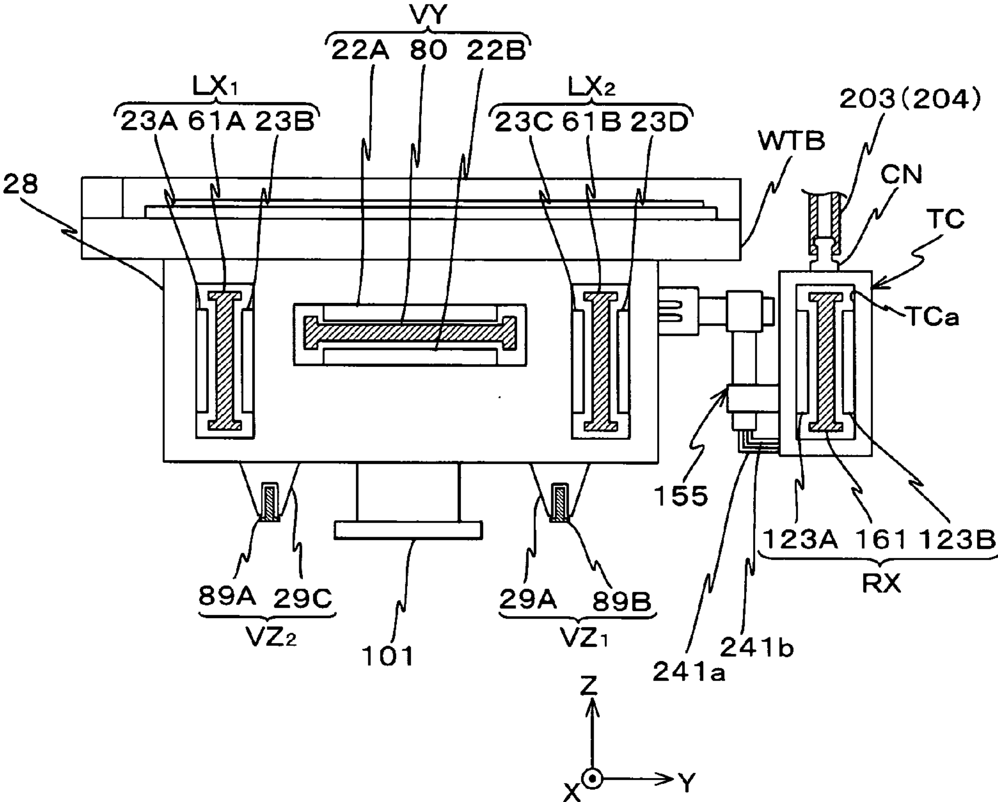


Fig. 6

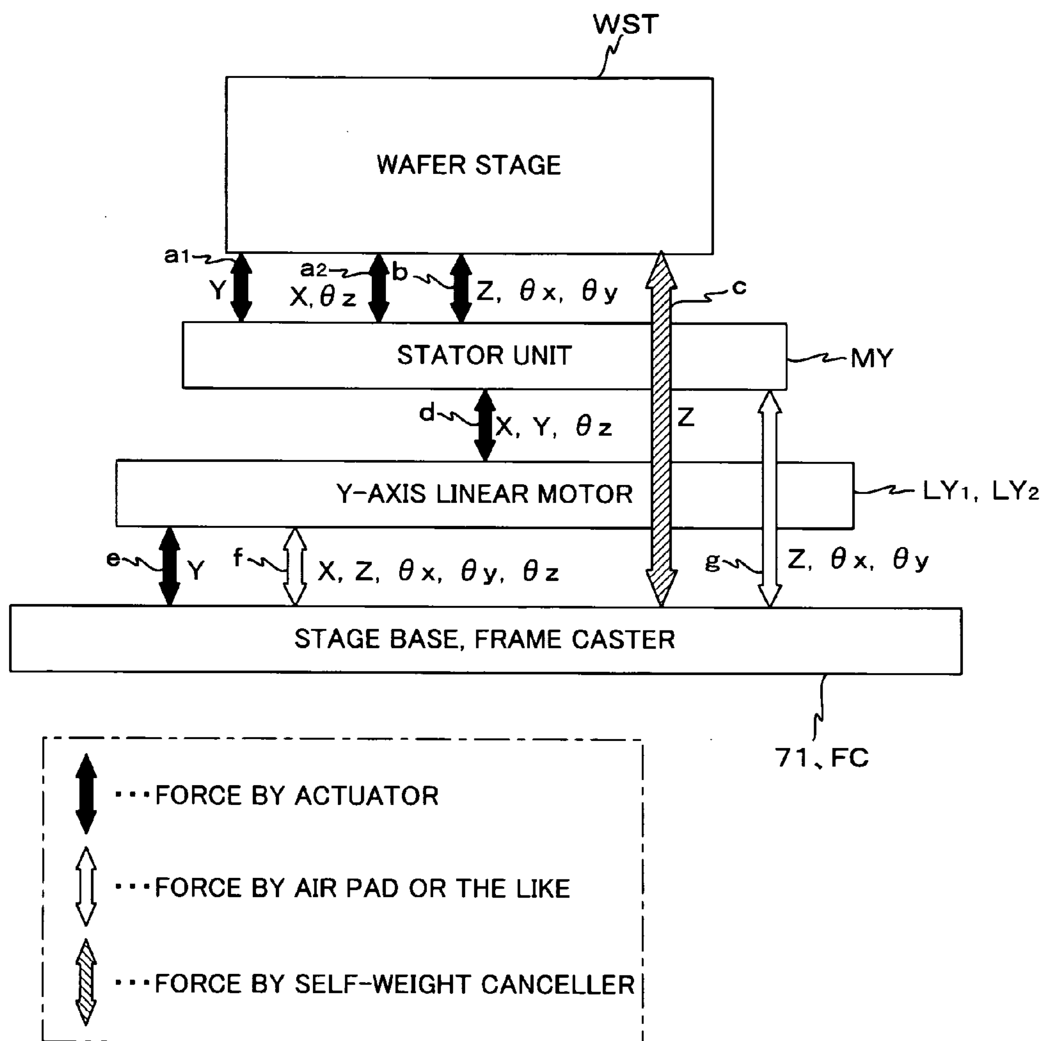


Fig. 7

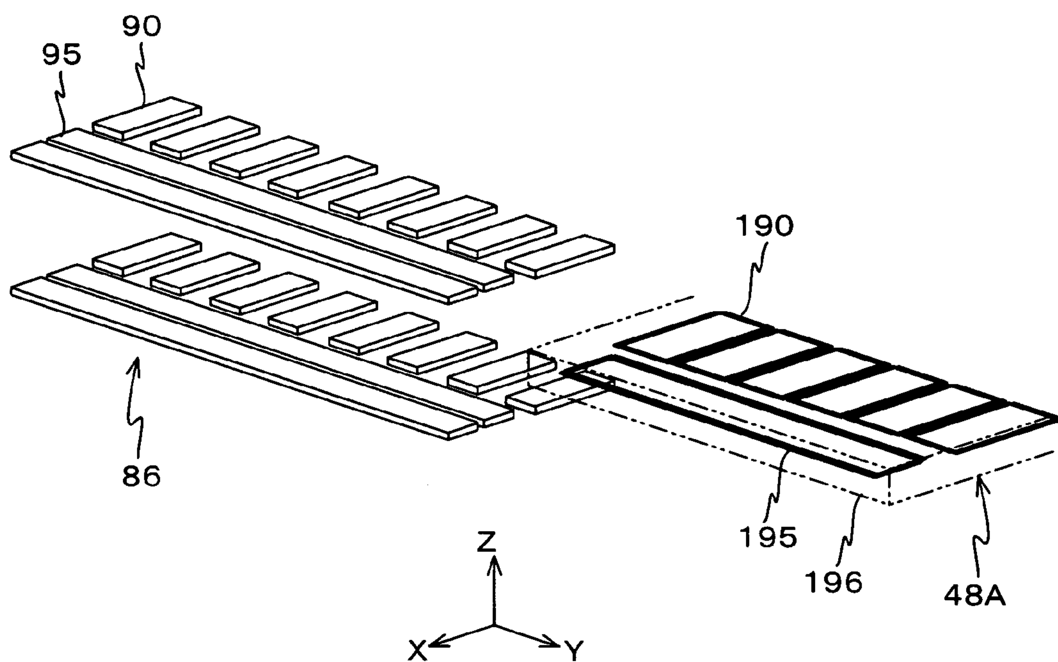


Fig. 8

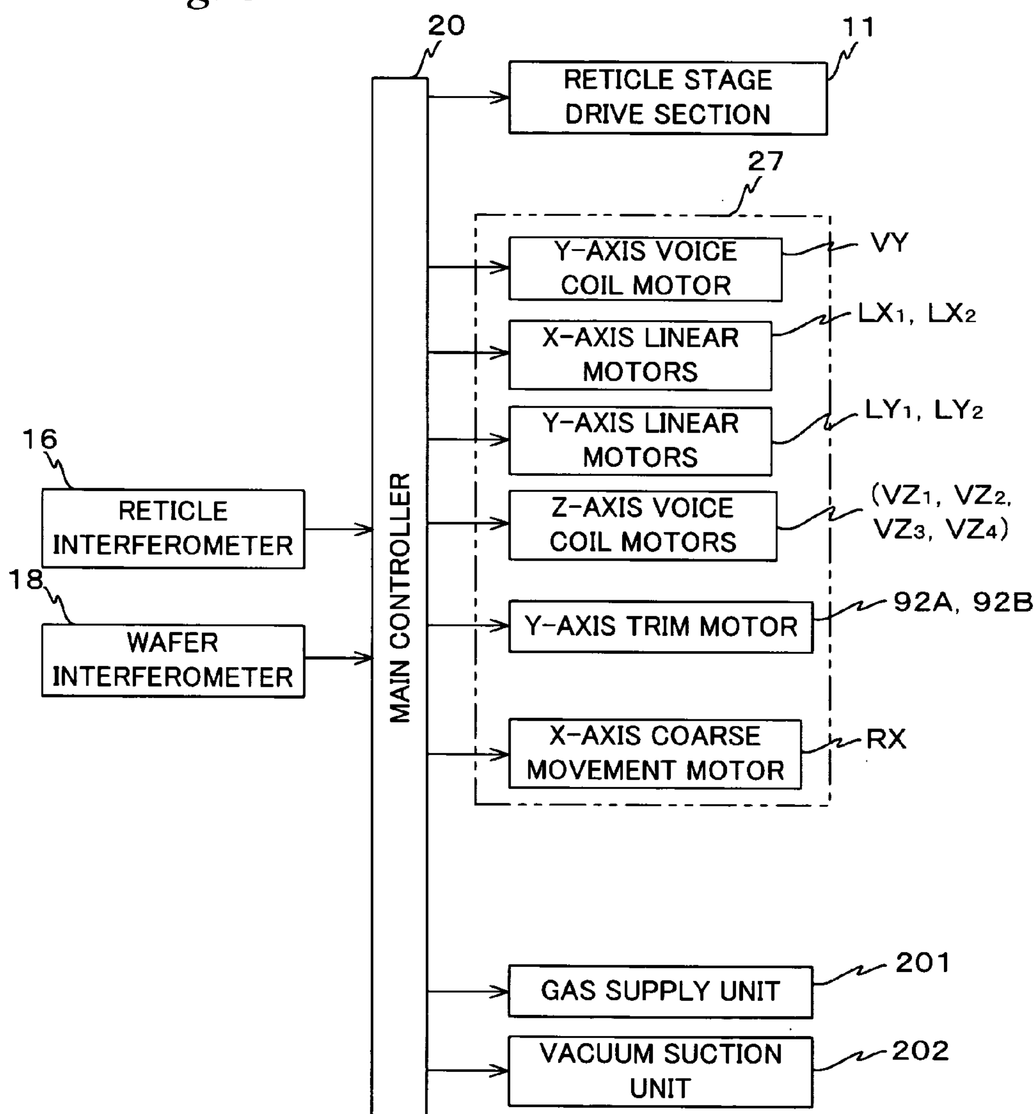


Fig. 9

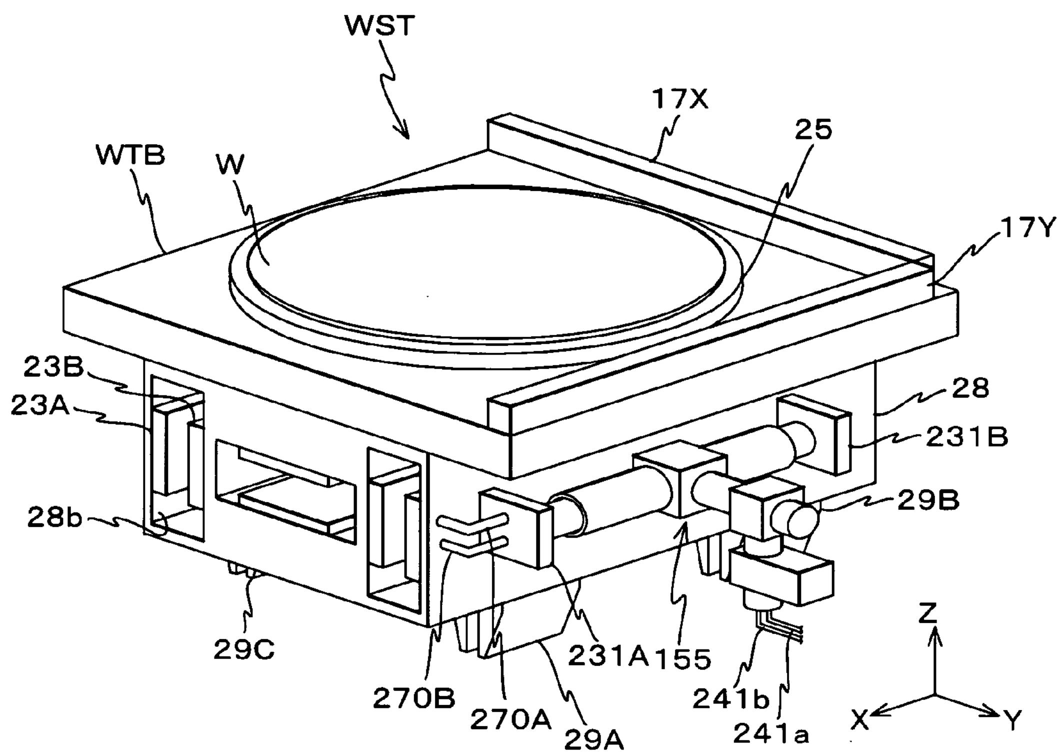


Fig. 10

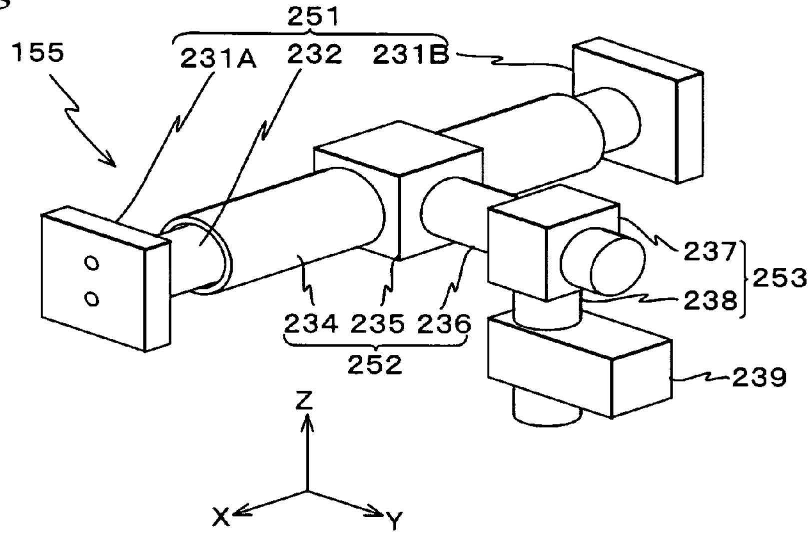


Fig. 11

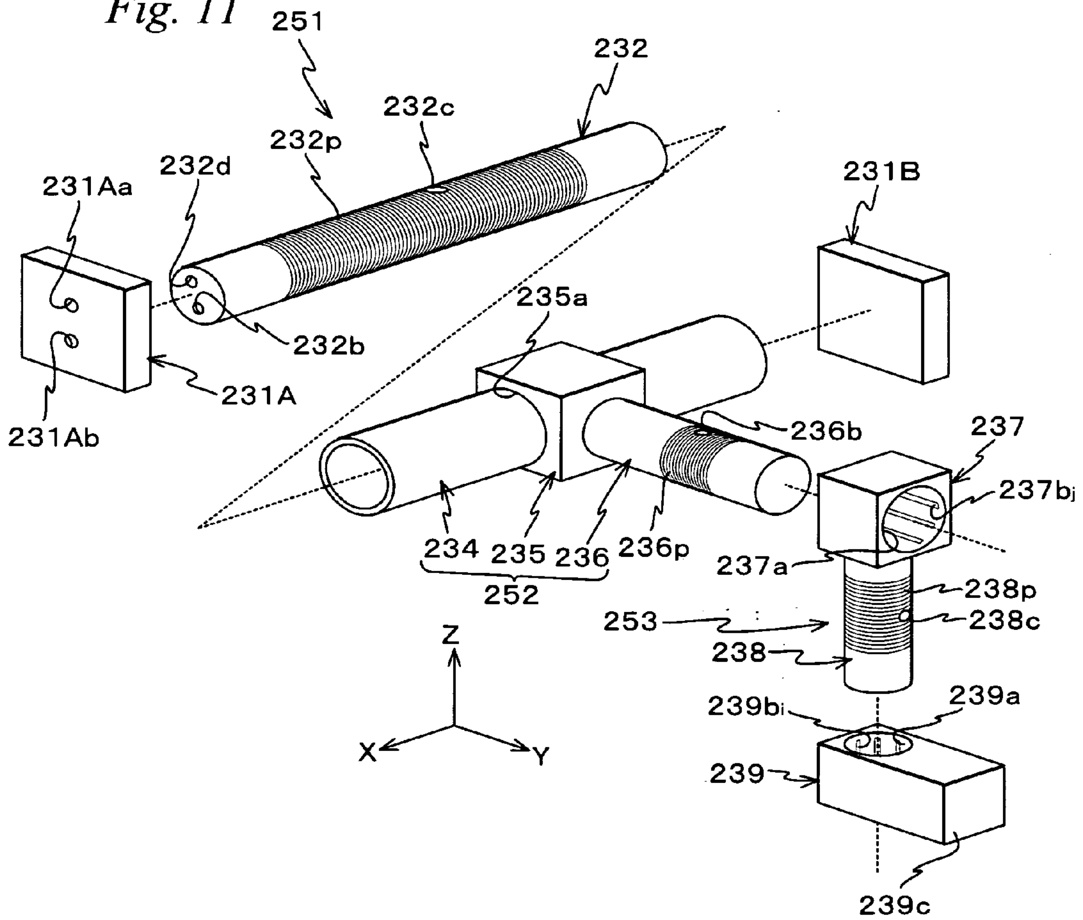


Fig. 12A

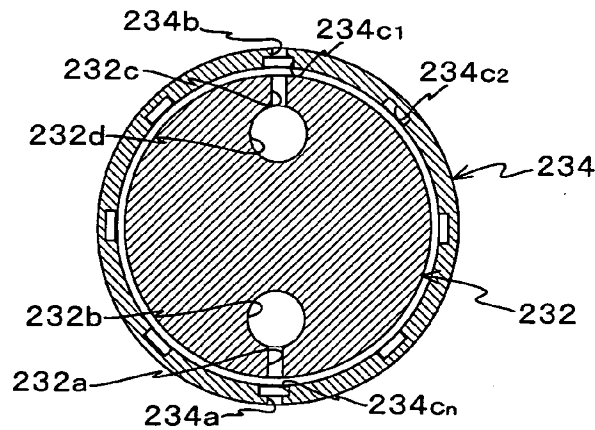


Fig. 12B

Fig. 13

Fig. 14A

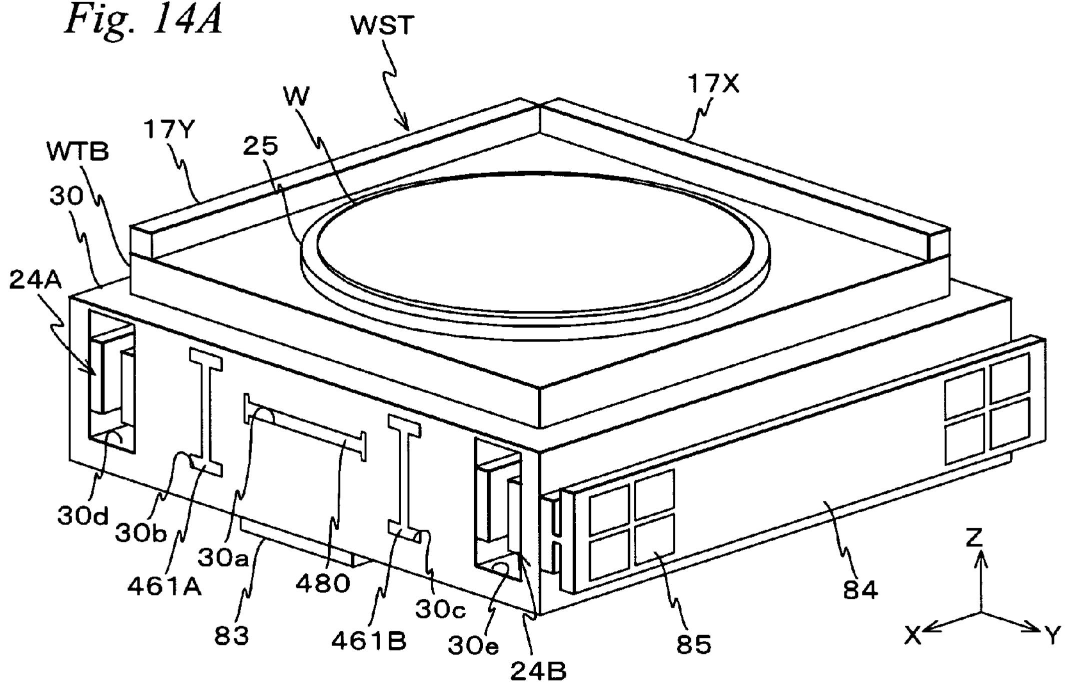


Fig. 14B

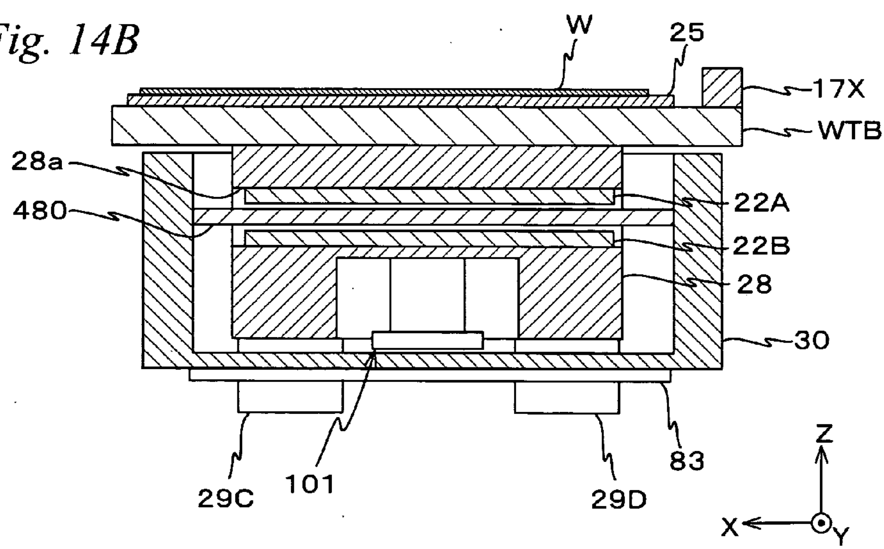


Fig. 15

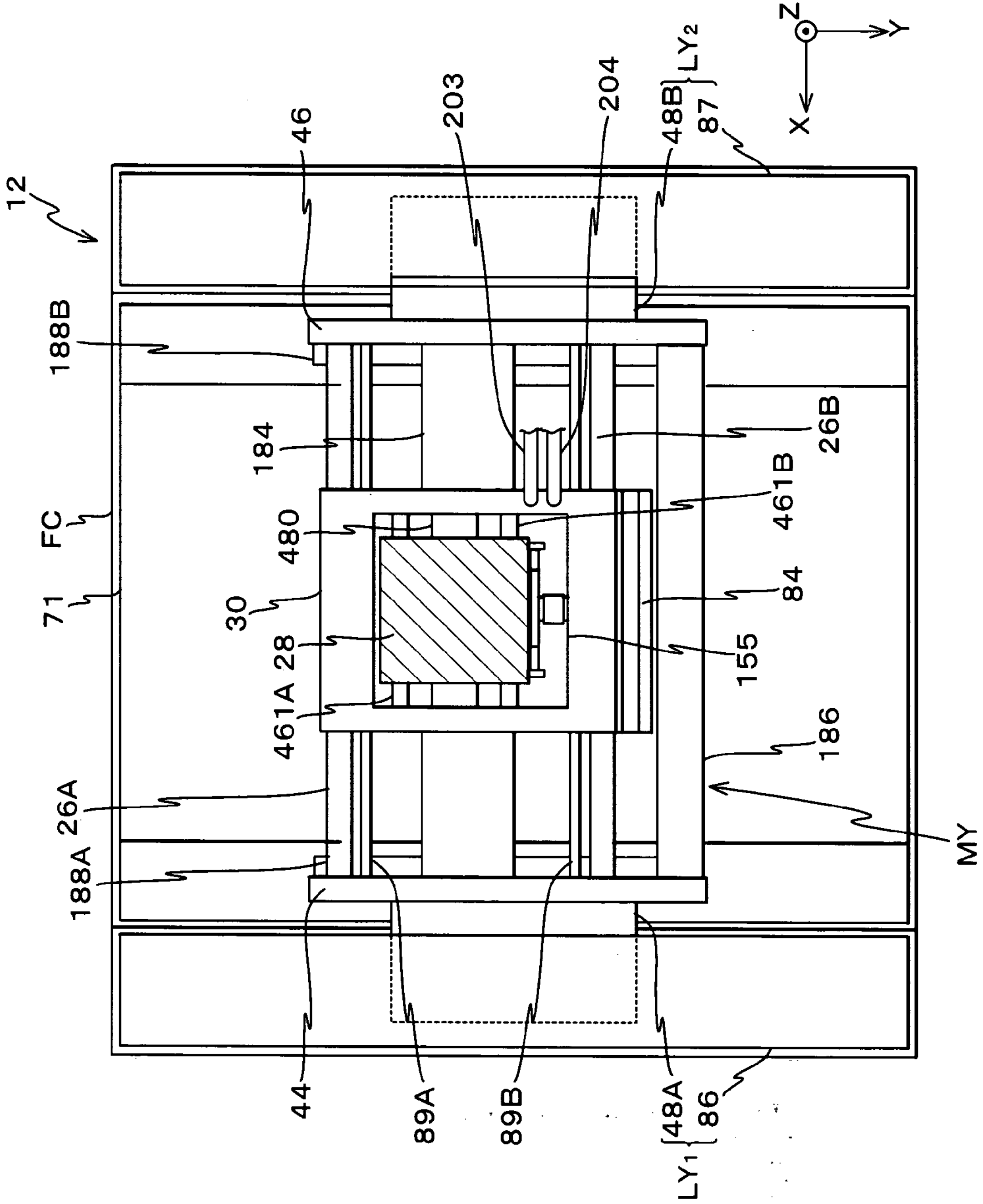


Fig. 16

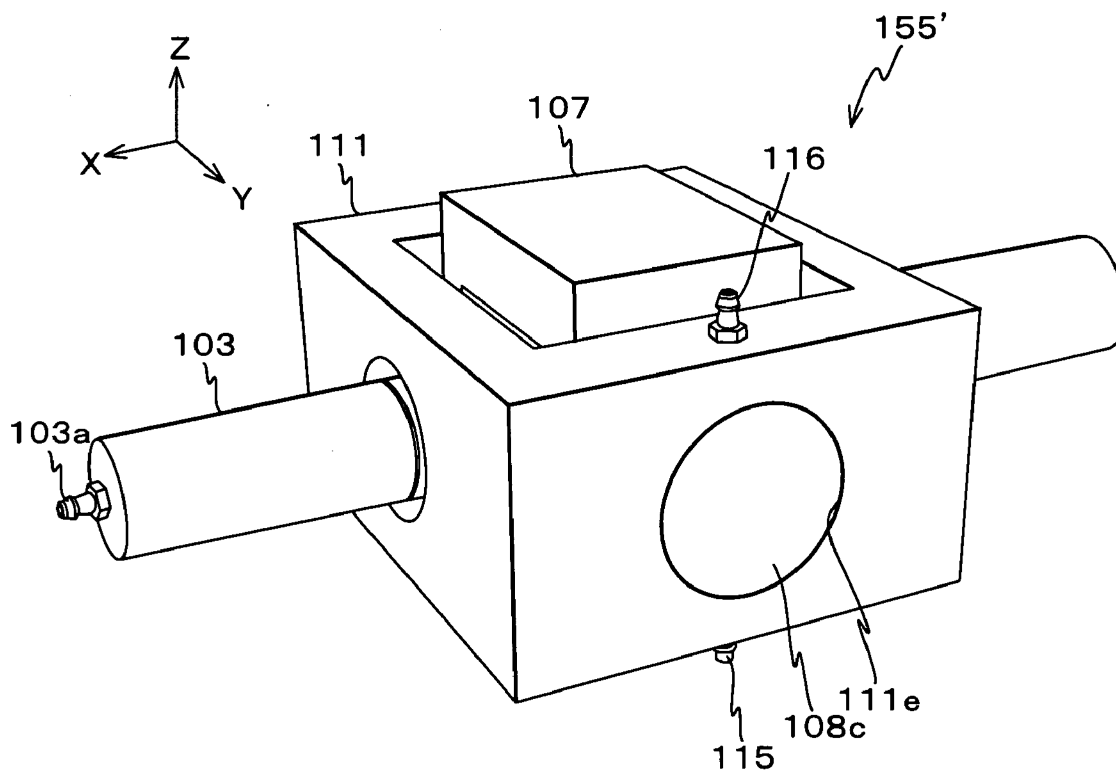


Fig. 17

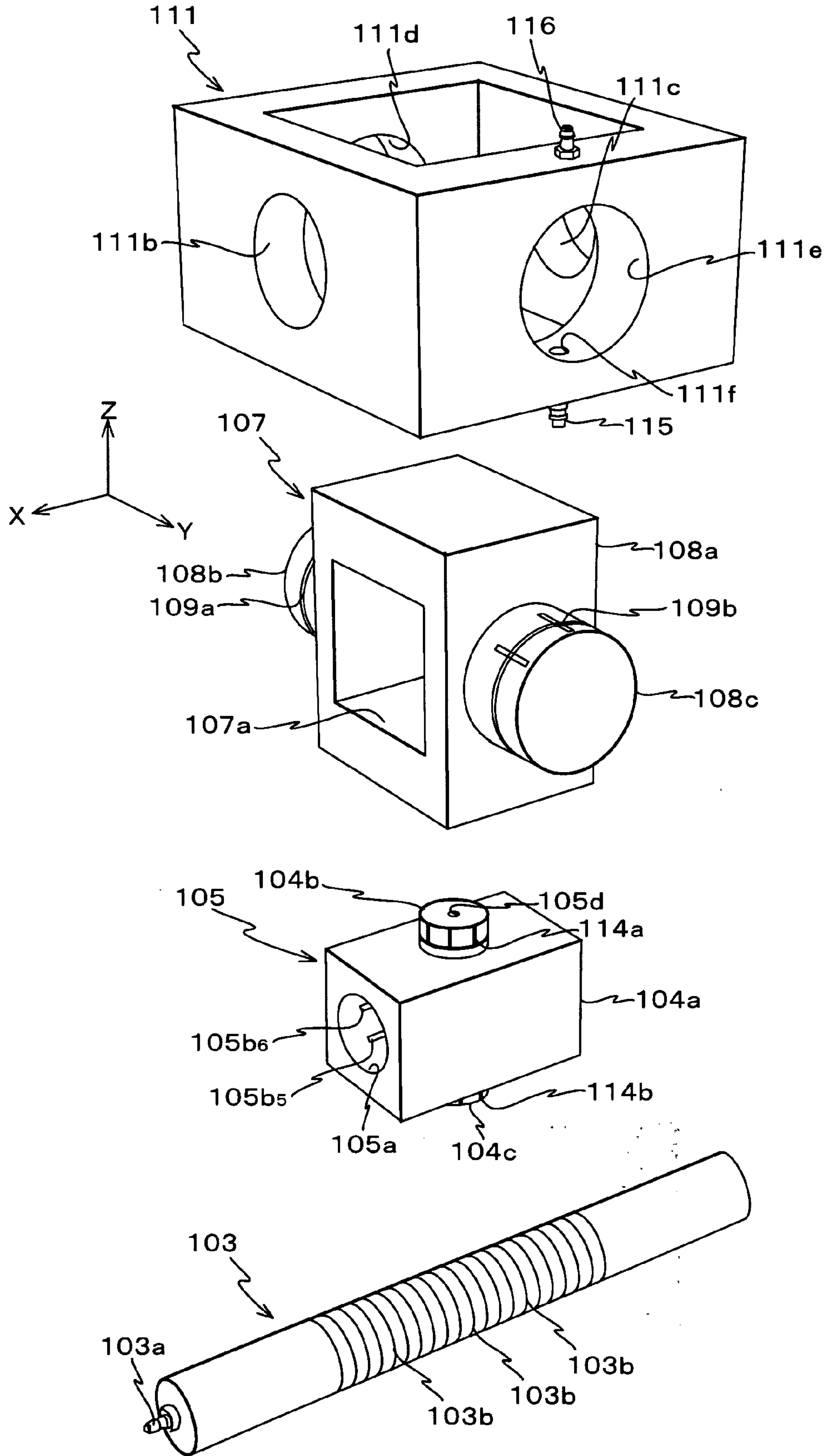


Fig. 18

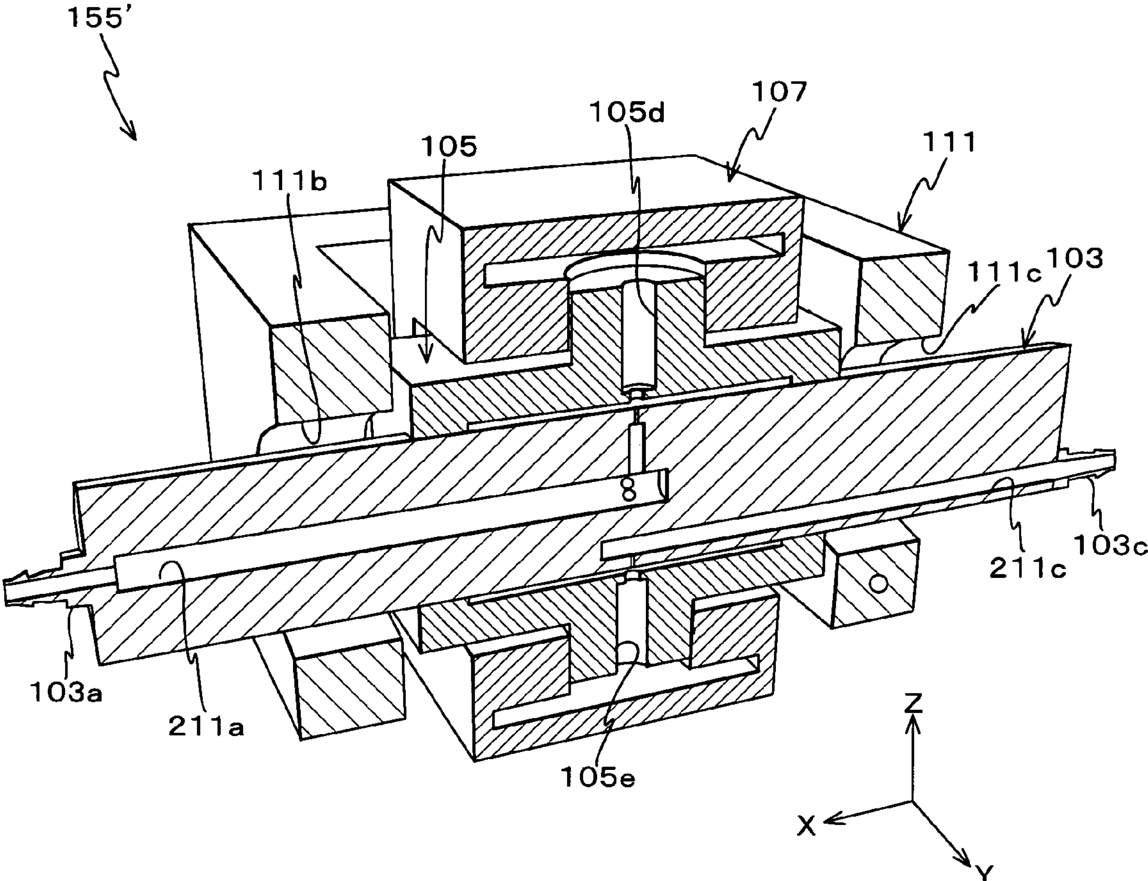


Fig. 19

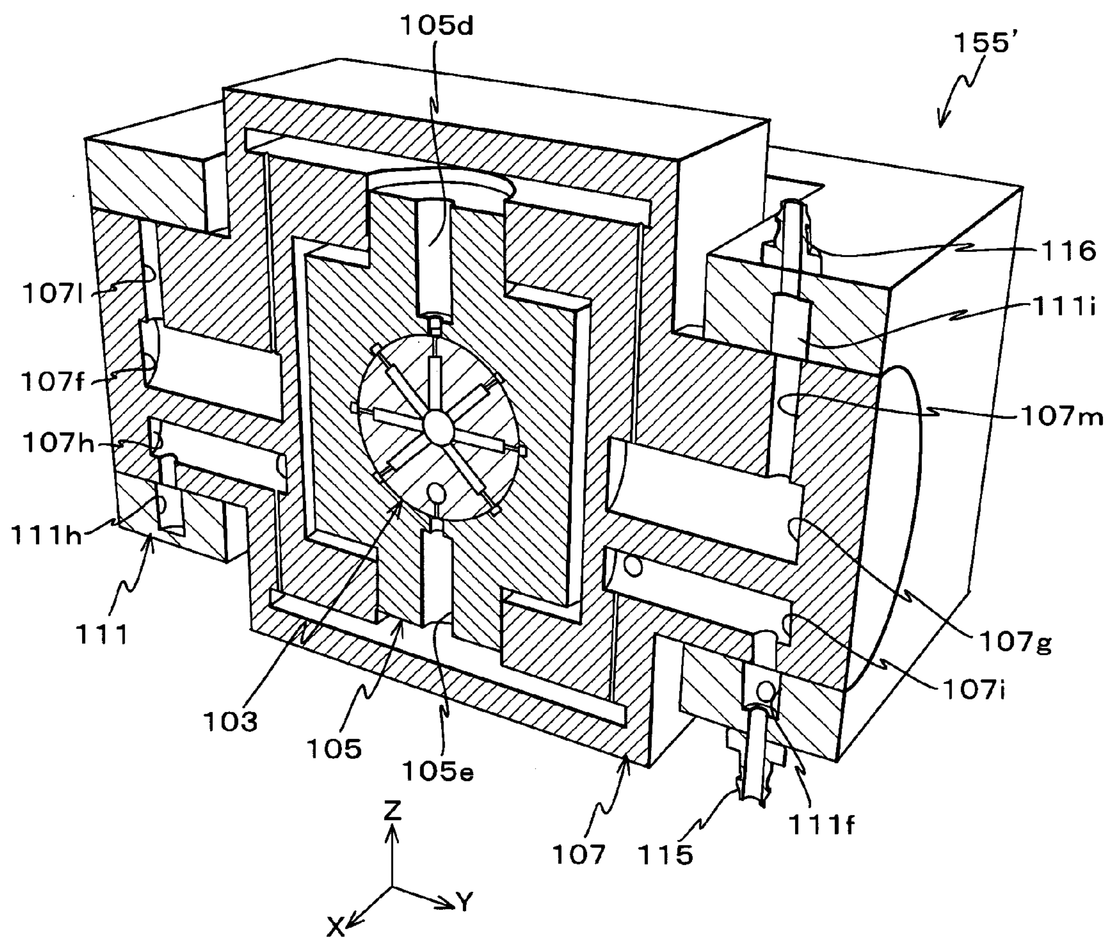
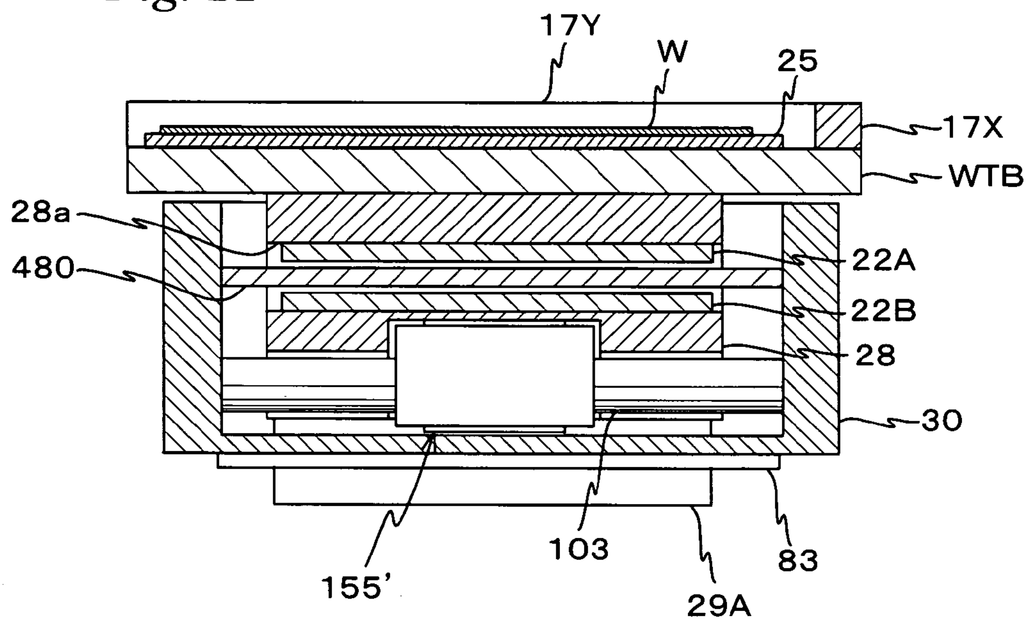


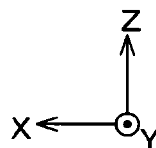
Fig. 20

Fig. 21

111i
H'
108c
107m
107g
107i
107q
G'
111f
I'
FROM 25
111e
H'
111
107k
F
80
E
105d
D
B
211b2
105b3
211c
B
211d
D'
E'
F'
107o
107
107c
105
105e
103
211a
105b1
211b1
211b7
105b6
E
E'
F'
81
107n
107j
F
111d
H'
H'
108b
107l
107f
107h
107p
G'
111g

Fig. 22





STAGE UNIT, EXPOSURE APPARATUS, AND EXPOSURE METHOD

TECHNICAL FIELD

[0001] The present invention relates to stage units, exposure apparatus, and exposure methods, and more particularly to a stage unit (stage device) that has a stage which moves on a movement surface, an exposure apparatus that is equipped with the stage unit, and an exposure method in which a pattern is formed by exposing a substrate on the stage.

BACKGROUND ART

[0002] In recent years, in a lithographic process to produce a semiconductor, a liquid crystal display device or the like, due to higher integration of semiconductors or the like, the sequentially moving type exposure apparatus is mainly used, such as the reduction projection exposure apparatus based on a step-and-repeat method (the so-called stepper) that can form a fine pattern on a photosensitive object with good accuracy and high throughput, the scanning projection exposure apparatus based on a step-and-scan method (the so-called scanning stepper (also called a scanner)) or the like.

[0003] In these types of exposure apparatus, as a drive unit for driving a photosensitive object such as a wafer or a glass plate (hereinafter referred to as a "wafer"), a wafer stage unit of a coarse/fine movement structure has been used, which has an XY stage supported by levitation by air bearings or the like on a platform and is driven within a two-dimensional plane by a two-axis linear motor, and a wafer table that holds a wafer on the XY stage and is finely driven in a Z-axis direction and a direction of inclination by voice coil motors or the like. Further, a wafer stage unit that is equipped with a single stage driven in directions of six degrees of freedom by linear motors or voice coil motors is also recently being developed.

[0004] However, in the wafer stage units referred to above, because wiring used in the linear motors or voice coil motors, piping (tubes) used in the air bearings or the like connects from the outside to the stage, the wiring, piping or the like was dragged along with the drive of the stage, which caused a decrease in position controllability of the wafer.

[0005] In order to improve such an inconvenience, for example, a moving magnet type linear motor can be used for driving the stage and pressurized gas for supporting the stage on the platform by levitation can also be supplied from the platform side, which allows the wiring, piping or the like connecting to the stage to be removed (for example, refer to Patent Document 1).

[0006] However, although it is relatively easy to employ the structure according to Patent Document 1 in which pressurized gas is supplied from the platform side to the stage side in a stage which is scanned in an uniaxial direction (e.g. scanning direction) such as in a reticle stage in the scanner, it is difficult to employ the structure in a wafer stage to which two-dimensional movement is essential. Therefore, in a wafer stage unit, the piping for supplying pressurized gas had to be connected to the stage, which left the piping dragging and still being a cause in the decrease in position controllability of the stage. As a matter of course, in the case piping inevitably has to be connected to the reticle stage also in a reticle stage unit, there is a similar risk of a decrease in position controllability.

[0007] Patent Document 1: Kokai (Japanese Unexamined Patent Application Publication) No. 2001-20951

DISCLOSURE OF INVENTION

Means for Solving the Problems

[0008] The present invention was made under the circumstances described above, and according to a first aspect of the present invention, there is provided a first stage unit that has a stage which moves on a movement surface and a power usage supply unit which supplies power usage to the stage wherein the power usage supply unit comprises: a first axis section that extends in a direction of a first axis within the movement surface; a first support section that movably supports the first axis section in the direction of the first axis and around the first axis; a second axis section that extends in a direction of a second axis intersecting with the first axis; and a second support section that movably supports the second axis section in the direction of the second axis and around the second axis.

