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(54) MACHINE FOR MACHINING PLATES IN A SUBSTANTIALLY VERTICAL POSITION, HAVING A CUP GRINDING TOOL WHICH CAN BE ORIENTED AROUND AN AXIS ORTHOGONAL TO THE PLANE OF THE PLATE

(57) A machine for machining the peripheral edge of plates of glass (L) or plates of natural or synthetic stone material, or plates of plastic material, comprises means for causing a plate (L) to be machined to advance in a substantially vertical position along a first horizontal X direction parallel to the plane of the plate (L), through a processing station (W). The processing station (W) comprises at least one machining head (H1) for machining the plate (L). The machining head is movable along a second substantially vertical Y direction, and includes a spindle coupled with a grinding tool (M) consisting of a cup grinding wheel (M) having an axis of rotation (15) parallel to the plane of the plate (L). The cup grinding wheel (M) is orientable around an axis (9) orthogonal to the plane of the plate (L), so that said cup machining wheel (M) is adapted to be arranged selectively at least in a first position in which its axis of rotation (15) is parallel to said second direction Y and in a second position in which its axis of rotation (15) is parallel to said first direction X.

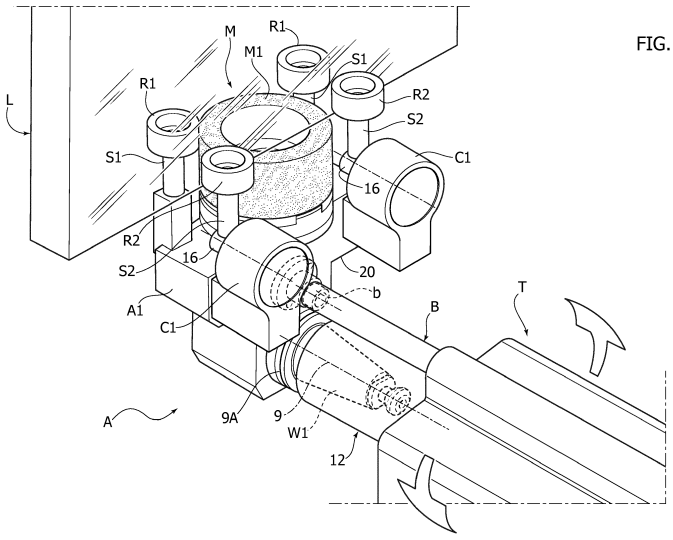

FIG. 2

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Description

Field of the invention

[0001] The present invention relates to a machine for machining the peripheral edge of plates, in particular plates of glass or plates of natural or synthetic stone material and plates of plastic material, in which the plates are to be machined in a substantially vertical position, said machine being of the type comprising:

- a guide structure for guiding a plate along a path in a first horizontal direction X parallel to the plane of the plate, while holding the plate in a substantially vertical position,
- a processing station arranged along said path of the plate and comprising at least one machining head for machining the plate, said machining head being movable along a second substantially vertical direction Y and said machining head including a motorized spindle coupled with a grinding tool,
- a transport device for advancing the plate along said path in said first direction X,
- an electronic control unit, for controlling the position of said plate along said first direction X, for controlling the position of said at least one machining head along said second direction Y and for controlling the rotation of said spindle, according to a programmed machining cycle.

Prior art

[0002] Machines of the above indicated type have been manufactured and marketed since long by the Applicant company. A machine of this type is for example disclosed in document EP 2 719 501 A1 of the same Applicant.

[0003] Originally, machines of this type have been used for performing drilling operations on glass plates. For this purpose, they usually have a processing station comprising first and second machining heads movable along said substantially vertical second Y direction, and arranged on opposite sides with respect to the general plane of the plate. The two machining heads have motorized spindles provided with drilling tools adapted to engage the glass plate from opposite sides, for performing a drilling operation through the plate.

[0004] Machines of the above indicated type have been used also for machining the peripheral edge of glass plates, in order to remove the sharp edge originated by a previous cutting operation. To this end, the motorized spindle of the machining head is coupled with a tangential-type grinding tool, having a cylindrical lateral wall which enters in contact with the edge of the plate for performing the grinding operation. After that a plate of a quadrangular shape is positioned on the machine, the front edge and the rear edge thereof (with reference to the advancing direction of the plate in the machine) are machined while holding the plate in a stationary position along said first X direction and by moving the machining head, or each machining head, along said substantially vertical second Y direction. The upper and lower edges of the plate are instead machined by moving the plate along said first X direction and holding the machining head, or each machining head, in a stationary position along said substantially vertical second Y direction. A machine of this type is disclosed in EP 2 039 464 A1.

[0005] In more recent times, machines of this type were further developed by providing automatic change of the tool of one or both of the machining heads, in order to perform different types of machining operations, such as drilling operations on the plate, or grinding and polishing operations on the edges of the plate, or milling operations, by which a portion of the plate is cut and removed in order to form an aperture in the plate.

[0006] The main drawback which is encountered in using these machines for operations for machining the peripheral edge of the plate lies in that it is impossible to obtain a high quality surface finishing on the plate edge. This is due to that the tangential-type grinding tools which are used for this purpose have a metal cylindrical body whose active lateral surface is made of an electrically-deposited hard metal and is subjected to a deformation of its profile following wear due to the machining operations. The deformation of the profile of the active surface of the tangential grinding tool gives rise to the formation of micro-grooves on the surface of the machined plate edge.

[0007] In the endeavour to solve this problem, a machine of the type discussed herein has been proposed in the past (see document EP 2 762 273 A1) comprising a carriage movable along said first X direction and carrying one or more grinding tools in the form of cup grinding wheels, of the type comprising an annular front active surface, which is not subjected to the drawback of a change of the profile of the active surface of the grinding wheel due to wear. In this known solution, the cup grinding wheels are adapted to engage the lower edge of the plate positioned in the machine. Furthermore, in the case of this known solution, there are further provided means for rotating the plate in its plane, in order to enable all the sides of the plate to be machined by the cup grinding wheels carried by said movable carriage.

[0008] The main drawback of this known solution lies in that it implies a greater complexity of the machine and a lower productivity due to the dead times which are needed for rotating the plate between machining of one side of the plate and machining of an adjacent side of the plate.

[0009] In the past there has been proposed a machine for machining a glass plate in a vertical position, comprising a vertically movable machining head provided with a machining tool constituted by a cup grinding wheel (see EP 0 769 348 A1). However, this machine is of a type different from that discussed herein, since it is intended for the removal of a film of plastic material acting

as a barrier against infrared rays (so-called low-emission film) applied on one face of a plate to be machined. To this end this solution has a machining head provided with a cup grinding wheel having an axis orthogonal to the plane of the plate to be machined.

