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DICING MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to a dicing machine which dices semiconductor wafers.

Dicing process in the manufacture of semiconductor requires precise control of the depth of a blade cutting into a semiconductor wafer, in order to maintain stable quality of processing. For this purpose, in a dicing machine, the height of the top surface of the semiconductor wafer relative to the blade is first recognized by means of an NC unit (numerical control unit) or the like. Actually, however, setup operation is first carried out to detect the position of the top surface of a chuck table whereon the semiconductor wafer is placed, because thickness of the semiconductor wafer is known in advance. Then the thickness of the semiconductor wafer is added to the top surface position of the chuck table which has been detected, to determine the top surface position of the semiconductor wafer, thereby to control the blade position relative to the semiconductor wafer.

In recent years, noncontacting setup operation is practiced wherein relative position of the chuck table and the blade is recognized without bringing them into contact with

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each other, in order to avoid damaging the blade.

Fig.8 schematically shows a part of a dicing machine of the prior art which carries out noncontacting setup operation.

As shown in the drawing, the conventional dicing machine has a setup stand 12 fixed on the chuck table 10, the setup stand having a top surface 12a which is lower than the top surface 10a of the chuck table 10. A spindle 16 which drives the blade 14 to rotate as indicated by an arrow has a touch sensor 18 fixed thereon via a fastening member which is not shown in the drawing. The touch sensor 18 switches on and off as a top end 21a of a guide bar 21 which is linked with a setup piece 20 touches a contact point 18a.

Because the touch sensor 18 has a very small response range, a specified clearance a (0.3mm for instance) has been provided between the contact point 18a and the top end 21a of guide bar 21 in the prior art, in order to prevent such an erroneous operation as switching by vibration. Also in the vicinity of the chuck table 10, a laser sensor 22 is installed which detects a member (the blade 14, the setup piece 20 or the like), which is located at the reference position, without making contact by means of a laser beam 22a emitted at a specified height (reference position) relative to the top surface 10a of the chuck table 10.

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In the conventional dicing machine, setup operation is carried out as described below.

Bottom ends of the blade 14 and the setup piece 20 are lowered successively to the position of the laser beam 22a thereby to detect the height of the reference position relative to the blade 14 and the setup piece 20. Then the setup piece 20 is brought into contact with a setup stand 12 and the height of the top surface 12a of the setup stand 12 relative to the setup piece 20 is detected through switching operation of the touch sensor 18 under this condition.

Upon completion of the setup operation described above, then the height of the top surface 10a of the chuck table 10 relative to the blade 14 is determined from the positional relations of the components which have been detected.

Specifically, vertical distance b between the top surface 12a of the setup stand 12 and the reference position is determined first, then height difference c between the known top surface 12a and the top surface 10a of the chuck table 10 is added to the distance b (b+c), to determine the height of the top surface 10a of the chuck table 10 relative to the reference position. Actually, however, because the clearance a exists between the touch sensor 18 and the setup piece 20, dimension a is used as a correction value to calculate (b+c)+a

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from which the height of the top surface 10a of the chuck table 10 relative to the reference position is determined. Because positional relationship of the blade 14 and the reference position has been recognized in the setup operation described previously, the height of the top surface 10a of the chuck table 10 relative to the blade 14 can be determined by adding the value (b+c)+a to the height of the reference position relative to the blade 14.

Then the cutting depth of the blade 14 is controlled according to the height over the top surface 10a of the chuck table 10 determined as described above.

In the conventional dicing machine, dimension of the clearance a may be changed during maintenance service of the touch sensor 18, and therefore it has been necessary to confirm the dimension of the clearance a every time maintenance service is done. For example, dimension of the clearance a is changed slightly (50 micrometers for instance) and trial cutting is done on a plurality of dummy wafers thereby to determine the proper dimension of clearance a.

This has been decreasing the operation efficiency and causing adverse effect on the productivity.

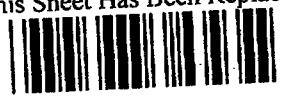
SUMMERY OF THE INVENTION

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In view of these problems, the present invention has a purpose of providing a dicing machine which is capable of improving the productivity.

The invention according to claim 1 achieves the purpose with a dicing machine which dices a semiconductor wafer, which is fixed on a processing table, by means of a blade driven to rotate by a spindle, the dicing machine being provided with a contactor arranged at a position where it can contact the processing table, a contactor holding mechanism which holds the contactor in such a way as the contactor can move forward and backward relative to the top surface of the processing table, holding mechanism moving means which brings the contactor into contact with the top surface of the processing table by controlling the position of the contactor holding mechanism, retracting distance detecting means which detects the amount of reaction of the contactor when it is brought into contact with the top surface of the processing table by the holding mechanism moving means, processing table position recognizing means which recognizes the top surface position of the processing table relative to the contactor from the amount of retraction detected by the retracting distance detecting means, noncontacting measuring means which measures the relative position of the contactor and the blade without making

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contact, and positional relationship recognizing means which recognizes the positional relationship between the blade and the top surface of the processing table, from the relative position of the contactor and the blade measured by the non-contacting measuring means and the top surface position of the processing table relative to the contactor which was recognized by the processing table position recognizing means.

The invention according to claim 2 achieves the purpose with a dicing machine of claim 1 which is further provided with fastening means which fastens the contactor holding mechanism onto the spindle, while the holding mechanism moving means controls the position of the contactor holding mechanism by moving the spindle, and the contactor holding mechanism is provided with contactor driving means which makes the contactor retract from the blade during dicing operation and makes the contactor protrude beyond the blade when it is in contact with the processing table.

The invention according to claim 3 achieves the purpose with a dicing machine of claim 1 wherein the noncontacting measuring means has an optical sensor which detects a member located at a reference position without making contact, by means of a light beam emitted onto the reference position which is set in a specified positional relationship with the

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top surface of the processing table, and measures the relative position of the blade and the contactor by detecting the blade and the contactor by means of the optical sensor and determining the positions of the blade and the contactor relative to the reference position.

In the dicing machine according to claim 1, the holding mechanism moving means controls the position of the contactor holding mechanism to bring the contactor into contact with the top surface of the processing table. This causes the contactor to take the retracting position while the retraction distance detecting means detects the retracting distance. The processing table position recognizing means recognizes the top surface position of the processing table relative to the contactor from the retracting distance detected by the retraction distance detecting means. The noncontacting measuring means measures the relative position of the contactor and the blade without making contact. The positional relationship recognizing means recognizes the positional relationship between the blade and the top surface of the processing table, from the relative position of the contactor and the blade which was measured by the noncontacting measuring means and the top surface position of the processing table relative to the contactor which was recognized by the processing table

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position recognizing means. Then the blade position is controlled according to the positional relationship between the blade and the processing table which has been recognized, thereby to control the cutting depth of the blade into a semiconductor wafer which is fixed on the processing table.

In the dicing machine according to claim 2, the holding mechanism moving means controls the position of the contactor holding mechanism by moving the spindle. Dicing process of the semiconductor wafer is carried out as the holding mechanism moving means moves the spindle to a specified position. During dicing operation, the contactor driving means makes the contactor retract from the blade. When the holding mechanism moving means brings the contactor into contact with the top surface of the processing table, the contactor driving means makes the contactor protrude beyond the blade. Through these operations, the blade and the contactor do not interfere with each other, even when the top surface of the processing table on which the contactor is brought into contact and the plane whereon the semiconductor wafer is fixed are flush. The processing table position recognizing means recognizes the position of the surface of the processing table on which the semiconductor wafer is fixed, namely the back surface of the semiconductor wafer.

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In the dicing machine according to claim 3, the noncontacting measuring means detects the blade and the contactor by means of the optical sensor and determines their positions relative to the reference position, thereby to measure the relative position of the blade and the contactor.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic plan view showing the entire dicing machine according to an embodiment of the invention.

Figure 2 is an oblique view showing dicing processing section of the above machine.

Figure 3 is a sectional side view showing the structure of the laser sensor in the above machine in detail.

Figure 4 is a front view of the sensor mechanism in the above machine.

Figure 5 is a partially cutaway side view of the sensor mechanism in the above machine.

Figure 6 is a rear view of the sensor mechanism in the above machine.

Figure 7 is a front view showing schematically the positional relationship of components in the above machine.

Figure 8 is an explanatory drawing showing schematically the positional relationship of components in the dicing

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machine of the prior art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the dicing machine according to the invention will now be described in detail below with reference to Fig.1 through Fig.7.

Fig.1 shows the dicing machine of this embodiment schematically.

As shown in the drawing, the dicing machine 30 has a stocker 32 where a plurality of semiconductor wafers are stored, a wafer feeder unit 34 which carries out and carries in the semiconductor wafer from and to the stocker 32, a dicing process unit 36 which carries out dicing process of semiconductor wafers, a rinsing unit 38 which rinses processed semiconductor wafers, and a transfer loader 40 which transfers the semiconductor wafers between the wafer feeder unit 34, the dicing process unit 36 and the rinsing unit 38 as indicated by arrow K.

Fig.2 shows the dicing process unit 36. In this drawing, X axis and Y axis, perpendicular to each other, are set in the horizontal plane and Z axis is set in the vertical direction.

As shown in Fig.2, the dicing process unit 36 has a chuck table 42 whereon the semiconductor wafer (not shown) is

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placed. The chuck table 42 holds the semiconductor wafer by sucking air. The chuck table 42 is also fixed on an X axis table 44 and is driven to rotate by a motor which is not shown in the drawing. The X axis table 44 is guided by a guide rail 50 to move horizontally in X axis direction by the rotation of a ball screw 48 driven by an X axis motor 46.

The dicing process unit 36 is also provided with a Y axis table 56 which is moved horizontally in Y axis direction by a Y axis motor 52 and a ball screw 54. Fixed on the Y axis table 56 is a vertical motion mechanism 66 which moves a spindle motor 60, that drives a disk-shaped blade 58, vertically in Z axis direction by means of a spindle vertical movement motor 62, a ball screw 64 and others. As the spindle motor 60 is moved down by the vertical motion mechanism 66, the blade 58 cuts into the semiconductor wafer.

Also fixed on the Y axis table 56 is a microscope 68 via a fastening member 70. The microscope 68 is used to get magnified views of the top surface of the chuck table 42 and the surface of the semiconductor wafer, and is moved vertically in Z axis direction relative to the fastening member 70 by a vertical motion mechanism not shown in the drawing. Focusing of the microscope 68 is adjusted by this vertical motion.

As shown in Fig.1, a laser sensor 72 used in setup is

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fixed on the X axis table 44.

Fig.3 shows the structure of the laser sensor 72.

As shown in this drawing, the laser sensor 72 has a light emitter 74 for emitting laser beam R, a light receiver 76 and mirrors 78a, 78b which guide the laser beam R emitted from the light emitter 74 to the light receiver 76. The laser sensor 72 is arranged so that the laser beam R emitted from the light emitter 74 converges at a mid point between the mirror 78a and the mirror 78b. The laser sensor 72 is also arranged so that the blade 58 moves across the laser beam R at its converging point P as shown in Fig.3, so that the edge of the blade 58 and others is detected by using the change in the intensity of light received on the light receiver 76.

In this embodiment, the spindle motor 60 has a sensor mechanism 80 mounted thereon to carry out setup operation, as shown in Fig.1 and Fig.2.

Fig.4 through Fig.6 show the detailed configuration of the sensor mechanism 80, Fig.4 showing the front view, Fig.5 showing the rear view and Fig.6 showing the side view of the sensor mechanism 80. In these drawings, the spindle motor 60 and the blade 58 are indicated by alternate long and two short dashes lines to show the assembling relationship.

The sensor mechanism 80 has a substantially L-shaped

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support block 84 which is mounted on the top and side of the spindle motor 60 by means of bolts 82a, 82b, etc. A vertical motion support 84a, located at the side of the spindle motor 60 on the support block 84, is provided with a setup piece 86 arranged at the lower end thereof.

The setup piece 86 is used in setup operation for the laser sensor 72 and the chuck table 42, similarly to the prior art, and is provided with a light interrupter 86a of thin sheet configuration attached at the bottom thereof, as shown in the cross section in Fig.5 of A-A line in Fig.4. The bottom surface of the light interrupter 86a is formed in a curved surface having a curvature similar to that of the periphery of the blade 58, as shown in Fig.4.

In this embodiment, the setup piece 86 is fixed at the bottom of two guide bars 88a, 88b as shown in the cross sectional view of Fig.4. These guide bars 88a, 88b are inserted into through holes 90a, 90b formed in the vertical motion support 84a, respectively, thereby to vertically penetrate the vertical motion support 84a. Arranged between steps formed at the bottom of the through holes 90a, 90b and the top end surface of the setup piece 86 are compressed oil springs 91a, 91b, respectively, which force the setup piece 86 downward.

