

GLASS-PLATE POLISHING APPARATUS AND METHOD THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention relates to a polishing apparatus for planarizing the surface of a glass plate, and more particularly to a continuous polishing apparatus for consecutively polishing glass plates which are continuously carried in.

10 2. Description of the Related Art

 A technique is known in which in a case where the surface of glass plate or a substrate is polished, the glass plate is set on either one of a lower surface of an upper surface plate which is linearly reciprocatable and swingable and an upper
15 surface of a lower surface plate which undergoes rotary motion, one surface or both surfaces of the glass plate are polished between the upper surface plate and the lower surface plate.

 For example, as a conventional technique for continuously polishing the surface of a glass plate, an apparatus for
20 continuously polishing glass plates is known which comprises a polishing table for transferring the glass plate in one direction and a plurality of polishing tools arranged above the polishing table along the transferring direction of the glassplate. These polishing tools are disposed so as to undergo
25 eccentric rotary motion with respect to the glass plate by means

of eccentric shafts and such that rotational phases of adjacent ones of the polishing tools are inverted. (see JP-A-2-83150)

Furthermore, a polishing method for a plate-shaped body and a device for polishing a plate-shaped body using roll-shaped abrasive pads as polishing tools are known. A plate-shaped body such as a glass plate is moved so that the surface of the plate-shaped body moves in the same plane. A plurality of roll-shaped abrasive pads are arranged such that their axes are parallel to the surface of the plate-shaped body and are set in a direction substantially perpendicular to the moving direction of the plate-shaped body. The adjacent roll-shaped abrasive pads are rotated in opposite directions to each other, and are pressed against the plate-shaped body to polish the surface of the plate-shaped body. (see JP-A-2-256454)

Both of the inventions disclosed in the aforementioned publications JP-A-2-83150 and JP-A-2-256454 polish the glass plates continuously. With the former technique, however, since it is a method in which the glass plate placed on the polishing table is fixed by an abrasive cloth moistened with water, there is a possibility that positional offset can occur on the table due to polishing pressure, causing the glass plate to come into colliding contact with other glass plates arranged in a row. In addition, depending on the interval with the adjacent glass plate, the plurality of polishing tools are likely to come into colliding contact with each other at the time of moving over.

Hence, there has been a problem in that breaking or cracking can possibly occur at a peripheral edge of the glass plate.

In addition, the latter technique has a problem in that since roll-shaped abrasive pads are used, the area of contact
5 between the pad and the plate-shaped body is excessively small, so that the polishing efficiency is low.

SUMMARY OF THE INVENTION

In view of the above-described circumstances, an object
10 of the invention is to make it possible to efficiently polish the glass plates which are continuously carried in, to ensure stable finished quality, to safely and reliably effect the attachment and detachment of the glass plate, and to continuously polish the glass plates in conjunction with their transport
15 in a simple construction.

Namely, in accordance with a first aspect of the present invention there is provided a glass-plate polishing apparatus having: a plurality of abrasive disks juxtaposed each other and horizontally rotated; a track support extended in a
20 horizontal direction above the abrasive disks; a plurality of carriages traveling freely along the track support and having an upper surface plate with a vertically movable pressure plate for equipping the glass plate thereto; a plurality of transport carriers reciprocated along the track support and each
25 detachably coupled to the carriage; and a horizontally

reciprocating unit reciprocating parallel with the track support and pressing the upper surface plate against the abrasive disk.

In the present invention, according to a second aspect of the present invention, there is provided that a glass-plate polishing apparatus as set forth in the first aspect, wherein the track support includes a transport rail attached to one side surface thereof and a traveling rail attached to the other side surfaces thereof, the carriage travels along the traveling rail, the transport carrier reciprocates along the transport rail, and the horizontally reciprocating unit reciprocates parallel with the traveling rail.

In the present invention, according to a third aspect of the present invention, there is provided that a glass-plate polishing apparatus as set forth in the second aspect, further having: a movable support for contacting with end portions or cut portions of the track support, the traveling rail and the transport rail, the movable support being provided in a space on extensions of end portions of the track support as well as the traveling rail and the transport rail, or in a space portion extending from the track support when an intermediate portion thereof is cut; a traveling rail attached to the movable support; a support column provided so as to be spaced apart from a counter side of a side of the movable support where the traveling rail is disposed; a tilting unit for rotating the upper surface plate

suspended from the movable support by rotating an arm being perpendicular to the movable support axially, the arm being supported on the support column.