Object of the invention

[0010] The object of the present invention is to overcome the drawbacks of the known machines and to provide in particular a machine of the type indicated at the beginning of the present description which is able to perform machining of the peripheral edge of a plate with a high finishing quality, by extremely simple means and with a high production efficiency.

Summary of the invention

[0011] In view of achieving this object, the invention provides a machine having the features which have been indicated at the beginning of the present description and further characterized in that the spindle carried by said at least one machining head which is movable along the second Y direction is coupled with a grinding tool consisting of a cup grinding wheel having an axis of rotation parallel to the plane of the plate, and in that said cup grinding wheel is orientable about an axis perpendicular to the plane of the plate, so that said cup grinding wheel is adapted to be arranged selectively at least in a first position, in which its axis of rotation is parallel to said second Y direction, and in a second position, in which its axis of rotation is parallel to said first X direction,
whereby said cup grinding wheel is adapted to perform the machining of the upper edge or the lower edge of the plate when the cup grinding wheel is in said first position, with its axis of rotation parallel to said second Y direction, by means of a movement of the plate along said first X direction, with said at least one machining head being in a stationary position along said second Y direction,
while said cup grinding wheel is adapted to perform the machining of the front edge or the rear edge of the plate when the cup grinding wheel is in said second position, with its axis of rotation parallel to said first X direction, by means of a movement along said second Y direction of said at least one machining head, with the plate being in a stationary position along said first X direction.

[0012] Due to the above indicated features, the machining of the peripheral edge of the plate is carried out by one or more cup grinding wheels, having a substantially planar annular front active surface, which is not subjected to a change of its profile due to wear. Wear of the active surface of the cup grinding wheel merely implies a repositioning of the cup grinding wheel with respect to the plate edge to be machined, which can be obtained by the electronic controller of the machine, which is able of controlling the position along the Y direction of the machining head and the position along the X direction of the plate, in order to provide proper engagement between the active surface of the cup grinding wheel and the edge of the plate.

[0013] The provision on the machining head of at least one tool in the form of a cup grinding wheel, which can be oriented around an axis orthogonal to the general plane of the plate, enables the various sides of the plate to be machined in sequence with minimum dead times between machining of one side of the plate and that of an adjacent side, with a resulting high productivity of the machine.

[0014] Further preferred features of the invention are indicated in the annexed dependent claims.

[0015] In the preferred embodiment of the machine according to the invention, the cup grinding wheel is mounted on a shaft which is rotatably supported within a tool-carrying body. The latter is mounted on a supporting structure which on its turn is carried by said machining head so as to be orientable around an axis orthogonal to the general plane of the plate. Also in the case of said preferred embodiment, said motorized spindle has its axis is substantially coincident with said axis orthogonal to the general plane of the plate, around which the supporting structure of the tool-carrying body can be oriented.

[0016] Furthermore, said tool-carrying body carries a 90-degrees mechanical transmission for connecting the motorized spindle to the shaft of said cup grinding wheel. In a first solution, said tool-carrying body forms part of a separate tool-carrying unit, removably connected to said orientable supporting structure. In this case, the 90-degrees mechanical transmission carried by said tool-carrying body has an input shaft which is removably coupled with said motorized spindle.

[0017] In an alternative solution, said tool-carrying body is rigidly connected to said orientable supporting structure and the 90-degrees mechanical transmission carried by said tool-carrying body has an input shaft permanently coupled with said motorized spindle. In both said solutions, said machining head carrying the cup grinding wheel can be a dedicated machining head, which is provided in addition to one or more machining heads of the machine on which further machining tools can be coupled, for performing further machining operations on the plate.

[0018] In the case of the first solution, in which the tool-carrying body forms part of a separate tool-carrying unit, the machining head to which this tool-carrying unit is associated can be the machining head of a conventional machine, on which further machining tools can be coupled, for performing further machining operations on the plate.

[0019] In the case of any of the above indicated solutions, but above all in the case of the solution with a dedicated head and a tool-carrying body rigidly connected to the orientable support around an axis orthogonal to the plane of the plate, a removable connection between the cup grinding wheel and the associated shaft can be provided.

[0020] According to a further preferred feature of the

invention, the tool-carrying body on which the shaft of the cup grinding wheel is rotatably mounted, also carries a guiding carriage for guiding the plate during the machining operation. This guiding carriage has at least one or more primary guiding wheels which are freely rotatable around respective axes parallel to the axis of the cup grinding wheel, for engagement on one face of the plate and at least one or more secondary guiding wheels which are freely rotatable around axes parallel to the axis of the cup grinding wheel, for engagement on the opposite face of the plate. These primary and secondary guiding wheels are carried by respective support pins which are displaceable relative to one another in a direction orthogonal to the plane of the plate, to enable the plate to be clamped and guided during machining thereof between said primary and secondary wheels, so as to prevent or reduce vibrations of the plate during machining.

Brief description of the drawings

[0021] Further features and advantages of the invention will become apparent from the following description with reference to the annexed drawings, given purely by way of non limiting example, in which:

- figure 1 is a diagrammatic perspective view of a machine according to the present invention,
- figure 2 is a diagrammatic perspective view of a tool-carrying unit with which the machine of figure 1 is provided, according to one embodiment of the present invention, this tool-carrying unit being shown in an operative position adapted for machining the lower edge of a glass plate in the machine,
- figure 3 is a perspective view of the tool-carrying unit of figure 2, which shows this unit in a different operative position, adapted for machining the rear edge of the plate (with reference to the direction of advancement of the plate),
- figure 4 is a perspective view of the plate being machined, which shows the operative positions of the cup grinding wheel associated to the tool-carrying unit of figures 2, 3 respectively during machining of the upper edge and machining of the front edge of the glass plate,
- figure 5 is a further perspective view of the tool-carrying unit of figures 2-4, and
- figure 6 is a diagrammatic view in a lateral elevation of the tool-carrying unit of figures 2-5.

Detailed description of the preferred embodiments

[0022] The machine according to the invention is generally designated in the drawings by reference numeral 1. According to the conventional art, machine 1 comprises a fixed supporting structure 2 defining a conveying line extending along a longitudinal X direction, along which the plates to be machined are caused to advance while being held in a almost vertical plane. To this end, the machine comprises two longitudinal arrays of motorized rollers 3,4 extending along the longitudinal X direction, upstream and downstream of a machining central station W.

[0023] The plates to be machined come from the left-hand end (with reference to the drawings) of the machine and are caused to rest with their lower edge on the roller line 3. As indicated, the plates are slightly inclined with respect to the vertical plane, so that they rest with their rear face (i.e. the face opposite to that facing towards the viewer in the figures) on arrays of wheels R which are freely rotatable around vertical axes, these arrays being carried by longitudinal bars forming part of a fixed frame 5. A similar frame 6, with wheels R for supporting the rear face of the machined plates, is arranged downstream of the processing station W (with reference to the X direction of advancement of the plates).

