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(54) **Method and apparatus for abrading a surface of an object**

(57) A method for shaping a surface (5) of an object (6) comprises the steps of: advancing the object (6) along an advancing direction (A); pressing abrasive tool means (9) against the surface (5) to abrade the surface, the abrasive tool means (9) comprising roller means (10); rotating the roller means (10) around a geometrical axis (Z) thereof contained in a plane that is substantially parallel to the advancing direction (A); and further comprises the step of making the roller means (10) oscillate around an oscillation axis (X) that is substantially parallel to the geometrical axis (Z) to obtain an undulated profile (39) of the surface (5). A shaping apparatus for shaping a surface (5) of an object (6) that is movable along an advancing direction (A) comprises abrasive tool means (9) arranged for pressing against the surface (5) to abrade the surface (5), the abrasive tool means (9) comprising roller means (10) that is rotatable around the geometrical axis (Z) thereof contained in a plane that is substantially parallel to the advancing direction (A), and further comprises oscillation generating means (17) arranged for making the roller means (10) oscillate around an oscillation axis (X) that is substantially parallel to the geometrical axis (Z) to obtain an undulated profile (39) of the surface (5).

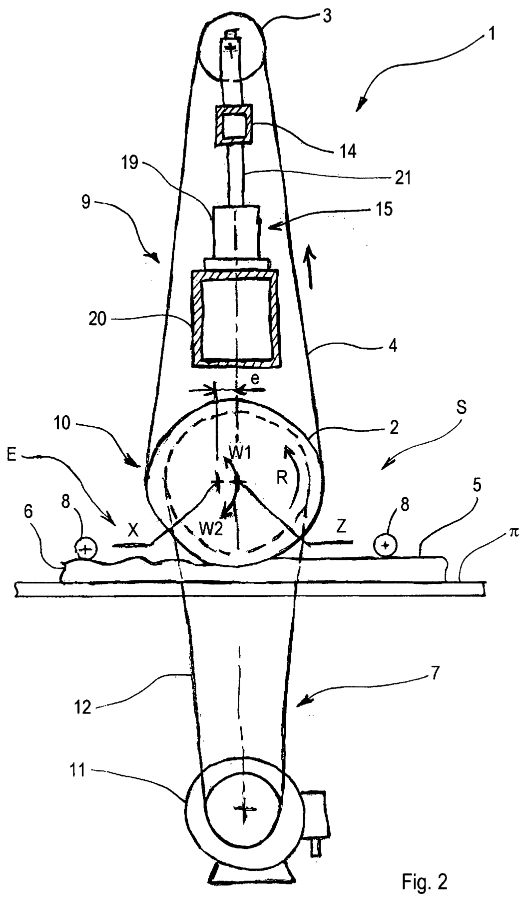

Fig. 2

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Description

[0001] The invention relates to a method for shaping the surface of an object, in particular of a panel, for example of wood, to obtain a corrugated surface.

[0002] The invention further relates to a shaping apparatus for shaping a surface of an object, which can be mounted on a sanding machine arranged for giving the surface of an object, in particular of a panel, an undulated profile.

[0003] Methods are known for shaping a surface of an object, in particular a panel, for obtaining an undulated profile of the surface, such as to give the panel an antique appearance. These methods are implemented by sanding machines on which a shaping apparatus 1' of the type shown in Figure 1 can be mounted.

[0004] The shaping apparatus 1' includes abrasive tool means comprising a first roller 2' and a second roller 3' around which an abrasive belt 4' closed in a loop is wound. The first roller 2' is arranged for pressing the abrasive belt 4' against a surface 5' of a panel 6' to be shaped. The first roller 2' is rotated by driving means 7'.

[0005] During operation, the abrasive belt 4', rotated by the first roller 2', interacts with the surface 5' whilst the panel 6' advances along an advancing direction A.

[0006] Simultaneously, the shaping apparatus 1' is driven by reciprocating movement along a direction indicated by the arrows V1 and V2 of Figure 1. The rotation of the abrasive belt 4' and the reciprocating movement of the shaping apparatus 1', and consequently of the first roller 2', enable the surface 5' to be shaped and an undulated profile to be obtained on the latter in which ridges and depressions alternate.

[0007] One drawback of known sanding machines is that moving the shaping apparatus 1' with reciprocating movement is rather complex and entails great expenditure of energy. In fact, the mass of the shaping apparatus 1' that is moved by reciprocating movement is rather high, comprising the mass of the abrasive tool means, of the driving means 7' and also of retaining rollers 8' that stop undesired shifts of the panel 6' during shaping.

[0008] Further, the inertia forces generated by the reciprocating movement of all the shaping apparatus 1' are the cause of undesired vibrations.

[0009] Another drawback is that ridges and depressions of the shaped profile obtained have a different surface quality from one another.

[0010] One object of the invention is to provide a method for shaping a surface that is an alternative to the method implemented by shaping apparatuses of known sanding machines.

[0011] A further object is to obtain a method for shaping a surface that enables the action of removing material by abrasive tool means to be improved.

[0012] Still another object is to provide a method for shaping a surface by means of which to obtain good-quality surfaces.

[0013] A further object is to improve shaping apparatuses of known type.

[0014] A still further object is to provide a shaping apparatus that enables an undulated profile to be obtained without great expenditure of energy.

[0015] Another object is to provide a shaping apparatus that enables an undulated profile with ridges and depressions to be obtained that has a substantially uniform surface finish. In a first aspect of the invention a method is provided for shaping a surface of an object comprising the steps of:

- advancing said object along an advancing direction,
- pressing abrasive tool means against said surface to abrade said surface, said abrasive tool means comprising roller means,
- rotating said roller means around a geometrical axis thereof, said geometric axis being contained in a plane that is substantially parallel to said advancing direction,

characterised in that it further comprises making said roller means oscillate around an oscillation axis that is substantially parallel to said geometrical axis to obtain an undulated profile of said surface.

[0016] The oscillation of the roller means gives the roller means a motion component that is substantially parallel to the advancing direction of the object. This enables the abrasive tool means to remove material from the surface of the object in a more efficient manner compared with the case of reciprocating movement that is orthogonal to the advancing direction of the object.

[0017] In a second aspect of the invention, a shaping apparatus is provided for shaping a surface of an object that is movable along an advancing direction, comprising abrasive tool means that is arranged for pressing against said surface to abrade said surface, said abrasive tool means comprising roller means that is rotatable around a geometrical axis thereof, said geometrical axis being contained in a plane that is substantially parallel to said advancing direction, **characterised in that** it further comprises oscillation generating means arranged for making said roller means oscillate around an oscillation axis that is substantially parallel to said geometrical axis to obtain an undulated profile of said surface.

[0018] Owing to the oscillation generating means, the motion of the roller means is decomposable into a component that is substantially orthogonal to the advancing direction and a further component that is substantially parallel to the advancing direction. This enables the abrasive tool means to come into contact with the surface gradually and to make abrasion machining uniform. Ridges and depressions obtained on the corrugated surface of the machined object have substantially the same surface finish quality.

[0019] The invention can be better understood and implemented with reference to the attached drawings that illustrate some embodiments thereof by way of non-limiting example, in which:

Figure 1 is a schematic side view of a shaping apparatus for shaping a surface of an object according to the prior art;

Figure 2 is a schematic and partially sectioned side view of a shaping apparatus for shaping a surface of an object;

Figure 3 is a right prospective partial view of the shaping apparatus in Figure 2;

Figure 4 is an enlarged detail of the shaping apparatus in Figure 2 illustrating oscillation generating means provided in the shaping apparatus;

Figure 5 is a view like that in Figure 2 illustrating an embodiment of tensioning means provided in the shaping apparatus;

Figure 6 is a view like that of Figure 2 illustrating a further embodiment of tensioning means provided in the shaping apparatus;

Figure 7 is a side view of a shaped panel having a undulated profile;

Figure 8 is a graph illustrating a theoretical profile that is obtainable by means of a shaping apparatus as specified in Figures 2 to 6.

Figure 9 is a schematic view of operating positions of roller means provided in the shaping apparatus of Figure 2;

Figure 10 is a view like that in Figure 2, illustrating an alternative embodiment of the oscillation generating means.