In the present invention, according to a fourth aspect
5 of the present invention, there is provided that a glass-plate polishing apparatus as set forth in any one of the first to third aspects wherein the track support is a substantially loop shape.

In the present invention, according to a fifth aspect
10 of the present invention, there is provided that a glass-plate polishing method having steps of: equipping a glass-plate to be polished onto an upper surface plate disposed on a carriage; coupling the carriage to a transport carrier detachably; transferring the transport carrier with carriage along a track
15 support disposed above a plurality of abrasive disks and positioning the transport carrier with carriage above one of the plurality of abrasive disks; positioning a horizontally reciprocating unit above the upper surface plate, the horizontally reciprocating unit reciprocating parallel with
20 the track support; pressing the upper surface plate against the abrasive disk by the horizontally reciprocating unit; and polishing the glass-plate on the abrasive disk.

In the present invention, according to a sixth aspect
of the present invention, there is provided that a glass-plate
25 polishing method as set forth in the fifth aspect, further

comprising steps of: contacting a movable support with end portions or cut portions of the track support, the movable support being provided in a space on extensions of end portions of the track support, or in a space portion extending from the track support when an intermediate portion thereof is cut; transferring the carriage to the movable support; rotating the upper surface plate suspended from the movable support by rotating an arm being perpendicular to the movable support; and releasing the glass-plate from the upper surface plate.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a fragmentary perspective view explaining the operation of an upper surface plate;

Fig. 2 is a side elevational view taken from a sectional side of a movable support which tilts;

Fig. 3 is a front elevational view of an overall assembly of this apparatus; and

Fig. 4 is a conceptual diagram of glass-plate polishing system of the present invention.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the invention, a plurality of upper surface plates which are capable of traveling and moving are provided above a plurality of juxtaposed abrasive disks, and the movement and polishing are effected continuously. As a result, the

polishing efficiency is increased, and the polished quality of the products polished by polishing under the same conditions using the plurality of juxtaposed abrasive disks becomes fixed. In addition, the glass-plate attaching and detaching operation
5 in which the glass plate is retained by and secured to the upper surface plate can be performed easily and safely by the tilting means.

Hereafter, a detailed description will be given of an embodiment of the invention with reference to the drawings.

10 Fig. 1 shows a fragmentary perspective view explaining the operation of an upper surface plate. Fig. 2 shows a side elevational view taken from a sectional side of a movable support which tilts. Fig. 3 shows a front elevational view of an overall assembly of this apparatus. Fig. 4 shows a conceptual diagram
15 of glass-plate polishing system of the present invention.

As shown in Fig. 3, a plurality of polishing tables 4, which are each provided with a horizontally rotatable abrasive disk 3 on a rotatively driving unit 2 mounted within a frame of a machine base 1, are arranged in series. An elongated track
20 support 9 having a square cross section is fixedly supported horizontally on brackets 6 respectively jutting out from a plurality of frames 5 provided uprightly in portal shapes in such a manner as to surround the plurality of polishing tables 4. The track support 9 is provided in such a manner as to extend
25 through the frames 5.

In addition, as shown in Fig. 1, two traveling rails 7 are provided horizontally at upper and lower positions on one side surface of the track support 9. Meanwhile, a transport rail 8 is secured to that side surface of the track support 9 which is away from its side where the traveling rails are provided.

A conventionally known carriage 10 is fitted to the two traveling rails 7 provided in parallel at upper and lower positions, in such a manner as to be capable of traveling freely. 10 The carriage 10 is fitted by being suspended so as to be assume a surface parallel to a side surface of the track support 9 by holding the traveling rails 7 between a plurality of pairs of wheels.

A coupling receiver 11 of a coupling means is secured 15 to an upper end of the carriage 10, and two bearing portions 12 and 12' are fixedly provided on the side surface of the suspended carriage 10 in such a manner as to project from its upper and lower positions. The bearing portions 12 and 12' axially support a shaft portion 13 passed therethrough, and 20 a fixed plate 14 fixed to the shaft portion 13 is supported by a pair of compression springs 15 respectively provided on both sides of the shaft 13.

Further, an upper surface plate 18 is fixedly provided on a lower end of the shaft portion 13. A pressure plate 17 25 is provided on a lower surface of the upper surface plate 18.

The pressure plate 17 is arranged such that unillustrated sheet-like foam (back pad) formed of felt, a porous urethane resin, or the like adheres to the lower surface of the upper surface plate 18 by a pressure sensitive adhesive double coated tape, so as to suck glass plate 16 by the surface tension and the like of water wetting the foam.

