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(54) APPARATUS FOR THE EXECUTION OF SOUND ABSORBING PANELS WITH MICRO-HOLES

(57) The present invention relates to the sector of processing wooden structural elements, and notably that of the production of sound absorbing panels. The invention relates in particular to an apparatus for the execution of sound absorbing panels of the so-called "micro-hole"

type, which can be used for coating walls, ceilings and the like, or also for the manufacture of doors, leaves, items of furniture, partition elements or other furnishing components.

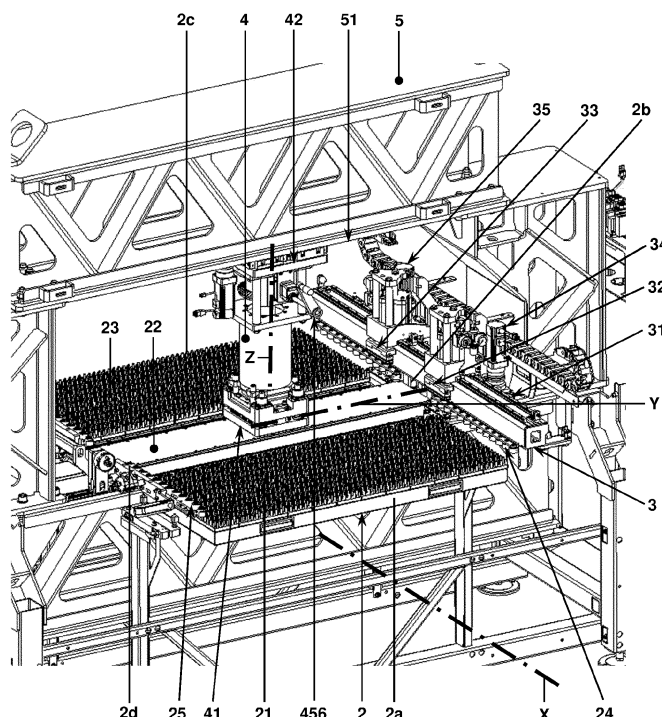


Fig. 1

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Description

[0001] The present invention relates to the field of the processing of wooden structural elements, and notably that of the production of sound absorbing panels. The invention relates in particular to an apparatus for the execution of sound absorbing panels of the so-called "micro-hole" type, which can be used for coating walls, ceilings and the like, or also for the manufacture of doors, leaves, items of furniture, partition elements or other furnishing components.

[0002] Wooden sound-absorbing panels currently comprise composite elements which have holes or cuts in communication with cavities, for the purpose of absorbing and dissipating the sound pressure wave. A base layer of the panel is normally made of chipboard, plywood, MDF or the like. The panel then has a coating sheet with an aesthetic function, for example made of thermoplastic, laminated, CPL, methacrylate, veneer sheets, plastic laminates and the like. In the "micro-hole" type, which is the one specifically relating to and affecting the present application, the coating sheet, on the side intended to be visible, has a distribution of micro-holes that are in communication with holes having a larger diameter made on the base or rear layer.

[0003] The micro-holes have a diameter less than 1 mm, generally 0.5-0.7 mm, with a pitch of 2.7 to 5 mm. The holes in the rear part are made with normal drill bits and with machines already existing on the market.

[0004] In a known solution, the coating sheet is processed separately through microdot rollers, which actually only affect the panel coating that is to be subsequently glued to the base material. The manufacturing process is therefore comprised of various steps and creates standardized formats. The cost of the rollers is high and there is certainly the problem of insufficient adaptation to the various formats required, both in terms of maximum size that can be processed and in terms of the diameter and pitch of the micro-holes.

[0005] Similar problems are posed by a production variant that envisages the use of punches still currently limited to the piercing of the coating of the insulated panel. Also in this case the coating is glued to the base material in a subsequent step. The punches are housed in a press that has a mould with a fixed pitch and size, the material advances synchronously in steps with the alternate vertical motion of the mould.

[0006] A known solution envisages the use of laser drilling systems. With such technology it is possible to process the coating sheet also once and after assembly is complete, therefore overcoming the production and rigidity problems highlighted above for punch or roller two phase systems. However, laser technology has other drawbacks. As well as causing small burns on the material, it forms openings that are actually slots with an elliptical profile. In fact, the laser device used is a sort of comb provided with rotary motion with respect to a parallel axis to the surface to be processed, therefore when

the laser beam is perpendicular to the surface the openings obtained on the sheet are circular, but when the beam is inevitably inclined with respect to the surface the opening has an elliptical slot profile. Such effect is undesired both from an aesthetic and a functional point of view.

[0007] A known machine adapted to carry out holes on panels as per the features in the pre-characterizing portion of attached claim 1 is disclosed in document CN107891473.

[0008] Considering this state of the art, the object of the present invention is that of providing an apparatus that is able to execute a micro-drilling treatment on the coating sheet of an already assembled sound absorbing panel (sheet already glued to the base material previously drilled), with a low production cost, which is flexible for being able to process different panel formats, and which does not have any of the aesthetic and functional drawbacks presented by systems that make use of laser drilling.

[0009] This and other objects are reached by the apparatus for the execution of micro-holes on sound absorbing panels according to the present invention, whose essential characteristics are defined by the appended claim 1. Other important additional characteristics are the subject matter of the dependent claims.

[0010] The characteristics and advantages of the apparatus for the execution of micro-holes on sound absorbing panels according to the present invention will become apparent from the following description of the embodiments thereof, provided by way of non-limiting example with reference to the appended drawings wherein:

- figure 1 is an overall perspective view of the apparatus according to the invention, omitting the structural parts outside the scope of the invention;
- figure 2 is a perspective view of a punching unit of the apparatus of figure 1, shown in isolation;
- figure 3 and figure 5 are views of an upper zone, with a height adjustment device, of the unit of figure 2, from respective sides highlighted by the arrows III and V of figure 2;
- figures 4 and 6 are sectional views according to the planes IV and VI represented in figures 3 and 5; and
- figures 7a to 7h represent respective exemplifying steps of the operating behaviour of the apparatus in action on a panel and wherein figures 7a, 7b, 7g and 7h make use of an overall perspective view similar to that of figure 1, figure 7c of a lateral view of the punching unit only, and figures 7d, 7e and 7f of a section of such unit in the lower zone, i.e. that in which the die comes into action on the panel.

[0011] With reference to the above figures, the apparatus according to the invention comprises, on a base 1 generally able to provide a suitable structural support resting on the ground plane, a support plane 2 for the support and advancement of the panels to be processed, a plane on which an axis X identifies the advancement

direction of the panel, and an axis Y orthogonal to the axis X identifies a transverse direction. A third axis Z that forms a Cartesian system with the other two, identifies a height or punching direction.

