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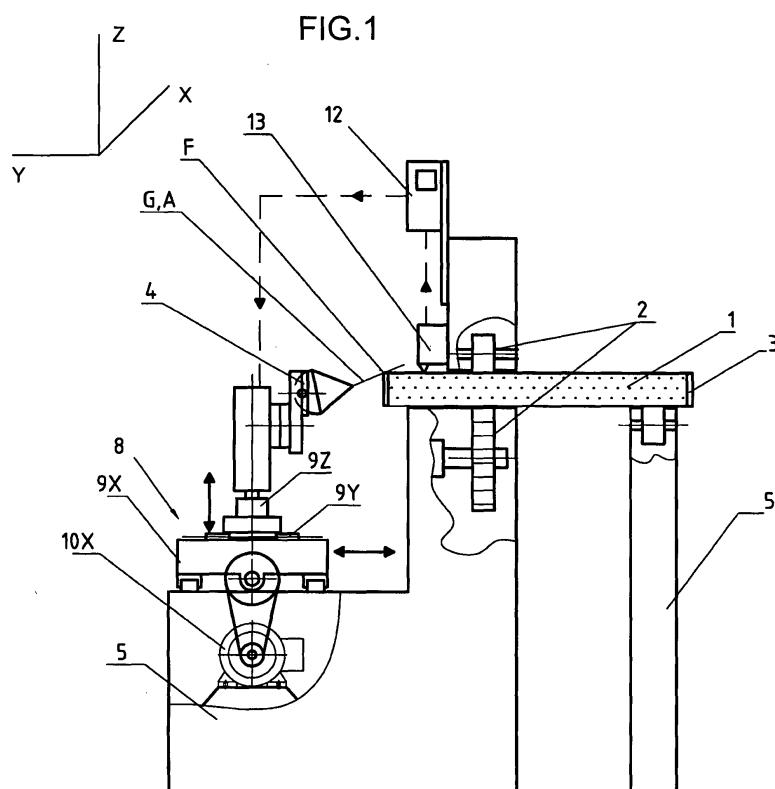
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(54) **An edge banding machine with laser cutting system**

(57) An edge banding machine comprising means (2) for feeding panels (1) in a horizontal plane along a direction X, a station for applying a strip (3) on the edge (1b) of a panel (1), and a station for trimming the strip (3), equipped with a laser cutting system (4) that generates a light beam (G), whose focal point (F) strikes the strip (3) and which operates to give the strip, in cross-

section, an outline (S) of the desired shape, using the laser beam cutting effect.

The means (8) supporting the laser system (4) relative to the base (5) of the machine comprise movement means (9X), (9Y), (9Z) and means (11) and (14) for angling the beam (G), so as to vary the position of the beam (G) and the strip (3) relative to one another, allowing contact between the beam (G) and the strip (3).



EP 1 588 812 A1

Description

[0001] The present invention relates to a linear edge banding machine for panels made of wood and the like, as a whole of a type substantially known in the sector of secondary wood machining, and in particular in the completion of the flat, normally rectangular, parts of furniture such as modular kitchens, office desks and the like.

[0002] Such machines are designed to apply a covering strip, normally of synthetic material, to at least one of the lateral edges of panels in transit in the machine, and to give the strip applied to the edge in this way the correct aesthetic finish. Such operations are known as a whole as panel edge banding.

[0003] In the above-mentioned linear edge-banding machines, the panels are inserted one after another and fed by a special conveyor, normally a feed belt, driven by one of the wheels (driving) between which it is stretched. On the conveyor, the panels are held down by the vertical action of an upper presser, usually in the form of a roller conveyor or idle belt, and fed forward in that way. The strip is applied to the edge of the panels by gluing in a special station on the machine, where a cutter then cuts most of the excess strip applied from a roll, deliberately leaving a small longitudinal excess at the front and rear of the panel, and a transversal excess relative to the upper and lower surfaces of the panel. In the particular case of edges with a rectangular profile, in the machines in the prior art, cutting to size (longitudinal end trimming) and transversal trimming are performed using rotary tools, in two stations on the machine located one after another, with particular attention paid to the aesthetic finish. Even in the rather common cases in which the front or rear profile of the panel is shaped - for example semi-circular - the strip applied is finished in such a way as to follow the profile of the edge perfectly by two rotary tools, substantially routers, called trimmers, one lower and one upper, operating according to predetermined strategies on each machine, on respective lower and upper parts of the edge of the panel in transit, and on the front and rear of the panel.

[0004] Therefore, on these machines precise trimming must normally be carried out, to rapidly obtain workpieces with a satisfactory appearance, and flexible operation is also necessary with regard to the many profiles which may appear each time, suitably adjusting the trimming operation - that is to say, the trajectories of the trimming tools - to the different profiles of the edges.

[0005] Therefore, the invention relates in particular to an edge banding machine on which a new system is implemented, able to flexibly and advantageously manage the operation for trimming the strip applied to the edges for each panel (or batch) machined, as described below.

[0006] At present in the edge banding machine sector, trimming is carried out using two rotary tools, which operate at the edge of the panel, one on the upper side and the other on the lower side of the panel. The two tools have independent drive units, allowing them to fol-

low the profile (that is to say, the perimeter) of the edge of the panel, even at the front and the rear of the panel.

