

TITLE OF THE INVENTION :

Chip Transporting Method And The Device Thereof

BACKGROUND OF THE INVENTION:

【0001】

【Technical Field】

The present invention relates to a method for transporting a chip of a semiconductor wafer and the device thereof, and more particularly relates to a method for transporting a chip cut out from of a semiconductor wafer and the device thereof, wherein the collet portion for holding the chip is moved with parallel motion from a chip pick-up position to a chip placing position. With such method and the device thereof, three (3) operation steps of the collet portion may be decreased, which may otherwise be required in the conventional method and device and the chip transporting efficiency is remarkably increased, and further the components of the chip transporting device may be reduced. As the result, the operation rate, that is the rotation number of drive motors required for movement of the collet portion may be reduced and therefore, the consumption of the drive motors may be avoided, and the cost down of the device may be attained

【0002】

【Background Art】

According to the conventional art, as seen in Fig. 10 showing the production process of semiconductor elements, the semiconductor wafer 1 (called "wafer" hereinafter) is attached to an adhesive tape 2, and then a plurality of semiconductor elements 3 are formed at the wafer 1. The semiconductor elements 3 are cut and separated from one another by a dicing device (not shown) and are formed into so many semiconductor chips 4 (called "chip" hereinafter)). Then the adhesive tape 2 is expanded so that the chips 4 may be pulled away from one another. Then the chips 4 are adsorbed by the adsorbing lip 5 a of the collet portion 5 so that the chips 4 may be taken off (picked up) one after another from the adhesive tape 2. Then the picked

up chips 4 are transported from the chip pick-up position 6 to the chip placing position 9 of a tray 8 or the like.

【0003】

The collet portion 5 is operated as follows in transportation of the chips 4; As shown in Figs. 10 and 11, at the time of starting operation, the collet portion 5 is located at a standby position 7 (that is spaced 90 mm, by way of example, from the chip placing position 9 in the direction to the chip pick-up position 6 and is spaced 30 mm from the chip pick-up position 6 in the direction to the chip placing position 9). Namely the collet portion 5 is not in the chip pick-up position 6 during a tip image confirming operation. The collet portion 5 is moved to the chip pick-up position 6 after the chip confirming operation or after the chip position amending operation is finished.

【0004】

If the collet portion 5 is located at the chip placing position 9 during the chip image confirming operation or during the chip position amending operation, the collet portion 5 is required to take so much waste time in movement (120 mm in total) in the X axis direction. The chip image treatment operation is started after the collet portion 5 is moved out of the view of image treating camera toward the chip placing position 9. The collet portion 5 is moved 90 mm, by way of example, from the chip placing position 9 as shown by arrow T after the chip placing operation is finished and is stopped at the standby position 7. After the tip image confirming operation (or chip position amending operation) is finished, the collet portion 5 is moved 30 mm, by way of example, from the standby position 7 to the chip pick-up position 6. Thus the time saving is plotted.

【0005】

According to the conventional art, firstly at step S 1, the chip image is confirmed. At step S 2, the wafer 1 is moved so that the chip position may be adjusted relative to the collet portion 5. At step S 3, the collet portion 5 is moved 30 mm in the X axis direction as shown by arrow F from the standby

position 7 to the chip pick-up position 6. At step S 4, the collet portion 5 is moved down 35 mm along Z axis as shown by arrow A to the chip pick-up position 6 until the chip adsorbing lip 5 a may slightly touch a chip 4. Then the chip adsorbing lip 5 a adsorbs the chip 4 by inhaling the air.

【0006】

At step S 5, the chip pick up operation (chip taking off operation) is carried out. The chip 4 is taken off from the wafer 1 by a needle (not shown) which is operated under the adhesive tape 2 to lightly push it up.

【0007】

Subsequently at step S 6, the collet portion 5 is moved 35 mm up to a collet transportation position 10 along Z axis as shown by arrow B.

【0008】

At step S 7, the collet portion 5 is moved 120 mm along X axis as shown by arrow C to the chip placing position 9. At step S 8, the collet portion 5 is operated to deliver the chip 4. Namely the collet portion 5 is moved down 35 mm along Z axis as shown by arrow D until the chip 4 held by the chip adsorbing lip 5 a of the collet portion 5 is lightly touched against the tray 8. Then the collet portion 5 is operated to cease to inhale the air for adsorbing the chip 4. The chip 4 is then released from the chip adsorbing lip 5 a and is placed on the tray 8. Thus the chip placing operation is finished. Then the collet portion 5 is moved up 35 mm along Z axis as shown by arrow E to the collet transportation position 10.

【0009】

Subsequently at step S 9, the collet portion 5 is moved 90 mm along X axis as shown by arrow T to the standby position 7, and the sequence operation is returned to step S 1 to be repeated.

【0010】

As mentioned above, according to the conventional chip transporting method and the device thereof, the collet portion 5 is required to move by 30 mm along X axis from the standby position 7 to the chip pick-up position 6 and to vertically

move by 35 mm along Z axis at the chip pick-up position 6, and is further required to move by 120 mm horizontally along X axis from the chip pick-up position 6 to the chip placing position 9 at the collet transporting position 10 and to move vertically along Z axis at the chip placing position 9 and is further required to move along X axis from the chip placing position 9 to the standby position 7. Thus the collet portion 5 is required to take totally nine (9) steps of movement. In addition, as the collet portion 5 is required to move along rectangular and stepped locus, the tact time in one cycle of chip transportation movement of the collet portion 5 is approximately 0.319 seconds and the chip transportation rate is not so good. It has been difficult to reduce the tact time of the conventional chip transporting method and the device thereof.

【0011】

Further as to the operation rate of the components such as, for example, the drive motors (not shown) for moving the collet portion 5 in X and Z axes respectively, the X axis drive motor is required to take six (6) rotations and the Z axis drive motor is required to take two (2) rotations for one cycle of chip transportation movement of the collet portion 5. It has been difficult to reduce the operation rate of the components of the conventional device.

【0012】

Further the conventional chip transporting device is required to have at least ninety-eight (98) number of components. It has been difficult to reduce the number of components.

【0013】

The conventional device is, therefore, rather costly. It has been difficult to reduce the cost of the device.

【0014】

【Patent Document 1】 JP-A-17(2005)-353873

【0015】

【Disclosure of the Invention】

【Subjects that the Invention is to Solve】

The invention has been provided to eliminate the defects and disadvantages of the prior art.

It is, therefore, an object of the invention to provide a method for transporting a chip which is cut out from an wafer from a chip pick-up position to a chip placing position of a tray, the method comprising the step of operating a Z axis drive mechanism reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position. Thus in one cycle of the tip transportation three (3) operation steps of the collet portion may be decreased, which may otherwise be required in the conventional method and device. Further the collet portion may be moved very smoothly as is changed from the conventional mode of movement taking a rectangular and stepped route. As the result, the tact time for the chip transportation may be reduced from the conventional time 0.319 seconds to 0.22 seconds, that is the time reduction of 31 % and is a remarkable improvement of chip transportation efficiency.

