100 floats with a substantially fixed floating amount with respect to the top surface of the floatation suction mixture section 50, and a stable floating state is obtained.

[0003]

Further, as illustrated in Figure 8 (A), in Patent Literature 2, the plate-shaped workpiece 100 floated above a flotation device 60 is chucked and conveyed in arrow directions with a conveying device not illustrated. In the flotation device 60, air is ejected from entire surfaces of porous plates 61, and the entire surfaces of the porous plates 61 become air bearing surfaces, so that it becomes possible to float the plate-shaped workpiece 100 without causing a warp, and convey the plate-shaped workpiece 100 without contacting the porous plates 61. Further, in a suction hole 62, a force that sucks the plate-shaped workpiece 100 is generated. The suction force regulates a floatation amount of the plate-shaped workpiece 100 that is floated by the air ejected from the porous plate 61. Accordingly, by controlling the suction force, it becomes possible to control the floatation amount of the plate-shaped workpiece 100.

[Citation List]

[Patent Literature]

[0004]

[Patent Literature 1] Japanese Patent Laid-Open No. 2006-266351

[Patent Literature 2] Japanese Patent Laid-Open No. 2008-110852

[Technical Problem]

raised, and flatness of the entire glass substrate becomes low. In order to eliminate the phenomenon, there are cited the method of disposing many suction holes in the central portion of the glass substrate, but it becomes the problem that the central portion is not fixed because the glass is conveyed and the optimum layout of the suction holes changes depending on the glass size.

[0007]

The present invention is made to solve the problems of the conventional apparatuses as described above, and one of the objects of the present invention is to provide a gas floated workpiece supporting apparatus and a noncontact workpiece support method that unify a floating amount of an entire surface of a plate-shaped workpiece of a glass substrate or the like, and can increase flatness of the plate-shaped workpiece.

[Summary]

[0008]

To be more specific, a gas floated workpiece supporting apparatus of one aspect of the present disclosure includes a gas upward ejector ejecting gas upward, and a gas downward ejector located at an upper side from the gas upward ejector and ejecting gas downward,

wherein the gas downward ejector is installed at a position where the gas downward ejector ejects the gas downward from above a plate-shaped workpiece and applies pressure, to the plate-shaped workpiece that is floated and supported by the gas ejected from the gas upward ejector.

[0009]

According to the above-described present disclosure, the plate-shaped workpiece is sandwiched by gas ejection from above, and gas ejection from below, the plate-shaped workpiece can be stably supported in a noncontact manner, and flatness of the plate-shaped workpiece can be enhanced.

[0010]

For the gas floated workpiece supporting apparatus of one embodiment, a part or a whole of the gas downward ejector is installed to correspond to a whole or a part of a region where the gas upward ejector is installed.

[0011]

According to the above-described present disclosure, the gas downward ejector can be disposed in accordance with the gas upward ejector, or the gas upward ejector can be disposed in accordance with the gas downward ejector, the plate-shaped workpiece can be favorably sandwiched by the gas in a desired area, and flatness of the plate-shaped workpiece can be increased.

[0012]

For the gas floated workpiece supporting apparatus of another embodiment, the gas downward ejector is installed except for a working area for the plate-shaped workpiece.

[0013]

According to the present disclosure, by disposing the gas downward ejector in an area except for the working area, the predetermined work can be smoothly performed.

Further, by the working method (process) of the plate-shaped workpiece, the floating amount and floating rigidity of the workpiece can be adjusted.

[0014]

For the gas floated workpiece supporting apparatus of another embodiment, the gas downward ejector is installed in accordance with part of a region where the gas upward ejector is installed, with a working area for the plate-shaped workpiece sandwiched between the gas downward ejector and the gas upward ejector.

[0015]

According to the above-described disclosure, by sandwiching the plate-shaped workpiece located in the working area by gas from both sides, the flatness of the plate-shaped workpiece in the working area is increased, and precise work is enabled.

In the process of performing work to a part of the plate-shaped workpiece, not only the entire surface but also the vicinity of a working point is included as the structure of the present disclosure, whereby the structure that obtains a uniform floating amount can be made with respect to a part of the plate-shaped workpiece. The floating amount and the floating rigidity at this time can be arbitrarily set by adjusting the flow rate and pressure of the pressurized gas from the gas downward ejector, and the flow rate and the pressure of the pressurized gas from the gas upward ejector. Further, pressure is applied to the plate-shaped workpiece from upward and downward directions, so that the force that corrects the plate-shaped workpiece to be flat is generated especially in the vicinity of the working area.

[0016]

The gas floated workpiece supporting apparatus of another embodiment further includes a position adjusting section that adjusts blowout positions partially or entirely with respect to one

or both of a plurality of gas upward ejection holes provided in the gas upward ejector and a plurality of gas downward ejection holes provided in the gas downward ejector.