[0007] The tools in question change according to the type of strip to be trimmed. The strip may vary both in thickness and in shape.

[0008] Systems are known which change the tool automatically in response to a change in the shape of the strip, taking the new tool from a tool magazine mounted on the machine. Systems are also known which require the operator to manually change the tool in response to changes in the strip. Other known systems use multi-radius tools, so that the same tool can be used for a wide range of sizes, by simply adjusting the position of the tool relative to the edge.

[0009] However, the known solutions have a series of disadvantages. Firstly, they require machine stops to change the tool when the size changes, stops which may be more or less long, depending on the type of tool change-over.

[0010] Systems with automatic tool change-over must have a dedicated space, or magazine, containing the tools that are not used, consequently increasing the dimensions of the apparatus.

[0011] Systems using multi-cutting edge tools are rather expensive, the tool is delicate, is difficult to sharpen and is unlikely to be suitable for all possible types of edge banding.

[0012] Therefore, a minimum number of size changes must always be expected.

[0013] It should also be said that systems using cutting tools of any kind are subject to wear on the cutting edge, which increases with use and leads to worsening of the edge surface finish. As the wear continues and the cutting edge becomes blunter, vibrations are generated, which lead to the formation of steps on the edge of the panel, with a consequent poor aesthetic finish on the workpiece machined. The seriousness of this disadvantage increases proportionally with the speed of panel feed.

[0014] Therefore, edge banding machines according to the prior art have noticeable operating problems linked to the aspects listed above, which - even if they were in some way accepted in the past - are now more important, since the furniture market is no longer open to compromises as regards a component's finish. Such problems are accentuated as soon as the high price range of edge banding machines is also considered, which necessitates the production of workpieces with minimum waste and with the best possible finish, so as to speed up the return on the investment that it represents.

[0015] Therefore, a machine which has a system that does not use conventional cutting tools for the operations to be performed on the strip at the edge profile, automatically adapting to the profile to be followed, and which does not suffer poor surface finish problems linked to wear on the cutting edge, would be a solution to the problems described above.

[0016] The aim of the present invention is to overcome the above-mentioned disadvantages by using a special system for trimming the strip on the profile of the edge of the panels, in particular by introducing on the edge banding machine a system able to adapt to the profile to be created, allowing consequent correct trimming of the strip on the edge, without the problems linked to adaptation of a mechanical tool to the type of profile.

[0017] The invention, as described in the claims herein, therefore solves the problem of producing an edge banding machine equipped with units for trimming the excess part of the strip applied on the edge, at the same time maintaining great operating flexibility and the functional characteristics of previous edge banding machines and, in fact, providing improvements.

[0018] The idea developed in the following description achieves the afore-said aims with a solution comprising a laser system that, during a movement relative to the edge, generates a laser beam focused and operating on the edge of the strip at the profile of the panel edge, said system being arranged along the panel edge feed line, therefore, at the side of the path followed by panels in transit in the machine, and subject to suitable electronic control and processing means.

[0019] In particular, the invention refers to a linear edge banding machine of the type known for machining the edges of flat wooden panels of limited thickness, which pass through the machine, such as flat parts of furniture, where the edges are substantially flat and have an assigned profile. Said machine comprises:

- means for feeding the panels relative to a base, in a horizontal plane XY, along its axis X, with reference to a right-angled X, Y, Z coordinate system;
- stations for machining the flat edges, located one after another, to which a panel is fed in sequence by the feed means and at which a strip of synthetic material is first glued to one of the vertical flat edges, then the excess strip applied is trimmed, to match it precisely to the respective profiles, by trimming units operating on the strip;
- machine electronic control means;

where the novel feature of the invention disclosed is the fact that the trimming units comprise a laser cutting system, supported by the base on supporting means, and controlled by the electronic control means. Said laser cutting system generates a laser beam with a predetermined axis and a relative focal point, which strikes the strip applied to the edge, operating on it to define, on the sections normal to said axis X, the desired outline.

[0020] Another novel feature of the invention disclosed is that there are substantially known means for detecting the position (and therefore the geometry) of said profile, and also the supporting means comprise sliding means, such as slides, which allow the device to slide along at least one of the directions identified by the

feed axes X, Y, Z. There are also rotation means, able to rotate the laser device about an axis perpendicular to the strip applied. The combination of the movements allows the laser device to be positioned relative to the panel machined, and to also machine the front and rear profiles of the panel.

[0021] The advantages obtained on the machine disclosed, as already partly mentioned, mainly derive from the possibility of changing the cross-section (outline) of the strip applied to the edge, at the edge profile, without the need to change the tool. The size of the machine is reduced, recovering the space occupied by the tool magazine, and production downtimes are reduced, eliminating the tool change-over time.

[0022] Moreover, the device proposed overcomes the problem deriving from a worn cutting edge, allows the speed of machining to be increased and maintains, or even increases, the level of surface finish thanks to a reduction in vibrations.

[0023] The invention is described in more detail below with reference to the accompanying with reference to the accompanying drawings, which illustrate a preferred embodiment without limiting the scope of its application.

[0024] The rest of the machine is substantially similar to one of the possible set-ups of a common and known linear edge banding machine, and therefore is not described or illustrated. The description and illustrations are substantially limited to the details relating to the layout and management of the laser cutting head which, although representing the innovative factor of the machine compared with the prior art, is therefore also to be considered as a device that is in itself known and, therefore, does not require special explanations.