[0012] The support plane 2 is materialized by a central band 22, which extends for the entire extension of the plane according to the axis Y and for a reduced extension according to the X axis; according to the latter axis, the central band 22 is preceded and followed by an inlet section 21, defined between an inlet side 2a and the central band, and by an outlet section 23, between the central band and an outlet side 2c of the plane 2. The central band 22 is comprised of a solid and smooth surface element, typically metallic, which, as will be seen below, has an anvil function, contrasting the thrust exerted on the panel by the drilling action without damaging the panel itself. The inlet 21 and outlet 23 sections instead advantageously envisage distributions of brushes that assist the movement of the panel along the axis X.

[0013] On one flank side 2b of the support plane, i.e. the edge parallel to the advancement axis X, a panel handling device 3 extends, comprising a first system of linear recirculating ball bearing guides 31 on which two grippers 32, 33 move, adapted to grasp the panel on the edge that is contiguous to the device itself. The grippers 32, 33 have mutually independent motion activated by respective motorizations 34, 35 typically brushless motors, and by a pinion-rack transmission (not visible). The action of the grippers is however controlled in a coordinated way by the apparatus control system, of the numerical control type (CNC). One gripper 32 has a stroke which extends from the inlet side 2a to a substantial part of the central band 22, the other gripper 33 instead has available for its stroke an area of the plane between the inside of the central band 22 and the outlet side 2c. The grippers cannot exceed the limit of the central band, in their respective strokes. The side 2b and the opposite side 2d have respective distributions of rolls 24, 25 for the sliding abutment of the advancing panel. The distribution 25 opposite the one adjacent to the grippers 32, 33 is mounted on a support movable along the axis Y, for exercising the function of a gripping alignment device on the panel, adapting the width of the plane to the dimensions of the panel. The alignment device can be manually moved, until the engagement of a block that stops it in the desired gripping position.

[0014] All of the components mentioned above, and therefore the panel handling and transportation device 3 and lateral panel abutment system, can be considered in themselves traditional and well-known to a person skilled in the art of machines for processing wooden panels. Therefore, a more detailed description is not necessary, also considering that, still based on the knowledge of a person skilled in the art, various alternative constructions can be contemplated equivalent to the one exemplified herein, without this having any impact on the scope of the present invention.

[0015] Coming to the characteristic aspects of the

present invention, the plane 2, but more specifically the central band 22, it is superposed, therefore in substantial alignment according to the punching axis Z, by a punching unit 4 comprising a punching die or mould 41. The unit 4 projects towards the plane 2, starting from a slide 42 which is slidably engaged on a guide bridge 5. The latter extends along the axis Y at the central band 22 of the plane 2 and on which a second system of linear guides 51 extends, e.g. of the recirculating ball bearing type, with which the slide 42 engages, for exercising the movement along the aforesaid transverse axis Y. The motion of the slide 42 with respect to the bridge 5 is activated by a motor 43 (e.g. a brushless motor) integral with the slide itself and meshing through a pinion 43a with a rack, not shown. Also in this case the control is entrusted to the centralized CNC system of the apparatus.

[0016] The slide 42 has advantageously a plate-shaped structure which has the task of supporting all the other elements of the group and absorbing the punching force. Among such elements, a linear actuating means for actuating the die can be distinguished in the form of a hydraulic piston 44 which extends along the axis Z and which, at a distal end opposite the connection end to the slide, bears the already mentioned die 41. The piston is of the pulse kind with an alternate fixed stroke (for example 10 mm) and is responsible, as can be seen, for the mechanical pressure which, when transmitted to the die, is used for a drilling step on the panel. The aforesaid stroke is in one basic embodiment a design parameter of the apparatus and cannot be modified. However, a more sophisticated embodiment can also be provided in which the stroke can represent a variable operating parameter. In fact, by modifying the stroke of the hydraulic piston, it is possible to generate micro-holes of substantial depth which may even cross of the entire thickness of the panel.

[0017] The force that can be exerted by the piston can clearly be calibrated by intervening on a control unit of the hydraulic circuit. Such calibration tends to be performed during manufacturing and installation and it is not necessary to modify it, but in general in the event of particular processes there is nothing to prevent re-calibrating the pressure even with the machine already installed.

[0018] The connection between the piston 44 and the slide 42 is carried out with the interposition of a device 45 which can be adjusted in height (axis Z), adapted to vary in an adjustable way the distance between the piston and the slide, and therefore the absolute distance between the die and the plane, an adjustment which is necessary for adapting the apparatus to operations on panels with different dimensional characteristics, and notably the thickness characteristics.

[0019] The device 45, which can be clearly seen in figures 2 to 6, envisages a body such as preferably a bushing 451 which is rotatably supported by the slide 42 about the axis Z, by means of axial bearings 452. The bushing, which internally defines a threaded seat 451 a, is engaged with a threaded shank 441 of the piston 44.

Obviously, in an equivalent way, a solid body can replace the bushing and the threaded coupling can be made with a seat obtained within the shank. Externally, a bevel gear 453 is fixed coaxially onto the bushing 451, such gear engaging with a pinion 454 whose spindle 454a is pivotally supported about its axis (parallel to the plane 2 or, geometrically speaking, to the plane XY) by a bracket 455 which fixedly projects from the slide 42. The rotation of the pinion 454, which can be activated manually in the example by a crank 456 shown in figure 1 and omitted in the other figures for illustrative clarity, therefore responds - thanks to the conical torque formed with the gear 453 - to the rotation of the bushing 451 about its own axis Z. An obvious variant may also clearly be a motorized actuation.

[0020] A flange 457 is fixed within the body of the piston 44, which flange extends orthogonally to the axis Z and is slidably engaged in a plurality (four in the example, at the four corners of the flange 457, quadrilateral here) of guide columns 458 which in turn extend solidly from the slide 42, and still parallel to the axis Z. The guide action of the columns prevents the rotation of the piston about its own axis, therefore the already mentioned rotation of the bushing 451 necessarily responds to a vertical translation of the piston, a translation which therefore represents the only degree of freedom of the adjustment movement of the piston itself.

[0021] Advantageously, on a reversible plug of the crank 456 placed outside the bracket 455 and indicated by number 459, such plug exposing the manoeuvring shaft 454a of the pinion 454, there is a numerical index adapted to directly translate the degree of rotation of the pinion into the height reached by part of the die along the axis Z. Such plug also incorporates the clamping of the reached and desired adjustment position, which can be seen in particular in figure 5 and indicated by the number 459a, acting on the pinion shaft, once the desired height/position has been reached.