It is another object of the invention to remarkably reduce the operation rate, that is the rotation number of drive motors required for movement of the collet portion in one cycle of chip transportation from the conventional rotation number 8 to 1,2, that is reduction of 85 %, so as to avoid the consumption of drive motors and to prolong the life of the chip transporting device.

It is another object of the invention to decrease approximately 20 % of the constituent components of the chip transporting device, thereby to prolong the life of the chip transporting device.

[0016]

It is another object of the invention to provide a method for transporting a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray,

the method comprising the step of operating a Z axis drive mechanism to reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to move the collet portion from the chip pick up position to the chip placing position in parallel motion, and further operating a rotating drive mechanism to be rotated relative to the arm on the arm in such manner that the rotational movement of the arm is nullified. Thus the chip is transported from the chip pick up position to the chip placing position with a slight movement in the Z axis direction due to the parallel motion of the collet portion and the swing reciprocation of the arm. As the result, the three (3) steps of operation of the collet portion may be reduced in contrast to the conventional chip transporting ed very smoothly in contrast to the rectangular and stepped movements in the conventional chip transporting method and the device thereof. Further the tact time for the chip transportation may be remarkably reduced to 0.22 sec. from 0.319 sec. of the conventional chip transporting method and the device thereof. Namely the tact time may be reduced approximately 31% extremely increasing the chip transportation efficiency.

It is another object of the invention to remarkably decrease the operation rate , that is the rotation number of drive motors required for movement of the collet portion in one cycle of chip transportation, namely to decrease the motor rotation number to 1.2 rotations from 8 rotations in the conventional chip transporting method and the device thereof. Thus the operation rate of drive motors may be reduced approximately 86%. As the result, the consumption of drive motors may be avoided and the chip transporting device may be used in so long time of period.

It is another object of the invention to decrease approximately 20% of the number of components of the chip transporting device in accordance to the formation as mentioned above, thus to decrease approximately 25% of the production cost of the device.

【0017】

It is another object of the invention to provide a method for transporting a chip that is cut out from a wafer from a chip pick-up position to the chip placing position of a tray, the method comprising the step of operating a Z axis drive mechanism to reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to produce relative movement between a fixed toothed pulley and a rotational toothed pulley and a toothed belt wherein the toothed belt is wound around the rotational toothed pulley and the fixed toothed pulley, the rotational toothed pulley being rotatable with a collet portion rotating shaft that is rotatably supported by the arm and the fixed toothed pulley being fixedly arranged as is coaxial with the rotation axis of the arm, so that the collet portion may be rotated in the direction in a same proportion opposite to the rotating direction of the of the arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick and transport the chip from the chip pick-up position to the chip placing position. Therefore the collet portion may be moved very smoothly with parallel motion through a combination of two (2) toothed pulleys and one toothed belt. As the result, three (3) operation steps of the collet portion in the chip transportation may be decreased, which may otherwise be required in the conventional method and device. Further the collet portion may be moved very smoothly with high efficiency from the chip pick-up position to the chip placing position in contrast to the conventional mode of movement taking a rectangular and stepped route. As the result, the tact time for the chip transportation may be remarkably reduced in contrast to the conventional art. In addition, the constituent components of the chip transporting device may be decreased. Further the operation rate, that is the rotation number of drive motors required for movement of the collet portion for chip transportation may be remarkably reduced in contrast to the conventional art. As the result, the consumption of drive

motors may be avoided and the chip transporting device may be used in so long time of period, and at the same time, the production cost of the device may be remarkably decreased.

【0018】

It is another object of the invention to provide a device for transporting a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the device comprising a collet portion for picking up the chip from the wafer, a Z axis drive mechanism for reciprocatingly moving the collet portion slightly to and away from the wafer, a θ axis rotating mechanism for reciprocatingly rotating an arm to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position. As the result, three (3) operation steps of the collet portion in the chip transportation may be decreased, which may otherwise be required in the conventional art and the constituent components of the chip transporting device may be decreased and further the tact time for the chip transportation may be remarkably reduced in contrast to the conventional art. In addition, the operation rate, that is the rotation number of drive motors required for movement of the collet portion for chip transportation may be remarkably reduced in contrast to the conventional art. As the result, the consumption of drive motors may be avoided and the chip transporting device may be used in so long time of period.

【0019】

It is another object of the invention to provide a device for transporting a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the device comprising a collet portion for picking up a chip from a wafer, a Z axis drive mechanism for reciprocatingly moving the collet portion slightly to and away from the wafer in Z axis direction, an arm for moving the collet portion from the chip pick-up position to the chip placing position, a θ axis rotating mechanism for reciprocatingly rotating the arm, a rotating drive mechanism that is mounted on the arm and is

rotated relative to the arm so that the rotating movement of the arm may be nullified thereby to cause the collet portion to move with parallel motion, wherein the chip is transported from the chip pick-up position to the chip placing position with a slight movement of the collet portion in the Z axis direction and the reciprocating rotation of the arm. As the result, the three (3) steps of operation of the collet portion may be reduced and the tact time for the chip transportation may be remarkably reduced. In addition, the constituent components of the chip transporting device may be considerably decreased. Further the operation rate, that is the rotation number of drive_motors required for movement of the collet portion for chip transportation may be remarkably reduced. As the result, the consumption of drive motors may be avoided and the chip transporting device may be used in so long time of period, and at the same time, the production cost of the device may be remarkably decreased.

【0020】

It is still another object of the invention to provide a device for transporting a chip that is cut out from a wafer from a chip pick-up position to a tip placing position of a tray, the device comprising a collet portion for picking up the chip from the wafer, a Z axis drive mechanism for reciprocatingly move the collet portion slightly to and away from the wafer, a θ axis rotating mechanism for reciprocatingly rotating an arm to produce relative movement between a fixed toothed pulley and a rotational toothed pulley and a toothed belt wherein the toothed belt is wound around the rotational toothed pulley and the fixed toothed pulley, the rotational toothed pulley being rotatable with the collet portion rotating shaft that is rotatably supported by the arm and the fixed toothed pulley being fixedly arranged as is coaxial with the rotation axis of the arm, so that the collet portion may be rotated in the direction in a same proportion opposite to the rotating direction of the arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the tip

pick-up position to the chip placing position. Therefore, the collet portion may be moved very smoothly with parallel motion through a combination of two (2) toothed pulleys and one toothed belt. As the result, three (3) operation steps of the collet portion in the chip transportation may be decreased, which may otherwise be required in the conventional method and device. Further the collet portion may be moved very smoothly with high efficiency from the chip pick-up position to the tip placing position in contrast to the conventional mode of movement taking a rectangular and stepped route. As the result, the tact time for the chip transportation may be remarkably reduced in contrast to the conventional art. In addition, the constituent components of the chip transporting device may be decreased. Further the operation rate, that is the rotation number of drive motors required for movement of the collet portion for chip transportation may be remarkably reduced in contrast to the conventional art. As the result, the consumption of drive motors may be avoided and the chip transporting device may be used in so long time of period.