[0020] Figures 2 and 3 show a shaping apparatus 1 for shaping a surface 5 of an object, in particular a panel 6, for example of wood. The shaping apparatus 1 is mounted on a sanding machine, which comprises a conveyor 16 for advancing the panel 6 along an advancing direction A.

[0021] The shaping apparatus 1 comprises abrasive tool means 9 arranged for abrading the surface 5.

[0022] Upstream and downstream of the abrasive tool means 9 retaining rollers 8 are provided that are arranged for stopping undesired shifts of the panel 6, for example to prevent the panel 6 lifting from the conveyor 16 during shaping. Between the retaining rollers 8 a shaping zone E is defined in which the abrasive tool means 9 shapes the surface 5.

[0023] The abrasive tool means 9 comprises an abrasive belt 4 wound in a ring around a roller means 10.

[0024] The roller means 10 comprises a first roller 2, or pressing roller, arranged for pressing the abrasive belt 4 against the surface 5.

[0025] The roller means 10 further comprises a second roller 3, or tensioning roller, arranged for keeping the abrading belt tensioned 4.

[0026] Alternatively, the second roller 3 may not be present. In this case, the abrasive tool means 9 may comprise an abrasive belt wound around a pressing roller or may comprise only a pressing roller having an abrasive surface. In the latter case, the pressing roller is arranged for pressing against the surface 5 to remove material therefrom by abrasion.

[0027] The first roller 2 is rotatable around a geometrical axis Z thereof according to a rotation indicated by the arrow R, that, with reference to the view of Figure 2, is anticlockwise. Alternatively, the rotation of the first roller 2 can also be clockwise.

[0028] The first roller 2 is arranged in such a manner that the geometrical axis Z is contained in a plane that is substantially parallel to a further plane Π containing the advancing direction A. The further plane Π is, for example, defined by the conveyor 16.

[0029] The first roller 2 is rotated by rotating driving means 7.

[0030] The rotating driving means 7 comprise a motor 11 and a transmission belt 12 mounted in a known manner between a driving pulley 50, connected to the motor 11 and a driven pulley 51, connected to an end 13 of the first roller 2 to transmit rotation to the first roller 2.

[0031] The rotation R of the first roller 2 causes a similar rotation of the abrasive belt 4 and of the second roller 3.

[0032] The shaping apparatus 1 further comprises oscillation generating means 17 arranged for making the first roller 2 oscillate around an oscillation axis X that is substantially parallel to the geometrical axis Z. The oscillation axis X is an eccentric axis of the first roller 2 and is distant from the geometrical axis Z by 'e'.

[0033] The oscillation axis X and the geometrical axis Z are arranged above the further plane Π.

[0034] Figure 2 shows the first roller 2 in an operating configuration S in which the oscillation axis X and the geometrical axis Z are substantially equally distant from the further plane Π.

[0035] The oscillation axis X is arranged downstream of the geometrical axis Z with respect to the advancing direction A.

[0036] In alternative embodiments that are not shown, the oscillation axis X can be arranged differently from the manner illustrated in Figure 2, for example, it can be nearer the further plane Π than the geometrical axis Z and/or upstream of the geometrical axis Z with respect to the advancing direction A.

[0037] The oscillation generating means 17 comprises driving means, comprising in particular a servomotor 18.

[0038] The servomotor 18 is for example a servomotor including a planetary gear motor.

[0039] The servomotor 18 is mounted on an eccentric pivot 42, shown in Figure 4, which is coaxial with the oscillation axis X. The eccentric pivot 42 is arranged near a further end 47 of the first roller 2, being the further end 47 opposite the end 13.

[0040] The servomotor 18 can transmit rotation to the eccentric pivot 42 via a joint 43, for example a toothed joint. The eccentric pivot 42 is supported by a bearing 45 mounted in a supporting element 46. The supporting element 46 is connected to the frame 20. The eccentric pivot 42 is connected to a supporting shaft 44.

[0041] As shown in Figure 4, the first roller 2 is a hollow roller and the supporting shaft 44 extends inside the first roller 2. The supporting shaft 44 and the first roller 2 are connected by revolving means 48. The revolving means 48 comprises a first bearing 49, arranged at the further end 47 of the first roller 2. The first bearing 49 comprises for example a revolving bearing, having an external ring, which is not shown, mounted inside the first roller 2 so as to guide the rotation of the first roller 2 around the geometrical axis Z. The first bearing 49 further comprises an internal ring, which is not shown, which is mounted on the supporting shaft 44. The revolving means 48 further comprises a second bearing, which is not shown, which is arranged near the end 13 of the first roller 2.

[0042] When the rotating driving means 7 rotates the first roller 2 around the geometrical axis Z, the supporting shaft 44 and, consequently, the eccentric pivot 42 remain fixed to the first roller 2.

[0043] When the servomotor 18 operates, it drives the joint 43 oscillate that transmits oscillation to the supporting shaft 44 and, through the revolving means 48, also to the first roller 2.

[0044] With reference to Figure 9, from the operating configuration S, the servomotor 18 causes oscillation by an angle α of the first roller 2, according to rotation directions indicated by arrows W1 and W2, between a first stop configuration B, in which the geometrical axis Z is further from the further plane Π and a second stop configuration C, in which the geometrical axis Z is nearer the further plane Π. In the first stop configuration B and in the second stop configuration C the motion of the first roller 2 is reversed.

[0045] Unlike what is shown in Figure 9, the first stop configuration B and the second stop configuration C may not be symmetrically arranged with respect to the operating configuration S.

[0046] The servomotor 18 may also rotate the first roller 2 around the oscillation axis X by an angle β, measured from the operating configuration S, such that the first roller 2 reaches an excluding configuration D, in which the geometrical axis Z is still further from the further plane Π than the first stop configuration B.

[0047] When the first roller 2 is in the excluding configuration D, the abrasive tool means 9, in particular the first roller 2 and the abrasive belt 4, are sufficiently distant from the panel 6 so as not to sand the surface 5. In the excluding configuration D, the shaping of the surface 5 is thus excluded and the panel 6 can advance below the abrasive tool means 4 without being machined.

[0048] During the oscillation α of the first roller 2, or during rotation β of the first roller 2 around the oscillation axis X the abrasive belt 4 remains adhering to the first roller 2, as will be disclosed better below.

[0049] The oscillation generating means 17 enables an undulated profile 39 of the surface 5 to be obtained, for example of the type shown in Figure 7, in which ridges 40 and depressions 41 alternate.

[0050] The undulated profile 39 gives the panel 6 an antique appearance.

[0051] The shaping apparatus 1 enables the surface 5 to be shaped to obtain the undulated profile 39 according to a method disclosed below.

[0052] It is supposed that when the shaping apparatus 1 is driven for the first time the abrasive tool means 9 is in the excluding configuration D.

[0053] The panel 6 advances along the advancing direction A in the sanding machine and a front edge of the panel 6 reaches the shaping apparatus 1, this front edge being a part of the panel 6 that first reaches the shaping zone E, i.e. the abrasive tool means 9, along the advancing direction A.

[0054] In the meantime, the rotating driving means 7 rotates the first roller 2 in the rotation direction R.

[0055] When the front edge of the panel 6 reaches a preset position with respect to the first roller 2, the servomotor 18 rotates the first roller 2 from the excluding configuration D to the operating configuration S, in which the abrasive tool means 9 interacts with the surface 5. The preset position can be chosen in such a manner that the operating configuration S is reached with a certain delay with respect to the advancing of the front edge of the panel 6, so as to prevent the front edge of the panel 6 being machined.

[0056] The first roller 2, by rotating in the rotation direction R, drags the abrasive belt 4 in the same direction. The abrasive belt 4, being pressed in contact against the surface 5 by the first roller 2, abrades the surface 5 whilst the panel 6 advances along the advancing direction A. The first roller 2 is subsequently made to oscillate α around the oscillation axis X by the oscillation generating means 17.

[0057] The rotation R of the abrasive belt 4 and the oscillation α of the first roller 2, and consequently of the abrasive belt 4, enables the surface 5 to be shaped and the undulated profile 39 to be obtained thereupon during advancing of the panel 6.

[0058] When a rear edge of the panel 6 reaches a further position that is preset with respect to the first roller 2, this rear edge being a part of the panel 6 that reaches the shaping zone E along the advancing direction A last, the servomotor 18 stops making the first roller 2 oscillate and rotates the first roller 2 as far as the excluding configuration D, in which the abrasive tool means 9 does not interact with the surface 5. The further preset position can be chosen in such a way that the excluding configuration D is reached ahead of the advancing of the rear edge of the panel 6, so as to prevent the rear edge of the panel 6 being machined.

