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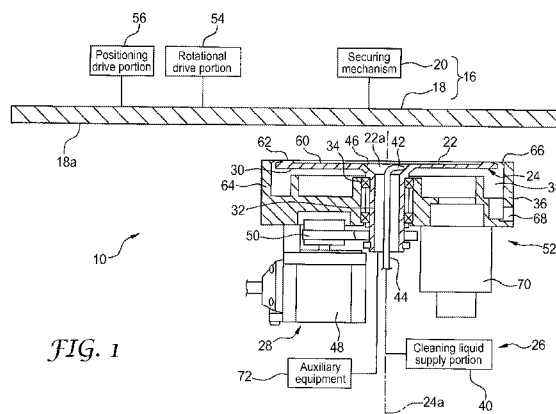


FIG. 1

(57) Abstract: A substrate cleaning device (10) is provided with a substrate support portion (16) for supporting a substrate (12) in a downward-facing orientation; a cleaning plate (24) that has a cleaning liquid support face (22), where the cleaning plate (24) is positioned in an upward-facing orientation at an operating position able to face the liquid support face (22) of a first face (12a) of the substrate (12) that is supported by the substrate support portion (16) across a gap G that has a specific dimension; a cleaning liquid supply portion (26) for supplying a cleaning liquid to a central region (22a) of the liquid support face (22) of the cleaning plate (24); and a cleaning plate drive portion (28) for rotating the cleaning plate (24) around a cleaning plate axis (24a) that is substantially perpendicular to the liquid support face (22). The substrate cleaning device (10) cleans the first face (12a) by causing the cleaning liquid that flows along the liquid support face (22) of the cleaning plate (24), which is rotated around the cleaning plate axis (24a), to contact the first face (12a) of the substrate (12).

SUBSTRATE CLEANING METHOD AND SUBSTRATE CLEANING DEVICE

TECHNICAL FIELD

The present invention relates to a substrate cleaning method and a substrate cleaning device for cleaning the surface of a substrate.

BACKGROUND

In manufacturing technologies for semiconductor integrated circuits there is a known technique wherein, after first forming circuits on one surface of a wafer having a specific thickness, then, in a state wherein a supporting plate made from film, glass, or the like, is bonded to the surface on which the circuits are formed (hereinafter termed the “circuit face”) in order to provide protection and support, the back face that is on the opposite side from the circuit face is ground so as to reduce uniformly the thickness of the wafer, and then the thinned wafer is separated, through cutting (generally known as “dicing”) to manufacture a plurality of semiconductor chips. At the time of dicing, a supporting film for protection and support, is bonded to the back face of the thinned wafer, the supporting plate is peeled from the circuit face of the wafer, and the exposed circuit face is cut. Here the circuit face is cleaned prior to performing the dicing because, in some cases, there is adhesive agent that was used for bonding to the supporting plate remaining on the circuit face of the wafer that has been removed from the supporting plate.

For example, Japanese Unexamined Patent Application Publication No. 2009-059776 relates to a “substrate processing device and substrate processing method wherein the wafer can be peeled easily and quickly from the supporting plate without breaking the wafer.” Japanese Unexamined Patent Application Publication No. 2009-059776 states that: “gas providing means 11 have a gas providing opening 11a that passes through the direction of thickness, a vacuum opening 11b, and a liquid/gas supplying opening 11c,” where “the gas providing means 11 are able to apply a pressure, in the direction of separating the substrate 1 from the supporting plate 2, to the adhesive agent layer 3, through providing a gas to the adhesive agent layer 3, by providing a solvent liquid. At this time, the supporting plate 2 is secured to the gas providing means 11, thus making it possible to peel the substrate 1 from the supporting plate 2 through the pressure that is applied to the adhesive agent layer 3.” “Cleaning liquid providing means are means for cleaning the surface of the substrate 1 after peeling of the supporting plate 2 from the substrate 1.” “The vacuum opening 11b and the liquid/gas providing opening 11c of the gas providing means 11 serve also as the vacuum opening and the cleaning liquid providing opening of the cleaning liquid providing means.”

“The gas providing means 11 are disposed so as to face the substrate 1, and the cleaning liquid is provided from the cleaning liquid providing opening 11c. Moreover, the cleaning liquid that is provided from the cleaning liquid providing opening 11c is drawn in through the vacuum opening 11b, which is provided in a ring shape at the end of the gas providing means 11. The flow of the cleaning liquid at this time is as indicated by the arrow in FIG. 9. Given this, the dicing tape 4a that is exposed is not exposed to the cleaning liquid, enabling better cleaning of the substrate 1.”

In some cases there is the need to prevent the cleaning agent for cleaning the surface from contacting the adhesive agent that is used to bond the support member to the back face of the substrate, when cleaning the front surface of the substrate (first surface), for the purpose of, for example, removing residual adhesive agent, in a state wherein a support member (a supporting film, in the case of a wafer) is adhered to the back face of the substrate (second surface), as in a wafer cleaning step prior to dicing in the manufacturing process for a semiconductor chip. In this case, it is desirable to be able to clean the surface of the substrate more reliably and more efficiently while preventing the cleaning liquid from contacting the adhesive agent on the back face side of the substrate.

SUMMARY

In one embodiment, the present invention is a substrate cleaning method including: preparing a substrate having a first face and a second face opposite the first face, and a cleaning plate having a liquid support face; placing the substrate in a downward orientation with the first face facing downward; placing the cleaning plate in an upward orientation with the liquid support face facing upward; positioning the downward-oriented substrate and the upward-oriented cleaning plate into an operating position mutually facing each other with a gap of a predetermined dimension between the first face and the liquid support face; providing a cleaning liquid to a central region of the liquid support face of the upward-oriented cleaning plate; rotating the upward-oriented cleaning plate around a cleaning plate axis that is determined in the cleaning plate as an axis that is substantially perpendicular to the liquid support face, in the central region; and cleaning the first face of the substrate by causing the cleaning liquid that flows along the liquid support face of the cleaning plate to contact the first face of the substrate.

In another embodiment, the present invention is a substrate cleaning device for cleaning a first face of a substrate that has a first face and a second face that is opposite the first face, including: a substrate support portion able to support a substrate in a downward-

facing orientation when the first face faces downward; a cleaning plate having a liquid support face, wherein the cleaning plate is positioned in an upward-facing orientation when the liquid support face faces upward, at an operating position wherein the liquid support face is able to face the first face of the substrate, which is supported by the substrate support portion, with a gap of a predetermined dimension interposed therebetween; a cleaning liquid providing portion for providing a cleaning liquid to a central region of the liquid support face of the cleaning plate; and a cleaning plate drive portion for rotating the cleaning plate around a cleaning plate axis that is determined in the cleaning plate as an axis that is substantially perpendicular to the liquid support face in the central region; wherein the cleaning liquid can be caused to contact the first face of the substrate to clean the first face of the substrate.

In the substrate cleaning method according to one embodiment of the present invention, the substrate is placed in a downward-facing orientation wherein the first face thereof faces downward; the cleaning plate is placed in an upward-facing orientation wherein the liquid support face thereof faces upward; and the cleaning process is performed at an operating position wherein the first face and the liquid support face are facing each other across a specific gap.

In the substrate cleaning device according to another embodiment of the present invention, the substrate support portion supports the substrate in the downward-facing orientation wherein the first face thereof faces downward, and, the cleaning step is performed in a state wherein the cleaning plate is in the upward-facing orientation wherein the liquid support face faces upward and wherein the liquid support face is positioned at an operating position facing the first face of the substrate across a specific gap.

Consequently, in both embodiments of the present invention, the cleaning liquid that flows outwardly from the central region of the liquid support face, through centrifugal force that is produced in accordance with the rotation of the cleaning plate, can be brought into contact with the entirety of the first face of the substrate while being moved in the direction of rotation, following along the rotating liquid support face, with the result of being able to clean the first face reliably and efficiently through the cleaning liquid while continuously and rapidly refreshing the portion of the cleaning liquid that contacts the first face of the substrate.

Furthermore, in both embodiments of the present invention, due to the structure wherein the cleaning liquid flows on the liquid support face of the upward-facing cleaning plate, it is possible to position the cleaning liquid easily into a position wherein it does not contact the support member, even when a support member which is a separate member is bonded to the second face of the substrate. Consequently, it is possible to prevent in advance the adhesive

agent, which is used for bonding the support member to the second face of the substrate, from being dissolved through cleaning by the cleaning liquid.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial cross-sectional diagram illustrating schematically a substrate cleaning device according to a first embodiment of the present invention.

FIG. 2 is a perspective diagram illustrating a cleaning plate unit of the substrate cleaning device in FIG. 1.

FIG. 3 is a perspective diagram of a substrate to which the substrate cleaning method according to the embodiment of the present invention can be applied.

FIG. 4 is a diagram illustrating a substrate cleaning method according to the first embodiment of the present invention, using the substrate cleaning device in FIG. 1.

FIG. 5 is an expanded cross-sectional diagram illustrating a cleaning step in the substrate cleaning method of FIG. 4.

FIG. 6 is a plan view illustrating schematically a cleaning step in FIG. 4.

FIG. 7A through 7G are plan views illustrating schematically various cleaning plates that can be used in the substrate cleaning device of FIG. 1.

FIG. 8 is a partial cross-sectional diagram illustrating schematically a substrate cleaning device according to a second embodiment of the present invention.

FIG. 9 is a diagram illustrating a substrate cleaning method according to a second embodiment using the substrate cleaning device of FIG. 8, and is an expanded cross-sectional diagram illustrating the cleaning step.

DETAILED DESCRIPTION

An embodiment of the present invention will be explained in detail in reference to the appended drawings. Corresponding structural elements are assigned identical reference codes throughout all of the drawings.