[0009] According to this unit, the power usage supply unit which supplies power usage to the stage that moves on the movement surface comprises the first axis section, the first support section, the second axis section, and the second support section, and the first axis section is movably supported by the first support section within the movement surface in the direction of the first axis and around the first axis, while the second axis section is movably supported by the second support section within the movement surface in the direction of the second axis intersecting with the first axis and around the second axis. Accordingly, even if a force in a direction of the four degrees of freedom (the direction of the first axis, the rotational direction around the first axis, the direction of the second axis, and the rotational direction around the second axis) acts on the power usage supply unit due to the movement of the stage, the power usage supply unit absorbs the force by changing its position and attitude according to the force. Therefore, by connecting the power usage supply unit to the stage, the position controllability does not decrease due to dragging a tube as in the case when piping such as a tube are used for supplying power usage, and the position controllability of the stage can be favorably secured.

[0010] In this case, the power usage supply unit can further comprise: a third axis section that extends in a direction of a third axis intersecting with the first axis and the second axis; and a third support section that movably supports the third axis section in the direction of the third axis and around the third axis. In such a case, even if a force in any direction acts on the power usage supply unit, because the power usage supply unit can change its position and attitude according to the force, the position controllability of the stage can be secured more favorably.

[0011] According to a second aspect of the present invention, there is provided a second stage unit, the unit comprising: a stage movably supported on a movement surface; a first drive unit that drives the stage; a counter mass that moves in an opposite direction of the stage by the reaction force caused when the first drive unit drives the stage; and a power usage supply unit that supplies power usage to the stage via the counter mass.

[0012] According to this unit, the stage movably supported on the movement surface comprises the power usage supply unit that supplies power usage to the stage via the counter mass that moves in the opposite direction of the stage by the

reaction force caused when the first drive unit drives the stage. Therefore, the power usage supply to the stage is performed relaying the counter mass located near the stage. Accordingly, when comparing the case with when the power usage (fluid) is supplied to the stage directly from outside the stage unit via piping such as tubes, the resisting force that accompanies the dragging of a tube can be reduced, which makes it possible to improve the position controllability of the stage.

[0013] According to a third aspect of the present invention, there is provided a first exposure apparatus that transfers a pattern of a mask mounted on a stage unit onto a substrate wherein a stage unit according to one of the first and second stage units is used as the stage unit.

[0014] According to this apparatus, one of the first and second stage units is used as the stage unit that moves the mask, therefore, the position controllability of the mask can be improved, and as a consequence, position alignment (or overlay) of the pattern formed on the mask and the substrate becomes favorable, and it becomes possible to transfer the pattern onto the substrate with high precision.

[0015] According to a fourth aspect of the present invention, there is provided a second exposure apparatus that forms a pattern by exposing a substrate mounted on a stage unit wherein a stage unit according to one of the first and second stage units is used as the stage unit.

[0016] According to this apparatus, one of the first and second stage units of the present invention is used as the stage unit that moves the substrate, therefore, the position controllability of the substrate can be improved, and as a consequence, it becomes possible to transfer the pattern onto the substrate with high precision.

[0017] According to a fifth aspect of the present invention, there is provided an exposure method in which a pattern is formed by exposing a substrate on a stage with a unit comprising a power usage supply unit that supplies power usage to the stage which moves within a two dimensional plane wherein the power usage supply unit is moved in a first axis direction within the two dimensional plane and also around the first axis, and the power usage supply unit is moved in a second axis direction intersecting with the first axis and also around the second axis.

[0018] According to this method, the power usage supply unit that supplies power usage to the stage which moves within the two dimensional plane moves in directions of four degrees of freedom (the direction of the first axis, the rotational direction around the first axis, the direction of the second axis, and the rotational direction around the second axis), which allows the power usage supply unit to follow the stage when it moves. Therefore, the position controllability does not decrease due to dragging a tube as in the case when piping such as tubes are used for supplying power usage, and the position controllability of the stage can be favorably secured, which makes it possible to increase the exposure accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** is a schematic view of an arrangement of an exposure apparatus related to a first embodiment;

[0020] FIG. **2** is a perspective view of a wafer stage unit **12** in FIG. **1**;

[0021] FIG. **3**A is a perspective view of a wafer stage;

[0022] FIG. **3**B is a view that shows a state in which the wafer stage in FIG. **3**A is engaged with a stator that constitutes a moving body unit;

[0023] FIG. **4** is a planar view of wafer stage unit **12**;

[0024] FIG. **5** is an XZ sectional view of a component part including a stator unit MY, a wafer stage WST movably engaged with stator unit MY, and a tube carrier TC;