The upper surface plate 18 is lowered as the shaft portion 13 is lowered while the compression springs are compressed by a pressing force from above. When the pressing force is canceled, the upper surface plate 18 stops in a state in which the fixed plate 14 is pressed against the upper bearing portion 12 by the restoring force of the compression springs 15. Thus the upper surface plate 18 is held in such a manner as to be vertically movable.

Further, the upper surface plate 18 suspended from the carriage 10 is capable of reciprocatingly jog along the traveling rails extended horizontally, or of traveling and passing over the plurality of polishing tables 4 along the traveling rails 7.

Meanwhile, a transport carrier 21 which is self-propelling by a plurality of wheels is installed on the transport rail 8. The transport carrier 21 has a forwardly and reversely rotatable transport motor 19 mounted thereon, and a coupling cylinder 20 of the coupling means is secured to an upper surface of the transport carrier 21.

If a rod of the coupling cylinder 20 is inserted in a hole provided in the coupling receiver 11 disposed on the carriage 10, and the carriage 10 and the transport carrier 21 are coupled, the transport carrier 21 becomes a driving source
5 of the carriage 10. The transport carrier 21 which is driven by the transport motor 19 is capable of forwardly moving the carriage 10 by a length corresponding to the pitch between the abrasive disks 3 disposed below.

If the transport motor 19 is reversely rotated after the
10 coupling cylinder 20 is disengaged from the coupling receiver 11 by retracting the rod of the coupling cylinder 20, only the transport carrier 21 is self-propelled and retracts, and can returned to its original position, i.e., the position of its origin.

15 A beam 22 having a hollow square section is provided at a position above the shaft portion 13 of the upper surface plate 18 in such a manner as to extend horizontally in parallel with the track support 9 and by a substantially identical length. The beam 22 provides a horizontally reciprocating means 23 in
20 conformity with the pitches of the plurality of polishing tables 4 arranged below in a row.

The horizontally reciprocating means 23 is constructed as follows: A rack 24 is provided on a side surface of the beam 22, and a pair of linear rails 25 are provided on a bottom
25 surface of the beam 22 in such a manner as to be spaced apart

from each other in a parallel state. A pressing cylinder 28 for pressing a top portion of the shaft portion 13 of the upper surface plate 18 is provided in such a manner as to be suspended from a lower surface of a horizontally reciprocating plate 26 to which a pair of guides 27 for fitting loosely over the linear rails 25 and movable along the linear rails are secured.

Normally, the cylinder rod of the pressing cylinder 28 and the shaft portion 13 are in a disengaged state. However, if the cylinder rod is extended by the actuation of the pressing cylinder 28, the state is such that the distal end of the cylinder rod downwardly presses the top portion of the shaft portion 13 in such a manner as to cover it, pressing the upper surface plate.

A horizontally reciprocating motor 30 which is forwardly and reversely rotatable is mounted on a side end of the horizontally reciprocating plate 26 by means of a mounting bracket 29, and a pinion 31 disposed so as to mesh with the rack 24 is secured to a shaft end of the horizontally reciprocating motor 30. If the horizontally reciprocating motor 30 is rotated, the horizontally reciprocating plate 26 undergoes linear motion. Thus, as the horizontally reciprocating motor 30 is forwardly or reversely rotated, the horizontally reciprocating means 23 is capable of reciprocating the pressing cylinder 28 along the linear rails 25 provided on the lower surface of the beam 22.

The track support 9 together with the transport rail 8 and the traveling rails 7 extends linearly in a row over the polishing tables 4. At its both ends, i.e., at both outermost ends of the polishing tables 4 arranged in series, the track support 9 and the traveling rails 7 are curved in an arcuate form with a curvature allowing the carriage 10 to pass, so as to form an endless loop as shown in Fig. 4, thereby making it possible to cause the carriage 10 to travel in a circulating manner.

The track support 9, the traveling rails 7, and the transport rail 8 are cut at two midway portions of the track support 9 and the traveling rails 7 in the endless loop form. A movable support 33, to which two traveling rails 7 are attached to transport the carriage 10 for suspending and supporting the upper surface plate 18, is newly inserted separately from the track support 9 into each of the short space portions thus formed by cutting removal.