[0024] As an alternative to rollers 3, 4, as a conveying device for conveying the plate in the X direction conveying belts or automated clamp-like movable members can be used. Also according to the conventional art, in the case of the example shown here, advancement of the plate L in the X direction is further obtained by means of a plurality of suction-cup carrying carriages C, provided with suction-cup members S which can be activated by vacuum and are movable from a rearwardly displaced position to a forwardly advanced position for engaging the rear face of plate L (i.e. the face opposite to that facing towards the viewer in the figures).

[0025] However, it is to be noted that the use of suction-cup carrying carriages provided in the examples described herein is not an essential feature of the present invention. The conveying device for causing the plates to advance along the X direction can simply comprise the motorized rollers described above and/or alternative devices, such as conveying belts and automated movable clamp-like members.

[0026] In the case of the embodiment described herein, each carriage C is independently slidably mounted on a longitudinal guide (not shown in the drawings) of the base fixed structure 2, so as to be movable along the X direction independently from the other suction-cup carrying carriages. According to a technique known per se, each carriage C is provided with motor means which drive movement thereof along the X direction, such as in the form of a motorized sprocket engaging a rack. Also these details of construction are not shown herein since they are known and do not fall, taken alone, within the scope of the invention. Also the details relating to the suction-cup gripping members S, the means for driving movement of these suction-cup gripping members along the direction orthogonal to the glass plate, between a rearwardly displaced position and a forwardly advanced position, and the means for communicating vacuum to the suction-cup gripping members are not shown herein, since they may be of any type known per se.

[0027] During machining of a glass plate, the general plane of the glass plate L is ensured by the suction-cup

members S of the suction-cup carrying carriages C. The precise position of plate L along the X direction is also ensured by carriages C, whose motor means are controlled in synchronism by an electronic control unit E which is associated with the machine (figure 1).

[0028] Also according to the conventional art, the processing station W comprises a fixed pillar structure 7 on which two machining heads H1, H2 are movably mounted parallel to a substantially vertical Y direction. The movement along the Y direction of each head is driven by a respective electric motor (not shown). The heads H1 and H2 each carry a motorized spindle having an axis parallel to a third direction Z (figure 1) orthogonal to directions X and Y. Preferably, the spindle is also provided, in a way known per se, with the possibility of moving along the Z direction. According to the conventional art, the spindle of each head can be selectively coupled with a machining tool (such as a grinding tool or a drilling tool or a milling tool or a combined tool). As shown in figure 1, at the top of the vertical structure 7 there is provided a tool magazine carried by a rack which is horizontally movable along the X direction with respect to structure 7 for enabling an automatic change of the tool carried by each machining head H1, H2, according to a technique known per se. As it is clearly apparent, these details are shown herein purely by way of example, while the general configuration of the machine can be made in any known way.

[0029] The two heads H1, H2 are arranged on opposite sides with respect to the general plane of the plate to be machined so that for example when on the spindles of the heads H1, H2 drilling tools are mounted, they can engage the plate L coaxially from opposite sides in order to properly perform a drilling operation, according to a technique known per se.

[0030] Also according to the conventional art, the machining operations of the longitudinal edges of the plate (which are parallel to the X direction) are performed by moving the carriages C along the X direction, with a simultaneous control of the position along the Y direction of the heads H1, H2 (which simultaneously perform the grinding operation on the upper and lower edges of the plate). The machining operation on the vertical edges of the plate is carried out by stopping the carriages C and by moving one of the heads H1, H2 along the Y direction. In the case of machining operations of this type, on the spindles of heads H1, H2 there are mounted grinding tools.

[0031] The electric motors which drive movement of the machining heads H1, H2 along the Y direction, and the movement of the suction-cup carrying carriages C along the X direction are controlled by the electronic control unit E, according to any predetermined programme.

[0032] Figure 2-6 relate to one embodiment of the machine according to the invention. According to this embodiment, one or both of the machining heads H1, H2 of the machine are provided with a grinding tool M in the form of a cup grinding wheel, for machining the edges of a glass plate L positioned in machine 1. As an alternative to this solution, the cup grinding wheel M (or each cup grinding wheel) can be associated with a respective dedicated machining head (not shown in figure 1) provided in the machine in addition to the machining heads H1, H2 and also movable at the processing station W along the vertical Y direction. The cup grinding wheel M, or each cup grinding wheel M, provided at the processing station W, is of any type known to the experts in the field. Typically the cup grinding wheel M has a cup shaped metal body having an annular front surface M1 which is substantially planar and coated with electrically-deposited fragments of hard material. Any other material and configuration of the cup grinding wheel which are adapted for the purposes indicated herein can naturally be also used.

[0033] In the case of the preferred embodiment shown herein, the cup grinding wheel M is carried by a tool-carrying body provided on a supporting structure T which is mounted on the respective machining head (such as machining head H1) so as to be orientable around a horizontal axis 9 orthogonal to the general plane of the plate in the machine (i.e. an axis parallel to direction Z shown in figure 1). The orientable supporting structure T can be rotated around the axis 9 with respect to the structure of the head (such as H1) by means of an electric motor (not shown) carried by the machining head (such as H1) and controlled by the electronic control unit E of the machine.

[0034] The orientable supporting structure T rotatably supports, around said axis 9, the body 12 of a spindle, which is driven in rotation by means of an electric motor (not shown) which is also carried by the orientable structure T. The motorized spindle 12 has one end portion projecting outwardly from the orientable supporting structure T and having at its end face, in a way known per se, a conical seat for removable coupling of the tool carrying body.

[0035] In this embodiment the tool is carried by body A1 of a tool-carrying unit A. With reference in particular to figure 6, within body A1 there is rotatably mounted an input shaft 13, diagrammatically shown in figure 8, which is connected in rotation, by means of a mechanical 90-degrees transmission, such as by means of a pair of conical sprockets 13A, 14A (also shown diagrammatically in figure 6) with an output shaft 14, which also is rotatably mounted within body A1 around its axis 15 and having a portion projecting outwardly from body A1 and carrying the cup-grinding wheel M. The input shaft 13 has a conical end portion W1, outside body A1, which is removably coupled within the conical seat on the end surface of the spindle (see in particular figure 2) by quick coupling means of any known type. As a consequence of the above described arrangement, in the coupled condition of unit A with spindle 12, the axis 15 of the cup grinding wheel M is arranged at 90 degrees with respect to axis 9 of spindle 12, around which the supporting structure is orientable. As a result of this, the axis 15 of the cup grinding wheel M is arranged parallel to the plane of the plate L.

[0036] The structure T carrying this spindle 12 is also provided with the possibility of moving along the axis Z with respect to the machining head by which it is supported, this movement along the Z direction being also controlled by an electric motor (not shown) carried by the head and controlled by unit E.

