(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 832 717 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
01.04.1998 Bulletin 1998/14

(51) Int Cl.^{6}: **B24B 9/06**

(21) Application number: **97307533.6**

(22) Date of filing: **25.09.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV RO SI

(30) Priority: **27.09.1996 JP 256858/96**

(71) Applicant: **Shin-Etsu Handotai Co., Ltd**
Chiyoda-ku Tokyo (JP)

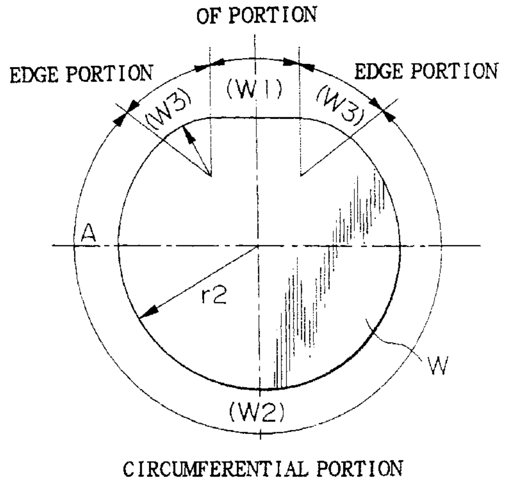
(72) Inventors:
- **Hasegawa, Fumihiko,**
c/o Shin-Etsu Handotai Co. Ltd
mura, Nishi-shirakawa-gun, Fukushima (JP)
- **Kuroda, Yasuyoshi,**
c/o SEH Shirakawa R&D Center
Nishi-shirakawa-gun, Fukushima (JP)
- **Yamada, Masayuki,**
c/o SEH Shirakawa R&D Center
Nishi-shirakawa-gun, Fukushima (JP)

(74) Representative: **Rackham, Stephen Neil**
GILL JENNINGS & EVERY,
Broadgate House,
7 Eldon Street
London EC2M 7LH (GB)

(54) Wafer processing

(57) A method for processing a peripheral chamfered portion of a wafer (W) having an orientation flat portion (W1), comprises: a first honing step for honing the orientation flat portion (W1) of the wafer (W) by relatively pressing the orientation flat portion (W1) against a cylindrical honing stone (21) with a first pressing force (F1), while rotating the wafer (W) at a first rotational speed (Ns1) and rotating the honing stone (21); a second honing step for honing the circumferential portion (W2) of the wafer (W) by relatively pressing the circumferential portion (W2) against the cylindrical honing stone (21) with a second pressing force (F2), while rotating the wafer (W) at a second rotational speed (Nsl) and rotating the honing stone (21); a third honing step for honing the edge portions (W3) of the wafer (W) by relatively pressing the edge portions (W3) against the cylindrical honing stone (21) with a third pressing force (F3), while rotating the wafer (W) at a third rotational speed (Ns3) and rotating the honing stone (21); and a polishing step for polishing the honed orientation flat portion (W1), the honed circumference portion (W2) and the honed edge portions (W3); wherein the first, second and third rotational speeds (Ns1, Ns2 and NS3), of the wafer (W) are different from one another; or the first, second and third pressing forces (F1, F2 and F3) are different from one another.

FIG.1



EP 0 832 717 A2

Printed by Jouve, 75001 PARIS (FR)

Description

The present invention relates to a method for processing a semiconductor wafer (hereinafter, which may be simply referred to "a wafer") including a honing step for honing the peripheral chamfered portion of the wafer and to a processing equipment including a honing device for honing the peripheral chamfered portion.

Conventionally, a wafer processing method comprising the steps of; chamfering a peripheral portion of a wafer for preventing the peripheral portion from being chipped off, lapping for making variation in thickness of wafers small, etching for removing a damaged layer and contaminated portions which were formed by abrasive grains sticking thereunto or the like, and mirror-polishing the peripheral chamfered portion and the main surface of the wafer, sequentially, is known. A method in which the order of the chamfering and lapping steps is reversed to that of the above-described method, is also known, as described in "Semiconductor Material Basic Engineering" published by Nikkan Kogyo Newspaper Publishing Company on February 28, 1994. However, in the latter method, because the peripheral portion of the wafer remains edged when lapping, there are the danger of occurrence of the peripheral portion chipped off during lapping and further the danger of the main surface of the wafer being scratched by broken silicon pieces or the like. Therefore, the method comprising a lapping step after a chamfering step, such as the former, is recently on the main stream.

There is another method as a modified example of the former, in which the chamfering step comprises a first grinding step for grinding to round and chamfer the peripheral portion of the wafer by using a grinding stone having large grain size (e.g., 800) and a second grinding step for grinding the chamfered portion by using a grinding stone having small grain size (e.g., 1500) just after the first grinding step. According to the method, the smoothness of the chamfered portion is a little degraded in a following etching step. However, because the smoothness thereof after the etching step is better than the case using only a grinding stone having large grain size, it is possible to easily carry out the work in a following polishing step for the chamfered portion.

In an etching step which is carried out just after a lapping step, in a conventional method for processing a silicon single crystal wafer, the so-called acid etching, i.e., an etching in which the wafer was immersed in a liquid mixture of hydrofluoric acid, nitric acid and acetic acid, or the like, was carried out. However, because acid etching has defects that it is difficult to keep the flatness of the wafer after lapping and that high costs are required for processing the waste of the used etching liquid, recently, alkali etching, i.e., an etching in which the wafer was immersed in an aqueous solution of sodium hydroxide, an aqueous solution of potassium hydroxide or the like, has been mostly used, instead of acid etching. Because alkali etching is an anisotropy one and is different from acid etching which is an isotropic one, when alkali etching is utilized, in particular, the rear surface or the periphery of the wafer is roughened, so that the smoothness of the wafer is degraded. Therefore, a further processing for the rear surface or the chamfered portion of the wafer is required. Particularly, there is a problem that the processing for the latter chamfered portion after alkali etching requires much time for processing the surface to have a roughness less than a predetermined value, to obtain the target smoothness, which is several times that of acid etching. When an alkali etching is utilized, in the step of polishing the surfaces of the wafer, a method to improve the smoothness of the rear surface of the wafer, in which a wafer is set on a carrier and the front and rear surfaces of the wafer are simultaneously polished by polishing pads which are set on polishing turn tables arranged in upper and lower sides of the wafer, is also carried out. However, in such a polishing for the front and rear surfaces of the wafer, some problems, that is, the chamfered portion of the wafer is shaved by the inner wall of the carrier to make the sectional shape of the chamfered portion get out of shape, and thereby in a photo-lithography step in the following manufacturing process of semiconductor devices, resist material to be removed remains on the peripheral portion of the wafer, may be encountered. Therefore, these problems have contributed to the prevention of higher integration of semiconductor device.

The present invention was developed in view of the above-described problem. An object of the present invention is to provide a method for processing the chamfered portion of a wafer and a processing apparatus therefor, which can contribute to reduction of polishing time and to higher integration of semiconductor device.

Another object of the present invention is to provide a processing method for the peripheral chamfered portion of a wafer and a processing apparatus therefor, which can hone the peripheral chamfered portion uniformly.

In accordance with one aspect of the present invention, the method for processing a peripheral chamfered portion of a wafer, which comprises an orientation flat portion, a circumferential portion having an approximately constant radius and edge portions provided between the orientation flat portion and the circumferential portion, comprising: a first honing step for honing the orientation flat (hereinafter, which may be simply referred to "OF") portion of the wafer by relatively pressing the orientation flat portion against a cylindrical honing stone with a first pressing force F1, while rotating the wafer at a first rotational speed Ns1 and rotating the honing stone; a second honing step for honing the circumferential portion of the wafer by relatively pressing the circumferential portion against the cylindrical honing stone with a second pressing force F2, while rotating the wafer at a second rotational speed Ns2 and rotating the honing stone; a third honing step for honing the edge portions of the wafer by relatively pressing the edge portions against the cylindrical honing stone with a third pressing force F3, while rotating the wafer at a third rotational speed Ns3 and rotating the honing stone; and a polishing step for polishing the honed orientation flat portion, the honed circumferential portion and the honed edge portions; wherein the first, second and third rotational speeds Nsl, Ns2 and Ns3, of the wafer are different from one another.

According to such a processing method, it is possible to improve the smoothness of the surface of the chamfered portion of the wafer to some extent and to recover the deformed sectional shape of the chamfered portion to some extent, for a short time, by honing the chamfered portion. As the result, it is possible to reduce the burden on a following polishing step for the chamfered portion and to shorten the time required for the entire processing.

Because the rotational speeds Ns1, Ns2 and Ns3 of the wafer during the first, second and third honings for the orientation flat portion, a circumferential portion and edge portions, are suitably different from one another, it is possible to perform an approximately uniform honing treatment by the honing stone over the entirety of the peripheral chamfered portion.

Preferably, the rotational speeds Ns1, Ns2 and Ns3 of the wafer when the orientation flat portion, the circumferential portion and the edge portions, of the wafer are honed, respectively, are controlled to have the relationship of Nsl<Ns2<Ns3. The reason for this is as follows.

The processing (polishing, honing or the like) capability C for the peripheral chamfered portion of a wafer can be generally expressed by the following relational approximate expression:

$$C = a_1 pVbT$$

wherein a_1 is a constant (hereinafter, a_2, a_3 ... a_n are also constants), p is a contact pressure, Vb is a relative speed which is proportional to a rotational speed Nb of a buff or honing stone, and T is a contact time which is proportional to 1/Ns (Ns: a rotational speed of the wafer).

Accordingly,

$$C = a_2 pNb/Ns.$$

According to approximation to two circles contact of a circle of a wafer and a circle of a honing stone,

$$p = a_3\{F(1/R1 + 1/R2)\}^{1/2} \quad (1)$$

wherein F is a pressing force.

Accordingly,

$$C = a_4 Nb\{F(1/R1 + 1/R2)\}^{1/2}/Ns$$

When each of a_4, Nb, and F is constant,

$$C = a_5(1/R1 + 1/R2)^{1/2}/Ns$$

If we assume that the radius R1 of the honing stone is constant and the radius R2 of the wafer W varies, a constant honing capability C requires a large rotational speed of wafer when R2 is small, and requires a small rotational speed of wafer when R2 is large. That is, it is understood that it is possible to carry out a uniform honing over the entirety of the peripheral chamfered portion of the wafer W which includes an OF portion, a circumferential portion and edge portions, by changing the rotational speeds of the wafer during honings of the OF portion, the circumferential portion and edge portions, as shown in the TABLE 1.

TABLE 1:

	OF PORTION W1	CIRCUMFERENTIAL PORTION W2	EDGE PORTION W3
R2	LARGE(∞)	MIDDLE (r2)	SMALL (r3)
Ns	SMALL	MIDDLE	LARGE

In accordance with another aspect of the present invention, the method for processing a peripheral chamfered portion of a wafer which comprises an orientation flat portion, a circumferential portion having an approximately constant radius and edge portions provided between the orientation flat portion and the circumferential portion, comprising: a first honing step for honing the orientation flat portion of the wafer by relatively pressing the orientation flat portion against a cylindrical honing stone with a first pressing force F1, while rotating the wafer at a first rotational speed Ns1 and rotating the honing stone; a second honing step for honing the circumferential portion of the wafer by relatively pressing the circumferential portion against the cylindrical honing stone with a second pressing force F2, while rotating the wafer at a second rotational speed Ns2 and rotating the honing stone; a third honing step for honing the edge portions of the wafer by relatively pressing the edge portions against the cylindrical honing stone with a third pressing force F3, while rotating the wafer at a third rotational speed Ns3 and rotating the honing stone; and a polishing step for polishing the honed orientation flat portion, the honed circumferential portion and the honed edge portions; wherein the first, second and third pressing forces F1, F2 and F3 are different from one another.