FIG. 1 and FIG. 2 are diagrams illustrating a substrate cleaning device 10 according to a first embodiment of the present invention; FIG. 3 is a diagram illustrating a substrate 12 for which the substrate cleaning method according to the present embodiment of the present invention can be applied; and FIG. 4 through FIG. 6 are diagrams illustrating a substrate cleaning method according to the first embodiment of the present invention, using the substrate cleaning device 10.

The substrate cleaning method and the substrate cleaning device 10 in the figures performs cleaning of a first face 12a of a substrate 12 that has a first face 12a and a second

face 12b that is on the opposite side therefrom, for the purpose of, for example, removing residual adhesive agent, in a state wherein a support member 14, which is a separate material, is bonded to the second face 12b, and, for example, can be used in a wafer cleaning step prior to dicing in a semiconductor chip manufacturing process. In the case of a wafer cleaning step prior to dicing, the support member 14 that is bonded to the second face 12b of the substrate (for example, a wafer) 12 is a supporting film 14, described below. However, the applications of the substrate cleaning method according to one embodiment of the present invention, and of the substrate cleaning device according to another embodiment of the present invention, are not limited thereto.

The substrate cleaning device 10 is provided with a substrate support portion 16 that is able to support the substrate 12, wherein a supporting film 14 is bonded to the second face 12b, in a downward-facing orientation wherein the first face 12a faces downward in the direction of gravity (FIG. 1 and FIG. 4). The substrate support portion 16 is provided with a table 18, which has a surface 14a that contacts the support member 14, to support securely the substrate 12 and the support member 14 on the surface 18a, and a securing mechanism 20 for securing removably the substrate 12 and the support member 14 on the surface 18a of the table 18. The table 18 has sufficient rigidity to be able to support and to be able to fix the substrate 12 and the support member 14 on the surface 18a with stability against external forces. The table 18 is structured as a member that has holes, for example, with the surface 18a acting as a vacuum suction surface. In a structure wherein the surface 18a of the table 18 acts as a vacuum suction surface, the locking mechanism 20 is structured from a vacuum device that includes a vacuum pump, and the like, that is connected to the surface 18a of the table 18. The substrate 12 and the support member 14 are secured removably to the table surface 18a by a vacuum effect. Conversely, the securing mechanism may instead be structured from a magnetic device, depending on the materials of the object to be supported, such as the substrate 12 and the support member 14. Note that there are no particular limitations on the structures for the table 18 and the securing mechanism 20.

The substrate cleaning device 10 is further provided with: a cleaning plate 23 that has a liquid support face 22, a cleaning liquid providing portion 26 for providing a cleaning liquid L (illustrated in FIG. 5) to a central region 22a of the liquid support face 22 of the cleaning plate 24, and a cleaning plate drive portion 28, for rotating the cleaning plate 24 around a cleaning plate axis 24a that is determined for the cleaning plate 24 as an axis that is substantially perpendicular to the liquid support face 22 in the central region 22a (FIG. 1 and FIG. 2). The cleaning plate 24 is disposed in an upward-facing orientation wherein the liquid

support face 22 faces upward in the direction of gravity, at an operating position (FIG. 4) that faces the first face 12a of the substrate 12, which is supported on the substrate support portion 16, across a gap G of a dimension that is determined in advance. The cleaning plate 24 has rigidity to be able to support the cleaning liquid L on the liquid support face 22 by
5 maintaining the shape of the cleaning plate 24 when rotated by the cleaning plate drive portion 28. The liquid support face 22 of the cleaning plate 24 may have a surface structure in the form of a mirrored surface that causes the cleaning liquid L to move smoothly across the entirety thereof.

In the configuration that is illustrated, the cleaning plate 24 has a plate-shaped main
10 portion 30 that has the liquid support face 22 and a hollow shaft portion 32 that is connected to the center of the main portion 30 extending along the cleaning plate axis 24a and that is open to the central region 22a of the liquid support face 22. The cleaning plate 24 is supported rotatably on a housing 36 through a bearing device that is attached to the shaft portion 32. The housing 36 is divided, internally, into a cleaning chamber 38 that can contain
15 rotatably at least the main portion 30 of the cleaning plate 24.

The cleaning liquid supply portion 26 has a cleaning liquid supplying source 40 and a nozzle 42 for expelling the cleaning liquid L that is supplied from the cleaning liquid supplying source 40 toward the central region 22a of the liquid support face 22 of the cleaning plate 24. In the configuration that is illustrated, a liquid tube 44 that connects
20 between the cleaning liquid supplying source 40 and the nozzle 42, and that conveys the cleaning liquid L, is contained in the hollow shaft portion 32 of the cleaning plate 24. Additionally, in the configuration that is illustrated, a shoulder face 46 that is able to retain temporarily the cleaning liquid L that is supplied to the central region 22a is formed at the opening portion of the shaft portion 32 in the central region 22a of the liquid support face 22,
25 and the nozzle 42 expels the cleaning liquid L toward the shoulder face 46 at the tip end of the liquid tube 44.

The cleaning plate drive portion 28 is provided with a prime mover 48, such as an air motor that is secured to and supported on the housing 36, and a driving force transmitting mechanism 50, such as a belt or a pulley, to transmit to the shaft portion 32 of the cleaning
30 plate 24 the rotational power of the prime mover 48. The cleaning plate drive portion 28 is able to rotate the driving plate 24 around the cleaning plate axis 24a while maintaining stably the gap G between the first face 12a of the substrate 12 that is supported on the substrate support portion 16 and the liquid support face 22 of the cleaning plate 24, in a state wherein the cleaning plate 24 is disposed at the aforementioned operating position. In the structure

that is illustrated, a cleaning plate unit 52 is structured so as to be able to position the cleaning plate 24 at the aforementioned operating position by the cleaning plate 24 and the cleaning plate drive portion 28 both being supported on the housing 36. (FIG. 2)

The substrate cleaning device 10 that is provided with the substrate support portion 16, the cleaning plate 24, the cleaning liquid supply portion 26, and the cleaning plate drive portion 28 is able to clean the first face 12a of the substrate 12 by causing the cleaning liquid L to flow along the liquid support face 22 of the cleaning plate 24, which is rotating around the cleaning plate axis 24a, to contact the first face 12a of the substrate 12 that is supported by the substrate support portion 16. (FIG. 4) This cleaning process is executed in a state wherein the substrate support portion 16 holds the substrate 12 in a downward-facing orientation wherein the first face 12a faces downward in the direction of gravity, and the cleaning plate 24 is positioned in an upward-facing orientation wherein the liquid support face thereof faces upward in the direction of gravity, and where the liquid support face 22 is positioned at the operating position facing the first face 12a of the substrate 12 across the gap G. Consequently, it is possible to cause the liquid L that flows to the outside from the central region 22a of the liquid support face 22, through the centrifugal force that is produced in accordance with the rotation of the cleaning plate 24, to make contact with the entirety of the first face 12a of the substrate 12 while moving in the direction of rotation along the liquid support face 22 that is rotating, with the result that the first face 12a of the substrate 12 can be cleaned reliably and efficiently by the cleaning liquid L, as the portion of the cleaning liquid L that contacts the substrate first face 12a is refreshed continuously and rapidly. Furthermore, because the structure is one whereon the cleaning liquid L flows over the liquid support face 22 of the cleaning plate 24 that is in the upward-facing orientation, the cleaning liquid L can be positioned easily at a position wherein it does not make contact with the support member 14 to which the second face 12b of the substrate 12 is bonded. Consequently, it is possible to prevent in advance the adhesive agent that is used for bonding the support member 14 to the substrate second face 12b from being dissolved through cleaning with the cleaning liquid L.

The substrate cleaning method according to the first embodiment of the first invention, which uses the substrate cleaning device 10, as described above, includes: preparing a substrate 12, having a first face 12a and a second face 12b, and a cleaning plate 24, having a liquid support face 22; placing the substrate 12 in a downward-facing orientation wherein the first face 12a faces downward in the direction of gravity; placing the cleaning plate 24 in an upward-facing orientation wherein the liquid support face 22 faces upward in the direction of gravity; positioning the downward-oriented substrate 12 and the upward-oriented cleaning

plate 24 in an operating position wherein the first face 12a and the liquid support face 22 face each other across a gap G of a predetermined dimension; supplying a cleaning liquid L to a central region 22a of the liquid support face 22 of the upward-oriented cleaning plate 24; rotating the upward-oriented cleaning plate 24 around a cleaning plate axis 24a that is
5 determined in the central region 22a as an axis that is substantially perpendicular to the liquid support face 22; and cleaning the first face 12a of the substrate 12 by causing the liquid L that flows along the liquid support face 22 of the cleaning plate 24 that is rotating around the cleaning plate axis 24a to contact the first face 12a of the substrate 12, at the operating position.

10 When cleaning the first face 12a of the substrate 12 by the substrate cleaning method set forth above, the first face 12a of the substrate 12, which is supported by the substrate support portion 16, and the liquid support face 22 of the cleaning plate 24 can be moved relatively in a direction other than the direction of rotation of the cleaning plate 24, which is centered on the cleaning plate axis 24a, in a state wherein the cleaning liquid L is caused to
15 contact the first face 12a. In order to perform this relative motion, the substrate cleaning device 10 is further provided with a rotational drive portion 54 for driving the cleaning plate 24 and the substrate 12, which is supported by the substrate support portion 16, so as to rotate relatively around a substrate axis 12c that is established in the substrate 12 on the table 18 as an axis that is substantially perpendicular to the first face 12a. In the configuration shown,
20 the rotational drive portion 54 is structured as a table drive portion (including a prime mover and a driving force transmitting mechanism, not shown) for rotating the table 18 around the substrate axis 12c. Additionally, the cleaning step in the substrate cleaning method set forth above includes a step for rotating the substrate 12 and the cleaning plate 24 relative to each other around the substrate axis 12c in a state wherein the cleaning liquid L is caused to
25 contact the first face 12a.

