(54) Title: APPARATUS FOR PROCESSING OF GLASS PLATES

(57) Abstract: Apparatus (14) for grinding the edges of glass sheets comprising supporting means (20) designed to support a sheet (22) being machined, and at least one machining head (18) provided with grinding means (18). The apparatus (14) comprises moreover movement means designed to move said machining heads (16) and said supporting means (20) relative to each other. The apparatus is characterized in that the grinding means (18) comprise at least two grinding wheels (28, 30, 32) with parallel and spaced axes of rotation. The grinding wheels (28, 30, 32) are designed to perform machining in the direction of relative movement of the machining head (16) along the edge of the sheet (22).
"Apparatus for processing of glass plates"

DESCRIPTION

The present invention relates to an apparatus for processing of glass plates.

In particular, the present invention relates to an apparatus for grinding the side edges of glass or laminated glass sheets.

In the present description reference shall be made to glass sheets, although it is clearly understood that such a reference is not intended to be limiting since the principles of the present invention may be applied similarly also to rigid sheets of material other than glass, as will become clear in the continuation of the present description.

Many types of machines for performing the grinding of the edges of glass sheets are known, said operation being referred to by the technical term "arrising". This operation is composed of two or three steps:

- a pass for rough-machining the edge in order to determine the correct size of the sheet;
- a finishing pass accompanied by beveling of one arris of the edge; and
- if necessary, a finishing pass accompanied by beveling of the other arris of the edge.

These three machining operations are carried out using three types of grinding wheel: a first rough-grinding wheel, a second grinding wheel used for beveling the first arris of the edge, and a third grinding wheel used for beveling the second arris of the edge.

In the machines which are most commonly used the sheet is positioned so as to lie slightly inclined relative to the vertical and is kept in position by means of a bottom and rear support structure.

The bottom support structure may comprise for example a series of rollers on which the sheet may travel or slide, depending on whether or not the rollers are designed to be rotated about their axes by the movement of the sheet. The sheet is usually gripped by a gripping device which positions it on top of the rollers.

The rear support structure may consist for example of a simple support, in the case of apparatuses for machining a static sheet, or a series of roller wheels in the case of an apparatus for machining a moving sheet.

The arrangement with the sheet vertical is advantageous compared to the arrangement with the sheet horizontal, in particular when the sheets are very large. In fact, horizontally arranged sheets occupy too much of the floor area of the production plant.

In order to explain clearly the way in which machining of a sheet with an apparatus according to the prior art is carried out, reference will be made for the sake of simplicity to a rectangular shaped sheet. Considering a rectangular sheet of glass arranged in the vertical position, the following may be defined:
a first substantially vertical edge, which, when the sheet enters the machining zone, is
directed towards the apparatus;
- a second edge, opposite to the first edge, and therefore also substantially vertical;
- a third edge or bottom edge, i.e. a substantially horizontal edge, which during
working conditions is directed towards the ground; and
- a fourth edge or top edge, opposite to the bottom edge, and therefore also
substantially horizontal.

Moreover, in this description, the terms "horizontal" and "vertical" will be used to
indicate respectively: a direction substantially parallel to the position of the apparatus on the
ground and a direction substantially perpendicular to the position of the apparatus on the
ground.

An example of an apparatus according to the prior art has one or more machining
heads equipped with a rotating grinding wheel. The machining head may be moved in the
vertical direction along a guide. In this type of apparatus, in order to perform arrising along a
vertical edge of the sheet, the machining head is moved along the edge so that the grinding
wheel runs along the edge, while, in order to machine the horizontal edges, the sheet is
moved in the horizontal direction, while the machining head is kept stationary in the highest
position or in the lowest position in order to machine the top edge or the bottom edge,
respectively.

In the case where the glass sheet is shaped or has curved profiles, the movements of
the sheet and the machining head may be interpolated by means of a control unit so that the
grinding wheel may follow curved paths.

Depending on the type of machining required, the machining cycle described may be
repeated two or three times, depending on whether it is required to bevel only one arris of the
edge or instead both arrises of the edge.