At the top ends of the guide bars 88a, 88b, on the other

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hand, a locking member 92 is fixed while an air cylinder 94 is fixed on the locking member 92 as shown in Fig.6. The air cylinder 94 has a cylinder body 96 having a pressure chamber (not shown) inside thereof, a piston rod 98 linked at the top end thereof with a piston (not shown) which is housed in the pressure chamber inside the cylinder body 96, and an air supply port 100 which supplies compressed air into the cylinder body 96. The air supply port 100 is connected with air supplying means such as a pump or the like which is not shown in the drawing.

The piston rod 98 is fixed at its bottom end on the support block 84, so that it does not move relative to the support block 84 together with the piston provided in the cylinder body 96. Consequently, pneumatic pressure applied onto the piston acts to move the cylinder body 96 vertically leaving the piston rod 98 remaining at the position. Also because the cylinder body 96 is in fixed relationship with the guide bars 88a, 88b via the locking member 92, driving of the air cylinder 94 results in a vertical movement of the setup piece 86. That is, driving of the air cylinder 94 causes the cylinder body 96, the locking member 92, the guide bars 88a, 88b and the setup piece 86 as a whole to move vertically relative to the vertical motion support 84a.

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However, stroke L (refer to Fig.4) of this vertical motion is limited by the locking member 92 and the setup piece 86 making contact with the top end surface and the bottom end surface of the vertical potion support 84a, respectively. In Fig.4 through Fig.6, the air cylinder 94 is in actuated state with compressed air being supplied into the cylinder body 96, and the setup piece 86 is located at the uppermost position T by resisting the forces of the coil springs 91a, 91b and contacting the bottom surface of the vertical motion support 84a. When the air in the cylinder body 96 is exhausted and accordingly the locking member 92 is forced down by the coil springs 91a, 91b into contact with the top end of the vertical motion support 84a, the setup piece 86 takes the lowermost position U as indicated by dashed line in Fig.4.

This embodiment is configured so that, when the setup piece 86 takes the uppermost position T, the bottom end thereof is positioned above the bottom position B of the blade 58 and, when the setup piece 86 takes the lowermost position U, the bottom end of the setup piece 86 is positioned below the bottom position B of the blade 58.

In the sensor mechanism 80 of this embodiment, on the other hand, the vertical motion support 84a is provided with a distance measuring instrument 102, as shown in Fig.4. The

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distance measuring instrument 102 consists mainly of a distance measuring instrument body 102a which is fixed by having part thereof housed in the vertical motion support 84a, and a measuring probe 102c which is moved vertically relative to the distance measuring instrument body 102a by contracting and elongating a bellows-like cover 102b.

The measuring probe 102c is fixed at the bottom thereof on the top end surface of the setup piece 86, so that it moves vertically in linkage with the setup piece 86. The distance measuring instrument body 102a outputs an electrical signal that represents the traveling distance of the measuring probe 102c, namely the traveling distance of the setup piece 86. As the distance measuring instrument 102, for example, an electrical micrometer or the like having a resolution of 1 micrometer or higher is used. The cover 102b is provided in order to prevent coolant, which is supplied to the cutting point during cutting operation, from entering the inside of the distance measuring instrument 102.

In this embodiment, driving operation of the drive unit, namely the X axis motor 46, the Y axis motor 52 or the air cylinder 94 for instance, is controlled by a control unit such as an NC unit which is not shown in the drawing, and the position of each unit is recognized by the control unit

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through a detection signal of a position sensor, the measuring probe 102c or the like.

Now the setup operation in the embodiment configured as described above will be described below. In the description that follows, it is assumed that components of the dicing machine 30 operate under the control of the control unit not shown in the drawing, while such description may be omitted in the following.

In the dicing machine 30 of this embodiment, the setup piece 86 is normally driven by the air cylinder 94 to take the uppermost position T shown in Fig.4 through Fig.6. In this initial state, when the control unit not shown generates a setup start signal, setup operation by the sensor mechanism 80 is started.

(Setup onto the top surface of the chuck table)

First, air in the cylinder body 96 is exhausted, thereby to make the setup piece 86 of the sensor mechanism 80 move down to the lowermost position U by the force of the coil springs 91a, 91b. Then the X axis motor 46 and the Y axis motor 52 move the X axis table 44 and the Y axis table 56 to specified positions, thereby to position the sensor mechanism 80 above the chuck table 42.

Then the spindle vertical drive motor 62 of the vertical

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motion mechanism 66 moves the spindle motor 60 downward, thereby to bring the setup piece 86 of the sensor mechanism 80 into contact with the top surface of the chuck table 42.

At this time, because the bottom end of the setup piece 86 is positioned below the blade 58 in this embodiment, only the setup piece 86 contacts the chuck table 42 without having the blade contacting the top surface of the chuck table 42.

When the setup piece 86 contacts the chuck table 42, the setup piece 86 moves (upward) relative to the vertical motion support 84a against the forces of the coil springs 91a, 91b by the distance the spindle motor 60 moves down. On the other hand, the control unit not shown monitors the output given by the distance measuring instrument 102 at this time, thereby to check to see whether the setup piece 86 contacts the chuck table 42 or not.

When a signal corresponding to the traveling distance of the setup piece 86 is output from the distance measuring instrument 102, the control unit not shown stops the downward movement of the spindle motor 60 and recognizes the traveling distance of the setup piece 86. Then the control unit subtracts the traveling distance of the setup piece 86 which has been recognized from the downward moving distance of the spindle motor 60, thereby to determine the height at which the

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light interrupter 86a makes contact with the chuck table 42. That is, top surface height of the chuck table 42 relative to the setup piece 86 is determined.

(Setup to the reference position)

When the top surface height of the chuck table 42 is determined, the spindle motor 60 is moved upward to a height where the light interrupter 86a departs from the chuck table 42. Then by moving the X axis table 44 and the Y table 56 again, the setup piece 86 is positioned right above the light converging point P (refer to Fig.3) in the laser sensor 72, thereby to move down the spindle motor 60 again. This causes the bottom end of the setup piece 86 moves down to the height of the laser beam R, the height being detected by the laser sensor 72. When the bottom end of the setup piece 86 is detected by the laser sensor 72, the control unit not shown stops the downward movement of the spindle motor 60 and, at the same time, recognizes the height of the laser beam R relative to the setup piece 86, namely the height of the reference position, from the position of the spindle motor at this time.

(Calculation of the top surface height of the chuck table 42 relative to the reference position)

Fig.7 schematically shows the positional relationships of

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the components of the dicing machine 30.

When the reference position and the height of the top surface of the chuck table 42 relative to the setup piece 86 are determined as described above, the control unit not shown determines, from the traveling distance of the spindle motor 60 in Z axis direction, the distance d (refer to Fig.7) between the reference position and the top surface of the chuck table 42 in Z axis direction.

When the distance d is calculated, the setup piece 86 is moved up to the uppermost position T again by the air cylinder 94 and each component is returned to its home position, to complete the setup operation upon generation of the setup complete signal.

On the other hand, the height of the reference position relative to the blade 58 is determined by moving down the spindle motor 60 to right above the converging point P and detecting the bottom of the blade 58 with the laser sensor 72. Thus, similarly to the prior art, the distance d is added to the height of reference position relative to the blade 58 thereby to calculate the top surface position of the chuck table 42 relative to the blade 58.

During dicing process, cutting depth of the blade 58 is controlled according to the top surface position of the chuck

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table 42 determined in the above processes.

As described above, in the dicing machine 30 of this embodiment, contact between the setup piece 86 and the chuck table 42 is detected by means of an analog signal corresponding to the traveling distance of the setup piece 86 obtained from the distance measuring instrument 102, and therefore the correction value (clearance a) is not necessary unlike the prior art. Thus because there is no need to check the correction value after maintenance service, the invention provides a higher operation efficiency and improves the productivity over that of the prior art.

In the dicing machine of this embodiment, because the setup piece 86 is driven by the air cylinder 94 to take the upper position (uppermost position T) and the lower position (lowermost position U) relative to the bottom end of the blade 58, the setup piece 86 and the blade 58 can be prevented from interfering each other during setup onto the chuck table 42 and during dicing operation. Therefore, while a setup stand 12 having a height different from that of the top surface 10a of the chuck table 10 has been necessary in the prior art in order to prevent interference between the setup piece 20 and the blade 14, this embodiment makes it possible to carry out setup operation directly on the top surface of the chuck table

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42 without using the setup stand 12. Thus it is not necessary to make calculation of (b+c) with the height difference between the setup stand 12 and the chuck table 10 taken into consideration, and the manufacturing cost of the machine can be reduced corresponding to the elimination of the setup stand 12.

Although setup operation is carried out by means of a servo system in the vertical motion mechanism 66 with the sensor mechanism 80 being fixed on the spindle motor 60 in the above embodiment, other vertical motion means may also be employed.

In the vertical motion mechanism, not shown in the drawing, of the microscope 68, for example, because a pulse motor or the like is used for its driving source to recognize the position of the microscope 68, vertical motion of the microscope 68 may be used in the setup operation. Specifically, the sensor mechanism 80 is installed so that the setup piece 86 protrudes beyond the bottom end of the microscope 68 and the setup piece 86 is brought into contact with the top surface of the chuck table 42 or the laser beam R of the laser sensor 72 is interrupted similarly to the setup operation described previously. Then the reference position recognized in terms of the Z axis coordinate in the vertical motion

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mechanism of the microscope 68 and the top surface position of the chuck table 42 are used to determine the distance z of these in Z axis direction. And the distance z thus determined is added to the reference position relative to the blade 58 which was recognized in terms of Z axis coordinate of the vertical motion mechanism 66, thereby to obtain the top surface position of the chuck table 42 relative to the blade 58.

In case the microscope 68 is provided with the sensor mechanism 80, adverse effect of vibration of the spindle motor 60 or the like on the sensor mechanism 80 can be prevented. Also because the microscope 68 is located apart from the cutting point, there occurs no adverse effect of the coolant on the sensor mechanism 80. This eliminates the need for the cover 102b and allows for simpler structure of the distance measuring instrument 102.

Although the setup piece 86 is brought into contact with the chuck table 42 at one point during setup onto the top surface of the chuck table 42 in the above embodiment, the setup piece 86 may also be brought into contact with the chuck table 42 at a plurality of points thereof, in order to automatically measure the parallelism of the chuck table 42. For example, the setup piece 86 is brought into contact with the chuck table 42 at four points along the circumference and

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one point at the center, five points in all, to measure the height of each point similarly to the embodiment described previously. Then parallelism on the top surface of the chuck table 42 is measured by calculating the distances between the points and the height difference. In case the result of measurement shows a parallelism lower than a specified criterion, the faulty state is notified to the operator by lighting a warning lamp or sounding a buzzer. The measured value of parallelism may also be fed back to position control of the blade 58 during processing, thereby to carry out more precise depth control with the error in the configuration of the chuck table 42 taken into consideration.

Moreover, although the position of the setup piece 86 is made variable in the above embodiment in order to carry out setup operation directly on the chuck table 42 without using the setup stand 12 (refer to Fig.8) of the prior art, the chuck table 42 may also be turned into a processing table provided with a setup stand without providing a mechanism for moving the setup piece 86 vertically, thereby to carry out setup operation onto the setup stand similarly to the prior art.

As the contact driving means for moving the setup piece 86 vertically, a device other than the air cylinder 94, an oil

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cylinder for instance, may be used.

The dicing machine of the invention is capable of improving the productivity.

CLAIMS

1. A dicing machine for dicing semiconductor wafers, which are fixed on a processing table, by means of a blade driven to rotate by a spindle, comprising;

a contactor arranged at a position where it can contact the processing table;

a contactor holding mechanism which holds the contactor in such a way as the contactor can move forward and backward along the top surface of the processing table;

holding mechanism moving means which brings the contactor into contact with the top surface of the processing table by controlling the position of the contactor holding mechanism;

retracting distance detecting means which detects the amount of retraction of the contactor when it is brought into contact with the top surface of the processing table by the holding mechanism moving means;

processing table position recognizing means which recognizes the top surface position of the processing table relative to the contactor, based on the amount of retraction

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cylinder for instance, may be used.

The dicing machine of the invention is capable of improving the productivity.