Providing the rotational drive portion 54 enables the relative speed of motion to be increased easily when the cleaning liquid L, which is supported on the liquid support face 22, is in contact with the first face 12a of the substrate 12, and enables the first face 12a to be cleaned using a liquid support face 22 that is smaller than the first face 12a. As a result, the
30 efficiency of cleaning by the cleaning fluid L can be increased. Note that instead of a structure wherein a table drive portion that rotates the table 18 around the substrate axis 12c is used as the rotational drive portion 54, or in addition thereto, the structure may use a cleaning plate unit drive portion that rotates the cleaning plate unit 52 around the substrate axis 12c. Additionally, the first face 12a of the substrate 12 that is supported by the substrate

support portion 16 and the liquid support face 22 of the cleaning plate 24 may be moved relative to each other through an action other than a rotation around the substrate axis 12c (for example, through a linear reciprocating action). However, from the dual perspective of the mechanical mechanism and the control mechanism, providing the rotational drive portion 54 is useful.

When, in the substrate cleaning method set forth above, the downward-oriented substrate 12 and the upward-oriented cleaning plate 24 are positioned at the operating position, the substrate 12 and the cleaning plate 24 can be positioned quickly and with excellent accuracy at an operating position that is determined in advance. In order to perform this positioning, the substrate cleaning device 10 is further provided with a table 18 for supporting the cleaning plate 24 and the substrate 12, and a positioning drive portion 56 for not only performing relative movement between a standby position wherein the liquid support face 22 and the first face 12a of the substrate 12 are not facing each other and an operating position wherein the liquid support face 22 and the first face 12a of the substrate 12 face each other in a substantially parallel state across a substantially uniform gap G, but also for performing the positioning at the operating position. In the configuration that is illustrated, the positioning drive portion 56 is structured as a table driving mechanism (including a prime mover and a driving force transmitting mechanism, not shown) for driving the table 18 between the standby position and the operating position. Providing the positioning drive portion 56 enables the substrate 12 and the cleaning plate 24 to be positioned quickly and with excellent accuracy at the operating position after the substrate 12 is supported by the substrate support portion 16 at the standby position. Additionally, this enables easy removal of the substrate 12 from the substrate support portion 16 at the standby position after substrate cleaning.

The substrate 12, as one example to which the substrate cleaning method described above can be applied, is a disk-shaped material having a first face 12a and a second face 12b, made from circular faces centered on the substrate axis 12c, as illustrated in FIG. 3. Both the first face 12a and the second face 12b of the substrate 12 are substantially flat surfaces, and are disposed substantially in parallel to each other. A disk-shaped support member 14, which has a surface 14a that is larger than the second face 12b is bonded, using an adhesive agent, not shown, to the second face 12b of the substrate 12. When the substrate 12 is a wafer that serves as the main material for a semiconductor chip, then the support member 14 is a flexible supporting film that is bonded in order to protect and support the back face (the second face 12b) of the wafer at the time of dicing the wafer that has been subjected to back-

face grinding. In this case, a frame member 58, having a ring shape and dimensions enabling disposal around the outer peripheral edge of the support member (the supporting frame) 14, and also having high rigidity, greater than that of the support member (the supporting film) 14, is secured to the support member (the supporting frame) 14 using bonding means such as an adhesive agent, is not shown.

The substrate 12 can be, for example, a wafer made from gallium, liquid crystal, sapphire, glass, or the like, or may be another substrate. If the substrate 12 has a disk shape, then the diameter of the substrate 12 may be, for example, between 50 mm and 500 mm. If the substrate 12 is a wafer, then the first face 12a is the circuit face wherein specific circuit patterns are formed. The wafer thickness is standardized to, for example, between 0.5 mm and 1 mm, along with the diameter. Additionally, the thickness of the semiconductor chip after back-face grinding is, for example, between 50 μm and 100 μm . Note that there is no particular limitation on the materials, shape, dimension, and the like for the substrate 12.

The support member (supporting film) 14 is a flexible film-shaped element, and, for example, is manufactured from resin, or the like, to have a thickness that is uniform overall. The support member (supporting film) 14 can be bonded to the second face (back face) 12b of the substrate (wafer) 12 through a specific adhesive agent so as to protect and support the second face 12b at the time of dicing of the substrate (wafer) 12. When a radiation-curable adhesive agent is used as this adhesive agent, then, preferably, the support member (the supporting film) 14 should have adequate radiation transmissivity, and may be, for example, a polymer film such as a polyester such as polyethylene terephthalate, a polyolefin resin such as polypropylene, a polyvinyl chloride resin, a polyvinylidene chloride resin, or a polyamide resin, or the like. Moreover, as one embodiment, the support member (supporting film) 14 is preferably a substance able to protect the second face (back face) 12b of the substrate (wafer) 12 so as to prevent soiling during dicing. In this case, the thickness of the support member (supporting film) 14 is, for example, between 5 μm and 200 μm . Note that the support member (supporting film) 14 that is illustrated is provided with a circular shape that is similar to the disk shape of the substrate 12 (and having the substrate axis 12c in common), but there is no particular limitation to the material, shape, dimensions, or the like of the support member 14, except for the point of having a surface 14a that is larger than the second face 12b of the substrate 12.

The adhesive agent for bonding the support member (the supporting film) 14 to the second face (the back face) 12b of the substrate (wafer) 12 may be, for example, a curable adhesive agent, a solvent adhesive agent, a thermoplastic resin (including a hot melt-type

adhesive agent), an aqueous dispersion-type adhesive agent, or the like, that is able to produce adhesive forces to hold, in a strongly secured state, the surface 14a of the support member 14 to the second face 12b of the substrate 12 through curing or hardening. Here the curable adhesive agent is a liquid adhesive agent that can be cured through heating or an energy beam such as ultraviolet radiation, where the solvent-type adhesive agent is an adhesive agent that solidifies through the volatilization of a solvent, and the hot-melt adhesive agent is an adhesive agent that is melted through heating and that solidifies through cooling. Moreover, the aqueous dispersion-type adhesive agent is an adhesive agent wherein the adhesive agent component is dispersed in water, and that solidifies through the evaporation of the water. The curable adhesive agent may be a single-liquid heat-curable adhesive agent based on an epoxy or urethane, may be a two-liquid-type mixing-reaction adhesive agent based on an epoxy, urethane, or acrylic, or may be an ultraviolet-curable or electron beam-curable adhesive agent based on an acrylic or epoxy. Moreover, the solvent-type acrylic agent may be a rubber-type acrylic agent wherein a rubber, an elastomer, or the like, is dissolved in a solvent. Note that in the present application, both curing, in the narrow sense, and hardening are termed "hardening".

If the substrate 12 is a wafer, then the adhesive agent can be the same adhesive agent used when bonding the supporting plate, for protecting and supporting, to the circuit face (the first face 12a) at the time of the step for grinding the back face of the wafer. While a supporting film (support member 14) for protecting and supporting is bonded to the back face of the thinned wafer, the supporting plate is peeled from the wafer circuit face at the time of dicing, and the exposed circuit face is cut. Given this, sometimes some of the adhesive agent used for bonding the supporting plate will remain on the circuit face of the wafer from which the supporting plate has been peeled, and thus the circuit face is cleaned, when necessary, prior to performing dicing. The substrate cleaning device 10 and substrate cleaning method according to these embodiments of the present invention can be applied in the step for cleaning the circuit face.

The frame member 58 is manufactured to an overall uniform thickness from metal, plastic, or the like. The frame member 58 has sufficient rigidity able to support a state wherein the central region of the support member 14, which is located on the interior of the frame member 58, is stretched through the frame member 58 being secured to the surface 14a along the outer peripheral edge of the support member 14. The rigidity of the frame member 58 can be set by the material, dimensions, and shape thereof, and the like, but all that is necessary is to have rigidity to the degree that the frame member 58 itself does not

undergo any significant twisting or deformation when, for example, some sort of tensile force is applied to the support member 14. For example, if the frame member 58 is circular and made out of stainless steel, then having a thickness of between about 1 mm and 2 mm, with an inner diameter of about 350 mm and an outer diameter of about 400 mm will be

5 appropriate for use with a silicon wafer having, in particular, a diameter of 30 mm. Note that while the frame member 58 that is illustrated is provided with a circular shape that is similar to the disk shape of the substrate 12 (and has the substrate axis 12c in common), there is no particular limitation to the materials, shape, dimensions, or the like, of the frame member 58, with the exception of the point that it should have a shape and dimensions that enable the
10 placement thereof around the outer peripheral edge of the support member 14 and have greater rigidity than that of the support member 14. The frame member 58 may also be made of the same material as that of the support member 14.

A specific structure for a particular substrate cleaning device 10, for cleaning the first face 12a of a substrate 12, as one example of that which is described above, will be explained
15 in greater detail in reference to FIG. 1 through FIG. 6.

The table 18 of the substrate support portion 16 has a substantially flat circular face 18a that resembles the disk shapes of the substrate 12 and the support member 14, and the entirety of the support member 14 can be supported on the surface 18a. The securing mechanism 20 is structured from the aforementioned vacuum device, for removably securing
20 the substrate 12 and the support member 14 to the surface 18a of the table 18 using a vacuum effect. If the frame member 58 that is secured along the outer peripheral edge of the support member 14 is made out of metal, then the securing mechanism 20 can be structured from a magnet device instead.