In the prior art apparatuses with a plurality of grinding stations, in which manipulator
devices, for example of the sucker type, are provided in order to rotate the sheet through 90°
or 180° before passing to the next grinding station, are also known.

The apparatuses of the prior art, although widely used and popular, are not without
drawbacks.

For example, the time taken to complete a full cycle for machining the edges of a
sheet, comprising for example three passes, is such that only a small number of sheets may be
machined in a working day and therefore the productivity of an apparatus of this type is very
low.

The prior art has attempted to solve this problem, for example by providing a
grinding tool which, with a single pass, performs rouging and finishing of the entire edge of
the sheet with the formation of the bevel on one or both the arrises of the edge.
The advantage achieved in terms of time, however, results in a very low speed of movement of the grinding wheel relative to the edge of the sheet and excessive wear of the tool which results in the need for frequent replacement thereof.

Moreover, during handling of the sheet in order to rotate it through 90° or 180°, it is possible that the glass may splinter or be scratched.

The object of the invention is therefore to overcome at least partially the drawbacks of the prior art.

A first task of the present invention is therefore to provide an apparatus which is able to reduce the production time and which at the same time is able to perform optimum machining of the sheet edges.

A second task of the present invention is to provide an apparatus which is able to achieve a high productivity without causing premature wear of the tool.

A further task is that of providing an apparatus which handles the sheets as little as possible so as to avoid damaging them during these operations, for example causing them to be scratched or to splinter.

The object and tasks are achieved with an apparatus according to the attached claims.

In particular, the object and the tasks are achieved with an apparatus for grinding the edges of glass sheets comprising means suitable for supporting a sheet being machined and at least one machining head provided with grinding means. The apparatus also comprises relative movement means which are designed to move the machining head and the sheet relative to each other. The apparatus is characterized in that the grinding means comprise at least two grinding wheels arranged alongside each other and designed to perform machining in the direction of movement of the machining head along the edge of the sheet.

The characteristic features and advantages of an apparatus according to the present invention will become clearer from the description below of possible embodiments, provided solely by way of a non-limiting explanation, with reference to the accompanying drawings, in which:

Fig. 1 shows a schematic perspective view of a portion of an apparatus according to the present invention, during machining of a sheet;

Fig. 2 shows a schematic perspective view of a portion of an alternative embodiment of apparatus according to the present invention, during machining of a sheet;

Fig. 3 shows a schematic side view of an apparatus according to the present invention, during machining of a sheet;

Figs. 4 and 5 show two schematic perspective view of a part of an apparatus according to a third embodiment of the present invention, during machining of a sheet;

Fig. 6 shows a schematic perspective view, on a larger scale, of a component of the apparatus according to the present invention;
Figs. 7 and 8 show in schematic form two operating configurations of a possible embodiment of an apparatus according to the present invention;

Figs. 9 to 12 show a machining sequence which may be carried out with an apparatus according to the present invention;

Fig. 13 shows in schematic form an operating configuration of a possible embodiment of an apparatus according to the present invention; and

Figs. 14A to 14C show a possible embodiment of the tools designed to be used with the apparatus according to the present invention.

Figure 1 shows in schematic form an apparatus according to the present invention, denoted generally by the reference number 14.

The apparatus 14 according to the present invention comprises supporting means 20 designed to support a sheet 22 being machined, and at least one machining head 16 provided with grinding means 18.

The sheet 22 being machined may be supported in a substantially horizontal position or a substantially vertical position. Obviously other positions or intermediate positions between a horizontal and vertical position are also possible and the principles of the present invention may in any case be applied to them, as will be clear to the person skilled in the art from the description below.

With reference to the embodiment shown for example in Figure 1, the supporting means 20 may comprise a bottom support structure 24 and a rear support structure 26.

The bottom support structure 24 may comprise for example a series of rollers 124 (which will also be indicated by the reference number 24) on which a sheet 22 may travel or slide. The rollers 24 may be free to rotate about their axis or may be fixed.