【0021】

【Means for Solving the Subjects】

In short, the method of the invention (Claim 1) is provided to transport a chip which is cut out from an wafer from a chip pick-up position to a chip placing position of a tray, the method comprising the step of operating a Z axis drive mechanism reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position.

【0022】

Further the method of the invention (Claim 2) is provided to transport a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the method comprising the step of operating a Z axis drive mechanism to reciprocatingly move a collet portion slightly to and away from

the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to move the collet portion from the chip pick up position to the chip placing position in parallel motion, and further operating a rotating drive mechanism so as to be rotated relative to the arm on the arm in such manner that the rotational movement of the arm is nullified. Thus the chip is transported from the chip pick up position to the chip placing position with a slight movement in the Z axis direction due to the parallel motion of the collet portion and the swing reciprocation of the arm.

【0023】

Further the method of the invention (Claim 3) is provided to transport a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the method comprising the step of operating a Z axis drive mechanism to reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to produce relative movement between a fixed toothed pulley and a rotational toothed pulley and a toothed belt wherein the toothed belt 9 is wound around the rotational toothed pulley 18 and a fixed toothed pulley, the rotational toothed pulley being rotatable with a collet portion rotating shaft that is rotatably supported by the arm and the fixed toothed pulley being fixedly arranged as is coaxial with the rotation axis of the arm, so that the collet portion may be rotated in the direction in a same proportion opposite to the rotating direction of the arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position.

【0024】

Further the device of the invention (Claim 4) is provided to transport a chip that is cut out from a wafer from a chip pick-up position 6 to a chip placing position 9 of a tray, the device comprising a collet portion for picking up the chip from the wafer, a Z axis drive mechanism for reciprocatingly moving

the collet portion slightly to and away from the wafer in Z axis direction, a θ axis rotating mechanism for reciprocatingly rotating an arm to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position.

【0025】

Further the device of the invention (Claim 5) is provided to transport a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the device comprising a collet portion for picking up the chip from the wafer, a Z axis drive mechanism for reciprocatingly moving the collet portion slightly to and away from the wafer, an arm for moving the collet portion from the chip pick-up position to the chip placing position, a θ axis rotating mechanism for reciprocatingly rotating the arm, a rotating drive mechanism that is mounted on the arm and is rotated relative to the arm in such manner that the reciprocating rotation of the arm may be nullified, thereby to cause the collet portion to move with parallel motion, wherein the chip is transported from the chip pick-up position to the tip placing position with a slight movement of the collet portion in the Z axis direction and the reciprocating rotation of the arm.

【0026】

Further the device of the invention (Claim 6) is provided to transport a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the device comprising a collet portion for picking up the chip from the wafer, a Z axis drive mechanism 13 for reciprocatingly move the collet portion slightly to and away from the wafer, a θ axis rotating mechanism for reciprocatingly rotating an arm to produce relative movement between a fixed toothed pulley and a rotational toothed pulley and a toothed belt wherein the toothed belt is wound around the rotational toothed pulley and the fixed toothed pulley, the rotational toothed pulley being rotatable with the collet portion rotating shaft that is rotatably supported by the arm and the fixed toothed pulley

being fixedly arranged as is coaxial with the rotation axis of the arm , so that the collet portion may be rotated in the direction in a same proportion opposite to the rotating direction of the arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position.

【0027】

【Advantages of the Invention】

According to the invention, as mentioned above, the chip transporting method is provided to transport a chip which is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the method comprising the step of operating a Z axis drive mechanism reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position. Thus in one cycle of the chip transportation three (3) operation steps of the collet portion may be decreased, which may otherwise be required in the conventional method and device. Further the collet portion may be moved very smoothly as is changed from the conventional mode of movement taking a rectangular and stepped route. As the result, the tact time for the chip transportation may be reduced from the conventional time 0.319 seconds to 0.22 seconds, that is the time reduction of 31 % and is a remarkable improvement of chip transportation efficiency.

Further the operation rate, that is the rotation number of drive motors required for movement of the collet portion in one cycle of chip transportation may be reduced from the conventional rotation number 8 to 1,2, that is reduction of 85 %. As the result, the consumption of drive motors may be avoided and the chip transporting device may be used in so long time of period.

Further 20 % of the constituent components of the chip

transporting device may be decreased. In this connection, approximately 25 % of production cost of the device may be decreased.

【0028】

Further according to the invention, the chip transporting method is provided to transport a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the method comprising the step of operating a Z axis drive mechanism to reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to move the collet portion from the chip pick up position to the chip placing position in parallel motion, and further operating a rotating drive mechanism to be rotated relative to the arm on the arm in such manner that the rotational movement of the arm is nullified. Thus the chip is transported from the chip pick up position to the chip placing position with a slight movement in the Z axis direction due to the parallel motion of the collet__portion and the swing reciprocation of the arm. As the result, the three (3) steps of operation of the collet portion may be reduced in contrast to the conventional chip transporting method and the device thereof, and further the collet portion may be moved very smoothly in contrast to the rectangular and stepped movements in the conventional chip transporting method and the device thereof. Further the tact time for the chip transportation may be remarkably reduced to 0.22 sec. from 0.319 sec. of the conventional chip transporting method and the device thereof. Namely the tact time may be reduced approximately 31% extremely increasing the chip transportation efficiency.

Further with the structure, the operation rate, that is the rotation number of drive motors required for movement of the collet portion in one cycle of chip transportation may be remarkably decreased. Namely the motor rotation number may be decreased to 1.2 rotations from 8 rotations in the conventional chip transporting method and the device thereof. Thus the operation rate of drive motors may be reduced approximately

86%. As the result, the consumption of drive motors may be avoided and the chip transporting device may be used in so long time of period.

Further with the structure, approximately 20% of the number of components of the chip transporting device may be decreased, thus to decrease approximately 25% of the production cost of the device.

【0029】

Further according to the invention, the chip transporting method is provided to transport a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the method comprising the step of operating a Z axis drive mechanism 13 to reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to produce relative movement between a fixed toothed pulley and a rotational toothed pulley and a toothed belt wherein

hed belt 9 is, wound around the rotational toothed pulley 18 and a fixed toothed pulley, the rotational toothed pulley being rotatable with a collet portion rotating shaft that is rotatably supported by the arm and the fixed toothed pulley being fixedly arranged as is coaxial with the rotation axis of the arm, so that the collet portion may be rotated in the direction in a same proportion opposite to the rotating direction of the arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position. Therefore, the collet portion may be moved very smoothly with parallel motion through a combination of two (2) toothed pulley and one toothed belt. As the result, three (3) operation steps of the collet portion in the chip transportation may be decreased, which may otherwise be required in the conventional method and device. Further the collet portion may be moved very smoothly with high efficiency from the chip pick-up position to the chip placing position in contrast to the conventional mode of movement taking a

rectangular and stepped route. As the result, the tact time for the chip transportation may be remarkably reduced in contrast to the conventional art. In addition, the constituent components of the chip transporting device may be decreased. Further the operation rate, that is the rotation number of drive motors required for movement of the collet portion for chip transportation may be remarkably reduced in contrast to the conventional art. As the result, the consumption of drive motors may be avoided and the chip transporting device may be used in so long time of period.