CLAIMS

1. A dicing machine for dicing semiconductor wafers, which are fixed on a processing table, by means of a blade driven to rotate by a spindle, comprising;

a contactor arranged at a position where it can contact the processing table;

a contactor holding mechanism which holds the contactor in such a way as the contactor can move forward and backward along the top surface of the processing table;

holding mechanism moving means which brings the contactor into contact with the top surface of the processing table by controlling the position of the contactor holding mechanism;

retracting distance detecting means which detects the amount of retraction of the contactor when it is brought into contact with the top surface of the processing table by the holding mechanism moving means;

processing table position recognizing means which recognizes the top surface position of the processing table relative to the contactor, based on the amount of retraction

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detected by the retracting distance detecting means;

noncontacting measuring means which measures the relative position of the contactor and the blade without making contact; and

positional relationship recognizing means which recognizes the positional relationship between the blade and the top surface of the processing table, from the relative position of the contactor and the blade measured by the noncontacting measuring means and the top surface position of the processing table relative to the contactor which was recognized by the processing table position recognizing means.

2. A dicing machine according to claim 1, wherein

fastening means which fastens the contactor holding mechanism on the spindle is provided;

the holding mechanism moving means controls the position of the contactor holding mechanism by moving the spindle; and

the contactor holding mechanism is provided with contactor driving means which makes the contactor retract from the blade during dicing process and makes the contactor protrude beyond the blade when it is in contact with the processing table.

3. A dicing machine according to claim 1, wherein

the noncontacting measuring means has an optical sensor

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which detects a member located at a reference position without making contact by means of a light beam emitted onto the reference position which is set in a specified positional relationship with the top surface of the processing table, and measures the relative position of the blade and the contactor by detecting the blade and the contactor by means of the optical sensor and determining the positions of the blade and the contactor relative to the reference position.

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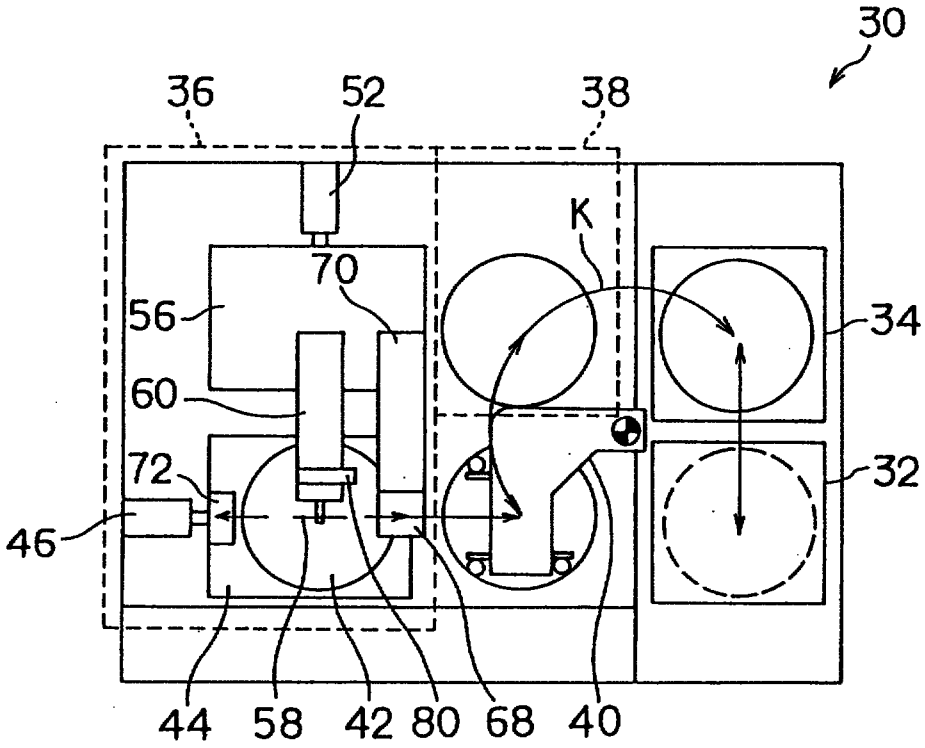
ABSTRACT

To provide a dicing machine capable of improving the productivity.

The setup piece 86 is moved vertically by the air cylinder 94, so that the bottom end thereof takes lower position and upper position relative to the blade 58. When the spindle motor moves down so that the setup piece 86 makes contact with the top surface of the chuck table, the setup piece 86 moves and the traveling distance thereof is measured by the distance measuring instrument 102. Then the top surface position of the chuck table relative to the setup piece 86 is determined from the measured value of the distance measuring instrument 102.

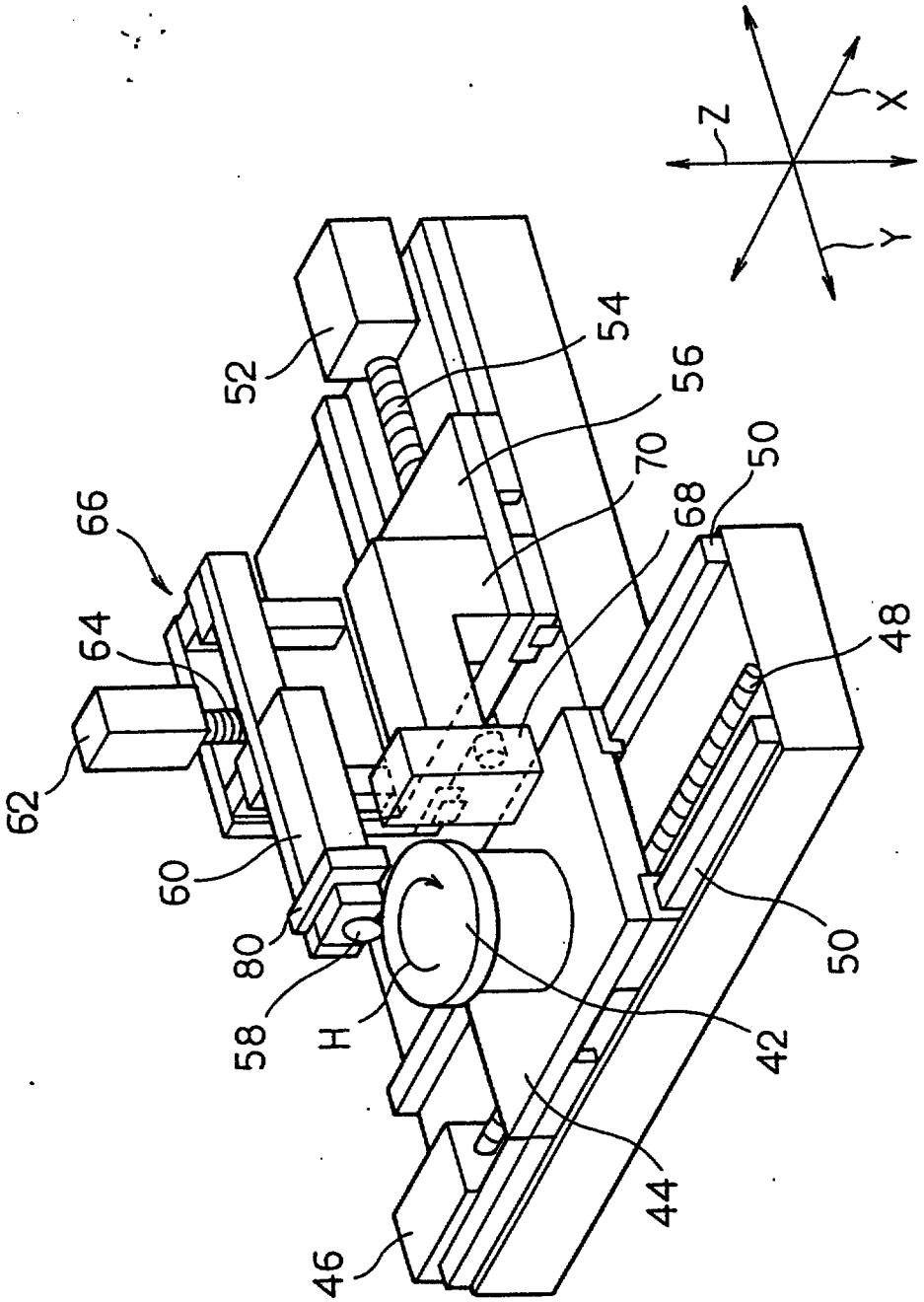
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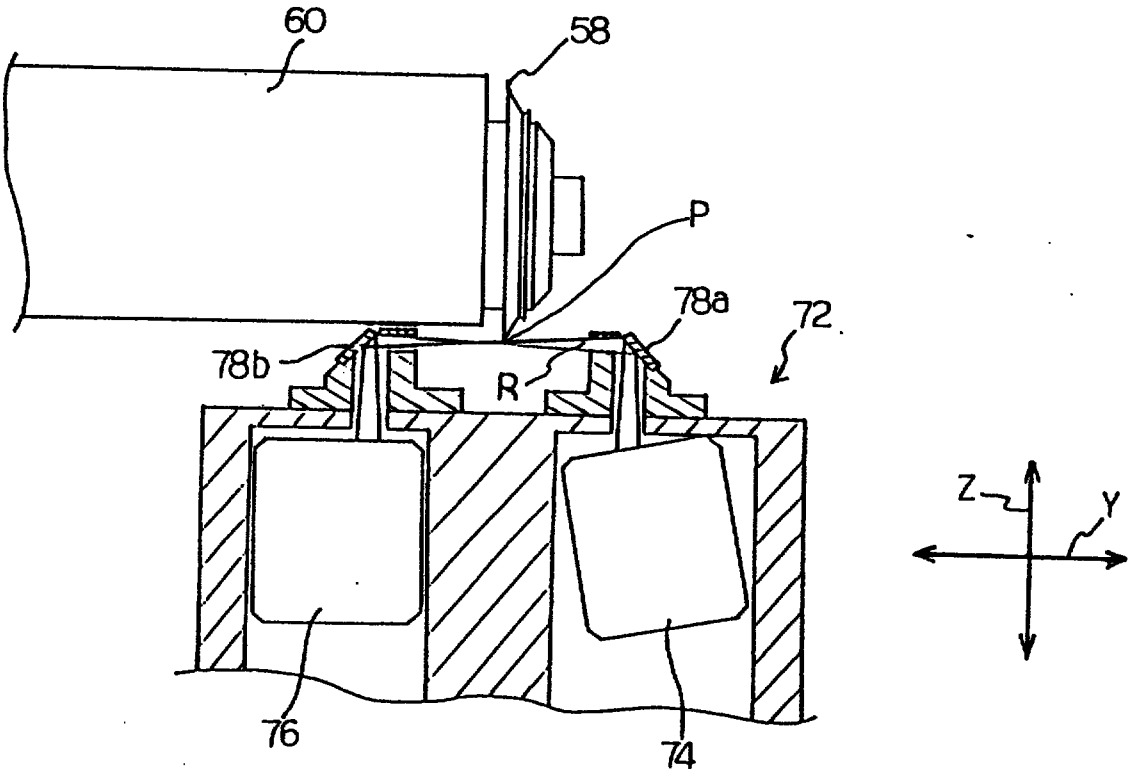
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FIG. 2



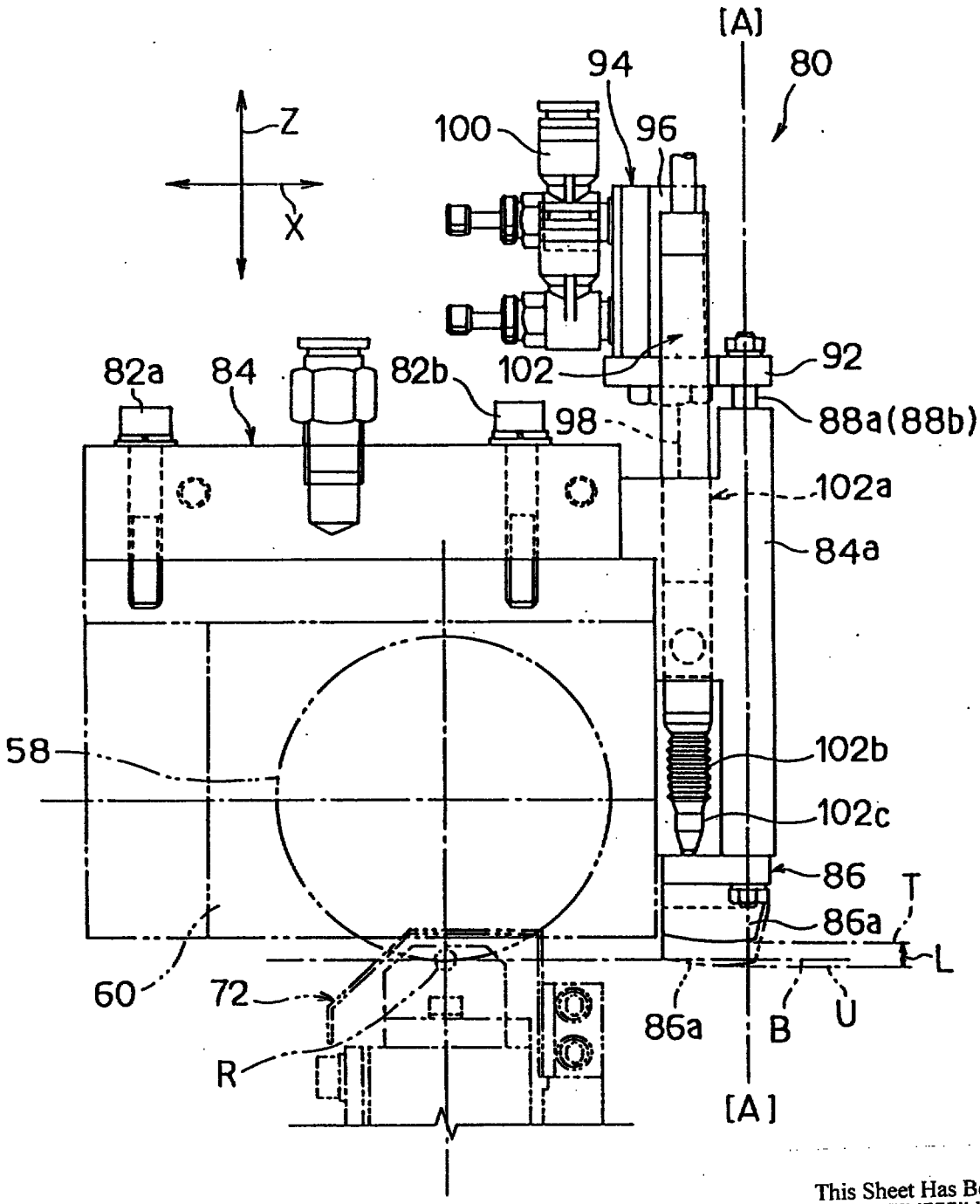
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FIG. 3