According to one possible embodiment of the present invention, at least some of the rollers 124 may be driven, i.e. equipped with one or more driving systems (not shown), so as to allow displacement of a sheet 22.

The rear support structure 26, still with reference to the embodiment shown in Figure 1, may comprise a series of roller wheels 26 (which will also be indicated by the reference number 26) designed to rotate so as to cause a sheet 22 to travel along a surface defined by the said roller wheels 26.

In accordance with a possible embodiment of the present invention, the roller wheels 26 may be aligned in the vertical and/or horizontal direction. The rollers wheels 26 may be advantageously equally spaced from each other in the vertical direction and horizontal direction.

The plurality of roller wheels 26 defines a travel surface over which a sheet 22 may be moved.

In accordance with an alternative embodiment of the present invention, the rear
support structure 26 may be formed, for example, by supporting points which are lined or formed by material suitable for allowing sliding of a sheet 22 without damaging it, such as felt.

With reference to the embodiment shown in Figure 1, the grinding means 18 comprise at least two grinding wheels 28, 30 suitable for performing machining in the direction of movement of the machining head 16 along the edge of the sheet 22.

In accordance with the embodiment of the present invention shown in Figure 1, the first grinding wheel 28 which encounters the edge of the sheet 22 in the machining direction is a rough-grinding wheel, while the second grinding wheel 30 is a finishing wheel and is designed to provide a bevel on one of the arrises of the edge of the sheet 22.

Figure 2 shows instead the preferred embodiment of the grinding means 18 according to the present invention, in which the grinding means 18 comprise three grinding wheels 28, 30, 32 arranged alongside each other and designed to perform machining in the direction of relative movement of the machining head 16 along the edge of the sheet 22.

The grinding wheels 28, 30, 32 are therefore designed to machine in sequence the edge of the sheet 2 during the movement along the edge thereof.

In accordance with a possible embodiment of the present invention, the first grinding wheel 28 which encounters the edge of the sheet 22 is a rough-grinding wheel, the second grinding wheel 30 is a finish-grinding wheel designed to perform a first bevel on one arris of the edge of the sheet, and the third grinding wheel 32 is a finish-grinding wheel designed to perform a second bevel on a second arris of the edge of the sheet.

Figures 14A-14C show a possible embodiment of the grinding wheels 28, 30, 32 designed to be used in an apparatus according to the present invention. In particular, Figure 14A shows a rough-grinding wheel with a substantially rectilinear profile 34. Figures 14B and 14C show two examples of embodiment of the finishing and shaping grinding wheels which may be used to perform finishing and beveling of the arrises of the edge of the sheet. These grinding wheels have in fact a profile 34 partially inclined with respect to the axis of rotation, precisely in order to provide the bevel on the arris of the edge.

Since these types of grinding wheel are well-known to the person skilled in the art, they will not be described further.

As can be clearly seen in Figure 6, the machining head 16 comprises a frame 36 on which the grinding wheels 28, 30, 32 are mounted.

According to a first embodiment, each grinding wheel 28, 30, 32 is provided with an associated drive motor 38, 40, 42 (these reference numbers are indicated only in Figure 6 so as not to complicate the figures).

Alternative embodiments are also possible where a drive motor is used in common for two or more grinding wheels (this embodiment is not shown in the attached figures).

The drive motor for the grinding wheels may be of the type known per se to the
person skilled in the art, for example powered electrically by means of a suitable connection (not shown).

According to a preferred embodiment of the present invention, each grinding wheel 28, 30, 32 is provided with its own drive motor 38, 40, 42, on the shaft of which the respective grinding wheel 28, 30, 32 is directly mounted via fixing means. The fixing means will not be further described since they are known per se to the person skilled in the art.

It is also possible for mechanical transmissions to be provided, in the case where the axis of rotation of the grinding wheels does not correspond to the axis of rotation of the output shaft of the drive motor.

