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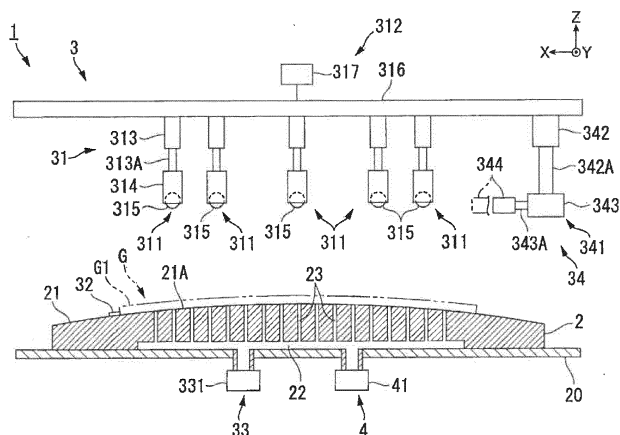
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(54) **BASE MATERIAL RETENTION DEVICE, BASE MATERIAL RETENTION METHOD, AND CURVED SURFACE SCREEN PRINTING DEVICE EQUIPPED WITH BASE MATERIAL RETENTION DEVICE**

(57) This base material retention device (1) comprises: a pedestal (2) having a retention surface (21A) on which a base material (G) is placed; a positioning unit (3) configured to position the base material (G) in a predetermined retention position on the retention surface (21A); and a suction unit (4) configured to suction, to the pedestal (2), the base material (G) positioned at the predetermined retention position. The positioning unit (3)

includes: a first pressing unit (31) configured to press the base material (G) to the pedestal (2); an outer edge contact member (32) that is provided to the pedestal (2) and that is configured to contact a portion of an outer edge of the base material (G); and a second pressing unit (34) configured to press the outer edge of the base material (G) so as to make the base material (G) contact the outer edge contact member (32).

[FIG. 1A]



Description

TECHNICAL FIELD

[0001] The present invention relates to a base material retention device, a base material retention method, and a curved surface screen printing machine equipped with a base material retention device.

BACKGROUND ART

[0002] Curved surface screen printing machines that perform printing on a base material having a curved surface have been known conventionally (refer to Patent Document 1, for example).

[0003] The curved surface screen printing machine of Patent Document 1 performs printing on a base material by moving a stage that retains the base material, a screen plate, and a squeegee relative to each other in a printing direction while rotating the stage about a rotation axis that is perpendicular to the printing direction. The surface of the stage of this curved surface screen printing machine is formed with a groove having the same shape as the base material and plural holes that penetrate through the stage.

[0004] After the base material is positioned being placed in the groove of the stage, a suction device sucks external air through the plural holes. The base material is fixed to the stage by this suction.

CITATION LIST

PATENT LITERATURE

[0005] Patent document 1: WO 2017/086197

SUMMARY OF INVENTION

TECHNICAL PROBLEMS

[0006] However, in such a configuration disclosed in Patent document 1, if an end portion of the base material is spaced from the surface of the stage due to a variation in the degree of bend of base materials, there may occur an event that the base material does not come into contact with the inner circumferential surface of the groove and positioning is disabled. Furthermore, if an end portion of the base material is spaced from the stage, a base material suction failure may occur.

[0007] One countermeasure that can be considered is to constitute positioning of the base material by a positioning pin and a means for pushing an outer edge of the base material toward the positioning pin. However, even in this case, the problem may still remain that in the event of a variation of the degree of bend, the above-mentioned positioning or suction cannot be performed properly.

[0008] Furthermore, even in a base material that was produced aiming a flat plate having no curved surface,

at least a portion such as an end portion of it may be warped. Similar problems may occur in fixing such a base material to a stage having a flat surface.

[0009] Similar problems may also occur in fixing a flat-plate-shaped base material to a stage having a curved surface.

[0010] An object of the present invention is to provide a base material retention device, a base material retention method, and a curved surface screen printing machine having a base material retention device, which are able to retain a plate-shaped base material while positioning it properly.

SOLUTION TO PROBLEM

[0011] A base material retention device according to one mode of the present invention is a base material retention device for retaining a plate-shaped base material and contains a stage having a retaining surface on which the base material is to be placed, a positioning unit that is configured so as to position the base material at a prescribed retaining position on the retaining surface, and a suction unit that is configured so as to suction, on the stage, the base material positioned at the prescribed retaining position, in which the positioning unit contains a first pressing unit that is configured so as to press the base material against the stage, an outer edge contact member that is provided on the stage and configured so as to come into contact with a portion of an outer edge of the base material, and a second pressing unit that is configured so as to bring the base material into contact with the outer edge contact member by pushing the outer edge of the base material.

[0012] According to this mode, even if a portion of the base material is spaced from the stage when placed on the stage due to, for example, a variation of the degree of bend of base materials, the base material can be pressed against the outer edge contact member while the spaced portion is brought closer to the stage by pressing the base material against the stage. Thus, the outer edge of the base material can be brought into contact with the outer edge contact member certainly and the positioning at the prescribed retaining position can be achieved. Furthermore, a suction failure can be prevented by suctioning the base material positioned at the prescribed retaining position while pressing against the stage.

[0013] In the above-mentioned base material retention device, it is preferable that the first pressing unit contain plural major surface contact members that are configured so as to come into contact with the major surface of the base material.

[0014] In this mode, the area of contact between the first pressing unit and the base material can be made smaller, whereby friction force that occurs when the second pressing unit pushes the base material can be reduced.

[0015] In the above-mentioned base material retention

device, it is preferable that the first pressing unit further contain an advance/retreat control unit that is configured so as to advance and retreat the plural major surface contact members independently of each other toward and from the stage.

[0016] This mode makes it possible to push each of base materials having various shapes by a proper force. Furthermore, this mode makes it possible to push the base material by a stable force by causing the major surface contact members to follow a shape of the base material when the second pressing unit pushes the base material.

[0017] In the above-mentioned base material retention device, it is preferable that the major surface contact member be a sphere.

[0018] This mode can reduce the friction force that occurs when the second pressing unit pushes the base material because the area of contact between each sphere and the base material can be minimized by bringing the spheres into point contact with the base material.

[0019] In the above-mentioned base material retention device, it is preferable that the first pressing unit further contain a sphere retaining unit that is configured so as to retain the sphere rotatably.

[0020] This mode can further reduce the friction force occurring between the base material and the sphere and thereby allows the base material to be positioned smoothly by causing the sphere being in contact with the base material to rotate when the second pressing unit pushes the base material. Furthermore, this mode can suppress scratching and damaging of the base material.

[0021] In the above-mentioned base material retention device, it is preferable that the positioning unit further contain a friction force reduction unit that is configured so as to reduce the friction force occurring between the base material and the stage.

[0022] This mode allows the second pressing unit to perform pressing smoothly by decreasing the friction force occurring between the base material and the stage.

[0023] In the above-mentioned base material retention device, it is preferable that the outer edge contact member have a height from the base material retaining surface of the stage being set to a thickness of the base material or smaller.

[0024] Where the base material retention device is applied to a curved surface screen printing machine, this mode can prevent a screen plate from being damaged by coming into contact with the outer edge contact member because the tip of the outer edge contact member does not project beyond a printing target surface of the base member even when the screen plate is brought in contact with the base member. Thus, this mode can provide a base material retention device that does not cause influence on a downstream process.

[0025] In the above-mentioned base material retention device, the retaining surface may have a curved surface.