[0022] Finally, as far as the die 41 is concerned, the latter comprises an upper plate 411 with a distribution of driven in needle-shaped punches 412, intended to impress the micro-holes on the panel, and a lower plate 413 parallel to the upper plate (both plates being orthogonal to the axis Z) pierced by the punches and acting as a guide thereof and also as a panel stop element in the working/piercing condition. The extension dimensions of the plates, and in particular their length measured according to the axis X, is, preferably, substantially the same as the central band 22 of the plane 2, at which the group, as mentioned, is arranged. In this way, the functional coupling between the percussive effect of the die and the anvil effect of the flat band 22 is guaranteed.

[0023] The two plates are movable towards one another, with the contrast of an elastic means 414; more precisely, the upper plate is integral with the piston, whereas the lower plate is connected to the upper plate so as to be able to retract in approach to the upper plate, a motion which is contrasted by the springs mentioned above.

Four columns 415 also in this case exercise the required guide action, rising integrally from the lower plate 413 and being inserted slidably in through seats obtained on the upper plate 411. Advantageously, the mentioned elastic means comprises helical springs 414 arranged coaxially to respective columns 415. Likewise, stop pins 416 are provided which, like the columns 415, rise from the lower plate and are inserted slidably in seats provided on the lower plate; such pins have heads 416a at the upper end which abut on the outside of the upper plate and exercise the support and blocking of the lower plate in the maximum distance position with respect to the upper plate, a position assumed due to the effect of the springs 414 in the rest condition.

[0024] The fixing of the die 41, or more precisely of the upper plate 411, to the rod 442 of the hydraulic piston is carried out thanks to a dismountable connection, to enable the easy replacement thereof where necessary, either for maintenance or due to wear, or to change the pitch of the micro-holes to be made according to production requirements. The die also enables the number of punches used to be reduced, in the event that they have particular panel dimensions or if micro-hole prints are to be made which follow a geometric pattern. The reduction takes place by simply removing the punches which do not need to take part in the process from the die.

[0025] A CNC system controls the operation of the apparatus on the basis of design criteria that are known and/or can be implemented by a person skilled in the art. Therefore, a detailed description of such system is omitted; similar considerations are valid for other design aspects (structure, power supply, hydraulic circuits, etc.).

[0026] With reference in particular to figures 7a to 7h, the operational behaviour of the apparatus envisages the following.

[0027] The first operation is represented by the height adjustment of the punching unit 4, through the actuation of the pinion 454 (a manual one in this case using the crank 456), as described above. This is, in general, an initial operation with respect to a processing session on a batch of uniform panels, for adapting the apparatus to the characteristics of the panels of such batch, and it is not therefore repeated except when passing on to the processing of a different batch, the adjustment remaining the same between the piercing of a panel and that of the subsequent panel of the sequence.

[0028] A panel P to be drilled, already assembled with base material and a coating sheet turned upwards, is fed onto the plane 2, gripped by the first gripper 32 (figure 7a) and transported thereby along the axis X (advancement direction) until a head portion thereof is superposed with the central band 22 (figure 7b).

[0029] The gripper stops, also stopping the panel. The punching unit 4 is stopped with respect to the guide bridge 5 in a stroke start position, in which it superposes a first region, adjacent to the side of the panel handling device 3, of that band of panel that overlaps with the central band 22. Due to the effect of the above-mentioned ad-

justment, the unit is, in height terms, in a zero position (figure 7c), such that the lower plate 413 of the die 41 remains raised with respect to the panel, at a distance such as to enable mutual movements (due to the advancement motion of the panel or the translation of the unit 4 along the guide bridge 5).

[0030] At this point a first punching stroke takes place due to the effect of the actuation of the piston 44. Such stroke first brings the lower plate into contact with the surface of the panel (figure 7d) and therefore, continuing the thrust by the piston, whereas such lower plate 413 remains in contact with such surface, the upper plate 411 sinks further bringing the punches 412 first into contact with the surface (figure 7e) and then penetrating the panel to the required depth to affect the coating sheet.

[0031] The springs 414 interposed between the two plates are compressed until reaching the entire stroke envisaged for the piston rod. At this point the return stroke begins, the upper plate 411 starts to lift extracting the punches from the processed material, whereas the lower one 413 continues to remain in contact with the surface of the panel and applies a force thereto, exercised by means of the springs mentioned above, which prevents the lifting of the panel itself. The zero position is reached again at the end of the return stroke, distancing the lower plate from the panel again.

[0032] It will be understood how, by varying the height of the die in the zero position, through the unit height regulation system, it is possible to modify the depth reached by the punches. In fact, by reducing the idle stroke that the die performs, the drilling depth is increased by the same amount. Therefore, by reducing the distance between the work plane and the die, a greater drilling depth is obtained; vice versa, by moving the die away from the work plane the drilling depth is lower.

[0033] Thus the aforesaid first portion of the panel band is drilled. To extend the drilling to the entire surface of the panel, the unit 4 is gradually translated in the Y direction along the guide bridge 5 (figure 7g), repeating at every stop the punch stroke as described above, until affecting the entire width of the panel. Subsequently, to perform the drilling of the other bands of panel, to cover the entire length thereof according to X, the panel P is made to advance in steps, with the contribution of the second gripper 33, superposing in sequence said bands of the panel with the central band 22 of the plane 2 (figure 7h).

[0034] After finishing the desired punching of the entire surface, the unloading of the panel can take place either on the opposite side to the inlet one, or by inverting the movement exiting from the same side as the insertion.

[0035] The advantageous prerogatives of the apparatus according to the invention are clear from what is described above. The possibility to process complete panels makes it possible to use normal material available on the market and process it as for any other use, without having to resort to dedicated production processes and with the need to have to buy specific material (micro-hole

coatings, glues, etc.).

[0036] The use of a single machine that combines technologies of a traditional nature in an innovative way enables a reduction in production costs, considering that large investments in equipment are not required and considering that a very short production cycle is performed (single step).

[0037] The dimensional flexibility enables the work field of the machine to be adapted to the piece to be produced rather than having to produce an object that needs to undergo further processing for reaching the final dimensions. The possibility to modify the diameter of the micro-holes, their pitch and the work field enables a simple and flexible system to be obtained, which can be modified in contained time scales.

[0038] The aesthetic result reached is of maximum accuracy, with circular micro-holes of great precision and regularity, therefore without any defects that are highlighted with known apparatus based on laser drilling technology, with respect to which the costs of the present invention are also very competitive.