According to such a processing method, it is possible to improve the smoothness of the surface of the chamfered portion of the wafer to some extent and to recover the deformed sectional shape of the chamfered portion to some extent, for a short time, by honing the chamfered portion. As the result, it is possible to reduce the serious burden on a following polishing step for the chamfered portion and to shorten the time required for the entire processing.

Because the pressing forces during honings for the orientation flat portion, a circumferential portion and edge portions are suitably different from one another, it is possible to perform an approximately uniform honing over the entirety of the peripheral chamfered portion by the honing stone.

Preferably, the pressing forces F1, F2 and F3 when an orientation flat portion, a circumferential portion and edge portions, of the wafer are honed, respectively, are controlled to have the relationship of F1>F2>F3.

If we assume that the radius R1 of the honing stone is constant and the radius R2 of the wafer (radius of curvature of each portion of the peripheral chamfered portion) varies, in the above equation (1), in order to obtain the same contact pressure p, i.e., a uniform honing, over the entirety of the peripheral chamfered portion, a large pressing force is required when 1/R2 is small, and a small pressing force is required when 1/R2 is large. That is, it is understood that it is possible to carry out a uniform honing over the entirety of the peripheral chamfered portion of the wafer W which includes an OF portion, a circumferential portion and edge portions, by having a relationship of F1>F2>F3 between the first, second and third pressing forces F1, F2 and F3 which are given between the wafer and the honing stone while the OF portion, a circumferential portion and edge portions are honed, respectively.

The first, second and third pressing forces F1, F2 and F3 may be determined to give an approximately constant contact pressure between the wafer and the honing stone while honing is performed over the entirety of the peripheral chamfered portion.

Preferably, the polishing step comprises: a first polishing step for polishing the orientation flat portion of the wafer by relatively pressing the orientation flat portion against a cylindrical buff with a first polishing pressing force Fp1, while rotating the wafer at a first polishing rotational speed Npl and rotating the buff; a second polishing step for polishing the circumferential portion of the wafer by relatively pressing the circumferential portion against the cylindrical buff with a second polishing pressing force Fp2, while rotating the wafer at a second polishing rotational speed Np2 and rotating the buff; and a third polishing step for polishing the edge portions of the wafer by relatively pressing the edge portions against the cylindrical buff with a third polishing pressing force Fp3, while rotating the wafer at a third polishing rotational speed Np3 and rotating the buff; wherein the first, second and third polishing rotational speeds Np1, Np2 and Np3, of the wafer are different from one another.

Because the rotational speeds Np1, Np2 and Np3 of the wafer during polishings for the OF portion, a circumferential portion and edge portions, are suitably different from one another, it is possible to perform an approximately uniform polishing by the buff over the entirety of the peripheral chamfered portion.

The rotational speeds Np1, Np2 and Np3 of the wafer when an OF portion, a circumferential portion and edge portions, of the wafer are polished, respectively, are preferably controlled to have the relationship of Np1<Np2<Np3. Accordingly, it is possible to obtain a uniform polishing by the buff over the entirety of the peripheral chamfered portion. The reason for this is like that of the above case of the rotational speeds Ns1, Ns2 and Ns3 of the wafer changed during honing.

Preferably, the polishing step comprises: a first polishing step for polishing the orientation flat portion of the wafer by relatively pressing the orientation flat portion against a cylindrical buff with a first polishing pressing force Fpl, while rotating the wafer at a first polishing rotational speed Np1 and rotating the buff; a second polishing step for polishing the circumferential portion of the wafer by relatively pressing the circumferential portion against the cylindrical buff with a second polishing pressing force Fp2, while rotating the wafer at a second polishing rotational speed Np2 and rotating the buff; and a third polishing step for polishing the edge portions of the wafer by relatively pressing the edge portions against the cylindrical buff with a third polishing pressing force Fp3, while rotating the wafer at a third polishing rotational speed Np3 and rotating the buff; wherein the first, second and third polishing pressing forces Fp1, Fp2 and Fp3 are different from one another.

Because the pressing forces Fp1, Fp2 and Fp3 during polishings for the orientation flat portion, a circumferential portion and edge portions, are suitably different from one another, it is possible to perform an approximately uniform polishing over the entirety of the peripheral chamfered portion by the buff.

The first, second and third polishing pressing forces Fp1, Fp2 and Fp3 may have a relationship of Fp1>Fp2>Fp3. The first, second and third polishing rotational speeds Np1, Np2 and Np3, of the wafer are preferably determined so that processing capabilities C for the orientation flat portion, a circumferential portion and edge portions, of the wafer are approximately equal to one another, under the following equation

$$C = a_5, (1/R1 + 1/R2)^{1/2}/Np,$$

wherein a_5, is a constant, R1 is a radius of the buff, R2 is a radius of curvature of the orientation flat portion, the circumferential portion or the edge portion, and Np is a rotational speed of the wafer for polishing.

In accordance with another aspect of the present invention, the wafer processing equipment for processing a peripheral chamfered portion of a wafer which comprises an orientation flat portion, a circumferential portion and edge portions provided between the orientation flat portion and the circumferential portion, comprises: a cylindrical rotatable honing stone for honing the orientation flat portion, a circumferential portion and edge portions, of the wafer; a wafer rotating member for supporting and rotating the wafer; a pressing member for relatively pressing the wafer supported on the wafer rotating member against the honing stone with a pressing force; a honing position detecting member for detecting a honing position of the wafer; and a rotational speed control member for changing a rotational speed of the wafer due to the wafer rotating member, on the basis of detected results by the honing position detecting member.

Such a wafer processing equipment can contribute to reduction of polishing time and to higher integration of semiconductor device.

In accordance with another aspect of the present invention, the wafer processing equipment for processing a peripheral chamfered portion of a wafer, comprises: a cylindrical rotatable honing stone for honing the orientation flat portion, a circumferential portion having an approximately constant radius, and edge portions, of the wafer; a wafer rotating member for supporting and rotating the wafer; a pressing member for relatively pressing the wafer supported on the wafer rotating member against the honing stone with a pressing force; a honing position detecting member for detecting a honing position of the wafer; and a pressing force control member for changing the pressing force due to the pressing member, on the basis of detected results by the honing position detecting member.

The wafer processing equipment having such a structure can contribute to reduction of polishing time and to higher integration of semiconductor device.

In the above wafer processing equipments, preferably, the honing position detecting member comprises a photosensor including a light emitting part and a light receiving part for receiving light emitted from the light emitting part, which is provided at a position at which the light emitted from the light emitting part is blocked by the circumferential portion of the wafer and is not blocked by the orientation flat portion.

The wafer processing equipment may further comprise: a cylindrical rotatable buff for polishing the orientation flat portion, the circumferential portion and the edge portions, of the wafer; a wafer polishing rotating member for supporting and rotating the wafer; a polishing pressing member for relatively pressing the wafer supported on the wafer polishing rotating member against the buff with a pressing force; a polishing position detecting member for detecting a polishing position of the wafer; and a polishing rotational speed control member for changing a rotational speed of the wafer due to the wafer polishing rotating member, on the basis of detected results by the polishing position detecting member.

According to the wafer processing equipment having such a structure, in addition to the above-described advantageous effects, an effect of uniform polishing over the entirety of the peripheral chamfered portion is also obtained.

The wafer processing equipment may further comprises: a cylindrical rotatable buff for polishing the orientation flat portion, the circumferential portion and the edge portions, of the wafer; a wafer polishing rotating member for supporting and rotating the wafer; a polishing pressing member for relatively pressing the wafer supported on the wafer polishing rotating member against the buff with a pressing force; a polishing position detecting member for detecting a polishing position of the wafer; and a polishing pressing force control member for changing the pressing force due to the polishing pressing member, on the basis of detected results by the polishing position detecting member.

According to the wafer processing equipment having such a structure, in addition to the above-described advantageous effects, an effect of uniform polishing over the entirety of the peripheral chamfered portion is also obtained.

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not intended as a definition of the limits of the present invention, and wherein;

FIG. 1 is a plan view showing an example of a wafer to which the present invention is applied,

FIG. 2 is a block diagram showing steps of the processing method according to an embodiment of the present

invention,
FIG. 3 is a schematic plan view of the processing apparatus according to the embodiment of the present invention,
FIG. 4 is a side view showing an example of a loader used for the embodiment,
FIG. 5 is a perspective view showing an example of a transfer device used for the embodiment,
FIG. 6 is a schematic view showing the whole construction of an embodiment of the chamfered portion honing device in the present invention,
FIG. 7 is a side view from an arrow Z of FIG. 6,
FIG. 8 is a block diagram showing an embodiment of the control device for controlling a stepping motor in the present invention,
FIGS. 9A and 9B are for explaining the change of the honing state of a wafer with time, and FIG. 9A is a plan viewof a rotating wafer and FIG. 9B is a graph showing the relationship between the wafer rotation angle θ and the wafer rotation speed Ns,
FIG. 10 is a schematic view showing the whole construction of another embodiment of the chamfered portion honing device in the present invention,
FIG. 11 is a side view of a part of the chamfered portion honing device shown in FIG. 10,
FIG. 12 is another side view of a part of the chamfered portion honing device shown in FIG. 10,
FIG. 13 is a graph showing an example of the pressing forces to give an approximately uniform contact pressure between the wafer and the honing stone, over the entirety of the peripheral chamfered portion, and
FIG. 14 is a side view showing an example of an unloader used for the embodiment.

FIG. 2 shows an embodiment of the wafer processing method of the invention. As shown in this Figure, the wafer processing method according to the embodiment comprises a chamfering step, a lapping step, an etching step, a double side polishing step, a chamfered portion honing and polishing step, and a front surface polishing step, which are sequentially performed.

(1) Chamfering step

The peripheral portion of a wafer which was obtained by slicing an ingot by using an inner diameter saw slicing machine or a wire saw slicing machine, is ground to round by using a grinding stone while supplying a grinding fluid. The reason for this is that if the peripheral portion of the wafer remains edged, there are the danger of occurrence of the peripheral portion chipped off during processing or occurrence of Si chips, and such dangers can contribute to the poor performance of an integrated circuit. The grain size of the grinding stone used for the chamfering step is not limited, however, is preferably about 300 to 800. The bond for the grinding stone in this case is not particularly limited, however, a metal bond is preferably used.

(2) Lapping step

One or both of the front and rear surfaces of the wafer for which the chamfering step was completed, are lapped by using a slurry containing abrasive grain, e.g., silica (SiO_2), zirconia (ZrO_2), alumina (Al_2O_3) or the like, and an additive such as a fatty acid salt or the like, under a pressure. Although thickness and degree of parallelization of a wafer are determined by slicing the ingot by using the inner diameter saw or the wire saw slicing machine, there are some variations necessarily in practice. This lapping step is for compensating such variations.