[0025] Therefore:

- Figure 1 is a view of the machine along the direction of the panel 1 feed axis X, basically illustrating the laser system 4 movement slides 9X, 9Y, 9Z, the panel 1 feed system 2, the slide 9X actuator 10X, the electronic control means 12, and a feeler 13 designed to detect the position Z in which the edge 1b of the panel 1 is located; the interaction between the beam G emitted by the laser system 4 and the upper part of the profile 1p of the edge 1b at the beam G focal point F is also illustrated;
- Figure 2 is substantially similar to Figure 1, except that the interaction of the beam G with the lower part of the profile 1p of the edge 1b is illustrated;
- Figure 3 is a view according to the axis X of the laser system 4 supporting means 8, in particular of a wrist 11 for rotating the platform 14 about an axis A1 normal to the edge 1b, and the possibility of angling the end part of the laser source 4 relative to the platform 14 thanks to a joint, so as to vary the angle of the beam G;
- Figure 4 is an axonometric view of the panel 1 and the strip 3 applied to it along the axis X, as they appear after trimming, that is to say, having an outline

S (in a cross-section normal to the axis X) characterised by the rounded shape of the edges;

- Figure 5 is a view of a further detail of the previous figure, illustrating a situation in which the laser beam G is operating on the upper profile 1p of the edge 1b; the axis A of the beam G is in a vertical plane normal to the axis X, and forms the angle B with the axis A1, or with a straight line parallel with it; the strip 3 has been partly trimmed at the upper part of the profile 1p, whilst it is still to be trimmed at the lower part of the profile 1p;
- Figure 6 illustrates the characteristic geometric elements involved in trimming the strip 3 applied to the panel 1; in particular, the edge 1b with its profile (perimeter) 1p, and the outline S of the normal cross-section of the strip 3, rounded after trimming;
- Figure 7 is an axonometric view illustrating the bundle of vertical planes incident upon the edge 1b, in which - thanks to the angling possibilities for the beam G that will be described - the axis A of the beam G may lie (they include the vertical plane normal to the axis X, as illustrated in Figure 5); any plane - at an angle B to the horizontal - substantially at a tangent to the outline S at the upper part of the profile 1p is also illustrated: said plane, for particular machining requirements, may be "swept" by the axis A of the beam G.

[0026] The laser cutting system 4 which characterises the edge banding machine disclosed is innovative due to the overall machine solution configured with it. Said machine, in its preferred configuration described below and illustrated in the drawings, normally comprises the path followed by the panels 1 which, arranged one after another in a horizontal plane XY, are fed along the axis X by the lower feed belt 2, operating in conjunction with the upper presser equipped with idle rollers.

[0027] In the part of the machine where the machining units are normally located, and where the various operations are performed on the edge 1b and on the strip 3, the above-mentioned laser beam G generating system 4 is also located, which, as already indicated, is of the substantially known type and supported by the base 5 of the machine with suitable supporting means 8.

[0028] Said means 8 comprise both sliding means 9 for laser system 4 movement and mechanical means 11 and/or 14 for angling the axis A of the beam G generated by the system 4. Moreover, inside the system 4 there are optical means 6 for adjusting the focal point F of the beam G on its axis A, means 7 for adjusting the power of the laser beam G used for cutting and internal means 15 for optically varying the angle of the axis A of the beam G.

[0029] Examining in more detail the supporting means 8 for the laser system 4, which are designed to move the system, a first slide 9X may be identified, which slides along the axis X on the base 5, driven by a respective actuator 10X controlled by the machine

electronic control 12, made according to customary layouts, here in particular with a device with a rotary motor and recirculating ball screw and lead nut system.

[0030] Thanks to the controlled movements along the axis X, the laser system 4 can move parallel with the panel 1, faster or slower than the panel, so as to manage the trimming cut on the strip 3 according to beam G action times that do not depend on the panel 1 feed speed, and in such a way that trimming can also be managed at the ends 1t and 1c of the profile 1p, which may be curved, respectively at the front and at the back.

[0031] A second slide 9Y, driven by a respective customary actuator 10Y, controlled by the electronic control 12 slides in the direction Y on first slide 9X guides.

[0032] Similarly, a third slide 9Z, driven by a respective customary actuator 10Z, also controlled by the electronic control 12, slides in the direction Z on second slide 9Y guides.

[0033] The movements of at least the slides 9Y and 9Z must be co-ordinated in order to bring the beam G - in particular its focal point F - into contact with the strip 3, at the edge profile 1p, for trimming. In practice, according to a section normal to the feed axis X, the movements of the slides 9Y and 9Z bring the beam G "to rest" on the strip 3 at the edge 1b profile 1p.

[0034] Obviously, the extent of the movements attributed to the slides by the numeric control 12 depends on the position of the profile 1p (therefore, also on its geometry) as detected by the detector means 13. In particular, the detector means 13 comprise a feeler for directly reading the panel 1 position Z at the profile 1p, and two optical position transducers (of customary type and therefore not illustrated) for reading the position Y of the profile 1p, and respectively, the position X of the profile at the front and/or rear of the panel.

