



(11) **EP 3 628 442 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.04.2020 Bulletin 2020/14

(21) Application number: **19199610.7**

(22) Date of filing: **25.09.2019**

(51) Int Cl.:
B24B 27/00 (2006.01) **B24B 7/22 (2006.01)**
B24B 9/06 (2006.01) **B24B 9/00 (2006.01)**
B24B 47/12 (2006.01) **B24B 41/047 (2006.01)**
B24B 55/02 (2006.01)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **27.09.2018 IT 201800008986**

(71) Applicants:
• **Donatoni Macchine S.R.L.**
37015 Sant'Ambrogio di Valpolicella (Verona) (IT)

• **Biesse S.p.A.**
61122 Chiusa di Ginestreto (Pesaro Urbino) (IT)

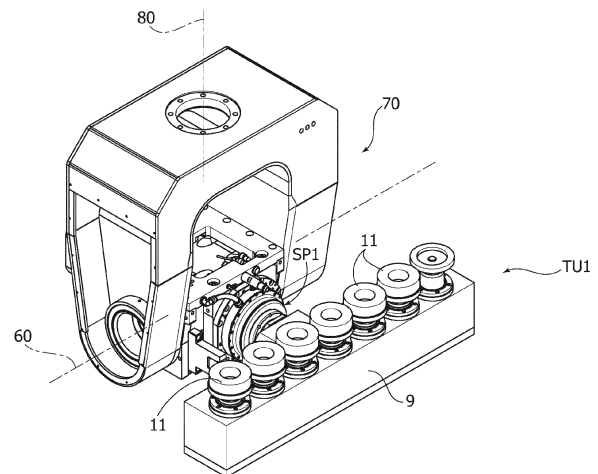
(72) Inventors:
• **DONATONI, Giorgio**
I-37015 Sant'Ambrogio di Valpolicella (Verona) (IT)
• **TRAINI, Matteo**
I-61122 Chiusa di Ginestreto (Pesaro Urbino) (IT)

(74) Representative: **Notaro, Giancarlo**
Buzzi, Notaro & Antonielli d'Oulx S.p.A.
Corso Vittorio Emanuele II, 6
10123 Torino (IT)

(54) **MULTI-TOOL AGGREGATE UNIT FOR POLISHING PLATES OF STONE MATERIAL OR SYNTHETIC MATERIAL, AND POLISHING MACHINE PROVIDED WITH THIS UNIT**

(57) A multi-tool aggregate unit (TU1) for a polishing head (H1) of an electronically-controlled polishing machine, for polishing edges of plate of stone material or synthetic material, such as for finishing operations in the mass production of kitchen tops or the like, comprises an aligned series of polishing tools (11) adapted to carry out progressively finer machining operations, the tools being arranged according to an order corresponding to the progression of the machining operation, with a tool (11) for the most coarse machining operation arranged at one end of the series and a tool (11) for the finest machining operation arranged at the opposite end. The supporting structure (9) of the multi-tool aggregate unit (TU1) rotatably supports a single driving rotating shaft (12) which is connected in rotation with all the tools (11) by means of a gear transmission (13,14). The driving rotating shaft (12) has an end conical shank (12A) configured to be removably connected in rotation within an end conical receptacle of a motorized spindle of a polishing head (H1) of the polishing machine, so that said spindle drives in rotation all the tools (11) of the multi-tool aggregate unit (TU1) while at the same time supporting the weight of said multi-tool unit. The supporting structure (9) of the multi-tool aggregate unit (TU1) is configured to engage the spindle supporting body to prevent a rotation of the supporting structure (9) of the multi-tool unit around the axis of the spindle.

FIG. 8



EP 3 628 442 A1

DescriptionField of the invention

[0001] The present invention relates to apparatus for machining plates of marble, granite, or stone material in general or plates of synthetic material, particularly for finishing operations in mass production of kitchen tops or the like, or for example the pieces of furniture, building structures or gravestone structures.

Prior art

[0002] As of today, depending upon the final characteristics of the product, the finishing process for a kitchen top requires the use of three main types of technologies/machines:

- so-called "edge polishing" machines: these machines are adapted to perform a rectilinear machining of one edge of the plate, the trimming of the plate thickness, surface machining, auxiliary engraving machining of the plate surface; these machines require the plate to be oriented with respect to the machining tools each time of that a new side of the plate has to be processed;
- waterjet cutting machines, adapted to perform cutting operations for forming through openings in the plate which are for example to constitute an opening for mounting the kitchen tube and an opening for mounting a cooking panel, the opening for mounting a tap; these machines are also used for forming inclined through cuts for subsequent coupling of the kitchen top with other components in order to provide a box-like covering structure;
- machining centers, adapted to perform finishing operations on the edges of the openings formed within the plate, finishing operations on the outer edge of the plate, according to a rectilinear or shaped profile, machining of the plates surface, and auxiliary machining, such as engraving operations.

[0003] With reference to the polishing operation of the edges and the surface of the plate, the need is felt for a working station which is able to perform all the operations of an entire cycle of polishing operations on the plate in a completely automated manner and with maximum operative flexibility. The need is also felt of providing this polishing station with a tool unit which is more efficient, more precise and more reliable with respect to the known devices.

[0004] A multi-tool unit according to the preamble of claim 1 is known from document US 9 289 872 B1. A similar solution is also known from document CN 107 855 899 A. These known solutions refer however to autonomous polishing devices, which include the tool driving motor and therefore are relatively complicated, heavy and expensive.