(3) Etching step

An etching for the surfaces of the wafer is carried out by immersing the wafer in an aqueous solution of sodium hydroxide, of potassium hydroxide or the like. On the surfaces of the obtained wafer to which the lapping step was performed, a damaged layer (a cracked and roughened portions) or contaminated portions (portions into which abrasive grains stick) exist. This etching step is for removing those portions. In order to accomplish the purpose, not only such an alkali etching but also an acid etching can be used. Preferably, an alkali etching is used to easily keep the flatness of the wafer after lapping and to reduce the cost for processing the waste of the used etchant.

(4) Double side polishing step

The wafer is set on a carrier and the front and rear surfaces of the wafer are simultaneously polished by polishing pads which are set on polishing turn tables arranged in upper and lower sides of the wafer, while supplying a polishing fluid. The double side polishing step is for improving the flatness of the wafer extremely and for improving the smoothness of the rear surface to prevent occurrence of Si chips. When an alkali etching was used in the preceding step, the double side polishing step is preferably carried out. On the contrary, when an acid etching was used in the preceding step, the double side polishing step is not essential.

(5) Chamfered portion honing and polishing step

Honing, that is, processing to grind the entirety of the peripheral chamfered portion of the wafer by a honing stone while controlling application of a predetermined load to the honing stone and supplying a grinding fluid, is carried out. This step is for compensating the deformation in a sectional shape of the peripheral chamfered portion of the wafer, which was generated in the preceding step, that is, for improving the smoothness and for recovering the sectional shape of the chamfered portion to some extent, which were damaged by the preceding lapping, etching, and double side polishing steps. The bond for the honing stone in this case is not particularly limited, however, a vitrified bond of ceramic raw material system, a metal bond, a resin bond, a metal-resin mixture bond, gum or the like is preferably used. Accordingly, it is possible to improve not only the smoothness of the surfaces but the ability to recover the sectional shape of the chamfered portion which was got out of shape in previous lapping and etching steps. Thereafter, the entirety of the peripheral chamfered portion of the wafer is polished by a buff or the like while supplying a polishing fluid. This step is for removing residual damage in the just surface layer due to the honing, for preventing generation of chips or fine particles of silicon in the middle of following step for manufacturing a device by smoothness, and for solving the problem that resist material to be removed remains on the peripheral portion of the wafer, in a photolithography step.

(6) Front surface polishing step

The front surface of the wafer is polished by a polishing pad while supplying a polishing fluid.

Next, an embodiment of a chamfered portion processing equipment used for the above-described method of the invention will be explained.

In this embodiment, a processing equipment for honing and polishing the chamfered portion of the wafer is shown in FIG. 3. The processing equipment 1 comprises a chamfered portion honing apparatus 2 and a chamfered portion polishing apparatus 3. The processing equipment 1 can carry out honing and polishing, continuously, for the peripheral chamfered portion of a wafer W, having an OF portion, as shown in FIG. 1.

The chamfered portion honing apparatus 2 comprises a cassette attachment part (A) for attaching a cassette 4 which contains a plurality of wafers W, a positioning part (B) for centering the wafer W taken out of the cassette 4 and for positioning the OF of the wafer W, and a chamfered portion honing part (C) for honing the peripheral chamfered portion of the wafer W. The chamfered portion polishing apparatus 3 comprises a chamfered portion polishing part (D) for polishing the peripheral chamfered portion of the wafer W, a wafer cleaning part (E), and a cassette attachment part (F) for attaching a cassette 4 to contain wafers W. In the processing apparatus 1, the cassette attachment part (A) has a loader 20, the positioning part (B) has a positioning device which is not shown, the chamfered portion honing part (C) has a chamfered portion honing device 21, the chamfered portion polishing part (D) has a chamfered portion polishing device 31, the wafer cleaning part (E) has a cleaning device which is not shown, and the cassette attachment part (F) has an unloader 30. In the processing equipment 1, a transfer device 40 is provided, as shown in FIG. 5. The transfer device 40 is for transferring the wafer W which was transferred to the positioning part (B) by the loader 20 and was positioned there, to the chamfered portion honing part (C), the chamfered portion polishing part (D), and the wafer cleaning part (E).

The loader 20 comprises a lifting device which is not shown, for lifting up or down the cassette 4 which can hold a plurality of wafers W therein, one over another, and a belt conveyor 20a for taking the wafer W out of the cassette 4 one by one, as shown in FIG. 4. The loader 20 has a structure in which the wafer W at the bottom position is taken out of the cassette 4 by the belt conveyor 20a in turn and is sent to the positioning part (B).

The transfer device 40 is provided with an arm 40a, as shown in FIG. 5, which can be reciprocally moved toward the arrangement of the positioning part (B), the chamfered portion honing part (C), the chamfered portion polishing part (D), and the wafer cleaning part (E). On the lower side of the top end of the arm 40a, a vacuum chuck 40b is provided. The vacuum chuck 40b is communicated with a vacuum pump which is not shown, through an air pipe (not shown), so that a wafer W can be held on the lower surface of the vacuum chuck 40b by vacuum suction. The vacuum chuck 40b can be moved up and down by a lifting device which is not shown.

The chamfered portion honing device 21 comprises a cylindrical honing stone 21a having a formed chamfering groove on the periphery thereof, as shown in FIGS. 3, 6 and 7. In the chamfered portion honing device 21, the honing stone 21a can be rotated by a motor 21b. Honing for the chamfered portion of the wafer W is carried out by pressing the chamfered portion of the wafer W against the formed chamfering groove of the honing stone 21a while rotating the wafer W slowly. In the chamfered portion honing device 21, the wafer W can come near or separate from the honing stone 21a in order to carry out honing. During the honing, the chamfered portion of the wafer W is pressed against the honing stone 21a with a predetermined load.

That is, the honing device 21 is provided with a pneumatic cylinder 21d which is operated by working air from a switching valve 21e. An end of a piston rod 21f of the cylinder 21d is in contact with a side surface of an arm 21h to press it, which can be reciprocally swung around a shaft 21g. As a result, by protrusion of the piston rod 21f, the arm 21h is rotated around the shaft 21g in the Y-direction shown in FIG. 7 to generate a pressing force F between the honing stone 21a and the wafer W.

In FIGS. 6 and 7, the reference numeral 21i denotes a vacuum chuck for holding the wafer W thereon by vacuum suction, which is mounted to a wafer rotational shaft 21j. In the vicinity of the wafer rotational shaft 21j, a wafer rotational speed detector 21k is provided. The wafer rotational speed detector 21k is for detecting the rotational speed Ns of the wafer rotational shaft 21j, that is, the rotational speed of a stepping motor 21c. In the vicinity of the honing stone rotational shaft 211, a honing stone rotational speed detector 21m for detecting the rotational speed of the honing stone rotational shaft 211 is provided.

The reference numeral 23 denotes a wafer honing position detector which comprises a photosensor having a light emitting part 23a and a light receiving part 23b, for detecting the OF portion, the circumferential portion and the edge portions, of the wafer W. The wafer honing position detector is arranged at a position at which the light emitted from the light emitting part 23a is blocked by the circumferential portion W2 of the wafer but is not blocked by the OF portion W1. Therefore, the photosensor detects the circumferential portion W2 being at the honing position by the light from the light emitting part 23a not to reach the light receiving part 23b because of interception by the circumferential portion W2 when the circumferential portion W2 is passing at the photosensor. When the OF portion W1 of the wafer is passing near the photosensor, the photosensor detects the OF portion W1 being at the honing position by the light from the light emitting part 2 3a to reach the light receiving part 23b. Detection of the edge portions W3 can be performed by detecting the change from the light interception state to the light receiving state and vice versa.

The reference numeral 21o denotes a pressing force detector for detecting the working air pressure in the cylinder 21d, that is, the pressing force F between the honing stone 21a and the wafer W. The reference numeral 22 denotes a control device. To the control device 22, data of the current working air pressure in the cylinder 21d, relating to the pressing force F between the honing stone 21a and the wafer W, from the pressing force detector 21o, data of the rotational speed Nb of the honing stone 21a from the honing stone rotational speed detector 21m, data of the rotational speed of the stepping motor 21c, that is, the rotational speed Ns of the wafer, from the wafer rotational speed detector 21k, data of the honed position of the wafer W from the wafer honing position detector 23 are input. On the basis of the input data, the control device 22 performs an operation of the optimum rotational speed of the stepping motor 21c and outputs the result to the stepping motor 21c.

Next, the wafer rotational speed control means in the invention will be explained, as follows.

FIG. 8 is a block diagram of the control device 22 which comprises a honing position judgement device 22a, a wafer rotational speed setting device 22b, a rotational speed comparator 22c, and a wafer rotational speed computing unit 22d.

The wafer rotational speed setting device 22b is for setting the wafer reference rotational speed No (the rotational speed of the wafer periphery), on the basis of the pressing force F between the wafer W and the honing stone 21a, which was detected by the pressing force detector 21o, and the honing stone rotational speed Nb which was detected by the honing stone rotational speed detector 21m.

The rotational speed comparator 22c is for calculating the deviation AN between the wafer reference rotational speed No and the detected rotational speed Nw of the wafer W. The wafer honing position judgement device 22a is for calculating the honing position on the basis of the detected signal Xw input from the wafer honing position detector 23, for discriminating the honing position between the OF portion, the circumferential portion, and the edge portions, and for transmitting the judgement signal (corresponding to the OF portion, the circumferential portion, or the edge portions) on the basis of the honing position to the wafer rotational speed computing unit 22d.

The wafer rotational speed computing unit 22d contains a memory 22e in which predetermined correction values are stored in advance. In the wafer rotational speed computing unit 22d, a correction value Sw is taken out of the memory according to the judgement signal (corresponding to the OF portion Swl, the circumferential portion Sw2, or the edge portions Sw3), and the corrected rotational speed Ns is calculated, for example, in accordance with the following equation and is output to the stepping motor 21c.

$$Ns = No(1 + Sw) \qquad (2)$$

Sw:Sw1 = -0.3, Sw2 = 0, Sw3 = +0.7

Next, operation of the honing apparatus 2 for the chamfered portion of a wafer will be explained, as follows.

In the pressing force detector 21o, the working air pressure Pa in the pneumatic cylinder 21d is detected and converted to a pressing force F between the wafer W and the honing stone 21a, taking into account the arm ratio of the arm 21h (the ratio of the distances between the shaft 21g and the lines of action), the sectional area of the pneumatic cylinder 21d, and the like, and the data thereof is input to the wafer rotational speed setting device 22b.

The wafer reference rotational speed No which is used as a reference in the equation (2) is expressed, as follows.

$$No = a_6 Nb F^{1/2} / C \qquad (3)$$

In the wafer rotational speed setting device 22b, a wafer reference rotational speed No which corresponds to the pressing force F and the honing stone rotational speed Nb, input thereto is calculated and input to the rotational speed comparator 22c.

In the rotational speed comparator 22c, the ratio of the deviation AN between the wafer reference rotational speed No and the detected wafer rotational speed Nw which is input from the wafer rotational speed detector 21k, to (No - Nw) is calculated and input to the wafer rotational speed computing unit 22d.

The wafer position data Xw is input to the wafer rotational speed computing unit 22d through the wafer honing position judgement device 22a.