[0035] In addition to the above-mentioned three slides, movement of the laser system 4 is allowed by further movement means 11, again ideally included in the afore-mentioned set of supporting means 8. In particular, the means 11 consist of a wrist which rotates about an axis A1 parallel with the axis Y, and a rotary support 14, in the form of a platform. Said wrist connects the slide 9Z on one side to the platform 14 on the other.

[0036] A joint inserted between the end part of the laser source 4 and the platform 14 completes the movement means 11, designed to vary the angle of the beam G. It should also be noticed that the laser system 4 used in this embodiment includes optical means 15, inside it, which allow the axis A of the beam G to assume a predetermined angle relative to the axes X, Y, Z, controlled by the electronic control means 12. This reveals the small number of mechanical movements required to collimate the beam G on the perimeter of the strip 3, thus also reducing inertia and increasing the possible operating speeds.

[0037] In this way, the degrees of freedom that the laser system 4 needs to perform trimming on the strip 3 are fully guaranteed.

[0038] Therefore, thanks to the kinematic chain described, the axis A of the beam G can be made incident upon the horizontal axis A1 of platform 14 rotation - at an angle B. That is to say, the axis A can be positioned askew relative to the axis A1. In these situations the axis A of the beam G may describe either a conical surface portion with half-opening B and axis A1, or respectively a generic ruled surface revolved about the axis A1.

[0039] The movement possibilities described clearly explain how the beam G can effectively be brought - with its focal point F - into contact with the perimeter of the strip 3, to perform trimming.

[0040] In another embodiment proposed, there are two cutting devices, one acting on the upper part of the perimeter of the strip (practically coinciding with the upper profile of the panel edge) and one acting on the lower perimeter of the strip. In this way, device operating times are practically halved. At an operational level, the edge banding machine equipped with the laser trimming system 4 structured in this way achieves the preset aim thanks to the action of the laser beam G generated by the system 4, which cuts the strip applied to the panel edge, eliminating the excess part and creating a rounded profile with the desired shape. The point at which the beam G operates is identified by the beam focal point F, where the position of said point F can be adjusted on the axis A and where beam intensity is also adjustable. In practice, with reference to the trimming at the long upper part of the profile 1p of the panel 1b, the strip 3 trimming laser cut is made by bringing the beam G into contact with the perimeter of the strip, substantially at a tangent and not secant to the edge of the strip, and at the focal point F. Obviously, the interaction between the electronic control means 12, the detector means 13 and the actuator means makes precise beam G positioning possible.

[0041] The beam G can operate whether positioned in a plane normal to the axis X (Figures 5 and 7), or in any of the vertical planes incident upon the profile 1p.

[0042] As regards focusing, in practice the focal point F is not actually a point in the geometric sense, but corresponds to a short section of the beam G. Therefore, for reasons linked to the optics of the source, focusing is often not strictly conical, but is a constriction of the beam at its throat section, which conventionally is used as the beam G focal point F.

[0043] As regards the rounding of the edge of the strip 3, required in the trimming operation, this takes place both thanks to the geometric action of the beam G, which acts like an optical cutter, and more often in association with the spontaneous retraction and rounding of the strip 3 material in the beam G action zone, thus producing, on the normal sections of the strip 3, the characteristic strip outline S rounded by the beam.

[0044] In the latter case it is evident how it is sufficient to perform a relative movement along the axis X between the beam G and the panel 1, maintaining the angle of inclination constant - for example equivalent to B

- between the axis A of the beam and the axis A1 normal to the panel edge 1b, to obtain a rounded strip outline S. If, in contrast, the material machined does not retract enough spontaneously, rounding would equally be possible using planes at a tangent to the edge of the strip; in practice, having the beam rapidly sweep such a tangent plane, which in turn has a varying angle, substantially describing a bundle of planes with the strip longitudinal edge as their axis.

[0045] The invention described and illustrated may be subject to other modifications and variations without thereby departing from the scope of the inventive concept. Moreover, all details of the invention may be substituted with technically equivalent elements.

Claims

1. A linear edge banding machine of the substantially known type for machining edges of panels (1) with limited thickness, made of wood or the like, moving through the machine, such as flat parts of furniture; said edges comprising flat edges (1b) with a profile (1p), the machine comprising:

- means (2) for feeding the panels (1) relative to a base (5), along an axis X of a substantially horizontal plane XY, with reference to a right-angled X, Y, Z coordinate system;
- stations for machining the flat edges (1b), located one after another, to which one of the panels is sequentially fed by the feed means (2) and where firstly a strip (3) of synthetic material is applied by gluing it to one of the vertical edges (1b), then the excess strip (3) applied on the edge (1b) is trimmed by the action of units (16) which trim the strip (3);
- machine electronic control means (12);

the edge banding machine being **characterised in that** the units (16) comprise a laser cutting system (4), supported by the base (5) with supporting means (8), controlled by the electronic control means (12) and generating a beam (G) of light with an axis (A), the focal point (F) of said beam incident upon the strip (3) applied to the edge (1b) and operating on said strip (3) in such a way as to create a strip outline (S) with the desired shape, in sections normal to the axis (X).

2. The edge banding machine according to claim 1, **characterised in that** there are means (13) for detecting the position of the profile (1p) of the edge (1b); said detector means (13) being connected to the electronic control means (12), to control the position of the beam (G) axis A.

