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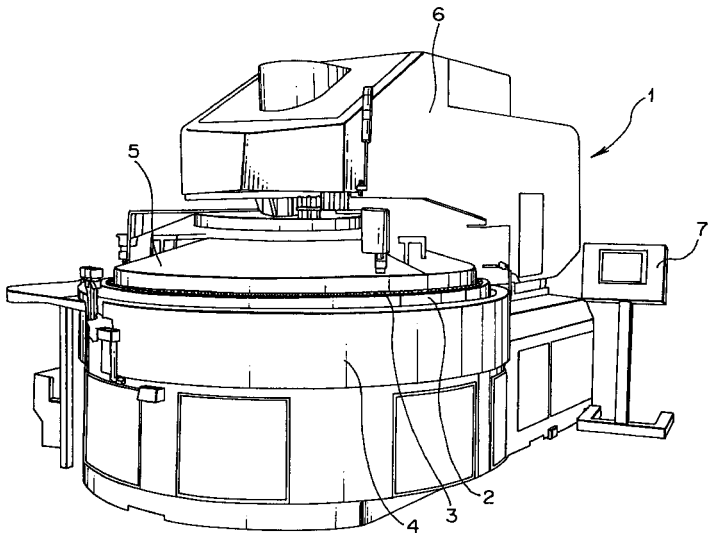
(54) Surface polishing apparatus

(57) A surface polishing apparatus made up of upper and lower surface plates (5, 2), an internal gear (3) and a sun gear (68), which are designed to be capable of surely polishing wafers held by a wafer holding member and of enhancing the throughput. The apparatus comprises a temperature adjusting mechanism for controlling the temperatures of the upper and lower surface plates (5, 2) to improve the flatness of the wafer, a plurality of small-sized drive sources (50) for driving the lower surface plate (2), a sun gear elevating mechanism for preventing abrasion of only a portion of the sun gear (68) in a height direction due to the engagement with the wafer holding member, a level balancing mechanism for lowering the upper surface plate (5) with respect to the lower surface plate (2) in a horizontal condition, and an abrasive recovering mechanism. In addition, a resin coating (121) is made on the upper and lower surface plates (5, 2) for preventing the occurrence of rust thereon.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a surface polishing apparatus, and more particularly to a surface polishing apparatus for polishing or grinding upper and lower surfaces of a semiconductor, such as a wafer.

2. Description of the Related Art

[0002] In general, as a surface polishing apparatus for polishing a wafer, there has been known a type in which a wafer holding member placed between upper and lower surface plates made to be rotatable in different directions is rotated between both the surface plates by the cooperating movements of an internal gear and a sun gear to polish upper and lower surfaces of the wafer held by the wafer holding member.

[0003] That is, such a surface polishing apparatus, as seen in Fig. 13 showing the positional relationship between a lower surface plate 200 and a wafer holding member 201 used therein, is made up of the disc-like lower surface plate 200 placed to be rotatable in horizontal directions, a disc-like upper surface plate (not shown) placed above the lower surface plate 200 in opposed relation to each other and rotatable in horizontal directions and in vertical directions, the thin disc-like wafer holding member 201 located on an upper part of the lower surface plate to be rotatable and revolvable in horizontal directions and made to hold at least one wafer, a rotationally driving mechanism designed to rotate the lower surface plate 200 and the upper surface plate in different directions from each other and to revolve the wafer holding member 201 in the same direction as that of the lower surface plate 200 and rotate it in a different direction, and a vertically moving mechanism such as a cylinder made to move the upper surface plate in vertical directions.

[0004] In addition, for the rotational driving, the apparatus is composed of a drive source, a transmission, a power transmission member such as a pulley and a belt for connection therebetween for driving force transfer, a ring-like internal gear 203 located on the outer circumferential side of the lower surface plate 200 to be rotatable and having a plurality of pins 209 protrusively provided to form a ring-like configuration, a power transmission member such as a gear for connecting the internal gear 203 and the lower surface plate 200 to the output shaft of the transmission, and a sun gear 204 fitted over the output shaft of the transmission and positioned in a central dead space of the lower surface plate 200 to be rotatable and further having a plurality of pins 208 protrusively provided to form a ring-like configuration.

[0005] The wafer holding member 201 is provided between the sun gear 204 and the internal gear 203, and has a plurality of wafer holding through-holes 205 made in its portions to hold disc-like wafers 210. Further, in its outer circumferential surface, recess portions 206 are made at a predetermined interval so that a tooth portion 207 is formed between the adjacent recess portions 206 which engages with a portion between the pins 208 of the sun gear 204 and with a portion between the pins 209 of the internal gear 203.

[0006] That is, a tooth portion 212 is formed between the pins 208 of the sun gear 204 to gear mutually with the tooth portion 207 of the wafer holding member 201.

[0007] In addition, a tooth portion 211 is formed between the pins 209 of the internal gear 203 to gear mutually with the tooth portion 207 of the wafer holding member 201.

[0008] In the conventional surface polishing apparatus thus constructed, the wafer 210 is set in each of the wafer holding holes 205 of the wafer holding member 201 and the cylinder of the vertical moving mechanism is operated to lower the upper surface plate so that the upper surface plate comes into contact with the upper surface of the wafer. Additionally, the wafer 210 is pressed at a predetermined load between the lower surface plate 200 and the upper surface plate, and the motor of the rotationally driving mechanism is operated to drive the transmission through the power transmission member so that the sun gear 204, the internal gear 203 and the upper surface plate rotate in the same direction as that of the output shaft of the transmission.

[0009] On the other hand, the lower surface plate 200 is rotated in a direction different from that of the output shaft of the transmission, and the wafer holding member 201 is revolved around the sun gear 204 in the same direction as that of the lower surface plate 200 and is rotated around its own axis in the opposite direction to that of the sun gear 204.

[0010] Furthermore, in this state, an abrasive is supplied to between the lower surface plate 200 and the upper surface plate to flow into between the upper surface of each of the wafers 210 and the upper surface plate and further between the lower surface of the wafer 210 and the lower surface plate 200 so that the upper and lower surfaces of each of the wafers 210 are polished to be finished up to a predetermined surface roughness. Incidentally, an abrasive pad is previously adhered onto the upper and lower surface plates.

[0011] However, the conventional surface polishing apparatus with the above-described construction creates, for example, the following problems.

1) A difference in temperature between portions of the abrasive pad of the surface plate occurs during the polishing operation, which leads to a defect in flatness of the wafer after polished.

2) Since one drive source operates for the rotationally driving mechanism, a large-output drive source becomes necessary for driving the lower surface

plate having a large mass, so that the whole comes to a high cost.

3) The sun gear wears with use and a need for the replacement of the sun gear exists after the elapse of a predetermined period of time, and the replacement operation requires a stop of the apparatus, which causes a high maintenance cost.

4) While the upper surface plate is moved vertically with respect to the lower surface plate, if tilting over at the downward movement, the upper surface plate comes partially into contact with a wafer, which has an adverse effect on later polishing operation, for example, causing a defect of the wafer in flatness or the like.

5) An abrasive is used at the wafer polishing and is made to be scratched with a scraper for reuse, but it cannot be reused directly because unnecessary fragments, dust or the like are collected together at the scratching.

6) When the wafer is positioned between the upper and lower surface plates in a state of being held in the wafer holding member, the lower surface plate and the upper surface plate are shifted from each other by man power before the mounting of the wafer or the replacement of the abrasive pad, which gives rise to a troublesome operation.

7) An abrasive pad is adhered onto the upper and lower surface plates and, if damages thereto occur, is replaced with new one, while the new abrasive pad has a size slightly larger than those of the upper and lower surface plates and, after the readhering, the extra portion thereof is removed with a knife or the like. At this removal, there is a possibility that the upper and lower surface plates are cut by the knife or the like and that rust occurs due to the abrasive.

SUMMARY OF THE INVENTION

[0012] Accordingly, it is an object of the present invention to provide a surface polishing apparatus which is capable of eliminating the aforesaid problems inherent to the conventional apparatus.

[0013] For this purpose, in accordance with this invention, there is provided a surface polishing apparatus which holds a semiconductor including a wafer, held by a wafer holding member, between upper and lower surface plates rotatable and rotates and revolves the wafer holding member by making the wafer holding member engage with an internal gear and a sun gear and further supplies an abrasive for polishing both surfaces of the wafer, characterised by comprising a temperature adjusting mechanism provided on at least a lower surface plate of upper and lower surface plates for reducing a difference in temperature on a polishing surface, a driving mechanism made up of a plurality of drive sources which cooperate with each other for rotationally driving the lower surface plate, a sun gear elevating mechanism for changing the height of the sun gear for preventing abrasion of only a portion of the sun gear in a height direction due to the engagement with the wafer holding member, an upper surface plate level balancing mechanism for preventing the upper surface plate from lowering eccentrically with respect to the lower surface plate at a lowering operation, an abrasive recovering mechanism made to be open against a circumferential edge portion of the lower surface plate and to lower partially to communicate with an external recovering circuit, and an upper surface plate turning mechanism for turning the upper surface plate in a horizontal direction with respect to the lower surface plate to provide one of a wafer mounting position and an abrasive pad replacing position, with a resin coating being made on the upper and lower surface plates, for preventing generation of rust at a portion of the upper and lower surface plates coming into contact with the abrasive and further for preventing a cut from being made on the surfaces of the upper and lower surface plates by hardening the surfaces of the upper and lower surface plates.

[0014] The surface polishing apparatus according to this invention can offer the following advantages.

1) The detection of temperature is made on or for a plurality of portions of the abrasive pad of the upper surface plate and, if the detected temperatures differ from each other, proportional control is implemented to uniformly adjust the temperature of hot water independently flowing into the respective portions, thereby maintaining the fatness of the wafer evenly after polished.

2) The lower surface plate with a large mass is driven with a plurality of drive sources, which permits the use of a small-sized drive source.

3) The using part of the sun gear gearing with the wafer holding member can be changed, thus lengthening the durable period of the sun gear.

4) While the upper surface plate is moved vertically with respect to the lower surface plate, particularly, when the upper surface plate is moved downwardly, the upper surface plate is moved downwardly while keeping a horizontal condition or position, thereby preventing the upper surface plate from coming eccentrically into contact with the lower surface plate.

5) A drain for recovering the abrasive is placed in a tilted state such that the abrasive is naturally led to the external after use; whereupon, the recovery of only the abrasive becomes feasible and the abrasive becomes reusable.

6) The upper surface plate is made to be capable of being turned in two steps in horizontal directions with respect to the lower surface plate so that an upper surface of the lower surface plate becomes open, thereby facilitating the mounting of a wafer and the replacement of the abrasive pad.

7) A resin coat is formed on portions of the upper

and lower surface plates, to which the abrasive pad is adhered, to harden this portion, thus surely eliminating the possibility that this portion is cut in error when the abrasive pad is cut by a knife or the like, or that rust occurs at this portion due to the abrasive and others.