In the wafer rotational speed computing unit 22d, a correction value is taken out of the memory 22e on the basis of the judgement signal for the OF portion Swl, the circumferential portion Sw2, or the edge portion Sw3; and the corrected wafer rotational speed Ns is calculated in accordance with the equation (2), i.e., Ns = No(1 + Sw) in which the taken correction value Sw is applied.

In this case, for example, when the correction value Sw are set so that Sw1 = -0.3, Sw2 = 0, and Sw3 = +0.7, the wafer rotational speed Ns1 comes to be 0.7 No when the detected signal for the wafer position (honing position) is one of the OF portion W1, the wafer rotational speed Ns2 comes to be No when the detected signal is one of the circumferential portion W2, and the wafer rotational speed Ns3 comes to be the maximum, i.e., 1.7 No when the detected signal is one of the edge portion W3.

By such a correction, a wafer rotational speed signal corresponding to the wafer rotational speed Ns shown in FIG. 9B is output from the wafer rotational speed computing unit 22d to the stepping motor 21c. FIG. 9B shows the wafer rotation speed Ns when the wafer W is rotated through a certain angle θ from the state shown in FIG. 9A. As the result, the stepping motor 21c is operated with rotational speeds Ns.

FIG. 10 shows another embodiment of the chamfered portion honing apparatus 2.

In this Figure, the reference numeral 24a denotes an arm which is rotatable around a supporting shaft 24b provided at an intermediate position of the arm 24a. At an end of the arm 24a, a honing stone 24c having a cylindrical shape is supported to rotate around a rotational shaft 24d. Over the circumferential surface of the honing stone 24c, a formed chamfering groove is formed.

At an upper end of the rotational shaft 24d which projects upwardly from the arm 24a, as shown in FIGS. 11 and 12, a pulley 24e is mounted. On the other hand, on the upper surface of the arm 24a near the other end thereof, a motor 24f is fixed. A belt 24h is wound around a pulley 24g which is fixed to the output shaft of the motor 24f, and around the pulley 24e.

A pneumatic cylinder 24i for pressing the arm 24a is provided near a side surface of the other end of the arm 24a. The interior of a cylinder 24j of the pneumatic cylinder 24i is divided into chambers S1 and S2 by a piston 24k. The top end of a rod 241 connected to the piston 24k is in contact with the side surface of the arm 24a, as shown in FIGS. 10 and 11.

In the vicinity of the honing stone 24c, a vacuum chuck 24m is arranged so as to rotate horizontally. The wafer W is chucked to be held on the upper surface of the vacuum chuck 24m by vacuum suction. The vacuum chuck 24m is rotated by a driving member which is not shown.

In the vicinity of the vacuum chuck 24m, a wafer honing position detector 25 for detecting the OF portion W1 of the wafer is disposed. The wafer honing position detector 25 comprises a photosensor comprising a light emitting part 25a and a light receiving part 25b. The wafer honing position detector 25 is arranged at a position at which the light emitted from the light emitting part 25a is blocked by the circumferential portion W2 of the wafer but is not blocked by the OF portion W1. When the light from the light emitting part 25a reaches the light receiving part 25b, the received light is transformed into the voltage having a value proportional to the intensity thereof. That is, when the circumferential portion W2 of the wafer is passing between the light emitting part 25a and the light receiving part 25b, of the photosensor, although the light from the light emitting part 25a does not reach the light receiving part 25b because of interception by the circumferential portion W2, when the OF portion W1 of the wafer is passing between the light emitting part 25a and a light receiving part 25b, the light from the light emitting part 25a reaches the light receiving part 25b, so that the photosensor can detect the OF portion W1 by light reception due to the light receiving part 25b. The detected signal from the photosensor is input into the controller (CPU) 26. In the controller 26, the central position of the OF portion W1 of the wafer W is found on the basis of the peak of the input voltage value from the photosensor. When the central position of the OF portion W1 is found, not only the OF portion W1 but also the circumferential portion W2 and the edge portions W3 can be found because the dimension of the OF portion W1 is known.

The honing apparatus 2 has a control member for switching the supplying pressure to the pneumatic cylinder 24i into three steps, i.e., P1, P2 and P3 (P2>P1>P3), on the basis of the detected results of the photosensor.

The control member comprises a pneumatic pressure control circuit 27 and the controller 26, as shown in FIG. 10.

The construction of the pneumatic pressure control circuit 27 will be explained in reference to FIG. 10, as follows.

In the pneumatic pressure control circuit 27 shown in the Figure, the reference character Lo denotes an original pressure line which is connected to a high pressure supply source (not shown) such as an air compressor or the like. To the original pressure line Lo, pressure control valves V1, V2 and V3 and electromagnetic valves MV1, MV2 and MV3 are connected in parallel, respectively.

The pressure control valves V1, V2 and V3 are for reducing the original pressure Po supplied fromthe original pressure line Lo to P1, P2 and P3 (P2>P1>P3), respectively. Each of the electromagnetic valves MV1, MV2 and MV3 can be switched to have the position "a", "b" or "c" which is shown in FIG. 10, by the controller 26. When the position is switched to "a", the compressed air which was reduced to P1, P2 or P3 is supplied to the chamber S2 of the pneumatic cylinder 24i through a reduced pressure line L1, L2 or L3, respectively. When the position is switched to "b" (the neutral position), the air in the chamber S2 of the pneumatic cylinder 24i is discharged into the atmosphere.

The chamber S1 of the pneumatic cylinder 24i is connected to an electromagnetic valve MV4 through a reduced pressure line L4. The electromagnetic valve MV4 can be also switched to have the position "a" or "b" which is shown in this Figure, by the controller 26. When the position in the electromagnetic valve MV4 is switched to "a", the pressure Po supplied from the original pressure line Lo is supplied to the chamber S1 of the pneumatic cylinder 24i, and when the position is switched to "b", the air in the chamber S1 of the pneumatic cylinder 24i is discharged into the atmosphere.

In the honing apparatus 2, the strength of the pressing forces F1, F2 and F3 for pressing the arm 1 during honing steps for the OF portion W1, the circumferential portion W2 and the edge portions W3, of the wafer W, respectively, can be set according to the radius r1 (=∞) of curvature of the OF portion W1, that r2 of the circumferential portion W2 and that r3 of the edge portions W3, so that F1>F2>F3, and the values σ1, σ2 and σ3 of respective contact pressures are approximately equal to one another, as shown in FIG. 13. As a result, it is possible to prevent generation of excessive contact pressure at a specific point of the wafer, in particular, at the edge portions W3, and thereby to effectively prevent the wafer W from cutting into the honing stone 21a.

For example, in the case of honing the chamfered portion of a wafer W having a diameter of 8 inches using a honing stone 24c having a radius of 150 mm, to have the radius r1 of curvature of the OF portion W1 being an infinity (r1=∞), the radius r2 of the circumferential portion W2 being 100 mm and the radius r3 of the edge portions W3 being 5 mm, it is possible to make the contact pressure values σ1, σ2 and σ3, of the OF portion W1, the circumferential portion W2 and the edge portions W3, of the wafer W, respectively, approximately equal to one another ($\sigma1 \approx \sigma2 \approx \sigma3$), by setting the ratio F1:F2:F3 of the strength of the pressing forces F1, F2 and F3 for pressing the arm 1 during honing steps for the OF portion W1, the circumferential portion W2 and the edge portions W3, of the wafer W, respectively, to 30:13:1.

As the chamfered portion polishing device 31, a device shown in FIGS. 6, 7 and 10-12 in which a cylindrical buff having a formed chamfering groove in the periphery thereof can be substituted for the honing stone 21a or 24c in the chamfered portion honing device 21 can be used. The function and the effects are approximately the same as those of the honing device 21.

That is, the wafer to the peripheral chamfered portion of which a uniform honing treatment was performed is transferred to the chamfered portion polishing device 31 which is like the device shown in FIG. 6 or 10, in order to take a uniform polishing treatment for the peripheral chamfered portion.

In the chamfered portion polishing device 31, the honed OF portion of the wafer is polished by relatively pressing against the formed chamfering groove of the cylindrical buff with first polishing pressing force Fp1, while rotating the wafer at a first polishing rotational speed Np1 and rotating the buff; the honed circumferential portion is polished by relatively pressing the circumferential portion against the buff with a second polishing pressing force Fp2, while rotating the wafer at a second polishing rotational speed Np2 and rotating the buff; and each of the honed edge portions is polished by relatively pressing the portion against the buff with a third polishing pressing force Fp3, while rotating the wafer at a third polishing rotational speed Np3 and rotating the buff, in order. For example, the first, second and third polishing pressing forces Fp1, Fp2 and Fp3 are set to be approximately equal to one another, and the first, second and third polishing rotational speeds Np1, Np2 and Np3, of the wafer is set to have the relationship of Np1<Np2<Np3. Accordingly, it is possible to perform an approximately uniform polishing over the entirety of the peripheral chamfered portion by the buff.

In order to perform an approximately uniform polishing, the first, second and third polishing pressing forces Fp1, Fp2 and Fp3 may have the relationship of Fp1>Fp2>Fp3 by the same reason in the case of honing for the chamfered portion. For example, in the case of polishing the chamfered portion of the wafer W having a diameter of 8 inches and having the radius r1 of curvature of the OF portion W1 being an infinity (r1=∞), the radius r2 of the circumferential portion W2 being 100 mm and the radius r3 of the edge portions W3 being 5 mm, by using a buff having a radius of 150 mm, it is possible to make the contact pressure values $\sigma1$, $\sigma2$ and $\sigma3$, of the OF portion W1, the circumferential portion W2 and the edge portions W3, of the wafer W, respectively, approximately equal to one another ($\sigma1 \approx \sigma2 \approx \sigma3$), by setting the ratio Fp1:Fp2:Fp3 of the strength of the pressing forces Fp1, Fp2 and Fp3 for pressing the arm 1 during polishing steps for the OF portion W1, the circumferential portion W2 and the edge portions W3, of the wafer W, respectively, to 30:13:1.

Furthermore, the first, second and third polishing rotational speeds Np1, Np2 and Np3, of the wafer can be also set so that processing capabilities C by the buff for the orientation flat portion, a circumferential portion and edge portions, of the wafer are approximately equal to one another, under the following equation

$$C = a_{5},(1/R1 + 1/R2)^{1/2}/Np,$$

wherein a_{5}, is a constant, R1 is a radius of the buff, R2 is a radius of curvature of the orientation flat portion, the circumferential portion or the edge portion, and Np is a rotational speed of the wafer for polishing.

The unloader 30 comprises a lifting device which is not shown, for lifting up or down the cassette 4 which can hold a plurality of wafers W therein, one over another, and a belt conveyor 31a for putting wafers W into the cassette 4 one by one, as shown in FIG. 14. The unloader 30 has a construction in which the wafers W can be put into the cassette 4 one by one by the belt conveyor 31a and lifted up step by step.

According to the embodiments of the method for processing a wafer or the processing equipment, because the peripheral chamfered portion is honed prior to polishing the peripheral chamfered portion, it is possible to extremely shorten the time required for processing the surface of the chamfered portion to have a roughness less than a predetermined value in the step of polishing the peripheral chamfered portion, to obtain the target smoothness, and also to set right the sectional shape of the chamfered portion which was got out of shape in a previous step. For example, according to the embodiment, the time required for obtaining a surface of the chamfered portion to have a roughness of about 50 nm in terms of P-V value was only about 20% of that of a method having no honing step.