[0025] FIG. **6** is a view that models forces generated within the wafer stage unit;

[0026] FIG. **7** is a perspective view that schematically shows the inner arrangement of a Y linear motor;

[0027] FIG. **8** is a block diagram of a control system in the first embodiment;

[0028] FIG. **9** is a perspective view that shows a state of a power usage supply unit related to the first embodiment attached to the wafer stage;

[0029] FIG. **10** is a perspective view that shows the power usage supply unit related to the first embodiment;

[0030] FIG. **11** is an exploded perspective view that shows the power usage supply unit related to the first embodiment;

[0031] FIG. **12**A is a YZ sectional view of the power usage supply unit related to the first embodiment;

[0032] FIG. **12**B is an enlarged sectional view of a first solid cylindrical member and a hollow cylindrical member;

[0033] FIG. **13** is a perspective view of a wafer stage unit **12'** related to a second embodiment;

[0034] FIG. **14**A is a perspective view of a counter mass and a wafer stage attached to the counter mass extracted from wafer stage unit **12'** in FIG. **13**;

[0035] FIG. **14**B is an XY sectional view of a component part in FIG. **14**A;

[0036] FIG. **15** is a planar view of wafer stage unit **12'** in a state where the wafer table is detached;

[0037] FIG. **16** is a perspective view that shows a power usage supply unit related to a modified example;

[0038] FIG. **17** is an exploded perspective view of the power usage supply unit in FIG. **16**;

[0039] FIG. **18** is a partially sectioned view (No. **1**) of the power usage supply unit;

[0040] FIG. **19** is a partially sectioned view (No. **2**) of the power usage supply unit;

[0041] FIG. **20** is a view (No. **1**) for describing a gas flow within the power usage supply unit;

[0042] FIG. **21** is a view (No. **2**) for describing a gas flow within the power usage supply unit; and

[0043] FIG. **22** is a sectional view of a wafer stage and a counter mass in a state where the power usage supply unit related to the modified example is incorporated.

BEST MODE OF CARRYING OUT THE INVENTION

A First Embodiment

[0044] A first embodiment of the present invention is described below, referring to FIGS. **1** to **12**B.

[0045] FIG. **1** is an entire view of an arrangement of an exposure apparatus **100** related to the first embodiment. Exposure apparatus **100** is a scanning exposure apparatus based on a step-and-scan method, that is, the so-called scanning stepper.

[0046] Exposure apparatus **100** is equipped with an illumination system **10** that includes a light source and an illumination optical system and illuminates an illumination light (exposure light) IL serving as an energy beam on a reticle R serving as a mask, a reticle stage RST that holds reticle R, a projection unit PU, a wafer stage unit **12** serving as a stage unit (stage device) that includes a wafer stage WST on which

a wafer W serving as an object is mounted, a body BD in which reticle stage RST and projection unit PU is installed, a control system for these parts and the like.

[0047] Illumination system **10** illuminates a slit-shaped illumination area set by a reticle blind (not shown) on reticle R with illumination light IL at a substantially uniform illuminance. In this case, for example, an ArF excimer laser beam (wavelength: 193 nm) is used as illumination light IL.

[0048] Reticle stage RST is supported by levitation above a reticle base **36** that constitutes a top plate of a second column **34** which will be described later, by air bearings or the like (not shown) arranged on the bottom surface of reticle stage RST via a clearance of, for example, around several aim. On reticle stage RST, reticle R is fixed, for example, by vacuum suction (or by electrostatic suction). In this case, reticle stage RST can be finely driven two dimensionally within an XY plane (in an X-axis direction, a Y-axis direction and a rotational direction (θz direction) around a Z-axis orthogonal to the XY plane) perpendicular to an optical axis AX of a projection optical system PL (to be described later) by a reticle stage drive section **11**, which includes a linear motor or the like, and can also be driven on reticle base **36** in a predetermined scanning direction (in this case, the Y-axis direction which is the lateral direction of the page surface in FIG. **1**) at a designated scanning speed. Reticle stage RST can employ the known coarse/fine movement structure.

[0049] In the case of the embodiment, measures are taken to reduce the influence of vibration due to reaction forces acting on stators of the linear motor when reticle stage RST is driven (especially during scanning drive) as much as possible. More specifically, as is disclosed in, for example, Kokai (Japanese Patent Unexamined Application Publication) No. 8-330224, the corresponding U.S. Pat. No. 5,874,820 and the like, the stators of the linear motor are each supported by a support member (a reaction frame) (not shown) arranged separately from body BD, and the reaction forces that act on the stators of the linear motor when reticle stage RST is driven is to be transmitted (released) to a floor surface F of the clean room via the reaction frame. Besides such a method, a reaction canceling mechanism that uses the law of conservation of momentum as is disclosed in, for example, Kokai (Japanese Unexamined Patent Application Publication) No. 08-63231 and the corresponding U.S. Pat. No. 6,246,204 and the like, can also be employed as the reaction canceling mechanism of reticle stage RST. As long as the national laws in designated states (or elected states), on which this international application is applied, permit, the above disclosures of each of the publications and their corresponding U.S. Patents are incorporated herein by reference.