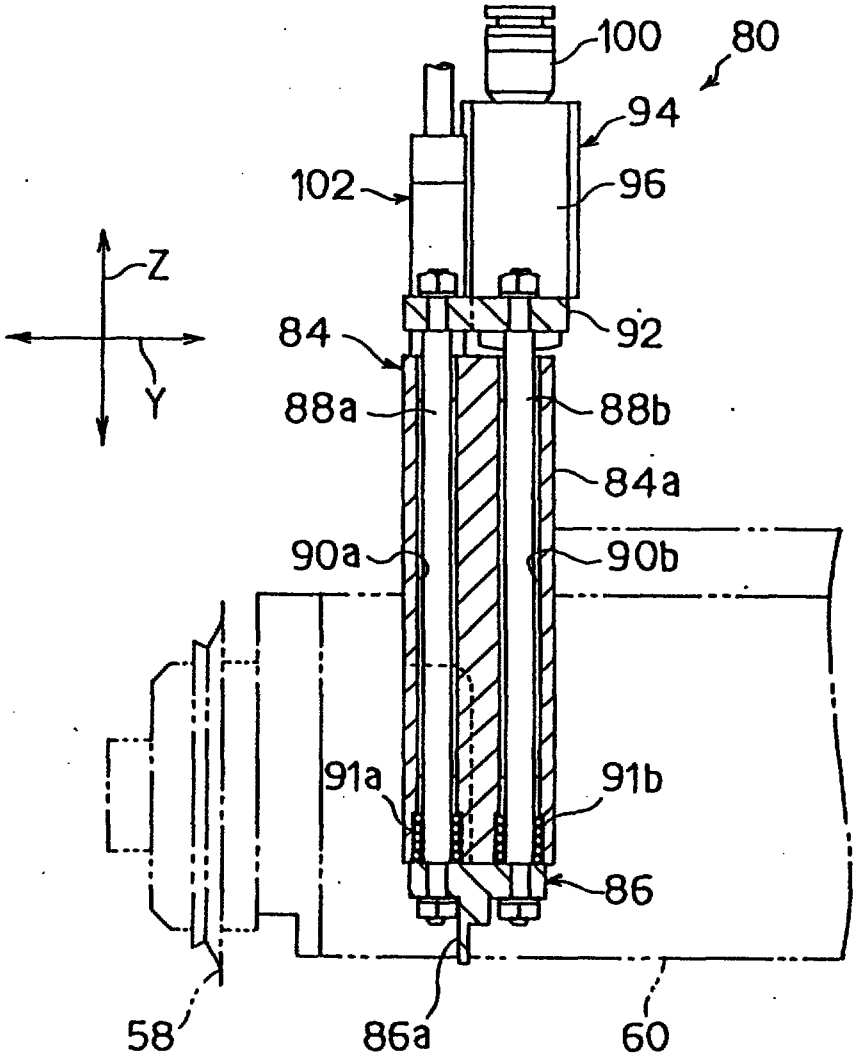
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FIG. 4



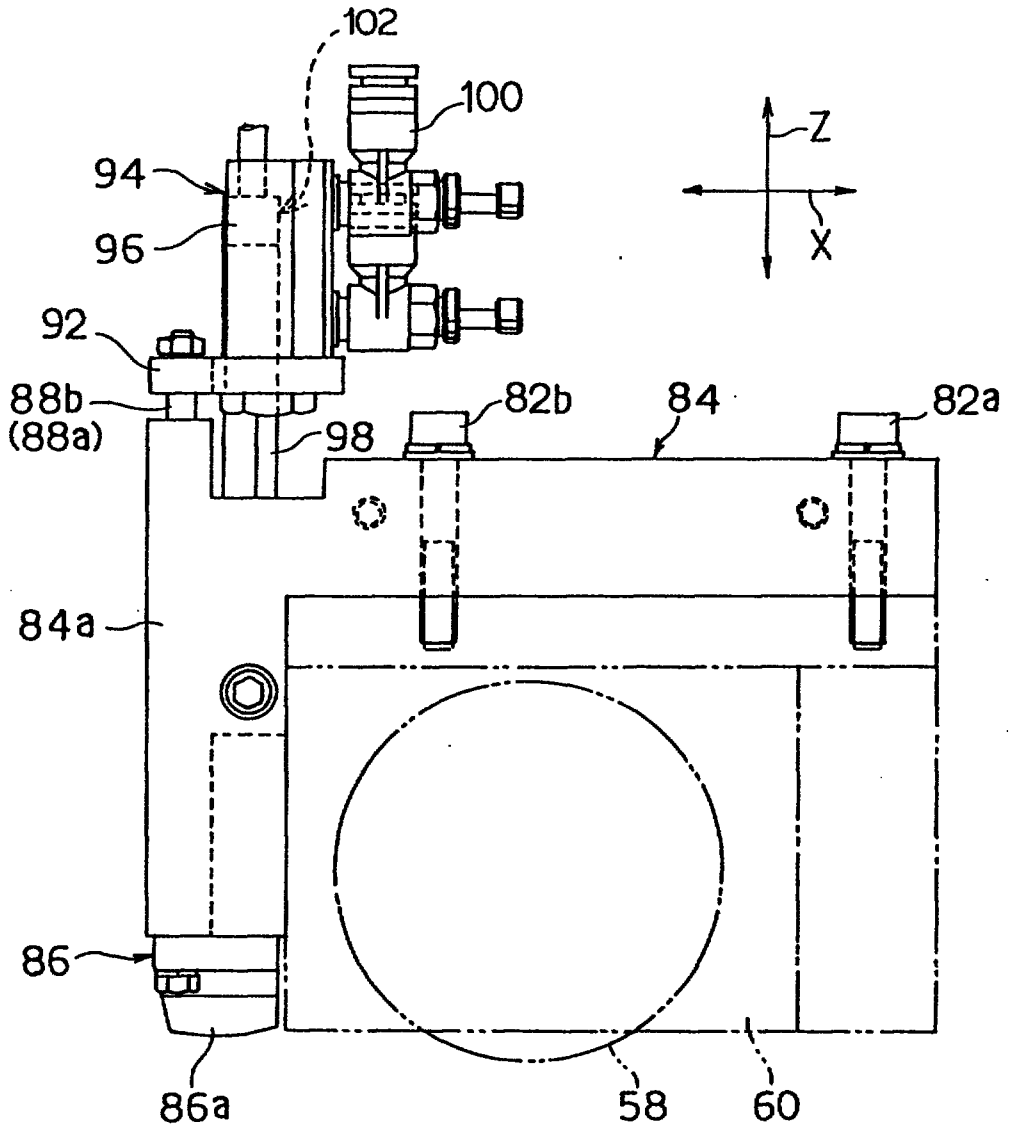
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FIG. 5



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FIG. 6



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FIG. 7

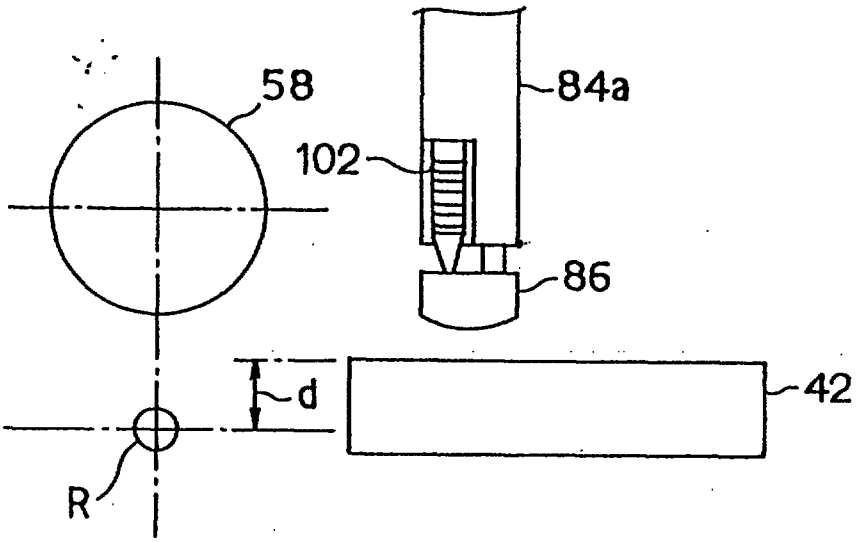
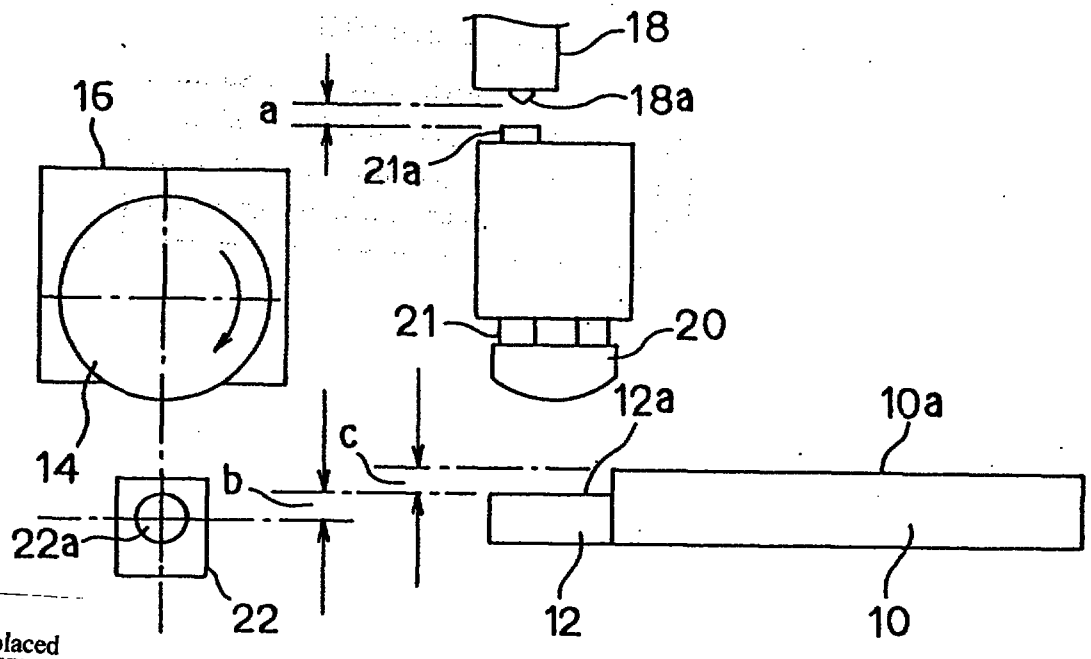


FIG. 8
PRIOR ART



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REPLACEMENT SHEETS SG
☑ Description : paged 1 to paged 25
☑ Claim(s) : paged 26 to paged 28
☑ Drawing(s) : paged 1 to paged 7
☑ Abstract : paged 29 to paged 29
DATE OF RECEIPT 29 OCT 1996

REPLACED SHEETS SG
☐ Description : paged ... to paged ...
☑ Claim(s) : paged 26 to paged 26
☐ Drawing(s) : paged ... to paged ...
☐ Abstract : paged ... to paged ...