According to the embodiment of the invention, it is possible to carry out uniform polishing over the whole chamfered portion of the wafer W including the OF portion W1, the circumferential portion W2 and the edge portions W3, and to secure the optimum polishing precision and thereby to improve productivity thereof.

In the above peripheral chamfered portion processing equipment according to the above embodiments, a honing stone or a buff is pressed against a wafer W. However, it is possible to adopt a construction in which a wafer W is pressed against a honing stone or a buff, conversely.

According to the invention, it is possible to extremely shorten the time required for processing the surface of the chamfered portion to have a roughness less than a predetermined value in the step of polishing the peripheral chamfered portion, to obtain the target smoothness, and also to set right the sectional shape of the chamfered portion which was got out of shape in a previous step.

Further, it is possible to carry out uniform polishing over the whole chamfered portion of the wafer including the OF portion, the circumferential portion and the edge portions, and to secure the optimum polishing precision and thereby to improve productivity thereof.

Claims

1. A method for processing a peripheral chamfered portion of a wafer, which comprises an orientation flat portion, a circumferential portion having an approximately constant radius and edge portions provided between the orientation flat portion and the circumferential portion, comprising:

    a first honing step for honing the orientation flat portion of the wafer by relatively pressing the orientation flat portion against a cylindrical honing stone with a first pressing force F1, while rotating the wafer at a first rotational speed Nsl and rotating the honing stone;
    a second honing step for honing the circumferential portion of the wafer by relatively pressing the circumferential portion against the cylindrical honing stone with a second pressing force F2, while rotating the wafer at a second rotational speed Ns2 and rotating the honing stone;
    a third honing step for honing the edge portions of the wafer by relatively pressing the edge portions against the cylindrical honing stone with a third pressing force F3, while rotating the wafer at a third rotational speed Ns3 and rotating the honing stone; and
    a polishing step for polishing the honed orientation flat portion, the honed circumferential portion and the honed edge portions;

wherein the first, second and third rotational speeds Ns1, Ns2 and Ns3, of the wafer and/or the first, second and third pressing forces F1, F2, F3 are different from one another.

2. A method as claimed in claim 1; wherein the first, second and third pressing forces F1, F2 and F3 are approximately equal to one another , and the first, second and third rotational speeds Ns1, Ns2 and Ns3 have a relationship of $Ns1<Ns2<Ns3$.

3. A method as claimed in claim 1 or 2; wherein the first, second and third rotational speeds Ns1, Ns2 and Ns3 are determined so that the processing capabilities C for the orientation flat portion, a circumferential portion and edge portions, of the wafer are approximately equal to one another, under the following equation.

$$C = a_5(1/R1 + 1/R2)^{½}/Ns,$$

wherein a_5 is a constant, R1 is a radius of the honing stone, R2 is a radius of curvature of the orientation flat portion, the circumferential portion or the edge portion, and Ns is a rotational speed of the wafer for honing.

4. A method as claimed in claim 1; wherein the first, second and third pressing forces F1, F2 and F3 have a relationship of $F1>F2>F3>$.

5. A method as claimed in claim 1 or 4; wherein the first, second and third pressing forces F1, F2 and F3 are determined so that contact pressures p between one orientation flat portion and the honing stone, between the circumferential portion and the honing stone and between the edge portion and the honing stone are approximately equal to one another.

6. A method as claimed in any preceding claim; wherein the polishing step comprises:

a first polishing step for polishing the orientation flat portion of the wafer by relatively pressing the orientation flat portion against a cylindrical buff with a first polishing pressing force Fp1, while rotating the wafer at a first polishing rotational speed Np1 and rotating the buff;
a second polishing step for polishing the circumferential portion of the wafer by relatively pressing the circumferential portion against the cylindrical buff with a second polishing pressing force Fp2, while rotating the wafer at a second polishing rotational speed Np2 and rotating the buff; and
a third polishing step for polishing the edge portions of the wafer by relatively pressing the edge portions against the cylindrical buff with a third polishing pressing force Fp3, while rotating the wafer at a third polishing rotational speed Np3 and rotating the buff;

wherein the first, second and third polishing rotational speeds Np1, Np2 and Np3, of the wafer and/or the first, second and third polishing pressing forces Fp1, Fp2, Fp3 are different from one another.

7. A method as claimed in claim 6; wherein the first, second and third polishing rotational speeds Np1, Np2 and Np3, of the wafer are determined so that processing capabilities C by the buff for the orientation flat portion, a circumferential portion and edge portions, of the wafer are approximately equal to one another, under the following equation

$$C = a_5,(1/R1 + 1/R2)^{½}/Np,$$

wherein a_5, is a constant, R1 is a radius of the buff, R2 is a radius of curvature of the orientation flat portion, the circumferential portion or the edge portion, and Np is a rotational speed of the wafer for polishing.

8. A method as claimed in claim 6 or 7; wherein the first, second and third polishing pressing forces Fp1, Fp2 and Fp3 are determined so that contact pressures p between the orientation flat portion and the buff, between the circumferential portion and the buff and between the edge portion and the buff are approximately equal to one another.

9. A wafer processing equipment for processing a peripheral chamfered portion of a wafer, which comprises an orientation flat portion , a circumferential portion having an approximately constant radius and edge portions provided between the orientation flat portion and the circumferential portion, comprising:

a cylindrical rotatable honing stone for honing the orientation flat portion, a circumferential portion and edge portions, of the wafer;
a wafer rotating member for supporting and rotating the wafer;
a pressing member for relatively pressing the wafer supported on the wafer rotating member against the honing stone with a pressing force;
a honing position detecting member for detecting a honing position of the wafer; and
a rotational speed control member for changing a rotational speed of the wafer due to the wafer rotating member, or a pressing force control member for changing the pressing force due to the pressing member, on the basis of detected results by the honing position detecting member.

10. A wafer processing equipment as claimed in claim 9, further comprising:

a cylindrical rotatable buff for polishing the orientation flat portion, a circumferential portion and edge portions, of the wafer;
a wafer polishing rotating member for supporting and rotating the wafer;
a polishing pressing member for relatively pressing the wafer supported on the wafer polishing rotating member against the buff with a pressing force;
a polishing position detecting member for detecting a polishing position of the wafer; and
a polishing rotational speed control member for changing a rotational speed of the wafer or a polishing pressing force control member for changing the pressing force, on the basis of detected results by the polishing position detecting member.

11. A wafer processing equipment as claimed in claim 9 or 10; wherein the honing position detecting member and/or the polishing position detecting member comprises a photosensor including a light emitting part and a light receiving part for receiving light emitted from the light emitting part, which is provided at a position at which the light emitted from the light emitting part is blocked by the circumferential portion of the wafer and is not blocked by the orientation flat portion.