[0059] The panel 6 leaving the shaping zone E has an undulated profile 39.

[0060] The shaping apparatus 1 enables the shape and dimensions of the undulated profile 39 to be controlled that it is desired to obtain.

[0061] With reference to Figure 8, Q indicates a work point of the surface of the first roller 2, i.e. a point of the surface of the first roller 2 that is intended for pressing the abrasive belt 4 against the surface 5. By hypothesizing that during oscillation the machining point Q of the surface of the first roller 2 moves with harmonic motion, the undulated profile 39 obtained will have the shape of a sinusoid.

[0062] Considering an x-y plane reference system, in which the axis x indicates a component of the movement of the work point Q in function of time in a direction parallel to the advancing direction A, to take account of the advance of the panel 6, and the axis y indicates the movement f the work point Q in function of time in a direction that is orthogonal to the further plane Π, thus defining a height of the ridges 40 of the undulated profile 39 with respect to a bottom of the depressions 41, it is possible to define the parameters listed below:

V_A [m/min] = advancing speed of the panel 6 along the advancing direction A;
ω [s^{-1}] = angular oscillating speed of the first roller 2;
H [mm] = height of a ridge with respect to the axis x, measured along the axis y, given by the double of the size of the sinusoid;
T [s] = period of the oscillation α
P [mm] = pitch, i.e. distance between two consecutive ridges measured parallel to the axis x;
V_{mR} [m/s] = average lifting or lowering speed of the first roller 2 with respect to the further plane Π during oscillation.

[0063] The aforesaid parameters fulfil known kinematic ratios.

[0064] By setting the shape of the undulated profile that it is desired to obtain, i.e. by setting the pitch P and the height H, and assuming that the advancing speed V_A of the panel 6 is constant, it is possible to obtain the parameters with which the servomotor 18 has to operate, i.e. the oscillation period T and the average lifting and lowering speed of the first roller 2 with respect to the further plane Π.

[0065] The laws that regulate the oscillating motion along the axis y and along the axis x of the machining point Q, that define position, speed and acceleration of the machining point Q in function of time are known laws of harmonic motion.

[0066] Owing to the component along the axis x of the oscillating motion of the machining point Q, the surface 5 is machined in a more gradual manner than is obtained with known shaping apparatuses, in which the abrasive tool means impacts against the surface in a sudden and monodirectional manner.

[0067] The oscillation generating means 17 enables the quality of the machined surface 5 to be improved and greater uniformity between the surface quality of the ridges and the depressions to be obtained compared with the shaping performed by prior-art apparatuses.

[0068] With reference to Figure 8, the ridges 40 and the depressions 41 are formed in the manner disclosed below.

[0069] When the first roller 2 moves from the operating configuration S to the first stop configuration B, a first wall 52 of the ridge 40 is formed whilst when the first roller 2 moves from the first stop configuration B to the operating configuration S, a second wall 53 of the ridge 40 is formed, the second wall 53 being adjacent to the first wall 52 along the advancing direction A.

[0070] Similarly, when the first roller 2 moves from the operating configuration S to the second stop configuration C, a third wall 54 of the depression 41 is formed whereas when the first roller 2 moves from the second stop configuration C to the operating configuration S, a fourth wall 55 of the depression 41 is formed in which the third wall 54 is adjacent to the second wall 53 and the fourth wall 55 is adjacent to the third wall 54.

[0071] When the abrasive tool means 9 forms the first wall 52 and the third wall 54, the component along the axis x of the oscillating motion of the machining point Q, indicated by an arrow F1, is in the same direction as the advancing direction A of the panel 6.

[0072] This means that the abrasive tool means 9 acts on the surface 5 in a progressively more incisive manner during formation of the first wall 52 and the third wall 54. This results in gentler excavation.

[0073] When the abrasive tool means 9 forms the second wall 53 and the fourth wall 55, the component along the axis x of the oscillating motion of the machining point Q, indicated by an arrow F2, is in an opposite direction to the advancing direction A of the panel 6.

[0074] This results in improved contact between the abrasive belt 4 and the surface 5, with a reduced risk of the abrasive belt 4 being able to slip on the first roller 2 or on the surface 5 when it finishes forming respectively the ridge 40 and the depression 41.

[0075] Owing to the oscillation generating means 17 it is possible to obtain a shaped surface that is precise and of good surface quality.

[0076] The oscillation generating means 17 further enables the distance of the geometrical axis Z of the first roller 2 from the surface 5 to be regulated. Regulating the distance of the geometrical axis Z from the surface 5 is in fact necessary when the abrasive belt 4 used is replaced by another abrasive belt, the thickness of the other abrasive belt being different from that of the abrasive belt 4.

[0077] The shaping apparatus 1 comprises a control unit, which is not shown, for checking how the driving means and the rotating driving means 7 operate.

[0078] During oscillation of the first roller 2, the first roller 2 is alternatively moved towards or away from the second roller 3.

[0079] The abrasive belt 4 is maintained taut by compensating means 15, arranged for compensating for the movement of the first roller 2 in relation to the second roller 3, this movement being able to reduce the tension of the abrasive belt 4. Compensating means 15 comprises a cylinder 19. The cylinder 19 is mounted on a frame 20 and comprises a stem 21 connected to a central zone of a transverse rod 14 that supports end zones of the second roller 3. The cylinder 19 is controlled by the control unit of the shaping apparatus 1.

[0080] During oscillation, when the first roller 2 approaches the second roller 3, the stem 21 extends, on the other hand, when the first roller 2 moves away from the second roller 3, the stem 21 retracts, thus contrasting the variations in distance between the first roller 2 and the second roller 3. The abrasive belt 4 is thus tensioned in the desired manner in order to machine the surface 5.

[0081] Owing to the compensating means 15, the abrasive belt 4 remains adhering to the surface of the first roller 2 also during oscillation of the first roller 2 around the oscillation axis X.

[0082] Similarly to the compensating means 15, there is provided tensioning means 22, shown in Figure 5, arranged for acting on the transmission belt 12 to contrast variations in the tension of the latter. The tensioning means 22 comprises a pulley 23 mounted in a freely rotatable manner on a pivot 24. The pulley 23 is arranged outside the ring defined by the transmission belt 12. The pivot 24 is connected to a spring 25 fixed to a portion 26 of a base that is not shown to which the frame 20 is stiffly connected.

[0083] During oscillation, the first roller 2 alternatively moves towards or away from the motor 11, causing variations in the distance between the driven pulley 51 and the driving pulley 50. In particular, when the first roller 2 moves towards the motor 11 tensioning of the transmission belt 12 would tend to decrease. In this case, the spring 25 exerts an elastic action on the pulley 23 and moves the pulley 23 to the portion 26. Owing to the tensioning means 22 it is possible to maintain the desired tensioning of the transmission belt 12.

[0084] In an alternative embodiment, which is not shown, instead of the spring 25 an actuator can be provided that acts as a pneumatic spring. In this case, the actuator is connected to the control unit of the shaping apparatus 1.

[0085] Figure 6 shows a shaping apparatus 100 that differs from the shaping apparatus 1 disclosed with reference to Figures 2 to 5 by the fact of comprising an alternative embodiment of the tensioning means. The shaping apparatus 100 comprises tensioning means 122 arranged for acting on the transmission belt 12 to contrast tension variations of the latter and comprising a further cylinder 27, in particular a dual-effect cylinder. The further cylinder 27 is fixed to a further portion 28 of the base that is stiffly connected to the frame 20 and comprises a further stem 29 connected to a support 30 on which the motor 11 is mounted. The support 30 is slidable along guides 56. The further cylinder 27 is connected to the control unit.

[0086] Owing to the further cylinder 27, the motor 11 is movable along a direction indicated by the arrows M1 and M2 of Figure 6.

[0087] During oscillation of the first roller 2, the driven pulley 51 would alternatively tend to move away from and towards the driving pulley 50, thus possibly causing tensioning vibrations in the transmission belt 12.

[0088] Owing to the tensioning means 122, it is possible to compensate for variations in distance between the driving pulley 50 and the driven pulley 51, and thus maintain the desired tensioning of the transmission belt 12.