DICING MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to a dicing machine which dices semiconductor wafers.

Dicing process in the manufacture of semiconductor requires precise control of the depth of a blade cutting into a semiconductor wafer, in order to maintain stable quality of processing. For this purpose, in a dicing machine, the height of the top surface of the semiconductor wafer relative to the blade is first recognized by means of an NC unit (numerical control unit) or the like. Actually, however, setup operation is first carried out to detect the position of the top surface of a chuck table whereon the semiconductor wafer is placed, because thickness of the semiconductor wafer is known in advance. Then the thickness of the semiconductor wafer is added to the top surface position of the chuck table which has been detected, to determine the top surface position of the semiconductor wafer, thereby to control the blade position relative to the semiconductor wafer.

In recent years, noncontacting setup operation is practiced wherein relative position of the chuck table and the blade is recognized without bringing them into contact with

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each other, in order to avoid damaging the blade.

Fig.8 schematically shows a part of a dicing machine of the prior art which carries out noncontacting setup operation.

As shown in the drawing, the conventional dicing machine has a setup stand 12 fixed on the chuck table 10, the setup stand having a top surface 12a which is lower than the top surface 10a of the chuck table 10. A spindle 16 which drives the blade 14 to rotate as indicated by an arrow has a touch sensor 18 fixed thereon via a fastening member which is not shown in the drawing. The touch sensor 18 switches on and off as a top end 21a of a guide bar 21 which is linked with a setup piece 20 touches a contact point 18a.

Because the touch sensor 18 has a very small response range, a specified clearance a (0.3mm for instance) has been provided between the contact point 18a and the top end 21a of guide bar 21 in the prior art, in order to prevent such an erroneous operation as switching by vibration. Also in the vicinity of the chuck table 10, a laser sensor 22 is installed which detects a member (the blade 14, the setup piece 20 or the like), which is located at the reference position, without making contact by means of a laser beam 22a emitted at a specified height (reference position) relative to the top surface 10a of the chuck table 10.

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In the conventional dicing machine, setup operation is carried out as described below.

Bottom ends of the blade 14 and the setup piece 20 are lowered successively to the position of the laser beam 22a thereby to detect the height of the reference position relative to the blade 14 and the setup piece 20. Then the setup piece 20 is brought into contact with a setup stand 12 and the height of the top surface 12a of the setup stand 12 relative to the setup piece 20 is detected through switching operation of the touch sensor 18 under this condition.

Upon completion of the setup operation described above, then the height of the top surface 10a of the chuck table 10 relative to the blade 14 is determined from the positional relations of the components which have been detected.

Specifically, vertical distance b between the top surface 12a of the setup stand 12 and the reference position is determined first, then height difference c between the known top surface 12a and the top surface 10a of the chuck table 10 is added to the distance b (b+c), to determine the height of the top surface 10a of the chuck table 10 relative to the reference position. Actually, however, because the clearance a exists between the touch sensor 18 and the setup piece 20, dimension a is used as a correction value to calculate (b+c)+a

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from which the height of the top surface 10a of the chuck table 10 relative to the reference position is determined. Because positional relationship of the blade 14 and the reference position has been recognized in the setup operation described previously, the height of the top surface 10a of the chuck table 10 relative to the blade 14 can be determined by adding the value (b+c)+a to the height of the reference position relative to the blade 14.

Then the cutting depth of the blade 14 is controlled according to the height over the top surface 10a of the chuck table 10 determined as described above.

In the conventional dicing machine, dimension of the clearance a may be changed during maintenance service of the touch sensor 18, and therefore it has been necessary to confirm the dimension of the clearance a every time maintenance service is done. For example, dimension of the clearance a is changed slightly (50 micrometers for instance) and trial cutting is done on a plurality of dummy wafers thereby to determine the proper dimension of clearance a.

This has been decreasing the operation efficiency and causing adverse effect on the productivity.

SUMMERY OF THE INVENTION

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In view of these problems, the present invention has a purpose of providing a dicing machine which is capable of improving the productivity.

The invention according to claim 1 achieves the purpose with a dicing machine which dices a semiconductor wafer, which is fixed on a processing table, by means of a blade driven to rotate by a spindle, the dicing machine being provided with a contactor arranged at a position where it can contact the processing table, a contactor holding mechanism which holds the contactor in such a way as the contactor can move forward and backward relative to the top surface of the processing table, holding mechanism moving means which brings the contactor into contact with the top surface of the processing table by controlling the position of the contactor holding mechanism, retracting distance detecting means which detects the amount of reaction of the contactor when it is brought into contact with the top surface of the processing table by the holding mechanism moving means, processing table position recognizing means which recognizes the top surface position of the processing table relative to the contactor from the amount of retraction detected by the retracting distance detecting means, noncontacting measuring means which measures the relative position of the contactor and the blade without making

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contact, and positional relationship recognizing means which recognizes the positional relationship between the blade and the top surface of the processing table, from the relative position of the contactor and the blade measured by the non-contacting measuring means and the top surface position of the processing table relative to the contactor which was recognized by the processing table position recognizing means.

The invention according to claim 2 achieves the purpose with a dicing machine of claim 1 which is further provided with fastening means which fastens the contactor holding mechanism onto the spindle, while the holding mechanism moving means controls the position of the contactor holding mechanism by moving the spindle, and the contactor holding mechanism is provided with contactor driving means which makes the contactor retract from the blade during dicing operation and makes the contactor protrude beyond the blade when it is in contact with the processing table.

The invention according to claim 3 achieves the purpose with a dicing machine of claim 1 wherein the noncontacting measuring means has an optical sensor which detects a member located at a reference position without making contact, by means of a light beam emitted onto the reference position which is set in a specified positional relationship with the

top surface of the processing table, and measures the relative position of the blade and the contactor by detecting the blade and the contactor by means of the optical sensor and determining the positions of the blade and the contactor relative to the reference position.

In the dicing machine according to claim 1, the holding mechanism moving means controls the position of the contactor holding mechanism to bring the contactor into contact with the top surface of the processing table. This causes the contactor to take the retracting position while the retraction distance detecting means detects the retracting distance. The processing table position recognizing means recognizes the top surface position of the processing table relative to the contactor from the retracting distance detected by the retraction distance detecting means. The noncontacting measuring means measures the relative position of the contactor and the blade without making contact. The positional relationship recognizing means recognizes the positional relationship between the blade and the top surface of the processing table, from the relative position of the contactor and the blade which was measured by the noncontacting measuring means and the top surface position of the processing table relative to the contactor which was recognized by the processing table

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position recognizing means. Then the blade position is controlled according to the positional relationship between the blade and the processing table which has been recognized, thereby to control the cutting depth of the blade into a semiconductor wafer which is fixed on the processing table.

In the dicing machine according to claim 2, the holding mechanism moving means controls the position of the contactor holding mechanism by moving the spindle. Dicing process of the semiconductor wafer is carried out as the holding mechanism moving means moves the spindle to a specified position. During dicing operation, the contactor driving means makes the contactor retract from the blade. When the holding mechanism moving means brings the contactor into contact with the top surface of the processing table, the contactor driving means makes the contactor protrude beyond the blade. Through these operations, the blade and the contactor do not interfere with each other, even when the top surface of the processing table on which the contactor is brought into contact and the plane whereon the semiconductor wafer is fixed are flush. The processing table position recognizing means recognizes the position of the surface of the processing table on which the semiconductor wafer is fixed, namely the back surface of the semiconductor wafer.

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In the dicing machine according to claim 3, the noncontacting measuring means detects the blade and the contactor by means of the optical sensor and determines their positions relative to the reference position, thereby to measure the relative position of the blade and the contactor.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic plan view showing the entire dicing machine according to an embodiment of the invention.

Figure 2 is an oblique view showing dicing processing section of the above machine.

Figure 3 is a sectional side view showing the structure of the laser sensor in the above machine in detail.

Figure 4 is a front view of the sensor mechanism in the above machine.

Figure 5 is a partially cutaway side view of the sensor mechanism in the above machine.

Figure 6 is a rear view of the sensor mechanism in the above machine.

Figure 7 is a front view showing schematically the positional relationship of components in the above machine.

Figure 8 is an explanatory drawing showing schematically the positional relationship of components in the dicing

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machine of the prior art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the dicing machine according to the invention will now be described in detail below with reference to Fig.1 through Fig.7.

Fig.1 shows the dicing machine of this embodiment schematically.

As shown in the drawing, the dicing machine 30 has a stocker 32 where a plurality of semiconductor wafers are stored, a wafer feeder unit 34 which carries out and carries in the semiconductor wafer from and to the stocker 32, a dicing process unit 36 which carries out dicing process of semiconductor wafers, a rinsing unit 38 which rinses processed semiconductor wafers, and a transfer loader 40 which transfers the semiconductor wafers between the wafer feeder unit 34, the dicing process unit 36 and the rinsing unit 38 as indicated by arrow K.

Fig.2 shows the dicing process unit 36. In this drawing, X axis and Y axis, perpendicular to each other, are set in the horizontal plane and Z axis is set in the vertical direction.

As shown in Fig.2, the dicing process unit 36 has a chuck table 42 whereon the semiconductor wafer (not shown) is

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placed. The chuck table 42 holds the semiconductor wafer by sucking air. The chuck table 42 is also fixed on an X axis table 44 and is driven to rotate by a motor which is not shown in the drawing. The X axis table 44 is guided by a guide rail 50 to move horizontally in X axis direction by the rotation of a ball screw 48 driven by an X axis motor 46.

The dicing process unit 36 is also provided with a Y axis table 56 which is moved horizontally in Y axis direction by a Y axis motor 52 and a ball screw 54. Fixed on the Y axis table 56 is a vertical motion mechanism 66 which moves a spindle motor 60, that drives a disk-shaped blade 58, vertically in Z axis direction by means of a spindle vertical movement motor 62, a ball screw 64 and others. As the spindle motor 60 is moved down by the vertical motion mechanism 66, the blade 58 cuts into the semiconductor wafer.

Also fixed on the Y axis table 56 is a microscope 68 via a fastening member 70. The microscope 68 is used to get magnified views of the top surface of the chuck table 42 and the surface of the semiconductor wafer, and is moved vertically in Z axis direction relative to the fastening member 70 by a vertical motion mechanism not shown in the drawing. Focusing of the microscope 68 is adjusted by this vertical motion.

As shown in Fig.1, a laser sensor 72 used in setup is

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fixed on the X axis table 44.

Fig.3 shows the structure of the laser sensor 72.

As shown in this drawing, the laser sensor 72 has a light emitter 74 for emitting laser beam R, a light receiver 76 and mirrors 78a, 78b which guide the laser beam R emitted from the light emitter 74 to the light receiver 76. The laser sensor 72 is arranged so that the laser beam R emitted from the light emitter 74 converges at a mid point between the mirror 78a and the mirror 78b. The laser sensor 72 is also arranged so that the blade 58 moves across the laser beam R at its converging point P as shown in Fig.3, so that the edge of the blade 58 and others is detected by using the change in the intensity of light received on the light receiver 76.

In this embodiment, the spindle motor 60 has a sensor mechanism 80 mounted thereon to carry out setup operation, as shown in Fig.1 and Fig.2.

Fig.4 through Fig.6 show the detailed configuration of the sensor mechanism 80, Fig.4 showing the front view, Fig.5 showing the rear view and Fig.6 showing the side view of the sensor mechanism 80. In these drawings, the spindle motor 60 and the blade 58 are indicated by alternate long and two short dashes lines to show the assembling relationship.

The sensor mechanism 80 has a substantially L-shaped

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support block 84 which is mounted on the top and side of the spindle motor 60 by means of bolts 82a, 82b, etc. A vertical motion support 84a, located at the side of the spindle motor 60 on the support block 84, is provided with a setup piece 86 arranged at the lower end thereof.

The setup piece 86 is used in setup operation for the laser sensor 72 and the chuck table 42, similarly to the prior art, and is provided with a light interrupter 86a of thin sheet configuration attached at the bottom thereof, as shown in the cross section in Fig.5 of A-A line in Fig.4. The bottom surface of the light interrupter 86a is formed in a curved surface having a curvature similar to that of the periphery of the blade 58, as shown in Fig.4.

In this embodiment, the setup piece 86 is fixed at the bottom of two guide bars 88a, 88b as shown in the cross sectional view of Fig.4. These guide bars 88a, 88b are inserted into through holes 90a, 90b formed in the vertical motion support 84a, respectively, thereby to vertically penetrate the vertical motion support 84a. Arranged between steps formed at the bottom of the through holes 90a, 90b and the top end surface of the setup piece 86 are compressed oil springs 91a, 91b, respectively, which force the setup piece 86 downward.