3. The edge banding machine according to claim 1 or

- 2, **characterised in that** the laser cutting system (4) and the supporting means (8) are designed to position the beam (G) axis (A) in a vertical plane, normal to the axis X, identified by said outline (S).
4. The edge banding machine according to one or more of the foregoing claims, **characterised in that** the laser cutting system (4) and the supporting means (8) are designed to position the beam (G) axis (A) in a vertical plane, striking the edge (1b).
5. The edge banding machine according to one or more of the foregoing claims, **characterised in that** the supporting means (8) comprise means (9X), in particular a slide (9X), which slide along the horizontal axis (X) relative to the base (5); there being actuator means (10X) for the slide (9X), controlled by the electronic control means (12).
6. The edge banding machine according to one or more of the foregoing claims, **characterised in that** the supporting means (8) comprise means (9Y), in particular a slide (9Y), which slide along the horizontal axis (Y) relative to the base (5); there being actuator means (10Y) for the slide (9Y), controlled by the electronic control means (12).
7. The edge banding machine according to one or more of the foregoing claims, **characterised in that** the supporting means (8) comprise means (9Z), in particular a slide (9Z), which slide along the vertical axis (Z) relative to the base (5); there being actuator means (10Z) for the slide (9Z), controlled by the electronic control means (12).
8. The edge banding machine according to one or more of the claims 5, 6, 7, **characterised in that** the supporting means (8) comprise movement means (11) designed to allow rotation of the laser cutting system (4) about an axis (A1) perpendicular to the edge (1b) of the panel (1); where, with the movement means (11) and one or more of the sliding means (9X), (9Y), (9Z) working in conjunction with one another, the focal point (F) of the beam (G) strikes the strip (3) close to the profile (1p) of the edge (1b); in particular, even for matching the strip (3) to the profile (1p), at sections (1t) and (1c) of the profile (1p) respectively at the front and the rear of the panel (1).
9. The edge banding machine according to claim 8, **characterised in that** the movement means (11) comprise a support (14) which rotates about the axis (A1), where the beam (G) axis (A) strikes the axis (A1) at an angle (B); said beam (G) axis (A) describing portions of a conical surface with axis (A1) and a half-opening (B) following rotation of the support (14) about the axis (A1).
10. The edge banding machine according to claim 8, **characterised in that** the movement means (11) comprise a support (14) which rotates about the axis (A1), where the beam (G) axis (A) is askew relative to the axis (A1); said beam (G) axis (A) describing portions of a surface of revolution having an axis (A1), following rotation of the support (14) about the axis (A1).
11. The edge banding machine according to claim 9 or 10, **characterised in that** the movement means (11) comprise a joint for moving the laser cutting system (4) relative to the rotating support (14).
12. The edge banding machine according to one or more of the foregoing claims, **characterised in that** the cutting system (4) comprises internal means (15) designed to generate a desired angle of the beam (G) axis (A).
13. The edge banding machine according to one or more of the foregoing claims, **characterised in that** the cutting system (4) comprises optical means (6) for adjusting the focal point (F) on the axis (A).
14. The edge banding machine according to one or more of the foregoing claims, **characterised in that** the cutting system (4) comprises means (7) for adjusting the power of the beam (G) of light.
15. The edge banding machine according to one or more of the foregoing claims, **characterised in that** the focal point (F) is preceded, and respectively followed, along the axis (A), by respective sections of the beam (G), useful for cutting.
16. The edge banding machine according to one or more of the foregoing claims, comprising a plurality of cutting systems (4), operating on separate sections of the profile (1p) of the edge (1b).