[0089] With reference to Figure 10, there is shown a shaping apparatus 200 that differs from the shaping apparatuses disclosed with reference to Figures 2 to 6 for the structure of the oscillation generating means.

[0090] The shaping apparatus 200 comprises oscillation generating means 217. The oscillation generating means 217 comprises driving means that is arranged for acting on opposite ends of lever means 35. In particular, the driving means comprises a servomotor 218 connected via motion transforming means to a first end 34 of the lever means 35. As Figure 10 shows, the servomotor 218 is connected to an operating screw 31 arranged for driving a nut screw, which is not shown, that is provided in a slide 32. The slide 32 is thus movable along an operating direction indicated by the arrows N1 and N2 of Figures 10. The operating direction N1, N2 is substantially orthogonal to the further plane Π. The slide 32 is arranged in contact with a wheel 33. The wheel 33 is rotatably supported at the first end 34 of the lever means 35. The operating screw 31, the slide 32 and the wheel 33 act to transform the rotations or oscillations generated by the servomotor 210 around an axis that is transverse to the further plane Π in rotations or oscillations of the first end 34 around an axis that is substantially parallel to the further plane Π.

[0091] The driving means further comprises an actuator, in particular a still further cylinder 38. A still further stem 37 of the still further cylinder 38 is rotatably connected to a second end 36 of the lever means 35.

[0092] In a zone comprised between the first end 34 and the second end 36, the lever means 35 is connected to the eccentric pivot 42 provided in the first roller 2, such that the lever means 35 is fixed in relation to the eccentric pivot 42. The first end 34 is thus opposite the second end 36 with respect to the eccentric pivot 42. The eccentric pivot 42 is mounted on a supporting shaft 44 that extends inside the first roller 2, similarly to what has been disclosed with reference to Figure 4.

[0093] The still further cylinder 38 is arranged for pushing the first roller 2 to the surface 5 to be machined and for taking the first roller 2 to the operating configuration S, defined with reference to the embodiment in Figures 2 to 6, such that the abrasive belt 4 can remove material from the surface 5 by abrasion.

[0094] The still further cylinder 38 further enables the first roller 2 to be taken to the excluding configuration D, in which the abrasive belt 4 is not in contact with the surface 5.

[0095] During operation, the slide 32 is moved alternatively along the operating screw 31 in the operating directions N1 ed N2, and, by pressing against the wheel 33, causes the lever means 35 to oscillate around the oscillation axis X. During oscillation of the lever means

35, and thus of the eccentric pivot 42, the still further cylinder 38 presses on the second end 36 so as to ensure that the wheel 33 remains in contact with the slide 32 even when the slide 32 moves along the operating direction N2 to the servomotor 218.

[0096] The action exerted by the shaping apparatus 200 on the panel 6 is similar to that disclosed with reference to the embodiments in Figures 2 to 6.

[0097] The lever means 35 can comprise a plurality of levers.

[0098] In all the embodiments disclosed above, the control unit checks how the oscillation generating means 17 operates, in particular the driving means, the rotating driving means 7, the compensating means 15 and the tensioning means 22, 122.

[0099] The shaping apparatus 1, 100, 200 enables a certain energy saving to be achieved with respect to known shaping apparatuses. In fact, it is not the mass of the shaping apparatus 1, 100, 200 that is moved to obtain the undulated profile, but only that of the abrasive tool means 9. The compensations performed by the compensating means 15 and by the tensioning means 22, 122 involve energy expenditure that is substantially negligible compared with the energy expenditure of a shaping apparatus of known type.

Claims

1. Method for shaping a surface (5) of an object (6) comprising the steps of:

- advancing said object (6) along an advancing direction (A),
- pressing abrasive tool means (9) against said surface (5) to abrade said surface (5), said abrasive tool means (9) comprising roller means (10),
- rotating said roller means (10) around a geometrical axis (Z) thereof, said geometrical axis (Z) being contained on a plane that is substantially parallel to said advancing direction (A),

characterised in that it further comprises

- oscillating said roller means (10) around an oscillation axis (X) substantially parallel to said geometrical axis (Z) to obtain an undulated profile(39) of said surface (5).

2. Method according to claim 1, wherein said oscillating occurs during said pressing.

3. Method according to claim 1, or 2, wherein said oscillating occurs during said rotating.

4. Method according to any one of claims 1 to 3, wherein said oscillation axis (X) and said advancing direction (A) are substantially orthogonal to one another.

5. Method according to any preceding claim, wherein said obtaining said undulated profile (39) comprises obtaining a ridge (40) and/or a depression (41), said ridge (40) and/or said depression (41) extending substantially parallel to said geometrical axis (Z).

6. Shaping apparatus for shaping a surface (5) of an object (6) that is movable along an advancing direction (A), comprising abrasive tool means (9) arranged for pressing against said surface (5) to abrade said surface (5), said abrasive tool means (9) comprising roller means (10) rotatable around a geometrical axis (Z) thereof, said geometrical axis (Z) being contained on a plane substantially parallel to said advancing direction (A), **characterised in that** it further comprises oscillation generating means (17) arranged for oscillating said roller means (10) around an oscillation axis (X) substantially parallel to said geometrical axis (Z) to obtain an undulated profile(39) of said surface (5).

7. Shaping apparatus according to claim 6, wherein said oscillation generating means (17) is connected to eccentric pivot means (42) provided in said roller means (10), said eccentric pivot means (42) being substantially coaxial to said oscillation axis (X).

8. Shaping apparatus according to claim 7, wherein said eccentric pivot means (42) is supported by revolving means (49) mounted on an internal wall of said roller means (10), said roller means (10) being internally hollow.

9. Shaping apparatus according to claim 7, or 8, wherein said oscillation generating means (17) comprises driving means (18; 38, 218) arranged for driving said eccentric pivot means (42) to oscillate around said oscillation axis (X) to cause oscillation of said roller means (10) around said oscillation axis (X).

10. Shaping apparatus according to claim 9, wherein said driving means (18; 38, 218) comprises a servomotor (18) mounted coaxially to said eccentric pivot means (42).

11. Shaping apparatus according to claim 9, wherein said driving means (38, 218) is connected to lever means (35) fixed relatively to said eccentric pivot means (42) for driving said lever means (35).

12. Shaping apparatus according to claim 11, wherein said driving means (38, 218) comprises a servomotor (218) connected via motion transforming means (31, 32, 33) to a first end (34) of said lever means (35) and an actuator (38) connected to a second end (36) of said lever means (35), said first end (34) being opposite said second end (36) with respect to said eccentric pivot means (42).