[0026] The base material retention device according to this mode can retain a base material having a curved

surface while positioning it properly.

[0027] Furthermore, the base material retention device according to this mode can, by retaining a flat-plate-shaped base material on the stage while bending, press the base material against the outer edge contact member while keeping the base material to a shape following the retaining surface of the stage. Thus, the outer edge of the base material comes into contact with the outer edge contact member certainly and the base material can be positioned at the prescribed retaining position. Furthermore, a suction failure can be prevented by suctioning the base material positioned at the prescribed retaining position while pressing it against the stage. Thus, also in a case of retaining a flat-plate-shaped base material by bending it, the base material retention device according to this mode can retain the base material while positioning it properly.

[0028] In the above-mentioned base material retention device, the retaining surface may be a flat surface.

[0029] The base material retention device according to this mode can retain, while positioning it properly, a base material that was produced aiming a flat plate having no curved surface and may be warped partially such as in an end portion.

[0030] The above-mentioned base material retention device may further contain a heating unit that is configured so as to heat the base material placed on the retaining surface.

[0031] The base material retention device according to this mode can fix the base material into a shape following the retaining surface of the stage by heating the base material in a state that it is pushed and bent. The heating temperature is controlled to, for example, a temperature that is room temperature or higher and a glass softening temperature or lower (e.g., 25°C to 500°C).

[0032] A curved surface screen printing machine according to one mode of the present invention is a curved surface screen printing machine for printing a prescribed pattern on a plate-shaped base material having a curved surface and contains the above-described base material retention device, a screen plate, a squeegee that is disposed above the screen plate and configured so as to apply ink to the base material being retained by the base material retention device through the screen plate, and a printing control unit that is configured so as to print the prescribed pattern on the base material by moving the stage of the base material retention device, the screen plate, and the squeegee relative to each other.

[0033] This mode can improve the quality of printing because it enables printing on the base material that has been positioned properly.

[0034] A base material retention method according to one mode of the present invention is a base material retention method for retaining a plate-shaped base material and contains placing the base material on a retaining surface on a stage, pressing the base material against the stage, positioning the base material at a prescribed retaining position on the retaining surface by pushing an

outer edge of the base material being pressed against the stage to bring into contact with an outer edge contact member that is configured to come into contact with a portion of the outer edge of the base material, and suctioning, on the stage, the base material being pressed against the stage and positioned at the prescribed retaining position.

[0035] This mode makes it possible to retain the base material while positioning it properly.

[0036] In the above-mentioned base material retention method, it is preferable that in pushing the outer edge of the base material, the base material be pressed against the stage by a first pressing force and that in suctioning the base material on the stage, the base material be pressed against the stage by a second pressing force that is stronger than the first pressing force.

[0037] In this mode, at the time of positioning, the base material can be brought into contact with the outer edge contact member smoothly because the base material is pressed against the stage by the first pressing force that is weaker than the second pressing force. At the time of suction, the base material can be suctioned smoothly because the base material is pressed against the stage by the second pressing force that is stronger than the first pressing force.

[0038] In the above-mentioned base material retention method, the retaining surface may either have a curved surface or be a flat surface.

[0039] In the above-mentioned base material retention method, the base material may either have a curved surface or be a flat plate.

[0040] In the above-mentioned base material retention method, the base material placed on the retaining surface may be heated.

BRIEF DESCRIPTION OF DRAWINGS

[0041]

[FIG. 1A] FIG. 1A is a schematic sectional view illustrating a rough configuration of a base material retention device according to one embodiment of the present invention.

[FIG. 1B] FIG. 1B is a schematic plan view illustrating the rough configuration of the base material retention device according to the one embodiment of the invention.

[FIG. 2A] FIG. 2A is an explanatory diagram of operation in the base material retention method using the above-mentioned base material retention device.

[FIG. 2B] FIG. 2B is an explanatory diagram of operation in the base material retention method using the above-mentioned base material retention device.

[FIG. 2C] FIG. 2C is an explanatory diagram of operation in the base material retention method using the above-mentioned base material retention de-

vice.

[FIG. 3A] FIG. 3A is an explanatory diagram of operation in the base material retention method, following FIGs. 2A-2C.

[FIG. 3B] FIG. 3B is an explanatory diagram of operation in the base material retention method, following FIG. 3A.

[FIG. 4A] FIG. 4A is a schematic diagram of a curved surface screen printing machine that is equipped with the above-mentioned base material retention device.

[FIG. 4B] FIG. 4B is an explanatory diagram of operation in a printing method using the curved surface screen printing machine.

[FIG. 4C] FIG. 4C is an explanatory diagram of operation in the printing method using the curved surface screen printing machine.

DESCRIPTION OF EMBODIMENTS

[First Embodiment]

[0042] A first embodiment of the present invention will be described below. To describe the location of each constituent element, directions are defined with respect to the X, Y, and Z axes shown in FIG. 1A; the +X direction, -X direction, +Y direction, -Y direction, +Z direction, and -Z direction are expressed as directions toward the right side, left side, front side, rear side, top side, and bottom side, respectively.

[Configuration of base material retention device]

[0043] As illustrated in FIG. 1A and FIG. 1B, a base material retention device 1 retains a plate-shaped base material G having a curved surface(s).

[0044] Examples of the base material G include plates made of glass, ceramic, a resin, wood, a metal, or the like. Examples of glass include colorless and transparent amorphous glass, crystallized glass, colored glass and the like. There are no particular limitations on the plan-view shape of the base material G; it may have any shape such as a polygon, a circle, or an ellipse.

[0045] The term "curved surface" means a surface whose radius of curvature is 5,000 mm or smaller. The curved surface(s) provided on the base material G may be constituted only of a convex surface where one major surface side projects to the other major surface side, may be constituted of a combination of a convex surface and a concave surface that projects in the opposite direction, and may be constituted of a combination of plural convex surfaces and plural concave surfaces. Where the curved surface has only a convex surface or a concave surface, it may have a portion(s) that is different in radius of curvature. Furthermore, the curved surface may have both of a flat portion and a bent portion or may have a bent portion that is twisted.

[0046] The base material G employed in the embodi-

ment is formed rectangular in a plan view and is bent in one direction from its center in the direction of its longer sides.

[0047] The base material retention device 1 is equipped with a stage 2, a positioning unit 3, a suction unit 4, and a control unit, which is not shown, controlling the entire base material retention device 1.

[0048] The base material G is placed on the stage 2. The surface 21 of the stage 2 is formed so as to be larger than the base material G in a plan view shape. A part of the surface 21 constitutes a retaining surface 21A that is the same in shape as a target bent shape of the base material G. In the embodiment, the retaining surface 21A is formed so as to have a convex shape.

[0049] A plate 20 is fixed to the back surface of the stage 2. A recessed space 22 is formed between the stage 2 and the plate 20. Plural holes 23 that communicate the space over the retaining surface 21A and the recessed space 22 with each other through them are provided on the stage 2.

[0050] The positioning unit 3 positions the base material G at a prescribed retaining position on the stage 2. The positioning unit 3 is equipped with a first pressing unit 31, an outer edge contact member 32, a friction force reduction unit 33, and a second pressing unit 34.

[0051] The first pressing unit 31 presses the base material G against the stage 2. The first pressing unit 31 is equipped with seven major surface pressing mechanism 311 and an elevation unit 312 for elevating and lowering the seven major surface pressing mechanism 311 with respect to the base material G.