[0015] That is, the employment of the above-described means according to this invention permits the wafer to be polished in a state where the temperatures at its portions are substantially constant so that its flatness improves, permits the lower surface plate to be driven in a manner that a plurality of drive sources cooperate with each other, prevents only a portion of the sun gear engaging with the wafer holding member for holding a wafer from wearing, allows the upper surface plate to lower at a lowering operation while maintaining its horizontal condition for preventing the upper surface plate from conducting eccentric pressing with respect to the lower surface plate, surely recover the used abrasive, facilitates the installation of a wafer and the replacement of an abrasive pad by turning the upper surface plate in horizontal directions with respect to the lower surface plate, and prevents the occurrence of rust and cut owing to the resin coating onto the upper and lower surface plates.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The object and features of the present invention will become more readily apparent from the following detailed description of the preferred embodiment taken in conjunction with the accompanying drawings in which:

Fig. 1 is a perspective view wholly and schematically showing a surface polishing apparatus according to this invention;
Fig. 2 is a side elevational view schematically showing the whole surface polishing apparatus;
Fig. 3 is a cross-sectional view showing the surface polishing apparatus;
Fig. 4 is a schematic illustration of a mechanism for turning an upper surface plate with respect to a lower surface plate;
Fig. 5 is a plan view schematically showing the surface polishing apparatus shown in Fig. 3;
Fig. 6 is a schematic illustration of a lower surface plate and a drive source therefor;
Fig. 7 is a cross-sectional view schematically showing the lower surface plate and a drive system therefor;
Fig. 8 is a cross-sectional view schematically showing a state where a slurry recovering mechanism is installed on the construction shown in Fig. 7;
Fig. 9 is a cross-sectional view schematically showing a state where a level balancing mechanism is mounted on the upper surface plate;
Fig. 10 is a cross-sectional view schematically showing a state where a resin is coated on the upper and lower surface plates and a base therefor;
Figs. 11A to 11C are plan views schematically showing a
state where the upper surface plate is turned relative to the lower surface plate;
Fig. 12 is an illustration of temperature variation taking place according to an operating time of an inner circumferential portion, central portion and outer circumferential portion of the upper and lower surface plates; and
Fig. 13 is an explanatory illustration of the relationship among a sun gear, a wafer holding member and an internal gear in a common surface polishing apparatus.

DESCRIPTION OF THE PREFFERED EMBODIMENT

[0017] An embodiment of the present invention will be described hereinbelow with reference to the drawings.

[0018] Fig. 1 is a perspective view schematically showing the whole configuration of a surface polishing apparatus according to this invention, and Fig. 2 is a side elevational view schematically showing the whole construction thereof.

[0019] In this surface polishing apparatus designated generally at numeral 1, a lower surface plate 2 rotatable by a drive source is installed, and an internal gear 3 is located with respect to an upper surface of the lower surface plate 3 in a state of forming a predetermined spacing from the outer circumferential side thereof as well as the conventional apparatus, and further a sun gear 68 is placed at a central section thereof.

[0020] Besides, numeral 4 represents an apparatus base section covering the outer side of the lower surface plate 2, numeral 5 denotes an upper surface plate, numeral 6 depicts a cover for covering a mechanism for moving the upper surface plate 5 vertically and for turning (swinging) it in horizontal directions, and numeral 7 designates a control panel.

[0021] Fig. 3 is a longitudinal cross-sectional view schematically showing an upper surface plate driving mechanism for rotating the upper surface plate 5 of the surface polishing apparatus 1 or turning it in horizontal directions, Fig. 4 shows a detailed construction of a drive source for an upper surface plate turning mechanism for turning the upper surface plate 5 in horizontal directions, and Fig. 5 illustrates a driving mechanism for the upper surface plate 5.

[0022] A cylindrical rising section 11 is provided integrally on an upper surface of an apparatus frame 10 behind the apparatus base section 4 accommodating the lower surface plate 2 internally, and a cylindrical suspending section 12 having a tooth portion 13 at its periphery is placed on the outer side of the rising section 11, with a bearing 14 being put between the suspending section 12 and the rising section 11.

[0023] The tooth portion 13 is placed on the suspending section 12 fixedly secured onto a lower surface of a base plate 15 extending horizontally, while this base plate 15 and a cylindrical side plate 16 rising from an upper surface side of the base plate 15 constitute a cylindrical frame 17.

[0024] An operating member 18 for elevation of the upper surface plate 5, fixedly secured to the aforesaid apparatus frame 10 to extend vertically, penetrates the base plate 15 of the frame 17, and a plurality of air cylinders 19 are fitted in the interior of the frame 17 in a state of being directed in vertical directions, and each of these air cylinders 19 is put connectedly through a buffering member 21 between a supporting plate 22 for supporting the upper surface plate 5 and the base plate 15 so that its operating section 20 bears the load of the upper surface plate 5, the supporting plate 22 and others.

[0025] An operating portion of the aforesaid operating member 18 is connected to a connecting plate 23 joined integrally to lower surfaces of the plurality of buffering members 21.

[0026] Furthermore, each of the buffering members 21 is disposed so that its end portion 21a is positioned at each peak of an equilateral triangle with respect to the aforesaid supporting plate 22.

[0027] A cylindrical side plate 24 fixed to the supporting plate 22 is positioned outside the frame 17, and a linear guide 25 and a slide member 26 are situated between both the side plates 16 and 24. That is, the linear guide 25 is fixed to the side plate 16 of the frame 17, while the slide member 26 is fixed to the side plate 24.

[0028] Meanwhile, as shown in detail in Fig. 4, the tooth portion 13 of the suspending section 12 fixed to the lower surface of the base plate 15 is made to engage with a tooth portion 28 of the operating member 27 fixed to the apparatus frame 10 for turning the upper surface plate 5.

[0029] Thus, when the aforesaid operating member 18 operates, the frame 17 is together shifted upwardly or downwardly to cause the simultaneous upward or downward movement of the supporting plate 22 for supporting the upper surface plate 5, and the frame 17 is turned by the operating member 27 to turn the supporting plate 22, with the supporting plate 22, the operating member 27 and others organize the upper surface plate turning mechanism.

[0030] In addition, as Fig. 5 shows, a pair of drive sources 40 for the upper surface plate 5 are provided on the aforesaid supporting plate 22, and the upper surface plate 5 is driven by these drive sources 40.

[0031] That is, each of the pair of drive sources 40 placed at the end portions of the supporting plate 22 drives a drive pulley 42 through an intermediate pulley 41, and a tooth portion 46 is provided on a drive shaft 43 of each of the drive pulleys 42 to engage with a tooth portion 45 fitted over a drive shaft 44 of the upper surface plate 5 (see Fig. 3).

[0032] Still additionally, as Fig. 6 shows, a plurality of (three in the illustration) drive sources 50 are set in the interior of the apparatus base section 4. Furthermore, a tooth portion 52 placed on a rotary shaft 51 of the lower surface plate 2 engages with a worm gear 54 attached to a shaft section 53 supported rotatably to be directed in a horizontal direction, while three pulleys 55 are fitted over the shaft section 53 and a belt 56 is stretched between each of the pulleys 55 and a driving section of a different drive source 50. The plurality of drive sources 50 constitute a driving mechanism for rotationally driving the lower surface plate 2.

[0033] The internal gear 3 and the sun gear 68 respectively provided at an outer circumferential edge portion and a central portion of the upper surface of the lower surface plate 2 are constructed as shown in Fig. 7.

[0034] That is, the internal gear 3 formed in a manner that the pins are disposed in a rising condition at a predetermined interval at an outer circumferential portion to form a ring-like configuration is located on a rotary frame section 62 made to be rotatable through a bearing 61 in a horizontal condition with respect to a base 60, and a drive source for driving the internal gear 3 is connected to a tooth portion 63 placed at a lower portion of the rotary frame section 62.

[0035] Furthermore, a ring-like base 65 positioned inside the internal gear 3 has a plurality of ring-like grooves 66 coaxially and independently made in its upper surface, and is supported integrally by a lower surface plate drive shaft 67, with an oil being put hermetically between the base 65 and a holding portion 60a of the base 60 protruding annularly.

[0036] Still furthermore, a tooth portion 90 is set on a lower side outer circumferential surface of the aforesaid lower surface plate drive shaft 67, and is made to engage with a tooth portion to be rotated by a lower surface plate drive source 91.

[0037] Moreover, in a central section forming an opening of the base 65, there are disposed a sun gear base plate 69 carrying the sun gear 68, constructed in a manner that the pins are planted at a predetermined interval in the upper surface outer circumferential edge portion, and a shaft section 70 suspending from a lower surface central portion of the sun gear base plate 69, which constitute a sun gear driving member 71.

[0038] A drive shaft 72, accepting the aforesaid shaft section 70, is constructed such that its lower end portion is closed, with a gear 73 being attached to its lower portion. This gear 73 is made to be rotated with a drive source 75 for driving the sun gear 68.

[0039] In addition, a space 76 defined by the lower surface of the shaft section 70 and the interior of the drive shaft 72 communicates with an oil cylinder 74 located externally, and this oil cylinder 74 is equipped with a pitch-feeding unit 134.

[0040] Accordingly, a sun gear elevating mechanism is provided to move the sun gear 68 and the sun gear driving member 71 vertically between a position indi-

cated by a solid line and a chain line in Fig. 7 in accordance with supply of the oil by the oil cylinder 74.

[0041] Still additionally, a slide member 77 is placed between the drive shaft 72 and the shaft section 70 to support the shaft section 70 with respect to the drive shaft 72 to permit only its vertical movements, and a sealing member is situated for preventing the leakage of the oil.

[0042] Besides, a construction similar to the aforesaid sun gear elevating mechanism is also given to the internal gear 3, so that the internal gear 3 can be altered in height by an oil cylinder (not shown).

[0043] Still additionally, the drive shaft 72 is placed to be rotatable through a bearing 79 in the interior of a cylindrical projecting section 78 formed at a central portion of the base 60, and supply ports a, b and c and a communicating member 80 are provided in an outer circumferential section of this cylindrical projecting section 78.

[0044] On the outer circumferential side of this communicating member 80, a tooth portion 90 is situated at a lower portion, and a communicating passage is formed independently between the tooth portion 90 and the communicating member 80, and the aforesaid lower surface drive shaft 67 is provided in a state of being fixed integrally through a connecting member 81 to the base 65, and further the lower surface plate rotating drive source 91 is connected to the tooth portion 90 at a lower portion of the lower surface plate drive shaft 67 as mentioned before.

[0045] Furthermore, the ring-like grooves 66 constituting a temperature adjusting mechanism together with the supply ports a, b and c are made in the upper surface of the base 65, and are in corresponding relation to the supply ports a, b and c made outside the cylindrical projecting section 78, which permits the supply of hot water, adjusted in temperature by a temperature adjuster (not shown), through a passage between the communicating member 80 and the lower surface plate drive shaft 67. Incidentally, reference marks d, e and f designate discharge ports for the hot water, respectively.

[0046] On the upper surface of the base 65, the lower surface plate 2 is positioned in a state of closing the grooves 66 made therein, and is designed to rotate together with the base 65 at the rotation of the base 65.

[0047] Fig. 8 shows a state in which a conduit-like drain receiver 100 constituting a slurry recovering mechanism is placed at a portion of the lower surface plate 2 thus constructed.

[0048] The construction shown in Fig. 8 is provided with the conduit-like drain receiver 100 installed by a change of a portion of the construction shown in Fig. 7. Portions other than the portions related to the slurry recovering mechanism are marked with the same numerals, and the detailed description thereof will be omitted for brevity.

[0049] A ring-like receiving plate 101 protruding in a horizontal direction is provided on the base 60, and a central portion of the rotary frame section 62 for supporting the internal gear 3 is raised annularly to form a receiving section 102.

[0050] A lower portion of the ring-like conduit-like drain receiver 100 is supported by the receiving plate 101, and an inner circumferential side edge portion of the drain receiver 100 is positioned within the ring-like receiving section 102.

