

[Name of Document] DESCRIPTION

[Title of Invention] TRANSPORT DEVICE AND TRANSPORT METHOD

[Technical Field]

[0001]

The present invention relates to a transport device and a transport method for transporting a workpiece.

[Background Art]

[0002]

Hitherto, when a workpiece, such as a substrate, is subjected to processing, such as film sticking, the workpiece is transported to a target position so as to be located at this position.

For example, when transporting a substantially circular substrate having a semiconductor formed thereon to a target position, an image of the substrate is taken with a camera and the substrate is located so that the central position of the substrate is adjusted to the target position.

A technology concerning a device for positioning a workpiece is disclosed in PTL 1, for example.

[Citation List]

[Patent Literature]

[0003]

[PTL 1] Japanese Unexamined Patent Application Publication (Translation of PCT Application) No. 2018-513563

[Summary of Invention]

[Technical Problem]

[0004]

When positioning of a workpiece, such as a substrate, is performed by taking an image of the substrate with a camera, however, the cost of equipment required for workpiece positioning is increased and information processing for positioning may also become complicated.

[0005]

It is an object of the present invention to perform positioning of a workpiece more simply and at a lower cost.

[Solution to Problem]

[0006]

In order to achieve the object described above, a transport device according to an aspect of the present invention comprising:

a storage means for storing therein a workpiece provided with an orientation flat;

a setting means for setting the workpiece thereon;

a transport means for transporting the workpiece from the storage means to the setting means;

a plurality of first sensors for detecting passing of the workpiece therethrough, the plurality of first sensors being disposed in a lateral direction of a first transport path through which the transport means linearly transports

the workpiece, the plurality of first sensors being separated from each other so that a distance therebetween is larger than a length of the orientation flat and is smaller than a dimension of the workpiece; and

a central-position obtaining means for obtaining a central position of the workpiece in a direction along the first transport path, based on a longest one of passing distances of the workpiece detected by the plurality of first sensors,

wherein the transport means sets the workpiece on the setting means, based on the central position of the workpiece in the direction along the first transport path.
[Advantageous Effects of Invention]
[0007]

According to the present invention, it is possible to perform positioning of a workpiece more simply and at a lower cost.
[Brief Description of Drawings]
[0008]

Fig. 1 is a side view schematically illustrating the entire configuration of a transport device 1 according to the embodiment.

Fig. 2 is a top view schematically illustrating the entire configuration of the transport device 1 according to the embodiment.

Fig. 3 is a schematic view illustrating a state in which a workpiece 100 is held at a correct position.

Fig. 4 is a schematic view illustrating a state in which a workpiece 100 is held at a position considerably deviating from the correct position.

Fig. 5 is a schematic view illustrating a state in which a workpiece 100 is held at a position slightly deviating from the correct position.

Fig. 6 is a flowchart illustrating a procedure for workpiece transport processing executed by the transport device 1.

Fig. 7 is a schematic view illustrating an example in which the central positions of a workpiece 100 in multiple directions are detected.

[Description of Embodiments]
[0009]

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

Fig. 1 is a side view schematically illustrating the entire configuration of a transport device 1 according to the embodiment. Fig. 2 is a top view schematically illustrating the entire configuration of the transport device 1 according to the embodiment.

The transport device 1 is a device that transports a workpiece 100, such as a substrate, provided with an orientation flat 101 from a rack 10, adjusts the position of the workpiece 100 to a position at which the workpiece 100 is subjected to processing (film sticking in this example), and places the workpiece 100.

[0010]

Instead of using expensive equipment, such as a camera, the transport device 1 uses two optical sensors 40a and 40b that are installed separately from each other so that a distance therebetween is larger than the length of the orientation flat 101 and is smaller than a dimension of the workpiece 100. By using these optical sensors 40a and 40b, the transport device 1 measures a distance by which the workpiece 100 passes through each of the optical sensors 40a and 40b when the workpiece 100 is transported in one direction, and detects the central position of the workpiece 100 in the transport direction, based on the measured passing distance.

Regarding the direction intersecting with the transport direction of the workpiece 100, the accuracy in positioning the workpiece 100 is mechanically guaranteed because of the restrictions in the storage space in the rack 10, the linearity accuracy of an arm 20 in transporting the workpiece 100, and the positioning function of edge clamps 31 of a stage 30 for placing the workpiece 100 thereon.