【0030】

Further according to the device of the invention, the chip transporting device is provided to transport a chip that is cut out from a wafer from a chip pick-up position 6 to a chip placing position 9 of a tray, the device comprising a collet for picking up the chip from the wafer, a Z axis drive mechanism for reciprocatingly moving the collet portion slightly to and away from the wafer, a θ axis rotating mechanism for reciprocatingly rotating an arm to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position. As the result, three (3) operation steps of the collet portion in the chip transportation may be decreased, which may otherwise be required in the conventional art and the constituent components of the chip transporting device may be decreased and further the tact time for the chip transportation may be remarkably reduced in contrast to the conventional art. In addition, the operation rate, that is the rotation number of drive motors required for movement of the collet portion for chip transportation may be remarkably reduced in contrast to the conventional art. As the result, the consumption of drive motors may be avoided and the chip transporting device may be used in so long time of period.

【0031】

Further according to the device of the invention, a chip that is cut out from a wafer is transported from a chip pick-up position to a chip placing position of a tray, the device

comprising a collet portion for picking up a chip from a wafer, a Z axis drive mechanism for reciprocatingly moving the collet portion slightly to and away from the wafer in Z axis direction, an arm for moving the collet portion from the chip pick-up position to the chip placing position, a θ axis rotating mechanism for reciprocatingly rotating the arm, a rotating drive mechanism that is mounted on the arm and is rotated relative to the arm so that the rotating movement of the arm may be nullified thereby to cause the collet portion to move with parallel motion, wherein the chip is transported from the chip pick-up position to the chip placing position with a slight movement of the collet portion in the Z axis direction and the reciprocating rotation of the arm. As the result, the three (3) steps of operation of the collet portion may be reduced and the tact time for the chip transportation may be remarkably reduced. In addition, the constituent components of the chip transporting device may be considerably decreased. Further the operation rate, that is the rotation number of drive motors required for movement of the collet portion for chip transportation may be remarkably reduced. As the result, the consumption of drive motors may be avoided and the chip transporting device may be used in so long time of period, and at the same time, the production cost of the device may be remarkably decreased.

【0032】

Further according to the device of the invention, a chip that is cut out from a wafer is transported from a chip pick-up position to a chip placing position of a tray, the device comprising a collet portion for picking up the chip from the wafer, a Z axis drive mechanism 13 for reciprocatingly move the collet portion slightly to and away from the wafer, a θ axis rotating mechanism for reciprocatingly rotating an arm to produce relative movement between a fixed toothed pulley and a rotational toothed pulley and a toothed belt wherein the toothed belt is wound around the rotational toothed pulley and the fixed toothed pulley, the rotational toothed pulley being rotatable with the collet portion rotating shaft that is

rotatably supported by the arm and the fixed toothed pulley being fixedly arranged as is coaxial with the rotation axis of the arm , so that the collet portion may be rotated in the direction in a same proportion opposite to the rotating direction of the arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position. Therefore, the collet portion may be moved very smoothly with parallel motion through a combination of two (2) toothed pulley and one toothed belt. As the result, three (3) operation steps of the collet portion in the chip transportation may be decreased, which may otherwise be required in the conventional method and device. Further the collet portion may be moved very smoothly with high efficiency from the chip pick-up position to the chip placing position in contrast to the conventional mode of movement taking a rectangular and stepped route. As the result, the tact time for the chip transportation may be remarkably reduced in contrast to the conventional art. In addition, the constituent components of the chip transporting device may be decreased. Further the operation rate, that is the rotation number of drive motors required for movement of the collet portion for chip transportation may be remarkably reduced in contrast to the conventional art. As the result, the consumption of drive motors may be avoided and the chip transporting device may be used in so long time of period.

【0033】

Brief Description of the Attached Drawings:

Figs.1 through 6 relate to the embodiments of the invention:
Fig. 1 is a side elevational view of a device for transporting a chip.

Fig. 2 is a side elevational view of a θ axis rotating mechanism shown partly in vertical section.

Fig. 3 is a front elevational view of an essential part of the chip transporting device.

Fig. 4 is a front elevational view of the essential part of

the chip transporting device shown as in operation.
Fig. 5 is a perspective s view of the essential part of the chip transporting device shown as in operation.
Fig. 6 is a flow chart showing a routine of the chip transporting device.
Figs. 7 and 8 relate to a second embodiment of the invention:
Fig. 7 is a front elevational view of an essential part of the chip transporting device shown as enlarged.
Fig. 8 is the same with the one as shown in Fig. 7, but is shown as is moved in operation.
Fig. 9 is a third embodiment of the invention and is a side elevational view of an essential part of the chip transporting device shown as enlarged.
Figs. 10 and 11 relate to a conventional art:
Fig. 10 is an explanatory perspective view of an essential part of the chip transporting device.
Fig. 11__is a flow chart showing a routine of the chip transporting device.

【0034】

Best Mode for Carrying Out the Invention:

The invention will be described in detail in reference to the embodiments as shown in the attached drawings.

In Figs. 1 through 5 showing a first embodiment of the invention, the chip transporting device 11 of the invention is provided to transport a chip 4 which is cut out from a wafer 1 from a chip pick-up position 6 to a chip placing position 9 of a tray 8. The tip transporting device 11 is, therefore, composed of a collet portion 12, a Z axis drive mechanism 13, a θ axis rotating mechanism 14, a fixed toothed pulley 15, a shaft 16 for rotating the collet portion 12, a rotational toothed pulley 18 and a toothed belt 19.

【0035】

In Fig. 2, the collet portion 12 is provided to pick up the chip 4 from the wafer 1 and has an adsorbing lip 12 a provided at the lower end thereof. The collet portion 12 is hollow within

and has an opening 12 b formed at a side thereof for inhaling air thereat through an air inhaling pipe (not shown) which is to be connected to the opening 12. The hollow collet portion 12 is adapted to be vacuumized by an external vacuum pump or the like (not shown). A hollow shaft 23 that is provided as formed in one body with the collet portion 12 is fitted in a ball bushing 22 and is slidably movable therein. The ball bushing 22 is fixedly connected to a bracket 20 by screws 21 while the bracket 20 is fixedly connected to the collet portion rotating shaft 16. The hollow shaft 23 is normally urged in the lower direction by a compression spring 24 and is reciprocatingly movable along Z axis so that the collet portion 12 may softly touch the wafer 1. The hollow shaft 23 has a stopper 25 provided at the top thereof for adjusting the vertical position of the collet portion 12. With manipulation of a plurality of nuts 26, a bolt 28 may be vertically positioned and the lower end of the bolt 28 may engage the bracket 20. as the result, the moving range of the collet portion 12 may be regulated.