[0051] In this case, the drain receiver 100 is set such that its bottom surface does not have the same height but one side is made to be higher than the other to produce a height difference δ. This is because the ring-like receiving plate 101 is not placed horizontally but its one side is higher than the other, that is, it is attached to the base 60 in a state of being tilted.

[0052] The outer circumferential edge portion of the drain receiver 100 has the substantially same height as that of the internal gear 3.

[0053] Furthermore, a lead-through pipe 103 is installed in the bottom portion of the lowered drain receiver 100 and coupled to a recovery circuit (not shown) for establishing a communication from the interior of the drain receiver 100 to the recovery circuit.

[0054] Incidentally, there is no need to place the receiving section 102 in the central portion of the rotary frame section 62, and if the drain receiver 100 itself is constructed such that its bottom portion assumes a difference in height between one side and the other, the receiving plate 101 can be placed horizontally with respect to the base 60.

[0055] Fig. 9 illustrates an upper surface plate level balancing mechanism whereby the upper surface plate 5 positioned above the lower surface plate 2 is moved vertically in a state of keeping its horizontal condition or position.

[0056] The aforesaid upper surface plate 5 is made to oscillate in arbitrary directions of the horizontal directions with respect to a drive member such as a drive shaft.

[0057] That is, as the outline is shown in Fig. 9, a lower end portion of the drive shaft 44 is formed into a curved portion 110 and a neck portion of the upper surface plate 5 is formed into a recessed curved portion 112 accepting the curved portion 110 of the drive shaft 44, thereby enabling the oscillation of the upper surface plate 5 in a state of being directed downwardly. Alternatively, although not shown, for example, the outer and inner layers formed by two ring-like members piled up are connected through a pin to each other, while a pin is installed outside the outer ring-like member to be perpendicular to the first-mentioned pin for supporting the upper surface plate 5, and the drive shaft 44 is supported by the inner ring-like member, thereby enabling the oscillation of the upper surface plate 5 in a state of being directed downwardly.

[0058] Furthermore, as an elevating mechanism for moving the upper surface plate 5 vertically is schemati-

cally shown in Fig. 9, three arms 113 are disposed at an equal angular interval (that is, 120°) on an outer circumferential surface of an outer circumferential side shaft cylinder 130 of the drive shaft 44 which supports the upper surface plate 5 and which moves vertically together with it, and a horizontally lowering mechanism unit 114 for the upper surface plate 5 is provided at the tip portion of each of the arms 113.

[0059] This upper surface plate horizontally lowering mechanism unit 114 is composed of an operating member 115 where an operating section such as a cylinder gets in and out and a roller 116 placed on the operating section of this operating member 115 and made to come into contact with an upper surface of the upper surface plate 5 so that it rotates in accordance with the rotation of the upper surface plate 5.

[0060] Besides, the operating members 115 of the upper surface plate horizontally lowering mechanism units 114 are driven in a synchronizing condition by a well-known control means.

[0061] Moreover, as Fig. 10 shows, a resin coating 121 is made on the surfaces of the upper and lower surface plates 2, 5 and the bases 65, 120 for supporting these upper and lower surface plates 2, 5.

[0062] For the lower surface plate 2 and the base 65 for supporting it, the resin coating 121 is conducted on the whole circumference of the lower surface plate 2 other than a portion coming into contact with the supporting base 65 and on the whole circumference of the base 65 except a portion coming into contact with the lower surface plate 2.

[0063] Similarly, for the upper surface plate 5 and the base 120 for supporting it, the resin coating 121 is conducted on the whole circumference of the upper surface plate 5 other than a portion coming into contact with the supporting base 120 and on the whole circumference of the base 120 except a portion coming into contact with the upper surface plate 5.

[0064] Accordingly, the resin coating 121 is made on the surfaces of the upper and lower surface plates 5 and 2 to which an abrasive pad is adhered and on all the circumferences contacting with the abrasive.

[0065] Incidentally, it is also appropriate that the resin coating is conducted on all the surfaces of the bases 65, 120 and the upper and lower surface plates 2, 5.

[0066] A description will be made hereinbelow of an operation of the above-described construction.

[0067] First of all, the surface polishing apparatus 1, stopping in a state of being maintained at the lifted position by the drive source, is started.

[0068] At this start, the upper surface plate turning operating member 27 is first put to operation.

[0069] The upper surface plate 5 is located on one end side of the supporting plate 22, while the supporting plate 22 itself is movable upwardly and downwardly relative to the apparatus frame 10 by the elevating operating member 18 placed on the other end side.

[0070] Furthermore, by the operating member 27 (see Fig. 4) for horizontally turning the upper surface plate 5 and others provided on the other end side of the supporting plate 22, the supporting plate 22 and the upper surface plate 5 provided thereon are turned horizontally to take a state where their outer circumferential edges are substantially positioned at the central portions of the upper and lower surface plates 5 and 2.

[0071] That is, the upper surface plate 5 waiting for the polishing operation in a state of coinciding with the lower surface plate 5 when viewed from a plane is turned by A from the waiting position shown in Fig. 11A in a horizontal direction by the operation of the operating member 27 to be shifted from the lower surface plate 2 to reach the position for mounting a wafer holding member as shown in Fig. 11B.

[0072] Thus, in a state where a portion of the upper surface of the lower surface plate 2 opens by this turning, the wafer holding member is mounted on the upper surface of the lower surface plate 2 in a state of being engaged with the sun gear 68 and the internal gear 3, before a wafer is set in the wafer holding member.

[0073] Besides, an abrasive pad (not shown) is adhered onto each of the lower surface plate 2 and the upper surface plate 5 in advance.

[0074] Still further, the aforesaid operating member 27 is operated in two steps to turn the upper surface plate 5, the supporting plate 22 and others. Unlike the first step described above, they are turned by B in the opposite direction.

[0075] That is, the operating member 27 is turned by B in a direction opposite to the direction of turning by A for mounting the wafer holding member from the waiting state where the upper and lower surface plates 5 and 2 coincide with each other. In this case, the upper surface plate 5, the supporting plate 22 and others are turned by approximately 90° in a horizontal direction from the waiting state (Fig. 11A) so that the polishing surfaces of the upper and lower surface plates 5 and 2 appear. Incidentally, the turning is not limited to 90°.

[0076] By turning them horizontally for making the polishing surfaces open, it is possible to perform the adhesion and replacement of the abrasive pad very easily.

[0077] Moreover, after the mounting of the wafer, the upper and lower surface plates 5 and 2 are returned by the operating member 27 to the state shown in Fig. 11A, and subsequently, the upper surface plate 5 is lowered to approach the lower surface plate 2 so that the wafer is held between the abrasive pads of both the surface plates 2 and 5 before the polishing operation starts. In this case, since the upper surface plate level balancing mechanism operates at the downward movement of the upper surface plate 5, the upper surface plate 5 lowers while maintaining its horizontal condition.

[0078] That is, the upper surface plate 5 is designed to be capable of oscillating downwardly with respect to the drive transmission member such as the drive shaft 44, while the three arms 113 are installed at an equal angular interval (that is, 120°) on the outer circumferen-

tial surface of the shaft cylinder 130 for supporting the upper surface plate 5, with the upper surface plate horizontally lowering mechanism unit 114 is placed at the tip portion of each of the arms 113.

[0079] Accordingly, the roller 116 put on the tip portion of the operating shaft of each of the operating members 115, such as cylinders, which project and retract by the same quantity under the control of a well-known control means is brought into contact with the upper surface plate 5, with the result that the upper surface plate 5 lowers in a state of being kept in a horizontal condition.

[0080] Furthermore, during the polishing operation, the operating shaft of the operating member 115 such as a cylinder is lifted so that its tip portion is set to a non-contacting condition, and the processing is made in a state where the alignment is possible (the upper surface plate 5 can oscillate).

[0081] Thus, although in the conventional construction the upper surface plate 5 can be lowered in a state of being tilted and at this time the pitching of the wafer can occur, the level balancing mechanism eliminates the possibility that the upper surface plate 5 lowers in a state of tilting.

[0082] Accordingly, the upper surface plate 5 of the upper and lower surface plates 5 and 2 taking the waiting condition as mentioned above is turned so that the wafer holding member and the wafer are mounted on the lower surface plate 2; subsequently, they are returned to the waiting condition and the elevating operating member 18 is started so that the supporting plate 22, the upper surface plate 5 and others are lowered in a state where the upper surface plate 5 is kept in a horizontal condition and the wafer holding member and the wafer held in this wafer holding member are put between the upper and lower surface plates 5 and 2, while the level balancing mechanism is made so as not to operate when the wafer is held between the upper and lower surface plates 5 and 2.

[0083] In this way, the wafer held by the wafer holding member is held between the upper and lower surface plates 5 and 2, and the upper surface plate 5 is rotationally driven in a manner that the two drive sources 40 installed on the supporting plate 22 operate in a cooperating condition, while the plurality of drive sources 50 shown in Fig. 6 are started for rotationally driving the lower surface plate 2.

[0084] Whereupon, each of the plurality of drive sources 50 rotates, through the pulley 55, the shaft section 53 of the worm gear 54 engaging with the tooth portion 52 of the rotary shaft 51 of the lower surface plate 2; consequently, the plurality of drive sources 50 operate in cooperation with each other to rotate the worm gear 54, thus rotationally driving the lower surface plate 2.

[0085] Besides, the plurality of drive sources 50 for rotationally driving the lower surface plate 2 are driven integrally by a well-known control mechanism.

[0086] In consequence, although the use of a large drive source has been required so far, the plurality of drive sources 55 are provided as a drive mechanism, that is, small drive sources operating in cooperation with each other are used to rotationally drive the lower surface plate 2; whereupon the size reduction of the drive source contributes to the reduction of the manufacturing cost.

[0087] Moreover, when the lower surface plate 2 is turned by the plurality of drive sources 50, the wafer holding member engaging with the internal gear 3 and the sun gear 68, together with the wafer held by this wafer holding member, revolves around the sun gear 68 while rotating around its own axis.

[0088] Meanwhile, the abrasive pad is adhered to each of the upper and lower surface plates 5 and 2 so that the wafer is held between the abrasive pads adhered thereto and even an abrasive is supplied to the abrasive pads, thus ensuring sure polishing effects.

[0089] During the polishing operation, a difference in temperature occurs among an inner circumferential portion, a central portion and an outer circumferential portion of the lower surface plate 2 due to heat generation. Fig. 12 shows the temperature difference arising among the inner circumferential portion, the central portion and the outer circumferential portion of the lower surface plate 2. In the case that the temperature difference occurs among the portions as shown in the illustration, the flatness of the wafer after the polishing becomes defective. Additionally, as well as the lower surface plate 2, such a temperature difference will occur among an inner circumferential portion, a central portion and an outer circumferential portion of the upper surface plate 5.

[0090] For eliminating such a failure in the flatness due to the temperature difference, a temperature adjusting mechanism is provided, which is composed of the plurality of grooves 66 coaxially made in the base 65 under the lower surface plate 2, a temperature sensor positioned in each of the grooves 66 for sensing the temperature of hot water and a temperature adjusting unit for adjusting the temperature of the hot water, to be supplied into the grooves 66, in accordance with the detection temperature by the temperature sensor. The temperature adjusting unit implements proportional control on the basis of a temperature signal issued from the temperature sensor to set the temperature of the hot water to be supplied into the grooves 66 to a predetermined value.

[0091] The hot water undergoing the temperature adjustment circulates in each of the grooves 66 through the supply ports a, b and c, and then gets out through the discharge ports d, e and f. This is repeatedly done while the hot water is controlled in temperature.