[0052] Each major surface pressing mechanism 311 is equipped with a pneumatic or oil hydraulic cylinder 313 as an advance/retreat control unit, a sphere retaining unit 314 that is fixed to an output shaft 313A of the cylinder 313, and a sphere 315 as a major surface contact member that is retained by the sphere retaining unit 314 rotatably.

[0053] The elevation unit 312 is equipped with a retaining body 316 that retains the seven major surface pressing mechanism 311 over the stage 2 and an elevation drive mechanism 317 that elevates and lowers the retaining body 316.

[0054] The retaining body 316 retains three major surface pressing mechanisms 311 at the center in the shorter side direction of the base material G placed on the stage 2 so that they are arranged in the longer side direction at the same interval. The retaining body 316 retains one of the three major surface pressing mechanisms 311 so that it is located at the center of the base material G. The retaining body 316 retains other two major surface pressing mechanisms 311 in such a manner that they are arranged at the same interval in the longer side direction at a position that is closer to one longer side than the center in the shorter side direction of the base material G and that each of them is located between two adjacent ones of the above three major surface pressing mechanisms 311 in the longer side direction.

The retaining body 316 retains the remaining two major surface pressing mechanisms 311 at such positions as to be line-symmetrical with the above two major surface pressing mechanism 311 with respect to an imaginary line that passes through the center of the base material G and is parallel with its longer sides.

[0055] The outer edge contact member 32 comes into contact with a portion of an outer edge of the base material G. The outer edge contact member 32 is a so-called positioning pin and has a cylindrical shape. The outer edge contact member 32 is provided so as to project from outside the retaining surface 21A of the surface 21 of the stage 2. The three outer edge contact members 32 are provided so as to come into contact with the center of the left-hand shorter side of the base material G, a portion of the base material G, closer to the left end of the bottom longer side than its center, and a portion of the base material G, closer to the right end of the bottom longer side than its center, respectively. The height of the outer edge contact member 32 with respect to the retaining surface 21A is set to the thickness of the base material G or smaller.

[0056] The friction force reduction unit 33 reduces the friction force acting between the base material G and the stage 2 by applying, to the base material G, separation force in such a direction as to go away from the stage 2. The friction force reduction unit 33 is constituted of the recessed space 22 and the holes 23 which are formed in the stage 2 and a gas supply unit 331 for supplying gas to the recessed space 22.

[0057] The second pressing unit 34 positions the base material G at a retaining position on the retaining surface 21A while preventing rotation by pressing associated outer edges of the base material G placed on the stage 2 to bring into contact with the three outer edge contact members 32. The second pressing unit 34 is equipped with three outer edge pressing mechanisms 341. The three outer edge pressing mechanisms 341 are retained by the retaining body 316 so as to press the base material G at positions that are opposite to the three respective outer edge contact members 32. Each outer edge pressing mechanism 341 is equipped with a vertical cylinder 342, a horizontal cylinder 343 that is fixed to an output shaft 342A of the vertical cylinder 342, and a quadrilateral-prism-shaped pressing member 344 that is fixed to an output shaft 343A of the horizontal cylinder 343.

[0058] The suction unit 4 suctions the base material G on the stage 2. The suction unit 4 is constituted of the recessed space 22 and the holes 23 which are formed in the stage 2 and a gas exhaust unit 41 for exhausting gas from the recessed space 22.

[Base material retention method]

[0059] Next, a base material retention method using the above-described base material retention device 1 will be described.

[0060] First, as illustrated in FIG. 1A, a worker or a

transport means, which is not shown, places the base material G on the stage 2 in an initial state that the first pressing unit 31 and the second pressing unit 34 are spaced upward from the stage 2. At this time, as illustrated in FIG. 2A, the entire surface of the base material G is in contact with the retaining surface 21A of the stage 2 as long as the curvature of the base material G is the same as a design value. However, if the curvature of the base material G is deviated from the design value, there may occur an event that an end portion is spaced from the retaining surface 21A as illustrated in FIG. 2B or the center is spaced from the retaining surface 21A as illustrated in FIG. 2C.

[0061] Then, the control unit lowers the retaining body 316 by driving the elevation drive mechanism 317 and thereby causes all the spheres 315 of the first pressing unit 31 to push the base material G as illustrated in FIG. 3A. The control unit thereafter stops the lowering of the retaining body 316 at a timing when almost the entire surface of the base material G has come into contact with the retaining surface 21A or at a timing when the bottom ends of the outer edges of the base material G have come to be located below the top ends of the confronting outer edge contact members 32, whereby the first pressing unit 31 pushes the base material G by a first pressing force that is weaker than a second pressing force that is described later.

[0062] The above operation may be performed in such a manner that the retaining body 316 is lowered in a state where all the spheres 315 are kept at the same height position as illustrated in FIG. 1A, and the output shafts 313A of the cylinders 313 are elongated or shortened according to the shape of the top surface G1 of the base material G after contact of the spheres 315 to the top surface G1. Alternatively, the retaining body 316 may be lowered in a state where the output shafts 313A have been elongated or shortened in advance so that all the spheres 315 are located at height positions that are suitable for the shape of the top surface G1.

[0063] Subsequently, the control unit applies separation force to the base material G by supplying gas to the holes 23 through the recessed space 22 by driving the gas supply unit 331 of the friction force reduction unit 33 in a state where the pressing state established by the first pressing unit 31 is maintained. The application of the separation force lowers the friction force acting between the base material G and the stage 2.

[0064] Then, the control unit lowers the horizontal cylinders 343 by driving all the vertical cylinders 342 of the second pressing unit 34 while the pressing state of the first pressing unit 31 and the separation force application state of the friction force reduction unit 33 are kept as they are. The control unit thereafter drives the horizontal cylinders 343 so that as illustrated in FIG. 3B the tips of the pressing members 344 press the base material G against the respective outer edge contact members 32. The control unit stops the driving of the output shafts 343A at a timing when the base material G has come

into contact with all the outer edge contact members 32 and the positioning has completed.

[0065] When the pressing members 344 push the base material G, the spheres 315 being in contact with the top surface G1 of the base material G rotate following the shape of the top surface G1 as the output shafts 313A of the cylinders 313 are elongated or shortened.

[0066] Subsequently, the control unit stops the driving of the gas supply unit 331 while keeping the pressing states of the first pressing unit 31 and the second pressing unit 34. The control unit adjusts the pressing force of the first pressing unit 31 to the second pressing force that is stronger than the first pressing force by performing at least one of lowering the retaining body 316 and elongating the output shafts 313A of the cylinders 313.

[0067] Subsequently, the control unit causes the base material G to be suctioned on the stage 2 by exhausting the gas from the recessed space 22 and the holes 23 by driving the gas exhaust unit 41 of the suction unit 4.

[0068] As a result of the above process, the base material G is positioned at the retaining position on the retaining surface 21A of the stage 2 and is retained by the stage 2 in a state where the tips of the outer edge contact members 32 do not project beyond the base material G.

[0069] Subsequently, the control unit causes the pressing members 344 to be spaced from the base material G by controlling the horizontal cylinders 343. Then, the control unit causes the first pressing unit 31 and the second pressing units 34 to return to their initial states illustrated in FIG. 1A by controlling the vertical cylinders 342, the cylinders 313, and the elevation drive mechanism 317.

[0070] Thereafter, the base material G is subjected to printing, application of an adhesive, coating, or a like process while being kept suctioned on the stage 2.