The movable support 33 is arranged such that the side surface of the movable support 33 is secured in the form of a balance through a bracket 36 to a shaft 35 provided rotatably through a bearing on a support column 34 provided uprightly in such a manner as to be spaced apart on the side of the movable support 33 away from its side where the traveling rails 7' are provided. An end of an arm 37 provided with a balancer 40 is connected to a rod 38 of a tilting cylinder 39 provided adjacent

to the support column 34 and constituting a tilting means 32. If the rod 38 of the tilting cylinder 39 is vertically moved, the arm 37 rotates in the direction of arrows shown in Fig. 2. As the movable support 33 integral with the arm 37 is tilted, the upper surface plate 18 suspended from and fitted to the traveling rails 7' by means of the carriage 10 is also tilted simultaneously to assume a slanting attitude, and shows a tilted position as seen in a side view. The tilting means 32 in Fig. 4 shows tilted situation.

10 Hereafter, a description will be given of the operation in accordance with the invention.

The carriage 10, which is at a standstill with the glass plate 16 retained by and secured to the pressure plate 17 at the position of the movable support 33, is moved to the position of the transport carrier 21 at a standstill by being retracted in advance to a predetermined position by the reverse rotation of the transport motor 19.

Immediately thereafter, the coupling cylinder 20 provided on the transport carrier 21 is actuated to extend its cylinder rod. The cylinder rod is then fitted to the coupling receiver 11 provided on the carriage 10, and is thereby coupled with the transport carrier 21. As the transport motor 19 is forwardly rotated, the transport carrier 21 moves forward together with the carriage 10 to a predetermined position above the abrasive disk 3 being rotated on the polishing table 4, and stops. As

the coupling cylinder 20 is returned at that stop position,
the transport carrier 21 and the carriage 10 are separated.
As the transport motor 19 is reversely rotated, the transport
carrier 21 retractingly moves again along the transport rail
5 8, stops at a predetermined position, and waits for an ensuing
carriage 10.

Meanwhile, the upper surface plate 18 suspended from the
carriage 10 stopped above the abrasive disk 3 follows the
operation of the horizontally reciprocating means 23 fitted
10 to the upper beam 22. First, as the horizontally reciprocating
motor 30 forwardly and reversely rotated, the horizontally
reciprocating plate 26 reciprocates along the linear rails 25,
and the cylinder rod is lowered by the actuation of the pressing
cylinder 28. The distal end of the cylinder rod is then brought
15 into contact with the top of the upper end portion of the shaft
portion 13 in such a manner as to cover it, and presses it so
as to lower the shaft portion 13 being supported by the springs
15. While the pressure plate 17 supporting the glass plate
16 integral with the shaft portion 13 is being horizontally
20 reciprocated, if the pressure plate 17 is lowered and is brought
into pressure contact with the abrasive disk 3 being rotated,
the surface of the glass plate 16 in contact with the abrasive
disk 3 is polished by the rotation of the abrasive disk 3 on
which a liquid film of a polishing fluid is formed, as well
25 as the reciprocating motion and the lowering and pressing of

the upper surface plate 18.

The glass plate 16 is polished for a fixed time while pressing the upper surface plate 18 against the abrasive disk 3 being rotated and by horizontally reciprocatably jogging the upper surface plate 18 along the traveling rails 7 by following the forward and reverse rotation of the horizontally reciprocating motor 30, the upper surface plate 18 is raised and is disengaged from the abrasive disk 3 by the returning of the pressing cylinder 28 and the stopping of the horizontally reciprocating motor 30.

Next, the carriage 10 at a standstill on the traveling rails 7 is coupled to the next transport carrier 21 waiting next on the transport rail 8. As the transport motor 19 is rotated, the carriage 10 moves forward again along the traveling rails together with the transport carrier 21.

At the position where the carriage 10 is subsequently stopped, an ensuing horizontally reciprocating means 23 is on standby at an upper position, while an ensuing abrasive disk 3 is disposed at a lower position. The glass plate 16 is polished again by the adjacent ensuing abrasive disk 3 by the returning motion of the coupling cylinder 20 and the operation of the pressing cylinder 28 and the horizontally reciprocating motor 30. Thus the glass plate 16 is consecutively polished by being moved to the juxtaposed abrasive disks 3. On the rear side of the line, the glass plate 16 retained by and secured to the

upper surface plate 18 suspended through the ensuing carriage 10 is simultaneously polished by repeating polishing and transport. Thus, the plurality of upper surface plates 18 consecutively effect polishing finish.