[0092] Concretely, each of the grooves 66 is connected independently to each of temperature adjusting circuits, and each of the temperature adjusting circuits is equipped with the temperature sensor forming a detecting member, a hot water supplying unit and a tem-

perature adjusting unit for receiving a signal from the temperature sensor to set the temperature of the hot water from the hot water supplying unit to an arbitrarily set temperature, with this temperature adjusting unit is made to implement the proportional control whereby an output signal is changed proportionally with respect to an input signal. Whereupon, each of the temperature adjusting unit can produce different temperature adjusted water, and the flatness of the lower surface plate plane can be changed in a manner of supplying different-temperature hot water to each base.

[0093] In the conventional construction, a temperature adjusting circuit has not been divided, and only the hot water of the same temperature has been supplied thereto, so that limitation has been imposed on the variation of the flatness of the lower surface plate plane. On the other hand, according to this invention, the flatness condition can easily be altered for the improvement of the finished accuracy of the wafer.

[0094] Incidentally, although only a pipe 132 and a rotary joint 133 are illustrated, grooves are also made in an inner circumferential portion, a central portion and an outer circumferential portion of the base 120 for the upper surface plate 5, and hot water temperature-adjusted independently circulates in each of these grooves.

[0095] Moreover, the resin coating 121 is made on at least the portions of the upper and lower surface plates 5 and 2 which come into contact with the abrasive pads.

[0096] This is because, when the abrasive pads are adhered onto the upper and lower surface plates 5, 2 and the portions thereof protruding from the upper and lower surface plates 5, 2 are cut with a knife or the like, a cut can be made in error.

[0097] Thus, in the case that a cut is made on surface of the upper and lower surface plates 5 and 2, to which the abrasive pad is adhered, the flatness deteriorates, which causes inferiority in the polishing operation of the wafer. For this reason, the resin coating is made on at least surfaces of the upper and lower surface plates 5 and 2, to which the abrasive pad is adhered, thereby eliminating the possibility of the poor wafer polishing operation.

[0098] Furthermore, an abrasive is used for the polishing operation, while, even if not cut exists on the upper and lower surface plates 5 and 2, rust occurs due to the abrasive, which impairs the durability.

[0099] The resin coating 121 can enhance the durability. Incidentally, since the rust due to the abrasive can occur on not only the upper and lower surface plates 5 and 2 but also on the bases 65 and 120 for supporting them, the resin coating 121 can also be conducted on the bases 65 and 120.

[0100] As the materials of this resin coating 121, there is used a silica solution forming a paint/coating material for producing an amorphous ceramic film showing hard and excellent adhesion properties by the usual application.

[0101] Accordingly, the coat formed with this silica solution shows a high flexibility and a high resistance to ultraviolet rays to provide an extreme durability, and additionally shows excellent incombustibility, water repellent, resistance to penetrability, resistance to chemicals and resistance to stains.

[0102] On the other hand, the wafer holding member is rotated and revolved by the internal gear 3 and the sun gear 68 for polishing the upper and lower surfaces of the wafer held therein, while this wafer holding member is always in engaging relation to the internal gear 3 and the sun gear 68. Thus, in the sun gear 68, only a portion of its outer circumferential surface in its height direction engages with the wafer holding member and wears.

[0103] As a means for solving this problem, a sun gear elevating mechanism is put to use.

[0104] That is, for the purpose of preventing the wearing of only a portion of the outer circumferential surface in the height direction due to the engagement with the wafer holding member, the sun gear driving member 71 is shifted upwardly and downwardly by the supply of oil by the oil cylinder 74 and the sun gear 68 itself is together moved upwardly and downwardly so that the engaging portion with the wafer holding member is altered, thereby preventing the partial wearing.

[0105] In addition, although the conventional apparatus has employed a screw as a means for moving the sun gear 68 and the sun gear driving member 71, the use of the oil pressure can simplifies the sun gear elevating mechanism itself, and makes the maintenance easy.

[0106] Still additionally, the oil cylinder 74 is provided with the pitch-feeding unit 134, which enables the minute vertical movements of the sun gear 68 so that the sun gear 68 can be used wholly in its height directions, that is, throughout the total length of each pin constituting the sun gear 68, thus lengthening the service life of each pin, that is, the life of the sun gear 68.

[0107] Moreover, an abrasive is given to the abrasive pads when a wafer is polished between the upper and lower surface plates 5 and 2, while an abrasive recovering mechanism is provided to recover the abrasive used at this time.

[0108] That is, the abrasive supplied to the abrasive pads for the polishing of the wafer drops into the conduit-like drain receiver 100, and this drain receiver 100 is constructed such that one side is lower in position than the other side, and the lead-through pipe 103 coupled to the recovering circuit is set to this one side so that the abrasive dropping into the drain receiver 100 is led through the lead-through pipe 103 to the recovering circuit to be recovered.

[0109] Accordingly, the abrasive (slurry) does not stay in the drain receiver 100 and the recovery efficiency is improvable.

[0110] On the other hand, the conventional apparatus has created a problem, for example, that the abrasive

stays in the drain receiver because the drain receiver is set in a horizontal condition so that the recovery efficiency deteriorates, and the abrasive collected becomes hard and, in some cases, the hardened abrasive is peeled off and recovered to be again used for the polishing processing so that a wafer can be scratched.

[0111] On the other hand, according to this invention, since the drain receiver 100 is set in a tilted condition, there is not possibility that the abrasive stays in the drain receiver 100 to enhance the recovery efficiency, and no collection of the abrasive surely prevents the abrasive hardened from being peeled off to be recovered for the reuse in the polishing process.

[0112] Furthermore, at the completion of the polishing operation, the drive sources 40 and 50 for the aforesaid upper and lower surface plates 5 and 2 come to a stop, and the elevating operating member 18 for the upper surface plate 5 is started so that the upper surface plate 5, the supporting plate 22 and others are together lifted to cause the separation of the upper surface plate 5 from the lower surface plate 2, and further the operating member 27 for turning is started to turn the upper surface plate 5, the supporting plate 22 and others by A for taking out the wafer holding member and the wafer held thereby.

[0113] In addition to the manual method, for the removal of the wafer, it is also appropriate that grooves are made in the upper and lower surface plates 5 and 2, and the upper surface plate 5 is designed to have a larger wafer-contact area than that of the lower surface plate 2 so that the wafer is absorbed on the upper surface plate 5 due to the difference in contact area, and it can be taken out after being moved together with the upper surface plate 5 at the turning.

[0114] According to this invention constructed as described above, a part of the upper surface plate, corresponding to the abrasive pad, is divided into a plurality of portions, while the temperature of each of the portions is detected so that, if a difference in temperature occurs among the portions, the proportional control is implemented to adjust the temperature of the hot water flowing independently in each of the portions for uniformizing, thus uniformizing the flatness of the wafer after the polishing.

[0115] Since the lower surface plate having a large mass is driven with a plurality of drive sources, it is possible to employ a small-sided drive source.

[0116] The using part of the sun gear gearing with the wafer holding member is changed, thus lengthening the durable period of the sun gear.

[0117] While the upper surface plate is moved vertically with respect to the lower surface plate, particularly, when being moved downwardly, the upper surface plate is moved downwardly while keeping a horizontal condition, thereby preventing the upper surface plate from coming eccentrically into contact with the lower surface plate.

[0118] A drain for recovering the abrasive is placed in a tilted state such that the abrasive is naturally led to the external after use; whereupon, the recovery of only the abrasive becomes feasible and the abrasive becomes reusable.

[0119] The upper surface plate is made to be capable of being turned in two steps in horizontal directions with respect to the lower surface plate so that an upper surface of the lower surface plate becomes open, thereby facilitating the mounting of a wafer and the replacement of the abrasive pad.

[0120] A resin coating is made on portions of the upper and lower surface plates, to which the abrasive pad is adhered, to harden this portion, thus surely eliminating the possibility that this portion is cut in error when the abrasive pad is cut by a knife or the like, or that rust occurs at this portion due to the abrasive and others.

[0121] It should be understood that the foregoing relates to only a preferred embodiment of the present invention, and that it is intended to cover all changes and modifications of the embodiment of the invention herein used for the purpose of the disclosure, which do not constitute departures from the spirit and scope of the invention.

Claims

1. A surface polishing apparatus which holds a semiconductor including a wafer, held by a wafer holding member, between upper and lower surface plates (5, 2) rotatable and rotates and revolves said wafer holding member by making said wafer holding member engage with an internal gear (3) and a sun gear (68) and further supplies an abrasive for polishing both surfaces of said wafer, characterised by comprising:

a temperature adjusting mechanism provided on at least a lower surface plate (2) of said upper and lower surface plates (5, 2) for reducing a difference in temperature on a polishing surface;

a driving mechanism made up of a plurality of drive sources (50) which cooperate with each other for rotationally driving said lower surface plate (2);

a sun gear elevating mechanism for changing the height of said sun gear (68) for preventing abrasion of only a portion of said sun gear (68) in a height direction due to the engagement with said wafer holding member;

an upper surface plate level balancing mechanism for preventing said upper surface plate (5) from lowering eccentrically with respect to said lower surface plate (2) at a lowering operation;

an abrasive recovering mechanism made to be open against a circumferential edge portion of said lower surface plate (2) and to lower par-

tially to communicate with an external recovering circuit; and

an upper surface plate turning mechanism for turning said upper surface plate (5) in a horizontal direction with respect to said lower surface plate (2) to provide one of a water mounting position and an abrasive pad replacing position,

a resin coating (121) being formed on said upper and lower surface plates (5, 2) for preventing generation of rust at a portion of said upper and lower surface plates (5, 2) coming into contact with said abrasive and further for preventing a cut from being made on surfaces of said upper and lower surface plates (5, 2) by hardening said surfaces of said upper and lower surface plates (5, 2).