The liquid support face 22 of the cleaning plate 24 can be a circular face centering on the cleaning plate axis 24a (FIG. 2). In this case, a diameter of the liquid support face 22 can be set to be less than a diameter of the first face 12a of the substrate 12 and greater than a radius thereof. If the diameter of the liquid support face 22 is less than the diameter of the first face 12a, then the operating position is positioned disposed with an offset, with the substrate axis 12c and the cleaning plate axis 24c substantially parallel to each other (FIG. 4).
25

The liquid support face 22 of the cleaning plate 24 may have a substantially flat recessed surface portion 60 and a raised surface portion 62 adjacent to the recessed surface portion 60 (FIG. 1 and FIG. 2). The raised surface portion 62 is, overall, substantially flat, and is positioned protruding in a direction along the cleaning plate axis 24a from the recessed surface portion 60. The height of the protrusion of the raised surface portion 62, using the
30

recessed surface portion 60 as a reference, is, for example, between about 1 mm and about 2 mm. In this configuration, the gap G that is formed between the first face 12a of the substrate 12, which is supported at the recessed surface portion 60 at the operating position, and the liquid support face 22 of the cleaning plate 24 will be formed between the first face 12a of the substrate 12 and the raised surface portion 62 of the liquid support face 22. The gap G is, for example, between about 0.1 mm and about 0.5 mm. Given this, the cleaning plate 24 can cause the cleaning liquid L that runs in the raised surface portion 62 to contact the first face 12a of the substrate 12, without causing the cleaning liquid L that runs in the recessed surface portion 60 to contact the first face 12a of the substrate 12, while maintaining with stability the gap G, while being rotated around the cleaning plate axis 24a by the driving of the cleaning plate drive portion 28. (FIG. 5)

The raised surface portion 62 of the liquid support face 22 of the cleaning plate 24 is formed in a region that includes at least a portion of an imaginary periphery P that is centered on the cleaning plate axis 24a and that has a diameter that is substantially equal to the radius of the first face 12a of the substrate 12 (FIG. 6). In the configuration that is illustrated, the raised surface portion 62 is a circular portion that is formed in a region that includes the entirety of the imaginary periphery P, and is located along the outer peripheral edge of the circular liquid support face 22, and encompasses the entirety of the recessed surface portion 60 (FIG. 2). In this case, the operating position is a position wherein the substrate axis 12c and the cleaning plate axis 24a are substantially parallel to each other and shifted by a distance that is substantially half of the radius of the first face 12a of the substrate 12 (FIG. 4 and FIG. 6).

The shaft portion 32 of the cleaning plate 24 has a hollow cylindrical shape, and the shoulder face 56 that is provided in the central region 22a of the liquid support face 22 can have a circular conical shape that extends smoothly between the cylindrical inner peripheral surface of the shaft portion 32 and the liquid support face 22 (FIG. 1 and FIG. 2). In this case, the nozzle 42 of a cleaning liquid supply portion 26 is disposed in a position wherein the cleaning liquid dispensing opening thereof is positioned facing the shoulder face 46 of the cleaning plate 24.

The housing 36 of the cleaning plate unit 52 can be provided, on the interior thereof, with a cylindrical outer wall that partitions a cleaning chamber 38 (FIG. 1 and FIG. 2). Additionally, a ring-shaped flange portion 66 that extends to the inside toward the main portion 30 of the cleaning plate 24, which is contained within the cleaning chamber 38, may be structured at the upper end, in the axial direction, of an outer wall 64, wherein the cleaning

chamber 38 is open. The outer wall 64 and the ring-shaped flange portion 66 function as a cleaning liquid recovering portion for recovering, on the outside of the cleaning plate 24, the cleaning fluid L that is scattered to the outside of the cleaning plate 24 after running along the liquid support face 22 of the cleaning plate 24 that is rotating centered on the cleaning plate axis 24a (FIG. 5). In this configuration, a drain opening 68 may be provided for draining toward a cleaning liquid reservoir portion, not illustrated, the cleaning liquid L that is recovered by the outer wall 64 and the ring-shaped flange portion 66 (FIG. 1).

The cleaning plate unit 52 may be provided with a gas exhaust portion 70 that puts the cleaning chamber 38 under negative pressure (FIG. 1). The gas exhaust portion 70 may be structured so as to draw the vapor of the cleaning liquid L that has been supplied to the liquid support face 22 of the cleaning plate 24 out of the cleaning chamber 38, to exhaust it, for example, toward a filtering device, not shown. Providing the gas exhaust portion 70 enables prevention of the vapor of the cleaning liquid L from escaping to the outside of the housing 36 and diffusing.

The cleaning plate unit 52 may further be provided with auxiliary equipment 72 having specific functions, such as a hot air supply device for supplying hot air into the space surrounding the cleaning plate 24, a nitrogen supply device for supplying nitrogen into the space surrounding the cleaning plate 24, and the like (FIG. 1). Providing the nitrogen supply device as the auxiliary equipment 72 makes it possible to prevent ignition of the cleaning liquid L, through reducing the oxygen concentration in the ambient gas, through the continuous provision of nitrogen into the space surrounding the cleaning plate 24, during the cleaning step, if a flammable cleaning fluid L is used. Additionally, providing the hot air providing device, as the auxiliary equipment 72, makes it possible to drive the first face 12a of the substrate 12 rapidly after cleaning, through the continuous provision of hot air into the space surrounding the cleaning plate 24 at the conclusion of the cleaning step. The nitrogen and the dry air can be provided into the space surrounding the cleaning plate 24 through the shaft portion 32 of the cleaning plate 24.

A plurality of cleaning liquids L, having differing compositions, may be prepared at the time of the cleaning step. In this case, the cleaning liquid supply portion 26 may supply, to the central region 22a of the liquid support face 22 of the cleaning plate 24, the plurality of cleaning liquids L in a predetermined sequence. Doing so makes it possible to cause the plurality of cleaning liquids L to contact the first face 12a of the substrate 12 in the predetermined sequence in the cleaning step. For example, first using a first cleaning liquid L that has excellent cleaning power but that includes a solvent that is difficult to dry, such as

acetone or the like, and then, after the first face 12a of the substrate 12 has been cleaned, removing the first cleaning liquid L through cleaning the first face 12a of the substrate 12 with a second cleaning liquid L, such as isopropyl alcohol or the like, makes it easy to dry the first face 12a of the substrate 12.

5 The following procedure is performed in the substrate cleaning method for the substrate 12 illustrated in FIG. 3 by the substrate cleaning device 10 having the configuration that is illustrated.

10 The support member 14 to which the frame member 58 is secured along the outer peripheral edge is bonded to the second face 12b of the substrate 12. In the substrate cleaning device 10, the cleaning plate 24 of the cleaning plate unit 52 is placed in advance at the operating position, but the table 18 of the substrate support portion 16 is placed in the standby position. The substrate 12, having the support member 14 bonded to the second face 12b thereof, is secured, by the securing mechanism 20, to the surface 18a of the table 18, which has been placed in the standby state, in an orientation wherein the entirety of the first face 12a is exposed, and the table 18 is moved from the standby position to the operating position by the positioning drive portion 56, to position the first face 12a of the substrate 12 at the operating position, facing the liquid support face 22 of the cleaning plate 24, substantially in parallel therewith, across a substantially uniform gap G. In the operating position, the substrate axis 12c of the substrate 12 and the cleaning plate axis 24a of the cleaning plate 24 are placed so as to be substantially parallel to each other, separated by a distance that is substantially half of the radius of the first face 12a of the substrate 12, so that the raised surface portion 62 of the liquid support face 22 of the cleaning plate 24 is positioned at a region that includes the entirety of the imaginary periphery P that is centered on the cleaning plate axis 24a and that has a diameter that is substantially equal to the radius of the first face 12a of the substrate 12 (FIG. 4 and FIG. 6).

25 In the operating position, the table 18 that supports the substrate 12 is rotated by the rotational drive portion 54 around the substrate axis 12c, along with the cleaning plate 24 being rotated by the cleaning plate drive portion 28 around the cleaning plate axis 24a. The direction of rotation of the substrate 12 and the direction of rotation of the cleaning plate 24 may either be the same direction or opposite directions. The speed of rotation of the substrate 12 (that is, of the table 18) is, for example, between about 2 RPM and about 20 RPM, and the speed of rotation of the cleaning plate 24 is, for example, between about 100 RPM and about 2000 RPM. The substrate 12 and the cleaning plate 24 are each rotated while the gap G is maintained with stability.

As the cleaning plate 24 is rotated around the cleaning plate axis 24a, the cleaning liquid L is provided either continuously or discontinuously to the central region 22a of the liquid support face 22 of the cleaning plate 24 by the cleaning liquid supply portion 26. At this time, the cleaning liquid L that is dispensed from the nozzle 42 is retained temporarily by the shoulder face 46 that is provided in the central region 22a of the liquid support face 22, after which it flows to the outside overflowing into the recessed surface portion 60 of the liquid support face 22, due to the centrifugal force produced in accordance with the rotation of the cleaning plate 24 (FIG. 5). The temporary retention of the cleaning liquid L by the shoulder face 46 results in the cleaning liquid L flowing after spreading to a wide range in the recessed surface portion 60 of the liquid support face 22. Note that the shoulder face 46 is not limited to being the truncated circular conical shape that is illustrated, but rather a different shape, such as a stair-step shape or the like may be used instead; however, preferably the shape is one wherein the cleaning liquid L remains within the shoulder face 46.

The cleaning liquid L is caused, by the centrifugal force that is produced in accordance with the rotation of the cleaning plate 24, to flow to the outside of the recessed surface portion 60 from the central region 22a of the liquid support face 22, without contacting the first face 12a of the substrate 12, and when it overflows the raised surface portion 62, it contacts the first face 12a of the substrate 12 while moving in the direction of rotation along the rotating liquid support face 22 (FIG. 5). Rotating the substrate 12 around the substrate axis 12c, against the cleaning plate 24 that is rotated around the cleaning plate axis 24a, causes the cleaning liquid L to contact the entirety of the first face 12a of the substrate 12, depending on the positioning and dimensional relationship between the raised surface portion 62 and the first face 12a. The result is that the cleaning liquid L cleans the first face 12a of the substrate 12 reliably and efficiently while that portion of the cleaning liquid L that contacts the substrate first face 12a is refreshed continuously and rapidly.