[0050] The position of reticle stage RST within a stage movement surface is constantly detected by a reticle laser interferometer (hereinafter referred to as "reticle interferometer") **16** via a movable mirror **15** at a resolution of, for example, around 0.5 to 1 nm. In this case, position measurement is performed, with a fixed mirror **14** fixed to the side surface of a barrel **40** that makes up projection unit PU serving as a reference. On reticle stage RST, a Y movable mirror that has a reflection surface orthogonal to the Y-axis direction and an X movable mirror that has a reflection surface orthogonal to the X-axis direction are actually arranged, and a reticle Y interferometer and a reticle X interferometer are also arranged corresponding to the movable mirrors, and furthermore, corresponding to the interferometers, a fixed mirror for position measurement in the X-axis direction and a fixed mirror for position measurement in the Y-axis direction are arranged, however, in FIG. **1** these are representatively indicated as movable mirror **15**, reticle interferometer **16**, and fixed mirror **14**.

[0051] The measurement values of reticle interferometer **16** are sent to a main controller **20**. Main controller **20** drives and controls reticle stage RST via reticle stage drive section **11**, based on the measurement values of reticle interferometer **16**.

[0052] Projection unit PU is held by a part of body BD, below reticle stage RST in FIG. **1**. Body BD is equipped with a first column **32** arranged on a frame caster FC placed on floor surface F of the clean room and the second column **34** fixed on the first column **32**.

[0053] Frame caster FC is equipped with a base plate BS laid horizontally on floor surface F, and a plurality of, e.g. three (or four), leg sections **39** (however, the leg section in the depth of the page surface of FIG. **1** is omitted in the drawings) fixed on base plate BS.

[0054] The first column **32** is equipped with a barrel platform (main frame) **38**, which is supported substantially horizontally by a plurality of, e.g. three (or four), first vibration isolation mechanisms **56** fixed individually on the upper end of the plurality of leg sections **39** that constitutes frame caster FC.

[0055] In barrel platform **38**, a circular opening (not shown) is formed substantially in the center, and in the circular opening, projection unit PU is inserted from above and is held via a flange FLG arranged on the outer circumferential section. On the upper surface of barrel platform **38**, at positions surrounding projection unit PU, one end (the lower end) of a plurality of, e.g. three (or four), legs **41** (however, the leg in the depth of the page surface of FIG. **1** is omitted in the drawings) is fixed. The other end (the upper end) of these legs **41** is substantially flush on a horizontal surface, and on each of the upper end surface of legs **41**, the lower surface of reticle base **36** described earlier is fixed. In the manner described above, the plurality of legs **41** horizontally supports reticle base **36**. That is, the second column **34** is configured by reticle base **36** and legs **41** supporting reticle base **36**. In reticle base **36**, an opening **36*a***, which serves as a path for illumination light IL, is formed in the center.

[0056] Projection unit PU is configured by barrel **40** that has a cylinder hollow shape and has flange FLG arranged on the outer periphery in the vicinity of the lower end section, and projection optical system PL consisting of a plurality of optical elements held in barrel **40**.

[0057] As projection optical system PL, for example, a dioptric system is used consisting of a plurality of lenses (lens elements) that share optical axis AX in the Z-axis direction. Projection optical system PL is, for example, a both-side telecentric dioptric system that has a predetermined projection magnification (such as one-quarter or one-fifth times). Therefore, when illumination light IL from illumination system **10** illuminates the illumination area on reticle R with illumination light IL that has passed through reticle R, a reduced image of the circuit pattern within the illumination area of reticle R (a partial reduced image of the circuit pattern) is formed on wafer W whose surface is coated with a resist (a photosensitive agent) via projection optical system PL. Wafer W is, for example, a disc-shaped substrate such as a semiconductor (silicon or the like) or an SOI (Silicon Insulator), and a resist is coated on the substrate.

[0058] As is shown in the perspective view in FIG. **2**, wafer stage unit **12** is equipped with a stage base **71**, which is supported substantially horizontally by a plurality of (e.g. three) second vibration isolation mechanisms (omitted in drawings) placed on base plate BS, wafer stage WST placed above the upper surface of stage base **71**, a tube carrier TC arranged on the +Y side of the wafer stage, a stage drive section that drives parts such as wafer stage WST and tube carrier TC, and the like. The stage drive is configured including a plurality of motors, which include a pair of Y-axis linear motors LY_1 and LY_2 shown in FIG. **2**, however, in FIG. **1**, the drive section is shown simply as a block as stage drive section **27**, for the sake of simplicity in the drawings.

[0059] Details on wafer stage unit **12** will now be described, referring to FIGS. **2** to **7**.

[0060] Stage base **71** is also called a platform, and is made of a flat plate that has a rectangular shape in a planar view (when viewed from above). Stage base **71** is placed in an area between protruded sections BSa and BSb, which are arranged in the vicinity of both edges of base plate BS in the X-axis direction extending in the Y-axis direction. The degree of flatness of the upper surface of stage base **71** is extremely high, and the upper surface serves as a movement surface when wafer stage WST moves.

[0061] As it can be seen from FIG. **3**A, which is a perspective view of wafer stage WST that has been taken out, wafer stage WST is equipped with a rectangular solid shaped wafer stage main body **28**, and a wafer table WTB fixed on the upper surface of wafer stage main body **28** by vacuum suction.

[0062] In wafer stage main body **28**, three openings **28***a*, **28***b*, and **28***c* that have a rectangular sectional shape are formed penetrating wafer stage main body **28** from the edge on the +X side to the edge on the –X side.

[0063] On the inner side of opening **28***a* on the vertical opposing surfaces, a pair of permanent magnets **22**A and **22**B, serving as a Y-axis mover, is respectively fixed.

[0064] On the inner side of openings **28***b* and **28***c* on the lateral opposing surfaces, magnetic pole units (a permanent magnet group) **23**A to **23**D, serving as X-axis movers, are respectively fixed.

[0065] Furthermore, in the vicinity of the four corners of the bottom surface of wafer stage main body **28**, magnetic pole units (permanent magnets) **29**A to **29**D (however, magnetic pole unit **29**D in the depth of the page surface is not shown) that have a triangular sectional shape are arranged. Details regarding magnetic pole units **29**A to **28**D will be given further, later in the description.

[0066] As is shown in the perspective views of FIGS. **2** and **3**B, wafer stage main body **28** is in a state engaged with a plurality of stators (armature coils) extending in the X-axis direction.

[0067] More specifically, as the plurality of stators (armature coils), as is shown in FIGS. **3**B and **4** (a planar view that shows a wafer stage unit), a Y-axis stator **187**, X-axis stators **61**A, **61**B, and **161**, and Z-axis stators **89**A and **89**B are arranged. The edge surface on the –X side of these six stators are each fixed to a plate shaped slider **46** which is placed substantially parallel to a YZ plane, and the edge surface on the +X side of these six stators are each fixed to a plate shaped slider **44** which is placed substantially parallel to the YZ plane (refer to FIGS. **2** and **4**). That is, sliders **44** and **46** and the six stators above constitute a stator unit MY.

[0068] In the embodiment, Y-axis stator **187** and the pair of permanent magnets **22**A and **22**B constitute a moving magnet type Y-axis voice coil motor VY that finely drives wafer stage WST in the Y-axis direction with respect to stator unit MY (refer to FIGS. **5**, **8** and the double pointing arrow (two-way arrow) a_1 in FIG. **6**, which models the force generated within wafer stage unit **12**).

[0069] Further, stator **61**A and the pair of magnetic pole units **23**A and **23**B constitute a moving magnet type X-axis linear motor LX_1 that drives wafer stage WST in the X-axis direction with respect to stator unit MY, and stator **61**B and the pair of magnetic pole units **23**C and **23**D constitute a moving magnet type X-axis linear motor LX_2 (refer to FIGS. **5** and **8**).

[0070] In this case, by making the Lorentz force generated in X-axis linear motors LX_1 and LX_2 the same, wafer WST is driven in the X-axis direction by X-axis linear motors LX_1 and LX_2, and also by making the Lorentz force generated in X-axis linear motors LX_1 and LX_2 differ slightly, wafer stage WST is driven in the rotational direction around the Z-axis (the θz direction) by X-axis linear motors LX_1 and LX_2 (refer to the double pointing arrow a_2 in FIG. **6**).

[0071] Furthermore, as is shown in FIG. **5**, magnetic pole units **29**A and **29**B and magnetic pole units **29**C and **29**D that are fixed to the bottom surface of wafer stage main body **28** are respectively in an engaged state with Z-axis stators **89**A and **89**B. Z-axis stators **89**A and **89**B each resemble the letter T turned upside down in the YZ section, and inside Z-axis stators **89**A and **89**B, armature coils (not shown) are arranged.

[0072] Magnetic pole unit **29**A and Z-axis stator **89**B constitute a Z-axis voice coil motor VZ_1 (refer to FIGS. **5** and **8**) that gives a drive force to wafer stage WST in the Z-axis direction, and similarly, magnetic pole unit **29**B and Z-axis stator **89**B constitute a Z-axis voice coil motor VZ_2 (refer to FIG. **8**) that gives a drive force to wafer stage WST in the Z-axis direction.

[0073] Similarly, magnetic pole unit **29**C and Z-axis stator **89**A constitute a Z-axis voice coil motor VZ_3 (refer to FIGS. **5** and **8**) that gives a drive force to wafer stage WST in the Z-axis direction, and similarly, magnetic pole unit **29**D and Z-axis stator **89**A constitute a Z-axis voice coil motor VZ_4 (refer to FIG. **8**) that gives a drive force to wafer stage WST in the Z-axis direction.

[0074] That is, by appropriately controlling Z-axis voice coil motors VZ_1 to VZ_4, wafer stage WST can be driven in the Z, θx, and θy directions with respect to stator unit MY (refer to the double pointing arrow b in FIG. **6**).

[0075] The self-weight of wafer stage WST is supported in a non-contact manner on a movement surface **71***a* of stage base **71** (refer to the double pointing arrow c in FIG. **6**) by a supporting force of a self-weight canceller **101** arranged on the bottom surface of wafer stage WST, as is shown in FIG. **5**. As self-weight canceller **101**, as an example, a unit that has a cylinder fixed facing downward on the bottom surface of wafer stage main body **28** and a piston inserted into the cylinder from below, and is structured having a static gas bearing (a thrust bearing) arranged on the bottom surface of the piston communicating with a positive pressure space formed inside the cylinder between the cylinder and the upper end surface of the piston can be used. In this case, a radial bearing composed of a static gas bearing is preferably arranged between the outer circumferential surface of the piston and the inner circumferential surface of the cylinder. As self-weight canceller **101**, for example, a bellows type self-weight canceller can be used.

[0076] As is shown in FIGS. **3**B and **5**, stator **161** engages with tube carrier TC, which has a rectangular frame shape when viewed from the +X (or −X) side. On the inner surface inside an opening section TCa of tube carrier TC on the +X side and the −X side, magnetic pole units **123**A and **123**B similar to magnetic pole units **23**A and **23**B described earlier are fixed. In the embodiment, stator **161** and the pair of magnetic pole units **123**A and **123**B constitute a moving magnet type X-axis linear motor RX (refer to FIGS. **5** and **8**) that drives tube carrier TC in the X-axis direction with respect to stator unit MY. As moving magnet type X-axis linear motor RX described above, a moving coil type linear motor can also be employed.

[0077] As is shown in FIGS. **3**B and **5**, one end of a gas supply pipe **203** and a discharge pipe **204** connects to tube carrier TC, via connector CN, respectively.

[0078] Between tube carrier TC and wafer stage WST (wafer stage main body **28**), a power usage supply unit **155** is arranged which connects tube carrier TC to wafer stage WST. The configuration of power usage supply unit **155** will be described later, along with the configuration of a supply system of pressurized gas and a supply system of vacuum power usage (vacuum discharge system) to wafer stage WST.

[0079] On each of the bottom surfaces of sliders **44** and **46**, plate shape members **188**A and **188**B are arranged as is shown in FIG. **4**. On the bottom surface of plate shape members **188**A and **188**B, a plurality of air bearings (not shown) are arranged along the Y-axis direction. And via the plurality of air bearings, sliders **44** and **46** are supported by levitation in a non-contact manner with respect to movement surface **71***a* of stage base **71** via a clearance of around several μm. Further, because the plurality of air bearings is disposed along the Y-axis direction, by making the levitation force of each air bearing differ, a force in the rotational direction around the X-axis (the θx direction) can be made to act on sliders **44** and **46**, and further, by making the levitation force of sliders **44** and **46** different, the whole stator unit MY can be finely driven in a rotational direction around the Y-axis (the θy direction) (refer to the double pointing arrow g in FIG. **6**).

[0080] As it can be seen when viewing FIGS. **4** and **2** together, Y-axis linear motors LY_1 and LY_2 are composed of Y-axis movers **48**A and **48**B consisting of armature units and Y-axis stators **86** and **87** consisting of magnetic pole units.

[0081] As it can be seen from FIG. **7** which models the structure inside Y-axis linear motor LY_1, one of the Y-axis movers, **48**A, has a plate shaped housing **196** shown by a dashed-two dotted line in the drawing, a plurality of first armature coils **190** that have a narrow rectangular shape extending in the X-axis direction placed at a predetermined spacing along the Y-axis direction within housing **196**, and a second armature coil **195** that has a narrow rectangular shape extending in the Y-axis direction placed on the +X side of the plurality of first armature coils **190**. The other Y-axis mover, **48**B, is configured similar to Y-axis mover **48**A although it is symmetric to Y-axis mover **48**A with respect to the Y-axis. As is shown in FIG. **2**, these Y-axis movers **48**A and **48**B are inserted into the inner space of Y-axis stators **86** and **87**, respectively.

[0082] As is shown in FIG. **2**, Y-axis stators **86** and **87** are each equipped with a stator **88**A and permanent magnets **90** and **95**, and are supported by levitation with respect to the upper surface of protruded sections BSa and BSb via a predetermined clearance by static gas bearings (not shown) such as, for example, air bearings, arranged on the lower surface of Y-axis stators **86** and **87**. Further, the movement of Y-axis stators **86** and **87** in the X-axis direction and in the θx, θy, and θz directions with respect to protruded sections BSa and BSb is limited (refer to the double pointing arrow f in FIG. **6**) by the static gas bearings (not shown) such as, for example, the air bearings. Further, although it is omitted in FIG. **2**, Y-axis trim motors **92**A and **92**B are arranged that drive Y-axis stators **86** and **87** in the Y-axis direction, respectively (refer to FIG. **8** and to the double pointing arrow c in FIG. **6**).

[0083] The other Y-axis stator, **87**, is configured similar to Y-axis stator **86** although it is symmetric to Y-axis stator **86** with respect to the Y-axis.

[0084] Because Y-axis linear motors LY_1 and LY_2 are configured in the manner described above, by supplying current to each of the first armature coils **190**, Lorentz forces that drive Y-axis movers **48**A and **48**B in the Y-axis direction are generated due to the electromagnetic interaction between the current and the alternating field described above. Further, by supplying current to the second armature coil **195**, Lorentz forces that drive Y-axis movers **48**A and **48**B in the X-axis direction are generated due to the electromagnetic interaction between the current and the magnetic field described above formed by the second permanent magnet group **95**. Accordingly, in the embodiment, by Y-axis linear motors LY_1 and LY_2, stator unit MY can be driven in the Y-axis direction as well as be driven finely in the X-axis direction, and also by making the drive force in the Y-axis direction generated in Y-axis linear motors LY_1 and LY_2 slightly different, stator unit MY (or as a consequence, wafer stage WST) can be driven in a rotational direction around the Z-axis (the θz direction) (refer to the double pointing arrow d in FIG. **6**).

[0085] As is obvious from the description above, in the first embodiment, Y-axis voice coil motor VY, X-axis linear motors LX_1 and LX_2, Y-axis linear motors LY_1 and LY_2, Z-axis voice coil motors VZ_1 to VZ_4, and Y-trim motors **92**A and **92**B make up a wafer stage drive section **27** that drives wafer stage WST (refer to FIG. **8**). Bearings such as the motors, the air bearings and the like that configure wafer stage unit **12** including wafer stage drive section **27** operate under the control of main controller **20** (refer to FIG. **8**).

[0086] Referring back to FIG. **1**, positional information on wafer stage WST within the XY plane is detected at all times by a wafer laser interferometer (hereinafter referred to as 'wafer interferometer') **18** via a movable mirror **17** fixed on the upper section of wafer stage WST (or to be more precise, the upper surface of wafer table WTB), at a resolution, for example, around 0.5 to 1 nm. Wafer interferometer **18** is fixed to barrel platform **38** in a suspended state, and measures the positional information of the reflection surface of movable mirror **17** whose reference is a reflection surface of a fixed mirror **57** fixed to the side surface of barrel **40** that makes up projection unit PU, as the positional information of wafer stage WST.

[0087] On wafer table WTB, as is shown in FIG. **3**A, a Y movable mirror **17**Y that has a reflection surface orthogonal to the scanning direction, which is the Y-axis direction, and an X movable mirror **17**X that has a reflection surface orthogonal to the non-scanning direction, which is the X-axis direction, are actually provided, and corresponding to these movable mirrors, laser interferometers and fixed mirrors are also arranged for position measurement in the X-axis direction and position measurement in the Y-axis direction; however, such details are representatively shown as movable mirror **17**, wafer interferometer **18**, and fixed mirror **57** in FIG. **1**. And,

for example, the edge surface of wafer table WTB can be mirror polished so as to form a reflection surface (corresponding to the reflection surfaces of movable mirrors **17**X and **17**Y). Further, the laser interferometer for position measurement in the X-axis direction and the laser interferometer for position measurement in the Y-axis direction are both multi-axis interferometers that have a plurality of measurement axes, and with these interferometers, other than the X and Y positions of wafer table WTB, rotation (yawing (rotation in the θz direction), pitching (rotation in the θx direction), and rolling (rotation in the θy direction) can also be measured. Accordingly, in the description below, wafer interferometer **18** is to measure the position of wafer table WTB in directions of five degrees of freedom, in the X, Y, θz, θy, and θx directions.

[0088] Positional information (or velocity information) on wafer stage WST is sent to main controller **20**, and based on the positional information (or velocity information) on wafer stage WST, main controller **20** controls the position of wafer stage WST within the XY plane via wafer stage drive section **27**.