FIG.1

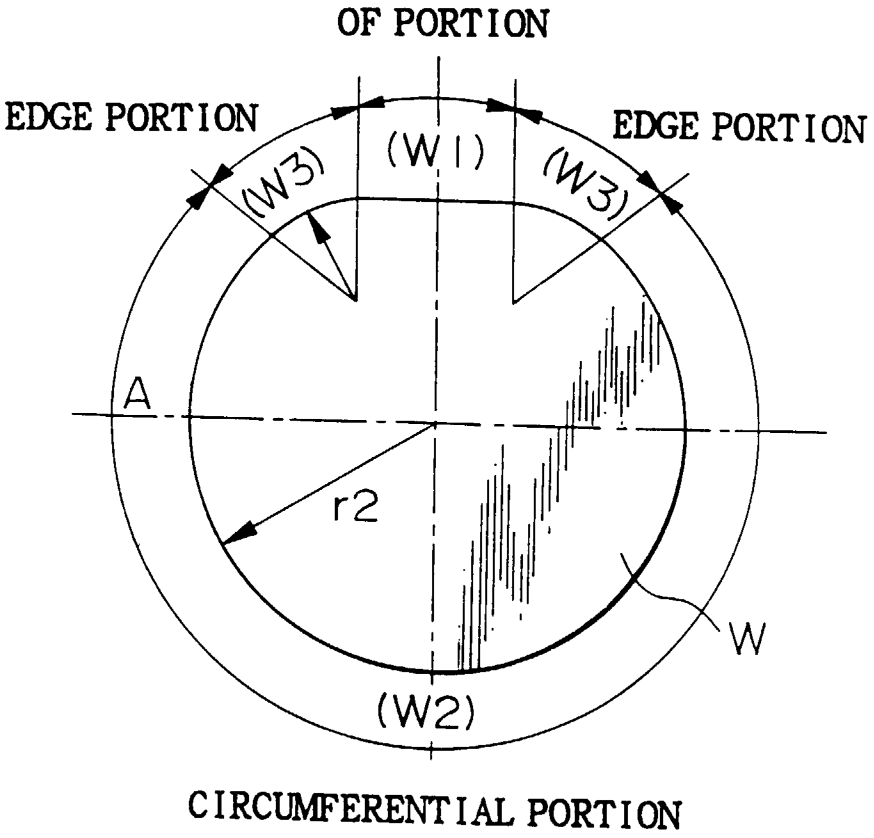

OF PORTION
EDGE PORTION
EDGE PORTION
(W1)
(W3)
(W3)
A
r2
W
(W2)
CIRCUMFERENTIAL PORTION

FIG.2

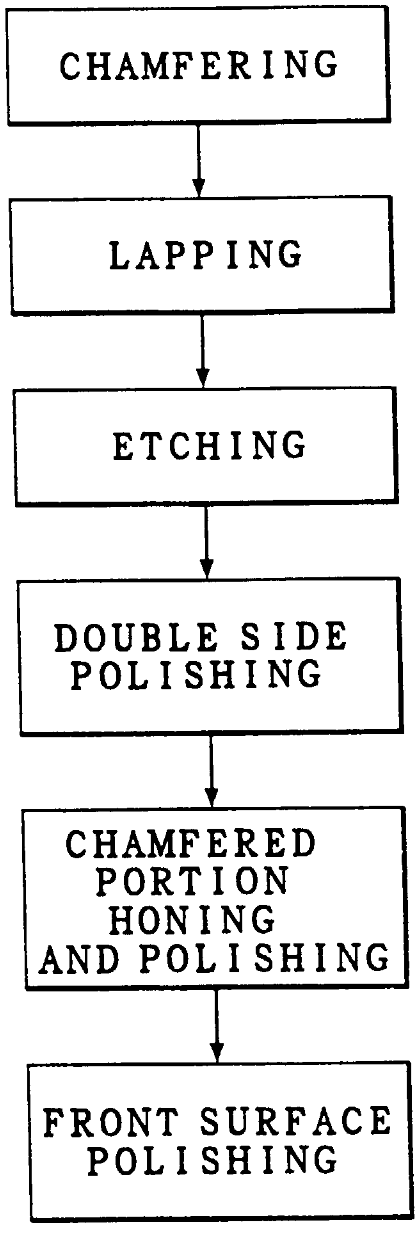

CHAMFERING
LAPPING
ETCHING
DOUBLE SIDE POLISHING
CHAMFERED PORTION HONING AND POLISHING
FRONT SURFACE POLISHING

FIG.3

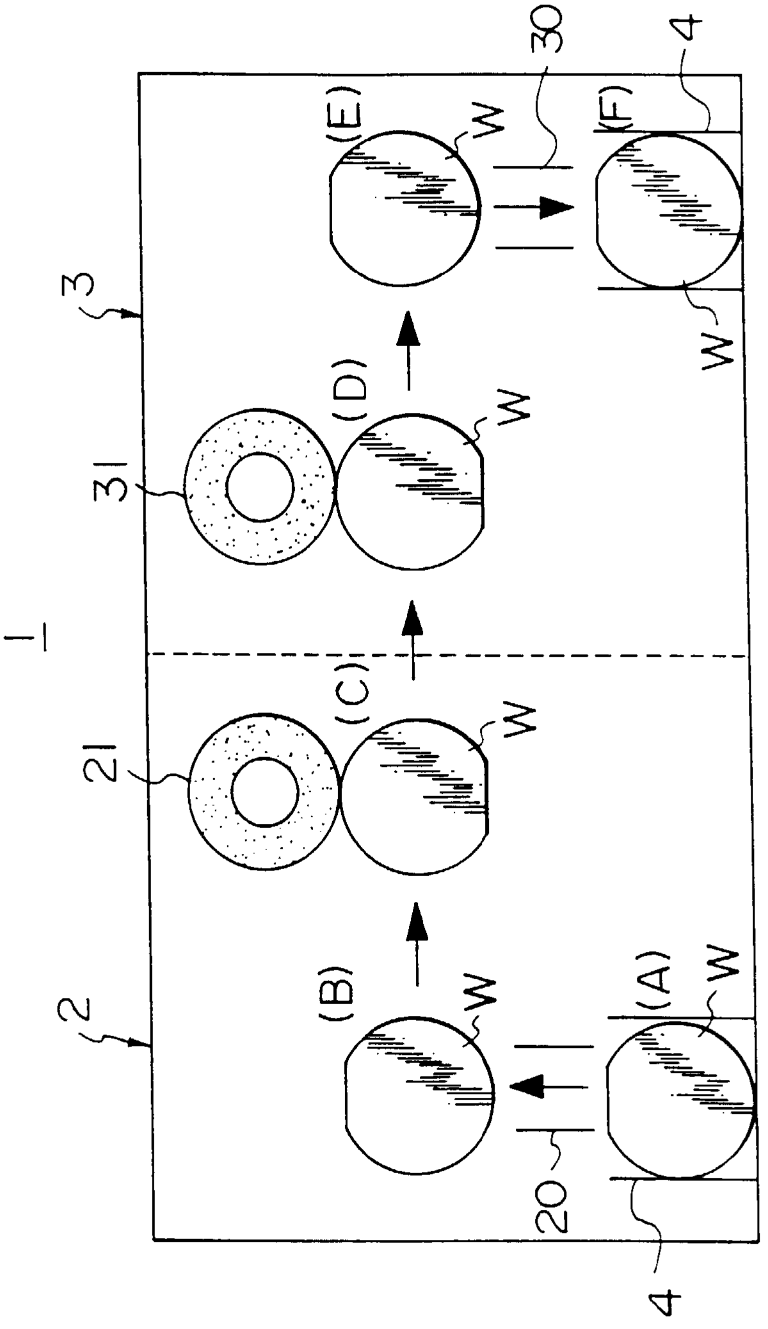


FIG.4

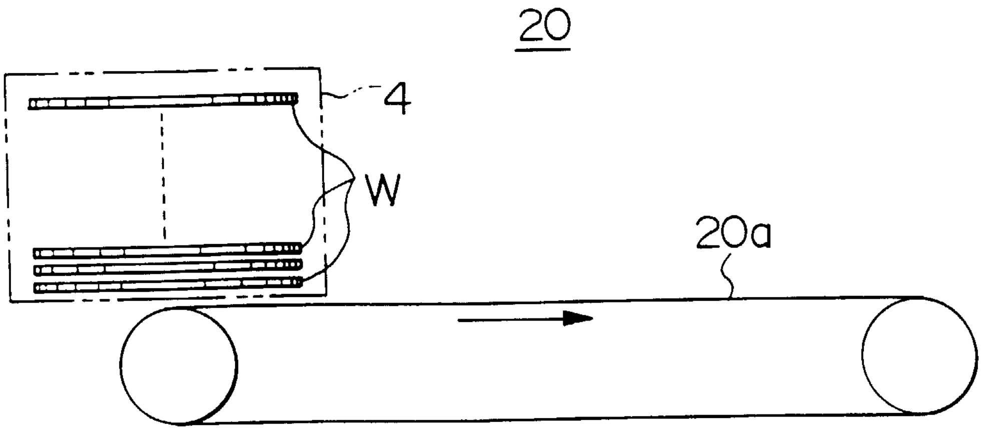


FIG.5

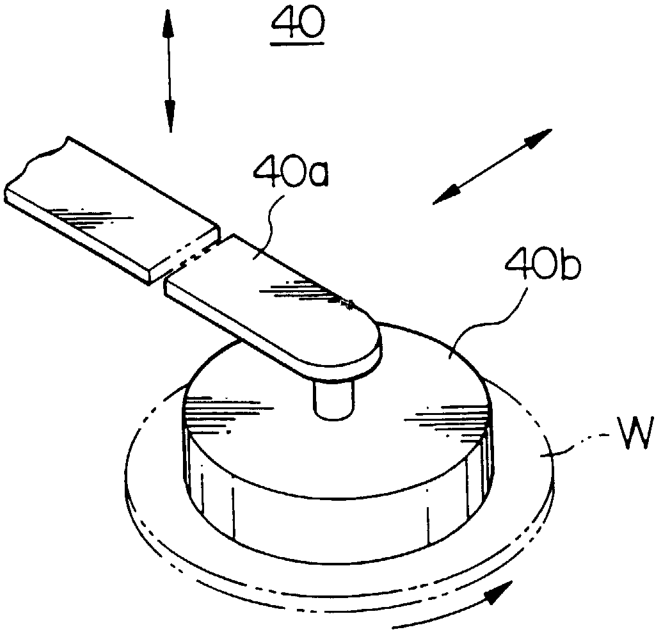


FIG.6

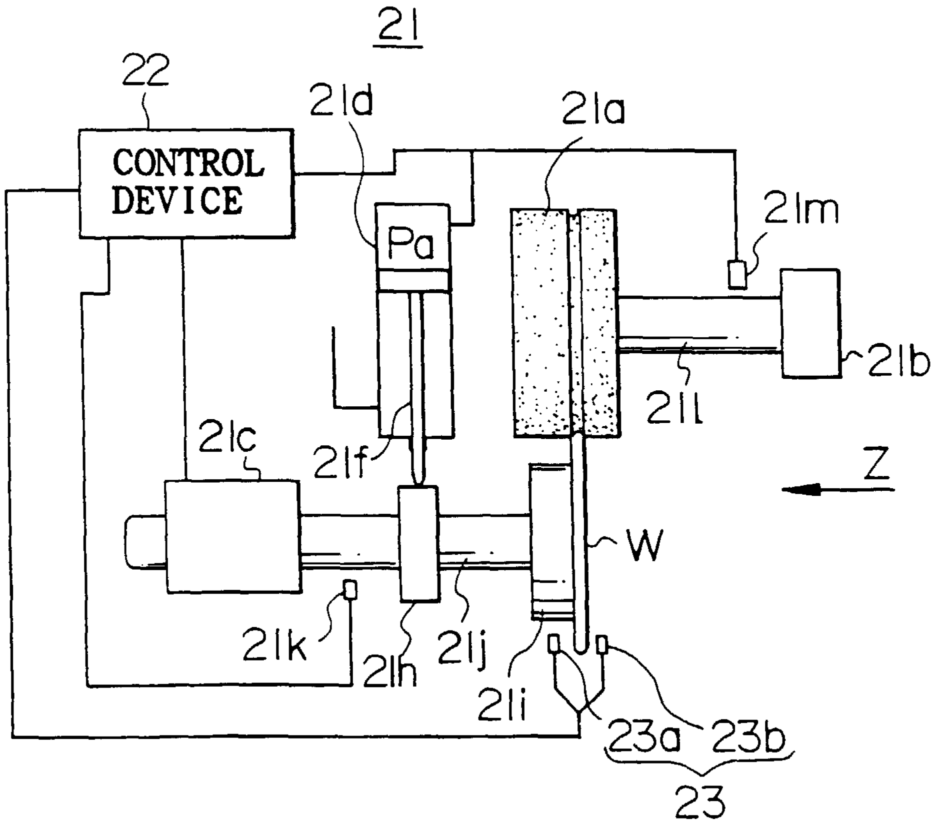

21
22
CONTROL DEVICE
21d
21a
Pa
21m
21b
21l
21c
21f
Z
W
21k
21h
21j
21i
23a
23b
23

FIG.7

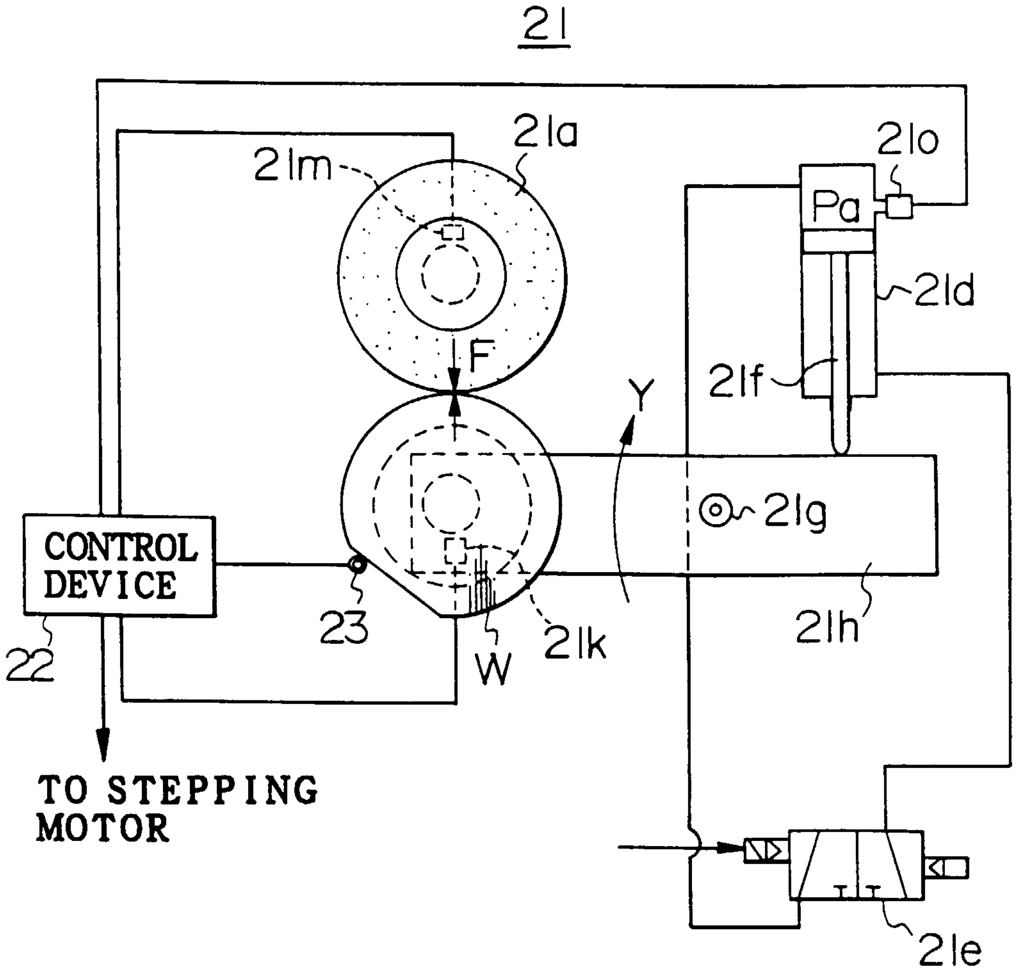

21
21a
21m
21o
Pa
21d
21f
F
Y
21g
CONTROL DEVICE
23
21k
W
21h
22
TO STEPPING MOTOR
21e