The raised surface portion 62 is formed along the outer peripheral edge of the liquid support face 22, thus enabling the peripheral speed of the raised surface portion 62 to be increased easily. Consequently, the speed of motion of the cleaning liquid L that moves in the direction of rotation along the raised surface portion 62 can be increased easily, thus making it possible to increase easily the cleaning performance for the substrate first face 12a by the cleaning liquid L.

The cleaning liquid L that has cleaned the first face 12a of the substrate 12 is scattered toward the outside of the cleaning plate 24 from the raised surface portion 62 of the liquid support face 22 by the centrifugal force that is produced in accordance with the rotation of the

cleaning plate 24. The scattered cleaning liquid L is caught and retained by the outer wall 64 and the ring-shaped flange portion 66 of the housing 36 of the cleaning plate unit 52, to flow down along the inner surface of the outer wall 64, to be expelled from the drain opening 68, and to thus be recovered (FIG. 4 and FIG. 5). Doing so makes it possible to clean the first
5 face 12a of the substrate 12 reliably and quickly by the cleaning liquid L without the cleaning liquid L coming into contact with the support member 14 that is bonded to the second face 12b of the substrate 12. Consequently, the adhesive agent that is used in order to bond the supporting plate 14 to the second face 12b of the substrate 12 can be prevented in advance from dissolving through being cleaned by the cleaning liquid L.

10 If necessary, during the aforementioned cleaning step, the cleaning chamber 38 is put under negative pressure by a gas exhaust portion 70 (FIG. 1), while, to prevent the vapor of the cleaning fluid L from flowing to the outside of the housing 36 and diffusing, nitrogen can be supplied into the space surrounding the cleaning plate 24 by a nitrogen supply device, as the auxiliary equipment 72 (FIG. 1), to prevent the ignition of a flammable cleaning liquid L,
15 and a plurality of types of cleaning liquids L can be supplied to the central region 22a of the liquid support face 22 of the cleaning plate 24, in a sequence that is set in advance, from the cleaning liquid supply portion 26 (FIG. 1). Additionally, if necessary, hot air can be supplied into the space surrounding the cleaning plate 24, by a hot air supply device, as the auxiliary equipment 72 (FIG. 1), after the completion of the cleaning step, to dry the first face 12a of
20 the substrate 12 quickly after cleaning.

FIG. 7 shows schematically various structures for the liquid support face 22 of the cleaning plate 24 that can be used by the substrate cleaning device 10. The structure of the liquid support face 22 is not limited to structures that include the single ring-shaped raised surface portion 62 of FIG. 7A, but instead may use, for example, FIG. 7B a structure that
25 includes two ring-shaped raised surface portions 62, one large and one small, position concentrically, FIG. 7C structures that include a plurality of bowed raised surface portions 62 that are segmented in the circumferential direction, FIG. 7D structures that include raised surface portions 62 that are disposed as straight lines running along the diameter of the cleaning plate 24, FIG. 7E structures that include a plurality of raised surface portions 62 that
30 are disposed radially, and the like. In any of these structures, at least one raised surface portion 62 is formed in a region that includes at least a portion of the aforementioned imaginary periphery P (FIG. 6). Furthermore, as illustrated in FIG. 7F and FIG. 7G, it is possible to use a structure wherein the central region 22a of the liquid support face 22 is not

provided with the opening (FIG. 1) and the shoulder face 46 of the shaft portion 32. In this case, the nozzle 42 can be positioned in the free space above the liquid support face 22.

FIG. 8 and FIG. 9 will be referenced to explain a substrate cleaning device 80 according to a second embodiment of the present invention and to explain a substrate
5 cleaning method according to a second embodiment of the present invention, which uses the substrate cleaning device 80. The substrate cleaning device 80 and substrate cleaning method in the second embodiment have identical structures to those of the substrate cleaning device 10 and the substrate cleaning method explained in reference to FIG. 1 and FIG. 7, with the exception of the point that the structure of the cleaning plate 24 is different. Consequently,
10 corresponding structural elements will be assigned identical reference codes, and explanations thereof will be omitted as appropriate.

The substrate cleaning device 80 is provided with a cleaning plate 24 that has a liquid support face 82 that is made from a surface that is, overall, uniformly flat. The liquid support face 82 can be a circular face centered on the cleaning plate axis 24a. In this case, the
15 diameter of the liquid support face 82 is set to be no more than the diameter and no less than the radius of the first face 12a of the substrate 12. When the diameter of the liquid support face 82 is smaller than the diameter of the first face 12a, the operating position is a position wherein the substrate axis 12c and the cleaning plate axis 24a are positioned so as to be mutually substantially parallel and shifted from each other (FIG. 8). In the case wherein the
20 diameter of the liquid support face 82 is equal to the diameter of the first face 12a, then the operating position is a position wherein the substrate axis 12c and the cleaning plate axis 24a are coincident.

The substrate cleaning device 80 is provided with a cleaning plate drive portion 28 for rotating the cleaning plate 24 around the cleaning plate axis 24a, and a rotational drive
25 portion 54 for rotating the cleaning plate 24 and the substrate 12, which is supported on the substrate support portion 16, relative to each other around the substrate axis 12c. When the diameter of the liquid support face 82 of the cleaning plate 24 is equal to the diameter of the first face 12a of the substrate 12, then, in the cleaning step, it will be possible to either rotate or not rotate the substrate 12, as appropriate, excluding a state wherein the substrate 12 is
30 rotated in the same direction and with the same speed as those of the cleaning plate 24.

The substrate cleaning method for the substrate 12 illustrated in FIG. 3 by the substrate cleaning device 80, having the configuration that is illustrated, performs the same procedures as the substrate cleaning method, described above, by the substrate cleaning device 10.

In the cleaning step, in the operating position, the table 18 that is supporting the substrate 12 is rotated by the rotational drive portion 54 around the substrate axis 12c (FIG. 1), and, additionally, the cleaning plate 24 is rotated by the cleaning plate drive portion 28 around the cleaning plate axis 24a. As the cleaning plate 24 is rotated around the cleaning plate axis 24a, the cleaning liquid L is provided either continuously or discontinuously to the central region 82a of the liquid support face 82 of the cleaning plate 24 by the cleaning liquid supply portion 26. The cleaning liquid L is caused, by the centrifugal force that is produced in accordance with the rotation of the cleaning plate 24, to flow to the outside from the central region 22a of the liquid support face 82, while contacting the first face 12a of the substrate 12, and simultaneously contacting the first face 12a of the substrate 12 while moving in the direction of rotation along the rotating liquid support face 82 (FIG. 9). Rotating the substrate 12 around the substrate axis 12c, against the cleaning plate 24 that is rotated around the cleaning plate axis 24a, causes the cleaning liquid L to contact the entirety of the first face 12a of the substrate 12. (If the diameter of the liquid support face 82 is equal to the diameter of the first face 12a, then the substrate 12 need not be rotated.) The result is that the cleaning liquid L cleans the first face 12a of the substrate 12 reliably and efficiently while that portion of the cleaning liquid L that contacts the substrate first face 12a is refreshed continuously and rapidly.

The cleaning liquid L that has cleaned the first face 12a of the substrate 12 is scattered toward the outside of the cleaning plate 24 of the liquid support face 82 by the centrifugal force that is produced in accordance with the rotation of the cleaning plate 24. The scattered cleaning liquid L is caught and retained by the outer wall 64 and the ring-shaped flange portion 66 of the housing 36 of the cleaning plate unit 52, to flow down along the inner surface of the outer wall 64, to be expelled from the drain opening 68, and to thus be recovered (FIG. 8 and FIG. 9). Doing so makes it possible to clean the first face 12a of the substrate 12 reliably and quickly by the cleaning liquid L without the cleaning liquid L coming into contact with the support member 14 that is bonded to the second face 12b of the substrate 12. Consequently, the adhesive agent that is used in order to bond the supporting plate 14 to the second face 12b of the substrate 12 can be prevented in advance from dissolving through being cleaned by the cleaning liquid L.

CLAIMS

1. A substrate cleaning method comprising:

preparing a substrate having a first face and a second face opposite the first face,
and a cleaning plate having a liquid support face;

placing the substrate in a downward orientation with the first face facing
downward;

placing the cleaning plate in an upward orientation with the liquid support face
facing upward;

positioning the downward-oriented substrate and the upward-oriented cleaning
plate into an operating position mutually facing each other with a gap of a
predetermined dimension between the first face and the liquid support face;

providing a cleaning liquid to a central region of the liquid support face of the
upward-oriented cleaning plate;

rotating the upward-oriented cleaning plate around a cleaning plate axis that is
determined in the cleaning plate as an axis that is substantially perpendicular
to the liquid support face, in the central region; and

cleaning the first face of the substrate by causing the cleaning liquid that flows
along the liquid support face of the cleaning plate to contact the first face of
the substrate.

2. The substrate cleaning method as set forth in Claim 1, wherein cleaning the first face
of the substrate includes rotating the substrate and the cleaning plate relatively around
a substrate axis that is established in the substrate as an axis that is substantially
perpendicular to the first face.

3. A substrate cleaning device for cleaning a first face of a substrate that has a first face
and a second face opposite the first face, comprising:

a substrate support portion able to support a substrate in a downward-facing
orientation when the first face faces downward;

a cleaning plate having a liquid support face, wherein the cleaning plate is
positioned in an upward-facing orientation when the liquid support face faces
upward, at an operating position wherein the liquid support face is able to face
the first face of the substrate, which is supported by the substrate support
portion, with a gap of a predetermined dimension interposed therebetween;

a cleaning liquid providing portion for providing a cleaning liquid to a central region of the liquid support face of the cleaning plate; and

a cleaning plate drive portion for rotating the cleaning plate around a cleaning plate axis that is determined in the cleaning plate as an axis that is

substantially perpendicular to the liquid support face in the central region;

wherein the cleaning liquid can be caused to contact the first face of the substrate to clean the first face of the substrate.