[0089] Next, a configuration of the supply system of pressurized gas to wafer stage WST, the vacuum system, power usage supply unit **155** and the like will be described in detail, referring to FIG. **5** and to FIGS. **9** to **12**B.

[0090] As is shown in FIG. **5**, the +Y end of power usage supply unit **155** is fixed to the surface of tube carrier TC on the −Y side, and the −Y end is fixed to the surface of wafer stage main body **28** on the +Y side.

[0091] Inside tube carrier TC, a gas supply pipe line and a discharge pipe line are formed (not shown). One end of both the gas supply pipe line and the discharge pipe line connect to one end of gas supply pipe **203** and discharge pipe **204**, respectively, via connecter CN. The other end of both gas supply pipe **203** and discharge pipe **204** connect to a gas supply unit **201** and a vacuum suction unit **202** (refer to FIG. **8**) arranged outside of wafer stage unit **12**.

[0092] The other end of both the gas supply pipe line and the discharge pipe line connect to one end of a supply pipe **241***b* and a vacuum pipe **241***a* via a connecter (not shown). The other end of both supply pipe **241***b* and vacuum pipe **241***a* connect to power usage supply unit **155**, respectively.

[0093] Power usage supply unit **155** supplies a fluid (pressurized gas) supplied from gas supply unit **201** via gas supply pipe **203**, tube carrier TC, and supply pipe **241***b* to wafer stage WST via a supply pipe **270**A, and also supplies a negative pressure supplied from vacuum suction unit **202** via discharge pipe **204**, tube carrier TC, and vacuum pipe **241***a* to wafer stage WST via a vacuum pipe **270**B.

[0094] In the embodiment, tube carrier TC relays the supply of pressurized gas from gas supply unit **201** to wafer stage WST, and also relays the supply of negative pressure generated in vacuum suction unit **202** to wafer stage WST.

[0095] As is obvious from the description so far, in the embodiment, tubes such as the supply pipe and the vacuum pipe connect to tube carrier TC, however, to wafer stage WST, no piping connects from the outside (excluding piping that is integrally fixed to wafer stage WST, such as supply pipe **270**A and vacuum pipe **270**B). That is, wafer stage WST in the embodiment is a tubeless stage.

[0096] FIG. **9** shows a state where power usage supply unit **155** is attached to a surface on the +Y side of wafer stage main body **28** that constitutes wafer stage WST. As is shown in FIG. **9**, power usage supply unit **155** is composed of a combination of a plurality of cylinder solid members and a plurality of rectangular solid shaped members.

[0097] More specifically, as is shown in FIG. **10**, which is an enlarged view of power usage supply unit **155** taken out, and in FIG. **11**, which is an exploded perspective view of power usage supply unit **155**, power usage supply unit **155** is equipped with a first unit **251**, consisting of a pair of plate shaped fixed members **231**A and **231**B fixed to the edge surface of wafer stage main body **28** on the +Y side and an X-axis solid cylindrical member **232** serving as a first axis section whose longitudinal direction is in the X-axis direction and has fixed members **231**A and **231**B fixed to both edge surfaces in the longitudinal direction, and a second unit **252** including a hollow cylindrical member **234** attached on the outer circumference of X-axis solid cylindrical member **232**, a third unit **253** sequentially connected to the second unit **252**, and a Z support member **239**. Therefore, X-axis solid cylindrical member **232** serving as the first axis section is also a moving section that moves according to the movement of wafer stage WST in an X direction.

[0098] As is shown in FIG. **11**, on the surface of X-axis solid cylindrical member **232** that constitutes the first unit **251**, a plurality of surface throttle grooves **232***p* of a predetermined depth (ex. a depth of around 10 μm) is formed along the longitudinal direction (the X-axis direction) at a predetermined spacing. Further, on the edge surface of X-axis solid cylindrical member **232** on the +X side, two circular holes **232***d* and **232***b* are formed that reach the area close to the center in the X-axis direction. As it is shown in FIG. **12**A, which is a YZ sectional view of power usage supply unit **155**, and FIG. **12**B, which is an enlarged view of X-axis solid cylindrical member **232** and hollow cylindrical member **234** in FIG. **12**A, one of the circular holes **232***d* is formed at a position slightly shifted to the +Z side from the center of the cross-sectional surface and the other circular hole **232***b* is formed at a position slightly shifted to the −Z side from the center of the cross-sectional surface.

[0099] Further, as is shown in FIG. **11**, on the upper surface of X-axis solid cylindrical member **232** at the center in the X-axis direction, a circular hole **232***c* is formed. As is shown in FIG. **12**B, circular hole **232***c* communicates with circular hole **232***d*. Circular hole **232***d* and circular hole **232***c* form a pipe line that resembles the shape of the letter L, and this pipe line is a first fluid supply pipe line.

[0100] Further, as is shown in FIG. **12**B, on the lower surface of X-axis solid cylindrical member **232** at the center in the X-axis direction, a circular hole **232***a* that communicates with circular hole **232***b* is formed. Circular hole **232***b* and circular hole **232***a* form a pipe line that resembles the shape of the letter L, and this pipe line is a first vacuum pipe line. In FIG. **11**, surface throttle grooves **232***p* were arranged in the circular hole **232***c* section, however, as it is obvious from FIG. **12**, on the opposite side of circular hole **232***c*, circular hole **232***b* that is the first vacuum pipe line is formed. Therefore, it is preferable to arrange surface throttle grooves **232***p* avoiding circular hole **232***b* (and circular hole **232***c*) and the vicinity of the holes.

[0101] As is shown in FIG. **11**, in one of the fixed members **231**A, flow passages **231**Aa and **231**Ab are formed penetrating fixed member **231**A, each made of a circular hole whose longitudinal direction is the X-axis direction so that the holes communicate with circular hole **232***d* and circular hole **232***b*. As is shown in FIG. **9**, flow passage **231**Aa connects to one end of supply pipe **270**A via a connecter (not shown) and flow

passage **231**Ab connects to one end of vacuum pipe **270**B via a connecter (not shown). The other end of supply pipe **270**A and vacuum pipe **270**B each connect to a part of wafer stage main body **28**. The other fixed member **231**B differs from fixed member **231**A, and is configured of a plate shaped member that does not have any passages formed.

[0102] As is shown in FIG. **10**, the second unit **252** is configured including hollow cylindrical member **234**, an attachment member **235** fixed on the outside of hollow cylindrical member **234** at the center in the longitudinal direction, and a Y-axis solid cylindrical member **236** serving as a second axis section that has a part of the tip on one end (the edge surface of on the −Y side) embedded in the edge surface of attachment member **235** on the +Y side and extends in the Y-axis direction. Y-axis solid cylindrical member **236** serving as the second axis section also serves as a moving section that moves according to the movement of wafer stage WST in the Y-axis direction.

[0103] As is shown in FIG. **10**, hollow cylindrical member **234** has a diameter slightly larger than the diameter of X-axis solid cylindrical member **232**, and is in a state where X-axis solid cylindrical member **232** is inserted inside. In this case, as is shown in FIG. **12**B, a predetermined gap is formed entirely between the inner circumferential surface of hollow cylindrical member **234** and the inner circumferential surface of X-axis solid cylindrical member **232**. Therefore, X-axis solid cylindrical member **232** is in a state where it can relatively move in the X-axis direction and the rotational direction around the X-axis with respect to hollow cylindrical member **234**. That is, hollow cylindrical member **234** configures a first support section that movably supports X-axis solid cylindrical member **232** in the X-axis direction and around the X-axis.

[0104] As is shown in FIG. **12**B, in hollow cylindrical member **234**, on the inner circumferential surface in the X-axis direction, a plurality of depressed grooves (e.g. eight) **234**c_1, **234**c_2, . . . , **234**c_n are formed at a predetermined angular spacing. As is shown in FIG. **12**B, one of the depressed grooves **234**c_1 is positioned so as to face circular hole **232***c* of X-axis solid cylindrical member **232**, and in a part of the bottom surface of depressed groove **234**c_1, a circular hole **234***b* that penetrates and reaches the outer surface of hollow cylindrical member **234** is formed. Further, at a position on the inner surface of hollow cylindrical member **234** facing depressed groove **234**c_1, depressed groove **234**c_n is positioned so as to face circular hole **232***a* previously described, and in a part of the bottom surface of depressed groove **234**c_n, a circular hole **234***a* that penetrates and reaches the outer surface of hollow cylindrical member **234** is formed. Depressed grooves **234**c_1, **234**c_2, . . . , **234**c_n can also be arranged not on the inner circumferential surface of hollow cylindrical member **234** but on the outer periphery surface of X-axis solid cylindrical member **232**. Furthermore, these depressed grooves **234**c_1, **234**c_2, . . . , **234**c_n do not necessarily have to be arranged along the X-axis direction, and a plurality of grooves can be arranged at a predetermined spacing in the X-axis direction on the outer periphery surface of X-axis solid cylindrical member **232**.

[0105] As is shown in FIG. **11**, attachment member **235** has an outer shape which is substantially a cube, and a through hole **235***a* of a circular shape is formed penetrating the cube from the edge surface on the +X side to the edge surface on the −X side. Inside through hole **235***a*, hollow cylindrical member **234** is inserted, and on the outside of hollow cylindrical member **234** at the center in the X-axis direction, attachment member **235** is attached in a state where there is no space between the members.

[0106] Inside attachment member **235**, pipe lines **235***c* and **235***b* are formed in a state where one end of each of the pipe lines communicates with circular hole **234***b* and circular hole **234***a* formed in hollow cylindrical member **234**, respectively, as is shown in FIG. **12**A. In the description below, for the sake of convenience, circular hole **234***b* and pipe line **235***c* will be referred to together as a second fluid supply pipe line, and circular hole **234***a* and pipe line **235***b* will be referred to together as a second vacuum pipe line.

[0107] As is shown in FIG. **12**A, on the edge surface of attachment member **235** on the +Y side, a shallow circular depressed section **235***d* is formed, and a Y-axis solid cylindrical member **236** orthogonal to X-axis solid cylindrical member **232** is fixed to attachment member **235** in a state where the tip section of Y-axis solid cylindrical member **236** on the −Y side is fitted in depressed section **235***d*. Y-axis solid cylindrical member **236** does not necessarily have to be orthogonal to X-axis solid cylindrical member **232** as long as it intersects X-axis solid cylindrical member **232**.

[0108] As is shown in FIG. **12**A, inside Y-axis solid cylindrical member **236**, a third fluid supply pipe line **236***b* and a third vacuum pipe line **236***a* are formed whose sectional shapes resemble the letter L and have one end that communicates with the other end of pipe lines **235***c* and **235***b* formed in attachment member **235** previously described, respectively. Further, on the surface of Y-axis solid cylindrical member **236**, a plurality of surface throttle grooves **236***p* of a predetermined depth (ex. a depth of around 10 μm) is formed along the longitudinal direction (the Y-axis direction) at a predetermined spacing, as is shown in FIG. **11**. It is also preferable to arrange the plurality of surface throttle grooves **236***p* formed on the surface of Y-axis solid cylindrical member **236**, while avoiding the circular hole **236***a* (and circular hole **236***b*) section on the surface of Y-axis solid cylindrical member **236**.

[0109] As is shown in FIG. **10**, the third unit **253** is configured including a Y support member **237** that has a substantially cubic outer shape and is arranged on the outer circumferential side in the vicinity of the edge section on the +Y side of Y-axis solid cylindrical member **236**, and a Z-axis solid cylindrical member **238** serving as a third axis section fixed to the lower surface (the surface on the −Z side) of Y support member **237** orthogonal to X-axis solid cylindrical member **232** and to Y-axis solid cylindrical member **236**. Z-axis solid cylindrical member **238** serving as the third axis section is also a moving section that moves according to the movement of wafer stage WST in a Z direction. Z-axis solid cylindrical member **238** does not necessarily have to be attached to Y support member **237** orthogonal to X-axis solid cylindrical member **232** and Y-axis solid cylindrical member **236**.

[0110] In Y support member **237**, a circular through hole **237***a* that penetrates Y support member **237** from the edge surface on the +Y side to the edge surface on the −Y side is formed (refer to FIG. **11**), and Y-axis solid cylindrical member **236** is inserted into through hole **237***a* via a predetermined clearance around the entire circumference of Y-axis solid cylindrical member **236**. Therefore, Y-axis solid cylindrical member **236** is in a relatively movable state in the Y-axis direction and the rotational direction around the Y-axis with respect to Y support member **237**. That is, Y support member

237 constitutes a second support section that movably supports Y-axis solid cylindrical member **236** in the Y-axis direction and around the Y-axis.

[0111] As is shown in FIG. **12**A, on the inner circumferential surface of Y support member **237**, a plurality of depressed grooves **237**b_j (j=1 to n, for example, n is 8,) that extend in the Y-axis direction is formed at a predetermined angular spacing as in depressed grooves **234**c_1, **234**c_2, . . . , **234**c_n of hollow cylindrical member **234** described earlier (however, in FIG. **12**A, only two depressed grooves **237**b_1 and **237**b_n are shown, refer to FIG. **11**). And, in Y support member **237**, a fourth vacuum pipe line **237**c is formed, in a state where the pipe line communicates with depressed groove **237**b_n located at a position closest to the −Z side. Further, in Y support member **237**, a fluid supply pipe line **237**d_2 is formed, in a state where the pipe line communicates with depressed groove **237**b_1 located at a position closest to the +Z side. Fluid supply pipe line **237**d_2 communicates with a fluid supply pipe line **237**d_1 formed on the lower half section of support member **237** via a fluid supply pipe line **237**d_3. In this case, fluid supply pipe line **237**d_3 is a half arc shaped pipe line formed inside Y support member **237** in half of the depth of the page surface of FIG. **12**A. In the description below, fluid supply pipe lines **237**d_1, **237**d_2, and **237**$d_3$will be referred to together as "a fourth liquid fluid supply pipe line **237**d". The plurality of depressed grooves **237**b_j can be formed not only on the inner circumferential surface of Y support member **237** but also on the outer circumference of Y-axis solid cylindrical member **236**, and the grooves do not necessarily have to be arranged along the Y-axis direction.

[0112] As is shown in FIG. **11**, in Z-axis solid cylindrical member **238**, surface throttle grooves **238**p of a predetermined depth (ex. a depth of around 10 μm) is formed in the center along the longitudinal direction (the Z-axis direction) at a predetermined spacing. Further, Z-axis solid cylindrical member **238** is fixed in a state where the upper end is fitted inside a shallow circular depressed section **237**e formed in the lower end surface of Y support member **237**. As is shown in FIG. **12**A, inside Z-axis solid cylindrical member **238**, a fifth vacuum pipe line **238**a in the Z-axis direction is formed in a penetrated state, in a state communicating with the fourth vacuum pipe line **237**c formed in Y support member **237** previously described. Further, inside Z-axis solid cylindrical member **238**, on the −Y side of the fifth vacuum pipe line **238**a, a fifth fluid supply pipe line **238**b in the Z-axis direction is formed, in a state communicating with the fourth fluid supply pipe line **237**d. The end of the fifth vacuum pipe line **238**a on the −Z side connects to one end of vacuum pipe **241**a described earlier via a connecter (not shown), and the end of the fifth fluid supply pipe line **238**b connects to one end of supply pipe **241**b described earlier via a connecter (not shown).

[0113] In Z-axis solid cylindrical member **238**, a branched pipe line **238**c is formed that branches from the fifth vacuum pipe line **238**a from the center in the Z-axis direction toward the +Y direction, and the tip of branched pipe line **238**c opens toward the outside of the outer circumferential surface of Z-axis solid cylindrical member **238** (refer to FIG. **11**). In Z-axis solid cylindrical member **238**, a branched pipe line **238**d is formed that branches from the fifth fluid supply pipe line **238**b from the center in the Z-axis direction toward the −Y direction, and the tip of branched pipe line **238**d opens toward the outside of the outer circumferential surface of Z-axis solid cylindrical member **238**. It is preferable to form surface throttle grooves **238**p formed on the surface of Z-axis solid cylindrical member **238**, while avoiding branched pipe line **238**c and its neighboring area.

[0114] As is shown in FIGS. **10**, **12** and the like, Z support member **239** has an outer shape which is a rough rectangular solid shape, and an edge surface **239**c of Z support member **239** on the +Y side is fixed to the edge surface of tube carrier TC on the −Y side (refer to FIG. **12**A).

[0115] In Z support member **239**, a circular through hole **239**a is formed from the edge surface on the +Z side to the edge surface on the −Z side (refer to FIG. **11**), and Z-axis solid cylindrical member **238** is inserted into through hole **239**a via a predetermined clearance around the entire circumference of Z-axis solid cylindrical member **238**. Therefore, Z-axis solid cylindrical member **238** is in a relatively movable state in the Z-axis direction and the rotational direction around the Z-axis with respect to Z support member **239**. That is, Z support member **239** constitutes a third support section that movably supports Z-axis solid cylindrical member **238** in the Z-axis direction and around the Z-axis.

[0116] As is shown in FIG. **12**A, on the inner circumferential surface of Z support member **239**, a plurality of depressed grooves **239**b_i (i=1 to n, for example, n is 8,) that extend in the Z-axis direction is formed at a predetermined angular spacing as in depressed grooves **234**c_1, **234**c_2, . . . , **234**c_n of hollow cylindrical member **234** described earlier (however, in FIG. **12**A, only two depressed grooves **239**b_1 and **239**b_n are shown, refer to FIG. **11**). The plurality of depressed grooves **239**b_j can be formed not only on the inner circumferential surface of Z support member **239** but also on the outer circumference of Z-axis solid cylindrical member **238**, and the grooves do not necessarily have to be arranged along the Z-axis direction.

[0117] Further, as the material for X-axis solid cylindrical member **232**, hollow cylindrical member **234**, Y-axis solid cylindrical member **236**, and Z-axis solid cylindrical member **238**, ceramic or aluminum can be used.

[0118] Next, the operation of power usage supply unit **155** configured in the manner described above will be briefly described.

[0119] As is described earlier, the fluid (pressurized gas) supplied to tube carrier TC from gas supply unit **201** via gas supply pipe **203** is supplied to the fifth fluid supply pipe line **238**b within Z-axis solid cylindrical member **238** of power usage supply unit **155**. Next, a part of the pressurized gas supplied inside the fifth fluid supply pipe line **238**b is discharged outside the outer circumferential surface of Z-axis solid cylindrical member **238** via branched pipe line **238**d, and most of the remaining gas passes through the fifth fluid supply pipe line **238**b and then moves toward the fourth fluid supply pipe line **237**d formed in Y support member **237**.