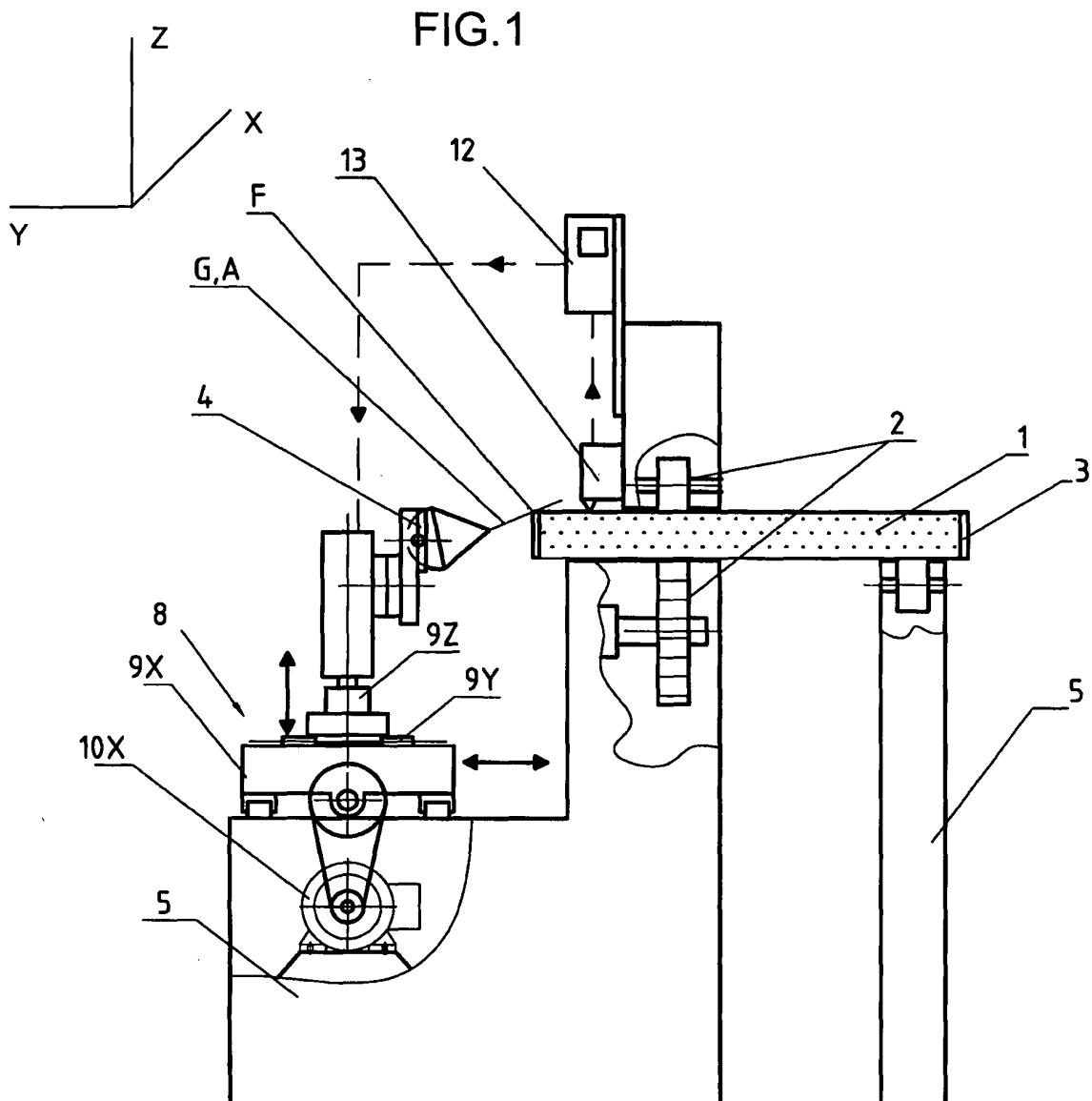


FIG.2

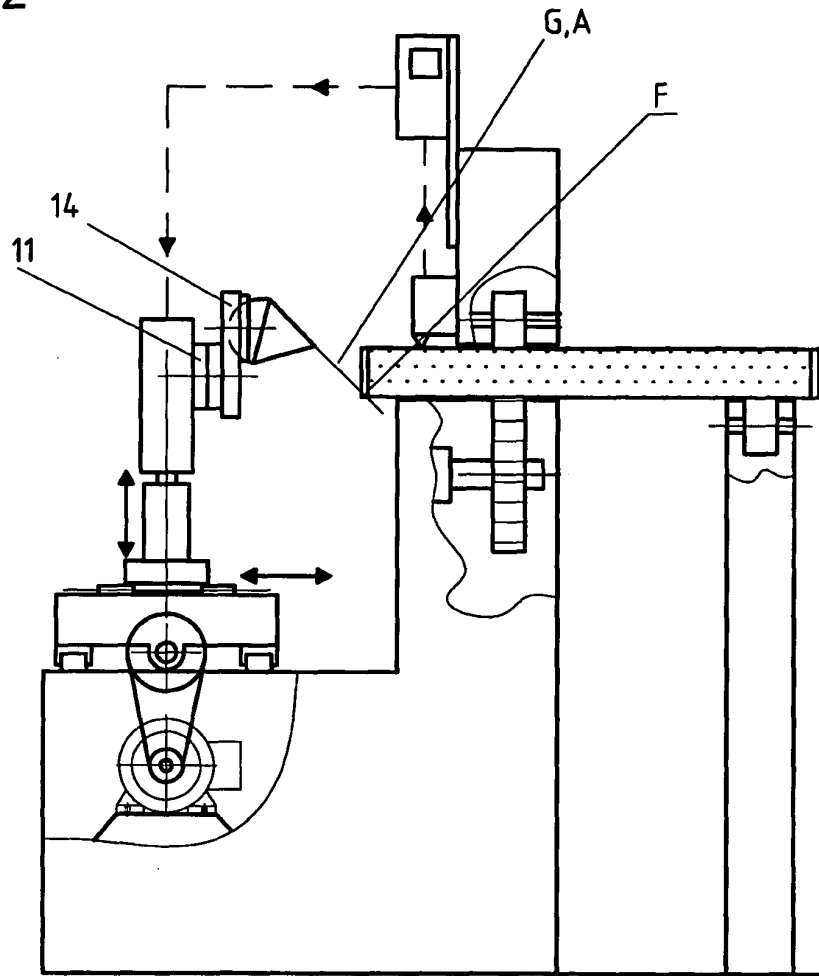


FIG.3

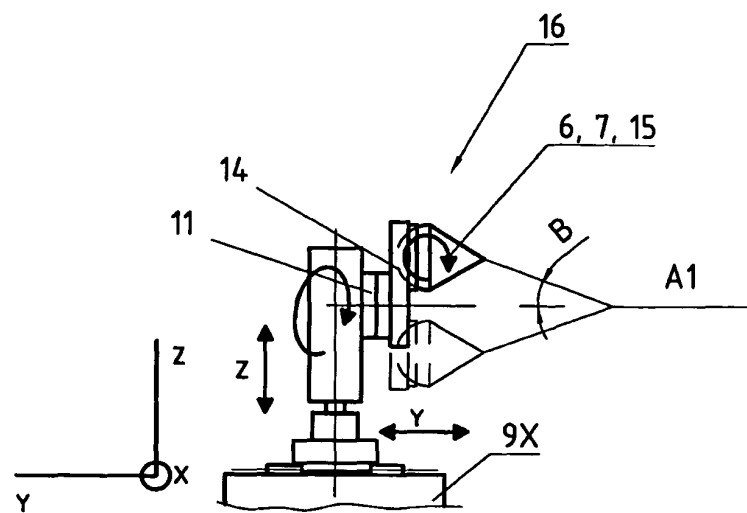


FIG.4

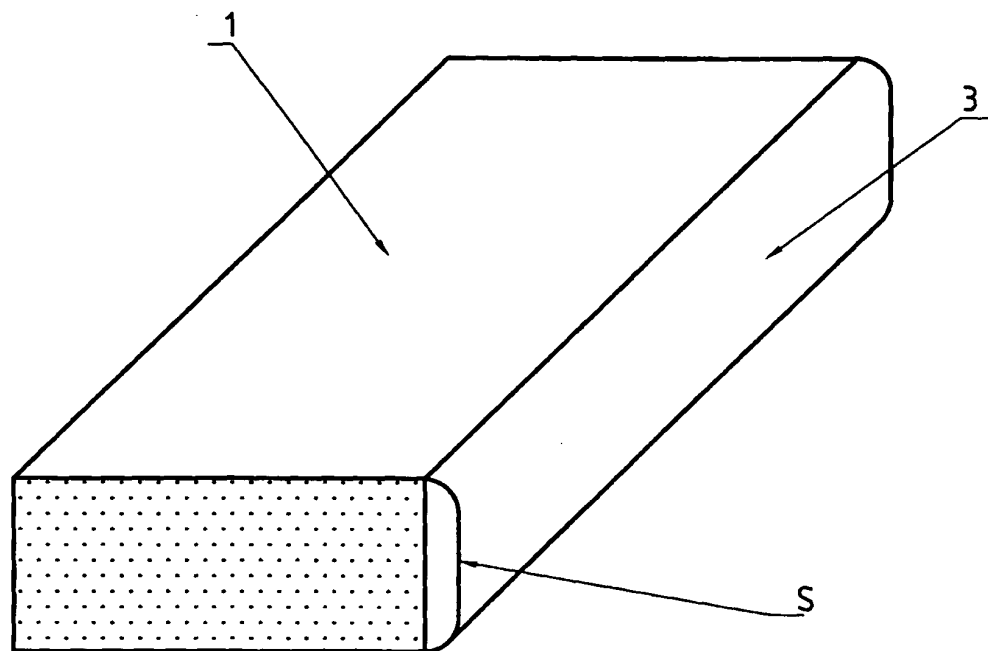


FIG.5