[0037] The coupling of the conical portion W1 within the cooperating conical seat on the end surface of the spindle 12 is used both for connecting shaft 13, and hence grinding wheel M, in rotation with the spindle 12, and also for supporting the entire tool-carrying unit A on the orientable supporting structure T. In order to prevent rotation of unit A, the latter is further connected rigidly to the orientable structure by a rigid tubular arm B, which projects in a cantilever fashion from the end surface of the structure T parallel to the spindle 12 and which is adapted to engage with its free end a bush b projecting from a front surface 20 (see figure 2) of body A1. In the coupled condition of the tool-carrying unit A on spindle 12, the unit A is therefore supported by the orientable structure T through the spindle 12. At the same time, the grinding wheel M of unit A is connected in rotation with the spindle 12 and coupling between the tubular arm B and the bush b prevents rotation of unit A with respect to the spindle.

[0038] As shown for example in figure 6, the conical portion W1 of unit A has, in a way known per se, a base circumferential groove 9A which is used for the engagement of a gripping member adapted for gripping unit A and provided at each of the tool-receiving locations of the tool magazine. According to the conventional art, when the tool-carrying unit A is arranged in the magazine 8, it is supported by said gripping member which engages the circumferential groove 9A.

[0039] Also according to the conventional art, when the tool-carrying unit A must be coupled with the spindle 12 carried by the machining head of the machine (such as head H1), the electronic control unit E drives the movement of the head (such as H1) along the Y direction until the axis of the spindle 12 is brought to be coincident with the axis of a conical portion W1 of the unit A arranged in the magazine, and subsequently drives a movement along the Z direction of the spindle 12 and the tubular arm B in order to obtain coupling of the conical portion W1 within the conical seat in the spindle 12 and the coupling of the end of the tubular arm B on bush b.

[0040] The movement along the Z direction of the spindle 12 and the tubular arm B is obtained since the entire orientable structure T, beyond being rotatable around the horizontal axis 9, on the machining head, is also movable along the Z direction with respect to the machining head, this movement along Z direction being driven by an electric motor (not shown) controlled by the electronic unit E.

[0041] Naturally, an inverted sequence of operations is carried out when the tool-carrying unit A must be discharged from the machining head into the magazine of the machine, for example when a tool change must be performed.

[0042] By orienting the orientable supporting portion T around axis 9, the cup grinding wheel M can be arranged along different operative positions, with axis 15 of the cup grinding wheel either parallel to the vertical Y direction or parallel to the X direction of the machine. When the axis 15 is oriented along the Y direction, the cup grinding wheel can have its active surface M1 facing upwardly, as shown in figure 2, so as to be adapted to machine the lower edge of the glass plate L, or it can have its active surface M1 facing downwardly (see the upper part of figure 4) so as to be adapted to machining of the upper edge of the glass plate L. When instead the cup grinding wheel M has its axis 15 oriented parallel to the X direction of the machine it can have its active surface M oriented forwardly or rearwardly (with respect to the direction of advancement of plate L in the machine), so as to be adapted to machine the rear edge of plate L (figure 3) or the front edge of the plate (right-hand part of figure 4), again with reference to the direction of advancement of the plate in the machine.

[0043] In order to avoid or reduce vibrations of the plate during machining by the cup grinding wheel M, the tool-carrying unit A is provided with a guiding carriage which, in the illustrated example, comprises two pairs of primary and secondary wheels R1, R2 facing each other, which are freely rotatably mounted on respective pins S1, S2 which are oriented parallel to axis 15 of the grinding wheel M. The wheels R1, R2 are adapted to engage the two opposite faces of the plate L. The pins S1 of the primary wheels R1 are rigidly connected to body A1 of the tool-carrying unit A, whereas each of the pins S2 is carried independently by the stem 16 of a respective fluid cylinder C1 mounted on body A1 of the tool-carrying unit.

[0044] In this manner, the position along the Z direction of the unit A can be controlled so as to arrange the primary wheels R1 in contact with the rear face of the plate L, once the latter has arrived at the processing station W of the machine. After this, each secondary wheel R2 can be moved by means of the respective fluid cylinder C1 for bring it in contact with the front face of the plate.

[0045] In this manner, the two pairs of wheels R1, R2 are adapted to grip and guide therebetween the plate during the machining operation, thus preventing or at least reducing any vibrations of the plate.

[0046] It is important to note that in the case of the embodiment illustrated herein there is provided a pair of primary and secondary wheels R1, R2 both upstream and downstream of the grinding wheel M, with reference to the direction of movement of the grinding wheel M relative to the plate. This always ensures that, when the grinding wheel M comes in proximity of the final end of one side of the plate on which the grinding wheel is operating, and a pair of wheels have already come out of the engagement with the plate, the other pair of wheels are still engaged with the plate, so as to limit vibrations thereof until a machining of said side of the plate is completed.

[0047] When it is necessary to perform a machining

operation with a high quality of surface finishing on the peripheral edge of the plate, the tool-carrying unit A is coupled with the orientable supporting structure T, in the way which has been illustrated above.

[0048] In order to perform a machining of the lower edge of the plate L, the orientable support T is positioned as shown in figure 2, so as to hold the cup grinding wheel M with its axis 15 oriented parallel to the Y direction and its active front surface M1 facing upwardly. In this condition, the machining head carrying the orientable support T is held in a stationary position along the vertical Y direction and the plate L is moved along the X direction. At the same time, the motorized spindle 12 is put in rotation, for driving rotation of the cup grinding wheel M through the 90-degrees transmission carried by the tool-carrying body of the tool-carrying unit A. The cup grinding wheel M thus performs a machining operation with a high quality of surface finishing on the lower edge of the plate (figure 2).

[0049] In order to perform the machining operation of the rear edge of the plate L (with reference to the direction of advancement of the plate in the machine) the orientable supporting structure T is rotated so as to arrange the cup grinding wheel M with its axis 15 oriented parallel to the X direction and its active front surface M1 facing forwardly, as shown in figure 3. The motorized spindle 12 is activated for putting the cup grinding wheel M in rotation while the machining head which carries the orientable support T is moved along the Y direction, with the plate L held by carriage C in a stationary position along the X direction.

[0050] The machine operations of the upper edge and the front edge of the plate (figure 4) are carried out in a similar way by orienting the cup grinding wheel M with its axis 15 directed parallel to the Y direction and with its active surface M1 facing downwardly, or by orienting the axis 15 parallel to the X direction, with its active surface M1 facing rearwardly, with respect to the advancement direction of the plate in the machine.

[0051] During the machining operation of the lower edge shown in figure 2, as also during the machining operation of the upper edge, the glass plate L slides between the two pairs of guiding wheels R1, R2, which prevent or at least reduce the vibrations of the plate during the machining operation. During machining of the rear edges shown in figure 3, as also during machining of the front edge, the two pairs of guiding wheels R1, R2, roll along the two faces of the plate, thus preventing or reducing the vibrations of the plate.