FIG. 1

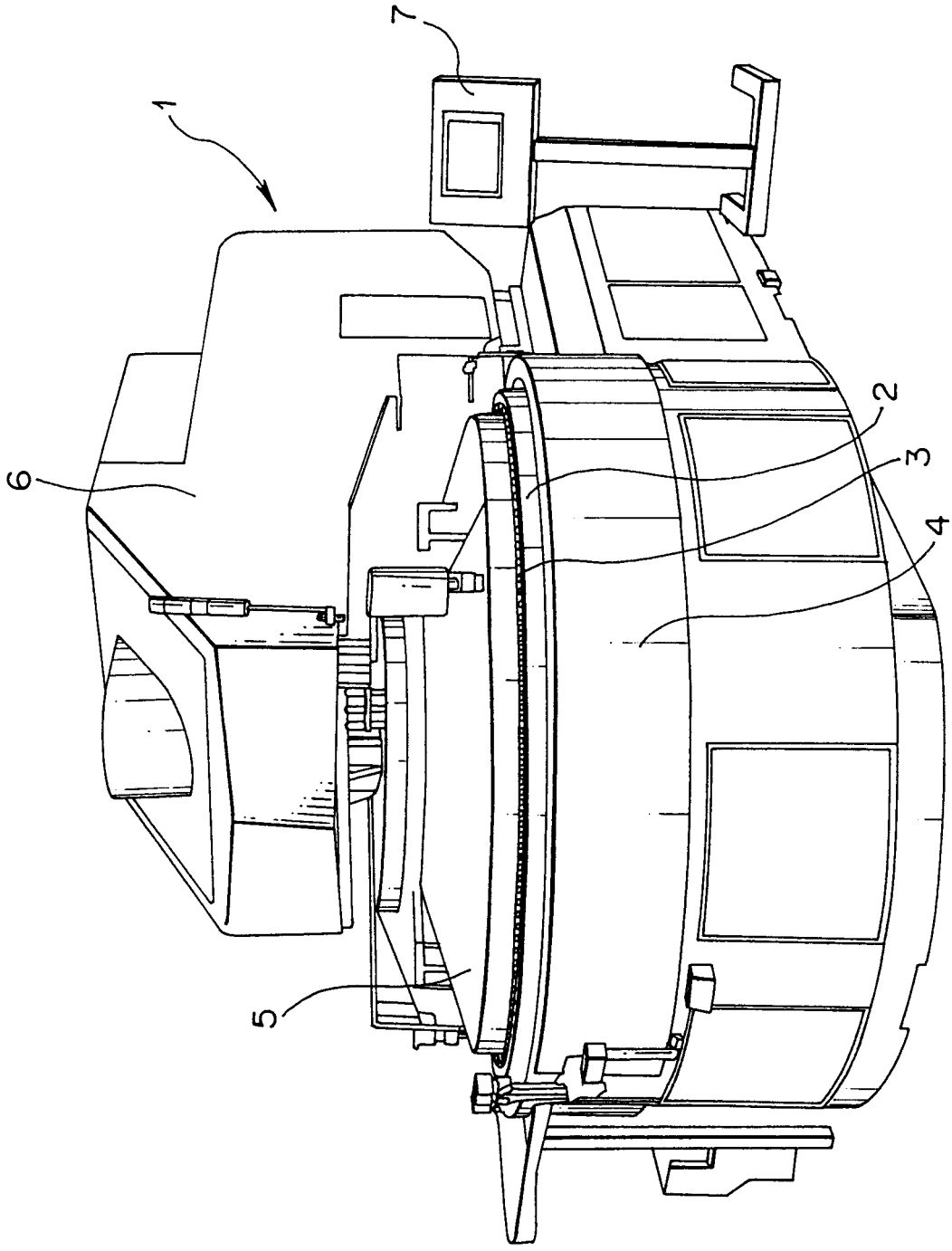
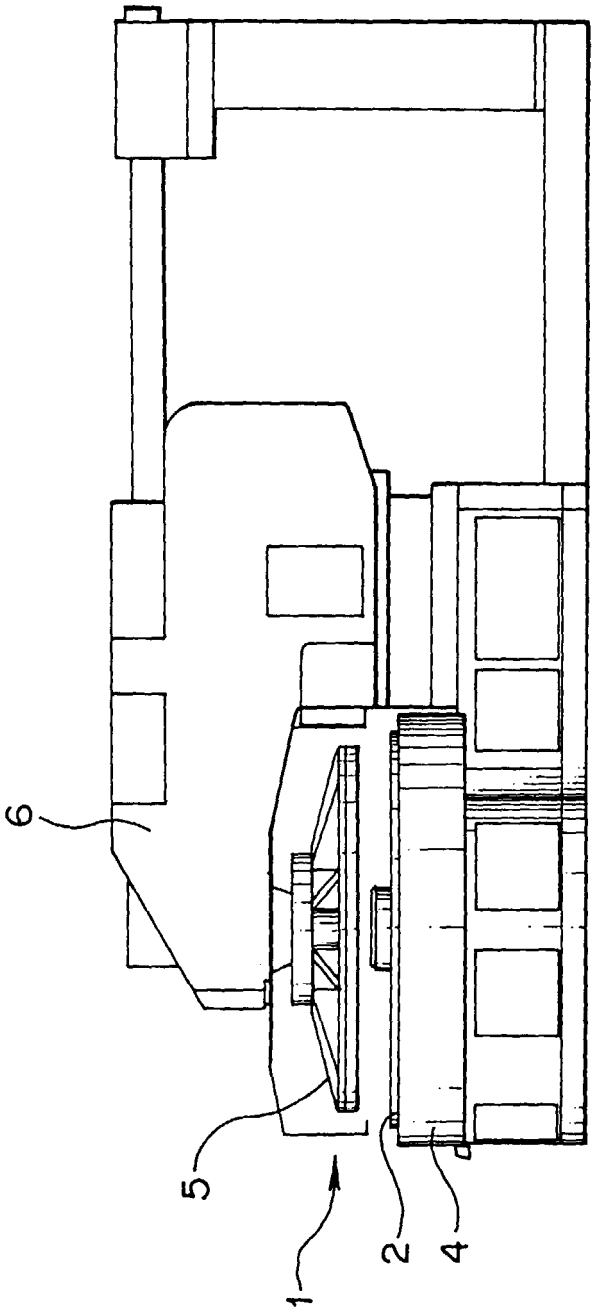


FIG.2



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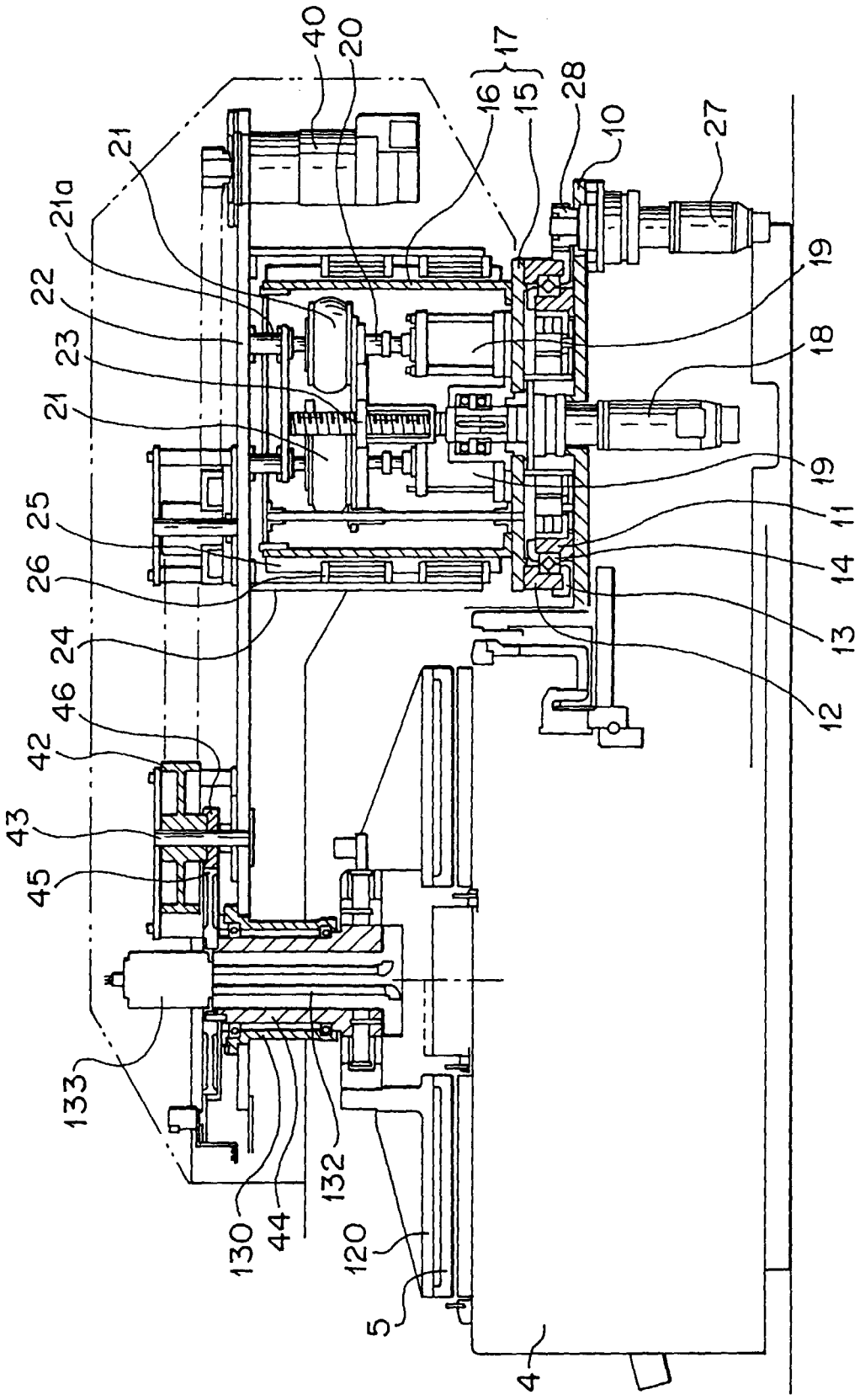
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FIG.4