[Function effects of base material retention device and base material retention method]

[0071] According to the above-described base material retention device 1, since the base material G is pressed against the outer edge contact members 32 by the second pressing unit 34 while pressing the base material G against the stage 2 by the first pressing unit 31, the base material G is in contact with all the outer edge contact members 32 certainly and positioned at the retaining position even if the base material G has an outer edge(s) spaced from the stage 2 when placed on the stage 2. Furthermore, a suction failure can be prevented by suctioning the base material G on the stage 2 while being pressed against the stage 2 by the first pressing unit 31.

[0072] Since the members that come into contact with the base material G, of the first pressing unit 31 are constituted of the plural spheres 315, the area of contact between the spheres 315 and the base material G can be small, whereby the friction force that occurs when the second pressing unit 34 pushes the base material G can

be reduced.

[0073] Since the spheres 315 are retained rotatably by the respective sphere retaining units 314, positioning of the base material G can be performed smoothly and scratching and damaging of the base material G can be suppressed.

[0074] Since the spheres 315 are rotated so as to follow the shape of the top surface G1 as the output shafts 313A of the cylinders 313 are elongated or shortened, the base material G can be pressed by a stable force.

[0075] When the base material G is pushed by the second pressing unit 34, the friction force occurring between the base material G and the stage 2 is reduced by applying separation force to the base material G, whereby the pushing by the second pressing unit 34 can be performed smoothly.

[0076] Since the force for pressing the base material G to the stage 2 at the time of positioning is set weaker than at the time of suction, both of smooth movement of the base material G by pushing by the second pressing unit 34 and smooth suction of the base material G on the stage 2 can be attained.

[Second Embodiment]

[0077] A second embodiment of the present invention will be described below. The descriptions of items having the same or similar ones in the first embodiment will be omitted or simplified as appropriate.

[Configuration of base material retention device]

[0078] A base material retention device according to this embodiment retains a flat-plate-shaped base material G on a retaining surface having a curved surface. That is, the base material retention device pushes and bends a flat-plate-shaped base material G to fix and retain it into a shape following a retaining surface having a curved surface.

[0079] The term "flat-plate-shaped base material" as used herein means a base material at least whose surface to be brought into contact with the retaining surface of the stage is a flat surface. The term "flat surface" means a surface whose radius of curvature is larger than 5,000 mm. The type of the base material G and the configuration of the base material retention device are the same as or similar to those in the first embodiment.

[Function effects of base material retention device and base material retention method]

[0080] Where a flat-plate-shaped base material G is placed on the retaining surface having a curved surface of the above-described base material retention device, the base material G may warp a little by its own weight but an end portion of it may be spaced from the retaining surface 21A as illustrated in FIG. 2B, for example. The same advantages as in the first embodiment can be ob-

tained by performing a base material retention method that is the same as or similar to that according to the first embodiment using the base material retention device according to this embodiment.

[Modification examples of base material retention device and base material retention method]

[0081] The present invention is not limited to only the above-described embodiments, and various improvements, design changes and the like can be made without departing from the spirit and scope of the invention.

[0082] For example, the number of major surface pressing mechanisms 311 may be one or larger and six or smaller, or may be eight or larger, and the major surface pressing mechanisms 311 may be arranged at such positions as to be able to push a portion, spaced from the stage 2, of the base material G.

[0083] Rollers may be employed as major surface contact members in place of or in addition to the spheres 315 in such a manner that their cylindrical portions are brought into line contact with the base material G. As a further alternative, members having a cylindrical shape or a polygonal prism shape may be employed. In the case where the member having a cylindrical shape or a polygonal prism shape is employed, the surface to be brought into contact with the base material G may be either made a flat surface or given the same shape as a curved surface of the base material G.

[0084] Instead of providing major surface pressing mechanism 311 with the advance/retreat control unit, the retaining body 316 may be configured so as to retain the sphere retaining units 314. In this case, each sphere retaining unit 314 may retain the sphere 315 in an unrotatable manner. Furthermore, instead of providing the sphere retaining units 314, the retaining body 316 may be configured so as to retain the sphere 315 (major surface contact member).

[0085] Four or more outer edge contact members 32 may be provided.

[0086] Polygonal-prism-shaped members may be employed as outer edge contact members in place of or in addition to the cylindrical outer edge contact member 32. In the case where the polygonal-prism-shaped member is employed, it may be provided so as to be brought into either point contact or line contact with the base material G. In the case where it is provided so as to be brought into line contact, two outer edge contact members may be provided so as to come into line contact with a longer side and a shorter side of the base material G, respectively, as long as they can restrict rotation of the base material G,

[0087] One outer edge contact member that is, for example, L-shaped in a plan view may be provided so as to come into line contact with a corner portion of the base material G as long as it can restrict rotation of the base material G.

[0088] The height of the outer edge contact member

32 from the retaining surface 21A may be set greater than the thickness of the base material G.

[0089] The retaining surface 21A may be provided with a roller as a friction force reduction unit in place of or in addition to the means for applying separation force, and the base material G may be moved by rotation of the roller.

[0090] A hole through which the gas supply unit 331 supplies gas may be formed separately from the hole through which the gas exhaust unit 41 of the suction unit 4 exhausts gas.

[0091] The friction force reduction unit may not be provided.

[0092] Four or more outer edge pressing mechanisms 341 may be provided. The outer edge pressing mechanism 341 may be provided so as to push the base material G at a position other than the position opposite to the outer edge contact member as long as it can prevent rotation of the base material G in cooperation with the outer edge contact member. Only one or two outer edge pressing mechanism(s) 341 may be provided.

[0093] A cylindrical member or a member that is shaped in a polygonal prism rather than a quadrilateral prism may be employed in place of or in addition to the quadrilateral-prism-shaped pressing member 344.

[0094] The retaining body 316 may retain the horizontal cylinder 343 without providing the outer edge pressing mechanism 341 with the vertical cylinder 342.

[0095] The outer edge pressing mechanism 341 may be retained by a member other than the retaining body 316.

[0096] Although the force for pressing the base material G against the stage 2 at the time of positioning is set weaker than the force produced at the time of suction in the above-described embodiments, the former may be set either stronger than or equal to the latter.

[0097] The base material G being retained by the base material retention device 1 may be subjected to working such as grinding or polishing, a process such as film sticking or masking, or measurement of dimensions, as well as printing, application of an adhesive, or coating.

[0098] Furthermore, although the retaining surface of the stage has a curved surface in the base material retention device and the base material retention method according to the above-described embodiments, the present invention is not limited thereto. For example, even a substrate that was produced aiming a flat plate having no curved surface may be warped partially such as in an end portion. The base material retention device and the base material retention method according to the present invention can provide the advantages described in the above-described embodiments even in a case that such a substrate is to be fixed to a stage having a flat retaining surface. Moreover, the base material retention device and the base material retention method according to the present invention can provide the advantages described in the above-described embodiments even in a case that a substrate having a curved surface is to be

fixed to a stage having a flat retaining surface. That is, the base material retention device and the base material retention method according to the present invention may serve for a flat-plate-shaped substrate at least part of which may be warped. The retaining surface of the stage may be a flat surface.

[0099] Still further, the base material retention device according to the present invention may have a constitution for heating a base material, for example, equipped with a heater unit inside the stage. A base material can be fixed into a shape following the surface of the stage by heating the base material in a state that it is pushed and bent. The heating temperature is controlled to a temperature that is room temperature or higher and a glass softening temperature or lower (e.g., 25°C to 500°C). Particularly in the case where a flat-plate-shaped base material is to be fixed to a retaining surface having a curved surface, it is preferable that the base material retention device according to the present invention be provided with a heater unit.