[0039] The present invention has been described herein with reference to preferred embodiments thereof. It is to be understood that there may be other embodiments that relate to the same inventive nucleus, all falling within the scope of protection of the claims provided below.

Claims

1. An apparatus for the execution of a distribution of micro-holes on sound absorbing panels, including: - a support plane (2) for supporting and feeding said panels, extending according to an advancement axis (X) of the panels and a transverse axis (Y) orthogonal to said advancement axis (X); - handling means (3) for transporting the panels on said plane (2) according to said advancement axis (X); - a punching unit (4) above said plane (2) and comprising a punching die (41) and linear actuating means (44) adapted to operate said die (41) according to a reciprocating punching stroke along a punching axis (Z) orthogonal to said plane (2), wherein said punching unit (4) comprises a slide (42) supporting said linear actuator (44) and slidably engaged with guide means (51) extending along said transverse axis (Y), and wherein between said slide (42) and said linear actuating means (44) the punching unit (4) comprises an adjusting device (45) for adjusting and locking the position of the unit according to said punching axis (Z), adapted to vary in an adjustable way the distance between said punching die (41) and said plane (2) in an inactive or resting condition of said linear actuating means (44), **characterized in that** said linear actuating means comprise a piston (44), said adjusting device comprising a body (451) pivotally supported by said slide (42) about said punching axis (Z), a threaded coupling between said body (451) and a

- shank (441) of said piston (44), piston linear guide means (458) of the piston arranged between said slide (42) and said piston (44), adapted to prevent the rotation of the piston with respect to the slide around said punching axis (Z), and means (453, 454, 456) for operating the rotation the rotation of said body (451), whereby the rotation of said body causes the translation of said piston (44) on said piston linear guide means (458) along said punching axis (Z).
2. The apparatus according to claim 1, wherein said body (451) comprises a bushing, which internally defines a threaded seat (451a) which engages with said externally threaded shank (441) of said piston (44).
 3. The apparatus according to claim 1 or 2, wherein said means for operating the rotation of said body (451) comprise a bevel gear (453) which engages with a pinion (454) of a spindle (454a) pivotally supported around its axis parallel to said support plane (2) by a bracket (455) which fixedly projects from said slide (44).
 4. The apparatus according to claim 3, wherein said locking means, for locking the position of the punching unit (4) comprise a clamp (459a) acting on said spindle (454a) of said pinion (454).
 5. The apparatus according to claim 3 or 4, wherein said means for operating the rotation of said body (451) comprise a crank (456) adapted to be releasably engaged with a plug (459) arranged outside said bracket (455) and bearing a numerical indexing directly translating the degree of rotation of said gear (454) into the height reached by the die (41) along said punching axis (Z).
 6. The apparatus according to any of the previous claims, wherein said piston linear guide means comprise a flange (457) extending from the piston (44) orthogonally to said punching axis (Z), and is engaged in a plurality of guide columns (458) which in turn extend solidly from said slide (44), parallel to said punching axis (Z).
 7. The apparatus according to any of the previous claims, wherein said piston (44) is a hydraulic piston (44) with fixed stroke.
 8. The apparatus according to any of the previous claims, wherein said punching die (41) includes an upper plate (411) connected to said linear actuating means (44) and with a distribution of needle-shaped punches (412) to impress the micro-holes on the panel, and a panel stop lower plate (413), parallel to said upper plate (411), both plates being orthogonal to said punching axis (Z), said lower plate (413) being slidably supported by the upper plate (411) along said punching axis (Z) and being pierced through by said punches (412), elastic means (414) being further arranged between said plates to oppose their mutual approach, starting from a position of maximum distance corresponding to an inactive condition of the punching unit (4).
 9. The apparatus according to claim 8, wherein a plurality of guide columns (415) and stop pins (416) integrally rise from said lower plate (413), said guide columns and said stop pins being slidable in through-holes formed in said upper plate (411), said stop pins (416) providing stop means (416a) adapted to abut on the outside of said upper plate (411) to exert a support and a block of the lower plate (413) in said position of maximum distancing, said elastic means comprising helical springs (414) coaxially arranged at respective guide columns (415).
 10. The apparatus according to claim 8 or 9, wherein said plates have dimensions in length, measured according to said advancement axis (X), substantially corresponding to the size of an anvil strip (22) of said plane (22), extending along the whole width of said plane along said transverse axis (22), in substantial alignment with said punching unit (4) with respect to said punching axis (Z).
 11. The apparatus according to claim 10, wherein said support plane (2) comprises, following said advancement axis (X) and divided by said anvil central band (22), a panel inlet section (21) and a panel outlet section (23), providing respective brush arrangements to assist the displacement of the panels, said anvil central band (22) being materialized by a solid and smooth surface element.
 12. The apparatus according to any of the previous claims, wherein said guide means (51) are arranged on a guide bridge (5), motorized means (43) and drive means being further provided between said bridge and said slide (42) to drive the translation of said slide with respect to the guide means (51).
 13. The apparatus according to claim 12, wherein said motorized means (43) comprise a motor (43) mounted on said slide, said drive means comprising a rack and pinion gear (43a).