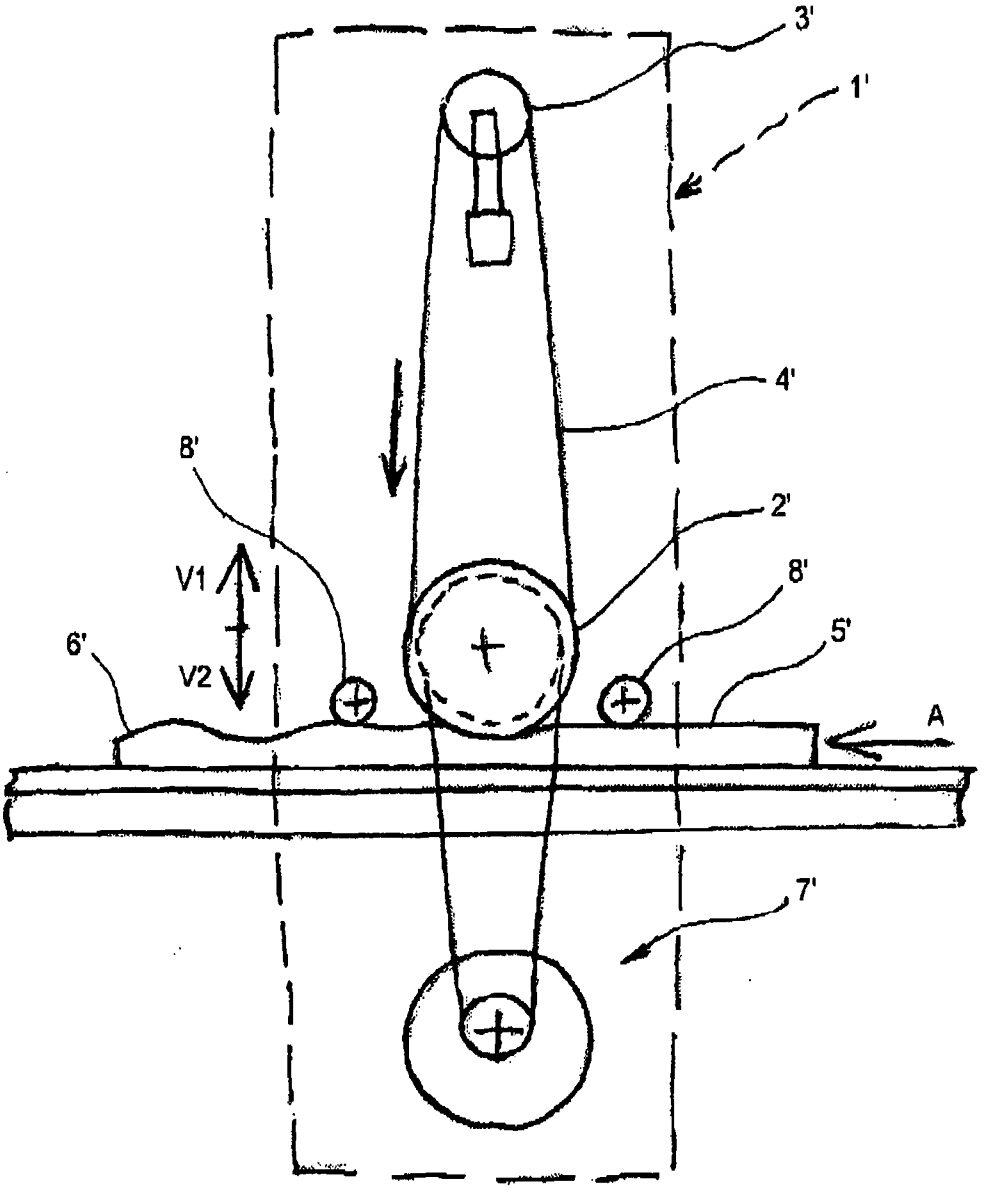
13. Shaping apparatus according to any one of claims 9 to 12, and further comprising a control unit for monitoring how said driving means (18; 38, 218) operates.

14. Shaping apparatus according to any one of claims 6 to 13, and further comprising compensating means (15) arranged for moving a roller (3) of said roller means (10) with respect to a further roller (2) of said roller means (10), so as to compensate for a variation in tension of an intended abrasive belt (4) when said roller means (10) oscillates, said roller (3) and said further roller (2) being arranged for being wound by said abrasive belt (4).

15. Shaping apparatus according to any one of claims 6 to 14, and further comprising further driving means (7, 12, 50, 51) arranged for driving said roller means (10) to rotate around said geometrical axis (Z), said further driving means (7, 12, 50, 51) comprising flexible transmission means (12), said shaping apparatus (1, 100, 200) further comprising tensioning means (22; 122) arranged for contrasting a tension variation of said flexible transmission means (12) when said roller means (10) oscillates.

16. Shaping apparatus according to any one of claims 6 to 15, wherein said oscillation axis (X) and said advancing direction (A) are substantially orthogonal to one another.

17. Shaping apparatus according to any one of claims 6 to 16, wherein said oscillation axis (X) is arranged downstream of said geometrical axis (Z) with respect to said advancing direction (A).