FIG.8

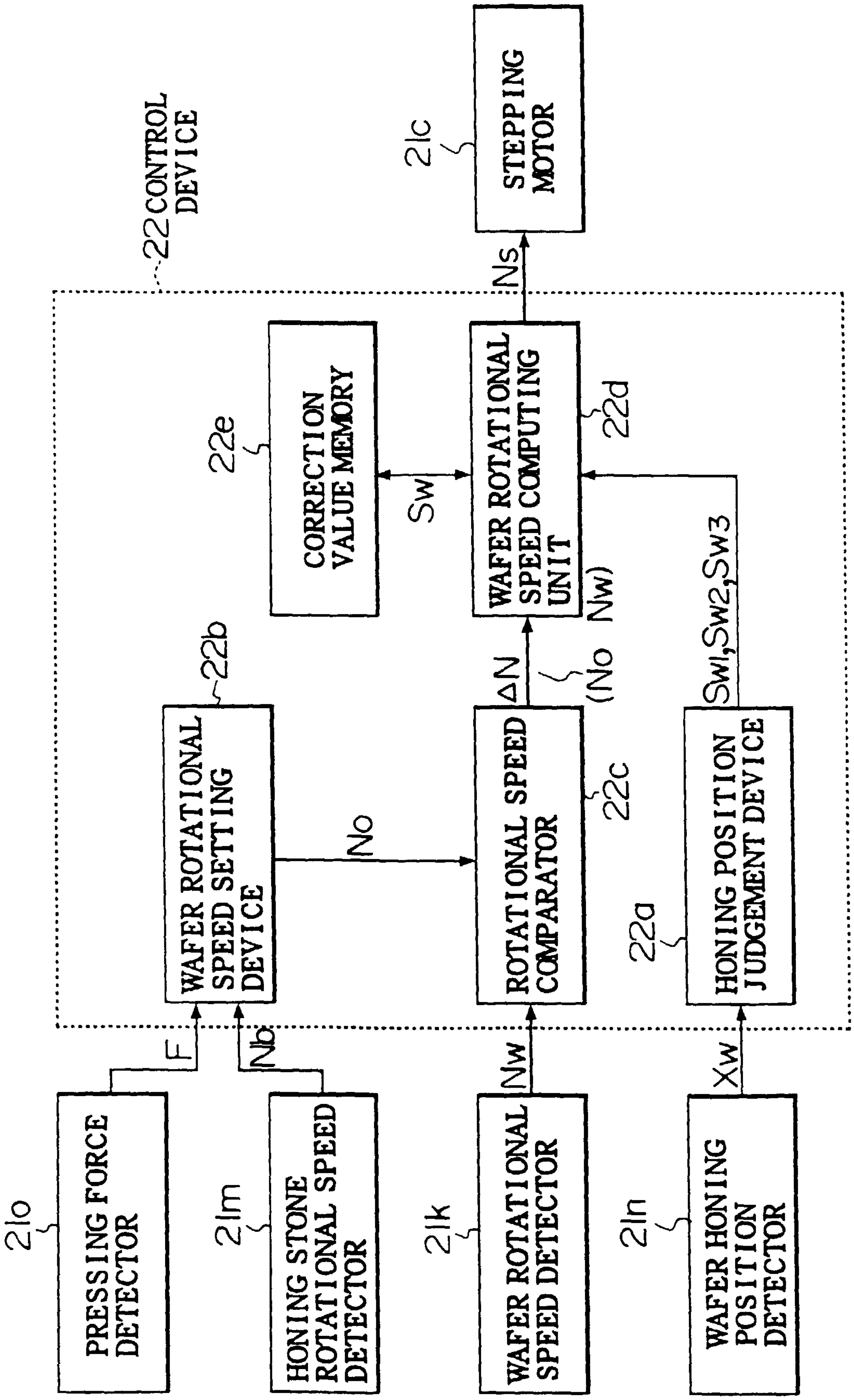

22 CONTROL DEVICE
21o PRESSING FORCE DETECTOR
21m HONING STONE ROTATIONAL SPEED DETECTOR
21k WAFER ROTATIONAL SPEED DETECTOR
21n WAFER HONING POSITION DETECTOR
F
Nb
Nw
Xw
22b WAFER ROTATIONAL SPEED SETTING DEVICE
22c ROTATIONAL SPEED COMPARATOR
22a HONING POSITION JUDGEMENT DEVICE
No
ΔN (No Nw)
Sw1,Sw2,Sw3
22e CORRECTION VALUE MEMORY
22d WAFER ROTATIONAL SPEED COMPUTING UNIT
Sw
Ns
21c STEPPING MOTOR

FIG.9A

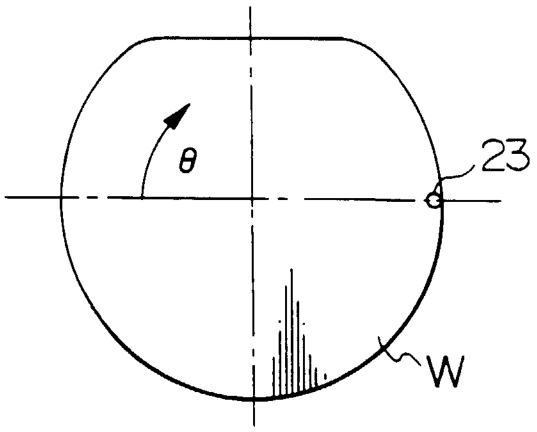

θ
23
W

FIG.9B

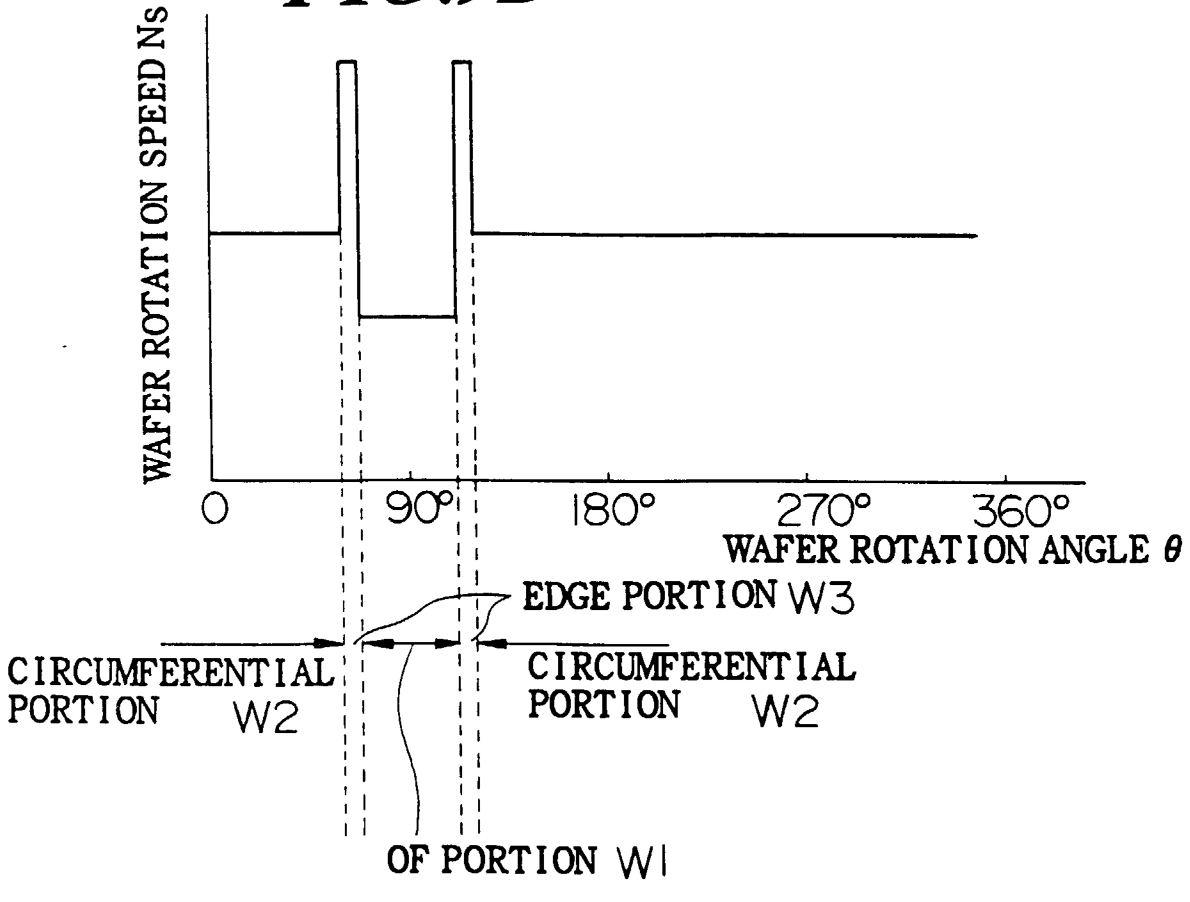

WAFER ROTATION SPEED Ns
0
90°
180°
270°
360°
WAFER ROTATION ANGLE θ
EDGE PORTION W3
CIRCUMFERENTIAL PORTION W2
CIRCUMFERENTIAL PORTION W2
OF PORTION W1