[0011]

As shown in Figs. 1 and 2, the transport device 1 includes a rack 10, an arm 20, a stage 30, optical sensors 40a and 40b, and a controller 50.

The rack 10 includes multiple rails, which support workpieces 100, on the opposing side walls inside the rack 10, and holds each workpiece 100 between a pair of opposing rails. In this manner, the rack 10 stores multiple workpieces 100 such that they are placed on top of each other. At an opening 11 of the rack 10, an optical sensor 10a is installed to detect an amount by which a workpiece 100 protrudes from the opening 11. When the optical sensor 10a detects that a workpiece 100 protrudes from the opening 11 of the rack 10 by an amount equal to or greater than a set allowance, such a state is treated as an error.

[0012]

The arm 20 removes a stored workpiece 100 from the rack 10 and transports it to the stage 30. As the arm 20, a robot arm, for example, including a hand which sucks a workpiece 100 from the back side thereof (side on which product elements are not formed) can be used. In the embodiment, the stage 30 is set at a certain distance from the opening 11 of the rack 10. When transporting a

workpiece 100 from the rack 10 to the stage 30, the arm 20 removes a workpiece 100 from the rack 10 via the opening 11 and then linearly moves the workpiece 100 to the stage 30. In a transport path through which the workpiece 100 passes, the optical sensors 40a and 40b, which will be discussed later, are installed. As a result of the workpiece 100 passing through a light detection region of each of the optical sensors 40a and 40b, the central position of the workpiece 100 in the transport direction can be detected. [0013]

The stage 30 places a workpiece 100, which is subjected to processing, at a set position and holds the workpiece 100 during a processing step (film sticking step in this example).

The stage 30 includes edge clamps 31 that hold a workpiece 100 transported by the arm 20 by pressing the peripheral edges of the workpiece 100 from outward toward the central direction of the stage 30. The edge clamps 31 are formed of, for example, resin members that abut against the peripheral edges of the workpiece 100 and press them toward the central direction of the stage 30. Plural (four in this example) edge clamps 31 are provided on the periphery of the stage 30. The edge clamps 31 are separated from the center of the stage 30 at an equal distance and are spaced out equally in the peripheral direction. The distance from the center of the stage 30 to the position of each edge clamp 31 is set to be longer than the radius of the workpiece 100 by a preset distance (the distance slightly longer than the assumed error in transporting a workpiece 100). [0014]

The workpiece 100 transported by the arm 20 is controlled to come to a halt above the stage 30 and in a region surrounded by the plural edge clamps 31. At this time, the stop position of the workpiece 100 in the transport direction (direction straight from the opening 11 of the rack 10) is controlled based on the central position of the workpiece 100 in the transport direction, which is detected by the optical sensors 40a and 40b. Regarding the direction intersecting with the transport direction, the position of the workpiece 100 is controlled to be within a preset margin of error due to the restrictions on the position of the workpiece 100 by the rails in the rack 10 and the linearity accuracy of the arm 20. After the workpiece 100 has stopped above the stage 30 and in the region surrounded by the plural edge clamps 31, the plural edge clamps 31 press the peripheral edges of the workpiece 100 from outward toward the central direction of the stage 30 so that the position of the workpiece 100 is adjusted to the center of the stage 30. The edge clamps 31 holding the

workpiece 100 then descend and release the workpiece 100. As a result, the workpiece 100 is located at a target position of the stage 30.

[0015]

The optical sensors 40a and 40b are constituted by sensors that detect the passing of an object by using the reflection of light (or the shielding of light). The optical sensors 40a and 40b are disposed on the transport path of the workpiece 100 extending from the opening of the rack 10 to the stage 30. The optical sensors 40a and 40b are also located on a line perpendicular to a path that is assumed to be a path through which the center of the workpiece 100 passes (hereinafter such a path will be called a center path) and they are located at positions separated from this center path by an equal distance (namely, at the positions laterally separated from the center path by an equal distance). Additionally, the optical sensors 40a and 40b are separated from each other so that the distance therebetween is larger than the length of the orientation flat 101 formed in the workpiece 100 and is also smaller than the diameter of the workpiece 100.