[Configuration of curved surface screen printing machine]

[0100] A curved surface screen printing machine 10 serves to print a prescribed pattern on a plate-shaped base material G having a curved surface. As illustrated in FIG. 4A, the curved surface screen printing machine 10 is equipped with the base material retention device 1, a screen plate 11, a squeegee 12, and a printing control unit 13.

[0101] The screen plate 11 is disposed on the right of the base material retention device 1 in FIG. 4A.

[0102] The squeegee 12 is disposed above the screen plate 11.

[0103] The printing control unit 13 moves the stage 2, the screen plate 11 and the squeegee 12 relative to each other.

[Printing method using curved surface screen printing machine]

[0104] Next, a printing method using the curved surface screen printing machine 10 will be described. The movement directions, operation order and the like of the stage 2, the screen plate 11 and the squeegee 12 are not limited to those described below; any printing directions, operation order and the like may be employed as long as they enable printing on the base material G.

[0105] First, the base material retention device 1 positions the base material G at a prescribed retaining position on the stage 2 and retains it, by using the above-described base material retention method.

[0106] Then, as illustrated in FIG. 4B, the printing control unit 13 moves the stage 2 until it is located right under the screen plate 11. In moving the stage 2 in this manner, the printing control unit 13 rotates the stage 2 so that the right end of the base material G comes closest to the

screen plate 11 as illustrated in FIG. 4B.

[0107] Subsequently, the printing control unit 13 lowers the screen plate 11 so that it comes closer to the base material G and thereafter lowers the squeegee 12 so that the bottom surface of the screen plate 11 is pressed against the top surface G1 of the base material G. Then, the printing control unit 13 moves the squeegee 12 in the horizontal direction to the position illustrated in FIG. 4C while keeping the screen plate 11 fixed and, in synchronism with the movement of the squeegee 12, rotates the stage 2 clockwise while moving the stage 2 leftward and downward. Because of the above-described movements of the squeegee 12 and the stage 2, the squeegee 12 pushes out ink through the screen plate 11 and applies the ink to the entire printing range of the base material G.

[0108] At this time, since the tip of the outer edge contact member 32 does not project beyond the top surface G1 of the base material G, the screen plate 11 does not come into contact with the outer edge contact member 32 during the printing. As a result, the screen plate 11 can be prevented from being damaged.

[0109] Subsequently, the printing control unit 13 returns the stage 2, the screen plate 11 and the squeegee 12 to their original positions illustrated in FIG. 4A.

[0110] The above-described printing method can improve the quality of printing because it performs printing on the base material G that has been positioned properly by the base material retention device 1.

[0111] Although the present invention has been described in detail and with reference to the particular embodiments, it is apparent to those skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope of the invention.

[0112] The present application is based on Japanese Patent Application No. 2019-010187 filed on January 24, 2019, the disclosure of which is incorporated herein by reference.

DESCRIPTION OF SYMBOLS

[0113] 1 ... Base material retention device; 2 ... Stage; 3 ... Positioning unit; 4 ... Suction unit; 10 ... Curved surface screen printing machine; 11 ... Screen plate; 12 ... Squeegee; 13 ... Printing control unit; 31 ... First pressing unit; 32 ... Outer edge contact member; 33 ... Friction force reduction unit; 34 ... Second pressing unit; 313 ... Cylinder (advance/retreat control unit); 314 ... Sphere retaining unit; 315 ... Sphere (major surface contact member); G ... Base material.

Claims

1. A base material retention device for retaining a plate-shaped base material, comprising:

a stage having a retaining surface on which the

base material is to be placed;

a positioning unit that is configured so as to position the base material at a prescribed retaining position on the retaining surface; and

a suction unit that is configured so as to suction, on the stage, the base material positioned at the prescribed retaining position,

wherein the positioning unit comprises:

a first pressing unit that is configured so as to press the base material against the stage; an outer edge contact member that is provided on the stage and configured so as to come into contact with a portion of an outer edge of the base material; and

a second pressing unit that is configured so as to bring the base material into contact with the outer edge contact member by pushing the outer edge of the base material.

2. The base material retention device according to Claim 1, wherein the first pressing unit comprises plural major surface contact members that are configured so as to come into contact with a major surface of the base material.

3. The base material retention device according to Claim 2, wherein the first pressing unit further comprises an advance/retreat control unit that is configured so as to advance and retreat the plural major surface contact members independently of each other toward and from the stage.

4. The base material retention device according to Claim 2 or 3, wherein the major surface contact member is a sphere.

5. The base material retention device according to Claim 4, wherein the first pressing unit further comprises a sphere retaining unit that is configured so as to retain the sphere rotatably.

6. The base material retention device according to any one of Claims 1 to 5, wherein the positioning unit further comprises a friction force reduction unit that is configured so as to reduce the friction force occurring between the base material and the stage.

7. The base material retention device according to any one of Claims 1 to 6, wherein the outer edge contact member has a height from the retaining surface being set to a thickness of the base material or smaller.

8. The base material retention device according to any one of Claims 1 to 7, wherein the retaining surface has a curved surface.

9. The base material retention device according to any

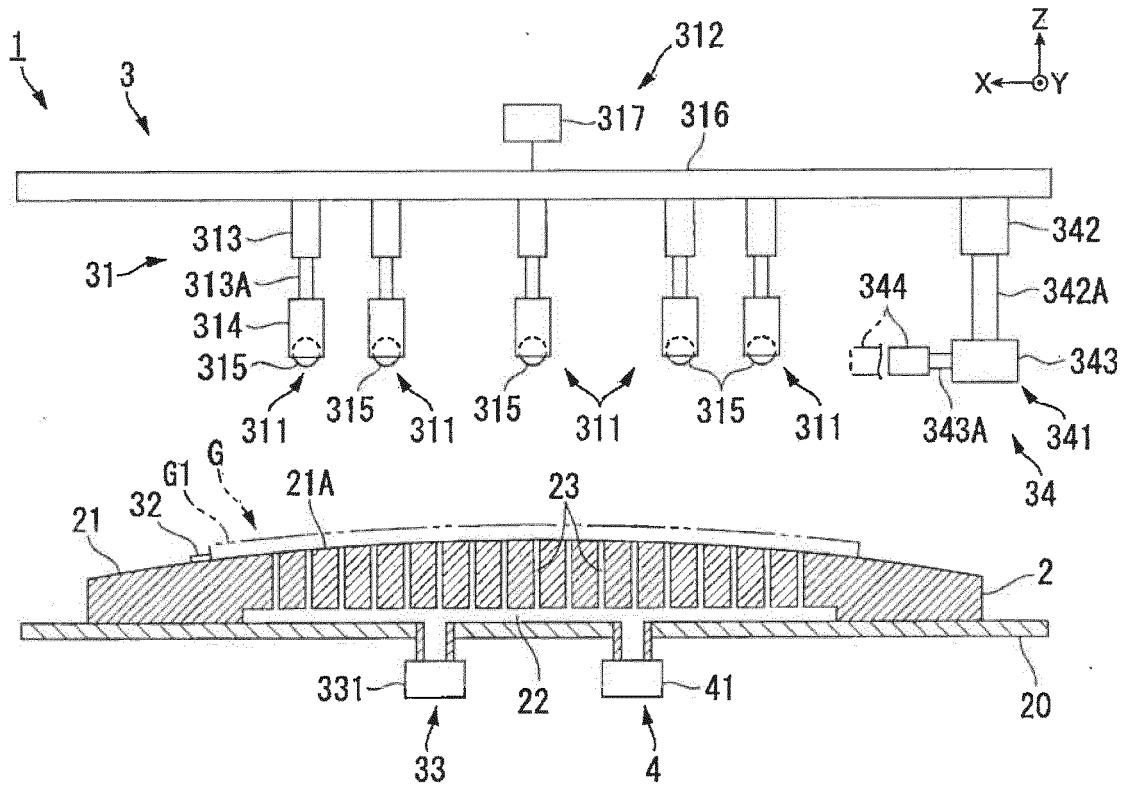
one of Claims 1 to 7, wherein the retaining surface is a flat surface.