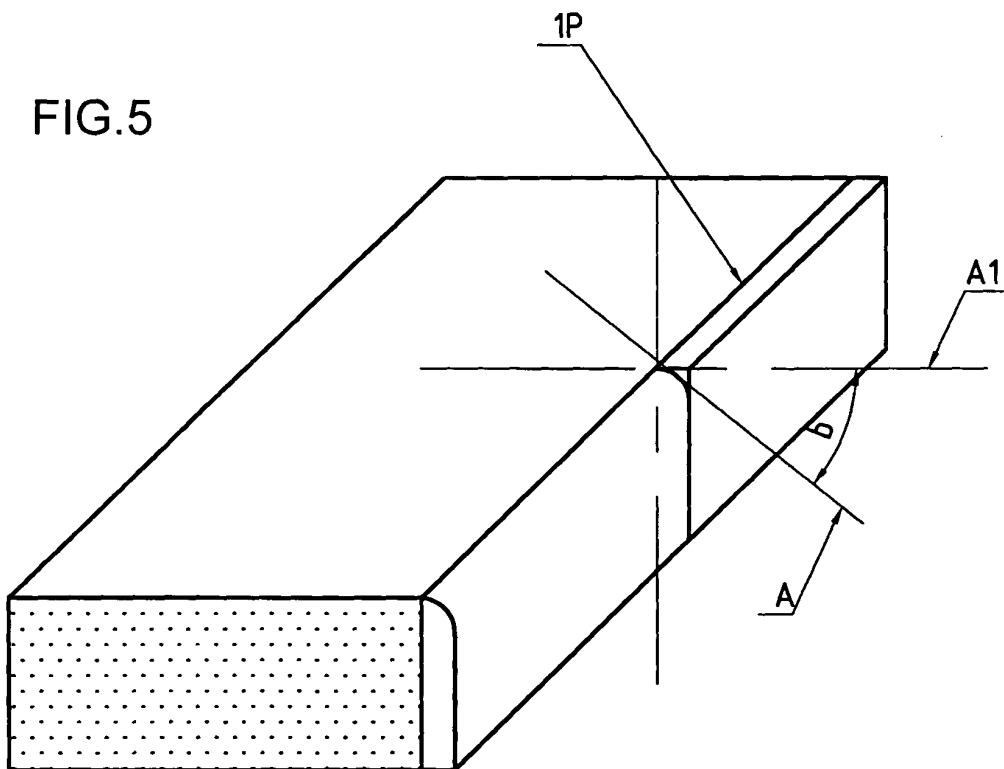


FIG.6

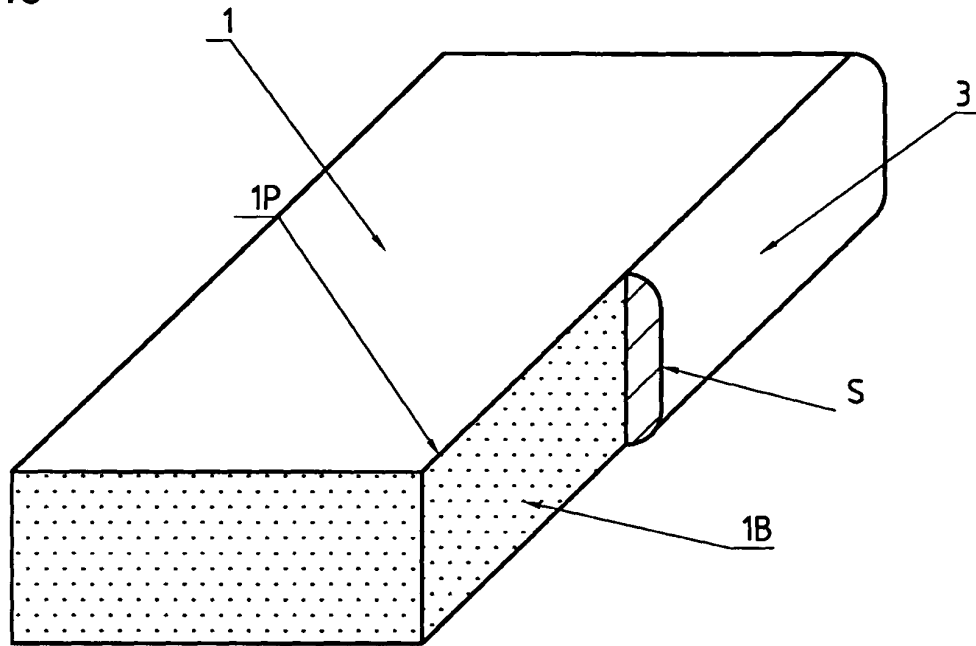
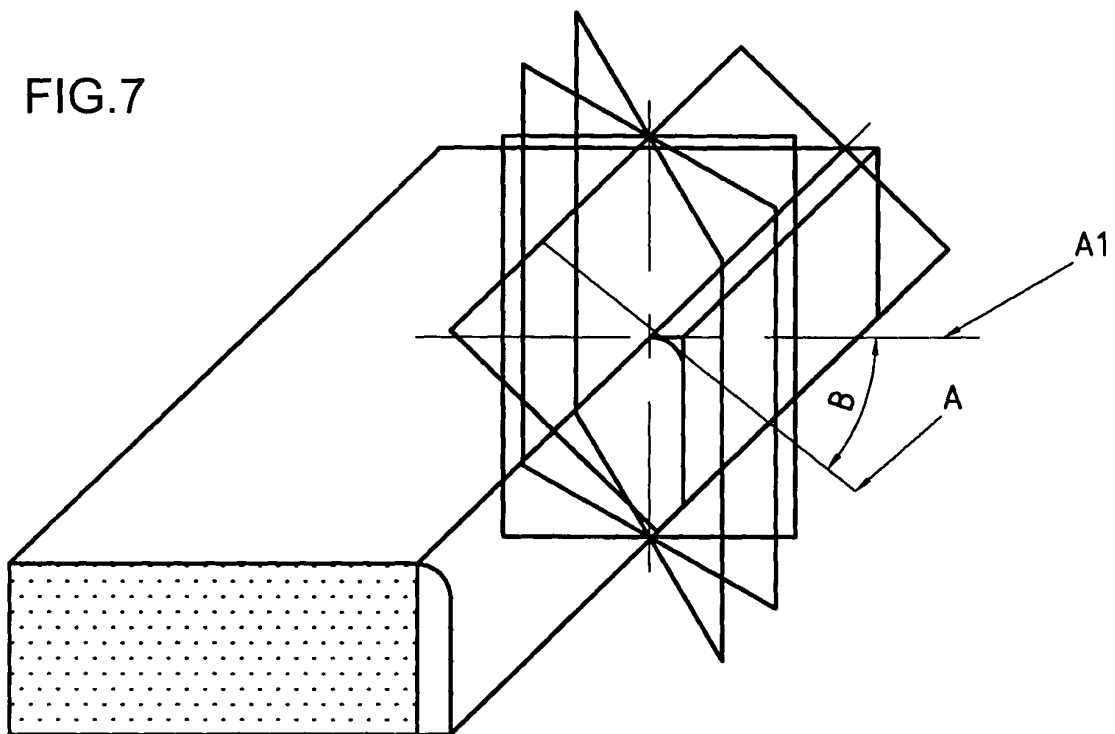


FIG.7





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 05 42 5248

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		2 August 2005	Meritano, L
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 42 5248

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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