[0016]

With this configuration, when the workpiece 100 passes at the positions of the optical sensors 40a and 40b, the orientation flat 101 does not pass through at least one of the optical sensors 40a and 40b.

Based on the passing distance of the workpiece 100 detected by one of the optical sensors 40a and 40b through which the orientation flat 101 of the workpiece 100 has not passed, the position at one half of the passing distance of the workpiece 100 is calculated. The central position of the workpiece 100 in the transport direction can thus be detected.

[0017]

The controller 50 controls the entirety of the transport device 1 so as to transport a workpiece 100 and perform positioning of the workpiece 100 or to detect the central position of the workpiece 100, for example.

More specifically, the controller 50 controls the operation of the arm 20 and causes it to remove a stored workpiece 100 from the rack 10 and to transport the workpiece 100 to the stage 30. At this time, if the optical sensor 10a detects that a workpiece 100 protrudes from the opening 11 of the rack 10 by an amount equal to or greater than the set allowance, the controller 50 determines that an error is occurring and stops the operation of the transport device 1.

[0018]

The controller 50 also controls the operation of the arm 20 so that the workpiece 100 passes at the positions at

which the optical sensors 40a and 40b are disposed, and detects the passing distances of the workpiece 100 by using the optical sensors 40a and 40b. Based on the passing distance of the workpiece 100 detected by one of the optical sensors 40a and 40b through which the orientation flat 101 has not passed (that is, a longer one of the passing distances), the controller 50 calculates the position at one half of the passing distance. The controller 50 then determines the calculated position to be the central position of the workpiece 100 in the transport direction.

[0019]

Based on the determined central position, the controller 50 causes the workpiece 100 to stop above the stage 30 and in the region surrounded by the edge clamps 31.

The controller 50 then causes the edge clamps 31 to move from outward toward the central direction of the stage 30 so as to adjust the position of the workpiece 100 to the center of the stage 30. The controller 50 then causes the edge clamps 31 holding the workpiece 100 to descend and release the workpiece 100, so that the workpiece 100 can be located at a target position of the stage 30. Then, the workpiece 100 located at the target position is subjected to processing.

[0020]

[Approach to Detecting Central Position of Workpiece 100]

In the above-described configuration, when the arm 20 removes a workpiece 100 from the rack 10, the orientation of the workpiece 100 (the position of the orientation flat 101 in the peripheral direction) may vary.

Because of this variation in the orientation of a workpiece 100, the passing distance of a workpiece 100 detected by one of the optical sensors 40a and 40b through which the orientation flat 101 has passed becomes different from that detected by the other one of the optical sensors 40a and 40b through which the orientation flat 101 has not passed.

The position at one half of the passing distance of the workpiece 100 detected by one of the optical sensors 40a and 40b through which the orientation flat 101 has passed does not represent the central position of the workpiece 100 in the transport direction.

[0021]

In the embodiment, the optical sensors 40a and 40b are located on a line perpendicular to the center path through which the center of a workpiece 100 is likely to pass and are located at the positions separated from this center path by an equal distance. Hence, at least one of the optical sensors 40a and 40b detects the passing distance of

a workpiece 100 whose orientation flat 101 does not pass.

Specific approaches to detecting the central position of a workpiece 100 in the transport direction in response to a variation in the orientation of a workpiece 100 held by the arm 20 will be explained below.

[0022]

[When a workpiece 100 is held at a correct position]

Fig. 3 is a schematic view illustrating a state in which a workpiece 100 is held at a correct position.

The correct position of a workpiece 100 refers to a state in which the position of the orientation flat 101 in the peripheral direction faces the front side of the transport direction.

As shown in Fig. 3, when the workpiece 100 is held by the arm 20 at the correct position, both of the optical sensors 40a and 40b can detect a distance by which part of the workpiece 100 other than the orientation flat 101 passes through the optical sensors 40a and 40b.

Accordingly, the position at one half of the passing distance of the workpiece 100 detected by one of the optical sensors 40a and 40b can be used as the central position of the workpiece 100 in the transport direction.

[0023]

[When a workpiece 100 is held at a position considerably deviating from the correct position]

Fig. 4 is a schematic view illustrating a state in which a workpiece 100 is held at a position considerably deviating from the correct position.

The state in which a workpiece 100 is held at a position considerably deviating from the correct position refers to a state in which the orientation flat 101 deviates from the correct position by about 90 degrees.