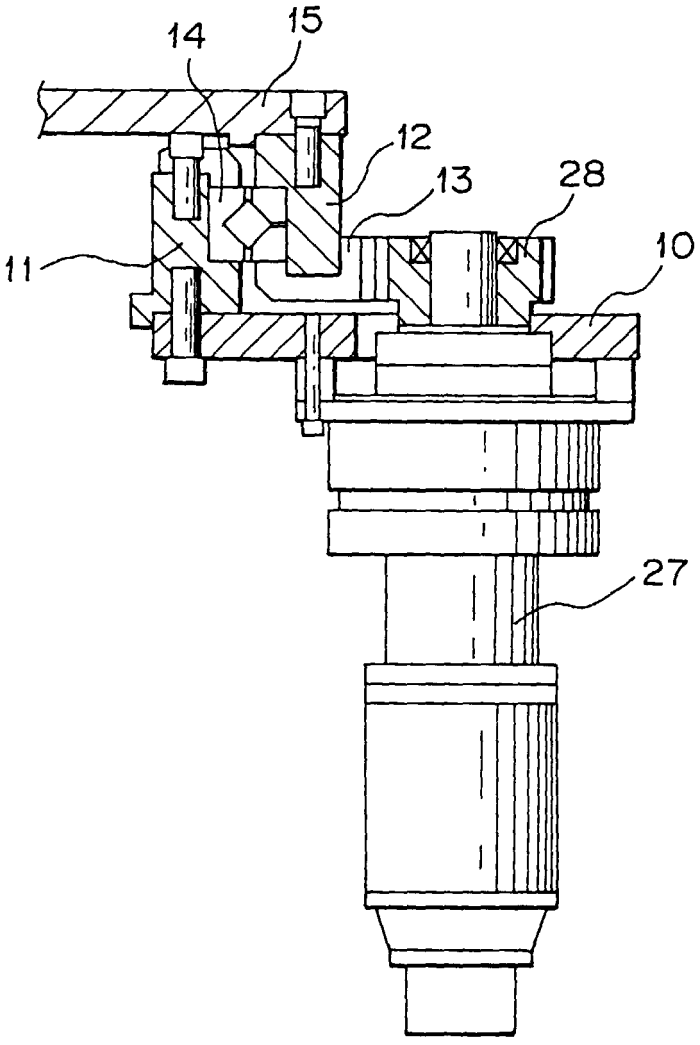

FIG.5

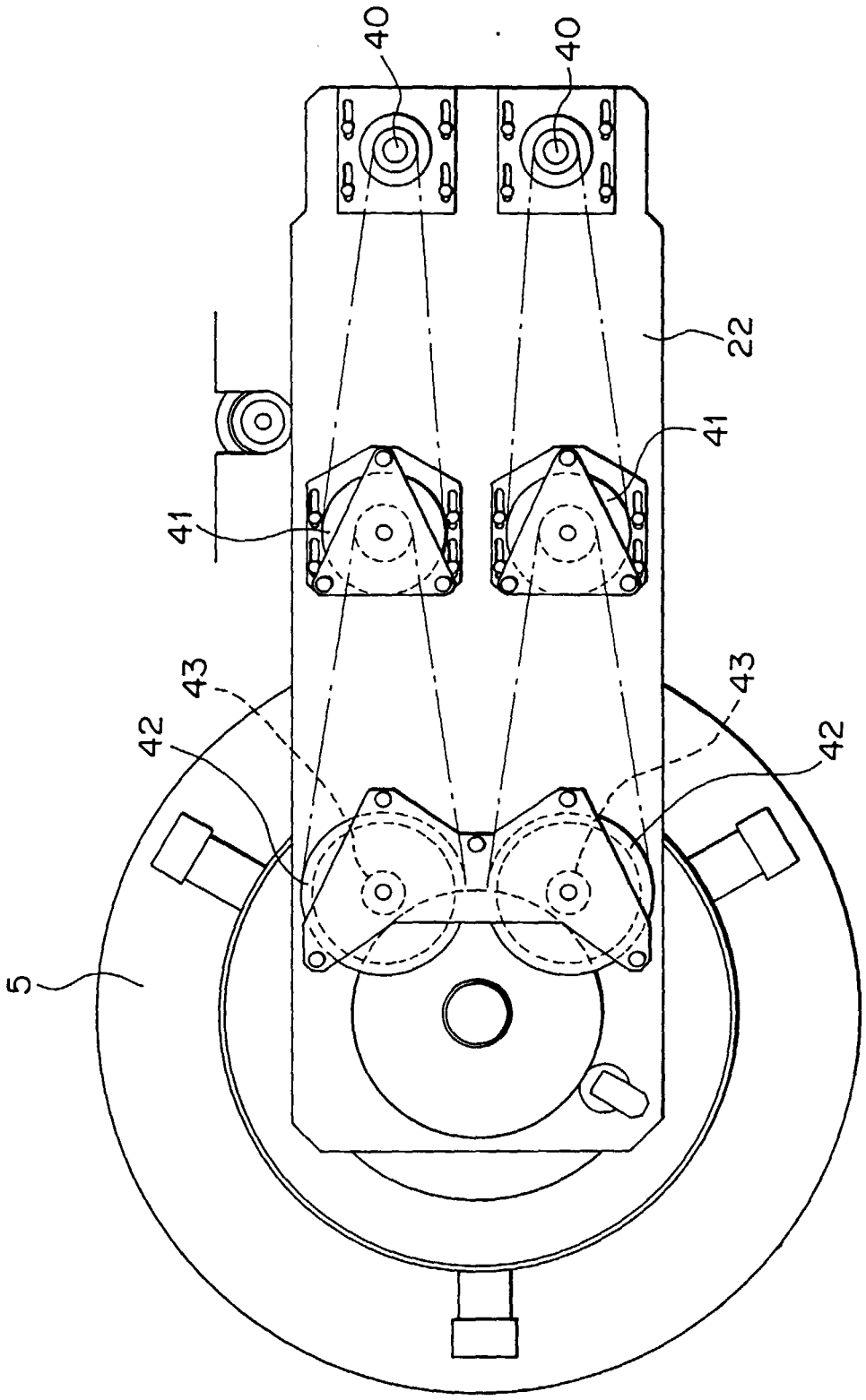

FIG.6

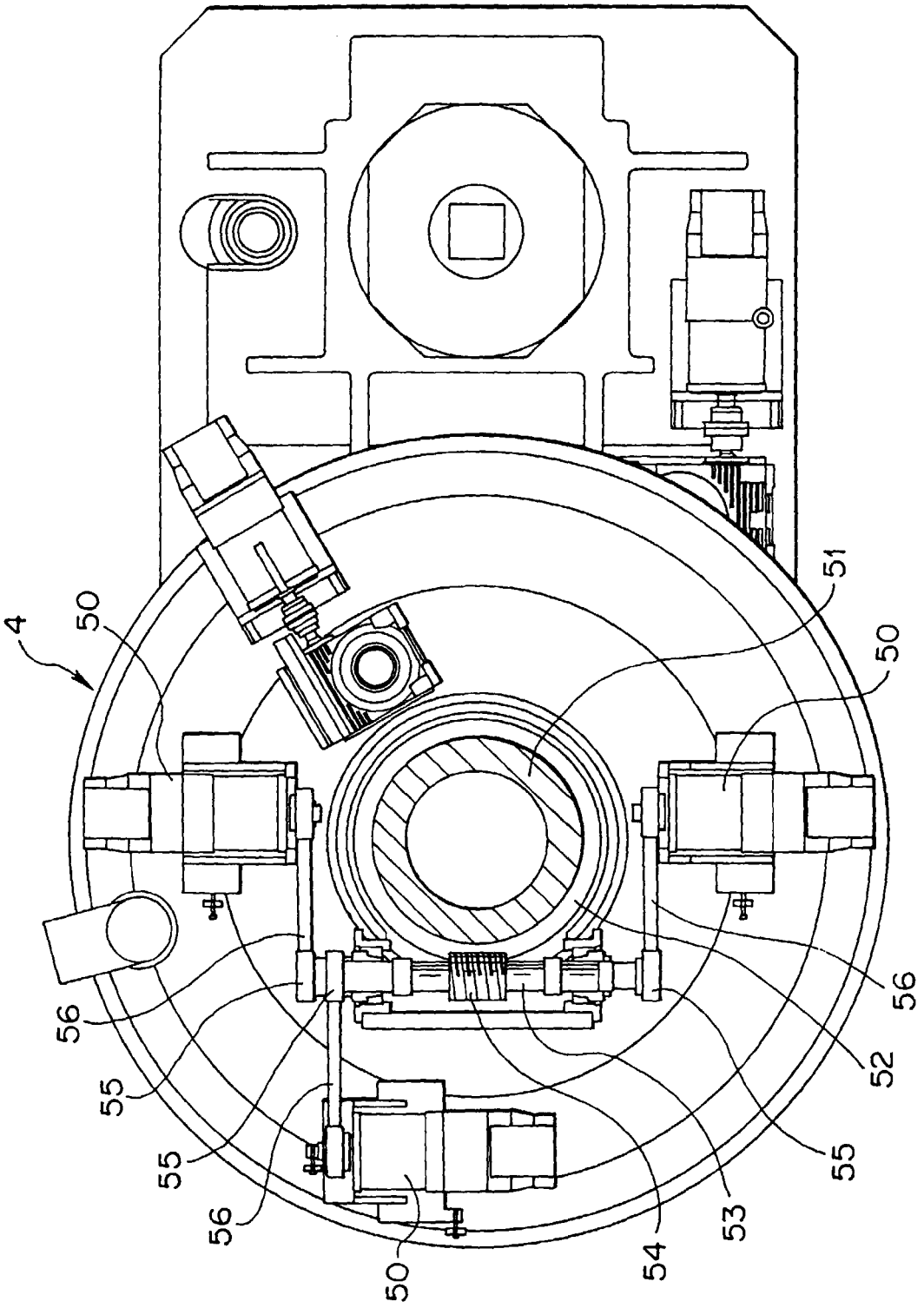

FIG. 7

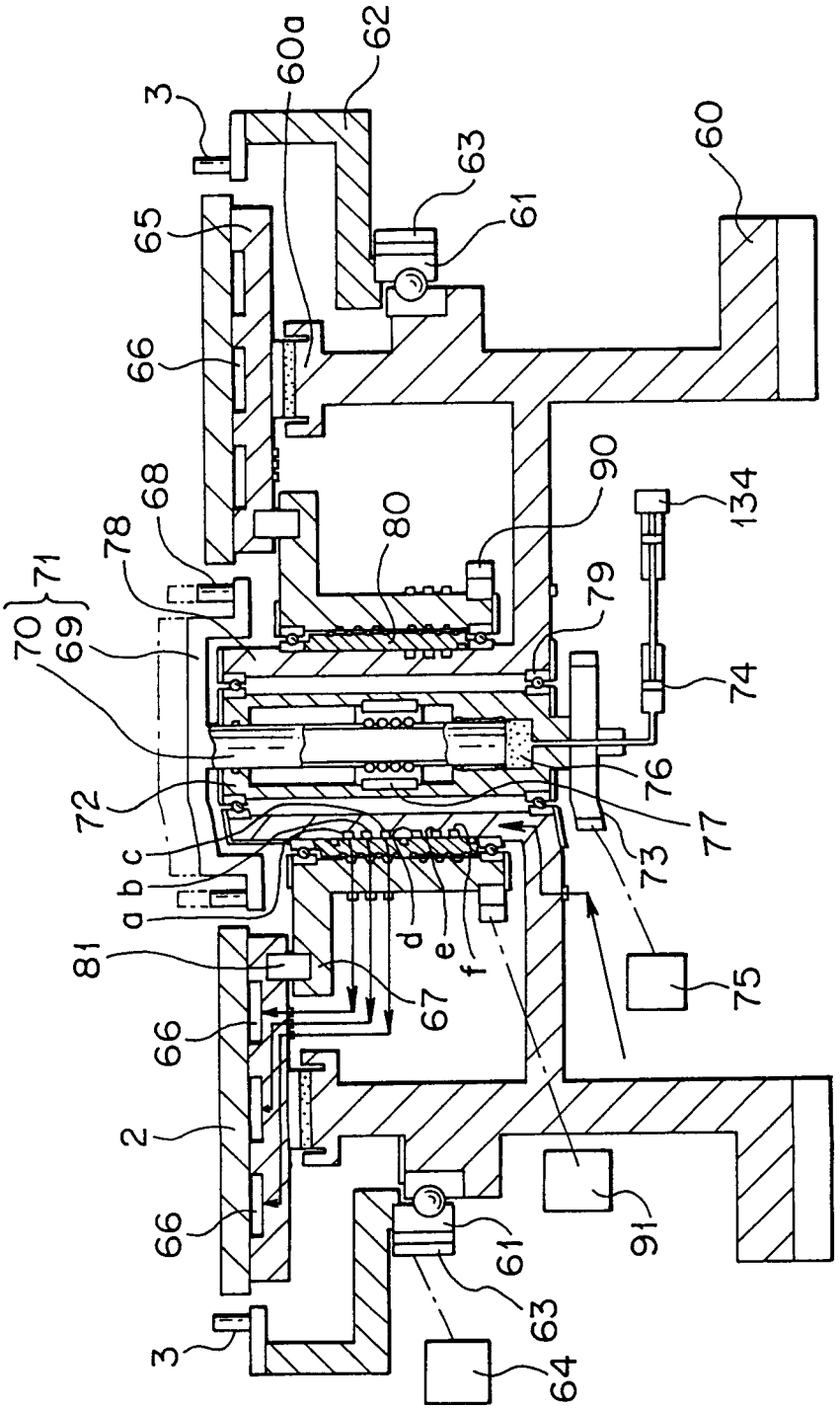
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FIG.8