[0017]

According to the above-described disclosure, it becomes possible to adjust pressure applied to the plate-shaped workpiece and change the floating position by adjustment of the blowout position by the position adjusting section.

[0018]

For the gas floated workpiece supporting apparatus of another embodiment, the position adjusting section is capable of position adjustment individually for each of ejection holes positions of which are adjustable, or every predetermined number of ejection holes.

[0019]

According to the above-described disclosure, by adjustment to some of the ejection holes, a warp and a curve of the plate-shaped workpiece can be precisely corrected.

[0020]

The gas floated workpiece supporting apparatus of another embodiment further includes a gas flow adjusting section that adjusts a gas blowout flow rate and/or pressure, with respect to a plurality of gas upward ejection holes provided in the gas upward ejector, and a part or all of a plurality of gas downward ejection holes provided in the gas downward ejector.

[0021]

According to the above-described disclosure, it is possible to adjust the pressure which is applied to the plate-shaped workpiece

and change the floating position by adjustment of the blowout flow rate and or pressure by the gas flow adjusting section.

[0022]

For the gas floated workpiece supporting apparatus of another embodiment, the gas flow adjusting section is capable of adjusting a gas blowout flow rate and/or pressure individually for each of ejection holes gas flows of which are adjustable, or every predetermined number of ejection holes.

[0023]

According to the above-described disclosure, a warp and a curve of the plate-shaped workpiece can be precisely corrected by adjustment to some of the ejection holes.

[0024]

The gas floated workpiece supporting apparatus of another embodiment further includes a control section that controls an adjustment amount of the position adjusting section at a time of floating and supporting the plate-shaped workpiece.

[0025]

According to the above-described disclosure, adjustment of the position adjusting section can be performed dynamically by operation of the control section.

[0026]

The gas floated workpiece supporting apparatus of another embodiment further includes a control section that controls an adjustment amount of the gas flow adjusting section at a time of floating and supporting the plate-shaped workpiece.

[0027]

According to the above-described disclosure, adjustment of the gas flow adjusting section can be performed dynamically by operation of the control section.

[0028]

The gas floated workpiece supporting apparatus of another embodiment further includes a detection section that detects a height position of the plate-shaped workpiece, wherein the control section controls the adjustment amount based on a detection result of the detection section.

[0029]

According to the above-described disclosure, stable support and high flatness can be obtained by controlling the position adjusting section and the gas flow adjusting section, in accordance with the state of the plate-shaped workpiece.

[0030]

For the gas floated workpiece supporting apparatus of another embodiment, some or all of a plurality of downward ejection holes provided in the gas downward ejector are overlaid on a plurality of upward ejection holes provided in the gas upward ejector, in mutual blowout directions.

[0031]

According to the above-described disclosure, the positions of the downward ejection holes are overlaid on the positions of the information ejection holes in the blowout directions, whereby the plate-shaped workpiece can be favorably sandwiched with upper and lower pressures.

[0032]

A noncontact workpiece support method of one aspect of the present disclosure is such that gas is ejected to the plate-shaped workpiece from above and below a plate-shaped workpiece respectively, and the plate-shaped workpiece is floated and supported in a noncontact manner while the plate-shaped workpiece is sandwiched by the gas.

[0033]

For the noncontact workpiece support method of another embodiment, a warp and a curve of the plate-shaped workpiece are corrected to flatten the plate-shaped workpiece, by adjusting one or both of a gap amount of ejection positions of gas to the plate-shaped workpiece, and a flow rate of the gas.

[0034]

More specifically, according to the present disclosure, the plate-shaped workpiece is floated by ejecting gas to an arbitrary surface (the entire or a part of the surface) of the plate-shaped workpiece from the upward and downward directions, so that uniform forces are applied to the arbitrary surface of the plate-shaped workpiece, an equivalent floating amount is obtained on the entire arbitrary surface of the plate-shaped workpiece, and further there is provided the effect of correcting a warp and a curve of the arbitrary surface of the plate-shaped workpiece to flatten the surface, by the forces.

[Brief Description of Drawings]

[0035]

[Figure 1] Figure 1 is a diagram illustrating a gas floated workpiece supporting apparatus of one embodiment of the present invention.

[Figure 2] Figure 2 is a graph showing a relationship between a distance of a gas upward ejector and a plate-shaped workpiece undersurface, and a force per unit volume by gas ejection of the gas upward ejector and a load on the plate-shaped workpiece per unit area, of the embodiment of the present invention.

[Figure 3] Figure 3 is a graph showing a relationship between a distance of a gas downward ejector and a plate-shaped workpiece top surface, and a force per unit volume by gas ejection of the gas downward ejector, of the embodiment of the present invention.