At the top ends of the guide bars 88a, 88b, on the other

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hand, a locking member 92 is fixed while an air cylinder 94 is fixed on the locking member 92 as shown in Fig.6. The air cylinder 94 has a cylinder body 96 having a pressure chamber (not shown) inside thereof, a piston rod 98 linked at the top end thereof with a piston (not shown) which is housed in the pressure chamber inside the cylinder body 96, and an air supply port 100 which supplies compressed air into the cylinder body 96. The air supply port 100 is connected with air supplying means such as a pump or the like which is not shown in the drawing.

The piston rod 98 is fixed at its bottom end on the support block 84, so that it does not move relative to the support block 84 together with the piston provided in the cylinder body 96. Consequently, pneumatic pressure applied onto the piston acts to move the cylinder body 96 vertically leaving the piston rod 98 remaining at the position. Also because the cylinder body 96 is in fixed relationship with the guide bars 88a, 88b via the locking member 92, driving of the air cylinder 94 results in a vertical movement of the setup piece 86. That is, driving of the air cylinder 94 causes the cylinder body 96, the locking member 92, the guide bars 88a, 88b and the setup piece 86 as a whole to move vertically relative to the vertical motion support 84a.

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However, stroke L (refer to Fig.4) of this vertical motion is limited by the locking member 92 and the setup piece 86 making contact with the top end surface and the bottom end surface of the vertical potion support 84a, respectively. In Fig.4 through Fig.6, the air cylinder 94 is in actuated state with compressed air being supplied into the cylinder body 96, and the setup piece 86 is located at the uppermost position T by resisting the forces of the coil springs 91a, 91b and contacting the bottom surface of the vertical motion support 84a. When the air in the cylinder body 96 is exhausted and accordingly the locking member 92 is forced down by the coil springs 91a, 91b into contact with the top end of the vertical motion support 84a, the setup piece 86 takes the lowermost position U as indicated by dashed line in Fig.4.

This embodiment is configured so that, when the setup piece 86 takes the uppermost position T, the bottom end thereof is positioned above the bottom position B of the blade 58 and, when the setup piece 86 takes the lowermost position U, the bottom end of the setup piece 86 is positioned below the bottom position B of the blade 58.

In the sensor mechanism 80 of this embodiment, on the other hand, the vertical motion support 84a is provided with a distance measuring instrument 102, as shown in Fig.4. The

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distance measuring instrument 102 consists mainly of a distance measuring instrument body 102a which is fixed by having part thereof housed in the vertical motion support 84a, and a measuring probe 102c which is moved vertically relative to the distance measuring instrument body 102a by contracting and elongating a bellows-like cover 102b.

The measuring probe 102c is fixed at the bottom thereof on the top end surface of the setup piece 86, so that it moves vertically in linkage with the setup piece 86. The distance measuring instrument body 102a outputs an electrical signal that represents the traveling distance of the measuring probe 102c, namely the traveling distance of the setup piece 86. As the distance measuring instrument 102, for example, an electrical micrometer or the like having a resolution of 1 micrometer or higher is used. The cover 102b is provided in order to prevent coolant, which is supplied to the cutting point during cutting operation, from entering the inside of the distance measuring instrument 102.

In this embodiment, driving operation of the drive unit, namely the X axis motor 46, the Y axis motor 52 or the air cylinder 94 for instance, is controlled by a control unit such as an NC unit which is not shown in the drawing, and the position of each unit is recognized by the control unit

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through a detection signal of a position sensor, the measuring probe 102c or the like.

Now the setup operation in the embodiment configured as described above will be described below. In the description that follows, it is assumed that components of the dicing machine 30 operate under the control of the control unit not shown in the drawing, while such description may be omitted in the following.

In the dicing machine 30 of this embodiment, the setup piece 86 is normally driven by the air cylinder 94 to take the uppermost position T shown in Fig.4 through Fig.6. In this initial state, when the control unit not shown generates a setup start signal, setup operation by the sensor mechanism 80 is started.

(Setup onto the top surface of the chuck table)

First, air in the cylinder body 96 is exhausted, thereby to make the setup piece 86 of the sensor mechanism 80 move down to the lowermost position U by the force of the coil springs 91a, 91b. Then the X axis motor 46 and the Y axis motor 52 move the X axis table 44 and the Y axis table 56 to specified positions, thereby to position the sensor mechanism 80 above the chuck table 42.

Then the spindle vertical drive motor 62 of the vertical

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motion mechanism 66 moves the spindle motor 60 downward, thereby to bring the setup piece 86 of the sensor mechanism 80 into contact with the top surface of the chuck table 42.

At this time, because the bottom end of the setup piece 86 is positioned below the blade 58 in this embodiment, only the setup piece 86 contacts the chuck table 42 without having the blade contacting the top surface of the chuck table 42.

When the setup piece 86 contacts the chuck table 42, the setup piece 86 moves (upward) relative to the vertical motion support 84a against the forces of the coil springs 91a, 91b by the distance the spindle motor 60 moves down. On the other hand, the control unit not shown monitors the output given by the distance measuring instrument 102 at this time, thereby to check to see whether the setup piece 86 contacts the chuck table 42 or not.

When a signal corresponding to the traveling distance of the setup piece 86 is output from the distance measuring instrument 102, the control unit not shown stops the downward movement of the spindle motor 60 and recognizes the traveling distance of the setup piece 86. Then the control unit subtracts the traveling distance of the setup piece 86 which has been recognized from the downward moving distance of the spindle motor 60, thereby to determine the height at which the

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light interrupter 86a makes contact with the chuck table 42. That is, top surface height of the chuck table 42 relative to the setup piece 86 is determined.

(Setup to the reference position)

When the top surface height of the chuck table 42 is determined, the spindle motor 60 is moved upward to a height where the light interrupter 86a departs from the chuck table 42. Then by moving the X axis table 44 and the Y table 56 again, the setup piece 86 is positioned right above the light converging point P (refer to Fig.3) in the laser sensor 72, thereby to move down the spindle motor 60 again. This causes the bottom end of the setup piece 86 moves down to the height of the laser beam R, the height being detected by the laser sensor 72. When the bottom end of the setup piece 86 is detected by the laser sensor 72, the control unit not shown stops the downward movement of the spindle motor 60 and, at the same time, recognizes the height of the laser beam R relative to the setup piece 86, namely the height of the reference position, from the position of the spindle motor at this time.

(Calculation of the top surface height of the chuck table 42 relative to the reference position)

Fig.7 schematically shows the positional relationships of

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the components of the dicing machine 30.

When the reference position and the height of the top surface of the chuck table 42 relative to the setup piece 86 are determined as described above, the control unit not shown determines, from the traveling distance of the spindle motor 60 in Z axis direction, the distance d (refer to Fig.7) between the reference position and the top surface of the chuck table 42 in Z axis direction.

When the distance d is calculated, the setup piece 86 is moved up to the uppermost position T again by the air cylinder 94 and each component is returned to its home position, to complete the setup operation upon generation of the setup complete signal.

On the other hand, the height of the reference position relative to the blade 58 is determined by moving down the spindle motor 60 to right above the converging point P and detecting the bottom of the blade 58 with the laser sensor 72. Thus, similarly to the prior art, the distance d is added to the height of reference position relative to the blade 58 thereby to calculate the top surface position of the chuck table 42 relative to the blade 58.

During dicing process, cutting depth of the blade 58 is controlled according to the top surface position of the chuck

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table 42 determined in the above processes.

As described above, in the dicing machine 30 of this embodiment, contact between the setup piece 86 and the chuck table 42 is detected by means of an analog signal corresponding to the traveling distance of the setup piece 86 obtained from the distance measuring instrument 102, and therefore the correction value (clearance a) is not necessary unlike the prior art. Thus because there is no need to check the correction value after maintenance service, the invention provides a higher operation efficiency and improves the productivity over that of the prior art.

In the dicing machine of this embodiment, because the setup piece 86 is driven by the air cylinder 94 to take the upper position (uppermost position T) and the lower position (lowermost position U) relative to the bottom end of the blade 58, the setup piece 86 and the blade 58 can be prevented from interfering each other during setup onto the chuck table 42 and during dicing operation. Therefore, while a setup stand 12 having a height different from that of the top surface 10a of the chuck table 10 has been necessary in the prior art in order to prevent interference between the setup piece 20 and the blade 14, this embodiment makes it possible to carry out setup operation directly on the top surface of the chuck table

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42 without using the setup stand 12. Thus it is not necessary to make calculation of (b+c) with the height difference between the setup stand 12 and the chuck table 10 taken into consideration, and the manufacturing cost of the machine can be reduced corresponding to the elimination of the setup stand 12.

Although setup operation is carried out by means of a servo system in the vertical motion mechanism 66 with the sensor mechanism 80 being fixed on the spindle motor 60 in the above embodiment, other vertical motion means may also be employed.

In the vertical motion mechanism, not shown in the drawing, of the microscope 68, for example, because a pulse motor or the like is used for its driving source to recognize the position of the microscope 68, vertical motion of the microscope 68 may be used in the setup operation. Specifically, the sensor mechanism 80 is installed so that the setup piece 86 protrudes beyond the bottom end of the microscope 68 and the setup piece 86 is brought into contact with the top surface of the chuck table 42 or the laser beam R of the laser sensor 72 is interrupted similarly to the setup operation described previously. Then the reference position recognized in terms of the Z axis coordinate in the vertical motion

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mechanism of the microscope 68 and the top surface position of the chuck table 42 are used to determine the distance z of these in Z axis direction. And the distance z thus determined is added to the reference position relative to the blade 58 which was recognized in terms of Z axis coordinate of the vertical motion mechanism 66, thereby to obtain the top surface position of the chuck table 42 relative to the blade 58.

In case the microscope 68 is provided with the sensor mechanism 80, adverse effect of vibration of the spindle motor 60 or the like on the sensor mechanism 80 can be prevented. Also because the microscope 68 is located apart from the cutting point, there occurs no adverse effect of the coolant on the sensor mechanism 80. This eliminates the need for the cover 102b and allows for simpler structure of the distance measuring instrument 102.

Although the setup piece 86 is brought into contact with the chuck table 42 at one point during setup onto the top surface of the chuck table 42 in the above embodiment, the setup piece 86 may also be brought into contact with the chuck table 42 at a plurality of points thereof, in order to automatically measure the parallelism of the chuck table 42. For example, the setup piece 86 is brought into contact with the chuck table 42 at four points along the circumference and

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one point at the center, five points in all, to measure the height of each point similarly to the embodiment described previously. Then parallelism on the top surface of the chuck table 42 is measured by calculating the distances between the points and the height difference. In case the result of measurement shows a parallelism lower than a specified criterion, the faulty state is notified to the operator by lighting a warning lamp or sounding a buzzer. The measured value of parallelism may also be fed back to position control of the blade 58 during processing, thereby to carry out more precise depth control with the error in the configuration of the chuck table 42 taken into consideration.

Moreover, although the position of the setup piece 86 is made variable in the above embodiment in order to carry out setup operation directly on the chuck table 42 without using the setup stand 12 (refer to Fig.8) of the prior art, the chuck table 42 may also be turned into a processing table provided with a setup stand without providing a mechanism for moving the setup piece 86 vertically, thereby to carry out setup operation onto the setup stand similarly to the prior art.

As the contact driving means for moving the setup piece 86 vertically, a device other than the air cylinder 94, an oil

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cylinder for instance, may be used.

The dicing machine of the invention is capable of improving the productivity.

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CLAIMS

1. A dicing machine for dicing semiconductor wafers, which are fixed on a processing table, by means of a blade driven to rotate by a spindle, comprising;

a contactor arranged at a position where it can contact the processing table;

a contactor holding mechanism which holds the contactor in such a way as the contactor can move forward and backward along the top surface of the processing table;

holding mechanism moving means which brings the contactor into contact with the top surface of the processing table by controlling the position of the contactor holding mechanism;

retracting distance detecting means which detects the amount of retraction of the contactor when it is brought into contact with the top surface of the processing table by the holding mechanism moving means;

processing table position recognizing means which recognizes the top surface position of the processing table relative to the contactor, based on the amount of retraction

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detected by the retracting distance detecting means;

noncontacting measuring means which measures the relative position of the contactor and the blade without making contact; and

positional relationship recognizing means which recognizes the positional relationship between the blade and the top surface of the processing table, from the relative position of the contactor and the blade measured by the noncontacting measuring means and the top surface position of the processing table relative to the contactor which was recognized by the processing table position recognizing means.