In accordance with a possible embodiment of the present invention, at least one of the finishing and shaping grinding wheels 30, 32 may be movable in a direction parallel to its axis of rotation so as to be able to machine sheets of varying thickness.

In this way, by maintaining the position of the rough-grinding wheel 28, it is possible to perform finishing and shaping of sheets of varying thickness without having to replace the finishing and shaping grinding wheels.

The movement of the finishing and shaping grinding wheels may be achieved in a manner known per se to the person skilled in the art, manually or automatically.

Advantageously, both the finishing and shaping grinding wheels 30, 32 may be movable.

In accordance with a first embodiment of the present invention, shown for example in Figure 6, the frame 36 is rigid and designed not to allow a relative movement of the grinding wheels.

In the embodiment shown in the aforementioned figure, the grinding means 18 comprise three grinding wheels 28, 30, 32, in which:

- one grinding wheel 30 is provided on a central element 44 of the frame;
- one grinding wheel 28 is provided on a first lateral support element 46 on a first side of the central element 44; and
- one grinding wheel 32 is provided on a second lateral support element 48 on a second side of the central element 44.

As can be seen in the attached figures, the first grinding wheel 28 which encounters the edge of the sheet 22 may be provided on a first lateral support element 46; the second grinding wheel 30 which encounters the edge of the sheet 22 may be provided on the central element 44; and the third grinding wheel 32 may be provided on the second lateral support element 48.

As mentioned above, alternative embodiments are also possible where only two grinding wheels are present and consequently the frame may comprise at least one lateral support element (see in this respect the embodiment shown in Figure 1).
According to an alternative embodiment of the present invention, shown for example in Figures 7 and 8, the frame comprises a central element 44 on which a first grinding wheel 28 is provided, and at least one lateral support element 46, 48 which is movable with respect to the central element 44 and on which a grinding wheel 30, 32 is provided.

Advantageously, the frame 36 comprises a central element 44 on which a grinding wheel 30 is provided, a first lateral support element 46 on which a grinding wheel 28 is provided, and a second lateral support element 48 on which a third grinding wheel 32 is positioned, wherein at least one of the two lateral support elements 46, 48 is movable with respect to the central element 44.

In accordance with a possible embodiment of the present invention, the lateral support element 46, 48 is designed to rotate about an axis 50 of a hinge formed between at least one lateral support element 46, 48 and the central element 44. Advantageously the axis 50 of the hinge may be parallel to the axes of rotation of the grinding wheels 28, 30, 32.

In accordance with one possible embodiment of the present invention, the axes of rotation 50 of the lateral support elements 46, 48 coincide.

Among the advantages which can be achieved with a machining head 16 provided with movable lateral support elements 46, 48, there is the possibility of excluding at least one of the associated grinding wheels 28, 32 from the machining operation and using the remaining grinding wheel or wheels.

A drive system may be provided for the movement of the projecting elements 46, 48, regulating the movement of said projecting elements 46, 48 via suitable means (not shown).

The frame 36 of the machining head 16 is provided with means 54 for performing fixing to the structure of the apparatus 14 according to the present invention.

In accordance with a possible embodiment of the present invention, the at least one machining head 16 may be designed to rotate about an axis substantially parallel to one of the axes of rotation of the grinding wheels 28, 30, 32.

The machining head 16 may be designed to rotate about an axis coinciding with the axis of rotation of the grinding wheel 30 positioned on the central element 44.

In accordance with a possible embodiment of the present invention, the machining head 16 may be designed to rotate about an axis substantially perpendicular to the position in which the sheet being machined is arranged.

The machining head 16 may therefore be designed to carry out machining of the edge of a sheet in a plurality of machining directions.

In accordance with a possible embodiment of the present invention, the machining head is provided with a head driving system 52 which, under the control of the control unit (not shown), adjusts the rotation and therefore the direction of the machining head 16.

The apparatus 14 according to the present invention may be of the type with:
- fixed sheet 22 and at least one moving machining head 16;
- moving sheet 22 and at least one fixed machining head 16; or
- moving sheet 22 and at least one moving machining head 16.