[0120] The pressurized gas discharged outside the outer circumferential surface of Z-axis solid cylindrical member **238** spreads swiftly entirely in the Z-axis direction in the gap between Z-axis solid cylindrical member **238** and Z support member **239** via grooves **239**b_1 to **239**b_n formed on the inner circumferential surface of Z support member **239**, and also enters surface throttle grooves **238**p on the outer circumferential surface of Z-axis solid cylindrical member **238** and spreads in the entire circumferential direction in the gap between Z-axis solid cylindrical member **238** and Z support member **239**. Accordingly, due to the static pressure of the pressurized gas (or the pressure within the gap) that has entered surface throttle grooves **238**p, Z-axis solid cylindrical member **238** is supported in a non-contact manner with

respect to Z support member **239**. That is, in the manner described above, a type of static gas bearing is configured in the entire area of surface throttle grooves **238***p*. In this case, because surface throttle grooves **238***p* of Z-axis solid cylindrical member **238** is formed on the entire circumference of the outer surface of Z-axis solid cylindrical member **238**, the static pressure of the pressurized gas is substantially equal along the entire circumference, therefore the same clearance is made in the entire circumferential direction of Z-axis solid cylindrical member **238**. As a consequence, Z-axis solid cylindrical member **238** is in a state where movement in the Z-axis direction and the rotational direction around the Z-axis of Z-axis solid cylindrical member **238** with respect to Z support member **239** is permissible.

[0121] Meanwhile, the pressurized air that moves toward the fourth fluid supply pipe line **237***d* sequentially passes through fluid supply pipe lines **237**d_1, **237**d_3, and **237**d_2 and then a part of the pressurized gas is discharged from an opening end of fluid supply pipe line **237**d_2 formed in the bottom surface inside depressed groove **237**b_1 into a slight gap in between Y-axis solid cylindrical member **236** and Y support member **237**, and most of the remaining gas moves toward the second fluid supply pipe line (**235***c* and **234***b*) formed inside attachment member **235** via the third fluid supply pipe line **236***b* formed within Y-axis solid cylindrical member **236**.

[0122] The pressurized gas discharged into the slight gap in between Y-axis solid cylindrical member **236** and Y support member **237** swiftly spreads in the entire Y-axis direction in the gap between Y-axis solid cylindrical member **236** and Y support member **237** via each of the grooves **237**b_1 to **237**b_n formed in the inner circumferential surface of Y support member **237**, and also enters surface throttle grooves **236***p* on the outer circumferential surface of Y-axis solid cylindrical member **236** and spreads in the entire circumferential direction in the gap between Y-axis solid cylindrical member **236** and Y support member **237**. Accordingly, due to the static pressure of the pressurized gas (or the pressure within the gap) that has entered surface throttle grooves **236***p*, Y-axis solid cylindrical member **236** is supported in a non-contact manner with respect to Y support member **237**. That is, in the manner described above, a type of static gas bearing is configured in the entire area of surface throttle grooves **236***p*. In this case, because surface throttle grooves **236***p* of Y-axis solid cylindrical member **236** is formed on the entire circumference of the outer surface of Y-axis solid cylindrical member **236**, the static pressure of the pressurized gas is substantially equal along the entire circumference, therefore the same clearance is made in the entire circumferential direction of Y-axis solid cylindrical member **236**. As a consequence, Y-axis solid cylindrical member **236** is in a state where movement in the Y-axis direction and the rotational direction around the Y-axis of Y-axis solid cylindrical member **236** with respect to Y support member **237** is permissible.

[0123] Meanwhile, of the second fluid supply pipe line (**235***c* and **234***b*), the pressurized air supplied to the second fluid supply pipe line is partially discharged from circular hole **234***b* formed in hollow cylindrical member **234** into a slight gap in between hollow cylindrical member **234** and X-axis solid cylindrical member **232** via depressed groove **234**c_1, and the remaining gas is supplied to the first fluid supply pipe line (**232***c* and **232***d*) formed in X-axis solid cylindrical member **232**.

[0124] The pressurized gas discharged into the slight gap in between hollow cylindrical member **234** and X-axis solid cylindrical member **232** swiftly spreads in the entire X-axis direction in the gap between hollow cylindrical member **234** and X-axis solid cylindrical member **232** via each of the grooves **234**c_1 to **234**c_n formed in the inner circumferential surface of hollow cylindrical member **234**, and also enters surface throttle grooves **232***p* on the outer circumferential surface of X-axis solid cylindrical member **232** and spreads in the entire circumferential direction in the gap between X-axis solid cylindrical member **232** and hollow cylindrical member **234**. Accordingly, due to the static pressure of the pressurized gas (or the pressure within the gap) that has entered surface throttle grooves **232***p*, X-axis solid cylindrical member **232** is supported in a non-contact manner with respect to hollow cylindrical member **234**. That is, in the manner described above, a type of static gas bearing is configured in the entire area of surface throttle grooves **232***p*. In this case, because surface throttle grooves **232***p* of X-axis solid cylindrical member **232** is formed on the entire circumference of the outer surface of X-axis solid cylindrical member **232**, the static pressure of the pressurized gas is substantially equal along the entire circumference, therefore the same clearance is made in the entire circumferential direction of X-axis solid cylindrical member **232**. As a consequence, X-axis solid cylindrical member **232** is in a state where movement in the X-axis direction and the rotational direction around the X-axis of X-axis solid cylindrical member **232** with respect to hollow cylindrical member **234** is permissible.

[0125] Meanwhile, the pressurized gas supplied to the first fluid supply pipe line (**232***c* and **232***d*) is sent inside wafer stage main body **28** sequentially passing through the first fluid supply pipe line, flow passage **231**Aa formed in fixed member **231**A (refer to FIG. **11**), and supply pipe **270**A (refer to FIG. **9**). The pressurized gas sent inside wafer stage main body **28** passes through a gas supply pipe line (not shown) inside wafer stage main body **28** and is supplied and used in various mechanisms of wafer stage WST. In the embodiment, for example, the pressurized gas sent inside wafer stage main body **28** is supplied to self-weight canceller **101** described earlier, and as well as to an elevating mechanism (not shown) that elevates vertical movement pins (center-ups) (not shown) arranged on wafer holder **25** for elevating wafer W.

[0126] Meanwhile, when vacuum suction by vacuum suction unit **202** begins, the negative pressure generated in vacuum suction unit **202** is supplied to a vacuum pipe line inside wafer stage main body **28** via discharge pipe **204**, tube carrier TC, vacuum pipe **241***a*, power usage supply unit **155**, and vacuum pipe **270**B.

[0127] During the suction operation, a gas flow that flows toward the second vacuum pipe line (**234***a* and **235***b*) sequentially from the wafer stage main body **28** side via vacuum pipe **270**B, flow passage **231**Ab formed in fixed member **231**A, the first vacuum pipe line (**232***b* and **232***a*) formed inside X-axis axis solid cylindrical member **232**, and depressed groove **234**c_n formed in hollow cylindrical member **234** is generated. By the negative pressure caused by the gas flow, the pressurized gas supplied to the gap between X-axis axis solid cylindrical member **232** and hollow cylindrical member **234** is suctioned, and by the suction force, the pressurized air swiftly spreads to the entire circumference of X-axis solid cylindrical member **232** and a constant amount of pressurized gas is also maintained within the gap.

[0128] Further, inside Y-axis solid cylindrical member **236** and Y support member **237**, a gas flow that flows toward the fourth vacuum pipe line **237**c from the third vacuum pipe line **236**a formed in Y-axis solid cylindrical member **236** via depressed groove **237**b_n formed in Y support member **237** is generated. By the negative pressure caused by the gas flow, the pressurized gas supplied to the gap between Y-axis axis solid cylindrical member **236** and Y support member **237** is suctioned, and the pressurized air swiftly spreads to the entire circumference of Y-axis solid cylindrical member **236** and a constant amount of pressurized gas is also maintained within the gap.

[0129] Further, inside the fifth vacuum pipe line **238**a formed in Z-axis solid cylindrical member **238**, a gas flow that flows toward vacuum pipe **241**a is generated. By the negative pressure caused by the gas flow, the pressurized gas supplied to the gap between Z-axis axis solid cylindrical member **238** and Z support member **239** is suctioned via branched pipe line **238**c, and the pressurized air swiftly spreads to the entire circumference of Z-axis solid cylindrical member **238** and a constant amount of pressurized gas is also maintained within the gap.

[0130] Further, inside vacuum pipe **241**a, tube carrier TC, and discharge pipe **204** a gas flow that flows toward vacuum suction unit **202** is generated.

[0131] In the embodiment, by the gas flow described above due to the negative pressure generated in vacuum suction unit **202**, operations such as for example, vacuum suction of wafer W by wafer holder **25**, vacuum suction of wafer table WTB by wafer stage main body **28**, vacuum suction of the wafer by the tip of the vertical movement pins (center-ups) and the like are performed inside wafer stage WST.

[0132] Further, as is stated in the pamphlet of International Publication WO2004/053953, in an immersion exposure apparatus that projects a pattern on a wafer in a state where a liquid (e.g. pure water) is supplied in the space between projection optical system PL and wafer W, when there is a risk of the liquid moving to the back surface of wafer W it is disclosed that the liquid is to be suctioned. Therefore, for example, a new suction pipe can be arranged in addition to discharge pipe **270**B, and the liquid that may move to the back surface of wafer holder **25** can be suctioned using the vacuum. In addition, the section with the risk of the liquid moving to the back surface of wafer stage WST can be appropriately suctioned using power usage supply unit **155**. In the case disturbance such as vibration occurs due to the suction of the liquid that may affect the exposure accuracy, the suction of the liquid can be performed when exposure operation is not being performed (e.g. during wafer exchange after the completions of the exposure operation). As long as the national laws in designated states (or elected states), on which this international application is applied, permit, the disclosure of the U.S. Patent Application corresponding to the pamphlet of International Publication WO2004/053953 is incorporated herein by reference.

[0133] Power usage supply unit **155** can supply the liquid whose temperature has been adjusted to wafer stage WST. To be more specific, a supply pipe independent from supply pipe **270**A can be arranged and the liquid whose temperature has been adjusted can be supplied to permanent magnets **22**A, **22**B, **23**A to **23**D, and **29**A to **29**D arranged in wafer stage main body **28**. Accordingly, heat generation of permanent magnets **22**A, **22**B, **23**A to **23**D, and **29**A to **29**D due to eddy current can be reduced. Further, by supplying the liquid whose temperature has been adjusted to wafer holder **25**, the temperature of wafer holder **25** can be adjusted.

[0134] In case the number of supply pipes and discharge pipes increases, a plurality of power usage supply unit **155** can be arranged. For example, in the case two power usage supply units **155** are arranged, the units can be arranged horizontally symmetrical or vertically symmetrical.

[0135] During the exposure operation, main controller **20** drives tube carrier TC via X-axis linear motor RX in the same direction as the stepping direction of wafer stage WST and makes tube carrier TC roughly follow wafer stage WST. In this operation, main controller **20** makes X-axis linear motor RX act a drive force that makes tube carrier TC move at a constant speed. In the embodiment, even if tube carrier TC does not follow wafer stage WST in the X, Y directions with good precision, hollow cylindrical member **234** movably supports X-axis axis solid cylindrical member **232** while Y support member **237** movably supports Y-axis axis solid cylindrical member **236**. Therefore, no force is applied to wafer stage WST from power usage supply unit **155**. Similarly, in the case wafer stage WST is driven in the Z direction, because Z support member **239** movably supports Z-axis axis solid cylindrical member **238**, no force (e.g. tension) is applied to wafer stage WST from power usage supply unit **155**.

[0136] As is described in detail above, according to wafer stage unit **12** in the embodiment, power usage supply unit **155** that connects to wafer stage WST, which moves on upper surface **71**a of stage base **71**, and supplies pressurized gas (fluid) or vacuum to wafer stage WST is configured including X-axis axis solid cylindrical member **232** (the first axis section), hollow cylindrical member **234** (the first support section), Y-axis axis solid cylindrical member **236** (the second axis section), Y support member **237** (the second support section), Z-axis axis solid cylindrical member **238** (the third axis section), and Z support member **239** (the third support section), and X-axis axis solid cylindrical member **232** is movably supported in the X-axis direction and around the X-axis by hollow cylindrical member **234**, Y-axis axis solid cylindrical member **236** is movably supported in the Y-axis direction and around the Y-axis by Y support member **237**, and Z-axis axis solid cylindrical member **238** is movably supported in the Z-axis direction and around the Z-axis by Z support member **239**. Accordingly, even if a force in any direction of six degrees of freedom acts on power usage supply unit **155** due to the movement of wafer stage WST, because power usage supply unit **155** absorbs the force by changing its position and attitude according to the force, power usage supply unit **155** does not interfere with the movement of the stage. Accordingly, there is no decrease in position controllability caused by dragging a tube as in the case when tubes are used for the piping when supplying the fluid and the position controllability of wafer stage WST can be favorably secured.

[0137] Further, because a first, second, and third static gas bearings are arranged between X-axis axis solid cylindrical member **232** and hollow cylindrical member **234**, Y-axis axis solid cylindrical member **236** and Y support member **237**, and Z-axis axis solid cylindrical member **238** and Z support member **239**, respectively, the space between X-axis axis solid cylindrical member **232** and hollow cylindrical member **234**, Y-axis axis solid cylindrical member **236** and Y support member **237**, and Z-axis axis solid cylindrical member **238** and Z support member **239** can each be configured in a non-contact manner, which allows power usage supply unit **155** to change

its position and attitude without generating a resisting force even if a force in any direction of six degrees of freedom acts on power usage supply unit **155** due to the movement of wafer stage WST. Accordingly, decrease in position controllability due to power usage supply unit **155** can be almost completely prevented.

[0138] Further, in the embodiment, because power usage supply unit **155** is arranged in tube carrier TC that moves in a constant speed along the X-axis direction, by making tube carrier roughly follow the movement of wafer stage WST in the X-axis direction, the permissible range of power usage supply unit **155** in the X-axis direction can be designed small, which consequently makes it possible to reduce the size of wafer stage unit **12** and also to reduce the amount of heat generated in the linear motor.

[0139] Further, according to exposure apparatus **100** of the embodiment, because wafer stage unit **12** described above is used as the stage unit for moving wafer W serving as a substrate, position controllability of wafer W (wafer stage WST) when performing exposure operation by the step-and-scan method in which the pattern of reticle R is transferred onto a plurality of shot areas on wafer W can be improved, and as a consequence, the pattern of reticle R can be transferred with high precision on wafer W.

[0140] In the embodiment above, the case has been described where tube carrier TC performs a constant speed motion, however, tube carrier TC can also be driven by arranging a reflection surface in tube carrier TC, measuring the position of tube carrier TC using an interferometer or an encoder, and making tube carrier TC follow wafer stage WST based on the measurement results.

[0141] In the embodiment described above, Y-axis axis solid cylindrical member **236** was attached to Z-axis axis solid cylindrical member **238**, however, hollow cylindrical member **234** or X-axis axis solid cylindrical member **232** can also be attached to Z-axis axis solid cylindrical member **238**.

[0142] Further, in the embodiment described above, X-axis axis solid cylindrical member **232** was configured to be a movement section, however, hollow cylindrical member **234** can also be configured to be a movement section. Similarly, Y-axis axis solid cylindrical member **236** and Z-axis axis solid cylindrical member **238** were configured to be movement sections, however, the members that surround both Y-axis axis solid cylindrical member **236** and Z-axis axis solid cylindrical member **238** can also be configured to be movement sections.

A Second Embodiment

[0143] A second embodiment of the present invention is described below, referring to FIGS. **13** to **15**. For parts that have the same or similar arrangement as the first embodiment previously described, the same reference numerals will be used, and the description thereabout will be brief, or entirely omitted. In the exposure apparatus of the second embodiment, only a part of the configuration of the wafer stage unit (stage unit) differs, and the configuration of other sections is similar to exposure apparatus **100** of the first embodiment previously described.

[0144] FIG. **13** shows a perspective view of a configuration of wafer stage unit **12'** related to the second embodiment. When comparing FIGS. **13** and **2**, it can be seen that the section driven in the Y-axis direction by Y-axis linear motors LY_1 and LY_2 of wafer stage unit **12'** in the second embodiment differs from wafer stage unit **12** in the first embodiment. More specifically, in wafer stage unit **12'**, instead of stator unit MY previously described, a moving body unit MY' is arranged, and instead of tube carrier TC attached to stator unit MY, a counter mass **30** in which wafer stage WST is incorporated is arranged. In the description below, from the viewpoint of avoiding repetition, these differences will be mainly described. The basic configuration of wafer stage unit **12'** in the embodiment is stated in the description of Japanese Patent Application No. 2004-116043, which is a previous application.

[0145] FIG. **14**A shows a perspective view of counter mass **30** and wafer stage WST attached to the counter mass extracted from wafer stage unit **12'**, and FIG. **14** shows a sectional view of FIG. **14**A in an X-Z plane. Further, FIG. **15** shows a planar view of wafer stage unit **12'** in a state where wafer table WTB is detached from wafer stage WST.

[0146] As is obvious from FIG. **15**, counter mass **30** has a rectangular shaped opening formed in the center on the upper surface, and has a shape of a box that has four thick side walls, especially the walls on both sides in the Y-axis direction. Wafer stage WST that can relatively move with respect to counter mass **30** is attached to counter mass **30** in a state where wafer stage main body **28** is housed inside the space in counter mass **30** (refer to FIG. **14**B).

[0147] In opening **30*a*** formed in the side wall of counter mass **30** on the +X side and an opening facing opening **30*a*** in the side wall on the −Y side, both ends of a Y-axis stator **480** in the longitudinal direction, consisting of an armature unit whose configuration is similar to Y-axis stator **80** previously described, are inserted and fixed. Similar to Y-axis stator **80** previously described, Y-axis stator **480** is also inserted into the space between the pair of permanent magnets **22**A and **22**B arranged in wafer stage main body **28**, and Y-axis stator **480** and the pair of permanent magnets **22**A and **22**B constitute a linear motor that finely drives wafer stage WST along the Y-axis direction.

[0148] Further, in openings **30*b*** and **30*c*** formed in counter mass **30**, both ends of X-axis stators **461**A and **461**B in the longitudinal direction, each consisting of an armature unit whose configuration is similar to X-axis stators **61**A and **61**B previously described, are inserted and fixed (refer to FIG. **14**A). Similar to X-axis stators **61**A and **61**B previously described, X-axis stators **461**A and **461**B are also inserted into the space between magnetic pole units **23**A and **23**B and the space between magnetic pole units **23**C and **23**D arranged in wafer stage main body **28**, respectively. That is, X-axis stators **461**A and **461**B and magnetic pole units **23**A to **23**D constitute a pair of linear motors that drives wafer stage WST along the X-axis direction.