PRIOR ART

Fig. 1

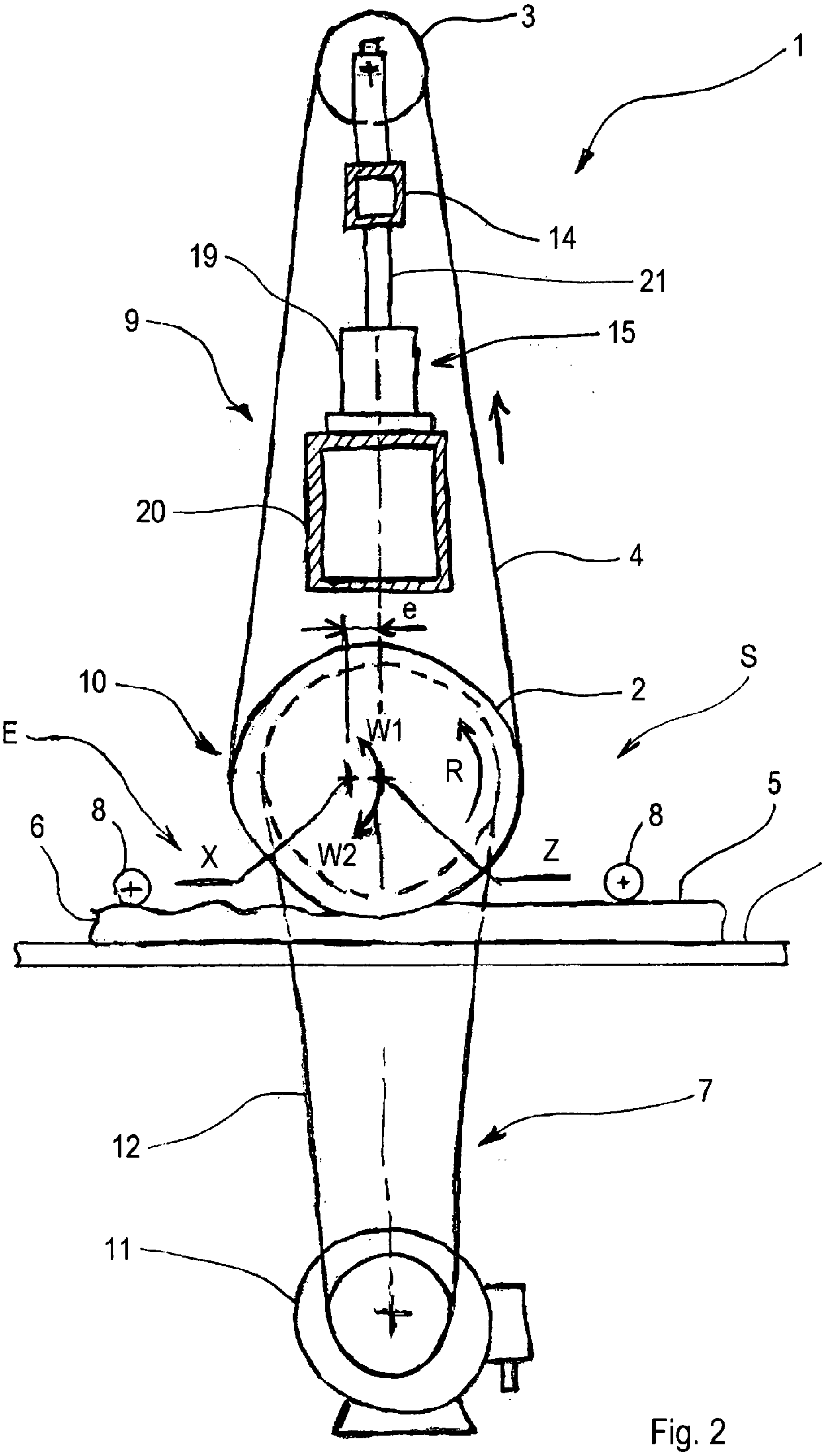


Fig. 2

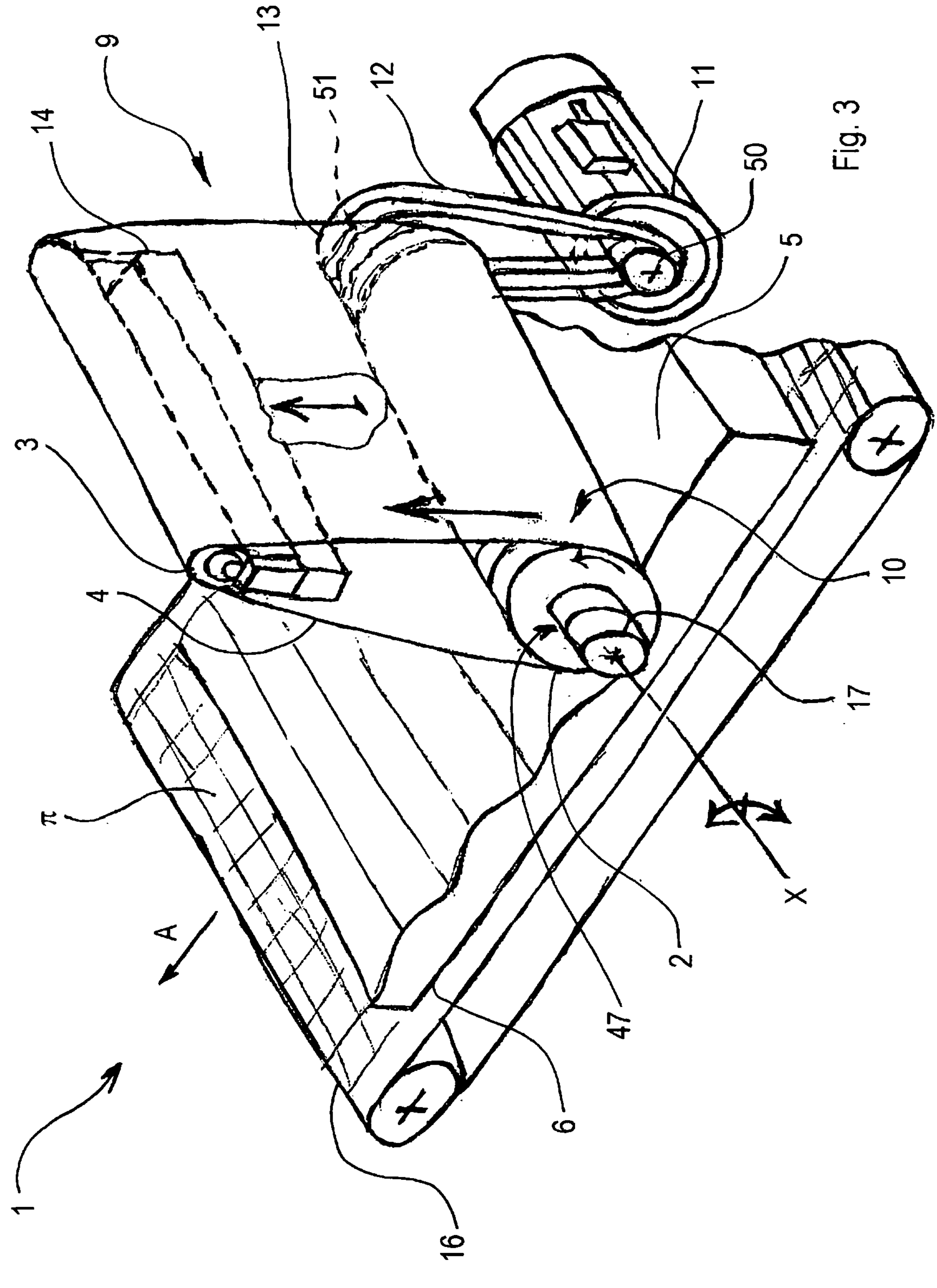


Fig. 3

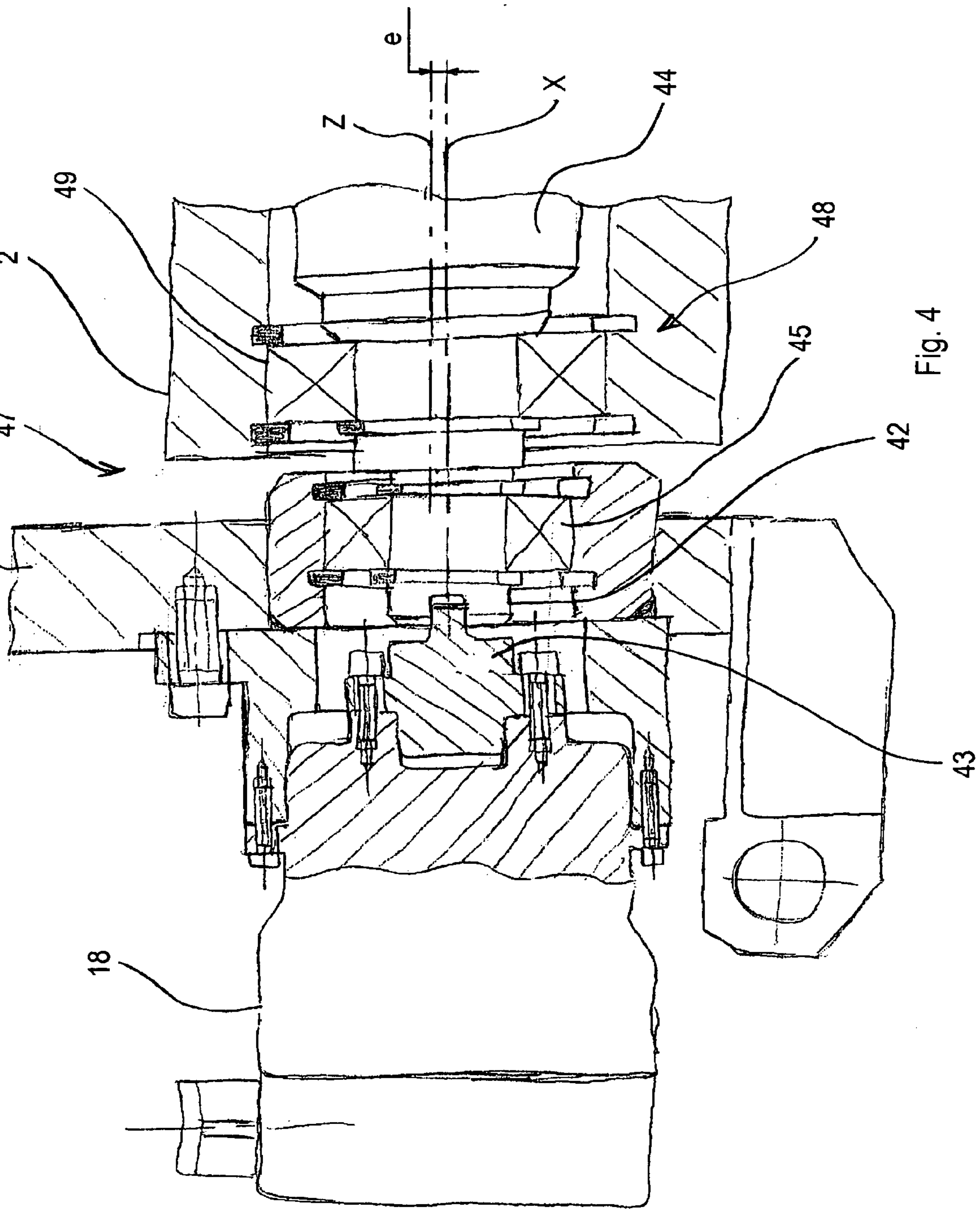
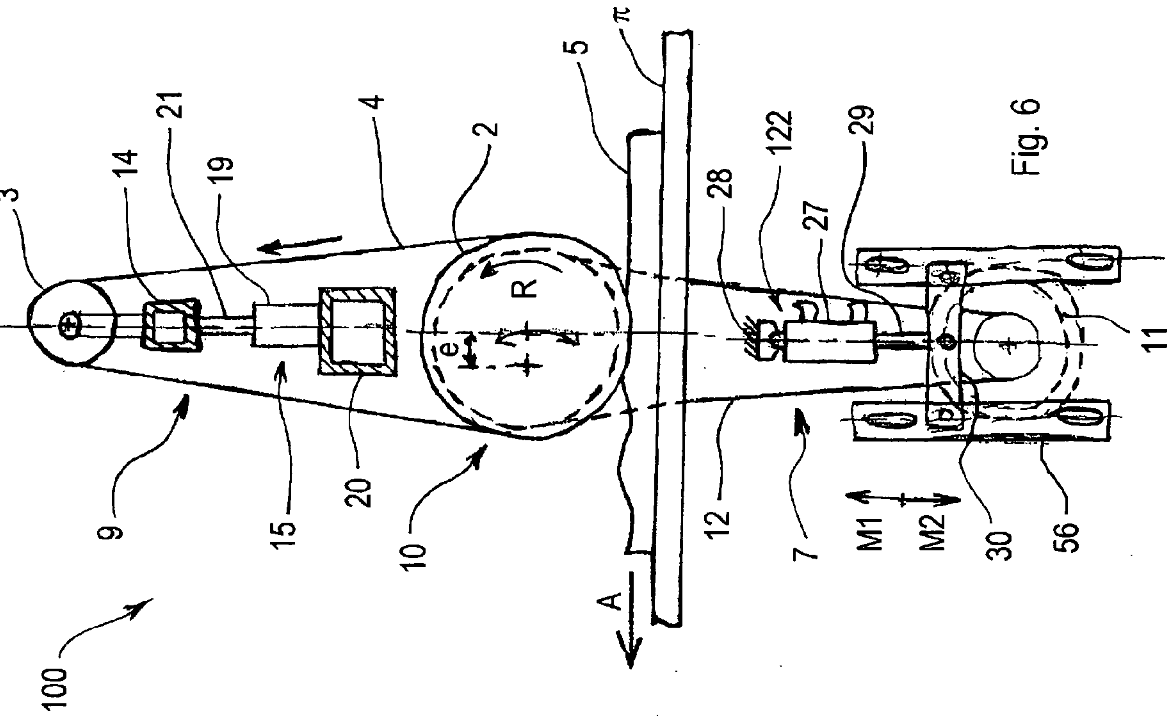