5 After passing the plurality of abrasive disks 3 and upon completion of polishing, the carriage 10 at a standstill short of the movable support 33 is forwardly moved manually or automatically onto the traveling rails 7' of the movable support 33. While the carriage 10 is at a standstill on the movable support 33, if the tilting cylinder 39 of the tilting means 32 is actuated, the rod 38 is lowered, and the arm 37 is rotated with the shaft 35 serving as an axis. The movable support 33 secured to the distal end of the arm 37 also rotates in a following manner. The upper surface plate 18 which is fitted to the rails 10 7' through the carriage 10 also moves in a following manner. Thus, the glass plate 16 adhering to the pressure plate 17 of the upper surface plate 18 is also set in a slanting state, and shows its appearance into the vision of an operator.

15 While that state is being maintained, the glass plate 20 16 for which polishing finish has been completed is removed, and glass plate to be newly polished is fitted. Then, as the tilting cylinder 39 is returned, and ends of the movable support 33 are brought close to ends of the track support 9 and assume a single straight line. The upper surface plate 18 suspended 25 from the carriage 10 is manually moved forward to the

predetermined position on the traveling rails 7, and waits for coupling with the transport carrier 21 at a predetermined position. After coupling, the above-described operation is repeated.

5 If the plurality of carriages 10 fitted to the traveling rails 7 are selectively provided at regular intervals with unillustrated dressing plates for clearing the loading of the abrasive disks 3 instead of the upper surface plates 18, the loading of the polishing surfaces of the plurality of abrasive
10 disks 3 can be cleared by the operation similar to that of the upper surface plates 18. Hence, the abrasive disks 3 can be consecutively regenerated, and satisfactory polishing finish surfaces can be maintained constantly.

 According to the invention, the efficiency is increased
15 as the substrates such as glass plates are continuously polished while being transported to a plurality of abrasive disks. In addition, the finished quality of polishing becomes constantly fixed. Since the tilting means is provided, the attachment and detachment of the glass plate can be performed safely and
20 reliably, and the object of the invention can be attained in a very simple construction. Thus, the advantages of the invention are appreciable.

What is claimed is:

1. A glass-plate polishing apparatus comprising:
a plurality of abrasive disks juxtaposed each other and
5 horizontally rotated;
a track support extended in a horizontal direction above
the abrasive disks;
a plurality of carriages traveling freely along the track
support and having an upper surface plate with a vertically
10 movable pressure plate for equipping the glass plate thereto;
a plurality of transport carriers reciprocated along the
track support and each detachably coupled to the carriage; and
a horizontally reciprocating unit reciprocating parallel
with the track support and pressing the upper surface plate
15 against the abrasive disk.

2. A glass-plate polishing apparatus as set forth in
claim 1, wherein the track support includes a transport rail
attached to one side surface thereof and a traveling rail
20 attached to the other side surfaces thereof, the carriage travels
along the traveling rail, the transport carrier reciprocates
along the transport rail, and the horizontally reciprocating
unit reciprocates parallel with the traveling rail.

25 3. A glass-plate polishing apparatus as set forth in

claim 2, further comprising:

a movable support for contacting with end portions or cut portions of the track support, the traveling rail and the transport rail, the movable support being provided in a space
5 on extensions of end portions of the track support as well as the traveling rail and the transport rail, or in a space portion extending from the track support when an intermediate portion thereof is cut;

a traveling rail attached to the movable support;

10 a support column provided so as to be spaced apart from a counterside of a side of the movable support where the traveling rail is disposed;

a tilting unit for rotating the upper surface plate suspended from the movable support by rotating an arm being
15 perpendicular to the movable support axially, the arm being supported on the support column.

4. A glass-plate polishing apparatus as set forth in any one of claims 1 to 3 wherein the track support is a
20 substantially loop shape.

5. A glass-plate polishing method comprising steps of:
equipping a glass-plate to be polished onto an upper surface plate disposed on a carriage;

25 coupling the carriage to a transport carrier detachably;

transferring the transport carrier with carriage along
a track support disposed above a plurality of abrasive disks
and positioning the transport carrier with carriage above one
of the plurality of abrasive disks;

5 positioning a horizontally reciprocating unit above the
upper surface plate, the horizontally reciprocating unit
reciprocating parallel with the track support;

 pressing the upper surface plate against the abrasive
disk by the horizontally reciprocating unit; and

10 polishing the glass-plate on the abrasive disk.

6. A glass-plate polishing method as set forth in claim
5, further comprising steps of:

 contacting a movable support with end portions or cut
15 portions of the track support, the movable support being provided
in a space on extensions of end portions of the track support,
or in a space portion extending from the track support when
an intermediate portion thereof is cut;

 transferring the carriage to the movable support;

20 rotating the upper surface plate suspended from the
movable support by rotating an arm being perpendicular to the
movable support; and

 releasing the glass-plate from the upper surface plate.