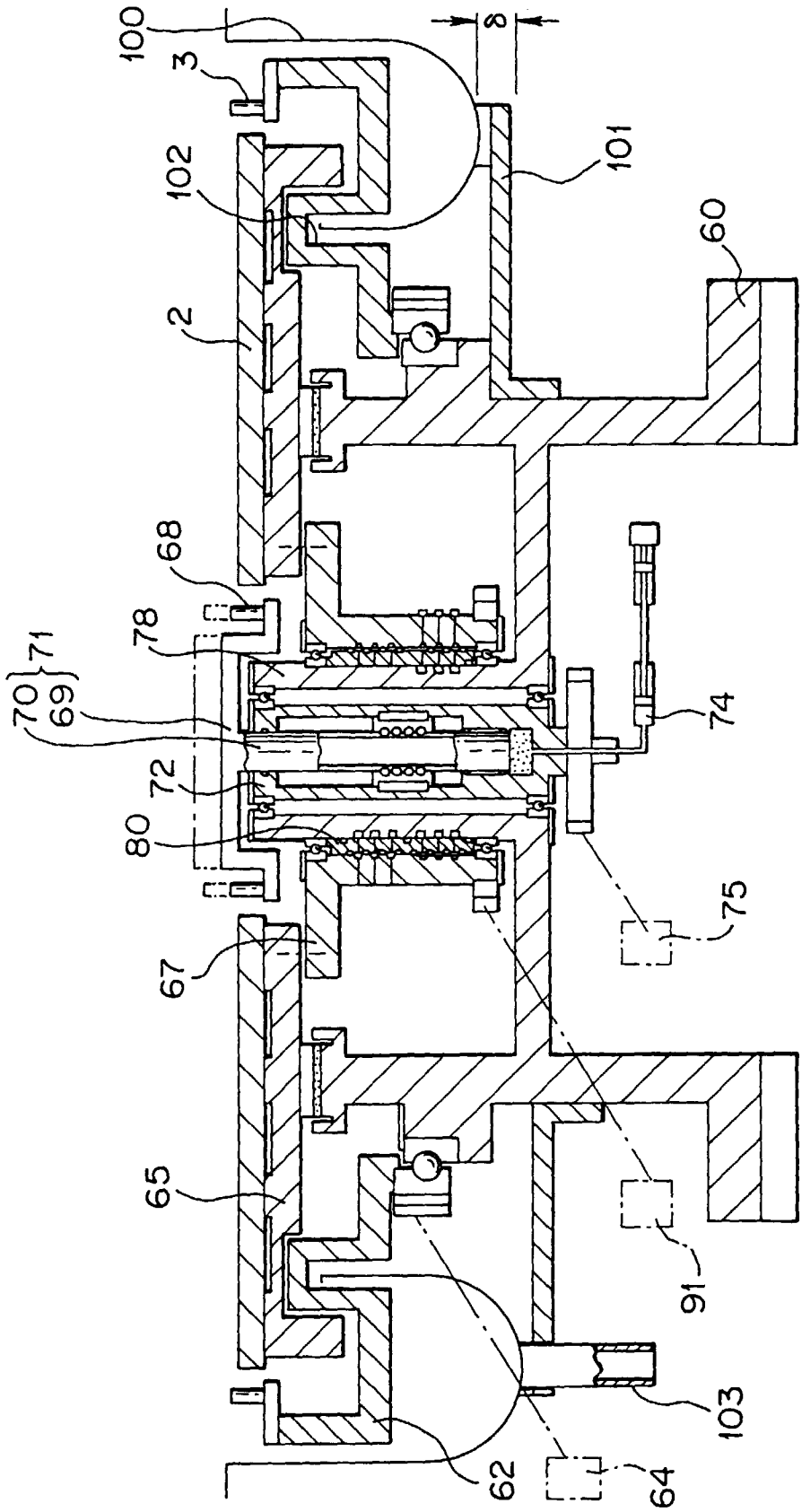

FIG.9

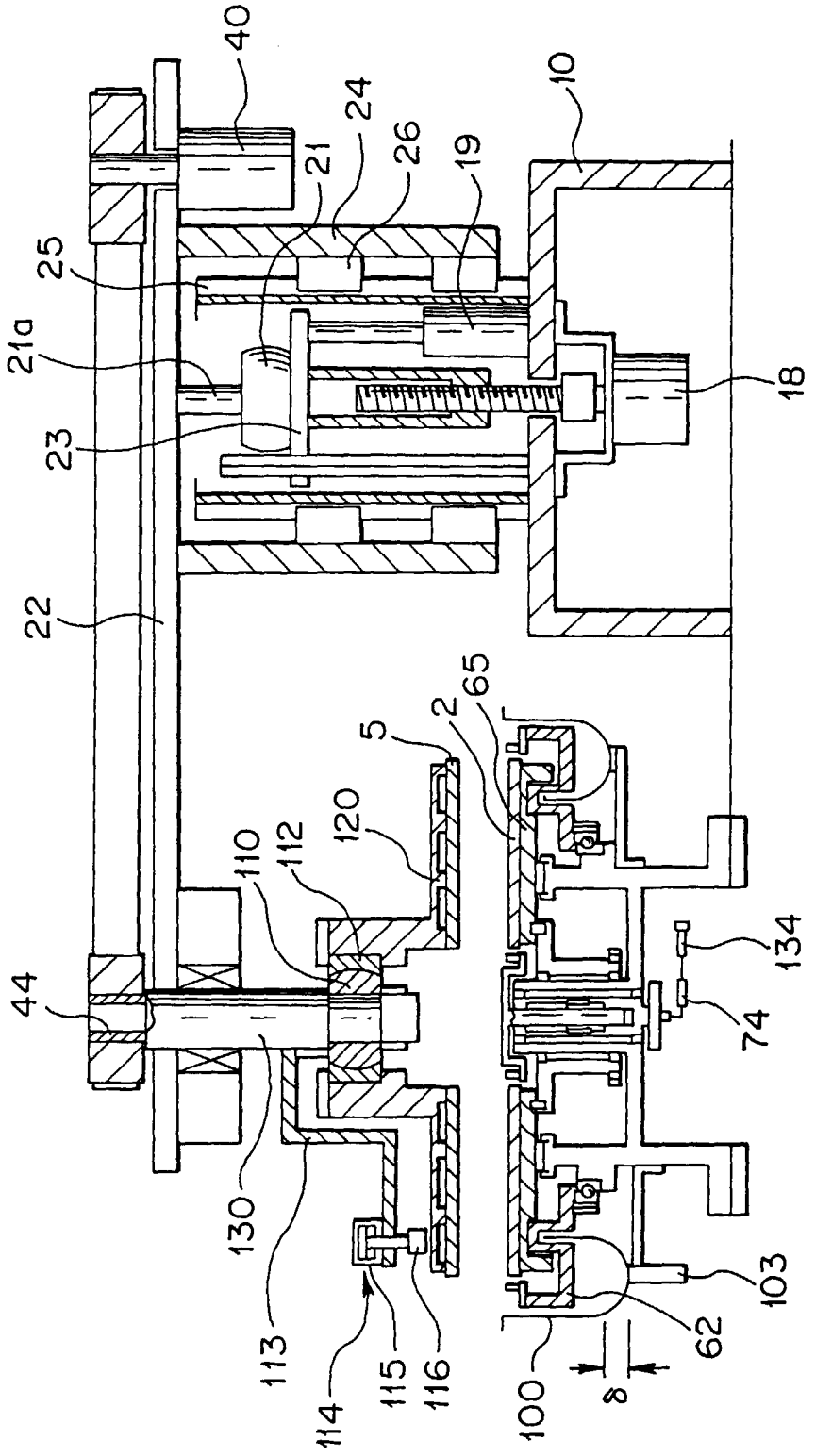
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FIG. 10