【0036】

The collet portion rotating shaft 16 has an arm 29 secured thereto. The arm 29 has a bar 30 fixedly implanted at one end thereof. The bar 30 is inserted into a bushing 31 that is pressed into the bracket 20 to prevent the bracket 20 from rotatingly moving relative to the collet portion rotating shaft 16.

【0037】

In Fig. 1, the Z shaft drive mechanism 13 is provided to slightly (approximately 5mm) move the collet portion 12 to and away from the wafer 1 along Z axis (vertical direction). The Z axis drive mechanism 13 is provided with a base 32 having a pair of guide rails 33 secured thereto by means of screws 37 and having a Z shaft drive motor 34 secured thereto by means of screws 35. The Z axis drive motor 34 has a rotational shaft 34 a which is rotatably supported by a bearing 36 secured to the base 32 and is connected to a Z axis drive screw 38.

The Z axis drive screw 38 is in threaded engagement with a nut 40 which is formed in one body with a slide table 39 which is fixedly connected to a pair of linear guides 41 by screws

42 while the linear guides 41 are fitted to a pair of guide rails 33 respectively and are slidably movable as guided by the guide rails 33. The slide table 39 has a base 44 secured thereto by means of screws 43 while the θ axis rotating mechanism 14 is mounted on the base 44.

【0038】

In Fig. 2, the θ axis rotating mechanism 14 is provided to reciprocatingly swing an arm 45 to which the collet portion 12 is connected. A θ axis rotation drive motor 46 is mounted on the base 44 of the slide table 39 so as to drive the θ axis rotating mechanism 14. The θ axis rotation drive motor 46 has a reduction gear 49 fixedly connected thereto by means of screw 48 while the reduction gear 49 is mounted on the base 44 by way of a bracket 50 to which the reduction gear 49 is fixedly connected.

The rotational shaft 46 a of the drive motor 46 (that is the output shaft of the reduction gear 49) is connected to a θ rotational shaft 53 through a joint 52 while the θ rotational shaft 53 is rotatably supported by a bearing 54 fixed to the base 44. The θ rotational shaft 53 has one end 53 a enlarged diametrically thereof and the stepped periphery 53 b is in contact with the inner race 54 a of the bearing 54. The θ rotational shaft 53 has the opposite end 53 c formed as a screw 53 d which is in threaded engagement with a nut 55 so that the θ rotational shaft 53 may be pressed against the inner race 54 b of the bearing 54.

【0039】

The arm 45 has one end 45 a connected to one end 53 a of the θ rotational shaft 53 by means of a screw 56 and has the opposite end 45 b supporting the collet portion rotating shaft 16 by way of a bearing 58. The collet portion rotating shaft 16 has a diametrically enlarged portion 16 a and a screw portion 16 c. The collet portion rotating shaft 16 is pressed against the inner races 58 a and 58 b of the bearing 58 by the stepped portion 16 b of the diametrically enlarged portion 16 a and a nut 59 which is in threaded engagement with the screw portion 16 c. As the result, collet portion rotating shaft 16 may be

rotated relative to the arm 45.

【0040】

In Figs 2 and 3, the fixed toothed pulley 15 is fixedly mounted on the base 44 of the θ axis rotating mechanism 14 at the position where the fixed toothed pulley 15 is coaxial with the swing center axis 0 of the arm 45. The fixed toothed pulley 15 is fixed to a bracket 61 by means of a screw 62 while the bracket 61 is fixed to the base 44 by means of a screw 60. Thus the fixed toothed pulley 15 is prevented from rotation. Incidentally the fixed toothed pulley 15 is provided with a number of teeth that is same with the rotational toothed pulley 18.

With such combination of the components, when the arm 45 is swingingly rotated, the toothed belt 19 wound around the fixed toothed pulley 15 and the rotational toothed pulley 18 in meshed engagement is turningly moved around the fixed toothed pulley 15. in the direction opposite to the rotating direction of the arm 45. As the result, the rotational toothed pulley 18 is rotated in the direction opposite to the rotating direction of the arm 45 by a same rotation angle with that of the arm 45.

【0041】

In Fig. 2, as mentioned above, the collet portion rotating shaft 16 is connected to the collet portion 12 while the collet portion rotating shaft 16 is rotatably supported on the arm 45 by way of the bearing 58.

【0042】

In Fig. 2, the rotational toothed pulley 18 is fixedly connected to the collet portion rotating shaft 16 by means of a screw 63 and may be rotated together with the collet portion 12. The rotation of the rotational toothed pulley 18 is caused by the turning movement of the toothed belt 19 that is caused by the rotation of the arm 45. The rotation angle of the rotational toothed pulley 18 is same with that of the arm 45 but the rotating direction is opposite to that of the arm 45. With the rotation of the rotational toothed pulley 18 in the opposite direction, the collet portion 12 is caused to move

with parallel motion.

【0043】

In Figs. 2 and 3, the toothed belt 19 is so called a timing belt that is wound around the rotational toothed pulley 18 and the fixed toothed pulley 15. The tension of the toothed belt 19 may be adjusted by an idle pulley 65 provided between the rotational toothed pulley 18 and the fixed toothed pulley 15 and pressed against the toothed belt 19.

【0044】

With relative movement between the fixed toothed pulley 15 and the rotational toothed pulley 18 and the toothed belt 19, the collet portion 12 may be rotated in the direction in a same proportion opposite to the rotating direction of the arm 45. Thus the collet portion 12 is moved with parallel motion so as to transport the chip 4 from the chip pick-up position 6 to the chip placing position 9 through additional slight movement of the collet portion 12 in Z axis direction and the reciprocating rotation movement of the arm 45.

【0045】

Subsequently in reference to Figs. 7 and 8 showing a second embodiment of the invention, the chip transporting device 11 for transporting the chip 4 that is cut out from the wafer 1 from the chip pick-up position 6 to the chip placing position 9 of the tray 8, the device 11 comprising a collet portion 12 for picking up the tip 4 from the wafer 1, a Z axis drive mechanism 13 for reciprocatingly moving the collet portion slightly to and away from the wafer 1 in Z axis direction, an arm 45 for moving the collet portion 12 from the chip pick-up position 6 to the chip placing position 6, a θ axis rotating mechanism 14 for reciprocatingly rotating the arm, a rotating drive mechanism 66 that is mounted on the arm 45 and is rotated relative to the arm so that the rotating movement of the arm may be nullified thereby to cause the collet portion 12 to move with parallel motion, wherein the chip 4 is transported from the chip pick-up position 6 to the chip placing position 9 with a slight movement of the collet portion 12 in the z axis direction and the reciprocating rotation of the arm 45.