[0149] As is shown in FIG. **14**A, inside each of the openings **30**d and **30**e formed in counter mass **30**, X-axis movers **24**A and **24**B are arranged, each consisting of a pair of magnetic pole units (a permanent magnet group) that extend in the X-axis direction. In the inner space of each of the X-axis movers **24**A and **24**B, X-axis stators (armature coils) **26**A and **26**B made up of armature units extending in the X-axis direction that constitute moving body unit MY' as it will be described later are inserted, respectively. X-axis movers **24**A and **24**B constitute a linear motor (a second drive unit) that drives the counter mass along the X-axis direction.

[0150] As is shown in FIG. **15**, moving body unit MY' is equipped with X-axis stators **26**A and **26**B previously described, a first plate shaped member **184** placed at a position equally apart from X-axis stators **26**A and **26**B in the

Y-axis direction under counter mass **30** parallel to the XY plane extending in the X-axis direction, Z-axis stators **89**A and **89**B placed on both sides of first plate shaped member **184** in the Y-axis direction whose longitudinal direction is the X-axis direction, a second plate shaped member **186** placed on the +Y side of X-axis stator **26**B whose longitudinal direction is the X-axis direction, and a slider **44** fixed to one end of X-axis stators **26**A and **26**B, the first plate shaped member **184**, Z-axis stators **89**A and **89**B, and the second plate shaped member **186** in the longitudinal direction (the end on the +X side) and a slider **46** fixed to the other end of X-axis stators **26**A and **26**B, the first plate shaped member **184**, Z-axis stators **89**A and **89**B, and the second plate shaped member **186** in the longitudinal direction (the end on the −X side). By sliders **44** and **46**, X-axis stators **26**A and **26**B, the first plate shaped member **184**, Z-axis stators **89**A and **89**B, and the second plate shaped member **186** are maintained in a predetermined positional relationship.

[0151] The first plate shaped member **184** has its upper surface (the surface on the +Z side) processed flatly, and is placed under the bottom surface of counter mass **30** as is shown in FIG. **15**. Meanwhile, on the bottom surface of counter mass **30** in the center in the Y-axis direction, a member **83** is fixed that has a plurality of static gas bearings (not shown) (e.g. air bearings) arranged at a predetermined spacing on its bottom surface along the X-axis direction. Counter mass **30** is supported in a non-contact manner with respect to each section of moving body unit MY' by the static pressure of the pressurized gas blowing out to the first plate shaped member **184** from the plurality of air bearings.

[0152] As is shown in FIG. **14**B, self-weight canceller **101** is arranged on the bottom surface of wafer stage WST (wafer stage main body **28**). As is shown in FIG. **14**B, in counter mass **30**, the surface that faces self-weight canceller **101** is a movement surface of wafer stage WST. Because counter mass **30** has the movement surface of wafer stage WST, stage base **71** can be made at a low cost.

[0153] In the space between counter mass **30** and wafer stage main body **28**, power usage supply unit **155** that has a configuration similar to the unit in the first embodiment is arranged, as is shown in FIG. **15**. Power usage supply unit **155** is used as a relay mechanism when supplying pressurized gas supplied from a gas supply unit (not shown) arranged outside the wafer stage unit via gas supply pipe **203** connected to counter mass **30** or supplying negative pressure generated in a vacuum suction unit (not shown) arranged outside the wafer stage unit via vacuum pipe **204** connected to counter mass **30** to wafer stage WST.

[0154] Other arrangements of wafer stage unit **12'** is similar to wafer stage unit **12** in the first embodiment previously described. Accordingly, forces similar to the first embodiment act between moving body unit MY', Y-axis linear motors LY_1 and LY_2, stage base **71**, and frame caster FC.

[0155] In the exposure apparatus of the second embodiment configured in the manner described above, operations similar to the ones described in the first embodiment previously described are performed. However, in the second embodiment, because the exposure apparatus is equipped with counter mass **30**, when wafer stage WST is driven in one direction (the +X direction (or the −X direction)) in the X-axis direction, counter mass **30** receives the reaction force and is driven in the opposite direction (the −X direction (or the +X direction)) of wafer stage WST. Further, in order to reduce the movement strokes of counter mass **30**, main controller **20** gives an initial velocity to drive counter mass **30** in the same direction as wafer stage WST using X-axis movers **24**A and **24**B and X-axis stators **26**A and **26**B that constitute the second drive unit.

[0156] The vacuum of wafer holder **25** used in wafer stage WST of wafer stage unit **12**, the supply of pressurized gas to self-weight canceller **101**, and the supply of pressurized gas used for elevating the center-ups for wafer elevation are performed via counter mass **30** and power usage supply unit **155** arranged in the space between counter mass **30** and wafer stage main body **28**. In this case, hollow cylindrical member **234** described in the first embodiment can movably support X-axis solid cylindrical member **232** along the X direction, according to the relative movement amount along the X direction to wafer stage main body **28** and counter mass **30**. Similarly, Y support member **237** and Z support member **239** movably support Y-axis solid cylindrical member **236** and Z-axis solid cylindrical member **238**, respectively, according to the movement of wafer stage main body **28** in the Y direction and Z direction.

[0157] As is described so far, according to wafer stage unit **12'** related to the second embodiment, since the unit is equipped with power usage supply unit **155** previously described connecting to wafer stage WST that moves on upper surface **71***a* of stage base **71**, and power usage supply unit **155** is arranged in counter mass **30**, decrease in position controllability of the wafer stage due to power usage supply unit **155** can be almost completely prevented as in the first embodiment previously described. Further, in the second embodiment, power usage supply unit **155** supplies fluid (pressurized gas) to wafer stage WST via counter mass **30** which moves in the opposite direction of wafer stage WST by the reaction force when wafer stage WST is driven in the X-axis direction, or more specifically, power usage supply unit **155** performs the supply of fluid to wafer stage WST relaying counter mass **30** arranged close to wafer stage WST, therefore, when the case is compared with when the fluid is supplied to the wafer stage directly from outside the stage unit via piping such as tubes, the resisting force that accompanies the dragging of a tube can be reduced, which makes it possible to improve the position controllability of wafer stage WST.

[0158] Further, according to the exposure apparatus of the second embodiment, because wafer stage unit **12'** described above is used as the stage unit that moves wafer W serving as a substrate, position controllability of wafer W (wafer stage WST) when performing exposure operation by the step-and-scan method in which the pattern of reticle R is transferred onto a plurality of shot areas on wafer W can be improved, and as a consequence, the pattern of reticle R can be transferred with high precision on wafer W.

[0159] In the second embodiment above, the case has been described where the so-called "local counter mass" that surrounds wafer stage WST is used as counter mass **30**, however, the present invention is not limited to this, and the configuration does not matter as long as the counter mass moves in the opposite direction of wafer stage WST by the reaction force of the drive of wafer stage WST.

A MODIFIED EXAMPLE

[0160] A modified example of the power usage supply unit is described below, referring to FIGS. **16** to **22**.

[0161] FIG. **16** shows a perspective view of a power usage supply unit **155'** of the modified example, whereas FIG. **17** shows an exploded perspective view of power usage supply

unit **155'**. Further, FIG. **18** shows a perspective view of power usage supply unit **155'** sectioned in the XZ surface around the center in the Y-axis direction, and FIG. **19** shows a perspective view of power usage supply unit **155'** sectioned in the YZ surface around the center in the X-axis direction. Further, FIGS. **20** and **21** are views used for describing the gas flow inside power usage supply unit **155'**. Of the drawings, FIG. **20** is a sectional view of power usage supply unit **155'** sectioned along corresponding to the same XZ surface in FIG. **18**, and FIG. **21** is a sectional view of power usage supply unit **155'** sectioned along corresponding to the same YZ surface in FIG. **19**.

[0162] Power usage supply unit **155'** is configured by a combination of four members shown in FIG. **17**; a first member **103**, a second member **105**, a third member **107**, and a fourth member **111**, serving as a first axis section. Power usage supply unit **155'** is incorporated in a stage unit that has counter mass **30** (refer to FIG. **22**) as in the second embodiment previously described. FIG. **17** is a view that shows the first to fourth members extracted, in a state assembled as power usage supply unit **155'** (the state in FIG. **16**), and it is a matter of course that the third member **107** and the fourth member **111** are each actually made of a plurality of components so that other members can be incorporated.

[0163] As is shown in FIG. **17**, the first member **103** consists of a solid cylindrical member whose longitudinal direction is in the X-axis direction, and on the outer circumferential surface excluding the section on both ends in the longitudinal direction, a plurality of surface throttle grooves **103***b* of a predetermined depth (ex. a depth of around 10 μm) is formed at a predetermined spacing. On the end section of the first member **103** on the +X side, a connecter section **103***a* is arranged, and on the end section on the −X side, a connecter section **103**c similar to connecter section **103***a* is arranged (not shown in FIG. **17**, refer to FIG. **18**). To connecter section **103***a*, one end of a gas supply pipe (not shown) is connected, and the other end of the gas supply pipe is connected to gas supply unit **201** (refer to FIG. **8**) previously described. To connecter section **103***c*, one end of a vacuum pipe (not shown) is connected, and the other end of the vacuum pipe is connected to vacuum suction unit **202** previously described.

[0164] As is shown in FIG. **18**, inside the first member **103**, a gas supply pipe line **211***a* that reaches the section slightly to the −X side of the center in the X-axis direction from the edge surface of connecter section **103***a* and a vacuum pipe line **211**c that reaches the section slightly to the +X side of the center in the X-axis direction from the edge surface of connecter section **103***c* are respectively formed.

[0165] The end section of gas supply pipe line **211***a* on the +X side is formed so that the diameter is slightly smaller than other sections. In the vicinity of the end section of gas supply pipe line **211***a* on the −X side, seven branched pipe lines **211**b_1 to **211**b_7 that reach the outer circumferential surface of the first member **103** are formed in a radial direction, as is shown in FIGS. **20** and **21**. Branched pipe lines **211**b_1 to **211**b_7 are each formed so that the diameter on the outer circumferential side is smaller than other sections.

[0166] As is shown in FIG. **21**, from the vicinity of the end section on the +X side of vacuum pipe line **211***c*, a branched pipe line **211***d* is formed in a state branching downward (to the −X side) and communicating with the outside of the first member **103**.

[0167] As is shown in FIG. **17**, the second member **105** has a first support section **104***a* that has a rough rectangular solid shape and a pair of second axis sections **104***b* and **104***c* that each integrally project in the Z-axis direction on the vertical surface (the surface on the +Z side) of the first support section **104***a*.

[0168] In the first support section **104***a*, a through hole **105***a* is formed that reaches the edge surface on the −X side from the edge surface on the +X side, and the first member **103** is inserted into through hole **105***a*. As is shown in FIGS. **17**, **20**, and **21**, on the inner circumferential surface of through hole **105***a* of the first support section, seven groove sections **105**b_1 to **105**b_7 are formed corresponding to the seven branched pipe lines **211**b_1 to **211**b_7 formed in the first member **103**. Further, on the inner circumferential surface of through hole **105***a* of the first support section, a groove section **105***c* is formed corresponding to branched pipe line **211***d* formed on the vacuum pipe line **211***c* side in the first member **103**.

[0169] As is shown in FIG. **17**, in one of the second axis sections **104***b* (the one positioned at the +Z side), surface throttle grooves **114***a* are formed. Surface throttle grooves **114***a* is configured of a first groove formed along the outer circumferential surface of the second axis section **104***b* and a plurality of second grooves that extend in the Z-axis direction formed at a predetermined spacing along the outer circumferential surface of the second axis section **104***b* in a state communicating with the first groove. Otherwise being vertically symmetric with the second axis section **104***b*, the other second axis section **104***c* (the one positioned at the −Z side) is also configured in the same manner, and surface throttle grooves **114***b* are formed on the outer circumferential surface.

[0170] As is shown in FIGS. **20** and **21**, inside the second member **105**, a through hole **105***d* is formed communicating with groove section **105**b_1 from the center of the upper end surface (the +Z edge surface) of the second axis section **104***b*. The diameter of the section in the vicinity of the lower end section communicating with groove section **105**b_1 is formed smaller than other sections.

[0171] Further, in the second member **105**, a through hole **105***c* is formed in a state penetrating the second member **105** from the center of the lower end surface (the −Z edge surface) of the second axis section **104***b* to opening **105***a*. The diameter of through hole **105***c* in the vicinity of the upper end section communicating with groove section **105***c* is set smaller than other sections.

[0172] As is shown in FIG. **17**, the third member **107** has a second support section **108***a* that has a rectangular solid outer shape in which a rectangular opening (almost a square) **107***a* penetrating the third member **107** from the surface on the +X side to the surface on the −X side is formed, and a pair of third axis sections **108***b* and **108***c* that each integrally project on the surface on both sides in the X-axis direction (the surface on the +X side) of the second support section **108***a*. On the outer circumferential surface of the third axis sections **108** and **108***c*, surface throttle grooves **109***a* and **109***b* are respectively formed.

[0173] As is shown in FIGS. **20** and **21**, in the second support section **108***a*, a circular opening **107***b* whose axial direction is in the vertical direction is formed in the upper wall surface of opening **107***a*, and a hollow section communicating with the upper end of circular opening **107***b* is formed inside the second support section **108***a*. In the modified example, the second axis section **104***b* previously described is inserted into circular opening **107***b* from below, and in this inserted state, a predetermined clearance is formed between the second axis section **104***b* and the inner circumferential

surface of circular opening **107**_b_. Further, in the state shown in FIGS. **20**, **21** and the like where the second axis section **104**_b_ is inserted into circular opening **107**_b_, a space **80** that serves as a gas chamber **80** is formed on the upper side of the second axis section **104**_b_ inside the second support section **108**_a_. In the description below, space **80** will also be referred to as gas chamber **80**.

[0174] Further, as is shown in FIGS. **20** and **21**, in the second support section **108**_a_, a circular opening **107**_c_ whose axial direction is in the vertical direction is formed in the lower wall surface of opening **107**_a_, and a hollow section communicating with the lower end of circular opening **107**_c_ is formed inside the second support section **108**_a_. In the modified example, the second axis section **104**_c_ previously described is inserted into circular opening **107**_c_ from above, and in this inserted state, a predetermined clearance is formed between the second axis section **104**_c_ and the inner circumferential surface of circular opening **107**_c_. Further, in the state shown in FIGS. **20**, **21** and the like where the second axis section **104**_c_ is inserted into circular opening **107**_c_, a space **81** that serves as a vacuum chamber **81** is formed on the lower side of the second axis section **104**_c_ inside the second support section **108**_a_. In the description below, space **81** will also be referred to as vacuum chamber **81**.

[0175] As is shown in FIG. **21**, inside one of the third axis sections **108**_b_ of the third member **107**, gas paths **107**_f_ and **107**_h_ are formed spaced apart vertically at a predetermined distance, and inside the other third axis section **108**_c_, gas paths **107**_g_ and **107**_i_ are formed spaced apart vertically at a predetermined distance. Gas paths **107**_f_ and **107**_g_ each communicate with gas chamber **80** via gas pipe lines **107**_j_ and **107**_k_ extending in the Z-axis direction. Further, gas paths **107**_h_ and **107**_i_ each communicate with vacuum chamber **81** via gas pipe lines **107**_n_ and **107**_o_ that extend in the Z-axis direction. Further, in the third axis section **108**_b_, a gas pipe line **107**_l_ that communicates gas path **107**_f_ and the outside of the outer circumferential surface of the third axis section **108**_b_ and a gas pipe line **107**_p_ that communicates gas path **107**_h_ and the outside of the outer circumferential surface of the third axis section **108**_c_ are formed. Further, in the third axis section **108**_c_, a gas pipe line **107**_m_ that communicates gas path **107**_g_ and the outside of the outer circumferential surface of the third axis section **108**_c_ and a gas pipe line **107**_q_ that communicates gas path **107**_i_ and the outside of the outer circumferential surface of the third axis section **108**_c_ are formed.

[0176] As is shown in FIG. **17**, the fourth member **111** is made of a hollow member that is vertically open having a rectangular frame shape in a planar view (when viewed from above), and in the wall on both sides in the X-axis direction, circular openings of a first diameter **111**_b_ and **111**_c_ are each formed, and in the wall on both sides in the Y-axis direction, circular openings of a second diameter (larger than the first diameter) **111**_d_ and **111**_e_ are formed.

[0177] As is obvious from FIG. **21**, the third axis sections **108**_b_ and **108**_c_ are inserted into circular openings **111**_d_ and **111**_e_, respectively. Meanwhile, into the remaining two circular openings **111**_b_ and **111**_c_, the first member **103** is inserted with a predetermined gap in between.

[0178] As is shown in FIGS. **17** and **21**, on the lower side of the inner wall surface of circular opening **111**_e_ of the fourth member **111** at the position facing gas pipe line **107**_q_ previously described, a vacuum pipe line **111**_f_ is formed that communicates vertically. Further, as is shown in FIG. **21**, on the lower side of the inner wall surface of circular opening **111**_d_ of the fourth member **111**, a depressed section **111**_g_ is formed at the position facing gas pipe line **107**_p_ previously described. Depressed section **111**_g_ and vacuum pipe line **111** are in a communicating state via a gas pipe line **111**_h_ (refer to FIG. **20**) formed inside the fourth member **111**. As is shown in FIG. **17**, to vacuum pipe line **111**_f_, a connecter **115** arranged on the lower surface side of the fourth member is connected.

[0179] Further, on the lower side of the inner wall surface of circular opening at the position facing gas pipe line **107**_m_ previously described, a gas supply pipe line **111**_i_ is formed that communicates vertically, and a connecter **116** arranged on the upper surface side of the fourth member **111** is connected to gas supply pipeline **111**_i_, as is shown in FIGS. **17** and **21**.

[0180] As is shown in FIG. **22**, power usage supply unit **155'** that has the configuration described above is attached to counter mass **30** and wafer stage WST in a state where both ends of the first member **103** in the longitudinal direction are connected to the side walls of counter mass **30** on both sides in the X-axis direction and the upper end section of the third member is connected to the bottom section of wafer stage main body **28**. And, in the state after the attachment is completed, connecter **115** previously described is connected to a vacuum chuck that constitutes wafer holder **25** arranged on wafer stage WST via a vacuum piping (not shown), and connecter **116** previously described is connected to a gas supply pipe line (not shown) inside wafer stage main body **28** via a piping (not shown).

[0181] Next, the operation of power usage supply unit **155'** configured in the manner described above will be described, referring to FIGS. **20** and **21**. In FIGS. **20** and **21**, the outlined arrows indicate the gas flow due to the supply of pressurized gas, and the black arrows indicate the gas flow caused by the vacuum suction (vacuum).