[0052] Naturally, the embodiment shown herein represents only one example for working the invention.

[0053] In case of use of a tool-carrying unit of the type shown in figures 2-6, it can be provided that the cup grinding wheel M is permanently connected to the respective shaft 14. In this case, when the cup grinding wheel M is excessively worn, it is necessary to replace the entire tool-carrying unit A. In any case, it is possible to provide for the cup grinding wheel M to be removably connected to the respective shaft 14.

[0054] According to a variant, instead of providing a tool-carrying unit A which can be separated with respect to the orientable supporting structure T, it can be provided that this unit is integral with the orientable support T or anyhow rigidly connected thereto so that it is only the cup grinding wheel M which is removably coupled with the respective shaft 14.

[0055] Furthermore, both in the solution with removable tool-carrying unit, and in the solution with a unit integral or rigidly connected with the orientable supporting structure T, this arrangement can be provided on each of the two machining heads H1, H2 of the machine, or only one of them, or on a dedicated machine head, which is additional with respect to the machining heads H1, H2 with which the machine is provided in order to perform a number of additional machining operations.

[0056] The devices for removable connection of each cup grinding wheel with the respective shaft, or of each tool-carrying unit A with the respective supporting structure can naturally be made in any known manner.

[0057] Although the annexed drawings show the application of a machine according to the invention to the machining of a glass plate, the invention is also applicable to machining of plates of stone, marble, or stone material in general, both natural or synthetic and, to machining of plates of plastic material.

[0058] Naturally, while the principle of the invention remains the same, the details of construction and the embodiments may widely vary with respect to what has been described and illustrated purely by way of example, without departing from the scope of the present invention.

Claims

1. A machine for machining the peripheral edge of plates (L) of glass or plates of natural or synthetic stone material or plates of plastic material, in which the plates are to be machined in a substantially vertical position, said machine comprising:

   - a guide structure (3, 4, 5) for guiding a plate (L) along a path in a first horizontal direction X parallel to the plane of the plate (L), while holding the plate in a substantially vertical position,
   - a processing station (W) arranged along said path of the plate and comprising at least one machining head (H1, H2) for machining the plate (L), said machining head (H1, H2) being movable along a second substantially vertical Y direction, and said machining head (H1, H2) including a motorized spindle (12) coupled with a grinding tool (M),
   - a transport device (C) for advancing the plate (L) along said path in said first direction X,
   - an electronic control unit (E), for controlling the position of said plate along said first X direction,

for controlling the position of said at least one machining head (H1, H2) along said second Y direction and for controlling the rotation of said spindle, according to a programmed machining cycle,

characterized in that said motorized spindle (12) carried by said at least one machining head (H1, H2) which is movable along the second direction Y is coupled to a grinding tool consisting of a cup grinding wheel (M) having an axis of rotation (15) parallel to the plane of the plate (L), and

in that said cup grinding wheel (M) is orientable about an axis (9) perpendicular to the plane of the plate (L), so that said cup grinding wheel (M) is adapted to be arranged selectively at least in a first position, in which its axis of rotation (15) is parallel to said second direction Y, and in a second position, in which its axis of rotation (15) is parallel to said first direction X,

whereby said cup grinding wheel (M) is adapted to perform the machining of the upper edge or the lower edge of the plate (L) when the cup grinding wheel (M) is in said first position, with its axis of rotation (15) parallel to said second direction Y, by means of a movement of the plate (L) along said first direction X , with said at least one machining head (H1, H2) being in a stationary position along said second direction Y,

while said cup grinding wheel (M) is adapted to perform the machining of the front edge or the rear edge of the plate (L) when the cup grinding wheel is in said second position, with its axis of rotation (15) parallel to said first X direction, by means of a movement along said second direction Y of said at least one machining head, with the plate (L) being in a stationary position along said first direction X.

2. Machine according to claim 1, **characterized in that** said cup grinding wheel is orientable so as to be arranged selectively:

- in a first position, with its axis of rotation (15) parallel to said second direction (Y) and an active front surface (M1) thereof facing upwardly,
- in a second position, with its axis of rotation (15) parallel to said first direction X and said active surface (M1) facing forwardly, with reference to the direction of advance of the plate in the machine,
- In a third position, in which the axis of rotation (15) is parallel to said second direction Y and said active surface (M1) is facing downwardly, and
- In a fourth position, in which said axis of rotation (15) is parallel to said first direction X and said active surface (M1) is facing backwardly, with reference to the direction of advance of the plate (L).

3. Machine according to claim 1, **characterized in that** the cup grinding wheel (M) is mounted on a shaft (14) which is rotatably supported within a tool-carrying body (A1), and **in that** said tool-carrying body (A1) is carried by a support structure (T) which in its turn is carried by said machining head (H1) so that it can be oriented about an axis (9) perpendicular to the plane of the plate.

4. Machine according to claim 1, **characterized in that** said motorized spindle (12) has its axis substantially coincident with said axis (9) perpendicular to the plane of the plate (L), around which said structure (T) for supporting the tool-carrying body is rotatably mounted, and **in that** said tool-carrying body (A1) carries a 90-degrees mechanical transmission (13, 14) for connecting the motorized spindle (12) to a shaft (14) of said cup grinding wheel (M).

5. Machine according to claim 3, **characterized in that** said tool-carrying body (A1) is part of a separate tool-carrying unit (A) removably connected to said orientable supporting structure (T), said 90-degrees mechanical transmission (13, 14) being carried by said supporting body (A1) and having an input shaft (13) removably coupled with said motorized spindle (12).

6. Machine according to claim 5, **characterized in that** said motorized spindle (12) is carried by said orientable supporting structure (T), **in that** the body (A1) of said tool-carrying unit (A) is connected to said orientable supporting structure (T) by means of said coupling between the input shaft (13) of the tool-carrying unit (A) and said motorized spindle (12) and by means of a further coupling (b, B) between the orientable supporting structure (T) and the body (A1) of said tool-carrying unit (A) which prevents a rotation of said unit (A) around the axis (9) of the spindle (12).

7. Machine according to claim 5, **characterized in that** further machining tools, for performing further machining operations on the plate, can be selectively removably coupled with the machining head (H1, H2) which removably carries said tool-carrying unit (A).

8. Machine according to claim 3, **characterized in that** said tool-carrying body (A1) is rigidly connected to said orientable supporting structure (T), the 90-degrees mechanical transmission (13, 14) carried by said tool-carrying body (A1) having an input shaft (13) coupled with said motorized spindle (12).

9. Machine according to claim 1, **characterized in that** said machining head carrying the cup grinding wheel (M) is a dedicated machining head, provided in ad-

dition to one or more machining heads (H1, H2) on which further machining tools are coupled, for further processing operations on the plate.

10. Machine according to claim 5 or 8, **characterized in that** the cup grinding wheel (M) is removably connected to its shaft (14).