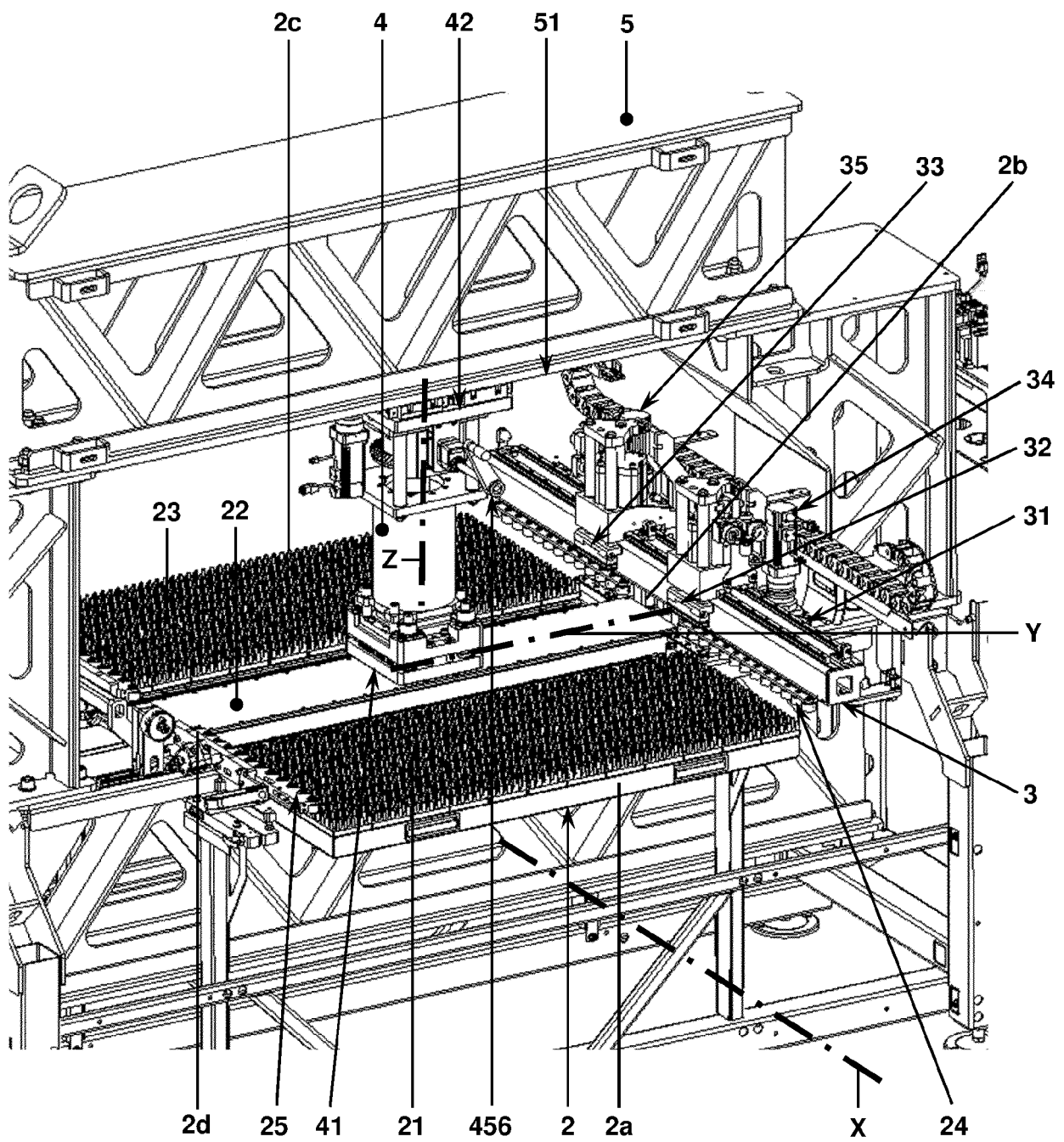


Fig. 1

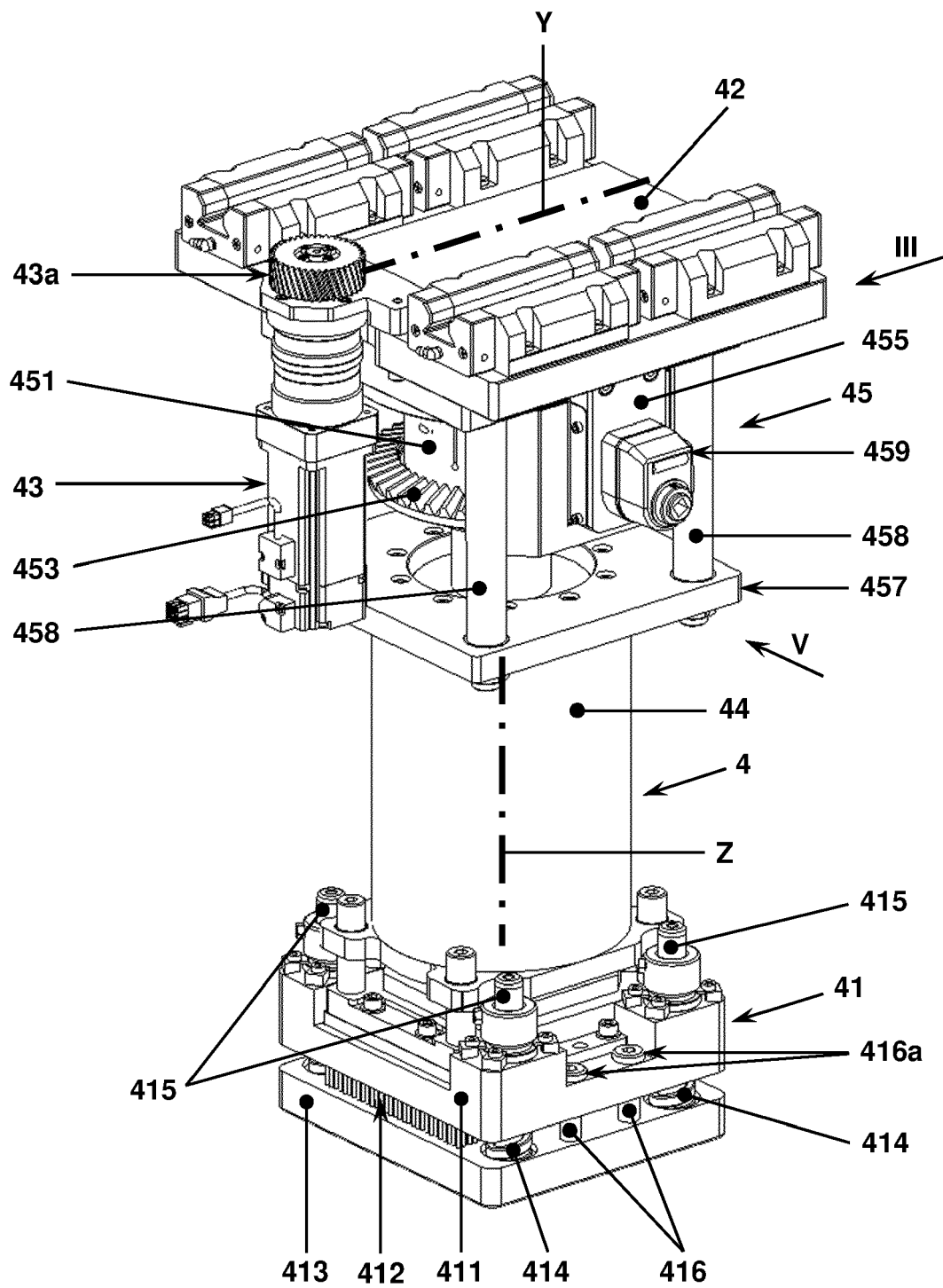


Fig. 2

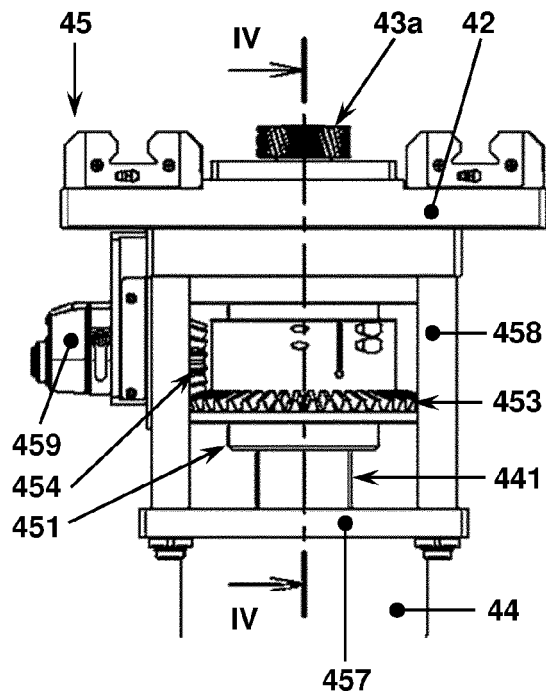


Fig. 3

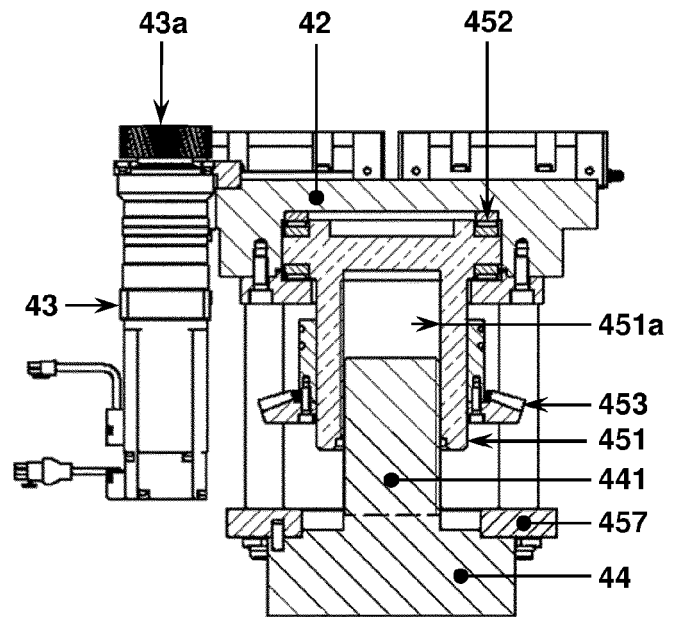


Fig. 4

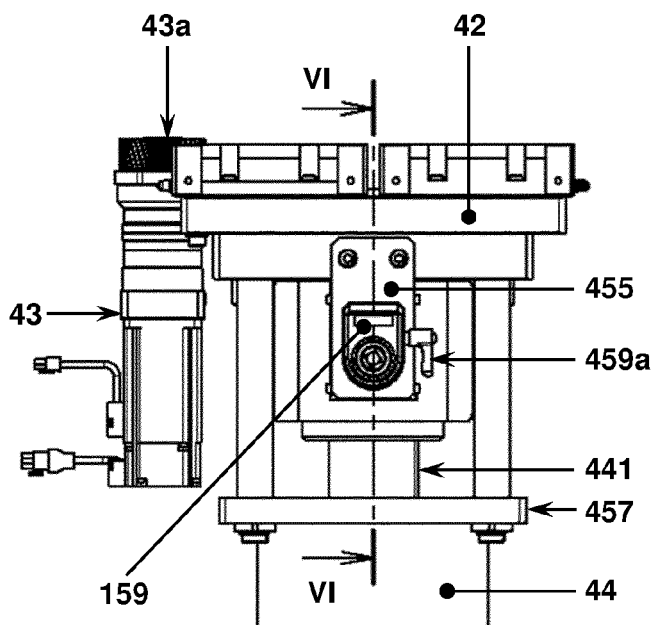


Fig. 5

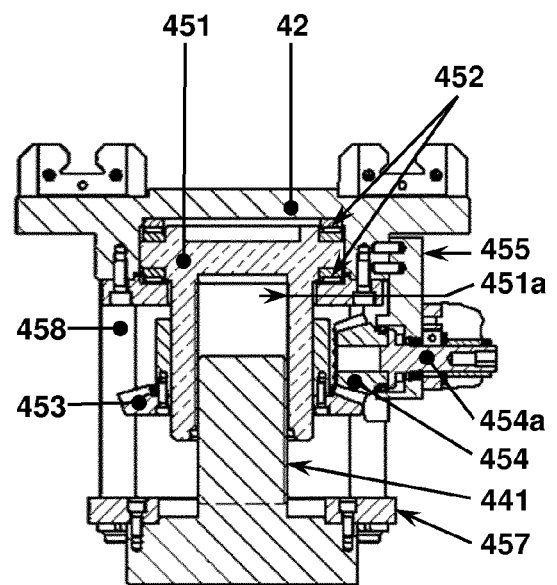


Fig. 6

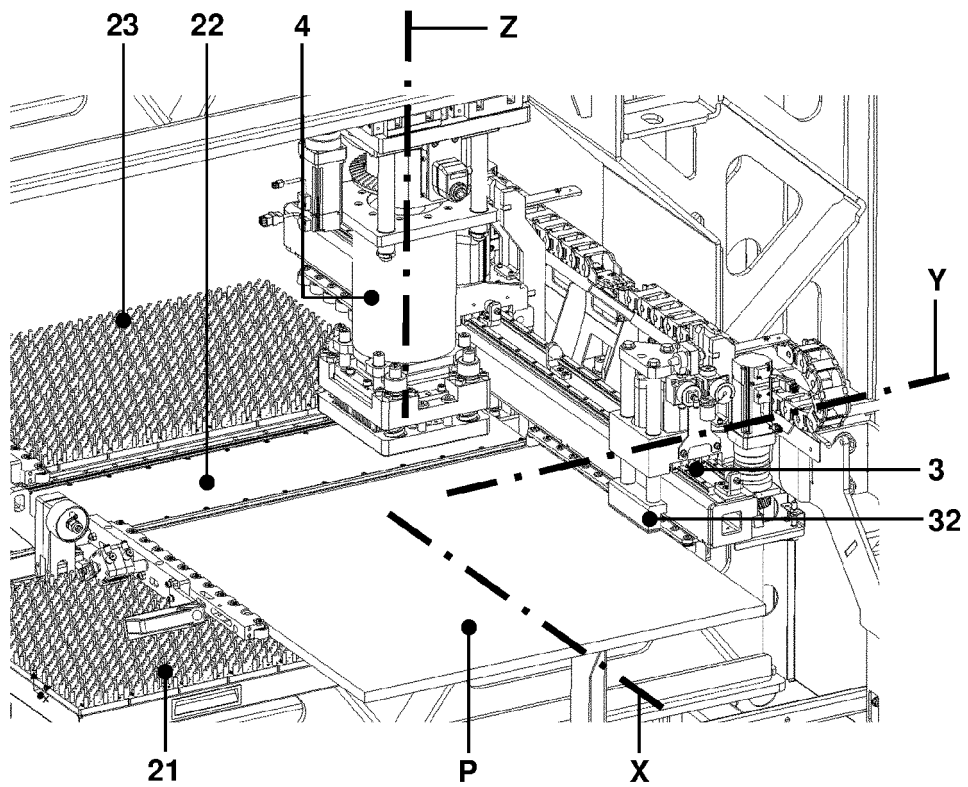


Fig. 7a