As shown in Fig. 4, when the workpiece 100 is held by the arm 20 at a position considerably deviating from the correct position, one of the optical sensors 40a and 40b does not detect that the workpiece 100 passes through this one of the optical sensors 40a and 40b.

In contrast, the other one of the optical sensors 40a and 40b detects a distance by which part of the workpiece 100 other than the orientation flat 100 passes through this other one of the optical sensors 40a and 40b.

Hence, based on the detection result of one of the optical sensors 40a and 40b that has detected the passing of the workpiece 100, the position at one half of the passing distance of the workpiece 100 can be set to be the central position of the workpiece 100 in the transport direction.

[0024]

[When a workpiece 100 is held at a position slightly deviating from the correct position]

Fig. 5 is a schematic view illustrating a state in which a workpiece 100 is held at a position slightly deviating from the correct position.

The state in which a workpiece 100 is held at a position slightly deviating from the correct position refers to a state in which the orientation flat 101 deviates from the correct position in a range of degrees greater than 0 degrees to smaller than 90 degrees.

As shown in Fig. 5, when the workpiece 100 is held by the arm 20 at a position slightly deviating from the correct position, one of the optical sensors 40a and 40b detects a distance by which part of the workpiece 100 other than the orientation flat 100 passes through this one of the optical sensors 40a and 40b.

[0025]

In contrast, the other one of the optical sensors 40a and 40b detects a distance by which part of the workpiece 100 including the orientation flat 100 passes through this other one of the optical sensors 40a and 40b.

Hence, the position at one half of the passing distance of the workpiece 100 detected by one of the optical sensors 40a and 40b through which part of the workpiece 100 other than the orientation flat 100 has passed (that is, a longer one of the passing distances) can be set to be the central position of the workpiece 100 in the transport direction.

[0026]

[Operation]

The operation of the transport device 1 will now be described below.

Fig. 6 is a flowchart illustrating a procedure for workpiece transport processing executed by the transport device 1.

Workpiece transport processing is started by the controller 50 in response to an instruction to execute workpiece transport processing.

[0027]

In step S1, based on a detection result of the optical sensor 10a, the controller 50 judges whether an error is occurring in the storage state of workpieces 100 in the rack 10 (that is, whether a state in which a workpiece 100 protrudes from the opening 11 by an amount equal to or greater than the set allowance is found).

If an error is occurring in the storage state of workpieces 100 in the rack 10, the result of step S1 is determined to be YES and workpiece transport processing is terminated.

If an error is not occurring in the storage state of workpieces 100 in the rack 10, the result of step S1 is determined to be NO and the process proceeds to step S2.

[0028]

In step S2, the controller 50 causes the arm 20 to remove a workpiece 100 from the rack 10.

In step S3, the controller 50 causes the arm 20 to transport the workpiece 100 and to pass the workpiece 100 at the positions of the optical sensors 40a and 40b.

In step S4, the controller 50 detects the central position of the workpiece 100 in the transport direction, based on the detection results of the optical sensors 40a and 40b.

In step S5, the controller 50 causes the workpiece 100 to stop above the stage 30 and in a region surrounded by the edge clamps 31, based on the detected central position.

[0029]

In step S6, the controller 50 causes the edge clamps 31 to move from outward toward the central direction of the stage 30 so as to adjust the position of the workpiece 100 to the center of the stage 30.

In step S7, the controller 50 causes the edge clamps 31 holding the workpiece 100 to descend and release the workpiece 100, thereby locating the workpiece 100 at a target position of the stage 30.

In step S8, the controller 50 executes processing on the workpiece 100.

[0030]

In step S9, the controller 50 judges whether an instruction to finish workpiece transport processing is provided. For example, when processing on all the workpieces 100 has been completed, an instruction to finish workpiece transport processing is provided.

If an instruction to finish workpiece transport processing is not provided, the result of step S9 is determined to be NO and the process returns to step S1.

If an instruction to finish workpiece transport processing is provided, the result of step S9 is determined to be YES and workpiece transport processing is completed.