10. The base material retention device according to any one of Claims 1 to 9, further comprises a heating unit that is configured so as to heat the base material placed on the retaining surface. 5
11. A curved surface screen printing machine for printing a prescribed pattern on a plate-shaped base material having a curved surface, comprising: 10
the base material retention device as described in Claim 7;
a screen plate; 15
a squeegee that is disposed above the screen plate and configured so as to apply ink, through the screen plate, to the base material being retained by the base material retention device; and
a printing control unit that is configured so as to print the prescribed pattern on the base material by moving the stage of the base material retention device, the screen plate, and the squeegee relative to each other. 20
25
12. A base material retention method for retaining a plate-shaped base material, comprising:
placing the base material on a retaining surface on a stage; 30
pressing the base material against the stage;
positioning the base material at a prescribed retaining position on the retaining surface by pushing an outer edge of the base material being pressed against the stage to bring into contact with an outer edge contact member that is configured to come into contact with a portion of the outer edge of the base material; and 35
suctioning, on the stage, the base material being pressed against the stage and positioned at the prescribed retaining position. 40
13. The base material retention method according to Claim 12, 45
wherein in pushing the outer edge of the base material, the base material is pressed against the stage by a first pressing force, and
wherein in suctioning the base material on the retaining surface, the base material is pressed against the stage by a second pressing force that is stronger than the first pressing force. 50
14. The base material retention method according to Claim 12 or 13, wherein the retaining surface has a curved surface. 55
15. The base material retention method according to

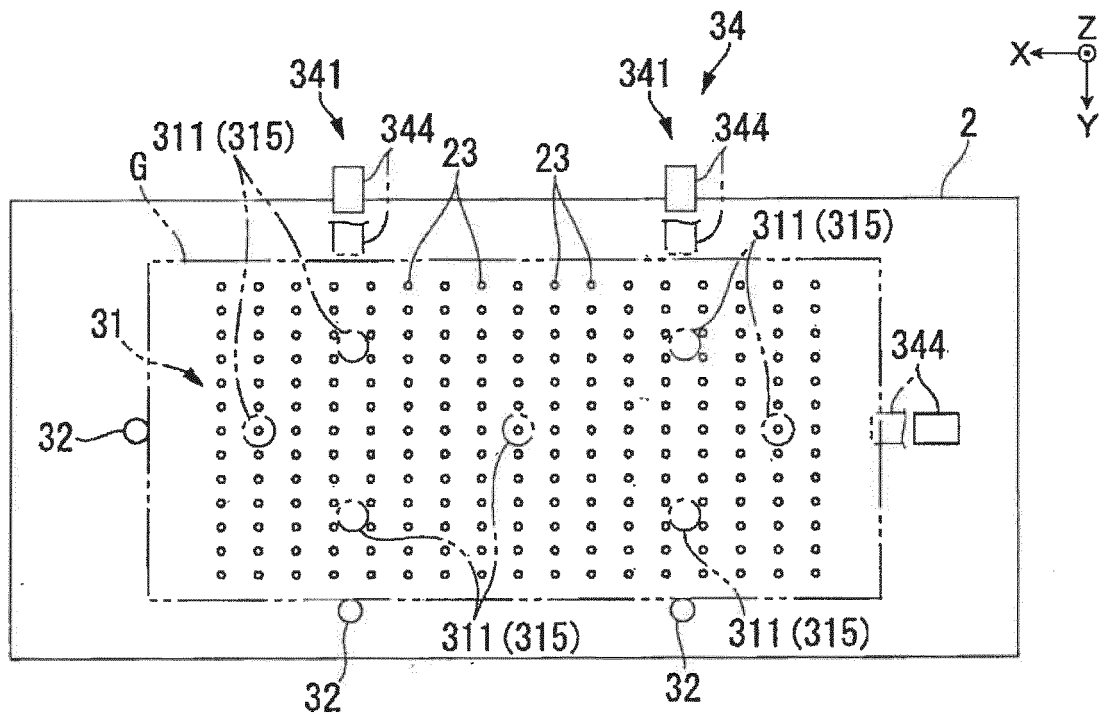
Claim 12 or 13, wherein the retaining surface is a flat surface.

16. The base material retention method according to any one of Claims 12 to 15, wherein the base material has a curved surface.
17. The base material retention method according to any one of Claims 12 to 15, wherein the base material is a flat plate.
18. The base material retention method according to any one of Claims 12 to 17, further comprising heating the base material placed on the retaining surface.

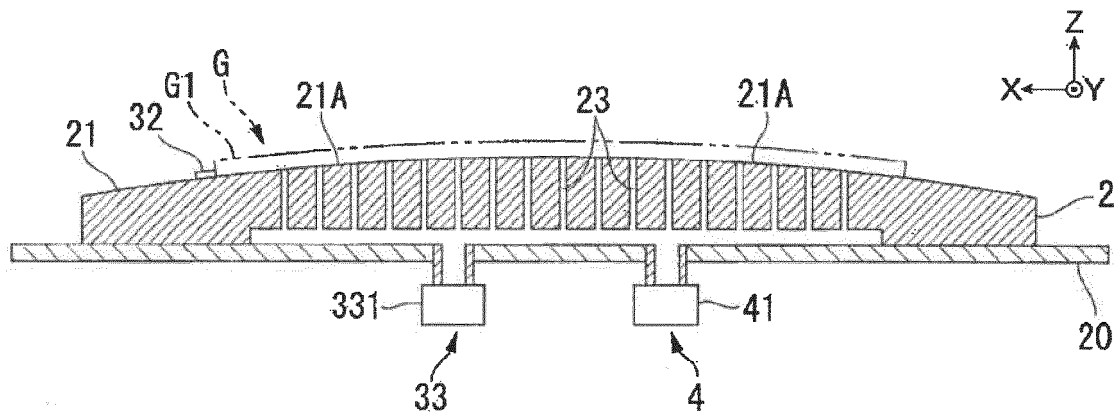
[FIG. 1A]



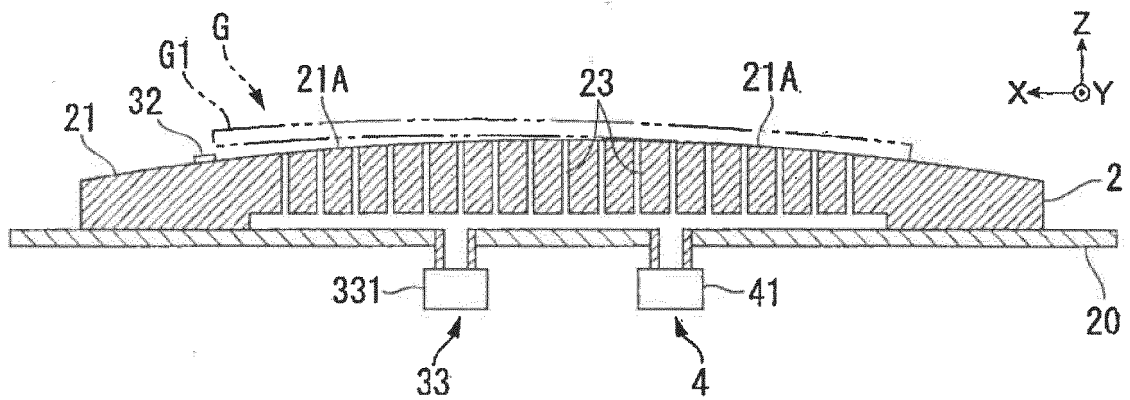
[FIG. 1B]