In order to illustrate all the types of apparatus 14 in a single description, reference will be made for the sake of simplicity to generic movement means designed to move the sheet 22 and/or the at least one machining head 16 provided with grinding means 18, relative to each other.

In a first embodiment of the present invention, the sheet 22 is fixed and the at least one machining head 16 is designed to be moved in machining directions along the edge of a sheet 22.

An embodiment of this type is shown in Figure 3. According to this embodiment, the relative movement means comprise a vertical guide 56 for the machining head 16, designed to be displaced in the horizontal direction, along a second guide 58. In this embodiment the machining head 16 is therefore designed to be displaced in the vertical direction along the vertical guide 56 and in the horizontal direction as a result of sliding of the vertical guide 56 on the second guide 58.

Figures 4 and 5 show an alternative embodiment of the present invention comprising two machining heads 16, 161. For the sake of simplicity, parts of the second machining head 161 substantially corresponding to parts of the first machining head 16 will be indicated by the same reference number followed by the suffix 1.

In accordance with a possible embodiment of the present invention, the apparatus comprises:
- two machining heads 16, 161, wherein a first machining head 16 is mobile, and the second machining head 161 is static, and
- means 62 designed to move a sheet in the horizontal direction.

Advantageously, the first machining head may be provided on a vertical guide 56 and may be designed to move along it in a vertical direction.

In this particular embodiment, the vertical guide may be static, since means 62 designed to move a sheet in the horizontal direction are provided.

In order to understand the mode of operation of this embodiment of the apparatus, a possible operating sequence will be described, taking into consideration a simplified sheet as described above.

The sheet is situated on the entry side of the apparatus in a substantially vertical position. The machining head 16 is moved in the vertical direction along the respective guide 56 so that the grinding wheels 28, 30, 32 carry out machining of the first edge of the sheet. During this machining operation, the machining head is directed so that the grinding wheels are aligned in a substantially vertical direction.
Then, the machining head 16 is rotated through 90° so that its grinding wheels 28, 30, 32 are oriented in a substantially horizontal direction and are directed towards the fourth edge of the sheet (top edge). The machining head is then displaced in the vertical direction towards the fourth edge, so that its grinding wheels 28, 30, 32 come into contact with the fourth edge.

The second machining head 161 is then moved towards the third edge of the sheet (bottom edge) so that its grinding wheels 281, 301, 321 come into contact with the third edge. As can be seen in Figures 4 and 5, the distance between the grinding wheels 281, 301, 321 of the second machining head 161 may allow the rollers of the bottom support structure 24 to pass between them.

With the machining heads 16, 161 and grinding wheels in operation, the sheet is displaced in the horizontal direction so that the third and fourth edges undergo machining.

Once machining has been completed, the machining heads are moved away from the respective edges of the sheet which have just been machined.

The first machining head is then rotated through a further 90°, so that its grinding wheels are aligned in a substantially vertical direction and directed towards the second edge of the sheet.

The machining head 16 is then moved towards the second edge of the sheet so that its grinding wheels 28, 30, 32 come into contact with said edge.

When the sheet stationary, the machining head is then moved along the vertical guide 56 downwards, so that the second edge of the sheet undergoes machining.

Movement of the machining head 16 along the vertical guide 56 may be performed for example by means of a drive system 60 and means designed to convey the machining head 16 along the vertical guide 48.

As shown in the example of Figure 5, in accordance with a possible embodiment of the present invention, the means 62 designed to move the sheet in the horizontal direction may comprise, for example, a gripping device designed to be fixed to the surface of the sheet. Advantageously the means 62 may comprise a sucker device connected to a suction plant and able to be controlled so as to adhere to the surface of the sheet.

The gripping device may slide along guide means 58 owing to a drive system (not shown) of the type known per se to the person skilled in the art.

The differences and advantages of the present invention compared to the prior art are therefore now clear.

Firstly, the rotating machining head 16 allows the machining of all the edges of the sheet, without the need for successive repositioning of the sheet.