[0031]

As described above, the transport device 1 according to the embodiment includes the optical sensors 40a and 40b disposed on a path through which a workpiece 100 is linearly transported from the rack 10 to the stage 30. The optical sensors 40a and 40b are disposed in the lateral direction of the path and are separated from each other so that the distance therebetween is larger than the length of the orientation flat 101 formed in the workpiece 100 and is also smaller than the diameter of the workpiece 100. The transport device 1 uses a longer one of the passing distances of the workpiece 100 having passed through the optical sensors 40a and 40b and determines the position at one half of this longer passing distance to be the central

position of the workpiece 100 in the transport direction. Based on the central position of the workpiece 100 in the transport direction, the transport device 1 causes the workpiece 100 to stop above the stage 30 and in a region surrounded by the edge clamps 31 and causes the edge clamps 31 to move from outward toward the central direction of the stage 30, thereby adjusting the position of the workpiece 100 to the center of the stage 30. The transport device 1 then causes the edge clamps 31 holding the workpiece 100 to descend and release the workpiece 100, thereby locating the workpiece 100 at a target position of the stage 30.

[0032]

Regarding the direction intersecting with the transport direction of the workpiece 100, the position of the workpiece 100 converges into the region surrounded by the edge clamps 31 of the stage 30 due to the restrictions in the storage space in the rack 10 and the linearity accuracy of the arm 20 in transporting the workpiece 100, and also, the accuracy in positioning the workpiece 100 is mechanically guaranteed due to the positioning function of the edge clamps 31.

With this configuration, without using expensive equipment, such as a camera, sensors for detecting the presence or the absence of an object, such as optical sensors, can detect the passing of a workpiece 100. As a result, the central position of the workpiece 100 in the transport direction can be detected.

It is thus possible to perform positioning of a workpiece more simply and at a lower cost.

[0033]

[First Modified Example]

The above-described embodiment has been discussed through illustration of an example in which the central position of a workpiece 100 in a single direction is calculated from the detection results of the optical sensors 40a and 40b. However, the invention is not limited to this example.

A workpiece 100 may be moved in a direction other than the transport direction illustrated in Fig. 1 in which the workpiece 100 is moved linearly from the rack 10 to the stage 30. In this case, optical sensors 40c and 40d may detect the passing distances of the workpiece 100, and the central position of the workpiece 100 in this direction may also be detected.

Fig. 7 is a schematic view illustrating an example in which the central positions of a workpiece 100 in multiple directions are detected.

The central positions of the workpiece 100 in multiple directions may be detected in the following manner, as shown in Fig. 7. The workpiece 100 is moved in a first

direction in which it is moved linearly from the opening 11 of the rack 10 and in a second direction shifted from the first direction by a predetermined angle (in a range of degrees greater than 0 degrees to smaller than 180 degrees), and then, the central position of the workpiece 100 in the first direction and that in the second direction can be calculated.

In this manner, as a result of detecting the central position of the workpiece 100 in the transport direction from the rack 10 to the stage 30 and that in a direction shifted from the transport direction by a predetermined angle, the overall central position of the workpiece 100 can be detected.

The predetermined angle to be set for shifting the workpiece 100 is not limited to a particular angle if the resulting angle does not become the same angle as the transport direction. The predetermined angle may be determined based on the allowance for detecting the central position or the detection accuracy of the optical sensors, for example.

The optical sensors 40c and 40d detect the passing distances of the workpiece 100 in a direction shifted from the transport direction from the rack 10 to the stage 30 by the predetermined angle. One of the optical sensors 40c and 40d may be replaced by one of the optical sensors 40a and 40b for detecting the passing distances of the workpiece 100 in the transport direction.

In this case, the overall central position of the workpiece 100 can be detected by a minimum of three optical sensors.

[0034]

The above-described embodiment is an example of embodiments of the present invention. Various embodiments implementing the functions of the invention are encompassed within the scope of the invention.

For example, in the above-described embodiment, optical sensors are used as sensors for detecting the passing of a workpiece 100. However, the sensors are not limited to optical sensors. Other types of sensors, such as magnetic sensors or sensors using acoustic waves or ultrasonic waves, may be used for detecting the passing of a workpiece 100.

[0035]

While the embodiment of the present invention has been discussed above, the invention is not limited to this embodiment. Moreover, the advantages described in the embodiment are the most effective advantages achieved by the invention. The advantages of the invention are not limited to those in the embodiment.