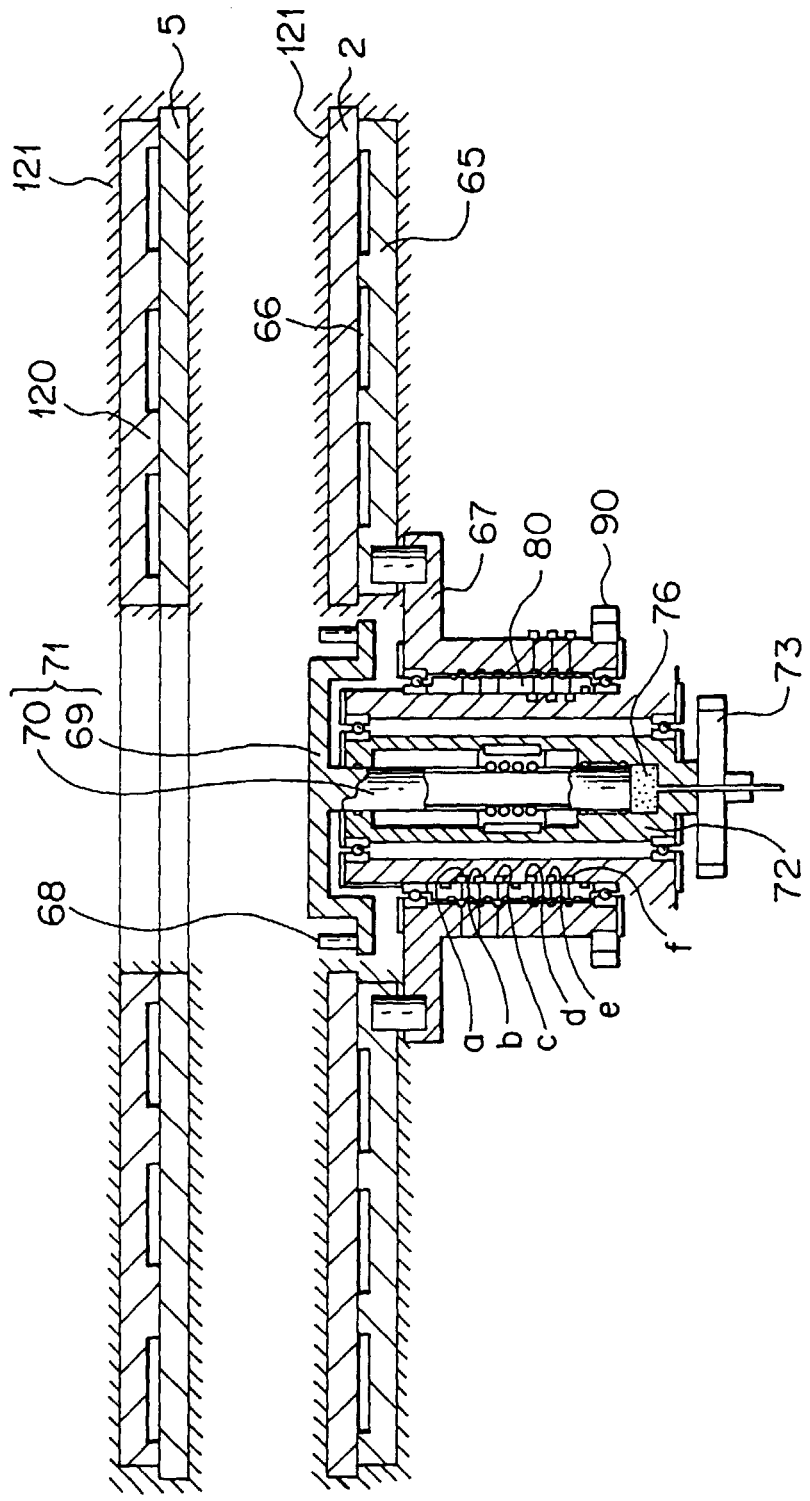


FIG.11

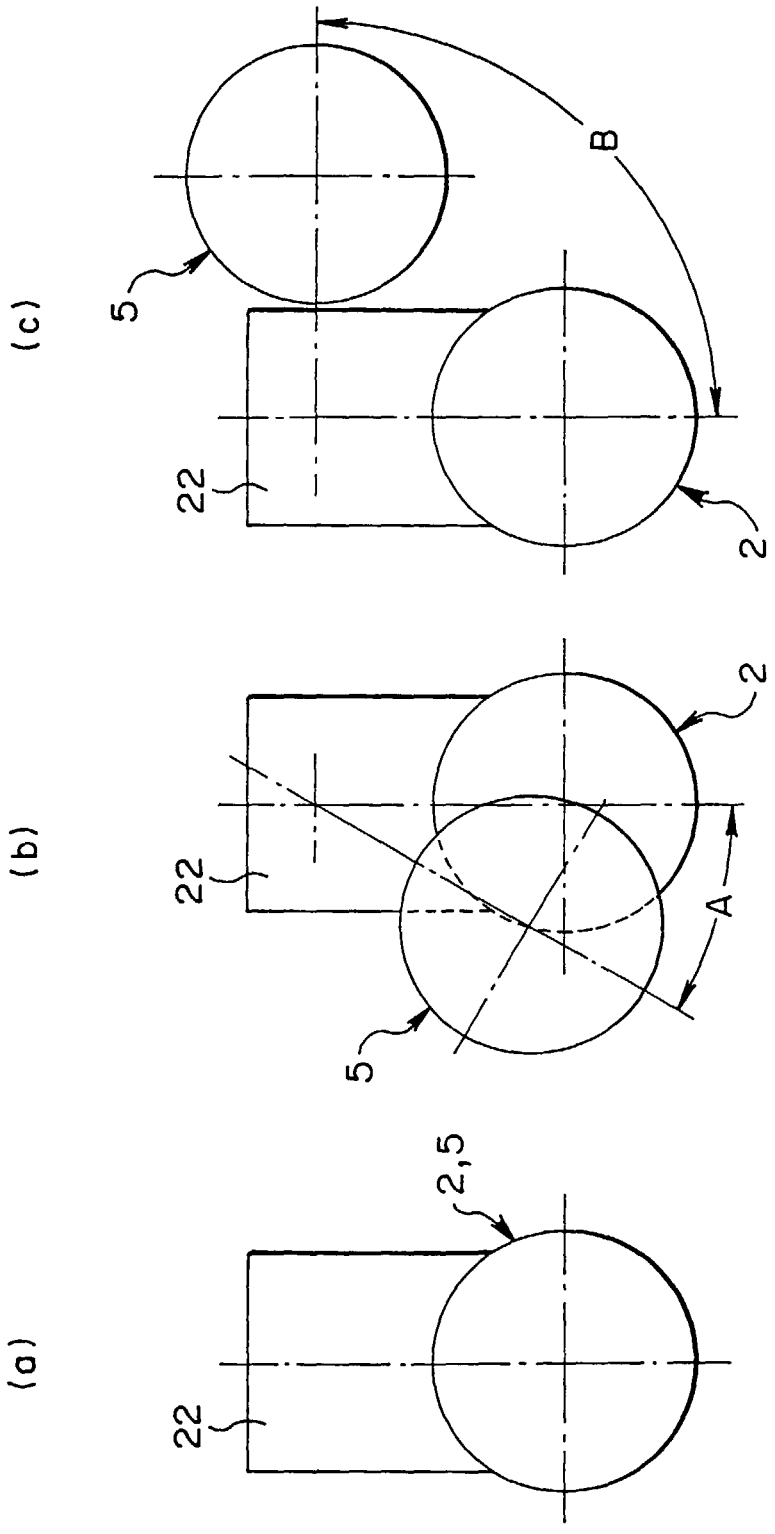
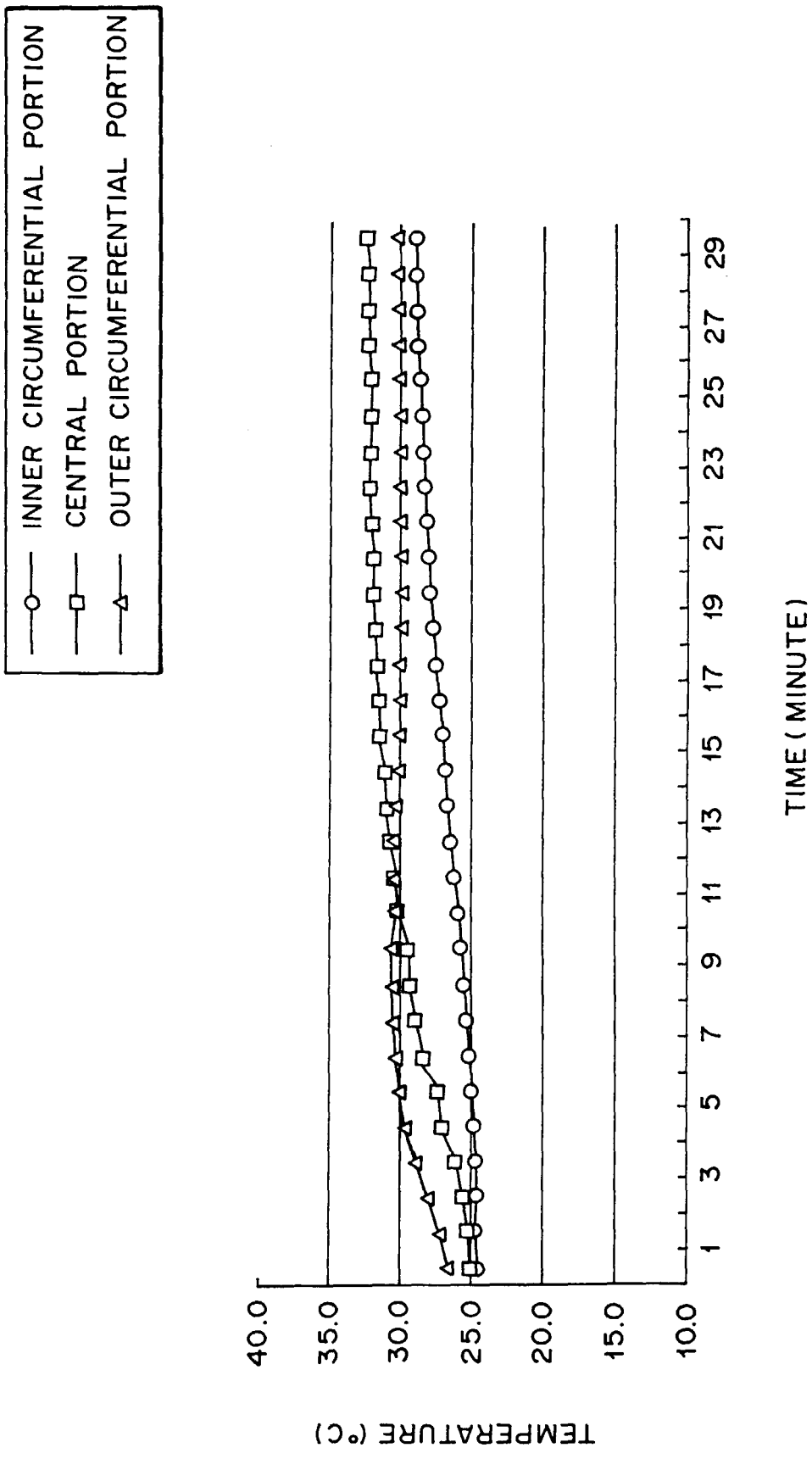


FIG.12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OUTER CIRCUMFERENTIAL PORTION
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15.0
10.0
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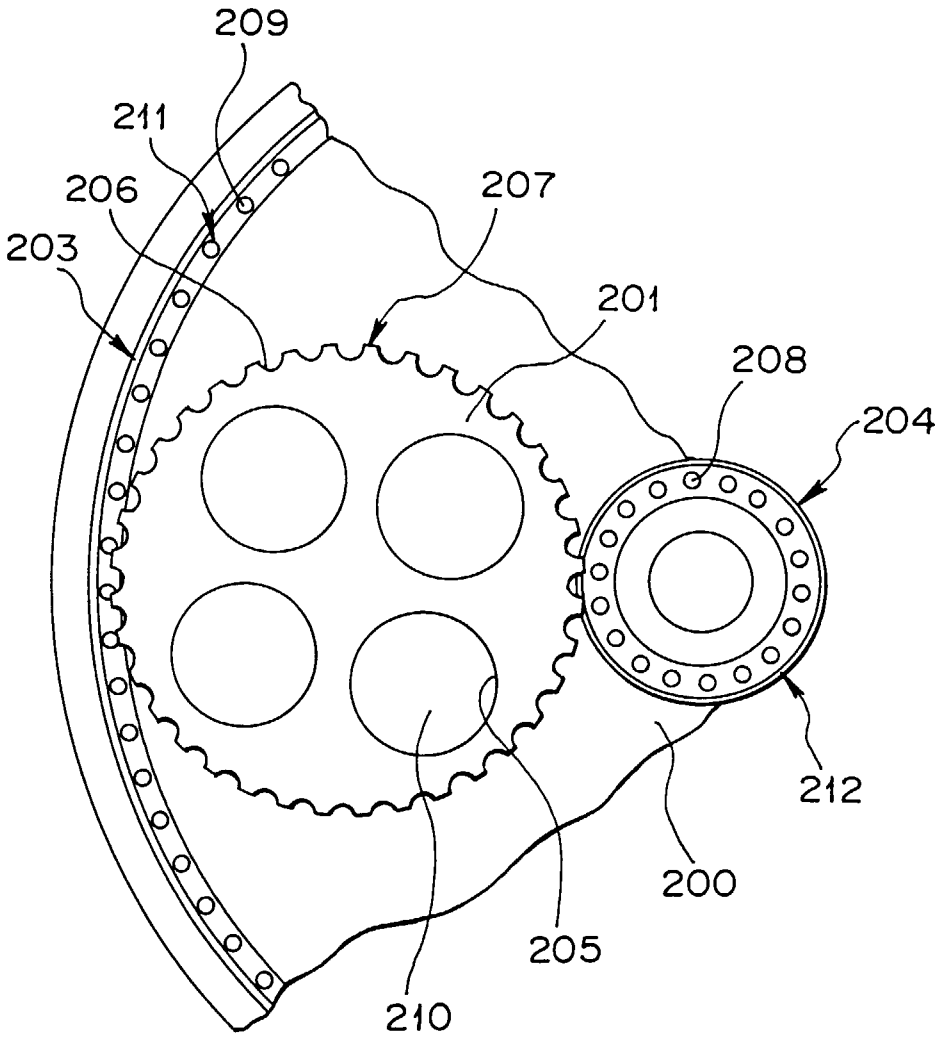
TIME (MINUTE)

FIG. 13



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 11 7210

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	US 5 782 678 A (CESNA ET AL.) 21 July 1998 (1998-07-21) * column 5, line 58 - column 6, line 1 * * column 7, line 1 - line 7 * * column 7, line 36 - line 50 * * column 8, line 65 - line 68 * * column 9, line 60 - line 62 *	1	B24B37/04 B24B41/06 B24B55/02 B24B57/02 //H01L21/304
Y	US 4 916 868 A (WITTSTOCK) 17 April 1990 (1990-04-17) * column 4, line 42 - line 49 *	1	
Y	PATENT ABSTRACTS OF JAPAN vol. 017, no. 130 (M-1382), 18 March 1993 (1993-03-18) -& JP 04 310365 A (TOSHIBA CORP), 2 November 1992 (1992-11-02) * abstract; figure 1 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 04, 30 April 1997 (1997-04-30) -& JP 08 323615 A (KYOCERA CORP), 10 December 1996 (1996-12-10) * abstract *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B24B
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A	US 4 007 560 A (JANSSEN) 15 February 1977 (1977-02-15) * abstract; figures *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24 November 1999	Garella, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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24-11-1999

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