FIG.10

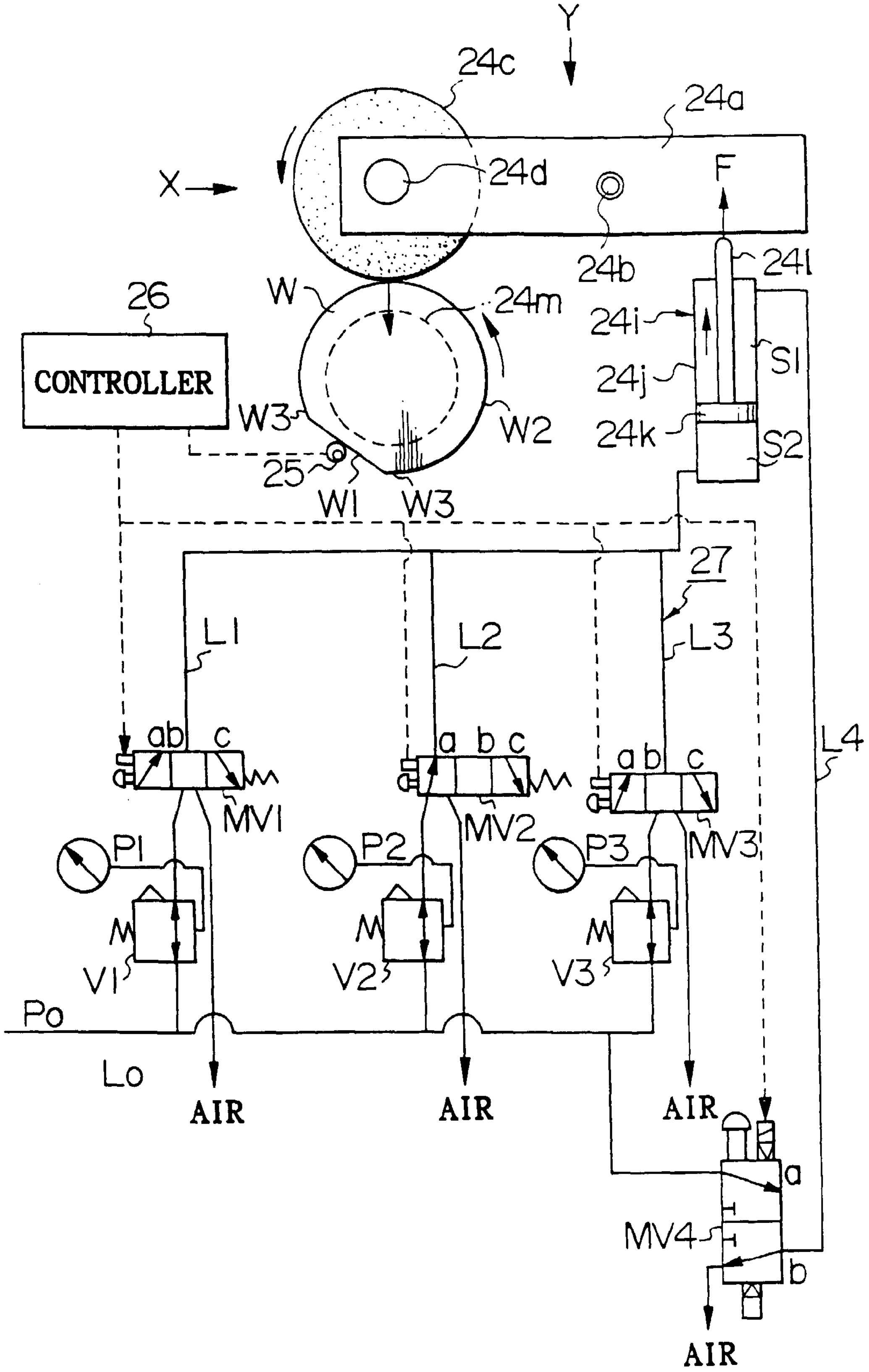

Y
24c
24a
X
24d
F
24b
24l
26
W
24m
24i
CONTROLLER
S1
24j
W3
W2
24k
25
S2
W1
W3
27
L1
L2
L3
a b
c
a
b
c
a
b
c
MV1
MV2
MV3
P1
P2
P3
L4
V1
V2
V3
Po
Lo
AIR
AIR
AIR
a
MV4
b
AIR

FIG.11

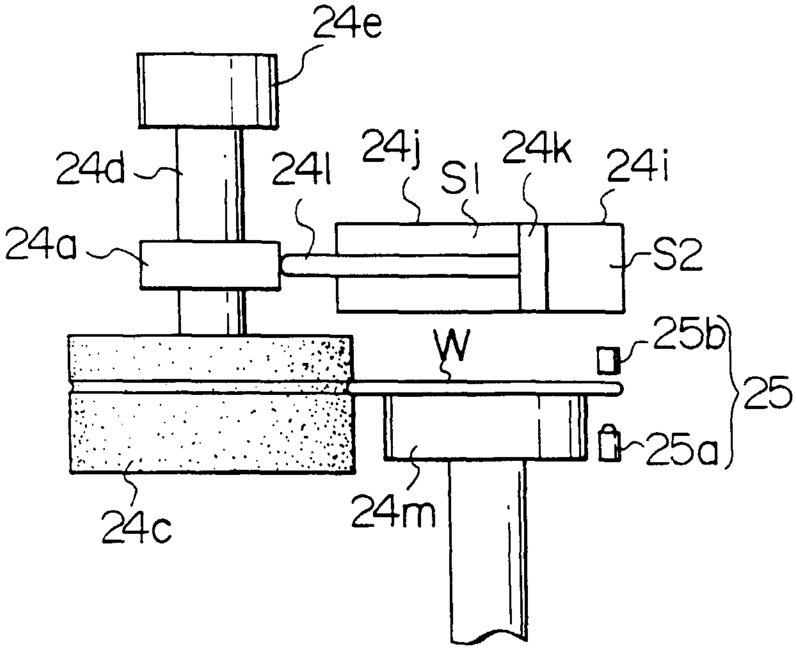

24e
24d
24l
24j
S1
24k
24i
24a
S2
W
25b
25
25a
24c
24m

FIG.12

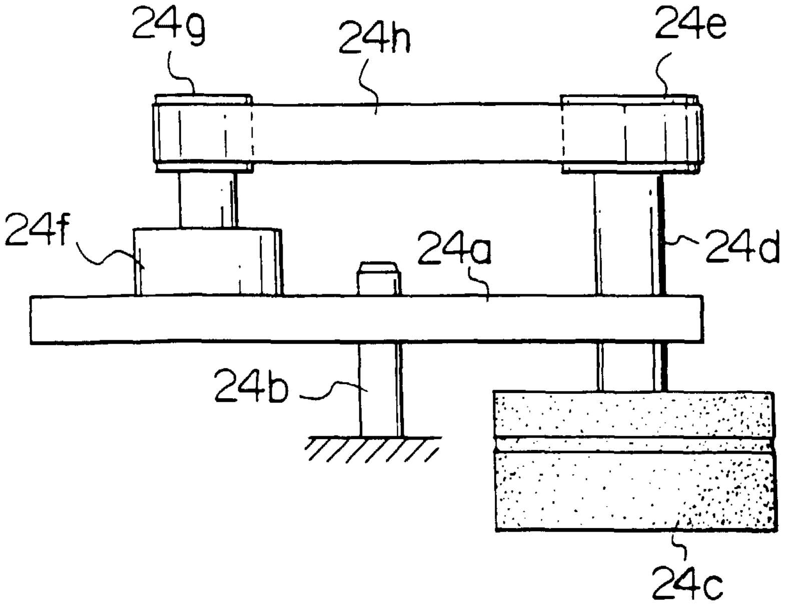

24g
24h
24e
24f
24a
24d
24b
24c

FIG.13

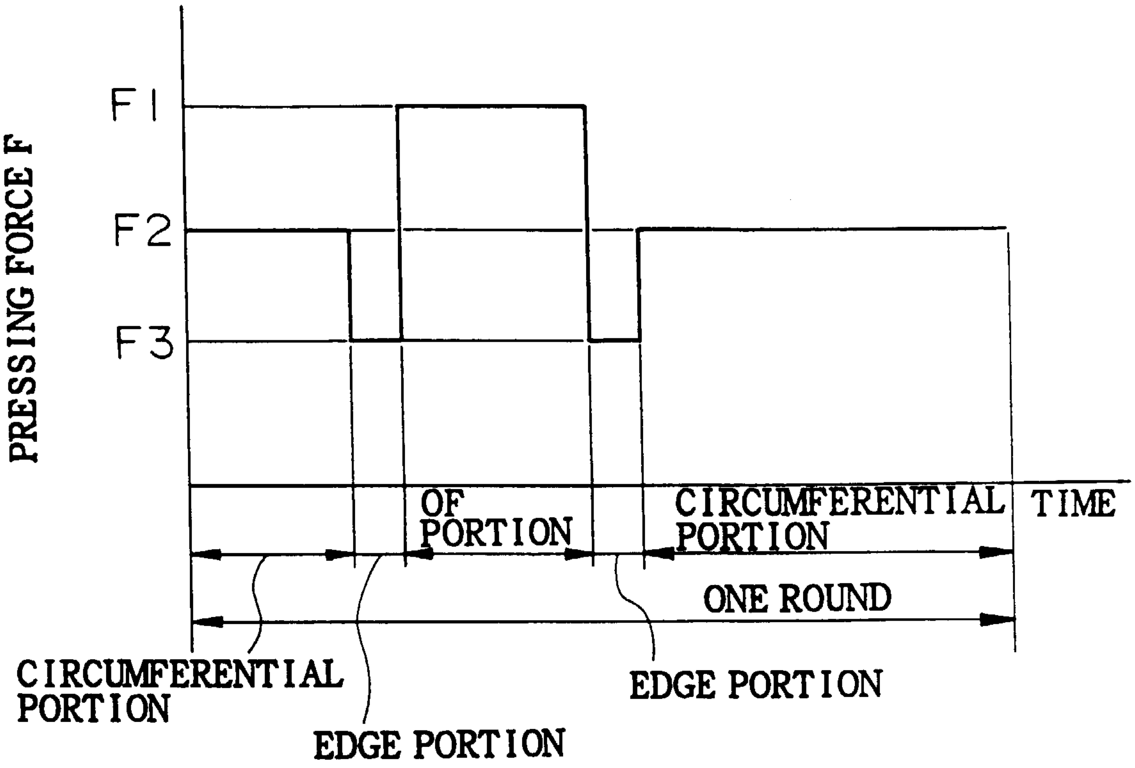
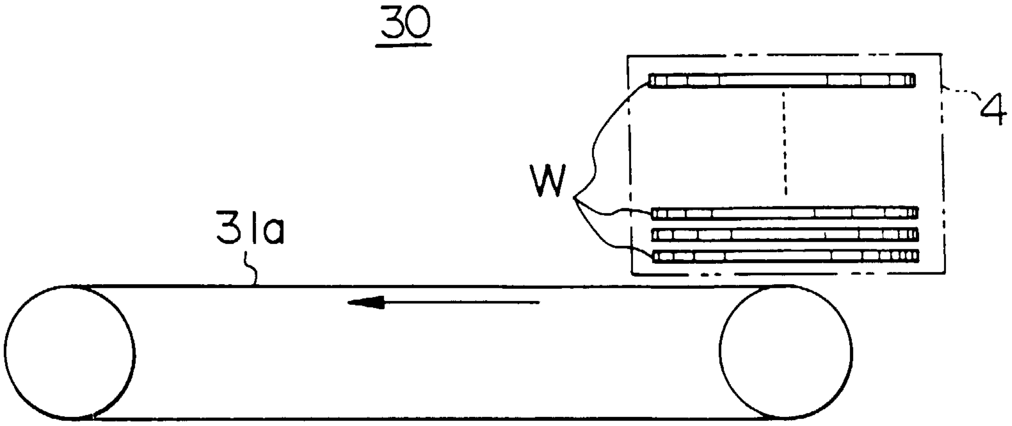

PRESSING FORCE F
F1
F2
F3
OF PORTION
CIRCUMFERENTIAL PORTION
TIME
ONE ROUND
CIRCUMFERENTIAL PORTION
EDGE PORTION
EDGE PORTION

FIG.14


30
4
W
31a