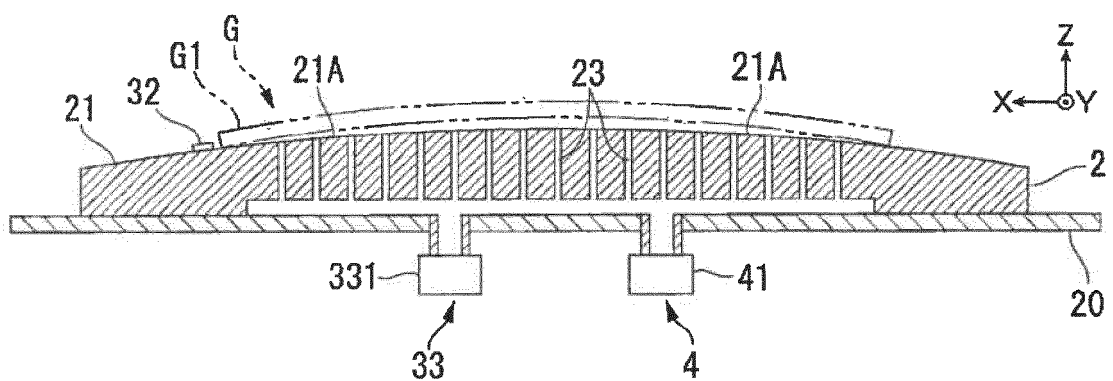
[FIG. 2A]



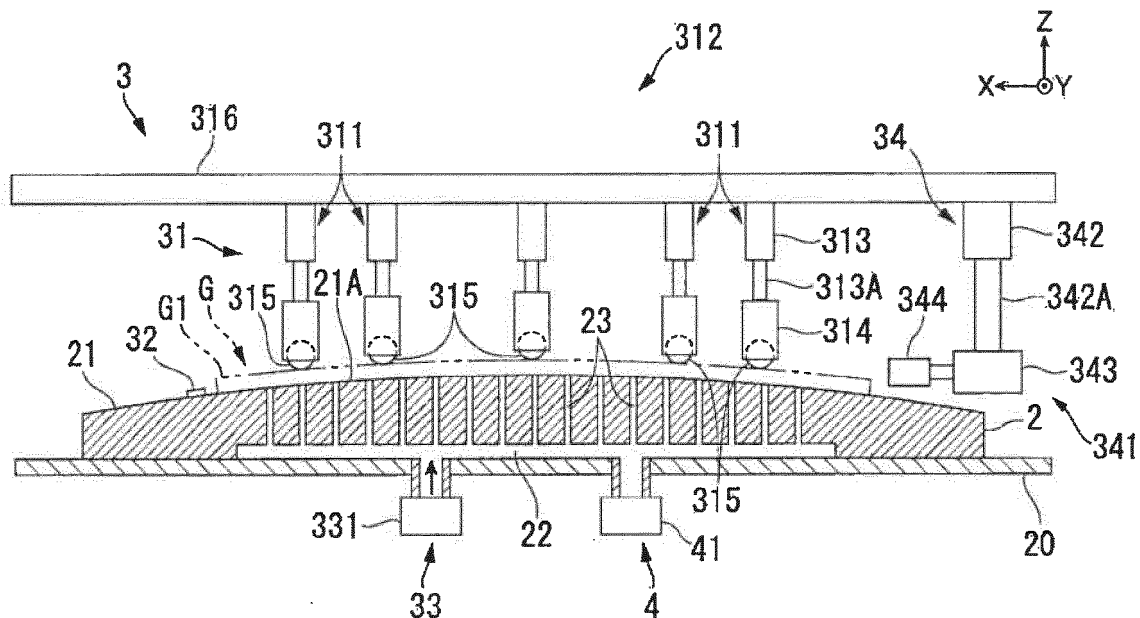
[FIG. 2B]



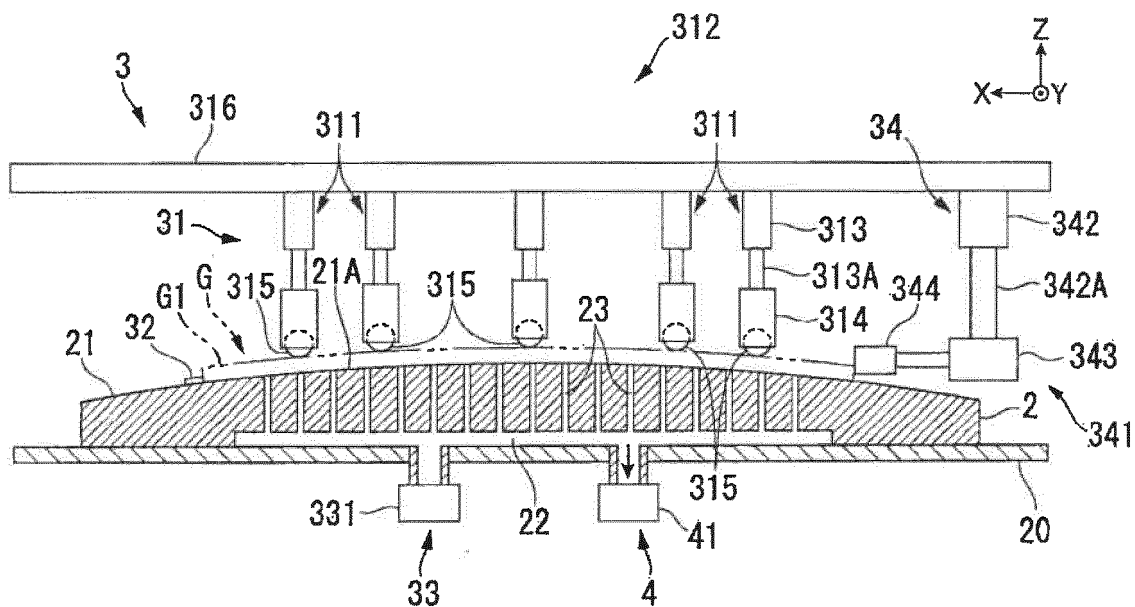
[FIG. 2C]