4. The substrate cleaning device as set forth in Claim 3, further comprising a rotational drive portion for driving the substrate and the cleaning plate relatively around a substrate axis that is established in the substrate as an axis that is substantially perpendicular to the first face

5. The substrate cleaning device as set forth in Claim 4, wherein the first face of the substrate is a circular face centered on the substrate axis, the liquid support face of the cleaning plate is a circular face centered on the cleaning plate axis, and a diameter of the liquid support face is no more than a diameter of the first face.

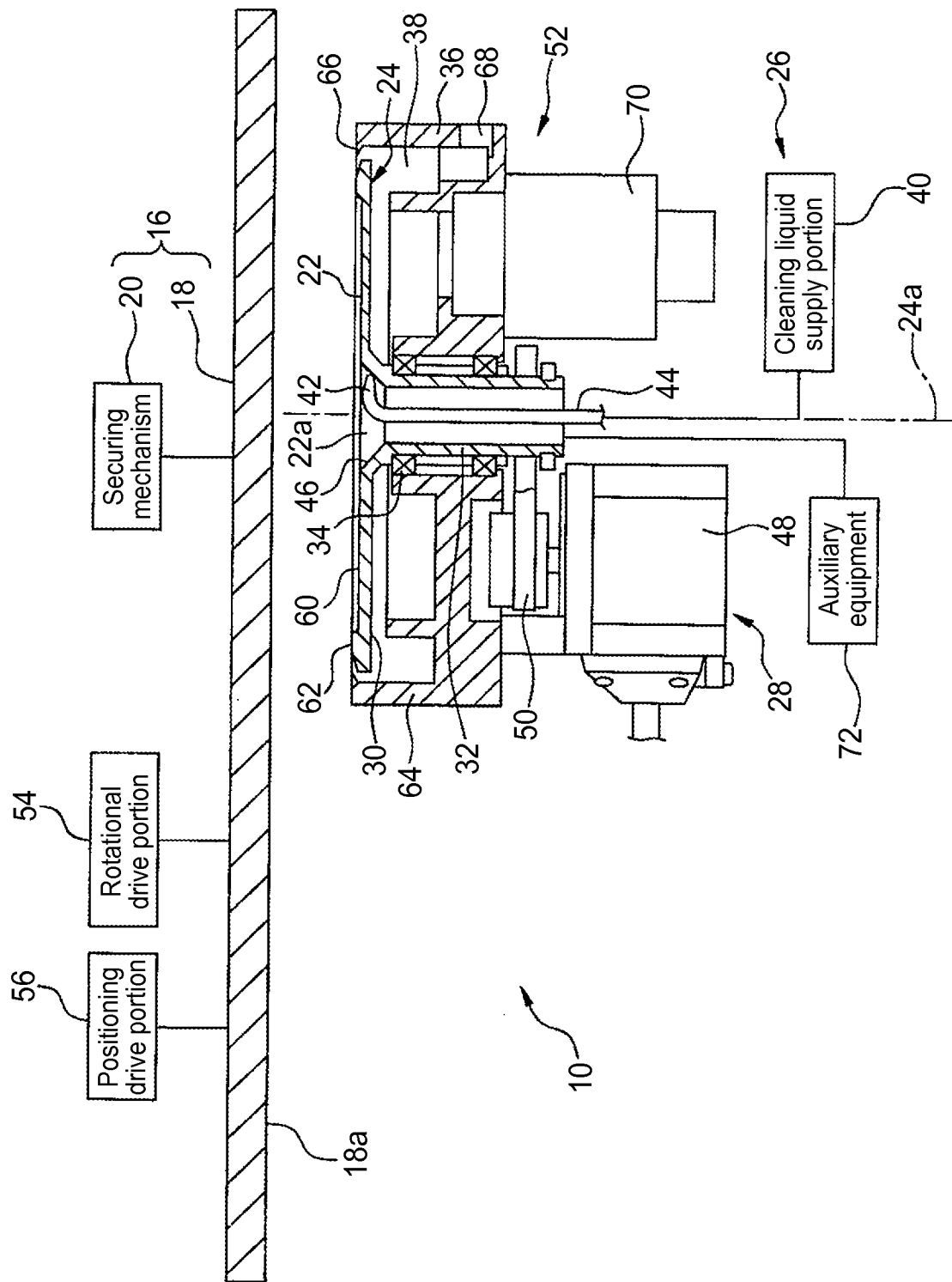
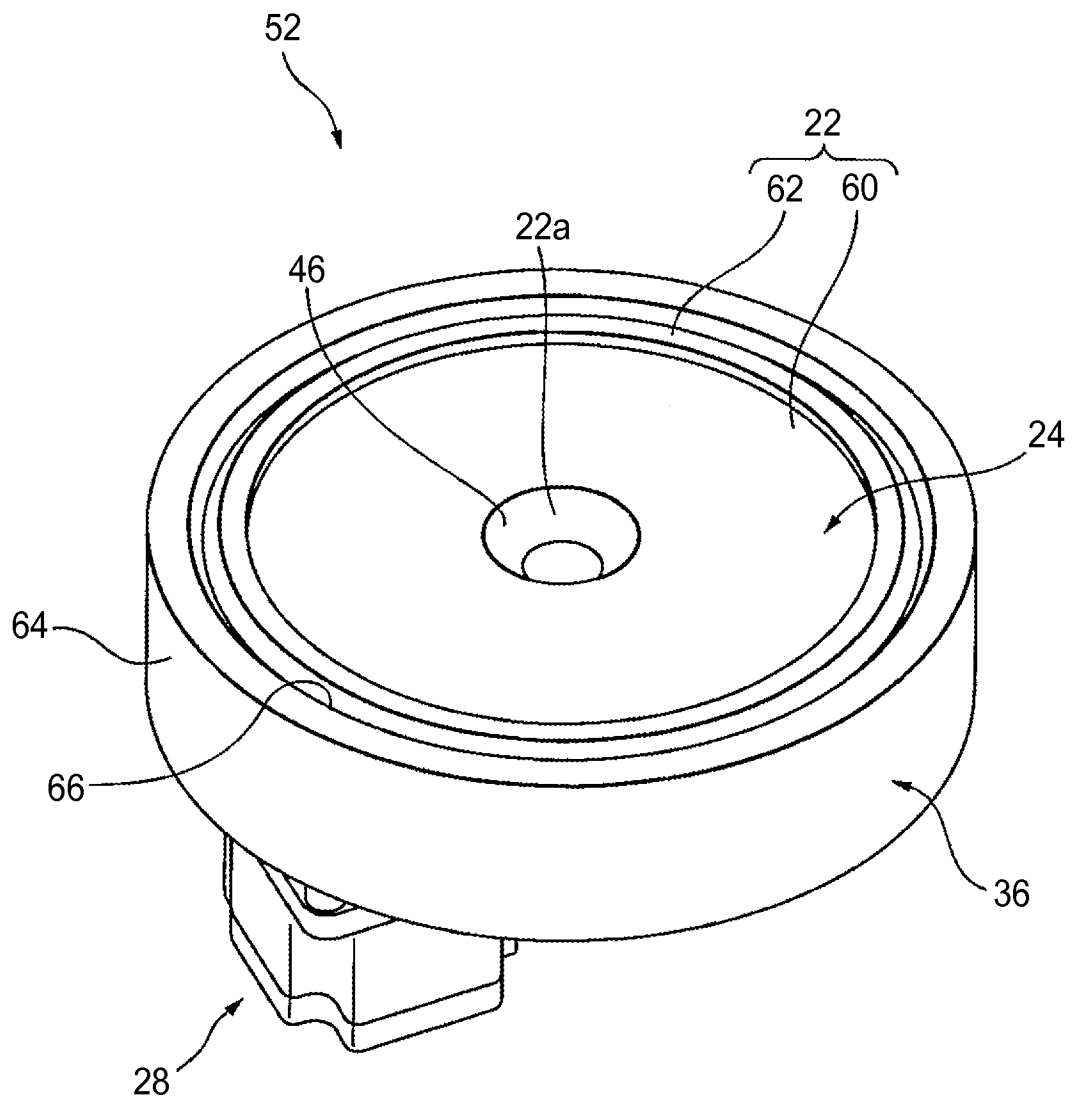
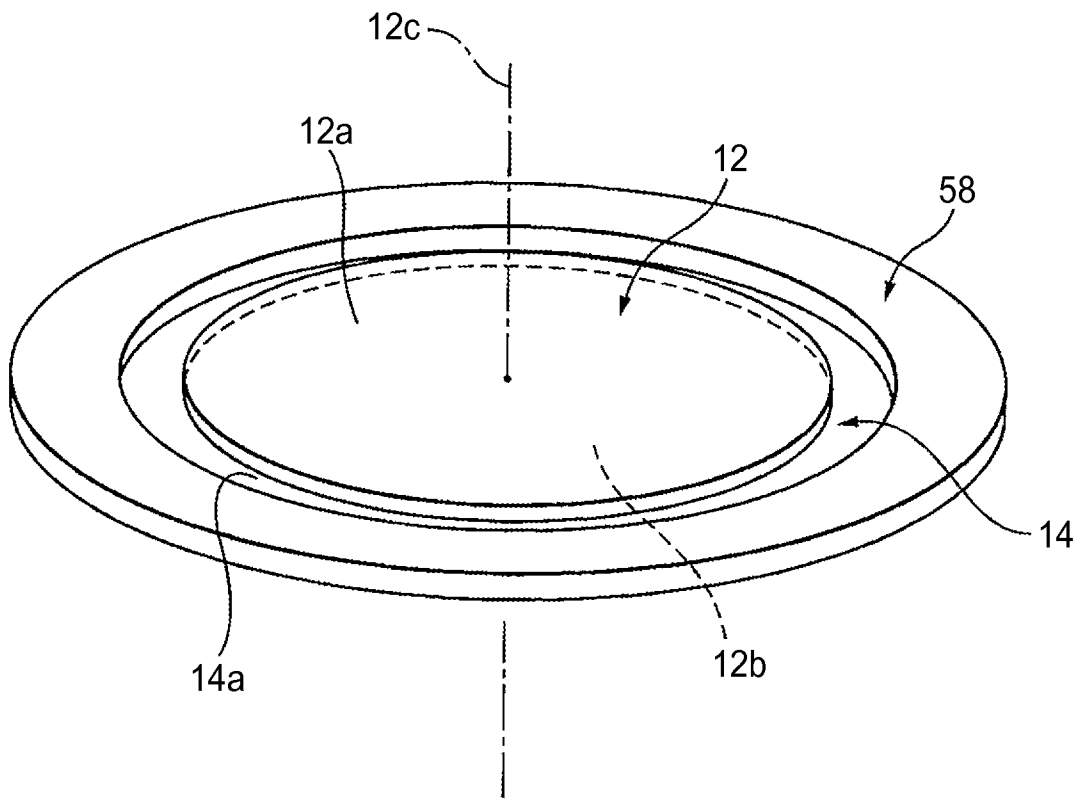