11. Machine according to claim 1, **characterized in that** said cup grinding wheel (M) has a shaft (14) rotatably mounted on a tool-carrying body (A1) which also carries a guide wheel unit (R1, R2) for guiding the plate during machining, said guide wheel unit having one or more primary guiding wheels (R1) freely rotatable about respective axes parallel to the axis (15) of the cup grinding wheel (M), for engagement on one face of the plate and one or more secondary guiding wheels (R2) freely rotatable about axes parallel to the axis (15) of the cup grinding wheel (M), for engagement on the opposite face of the plate (L), said primary and secondary guiding wheels (R1, R2) being carried by respective support pins which are displaceable relative to one another in a direction orthogonal to the plane of the plate (L), to enable the plate (L) to be clamped and guided during processing thereof between said primary and secondary guiding wheels (R1, R2), in such a way as to prevent or reduce vibrations of the plate (L) during machining.

12. Machine according to claim 1, **characterized in that** there is provided a pair of primary and secondary wheels (R1, R2), both upstream and downstream of the cup grinding wheel (M), with reference to the direction of movement of the grinding wheel (M) relative to the plate.

FIG. 1

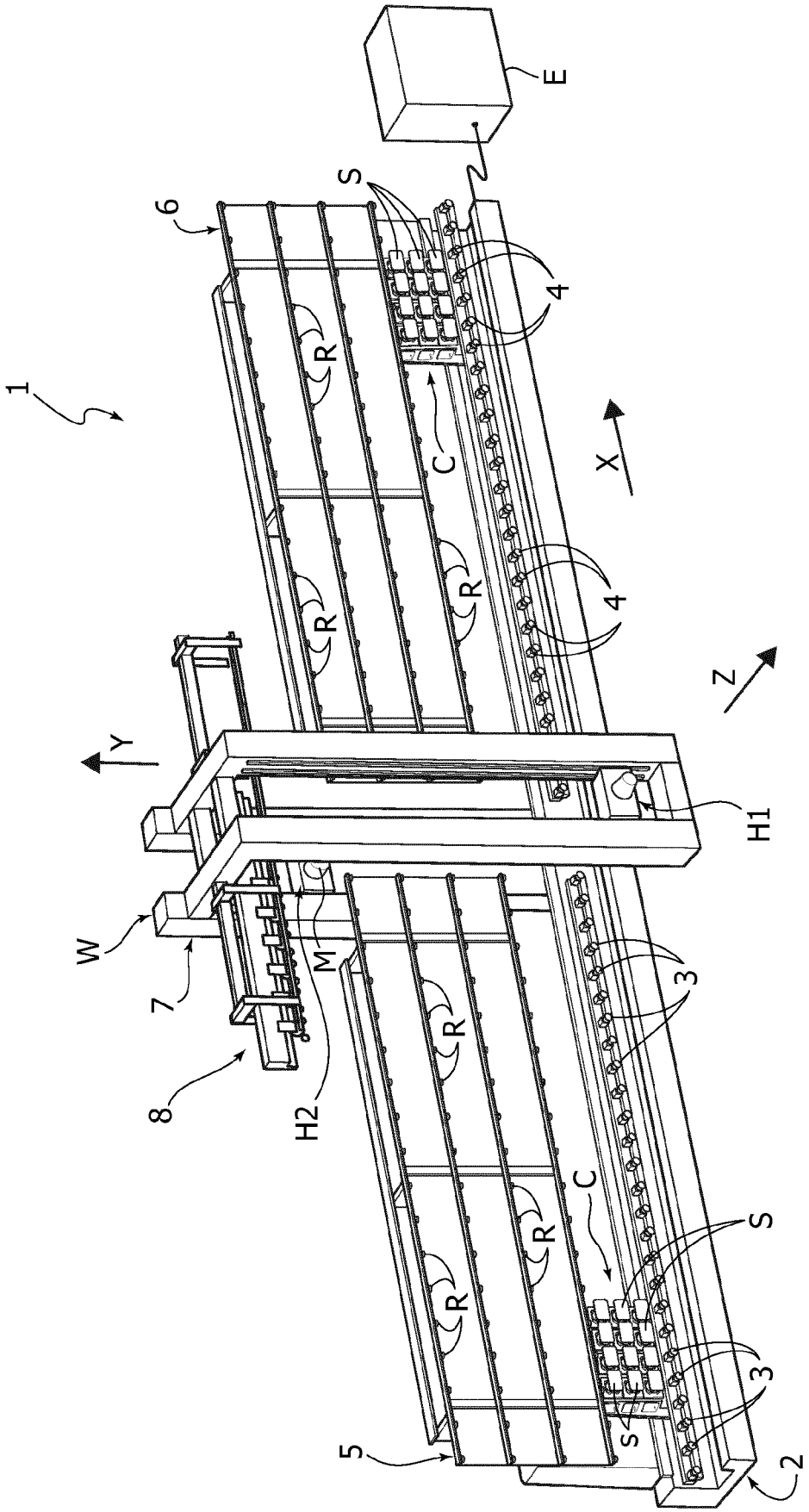