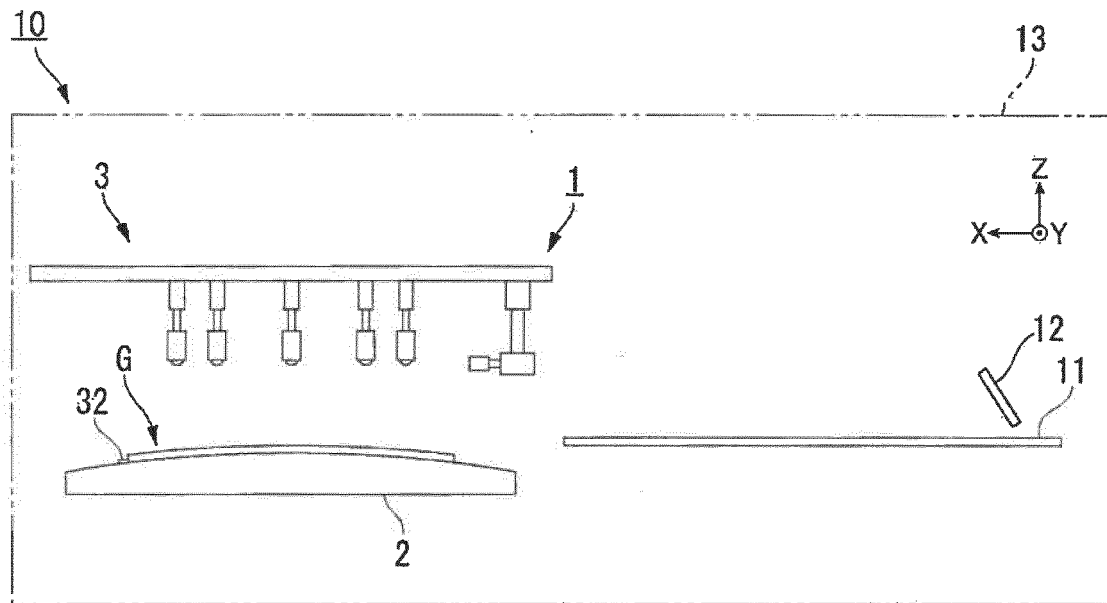
[FIG. 3A]



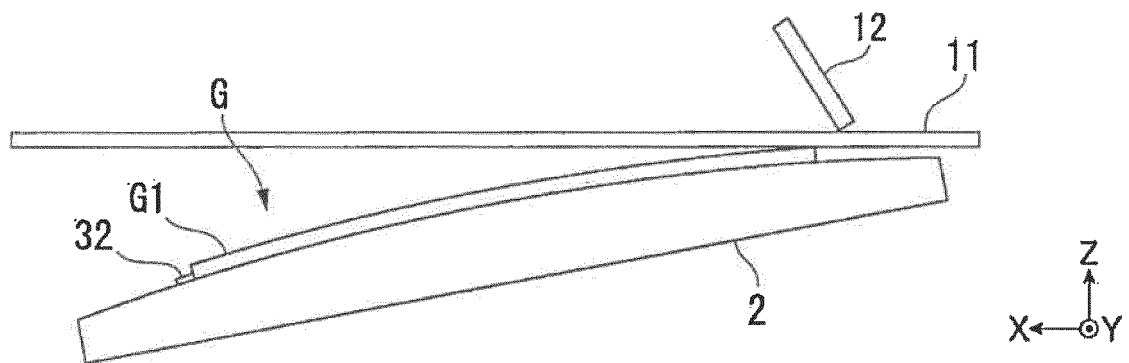
[FIG. 3B]



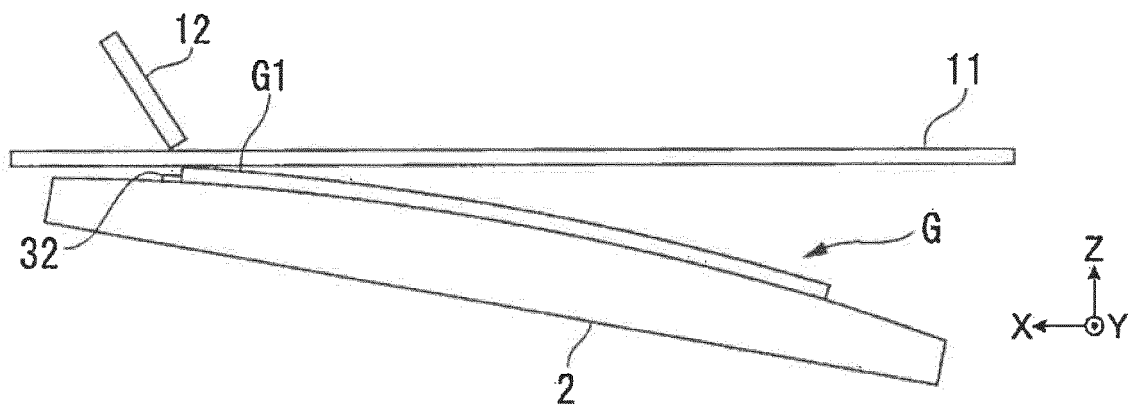
[FIG. 4A]



[FIG. 4B]



[FIG. 4C]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/002611

A. CLASSIFICATION OF SUBJECT MATTER

B41F 15/20 (2006.01) i; B41F 15/08 (2006.01) i

FI: B41F15/20; B41F15/08 303L

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B41F15/20; B41F15/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2020

Registered utility model specifications of Japan 1996-2020

Published registered utility model applications of Japan 1994-2020

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2003-34013 A (JUKI CORP.) 04.02.2003 (2003-02-04) paragraphs [0002]-[0003], [0017]-[0025], [0031]-[0035], fig. 1, 3, 5	1-3, 6-12, 14-18 4-5, 13
A		
Y	JP 2007-16Q692 A (YAMAHA MOTOR CO., LTD.) 28.06.2007 (2007-06-28) paragraphs [0019]-[0028], [0047]-[0069], fig. 1-4, 8-9, 11	1-3, 6-12, 14-18
Y	WO 2017/0861 97 A1 (ASAHI GLASS CO., LTD.) 26.05.2017 (2017-05-26) paragraphs [0043]-[0044], fig. 11	8, 10, 14, 18
Y	JP 56-84962 A (TOKYO DENKI KAGAKU KOGYO K.K.) 10.07.1981 (1981-07-10) specification, page 2, lower right column to page 3, upper right column, fig. 1	10, 18
Y	JP 2009-119512 A (MICRO-TEC CO., LTD.) 04.06.2009 (2009-06-04) paragraph [0031], fig. 3	10, 18



Further documents are listed in the continuation of Box C.



See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search
25 March 2020 (25.03.2020)Date of mailing of the international search report
07 April 2020 (07.04.2020)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/002611

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	JP 3-69366 A (PILOT CORPORATION) 25.03.1991 (1991-03-25) entire text, all drawings	1-18
A	JP 6-210827 A (SANYO ELECTRIC CO., LTD.) 02.08.1994 (1994-08-02) entire text, all drawings	1-18
A	US 2016/0039196 A1 (HARRIS, Tom et al.) 11.02.2016 (2016-02-11) entire text, all drawings	1-18

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application no.

PCT/JP2020/002611

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	JP 2007-160692 A	28 Jun. 2007	CN 1982056 A	
10			specification, pp. 8- 10, 14-19, fig. 1-4, 8-9, 11	
	WO 2017/086197 A1	26 May 2017	US 2018/0264800 A1	
			paragraphs [0132]- [0134], fig. 11	
15	JP 56-84962 A	10 Jul. 1981	US 4398462 A	
			specification, column 5, line 49 to column 6, line 5, fig. 8-9	
			GB 2050946 A	
			DE 30204 77 A1	
20	JP 2009-119612 A	04 Jun. 2009	(Family: none)	
	JP 2012-92395 A	17 May 2012	US 2012/0107506 A1	
			entire text, all drawings	
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	JP 6-210827 A	02 Aug. 1994	(Family: none)	
	US 2016/0039196 A1	11 Feb. 2016	WO 2014/166956 A1	
			entire text, all drawings	
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30			entire text, all drawings	
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REFERENCES CITED IN THE DESCRIPTION

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