[0182] When the pressurized gas is supplied from gas supply unit **201** into gas supply pipe line **211**_a_ inside the first member **103** via a supply pipe (not shown) and connecter section **103**_a_ connecting to counter mass **30** as is indicated by arrow A in FIG. **20**, the pressurized gas flows (rises) in the direction indicated by arrow B within branched pipe line $\mathbf{211}b_1$, and the pressurized gas also flows within the other branched pipe lines $\mathbf{211}b_2$ to $\mathbf{211}b_7$ in the direction indicated by arrow B toward the outside of the outer circumferential surface of the first member **103** as is shown in FIG. **21**. Then, most of the pressurized gas that flows within branched pipe line $\mathbf{211}b_1$ flows in the direction indicated by arrow D in through hole **105**_d_ and is supplied to gas chamber **80** previously described, and the remaining gas flows in the direction indicated by arrow C within groove section $\mathbf{105}b_1$ formed in the second member **105** as is shown in FIG. **20**, and the pressurized gas is filled into the space made with groove section $\mathbf{105}b_1$ and the first member **103**. Further, also in groove sections $\mathbf{105}b_2$ to $\mathbf{105}b_7$, pressurized gas flows in the same direction as arrow C, and the pressurized gas is filled into the space made with groove sections $\mathbf{105}b_2$ to $\mathbf{105}b_7$ and the first member **103**. And, the pressurized gas also flows within surface throttle grooves **103**_b_ formed on the surface of the first member **103**. In this case, similar to the first embodiment previously described, the first member **103** is supported in a non-contact manner with respect to the first support section **104**_a_ of the second member **105** by the static pressure of the pressurized gas in the gap between surface throttle grooves **103**_b_ and the second member **105**. That is, in the manner described above, a type of static gas bearing is con-

figured in the entire area of surface throttle grooves **103***b*. As a consequence, the first member **103** is in a state where movement in the X-axis direction and the rotational direction around the X-axis of the first member **103** with respect to the first support section **104***a* is permissible.

[0183] Meanwhile, the inside of gas chamber **80** is filled with the pressurized gas supplied in the manner previously described, and a part of the pressurized gas that is filled flows (leaks) in the direction indicated by arrow E in the extremely small gap between opening **107***b* formed in the third member **107** (the second support section **108***a*) and the second axis section **104***b* of the second member **105** as is shown in FIG. **20**. Accordingly, as is previously described, a type of static gas bearing is configured in the entire area of surface throttle grooves **114***a* formed in the second axis section **104***b*, and the second axis section **104***b* is in a state where movement in the Z-axis direction and the rotational direction around the Z-axis of the second axis section **104***b* with respect to the second support section **108***a* is permissible.

[0184] As is shown in FIG. **21**, a part of the pressurized gas filled inside gas chamber **80** flows in the direction indicated by arrow F (the –Z direction) within gas pipe lines **107***j* and **107***k*, sequentially goes through gas paths **107***f* and **107***h* and gas pipe lines **107***l* and **107***m* and flows out into a gap, which is formed with the fourth member **111** outside the third axis sections **108***b* and **108***c* of the third member **107**. The pressurized gas flows within surface throttle grooves **109***a* and **109***b* (refer to FIG. **17**) formed in the third axis sections **108***b* and **108***c* of the third member **107**, respectively. Accordingly, as is previously described, a type of static gas bearing is configured in the entire area of surface throttle grooves **109***a* and **109***b* formed in the third axis sections **108***b* and **108***c*, respectively, and the third axis sections **108***b* and **108***c* are in a state where movement in the Y-axis direction and the rotational direction around the Y-axis of the third axis sections **108***b* and **108***c* with respect to the fourth support member **111** is permissible.

[0185] Further, the pressurized gas that flows outside the third axis section **108***c* via gas pipe line **107***m* is sent to the inside of wafer stage main body **28** via gas supply pipe line **111***i* formed in the fourth member **111** facing gas pipe line **107***m*, and is supplied, for example, to self-weight canceller **101** previously described, as well as to the elevating mechanism (not shown) that elevates vertical movement pins (center-ups) arranged in wafer holder **25** for elevating wafer W.

[0186] When vacuum operation by vacuum suction unit **202** begins and negative pressure is generated, the negative pressure is supplied to vacuum pipe line **211***c* via a vacuum pipe connecting to connecter section **103***c* of the first member **103**, and a gas flow indicated by arrow A' in FIG. **20** occurs in vacuum pipe line **211***c*. By the negative pressure caused by the gas flow, the gas inside vacuum chamber **81** is suctioned to the vacuum pipe line **211***c* side, and a gas flow indicated by arrow D' in FIG. **20** occurs inside through hole **105***e*, as well as a gas flow indicated by arrow C' in FIG. **20** occurs in the space formed by the first member **103** and groove **105***c* formed in the second member **105**. And by the latter gas flow, the pressurized gas that flows out into the gap between the first member **103** and the second member **105** via grooves $105b_1$ to $105b_7$ is suctioned along surface throttle grooves **104***b* of the first member **103** and the pressurized gas smoothly spreads to the entire circumference of surface throttle grooves **104***b* as is previously described, and the pressurized gas that reaches groove **105***c* is also recovered.

[0187] The gas flow indicated by arrow D' in FIG. **20** that occurs inside through hole **105***e* described above creates negative pressure (vacuum state) in vacuum chamber **81**, and by the negative pressure, a gas flow occurs in the direction indicated by arrow E' in the space formed by the second axis section **104***c* of the second member **105** and the third member **107** (the second support section **108***a*) as is shown in FIGS. **20** and **21**, and by the gas flowing within surface throttle grooves **114***b* formed in the second axis section **104***c*, a type of static gas bearing is configured in the entire area of surface throttle grooves **114***b*, and the second axis section **104***c* is in a state where movement in the Z-axis direction and the rotational direction around the Z-axis of the second axis section **104***c* with respect to the second support section **108***a* is permissible. Accordingly, power usage supply unit **155'** of the modified example has a configuration in which the position and attitude in directions of six degrees of freedom can be changed.

[0188] Further, by the negative pressure inside vacuum chamber **81**, the gas inside gas paths **107***f* and **107***h* are suctioned to vacuum chamber **81**, and a gas flow indicated by arrow F' in FIG. **21** occurs in gas pipe lines **107***n* and **107***o*. This gas flow creates negative pressure inside gas paths **107***f* and **107***h*, and by the negative pressure, a gas flow indicated by arrow G' in FIG. **21** occurs inside vacuum pipe line **111***f* formed in the fourth member **111** as well as inside depressed section **111***g* communicating with vacuum pipe line **111***f* via gas pipe line **111***h*, and a gas flow indicated by arrow H' in FIG. **21** also occurs in the gap between circular opening **111***d* of the fourth member **111** and the third axis section **108***b* and the gap between circular opening **111***c* and the third axis section **108***c*. And by the latter gas flow, the pressurized gas that flows out into the gap between circular opening **111***d* and the third axis section **108***b* and the gap between circular opening **111***c* and the third axis section **108***c* from gas pipe lines **107***l* and **107***m*, respectively, is suctioned along surface throttle grooves **109***a* and **109***b* of the third axis sections **108***b* and **108***c* and the pressurized gas smoothly spreads to the entire circumference of surface throttle grooves **109***a* and **109***b*, and the pressurized gas that reaches the lowest section of surface throttle grooves **109***a* and **109***b* is also recovered.

[0189] By the gas flow indicated by the arrow G', negative pressure is created inside vacuum pipe line **111***f*, and by the negative pressure, a gas flow occurs indicated by arrow I' in FIG. **21** in the vacuum pipe connecting the vacuum chuck of wafer holder **25** and the-fourth member **111**, and wafer W is suctioned by vacuum chucking.

[0190] As is described above, power usage supply unit **155'** of the modified example has six degrees of freedom, and because fluid (pressurized gas) supply can be performed via the counter mass according to power usage supply unit **155'**, the same effects as in the second embodiment previously described can be obtained.

[0191] Also in the modified example above, an arrangement that employs a tube carrier as in the first embodiment can be employed.

[0192] In the modified example above, the fourth member **111** of power usage supply unit **155'** does not have to be arranged. In this case, although the degrees of freedom of the power usage supply unit will be four degrees of freedom, a highly precise stage control can be performed when compared with the case where piping (tubes) are employed.

[0193] In each of the embodiments above and in the modified example, the case has been described where the stage unit

of the present invention is employed in a wafer stage unit, however, the stage unit can also be employed in a reticle stage unit that includes reticle stage RST.

[0194] In each of the embodiments above and in the modified example, the case has been described where the present invention is applied to a scanning stepper, however, the scope of the present invention is not limited to this, and the present invention can also be suitably applied to a static type exposure apparatus such as a stepper that performs exposure in a state where the mask and the substrate are static. Further, the present invention can also be suitably applied to an exposure apparatus by the step-and-stitch method.

[0195] The object serving as the subject for exposure of the exposure apparatus is not limited to a wafer for manufacturing semiconductors as in the embodiments above, and it can also be a square shaped glass plate for manufacturing display units such as a liquid crystal display, a plasma display, and an organic EL, a thin film magnetic head, an imaging device (such as CCDs), and a substrate for manufacturing a mask or a reticle.

[0196] Further, in each of the embodiments above and in the modified example, as illumination light IL of the exposure apparatus, the light is not limited to light having the wavelength equal to or greater than 100 nm, and it is needless to say that light having the wavelength less than 100 nm can also be used. For example, in recent years, in order to expose a pattern equal to or less than 70 nm, development is performed of an EUV exposure apparatus that makes an SOR or a plasma laser as a light source generate an EUV (Extreme Ultraviolet) light in a soft X-ray range (such as a wavelength range from 5 to 15 nm), and uses a total reflection reduction optical system designed under the exposure wavelength (such as 13.5 nm) and the reflective type mask. Furthermore, for example, the present invention can also be suitably applied to an immersion exposure apparatus that has liquid (e.g. pure water or the like) filled in between projection optical system PL and a wafer whose details are disclosed in, for example, the pamphlet of International Publication WO99/49504 and the like.

[0197] Further, the present invention can also be applied to an exposure apparatus that uses a charged particle beam such as an electron beam or an ion beam. Incidentally, the electron beam exposure apparatus can be an apparatus by any one of a pencil beam method, a variable-shaped beam method, a self-projection method, a blanking aperture array method, and a mask projection method.

[0198] The stage unit related to the present invention can be applied not only to an exposure apparatus, but can also be widely applied to other substrate processing units (e.g. a laser repair unit, a substrate inspection unit or the like), or to a position unit of a sample in other precision machinery, a wire bonding apparatus or the like.

[0199] The exposure apparatus related to the present invention such as exposure apparatus **100** or the like in the embodiments described above can be made by incorporating an illumination unit made up of a plurality of lenses, a projection optical system and the like into the main body of the exposure apparatus, and then performing optical adjustment. Then, parts described above such as the X-axis stator, the X-axis mover, the Y-axis stator, the wafer stage, the reticle stage, and other various parts are also mechanically and electrically combined and adjusted. And then, total adjustment (such as electrical adjustment and operation check) is performed, which completes the making of the exposure apparatus. The exposure apparatus is preferably built in a clean room where conditions such as the temperature and the degree of cleanliness are controlled.

[0200] Semiconductor devices are manufactured through the following steps: a step where the function/performance design of a device is performed; a step where a reticle based on the design step is manufactured; a step where a wafer is manufactured using materials such as silicon; a lithography step where the pattern formed on the mask is transferred onto a photosensitive object by the exposure apparatus described in the embodiments above; a device assembly step (including processes such as dicing process, bonding process, and packaging process); inspection step, and the like. In this case, in the lithography step, because the exposure apparatus in the embodiments above is used, high integration devices can be manufactured with good yield.

INDUSTRIAL APPLICABILITY

[0201] As is described above, the stage unit in the present invention is suitable for making the stage move along a movement surface. Further, the exposure apparatus and the exposure method are suitable for forming a pattern by exposing a substrate.

1. A stage device that has a stage which moves on a movement surface and a power usage supply unit which supplies power usage to the stage wherein

the power usage supply unit comprises:

a first axis section that extends in a direction of a first axis within the movement surface;

a first support section that movably supports the first axis section in the direction of the first axis and around the first axis;

a second axis section that extends in a direction of a second axis intersecting with the first axis; and

a second support section that movably supports the second axis section in the direction of the second axis and around the second axis.

2. The stage device of claim **1** wherein

the power usage supply unit further comprises:

a third axis section that extends in a direction of a third axis intersecting with the first axis and the second axis; and

a third support section that movably supports the third axis section in the direction of the third axis and around the third axis.

3. The stage device of claim **2** wherein

between the first axis section and the first support section, the second axis section and the second support section, and the third axis section and the third support section, a first, second, and third static gas bearings are arranged, respectively.

4. The stage device of claim **1** wherein

the power usage supply unit is arranged in a carrier that moves in a constant speed along the direction of the first axis.

5. The stage device of claim **1** wherein

between the first axis section and the first support section, and the second axis section and the second support section, first and second static gas bearings are arranged, respectively.

6. The stage device of claim **1** wherein

the power usage supply unit has a suction unit.

7. The stage device of claim **6** wherein

the suction unit suctions liquid on the stage.

8. The stage device of claim **1**, the unit further comprising:
a drive unit that drives the stage, wherein
the power usage supply unit supplies the drive unit a temperature adjustment fluid used to adjust the temperature of the drive unit.
9. The stage device of claim **8** wherein
the drive unit has a magnet arranged in the opening section of the stage.
10. The stage device of claim **1** wherein
the stage device has a plurality of power usage supply units.
11-22. (canceled)
23. An exposure apparatus that transfers a pattern of a mask mounted on a stage device onto a substrate wherein
a stage device according to claim **1** is used as the stage device.
24. An exposure apparatus that forms a pattern by exposing a substrate mounted on a stage device wherein
a stage device according to claim **1** is used as the stage device.
25. A device manufacturing method that includes a lithography process in which a device pattern is transferred onto a substrate using the exposure apparatus according to claim **23**.
26. A device manufacturing method that includes a lithography process in which a device pattern is formed by exposing a substrate using the exposure apparatus according to claim **24**.
27. A stage device, the unit comprising:
a stage movably supported on a movement surface;
a first drive unit that drives the stage;
a counter mass that moves in an opposite direction of the stage by the reaction force caused when the first drive unit drives the stage; and
a power usage supply unit that supplies power usage to the stage via the counter mass.
28. The stage device of claim **27** wherein
the movement surface is formed on the counter mass.
29. The stage device of claim **27**, the unit further comprising:
a second drive unit that drives the counter mass.
30. The stage device of claim **27** wherein
the power usage supply unit comprises a movement section that moves corresponding to the movement of the stage.
31. An exposure apparatus that transfers a pattern of a mask mounted on a stage device onto a substrate wherein
a stage device according to claim **27** is used as the stage device.
32. An exposure apparatus that forms a pattern by exposing a substrate mounted on a stage device wherein
a stage device according to claim **27** is used as the stage device.
33. A device manufacturing method that includes a lithography process in which a device pattern is transferred onto a substrate using the exposure apparatus according to claim **31**.
34. A device manufacturing method that includes a lithography process in which a device pattern is formed by exposing a substrate using the exposure apparatus according to claim **32**.
35. An exposure method in which a pattern is formed by exposing a substrate on a stage with a unit comprising a power usage supply unit that supplies power usage to the stage which moves within a two dimensional plane wherein
the power usage supply unit is moved in a first axis direction within the two dimensional plane and also around the first axis, and
the power usage supply unit is moved in a second axis direction intersecting with the first axis and also around the second axis.
36. The exposure method of claim **35** wherein
the power usage supply unit substantially does not provide any resisting force to the stage.
37. The exposure method of claim **35** wherein
the power usage supply unit moves in a third axis direction intersecting with the first axis direction and the second axis direction and also around the third axis.
38. The exposure method of claim **35** wherein
the power usage supply unit suctions liquid on the stage.
39. The exposure method of claim **38** wherein
the suction of the liquid is performed after completion of an exposure operation.
40. The exposure method of claim **35** wherein
the power usage supply unit supplies a drive unit that drives the stage a temperature adjustment fluid used to adjust the temperature of the drive unit.
41. A device manufacturing method that includes a lithography process in which a device pattern is formed by exposing a substrate using the exposure method according to claim **35**.
42. A stage device, the device comprising:
a stage relatively movable with respect to a movement surface in four or more degrees of freedom; and
a power usage supply unit that supplies power usage to the stage wherein
the power usage supply unit includes
a moving section that has a supply member which supplies the power usage and is relatively movable to the movement surface independent from the stage;
a first unit that has a first member movable in a direction of a first axis and a second member that has a section opposing the first member and can relatively move with respect to the first member in at least two or more degrees of freedom including the direction of the first axis as one degree of freedom, and performs the delivery of the power usage between the first member and the second member; and
a second unit arranged between the moving section and the second member that allows relative movement between the moving section and the second member in directions of remaining directions of freedom when the at least two degrees are excluded from the four degrees of freedom, and performs the delivery of the power usage between the supply member and the second member.
43. The stage device of claim **42** wherein
the stage relative moves in six degrees of freedom with respect to the movement surface, and
the first member and the second member relatively moves in two degrees of freedom.
44. The stage device of claim **42** wherein
a first static gas bearing is arranged in the opposing section between the first member and the second member.
45. The stage device of claim **42** wherein
the moving section is arranged with a carrier that constantly moves along a direction of the first axis.
46. The stage device of claim **42** wherein
the first member is fixed to the stage.
47. The stage device of claim **42** wherein
the first member includes a first axis section that extends in a direction of the first axis, and

the second member includes a first support section that movably supports the first axis section in a direction of the first axis and the direction around the first axis whereby

the second unit includes a second axis section that extends in a direction of a second axis intersecting the first axis and a second support section that movably supports the second axis section in a direction of the second axis and the direction around the second axis.

48. The stage device of claim **47** wherein

the second unit further includes a third axis section that extends in a direction of a third axis intersecting the first axis and the second axis and a third support section that movably supports the third axis section in a direction of the third axis and the direction around the third axis.

49. An exposure apparatus that transfers a pattern of a mask mounted on a stage device onto a substrate wherein

a stage device according to claim **42** is used as the stage device.

50. An exposure apparatus that forms a pattern by exposing a substrate mounted on a stage device wherein

a stage device according to claim **42** is used as the stage device.

51. A device manufacturing method that includes a lithography process in which a device pattern is transferred onto a substrate using the exposure apparatus according to claim **49**.

52. A device manufacturing method that includes a lithography process in which a device pattern is formed by exposing a substrate using the exposure apparatus according to claim **50**.

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