2. A dicing machine according to claim 1, wherein

fastening means which fastens the contactor holding mechanism on the spindle is provided;

the holding mechanism moving means controls the position of the contactor holding mechanism by moving the spindle; and

the contactor holding mechanism is provided with contactor driving means which makes the contactor retract from the blade during dicing process and makes the contactor protrude beyond the blade when it is in contact with the processing table.

3. A dicing machine according to claim 1, wherein

the noncontacting measuring means has an optical sensor

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which detects a member located at a reference position without making contact by means of a light beam emitted onto the reference position which is set in a specified positional relationship with the top surface of the processing table, and measures the relative position of the blade and the contactor by detecting the blade and the contactor by means of the optical sensor and determining the positions of the blade and the contactor relative to the reference position.

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DICING MACHINE

ABSTRACT

To provide a dicing machine capable of improving the productivity.

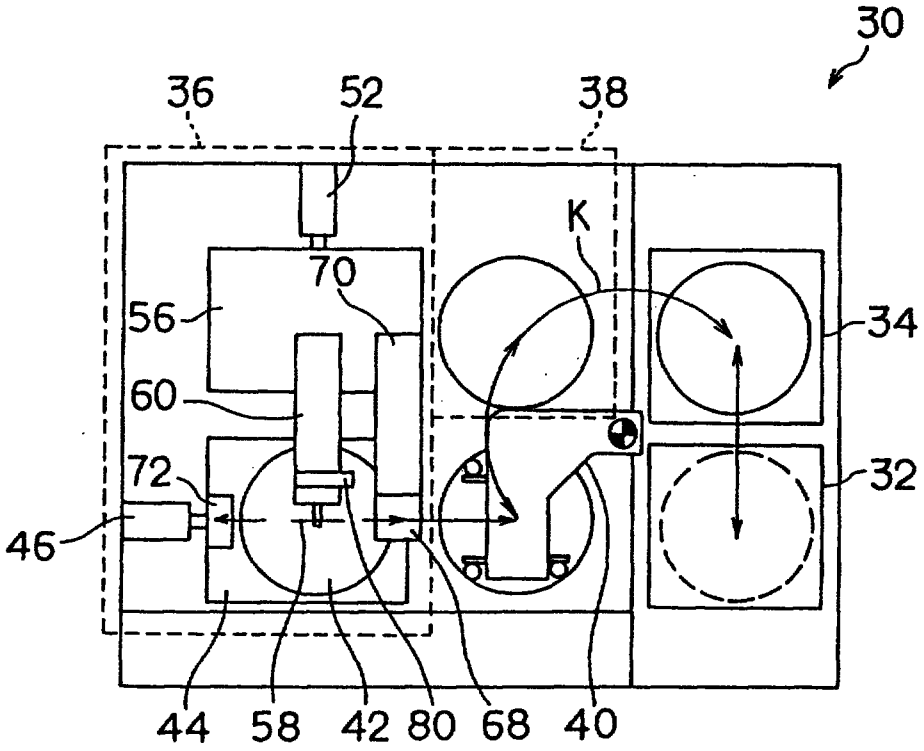
The setup piece 86 is moved vertically by the air cylinder 94, so that the bottom end thereof takes lower position and upper position relative to the blade 58. When the spindle motor moves down so that the setup piece 86 makes contact with the top surface of the chuck table, the setup piece 86 moves and the traveling distance thereof is measured by the distance measuring instrument 102. Then the top surface position of the chuck table relative to the setup piece 86 is determined from the measured value of the distance measuring instrument 102.

Fig. 4

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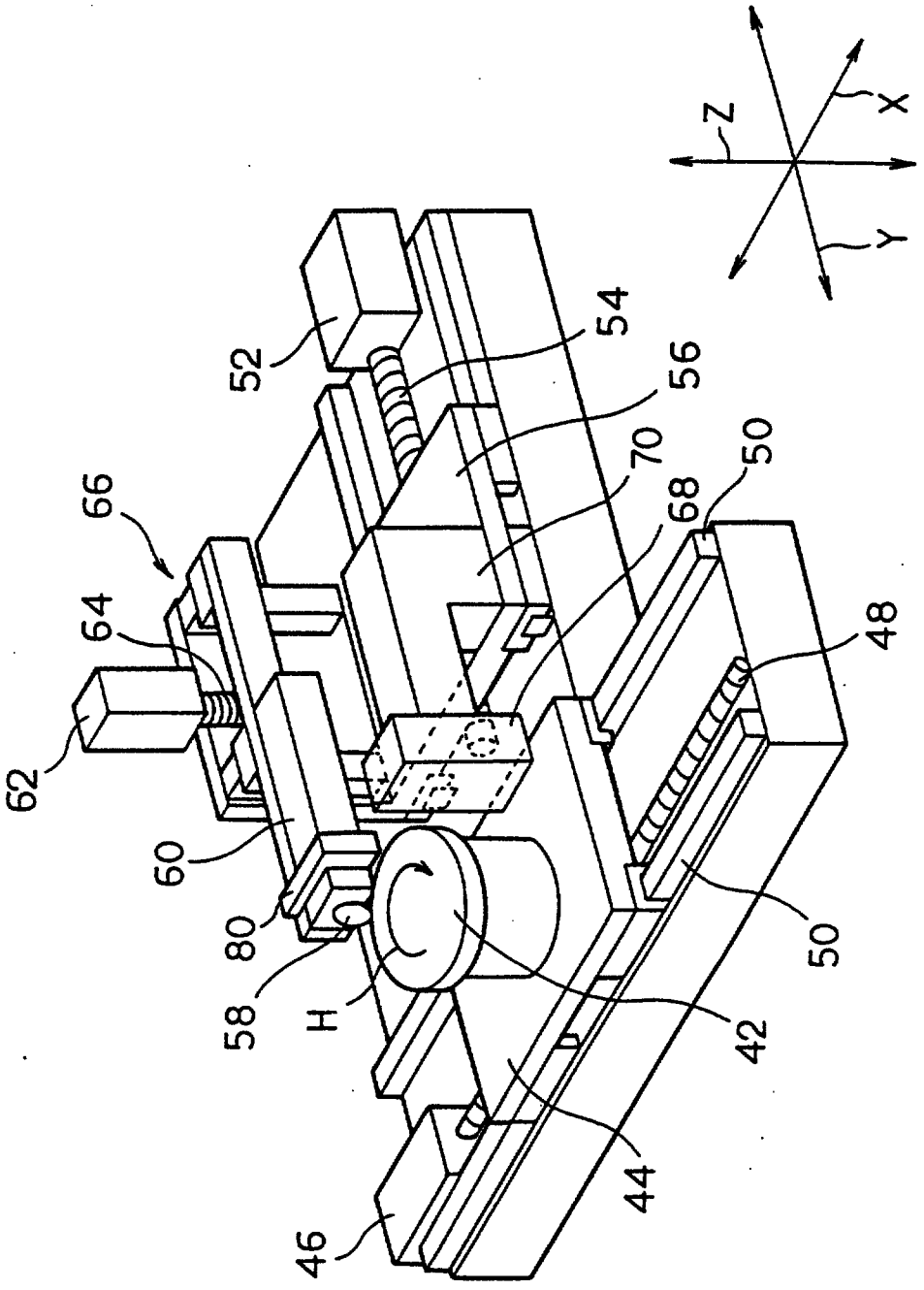
FIG. 1



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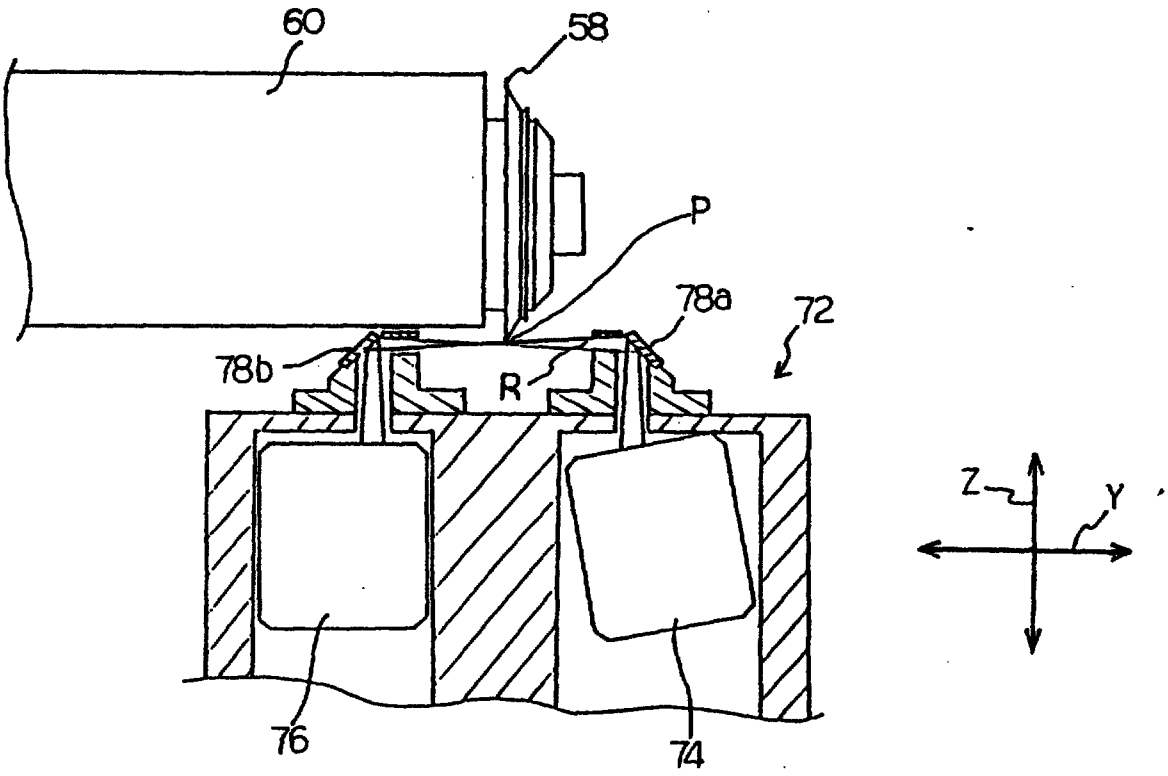
FIG. 2



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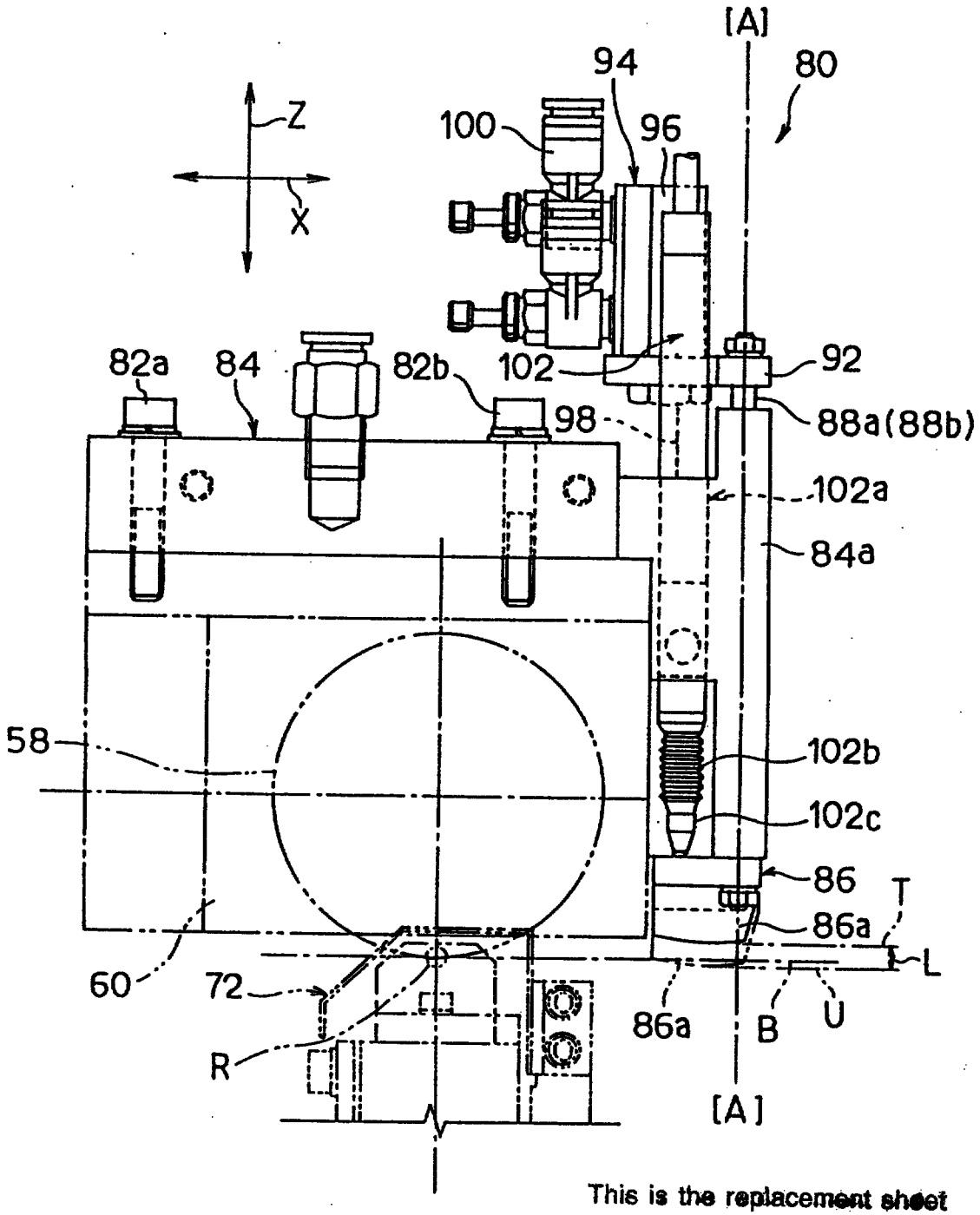
FIG. 3