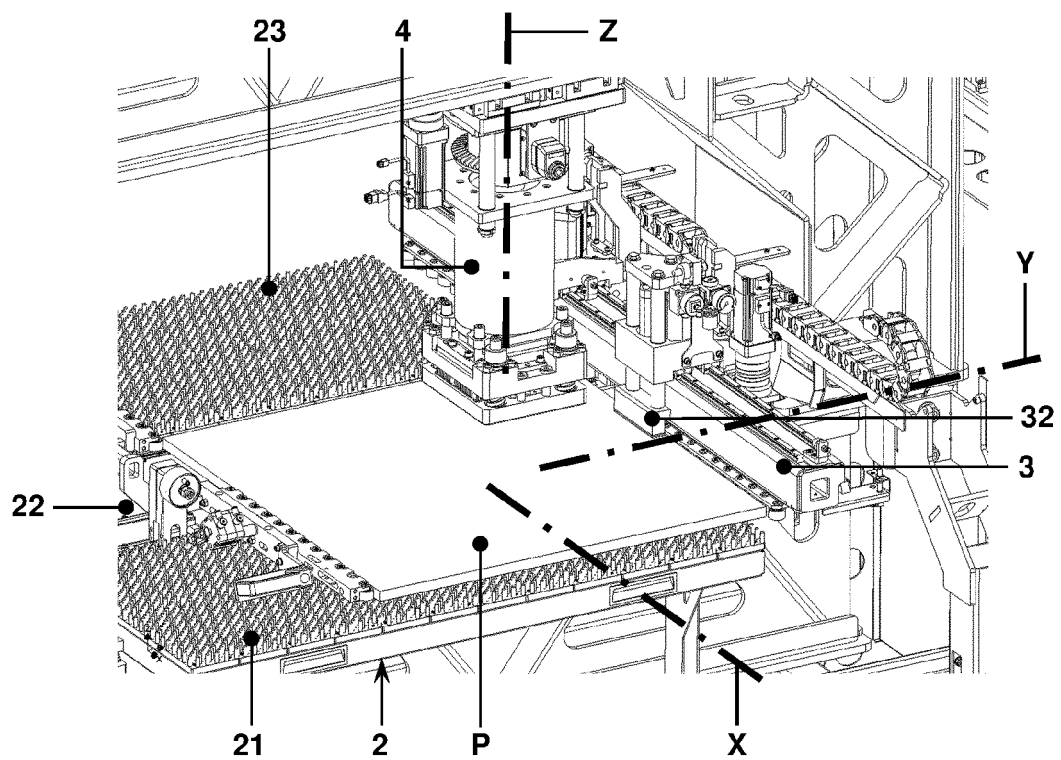


Fig. 7b

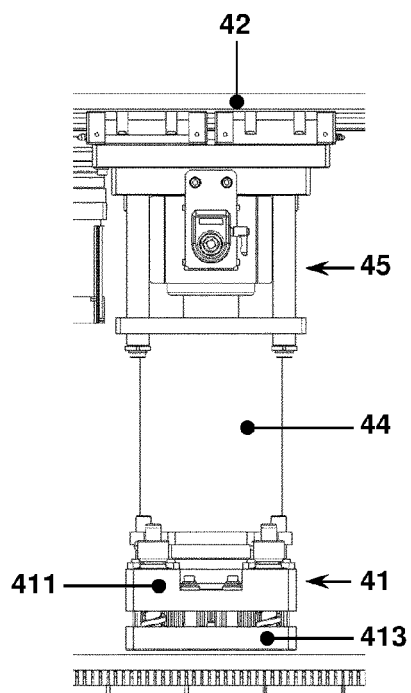


Fig. 7c

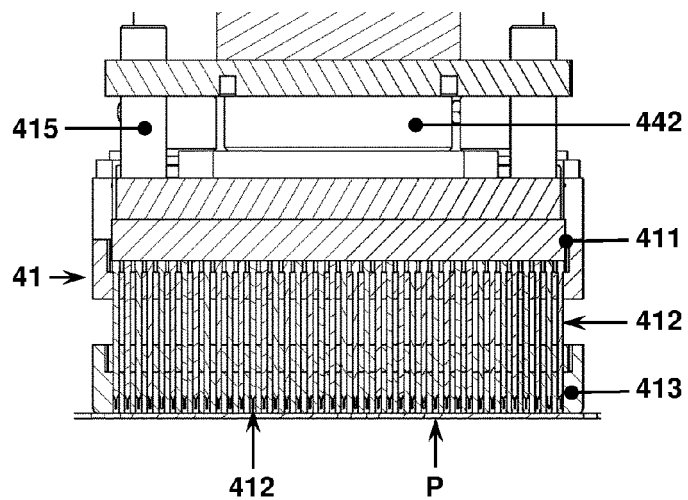


Fig. 7d

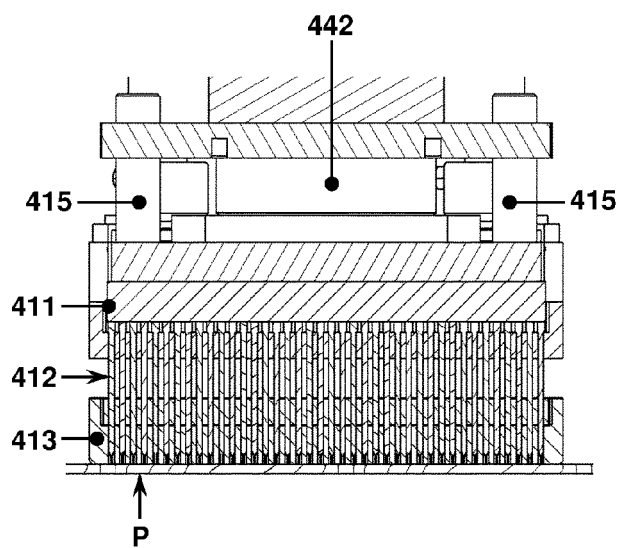


Fig. 7e

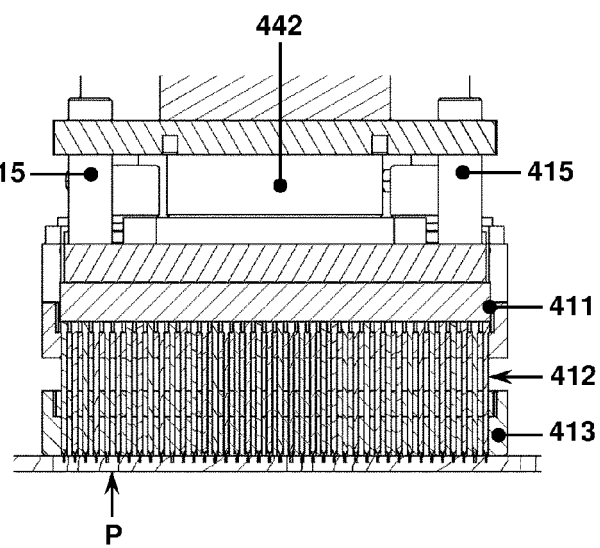


Fig. 7f

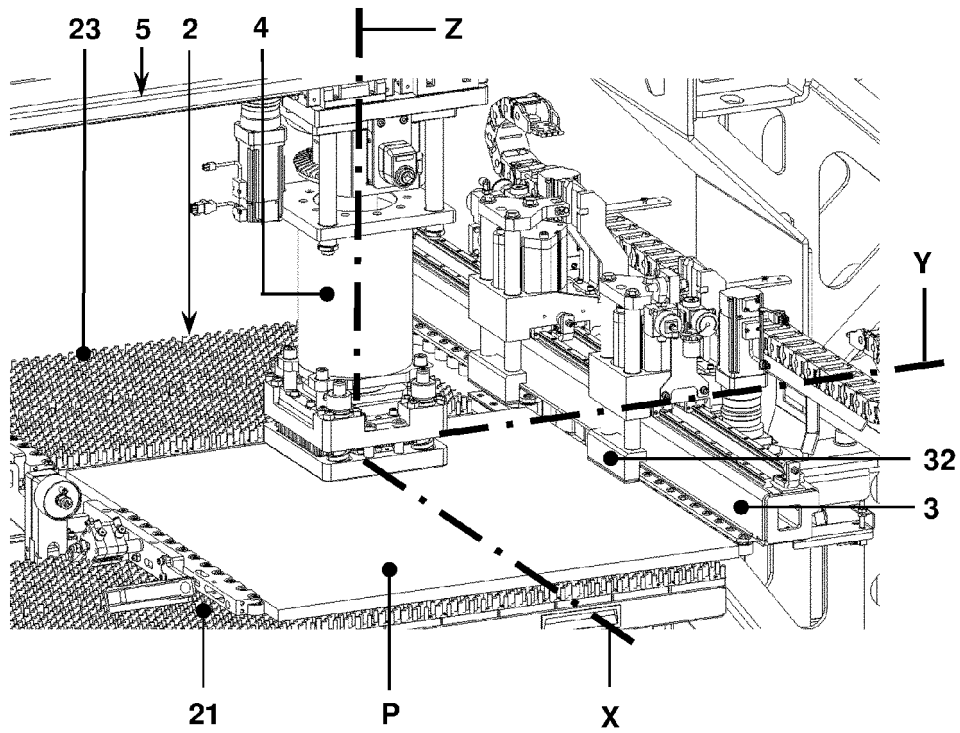


Fig. 7g

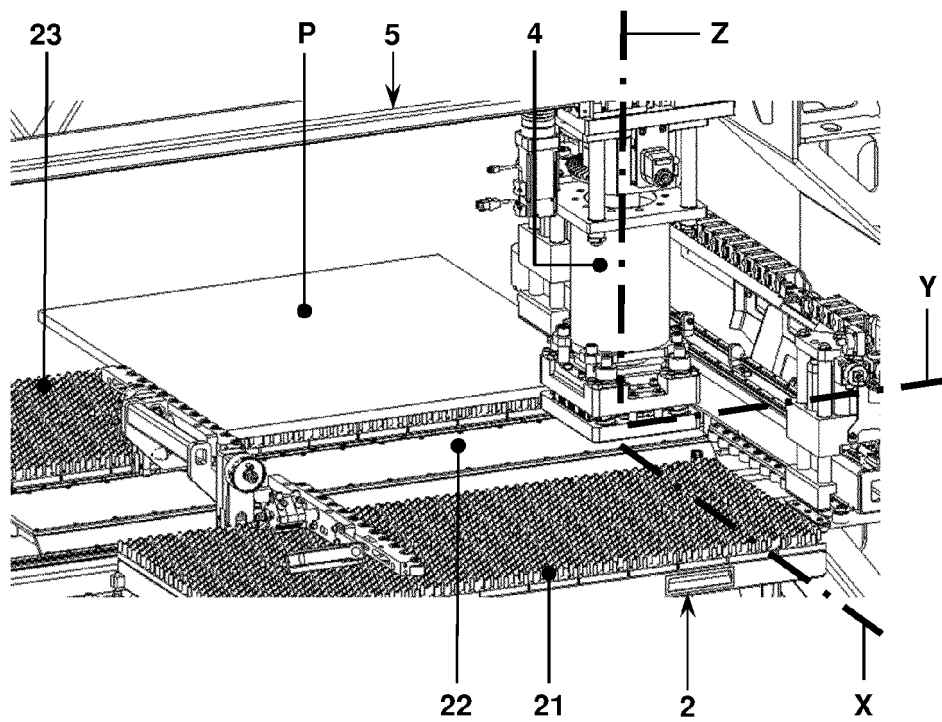


Fig. 7h



EUROPEAN SEARCH REPORT

Application Number
EP 21 16 7689

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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	CN 107 891 473 A (GUANGZHOU ZIHE ARCH DECORATION CO LTD) 10 April 2018 (2018-04-10) * abstract; figures *	1-13	INV. B27M1/04 B27M3/00
A	CN 209 998 176 U (SUZHOU YUCHAO PREC MACHINERY CO LTD) 31 January 2020 (2020-01-31) * abstract; figures *	1-13	
			TECHNICAL FIELDS SEARCHED (IPC)
			B27M
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 24 August 2021	Examiner Mirza, Anita
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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REFERENCES CITED IN THE DESCRIPTION

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