FIG. 1

*FIG. 2*

3/9

*FIG. 3*

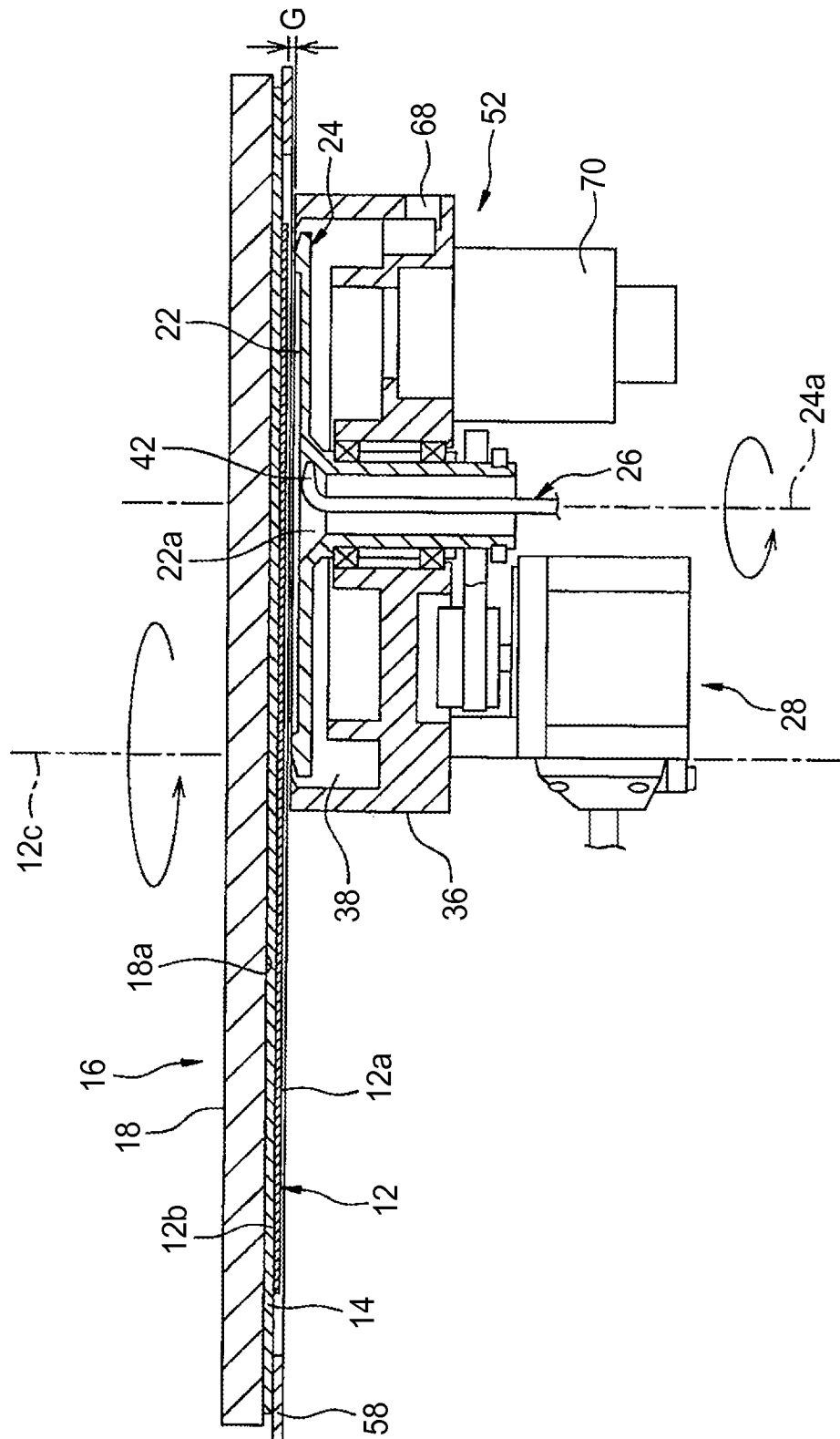


FIG. 4

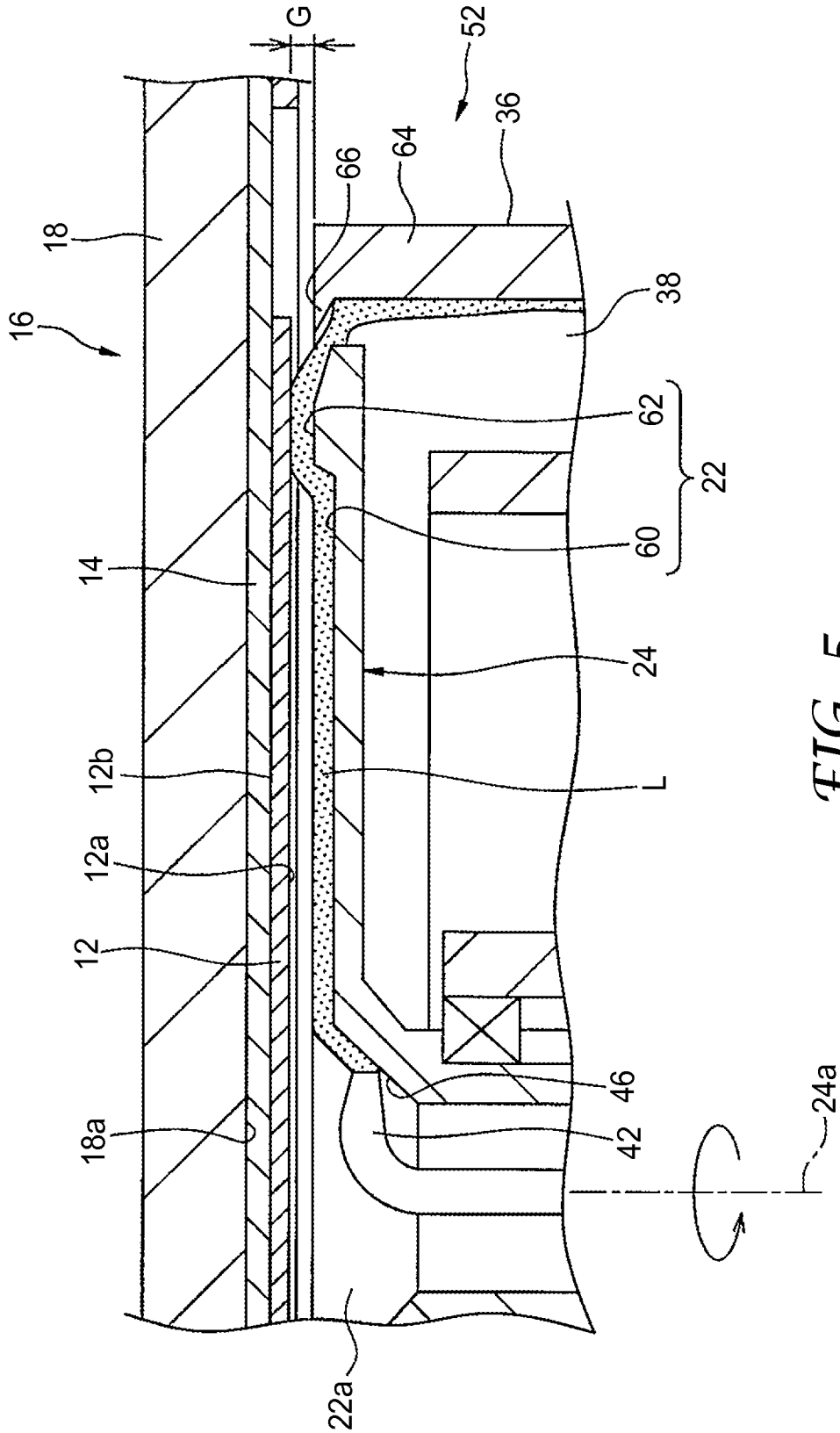


FIG. 5

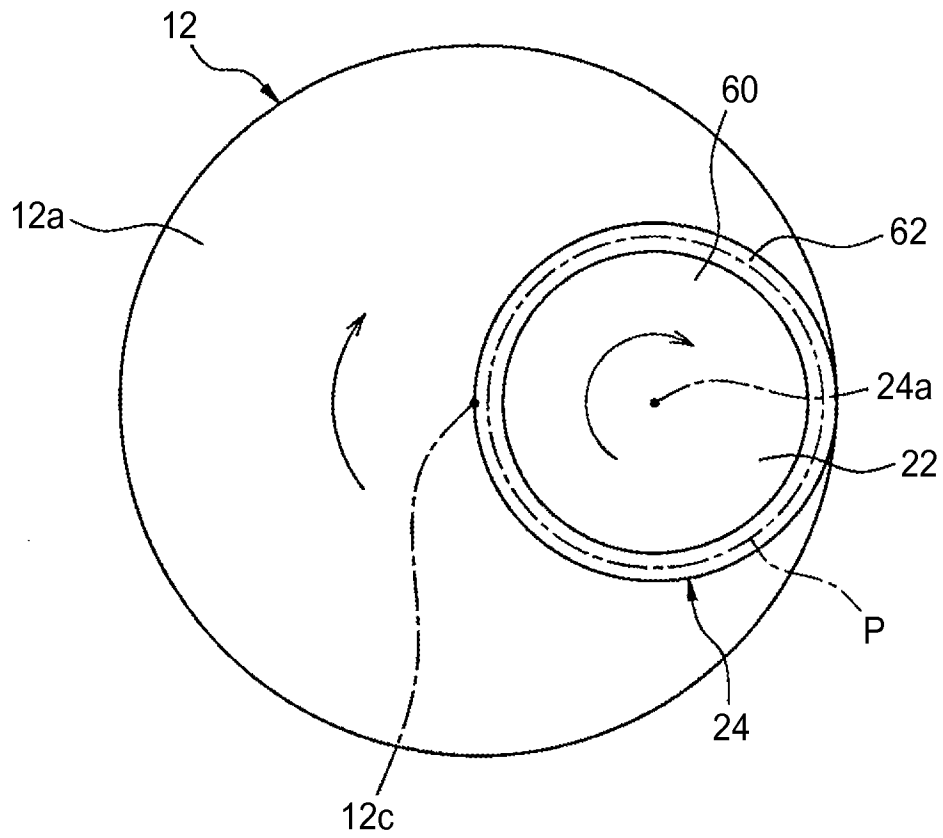


FIG. 6

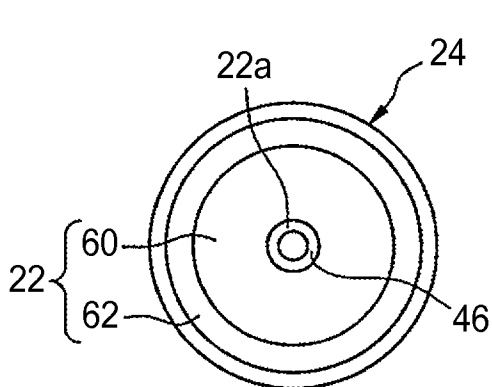


FIG. 7A

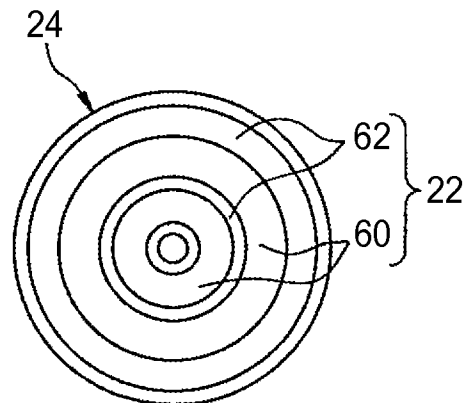


FIG. 7B