FIG. 2

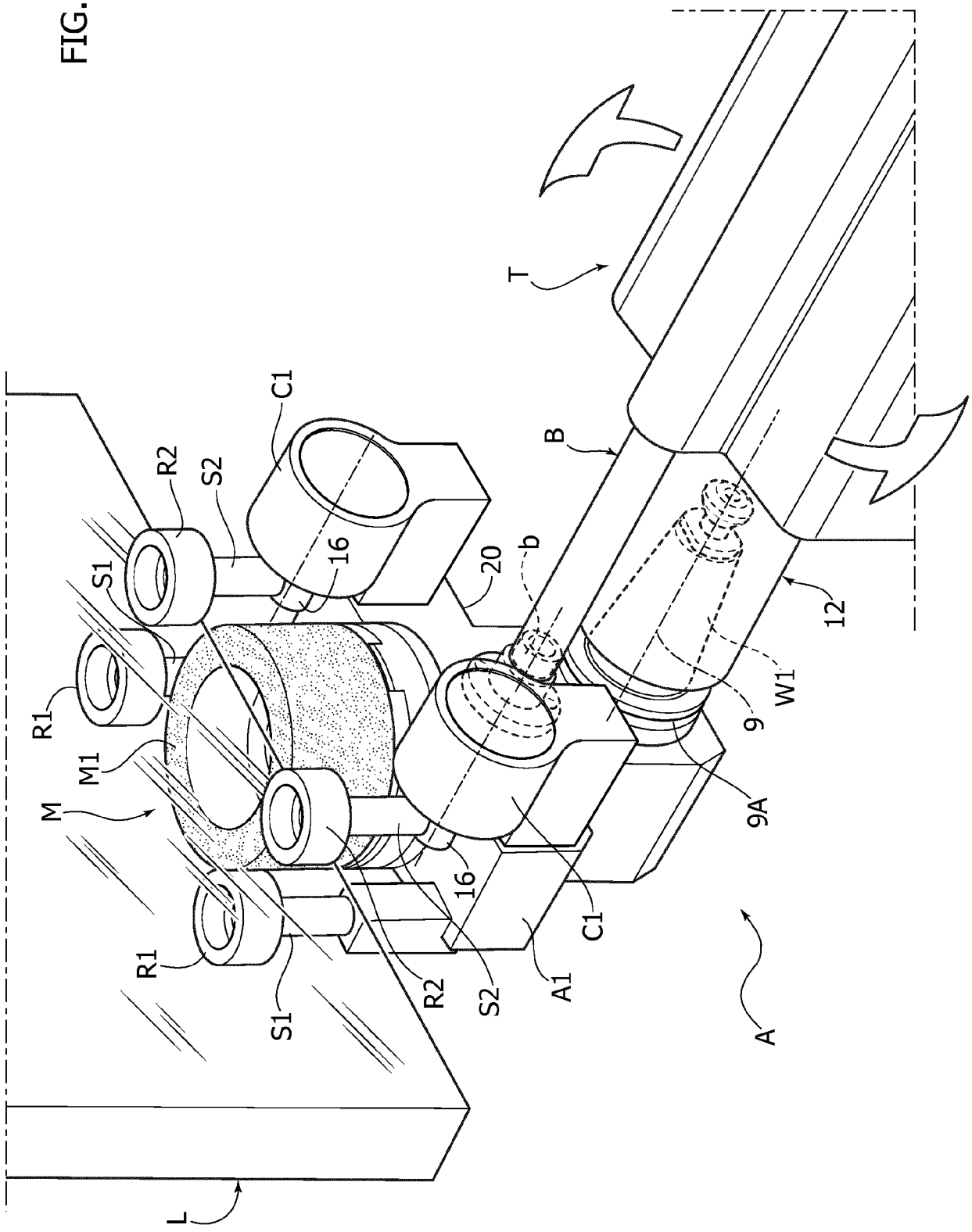


FIG. 4

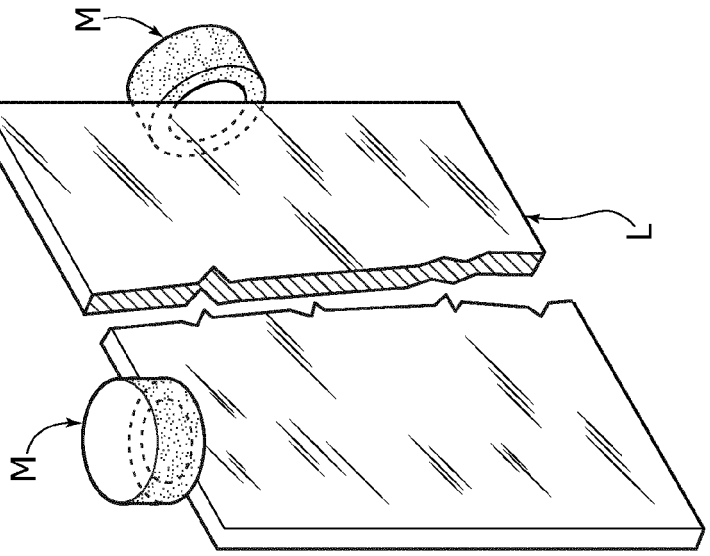


FIG. 3

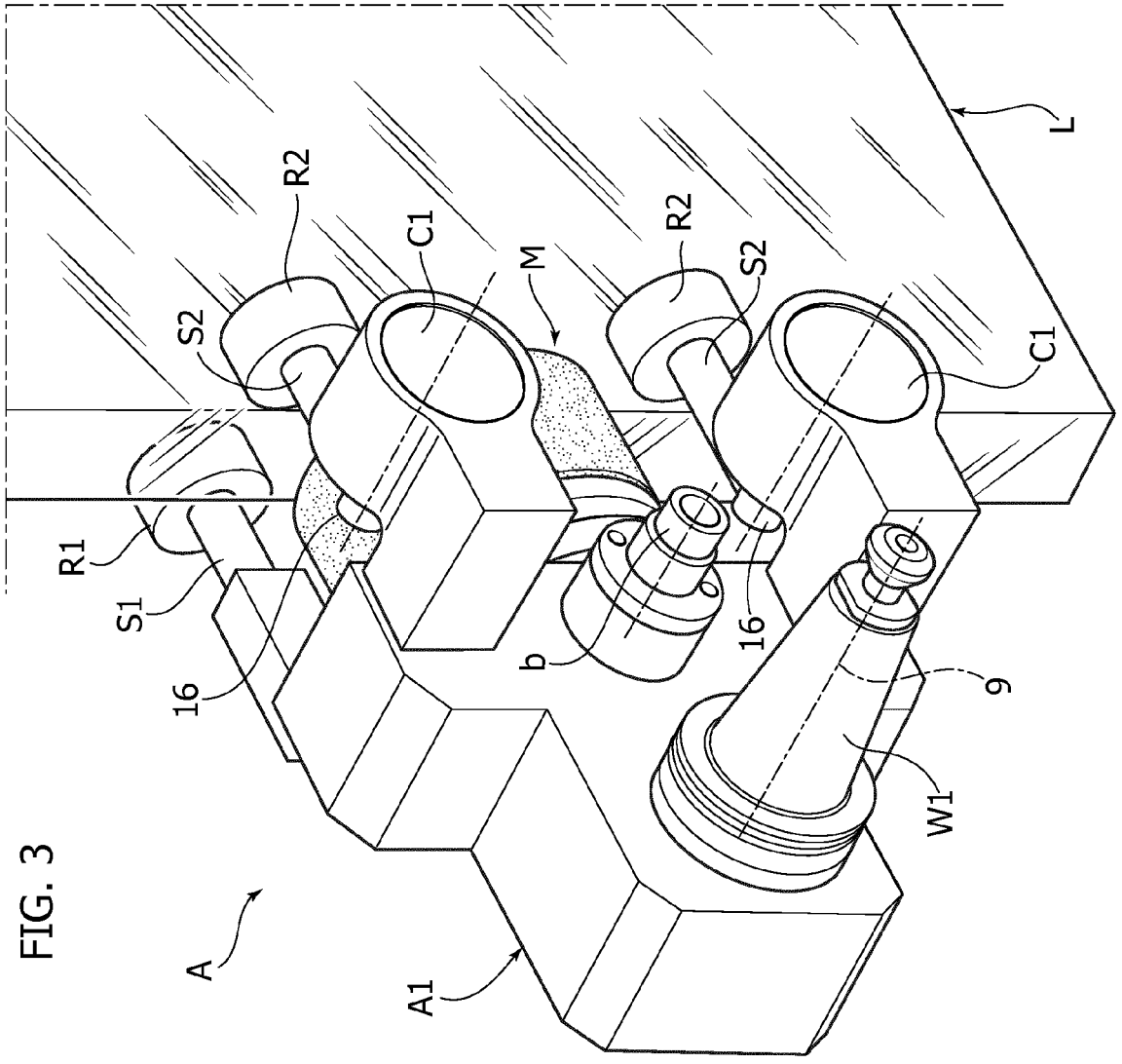


FIG. 6

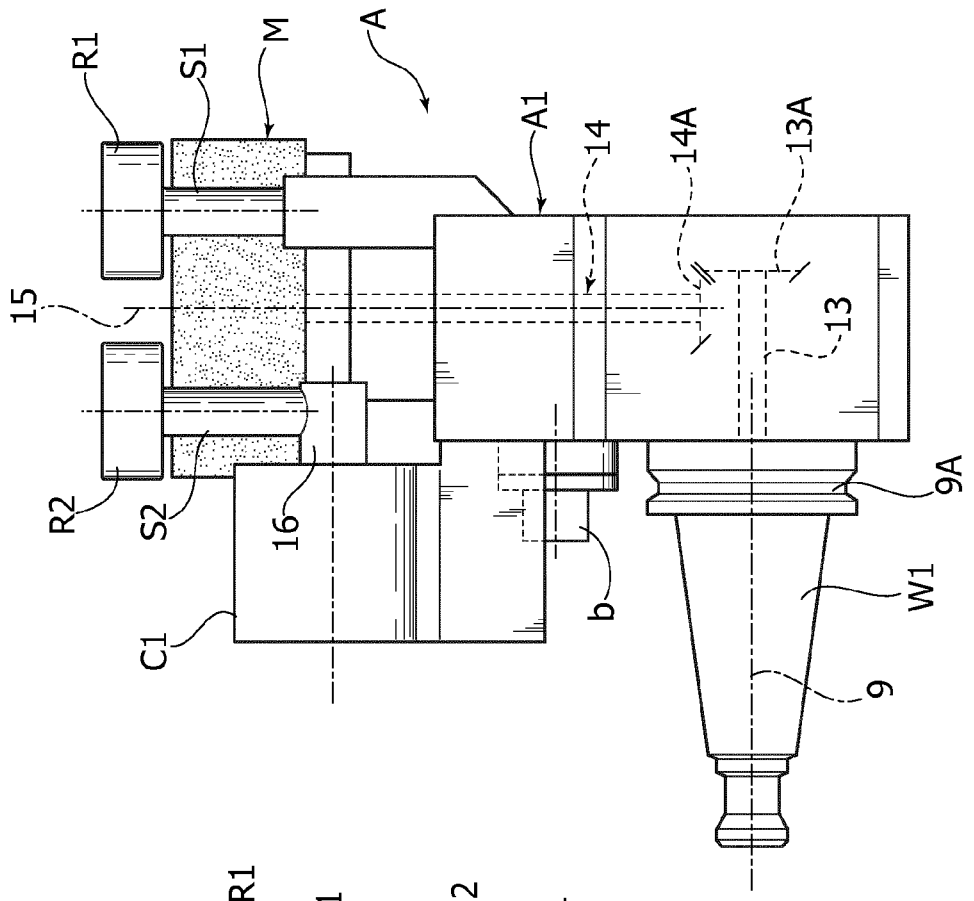
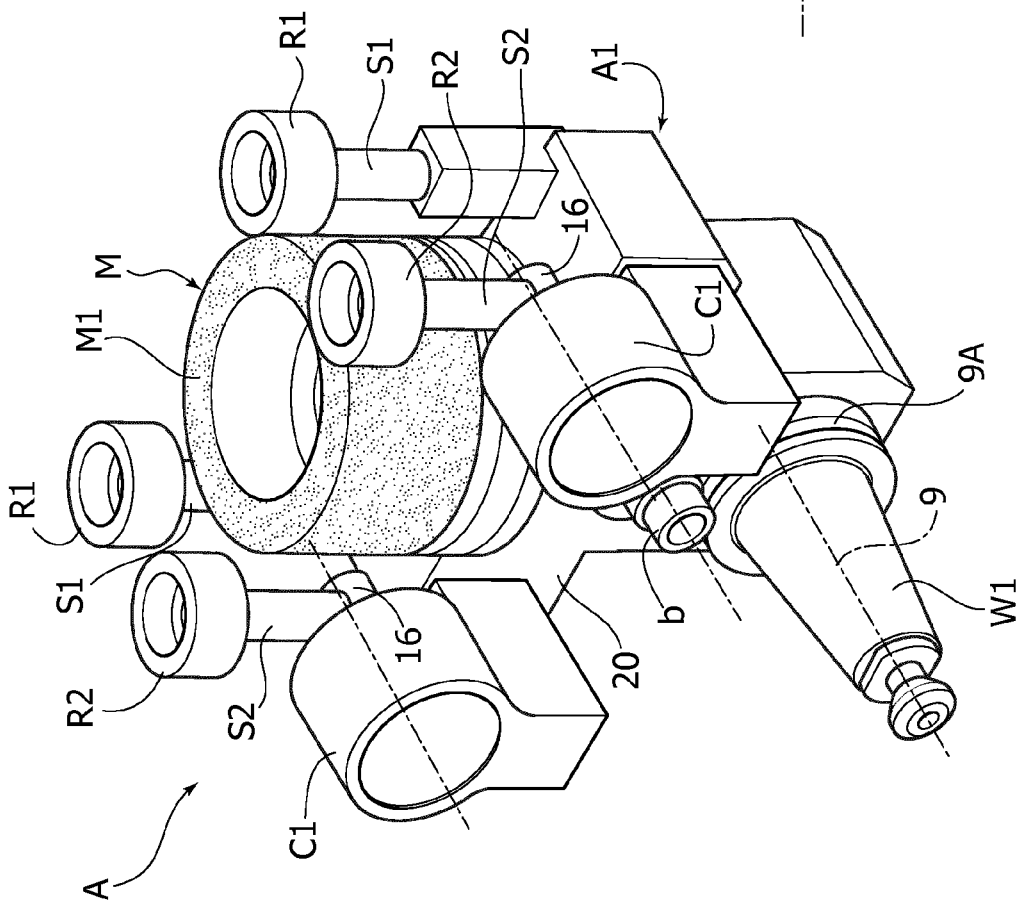

R1
S1
M
A
A1
14
14A
13A
15
13
R2
S2
16
9A
C1
b
W1
9

FIG. 5


R1
S1
R2
S2
A1
16
M
M1
C1
9A
R1
9
S1
b
W1
16
20
R2
S2
C1
A

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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 6823

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Place of search	Date of completion of the search	Examiner
Munich	28 March 2017	Herrero Ramos, J

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