【0046】

In Fig. 7, the rotating drive mechanism 66 is rotatable relative to the arm 45 that is rotatably mounted on the screw 62 fixed to the base 44 of the θ axis rotating mechanism, the rotating drive mechanism 66 substantially comprising a sun gear 68 that is fixedly arranged as is not rotated relative to the base 44 and the screw 62, a first planet gear 71 that is rotatably mounted to the arm 45 by way of a rotational shaft 69 and is in mesh with the sun gear 68, the first planet gear 71 being of a same pitch radius, of a same module and of a same number of teeth with the sun gear 68, and a second planet gear 72 that is fixed to the collet portion rotating shaft 16 that is rotatable on the arm 45, the second planet gear 72 being in mesh with the first planet gear 71 and being of a same pitch radius, of a same module and of a same number of teeth with the sun gear 68 and the first planet gear 71. The rotating drive mechanism 66 is so formed as to rotate relative to the arm 45 in such manner that the rotational movement of the arm 45 may be nullified, thereby to cause the collet portion 12 to move with parallel motion.

In this connection, the second embodiment is described by use of the same reference numerals as to the same parts with the first embodiment shown in Figs. 1 through 5 and the description is abbreviated as to the same parts.

【0047】

Substantially in reference to Fig. 9 showing a third embodiment of the invention, an electric motor 73 is used by way of example in place of the rotating drive mechanism 66 used in the second embodiment. The electric motor 73 is fixedly mounted to the arm 45 and is reciprocatingly rotated together with the arm 45. The electric motor 73 is provided with a rotational shaft 73a. The rotational shaft 73a has a coupling 75 coaxially secured thereto by means of a screw 74, the coupling 75 being secured to the collet rotating shaft 16.

Incidentally, the electric motor 73 may include a pulse motor, a servomotor and so on. Actually the rotating drive mechanism is not limited to the electric motors, but may include

any drivers such as actuators which will be responsive to control signals to move in optional directions with optional angles.

According to the embodiment, with control of the electric motor 73 so as to enable the rotational shaft 73a to take the rotation angle $-\theta$ to the base 44 while the arm 45 takes the rotation angle θ to the base 44, the reciprocating rotational movement of the arm 45 is nullified and the collet portion 12 secured to the rotational shaft 73a is moved with parallel motion.

In this connection, the embodiment is described by use of the same reference numerals as to the same parts with the first embodiment shown in Figs. 1 through 5 and the description is abbreviated as to the same parts.

【0048】

The chip transporting method of the invention (Claim 1) is to transport the chip 4 that is taken off from the wafer 1 from the chip pick-up position 6 to the chip placing position 9 of the tray 8, the method comprising the step of operating the Z axis drive mechanism 13 to reciprocatingly move the collet portion 12 slightly to and away from the wafer 1 in Z axis direction while operating the θ axis rotating mechanism 14 to reciprocatingly rotate the arm 45, thereby to move the collet portion 12 with parallel motion so as to enable the collet portion 12 to pick up and transport the chip 4 from the chip pick-up position 6 to the chip placing position 9.

【0049】

Further the chip transporting method of the invention (Claim 2) is to transport the chip 4 that is taken off from the wafer 1 from the chip pick-up position 6 to the chip placing position 9 of the tray 8, the method comprising the step of operating the Z axis drive mechanism 13 to reciprocatingly move the collet portion 12 slightly to and away from the wafer 1 in Z axis direction while operating the θ axis rotating mechanism 14 to reciprocatingly rotate the arm 45, thereby to move the collet portion 12 from the chip pick-up position 6 to the chip placing position 9. At the same time, the rotating drive mechanism 66

that is mounted on the arm 45 is rotated relative to the arm 45, thereby to move the collet portion 12 with parallel motion so as to enable the collet portion 12 to pick up and transport the chip 4 from the chip pick-up position 6 to the chip placing position 9.

【0050】

The chip transporting method of the invention (Claim 2) is to transport a chip 4 that is taken off from a wafer 1 from a chip pick-up position 6 to a chip placing position 9 of a tray 8, the method comprising the step of operating a Z axis drive mechanism 13 reciprocatingly move a collet portion 12 slightly to and away from the wafer 1 in Z axis direction while operating a θ axis rotating mechanism 14 to reciprocatingly rotate an arm 45, thereby to produce relative movement between a fixed toothed pulley 15 and a rotational toothed pulley 18 and a toothed belt 9 wherein the toothed belt 9 is wound around the rotational toothed pulley 18 and a fixed toothed pulley 15, the rotational toothed pulley 18 being rotatable with a collet portion rotating shaft 16 that is rotatably supported by the arm 45 and the fixed toothed pulley 15 being fixedly arranged as is coaxial with the rotation axis of the arm 45, so that the collet portion 12 may be rotated in the direction in a same proportion opposite to the rotating direction of the arm 45, thereby to move the collet portion 12 with parallel motion so as to enable the collet portion 12 to pick up and transport the chip 4 from the chip pick-up position 6 to the chip placing position 9.

【0051】

The invention is a combination of the components as mentioned above. The operation is as follows;

Firstly the fundamental operation of the chip transporting device 11 will be described. In Fig. 1, the Z axis drive mechanism 13 is provided with the Z axis drive motor 34. With rotation of the Z axis drive motor 34, the Z axis drive screw 38 is rotated through the rotational shaft 34 a of the drive motor 34. With rotation of the Z axis drive screw 38, The nut 40 that is in threaded engagement with the Z axis drive screw

38 is moved in the direction of Z axis. With the movement of the nut 40, the pair of linear guides 41 are moved in the direction of Z axis as guided by the pair of guide rails 33. As the result, the θ axis rotating mechanism 14 is wholly moved in the direction of Z axis. It is, therefore, apparent that the position of the collet portion 12

and the adsorbing lip 12 a in the direction of Z axis (vertical position) relative to the wafer 1 or tray 8 may be optionally controlled.

【0052】

Subsequently in Figs. 2 through 5, the operation of the θ axis rotating mechanism 14 will be described. When the θ axis rotation drive motor 46 is driven (reciprocatingly rotated), the rotational shaft 46 a of the drive motor 46 is rotated to rotate the θ rotating shaft 53 through the joint 52. As the result, the arm 45 connected to the θ rotating shaft 53 is reciprocatingly rotated around the rotation center 0 in the direction as shown by the arrow G or H. Then the collet portion rotating shaft 16, which is rotatable relative to the arm 45, is revolved around the rotation center 0 together with the rotational toothed pulley 18 and the collet portion 12 in the direction as shown by the arrow I or J.