[Reference Signs List]

[0036]

1 transport device, 10 rack, 10a, 40a to 40d
optical sensor, 11 opening, 20 arm, 30 stage, 31 edge
clamp, 50 controller, 100 workpiece, 101 orientation
flat

[Name of Document] CLAIMS

[Claim 1]

A transport device comprising:
a storage means for storing therein a workpiece provided with an orientation flat;
a setting means for setting the workpiece thereon;
a transport means for transporting the workpiece from the storage means to the setting means;
a plurality of first sensors for detecting passing of the workpiece therethrough, the plurality of first sensors being disposed in a lateral direction of a first transport path through which the transport means linearly transports the workpiece, the plurality of first sensors being separated from each other so that a distance therebetween is larger than a length of the orientation flat and is smaller than a dimension of the workpiece; and
a central-position obtaining means for obtaining a central position of the workpiece in a direction along the first transport path, based on a longest one of passing distances of the workpiece detected by the plurality of first sensors,
wherein the transport means sets the workpiece on the setting means, based on the central position of the workpiece in the direction along the first transport path.

[Claim 2]

The transport device according to Claim 1, wherein:
the setting means includes a plurality of positioning members that press from outward the workpiece transported by the transport means so as to position the workpiece at a central position of the setting means; and
the transport means transports the workpiece to a region surrounded by the plurality of positioning members, based on the central position of the workpiece in the direction along the first transport path.

[Claim 3]

The transport device according to Claim 2, wherein:
the storage means has a storage space having a predetermined dimension for storing the workpiece therein;
the transport means transports the workpiece, which is removed from the storage space of the storage means, within a preset margin of error which is determined for the lateral direction with respect to the direction along the first transport path; and
the region surrounded by the plurality of positioning members of the setting means has a dimension including the predetermined dimension of the storage space and a dimension corresponding to the preset margin of error of the transport means.

[Claim 4]

The transport device according to one of Claims 1 to

3, wherein the transport means transports the workpiece in a direction of a second transport path, the direction of the second transport path being shifted from the direction along the first transport path,

the transport device further comprising:
a plurality of second sensors for detecting passing of the workpiece therethrough in the direction of the second transport path, the plurality of second sensors being disposed in a lateral direction of a transport path through which the transport means linearly transports the workpiece, the plurality of second sensors being separated from each other so that a distance therebetween is larger than the length of the orientation flat and is smaller than the dimension of the workpiece,

wherein the central-position obtaining means obtains a central position of the workpiece in the direction along the second transport path, based on a longest one of passing distances of the workpiece detected by the plurality of second sensors.

[Claim 5]

A transport method comprising:

a transporting step of transporting a workpiece provided with an orientation flat from storage means for storing the workpiece therein to setting means for setting the workpiece thereon;

a passing-distance detecting step of detecting a passing distance of the workpiece by using a plurality of first sensors that detect passing of the workpiece therethrough, the plurality of first sensors being disposed in a lateral direction of a first transport path through which the workpiece is linearly transported in the transporting step, the plurality of first sensors being separated from each other so that a distance therebetween is larger than a length of the orientation flat and is smaller than a dimension of the workpiece;

a central-position obtaining step of obtaining a central position of the workpiece in a direction along the first transport path, based on a longest one of passing distances of the workpiece detected by the plurality of first sensors; and

a setting step of setting the workpiece on the setting means, based on the central position of the workpiece in the direction along the first transport path.

[Name of Document] ABSTRACT

[Abstract]

[Object] To perform positioning of a workpiece more simply and at a lower cost.

[Solution] A transport device includes: storage means for storing therein a workpiece provided with an orientation flat; setting means for setting the workpiece thereon; transport means for transporting the workpiece from the storage means to the setting means; plural first sensors for detecting passing of the workpiece therethrough, the plural first sensors being disposed in a lateral direction of a first transport path through which the transport means linearly transports the workpiece, the plural first sensors being separated from each other so that a distance therebetween is larger than a length of the orientation flat and is smaller than a dimension of the workpiece; and central-position obtaining means for obtaining a central position of the workpiece in a direction along the first transport path, based on a longest one of passing distances of the workpiece detected by the plural first sensors. The transport means sets the workpiece on the setting means, based on the central position of the workpiece in the direction along the first transport path.

[Selected Figure] Fig. 1