Moreover, a sheet may undergo complete machining, being understood as rough-machining and grinding of both the arrises of an edge, with a single pass of the machining
head along the edge of the sheet.

Owing to the provision of second static machining head, it is possible to reduce the machining cycle time, with significant savings in terms of the resources which are used.

Moreover, as a result of the system for excluding the grinding wheels of the head with movable lateral support elements, it is possible to exclude one or more grinding wheels from machining and also perform the machining of curved corner joining lines and curved and shaped glass as in the conventional system.

The movement of the sheet and the at least one machining head may be controlled by a programmable control unit which, interpolating the various movements, may allow the execution of curved machining paths.

Advantageously, during the machining of curved sections, at least one grinding wheel may be excluded from machining.

In accordance with a possible embodiment of the present invention, it is also possible to provide an automatic tool changing system combined with an associated tool magazine. At least one of the grinding wheels may be, for example, replaced by a tool of a different type, such as a drill or a milling cutter, in order to machine various forms, such as a bore hole, a pocket or a step.

As will now be clear to the person skilled in the art, the speed of machining of a sheet is nearly twice that possible with an apparatus according to the prior art. This is due to the fact that the machining operations are performed with a single pass and also because the presence of the second machining head allows simultaneous grinding of two edges of the sheet.

Moreover, the simultaneous use of different types of grinding wheels reduces the required number of tool changing operations and reduces the wear of the said tools.

The person skilled in the art, in order to satisfy specific requirements, may make modifications to the embodiments described above and/or replace the parts described with equivalent parts, without thereby departing from the scope of the accompanying claims.

For example, it is possible to use the apparatus according to the present invention in the manner of a normal machine according to the prior art, with operation of one grinding wheel at a time, excluding the other wheels by moving the corresponding lateral support element or disengaging the wheels from the machining head.
CLAIMS

1. Apparatus (14) for grinding the edges of glass sheets comprising supporting means (20) designed to support a sheet (22) being machined, and at least one machining head (18) provided with grinding means (18); said apparatus (14) comprising moreover movement means designed to move said machining heads (16) and said supporting means (20) relative to each other;

characterized in that said grinding means (18) comprise at least two grinding wheels (28, 30, 32) with parallel and spaced axes of rotation, said grinding wheels (28, 30, 32) being designed to perform machining in the direction of relative movement of the machining head (16) along the edge of the sheet (22).

2. Apparatus (14) according to Claim 1, characterized in that the supporting means (20) are designed to support a sheet (22) being machined in a substantially vertical position.

3. Apparatus (14) according to the preceding claim, characterized in that the supporting means (20) comprise a bottom support structure (24) and a rear support structure (26).

4. Apparatus (14) according to any one of the preceding claims, characterized in that the first grinding wheel (28) which encounters the edge of the sheet (22) in the machining direction, is a rough-grinding wheel, while the second grinding wheel (30) is a finishing wheel and is designed to form a bevel on one of the arrises of the edge of the sheet (22).

5. Apparatus (14) according to Claim 1, characterized in that the grinding means (18) comprise three grinding wheels (28, 30, 32) arranged alongside each other and designed to perform machining in the direction of relative movement of the machining head (16) along the edge of the sheet (22).

6. Apparatus (14) according to Claim 5, characterized in that the first grinding wheel (28) which encounters the edge of the sheet (22) is a rough-grinding wheel, the second grinding wheel (30) is a finish-grinding wheel designed to perform a first bevel on one arris of the edge of the sheet, and the third grinding wheel (32) is a finish-grinding wheel designed to perform a second bevel on a second arris of the edge of the sheet.

7. Apparatus (14) according to either one of Claims 5 and 6, characterized in that each grinding wheel (28, 30, 32) is provided with its own drive motor (28, 30, 32).

8. Apparatus (14) according to any one of the preceding claims, characterized in that the machining head (16) comprises a frame (36) on which the grinding wheels (28, 30, 32) are mounted, said frame (36) being rigid and designed not to allow a relative movement of the grinding wheels (28, 30, 32).