Fig. 4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3
14
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19
4
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5
π
A
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M1
M2
30
56
28
122
27
29
11

Fig. 6

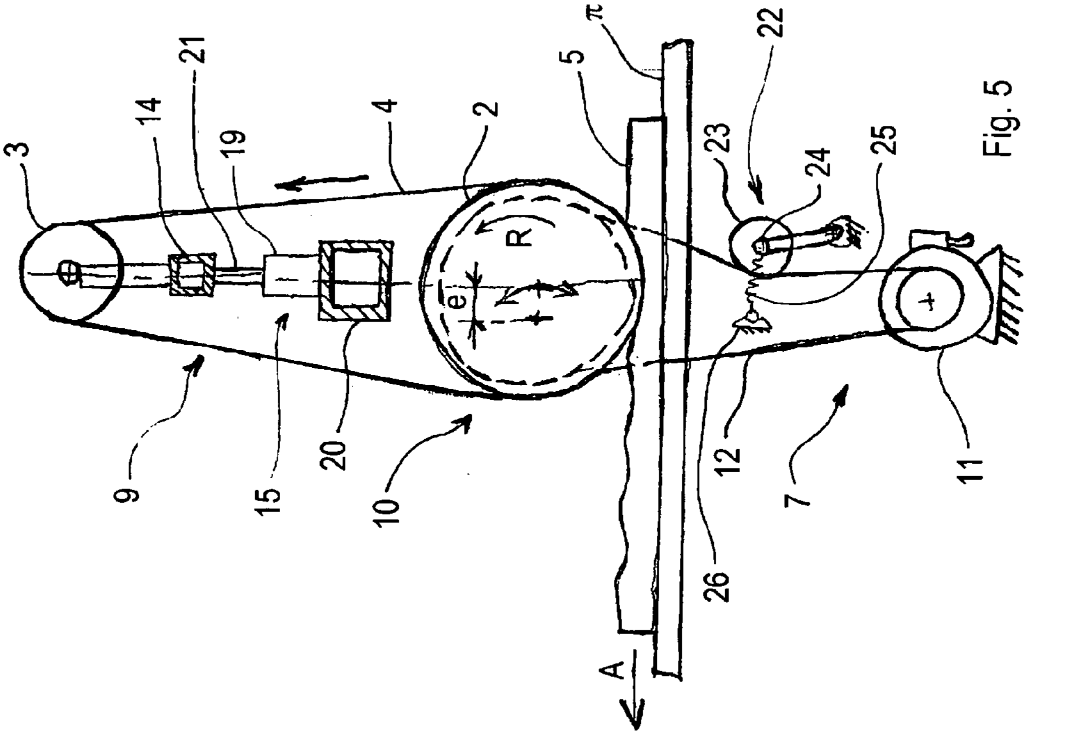
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Fig. 5

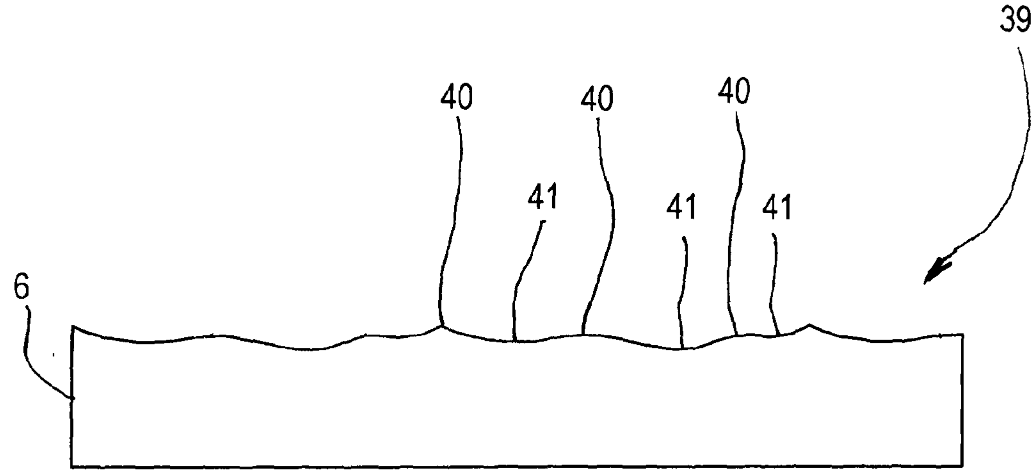
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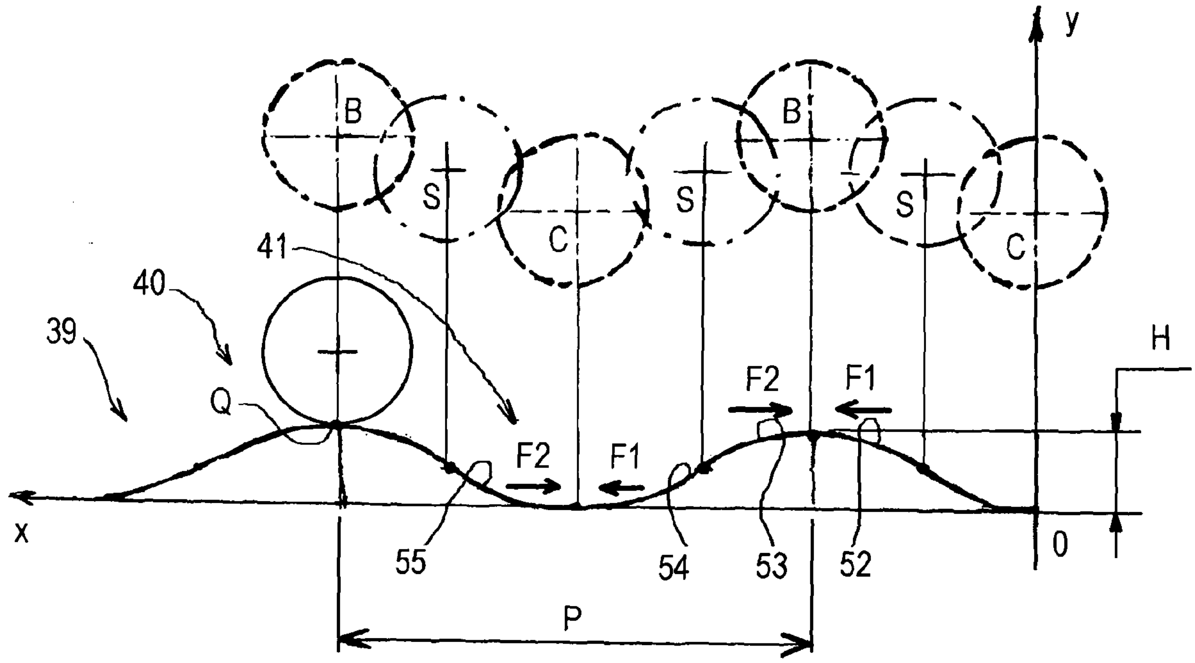
Fig. 7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C
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54
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52
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P