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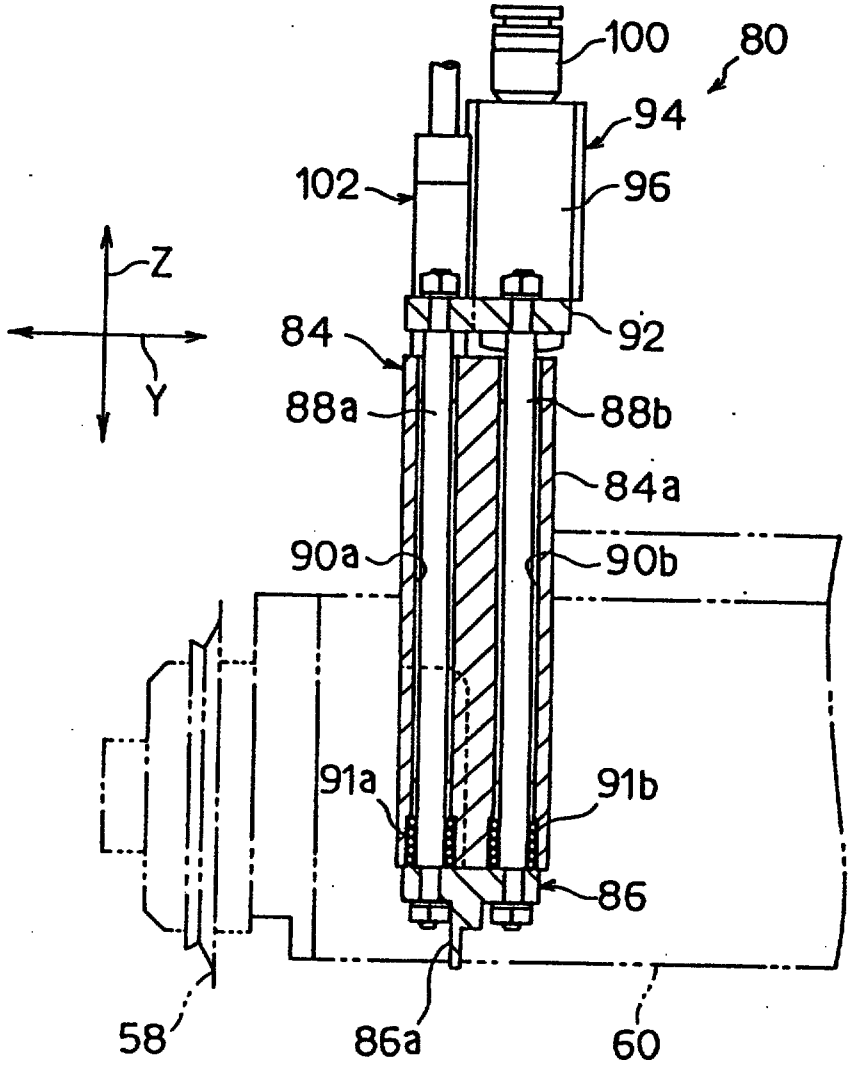
FIG. 4



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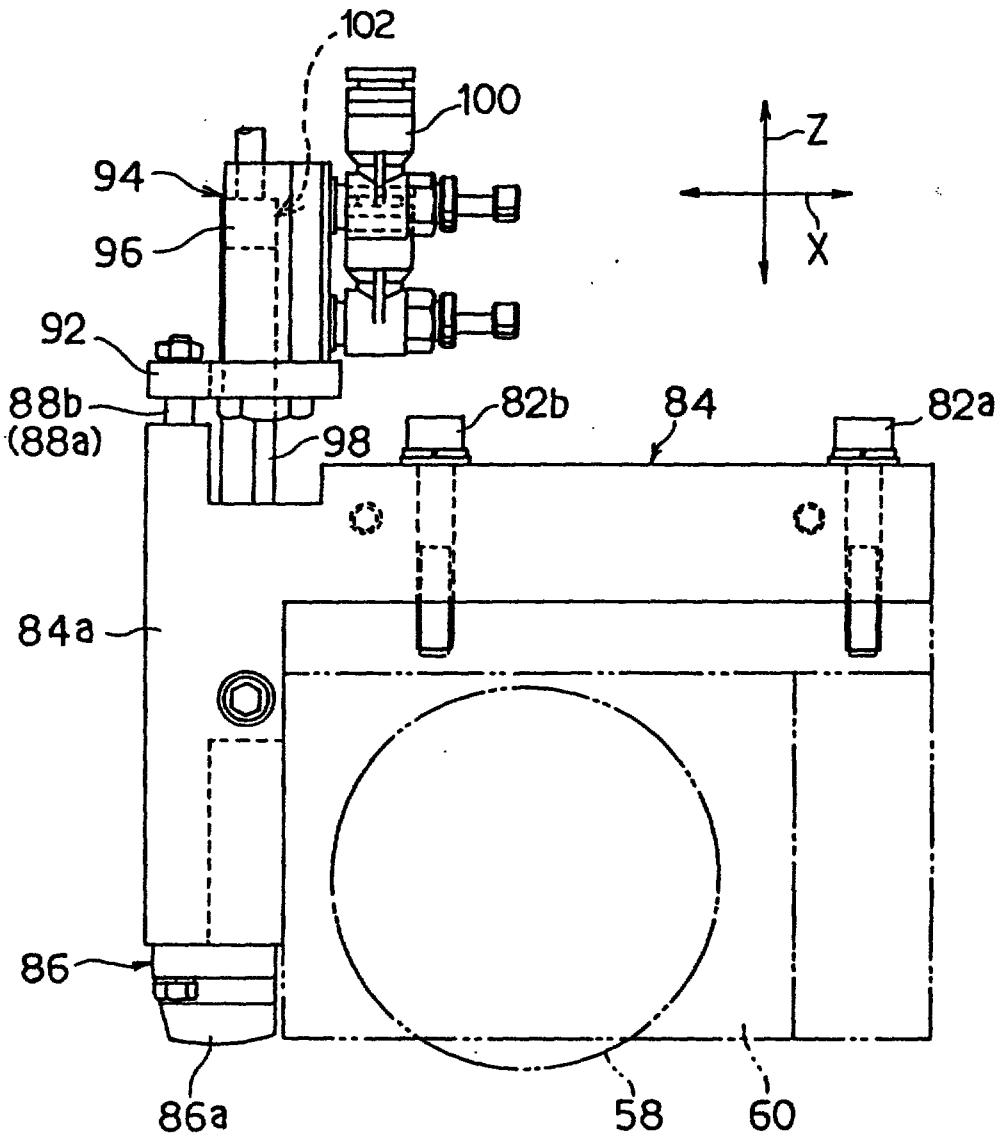
FIG. 5



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FIG. 6



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FIG. 7

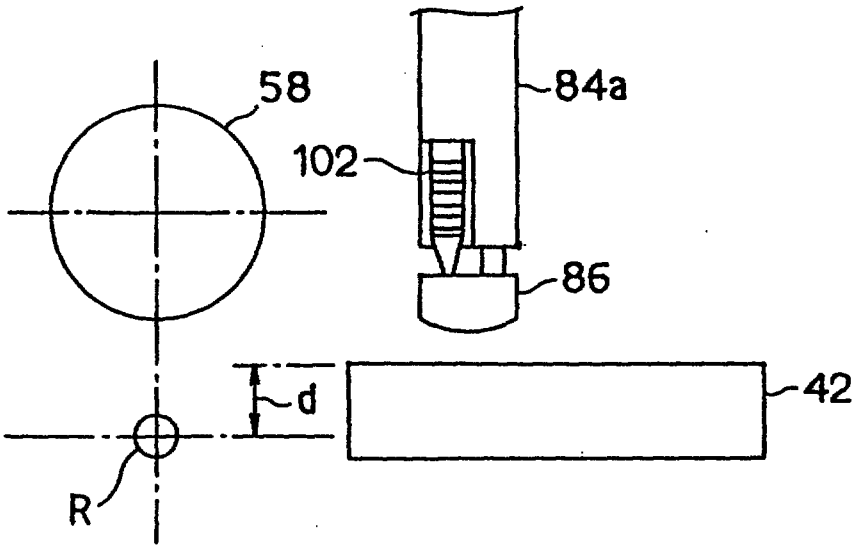
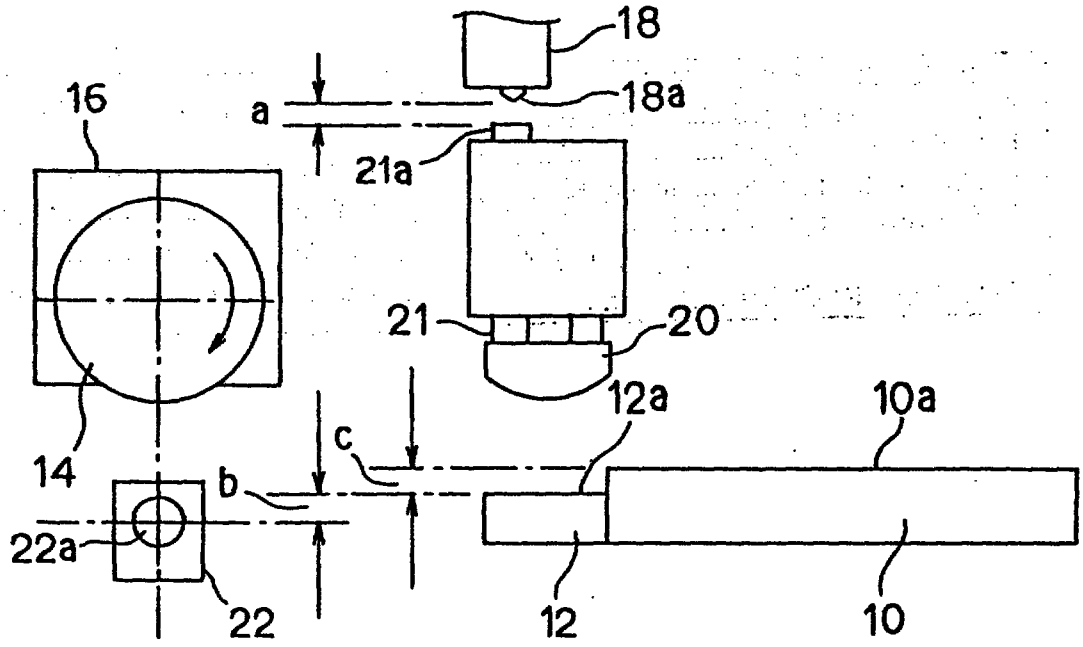


FIG. 8
PRIOR ART



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REPLACEMENT SHEETS 30
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☑ Claim(s) : paged 26 to paged 26
☐ Drawing(s) : paged ... to paged ...
☐ Abstract : paged ... to paged ...
DATE OF RECEIPT 31 JUL 1997

CLAIMS

1. A dicing machine for dicing semiconductor wafers, which are fixed on a processing table, by means of a blade driven to rotate by a spindle, comprising;

a contactor arranged at a position where it can contact the processing table;

a contactor holding mechanism which holds the contactor in such a way as the contactor can move forward and backward relative to the top surface of the processing table;

holding mechanism moving means which brings the contactor into contact with the top surface of the processing table by controlling the position of the contactor holding mechanism;

retracting distance detecting means which detects the amount of retraction of the contactor when it is brought into contact with the top surface of the processing table by the holding mechanism moving means;

processing table position recognizing means which recognizes the top surface position of the processing table relative to the contactor, based on the amount of retraction

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