9. Apparatus (14) according to any one of Claims 1 to 7, characterized in that the grinding means (18) comprise three grinding wheels (28, 30, 32), wherein:

- one grinding wheel (30) is provided on a central element (44) of a frame (36);
- one grinding wheel (28) is provided on a first lateral support element (46) on a first side of the central element (44); and

- one grinding wheel (32) is provided on a second lateral support element (48) on a second side of the central element (44), wherein at least one of the two lateral support elements (46, 48) is movable with respect to the central element (44).

10. Apparatus (14) according to the preceding claim, characterized in that each lateral support element (46, 48) is designed to rotate about an axis (50) of a hinge formed between at least one lateral support element (46, 48) and a central element (44).

11. Apparatus (14) according to the preceding claim, characterized in that the axis (50) of the hinge is parallel to the axes of rotation of the grinding wheels (28, 30, 32).

12. Apparatus (14) according to any one of the preceding claims, characterized in that the at least one machining head (16) is designed to rotate about an axis substantially parallel to one of the axes of rotation of the grinding wheels (28, 30, 32).

13. Apparatus (14) according to the preceding claim, characterized in that the machining head is provided with a head drive system (52) which, under the control of a control unit, adjusts the rotation and therefore the direction of the machining head (16).

14. Apparatus (14) according to any one of the preceding claims, characterized in that it comprises two machining heads (16, 161), wherein a first machining head (16) is movable along a vertical guide, and a second machining head (161) is static, and means (62) designed to move a sheet in the horizontal direction.

15. Apparatus (14) according to Claim 6, characterized in that at least one of the finishing and shaping wheels (30, 32) can be moved in a direction parallel to its axis of rotation so as to be able to machine sheets of varying thickness.
### A. CLASSIFICATION OF SUBJECT MATTER

**INV.** B24B27/00  B24B9/10  ADD.

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)

- B24B

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

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Relevant to claim No.</th>
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<td>X</td>
<td>EP 1 914 039 A1 (GLASTON ITALY SPA [IT]) 23 April 2008 (2008-04-23) paragraphs [0017] - [0041]; figures</td>
<td>1,5-8, 13,15, 9-12,14</td>
</tr>
<tr>
<td>Y</td>
<td>WO 2014/063172 A1 (LISEC AUSTRIA GMBH [AT]) 1 May 2014 (2014-05-01) figure 1</td>
<td>2,3</td>
</tr>
<tr>
<td>Y</td>
<td>EP 1 060 833 A1 (CORNING INC [US]) 20 December 2000 (2000-12-20) paragraph [0009]; figure 1</td>
<td>4</td>
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### Date of the actual completion of the international search

- **8 June 2016**

### Date of mailing of the international search report

- **16/06/2016**

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- **Gelder, Klaus**
**INTERNATIONAL SEARCH REPORT**

**DOCUMENTS CONSIDERED TO BE RELEVANT**

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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>EP Θ 920 954 A2 (LI SEC PETER [AT]) 9 June 1999 (1999-06-09) figures 1,2</td>
<td>14</td>
</tr>
</tbody>
</table>
## INTERNATIONAL SEARCH REPORT

**International application No**

PCT/IB2016/05 1239

### Information on patent family members

<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>US 2008090502 Al</td>
<td>17-04-2008</td>
</tr>
<tr>
<td>Wo 2014063172 Al</td>
<td>01-05-2014</td>
<td>AT 513510 A4</td>
<td>15-05-2014</td>
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<td></td>
<td>Wo 2014063172 Al</td>
<td>01-05-2014</td>
</tr>
<tr>
<td>EP 1060833 Al</td>
<td>20-12-2000</td>
<td>CN 1277090 A</td>
<td>20-12-2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 60017318 Dl</td>
<td>17-02-2005</td>
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<td>JP 4805444 B2</td>
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<td>JP 200109689 A</td>
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<td>KR 20010049537 A</td>
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Form PCT/IBA/210 (patent family annex) (April 2005)