【0053】

With the revolution of the collet portion rotating shaft 16 and the rotational toothed pulley 18, the toothed belt 19 will be revolved while the toothed belt 19 is in mesh with the fixed toothed pulley 15. Precisely as the fixed toothed pulley 15 is not rotatable, the toothed belt 19 is revolved while the meshed positions are shifted relative to the fixed toothed pulley 15. Therefore, in case the arm 45 is rotated in the direction as shown by the arrow I, the toothed belt 19 is moved in the direction as shown by the arrow K (in the clockwise direction in Fig. 4). In case the arm 45 is rotated in the direction as shown by the arrow J, the toothed belt 19 is moved in the direction as shown by the arrow L (in the counterclockwise direction in Fig. 4).

【0054】

As the result, since the fixed toothed pulley 15 and the rotational toothed pulley 18 are provided with a same number of teeth, when the arm 45 is rotated in the direction as shown by the arrow I, the rotational toothed pulley 18 is rotated (while it is revolved) in the direction as shown by the arrow M (that is opposite to the rotating direction of the arm 45) under the action of the toothed belt 19. On the other hand, when the arm 45 is rotated in the direction as shown by the arrow J, the rotational toothed pulley 18 is rotated (while it is revolved) in the direction as shown by the arrow N (that is opposite to the rotating direction of the arm 45) under the action of the toothed belt 19. In either case, the collet portion 12 is always caused to rotate through the collet portion rotating shaft 16 in the direction as shown by the arrow M or N that is opposite to the rotating direction of the arm 45 but by the rotation angle that is the same with the rotation angle of the arm 45. As the result, with the reciprocating rotation of the arm 45, the collet portion 12 is moved with parallel motion between a chip pick-up position 6 and a chip placing position 9 while the posture of collet portion 12 is maintained as unchanged in the vertical direction (Z direction).

【0055】

In short, with the reciprocating rotation of the arm 45 between the directions I and J, the collet portion 45 is operated to smoothly move with parallel motion between the chip pick-up position 6 and the chip placing position 9 as shown in Figs. 3 through 5.

【0056】

Firstly the collet portion 12 is located at a start position that is the chip placing position 9. In contrast to the conventional art, it is not required to move the collet portion to the standby position. At step S 1, the image of the chip is treated and at step S 2, amendment is made as to the position of the chip.

【0057】

At step S 3, the arm 45 is rotated by 207° in the direction

as shown by arrow J so as to move the collet portion 12 with parallel motion to the chip pick-up position 6. Then the Z axis drive mechanism 13 is operated to slightly move down (approximately 5 mm) the collet portion 12 along the Z axis so as to slightly press the adsorbing lip 12 a of the collet portion 12 against the chip 4 of the wafer 1.

【0058】

At step S 4, a chip pick-up operation is made (chip taking off operation). Precisely, a needle 64 is moved up from under the wafer 1 as shown by mark R so as to push up the adhesive tape 2 while the collet portion 12 is inhaling the air as shown by mark S. As the result, the chip 4 is adsorbed to the adsorbing lip 12 a and is taken off from the wafer 1. Then the Z axis drive mechanism 13 is operated to slightly move up the collet portion 12 (approximately 5 mm) as shown by mark Q along the Z axis and thus to move up the collet portion 12 away from the wafer 1 while the adsorbing lip 12 a is holding the chip 4.

【0059】

Subsequently at step S 5, the arm 45 is operated to rotate by 207° in the direction as shown by arrow I so as to move the collet portion 12 with parallel motion to the chip placing position 9 while the collet portion 12 is holding the chip 4. Then the Z axis drive mechanism 13 is operated again to slightly move down (approximately 5 mm) the collet portion 12 as shown by arrow P along the Z axis close to the tray 8.

【0060】

Finally at step S 6, the air inhaling operation of the collet portion 12 is stopped to release the chip 4 from the adsorbing lip 12 a and place it on the tray 8. Thus the placing operation of the chip 4 that is the chip delivering operation is finished.

【0061】

subsequently the operation of the second embodiment of the invention will be described in reference to Figs. 7 and 8.

The rotating drive mechanism 66 is substantially composed of the sun gear 68, the first planet gear 71, and the second planet gear 72. The sun gear 68 is fixed to the base 44 and the screw 62 and is not rotatable. Therefore, for example, if

the arm 45 is rotated by the θ axis rotating mechanism 14 by rotation angle θ in the counterclockwise direction relative to the base 44 from the position as shown in Fig. 7 to the position as shown in Fig. 8 as shown by arrow U, the first planet gear 71 is revolved by the same rotation angle θ together with the arm 45 in the counterclockwise direction while the first planet gear 71 itself is rotated by the same rotation angle θ around the sun gear 68 in the counterclockwise direction as shown by arrow V. Therefore, as the arm 45 is rotated by rotation angle θ , the first planet gear 71 is rotated by totally 2θ relative to the base 44 in the counterclockwise direction while the first planet gear 71 is rotated by rotation angle θ relative to the arm 45 in the counterclockwise direction.

[0062]

On the other hand, at the step that the second planet gear 72 is considered without taking into consideration that the gear 72 is in mesh with the first planet gear 71, the second planet gear 72 is rotated due to revolution of rotation angle θ together with the arm 45 in the counterclockwise direction relative to the base 44, and therefore, is rotated by totally angle θ relative to the base 44. Therefore the rotation angle difference between the second planet gear 72 and the first planet gear 71 is $2\theta - \theta = \theta$ relative to the base 44.

However actually the second planet gear 72 is in mesh with the first planet gear 71 which is of the same number of teeth with the second planet gear 72 and is rotated by angle θ in the counterclockwise direction relative to the arm 45 as shown by arrow V. Therefore the second planet gear 72 is rotated by $-\theta$ by the first planet gear 71 in the clockwise direction as shown by arrow W. As the result, the second planet gear 72 is not rotated at all relative to the base 44 as the rotation angle θ of the arm 45, because the rotation angle difference $\theta - \text{rotation angle } \theta = 0$.

This relation is unchanged in any reciprocating rotational positions of the arm 45. Therefore the second planet gear 72 is always kept as being not rotated relative to the base 44, that is, kept in the condition of parallel motion.

【0063】

Namely in reference to Fig. 7, provided that the point PC of a particular tooth of the second planet gear 72 is positioned at the top, this condition is unchanged even if the arm 45 is amply rotated in the counterclockwise direction as shown by arrow U in Fig. 8. Thus the second planet gear 72 and the collet portion 12 connected to the gear 72 are moved with parallel motion. Namely the collet portion 12 may be moved between the chip pick-up position 6 and the chip placing position 9 with the posture kept unchanged.

As the operation is same with the first embodiment, the description is abbreviated.

【0064】

Subsequently in reference to Fig. 9 showing the third embodiment of the invention, the rotating drive mechanism 66 is the electric motor 73 employed as a driver by way of example. In this embodiment, the rotation angle θ of the arm 45 is used as the signal for controlling the electric motor 73. Therefore if the arm 45 is rotated by angle θ in the counterclockwise direction, the rotational shaft 73a of the electric motor 73 is simultaneously rotated by angle $-\theta$ in the clockwise direction in the manner that the rotational movement of the arm 45 is nullified. Thus the collet rotating shaft 16 is always kept as being standstill, that is, not rotated relative to the base 44, so that the collet portion 12 may be moved with parallel motion between the chip pick-up position 6 and the chip placing position 9.