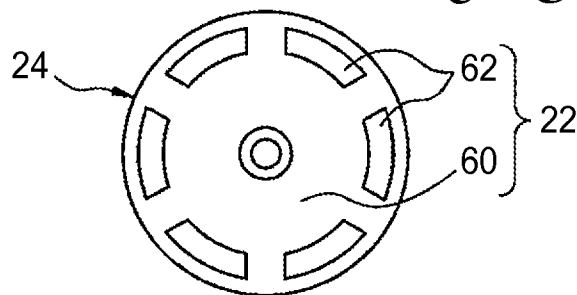


FIG. 7C

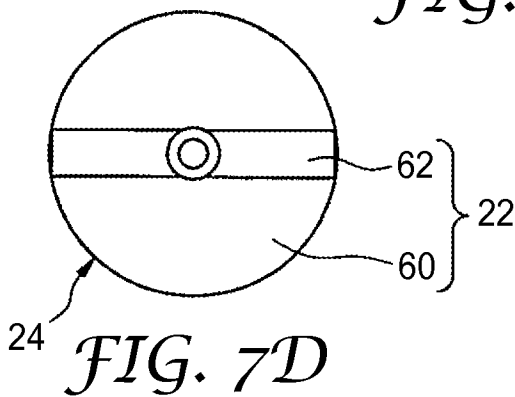


FIG. 7D

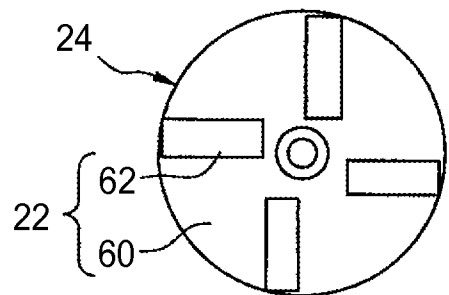


FIG. 7E

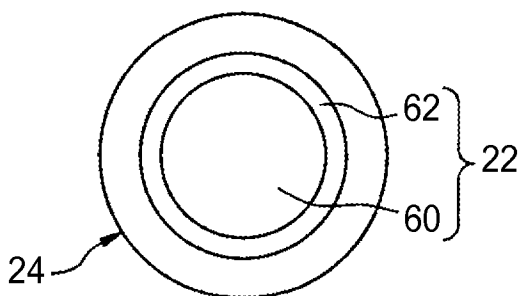


FIG. 7F

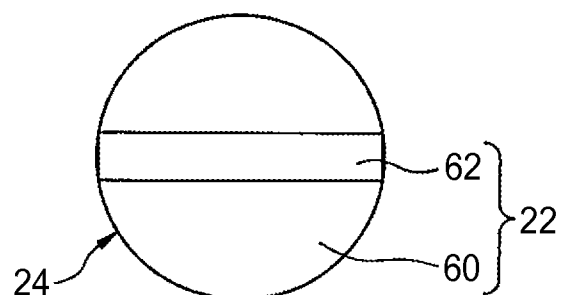


FIG. 7G

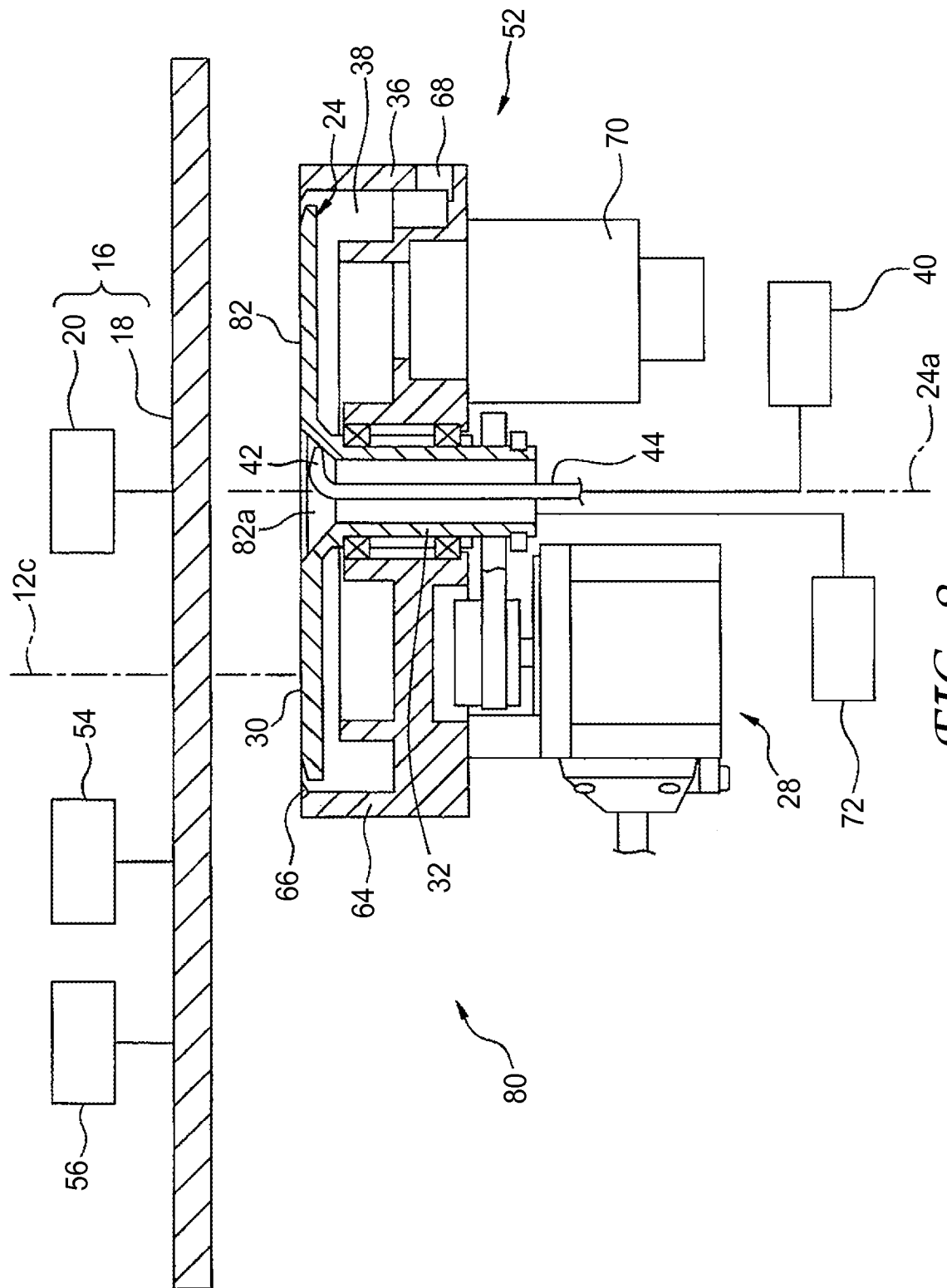


FIG. 8