Fig. 8

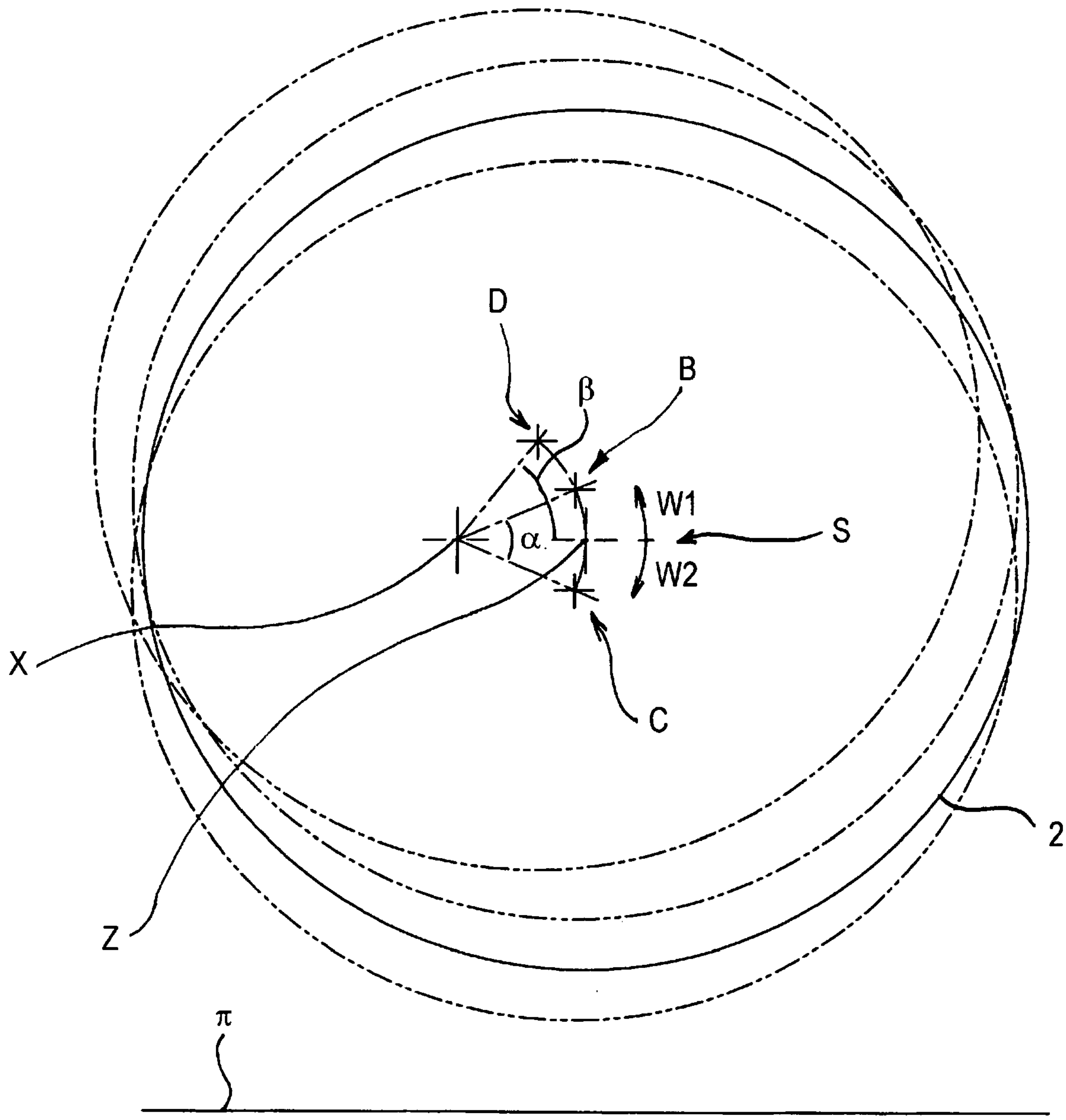

Fig. 9

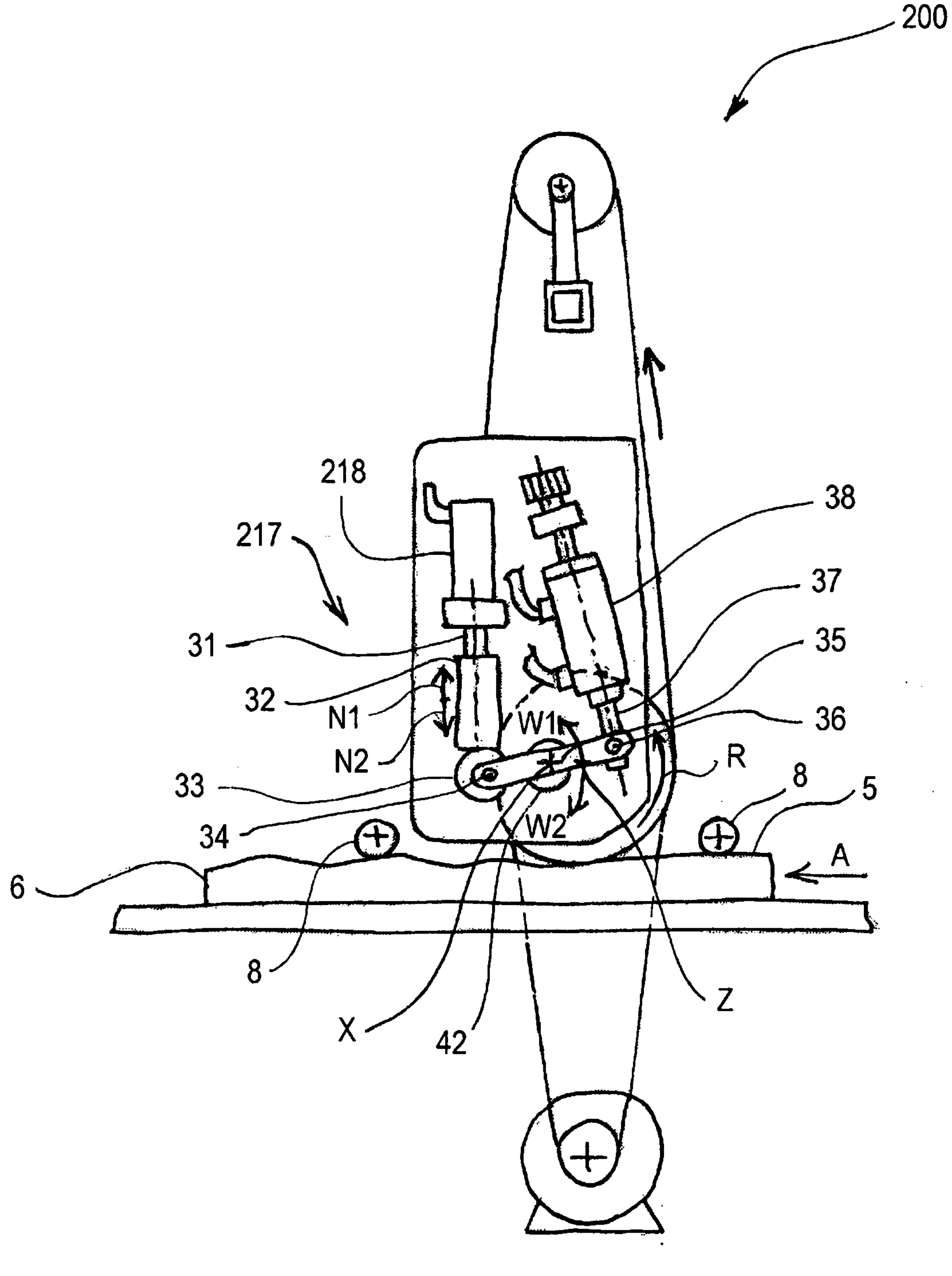

Fig. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 10 16 3009

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2004/087260 A1 (WANG WANG TIEN [TW]) 6 May 2004 (2004-05-06) * paragraphs [0006], [0007], [0023] - [0031]; figures * -----	1-17	INV. B24B21/12 B24B21/22 B24B7/19
A	DE 101 02 184 A1 (FRAUNHOFER GES FORSCHUNG [DE]) 1 August 2002 (2002-08-01) * paragraphs [0009], [0011], [0018] - [0022] * -----	1-17	

TECHNICAL FIELDS SEARCHED (IPC)
B24B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 August 2010	Gelder, Klaus

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CATEGORY OF CITED DOCUMENTS

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The members are as contained in the European Patent Office EDP file on
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03-08-2010

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82