As the operation is same with the first embodiment of the invention, the description is abbreviated.

【0065】

According to the chip transporting method and the device thereof of the invention, the collet portion 12 may be smoothly moved with parallel motion between the chip pick-up position 6 and the chip placing position 9. Therefore the chip transportation movement is extremely simple and speedy. Actually, in one cycle of the chip transportation, three (3) operation steps may be decreased, which may otherwise be

required in the conventional art.

As the result, the tact time may be reduced to 0.22 seconds (conventional time is 0.319 seconds) and the operation rate of the drive motors may be reduced by approximately 85 %. Further the number of constituent components may be reduced by approximately 20 % and the production cost may be reduced by approximately 25 %.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications are intended to be included within the scope of the following claims.

What is claimed is:

Claim 1

A method for transporting a chip which is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, said method comprising the step of operating a Z axis drive mechanism to reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position.

Claim 2

A method for transporting a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, said method comprising the step of operating a Z axis drive mechanism to reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to move the collet portion from the chip pick up position to the chip placing position in parallel motion, and further operating a rotating drive mechanism so as to be rotated relative to the arm on the arm in such manner that the rotational movement of the arm is nullified, so that the chip may be transported from the chip pick up position to the chip placing position with a slight movement in the Z axis direction due to the parallel motion of the collet portion and the swing reciprocation of the arm.

Claim 3

A method for transporting a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, said method comprising the step of operating a Z axis drive mechanism to reciprocatingly move a collet portion slightly to and away from the wafer in Z axis direction while

operating a θ axis rotating mechanism to reciprocatingly rotate an arm, thereby to produce relative movement between a fixed toothed pulley and a rotational toothed pulley and a toothed belt wherein the toothed belt is wound around the rotational toothed pulley and a fixed toothed pulley, the rotational toothed pulley being rotatable with a collet portion rotating shaft that is rotatably supported by the arm and the fixed toothed pulley being fixedly arranged as is coaxial with the rotation axis of the arm, so that the collet portion may be rotated in the direction in a same proportion opposite to the rotating direction of the arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position.

Claim 4

A device for transporting a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, said device comprising a collet portion for picking up the chip from the wafer, a Z axis drive mechanism for reciprocatingly moving the collet portion slightly to and away from the wafer in Z axis direction, a θ axis rotating mechanism for reciprocatingly rotating an arm to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the chip placing position.

Claim 5

A device for transporting a chip of that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the device comprising a collet portion for picking up the chip from the wafer, a Z axis drive mechanism for reciprocatingly moving the collet portion slightly to and away from the wafer, an arm for moving the collet portion from the chip pick-up position to the chip placing position, a θ axis rotating mechanism for reciprocatingly rotating the arm, a rotating drive mechanism that is mounted on the arm and is

rotated relative to the arm in such manner that the reciprocating rotation of the arm may be nullified, thereby to cause the collet portion to move with parallel motion, wherein the chip is transported from the chip pick-up position to the chip placing position with a slight movement of the collet portion in the Z axis direction and the reciprocating rotation of the arm.

Claim 6

A device for transporting a chip that is cut out from a wafer from a chip pick-up position to a chip placing position of a tray, the device comprising a collet portion for picking up the chip from the wafer, a Z axis drive mechanism for reciprocatingly move the collet portion slightly to and away from the wafer, a θ axis rotating mechanism for reciprocatingly rotating an arm to produce relative movement between a fixed toothed pulley and a rotational toothed pulley and a toothed belt wherein the toothed belt is wound around the rotational toothed pulley and the fixed toothed pulley, the rotational toothed pulley being rotatable with the collet portion rotating shaft that is rotatably supported by the arm and the fixed toothed pulley being fixedly arranged as is coaxial with the rotation axis of the arm, so that the collet portion may be rotated in the direction in a same proportion opposite to the rotating direction of the arm, thereby to move the collet portion with parallel motion so as to enable the collet portion to pick up and transport the chip from the chip pick-up position to the tip placing position.

Description of Reference Numerals and Signs

- 1: Wafer
- 2: Adhesive tape
- 3: Semiconductor element
- 4: Chip
- 5: Collet portion
- 5 a: Adsorbing lip
- 6: Chip pick-up position
- 7: Standby position
- 8: Tray
- 9: Chip placing position
- 10: Collet transporting position
- 11: Chip transporting device
- 12: Collet portion
- 12 a: Adsorbing lip
- 12 b: Air inhaling opening
- 13: Z axis drive mechanism
- 14: θ axis rotating mechanism
- 15: Fixed toothed pulley
- 16: Collet portion rotating shaft
- 16 a: Diametrically enlarged portion
- 16 b: Stepped portion
- 16 c: Screw portion
- 18: Rotational toothed pulley
- 19: Toothed belt
- 20: Bracket
- 21: Screw
- 22: Ball bushing
- 23: Hollow shaft
- 24: Compression spring
- 25: Stopper
- 26: Nut
- 28: Bolt
- 29: Arm
- 30: Fixing bar
- 31: Bushing

32: Base
33: Guide rail
34: Z axis drive motor
34 a: Rotational shaft
35: Screw
36: Bearing
37: Screw
38: Z axis drive screw
39: Slide table
40: Nut
41: Linear guide
42: Screw
43: Screw
44: Base of θ axis rotating mechanism
45: Arm
45 a: One end
45 b: Opposite end
46: θ axis rotating motor
46 a: Rotational shaft
48: Screw
49: Reduction gear
50: Bracket
52: Joint
52: Joint
53: θ axis rotating shaft
53 a: One end
53 b: Stepped portion
53 c: Opposite end
53 d: Screw portion
54: Bearing
55: Nut
56: Screw
58: Bearing
58 a: Inner race
58 b: Inner race
59: Nut
60: Screw

61: Bracket
62: Screw
63: Screw
64: Needle
65: Idle pulley
66: Rotating drive mechanism
68: Sun gear
69: Rotational shaft
71: First planet gear
72: Second planet gear
73: Electric motor by way of example of rotating driver
73a: Rotational shaft
74: Screw
75: Coupling
A: Arrow
B: Arrow
C: Arrow
D: Arrow
E: Arrow
F: Arrow
G: Arrow
H: Arrow
I: Arrow
J: Arrow
K: Arrow
L: Arrow
M: Arrow
N: Arrow
O: Rotation center
P: Arrow
PC: Point of particular tooth
Q: Arrow
R: Arrow
S: Arrow
T: Arrow
U: Arrow
V: Arrow

W: Arrow
X: X axis direction
Z: Z axis direction
 θ : Rotation angle