Object of the invention

[0005] Therefore, the object of the invention is that of providing a tool unit which can be removably associated, so as to be replaceable, to a polishing head of an electrically controlled polishing machine, said tool unit been adapted to enable the polishing operation to be carried out in a more efficient manner and with an higher quality with respect to what it is possible with the use of the known devices.

[0006] A further object of the invention is that of providing a full unit of the above indicated type which has a relatively simple and reliable structure.

[0007] A further object of the invention is that of providing a new configuration of polishing machine in which the tool unit according to the invention can be used in a particularly advantageous way.

Summary of the invention

[0008] In view of achieving one or more of the above indicated objects, the invention provides a multi-tool aggregate unit according to claim 1 and a polishing machine according to claim 5.

Detailed description of the invention

[0009] Further features and advantages of the invention will become apparent from the description which follows with reference to the annexed drawings, given purely by way of non-limiting example, in which:

- figure 1, diagrammatically shows a plan view of an automated line including the polishing station,
- figure 1B diagrammatically shows a lateral elevational view of the automated line of figure 1,
- figures 2, 2B are diagrammatic plan and elevational views of a polishing station forming part of the line,
- figures 3, 3B are an elevational view and a plan view of detail of the polishing station of figures 2, 2B,
- figures 3C, 3D show a perspective view of a variant of the conveyor and plate locking unit of the polishing station, in two different operative conditions,
- figure 3E shows a plan view of a detail of the unit of figures 3C, 3D,
- figure 3F is a cross-sectional view of the unit of figures 3C, 3D in a vertical plane transverse relative to the conveying direction,
- figures 3G, 3H show two variants of the solution of figures 3C, 3D,
- figures 4, 4B are a plan view and a lateral elevational view of a waterjet cutting station forming part of the automated line,
- figures 5, 5B are a plan view and an elevational view of a machining center forming part of the automated line,
- figure 5C is a variant of figure 5,
- figure 5D shows a further variant of the machining

- center,
- figure 6 is a diagrammatic view, in a plane orthogonal to the direction of the conveyor line, which shows an alternative embodiment of the devices for locking the plate,
- figure 7 is a diagrammatic perspective view of a multi-tool aggregate unit,
- figure 8 is a perspective view of the fork-like member carrying the multi-tool aggregate unit of figure 7.

[0010] For a better understanding of the invention, a detailed description of a preferred environment of an automated process line including a polishing station provided with the multi-tool aggregate unit according to the invention is presented hereinafter.

General characteristics of the automated line

[0011] In figures 1, 1B, numeral 1 generally designates an integrated automated line for finishing operations on plates of marble, granite, or stone material in general, or plates of synthetic material, in particular for masses production of kitchen tops or the like. Automated line 1 comprises an automated conveyor line 2, whose conveying direction is indicated by arrows A.

[0012] In the illustrated example, the automated conveyor line 2 includes a pair of belt conveyor devices 2A which are parallel to and spaced apart from each other. As will be described in more detail in the following, the conveyor line 2 comprises a number of line sections which are separate from each other and arranged in sequence after each other, in order to advance a sequence of plates along line 1, while keeping the plates in an horizontal position.

[0013] As illustrated for example in figure 3A, each belt conveyor device 2A comprises a belt 20A which at each end of the belt conveyor device 2A is engaged on a wheel 21A, rotatably mounted on a support structure 22A. One of the two wheels 21A on which each belt 20A is engaged is driven by a respective electric motor (not shown). The belt 20A is arranged with an active upper run which is for receiving thereon the plate to be conveyed, as well as a lower run.

[0014] All the details of construction of the belt conveyor devices 2A are not described nor shown herein, since they can be made in any known way.

[0015] It is also clearly apparent that other use of belt conveyor devices is illustrated herein only by way of example, since it is well possible to use any other type of conveyor device in place of belt conveyor devices, such as a conveyor device with motorized rollers.

[0016] Reverting to the general configuration of the finishing line as shown in figures 1A, 1B, the conveyor line 2 conveys a sequence of plates from a loading station L up to a final unloading station UL, by causing the plates to pass through a sequence of processing stations. In the example which is described and shown herein, the sequence of the processing stations includes, in the prop-

er order, a polishing station P, a waterjet cutting station WJ, and a machine center MC. It is well understood that each of these stations might be duplicated many times along the line. Also, the stations might be arranged in a different order.

[0017] The operation of the conveyor automated line and the operation of the single processing stations P, WJ, MC is controlled by an electronic circuit generally indicated by EG which can include, purely by way of example, electronic controllers, E1, E2, E3... respectively associated to the different processing stations of the line, and a supervising electronic controller E in communication with the electronic controllers E1, E2, E3.

[0018] Each new plate to be processed is positioned on a first section of the conveyor line 2, by a manual operation, or by any automated loading device. The starting section of the conveyor line 2 is activated to introduce a new plate to be machined into the polishing station P, which in the illustrated example constitutes the first station of the line. To the loading station L there is associated a detection station 3, including at least one detection device (for example an optical scanner) adapted to detect one or more dimensions of the plate to be processed (typically length, width and thickness) and/or at least one detection device adapted to detect information relating to the configuration of the product to be obtained, this information being provided on an information support associated to the plate (such as a label glued to the plate and bearing a bar code which is read by a bar code optical reader). One or more electronic controllers are configured for receiving a signal indicative of the detected information from said detection devices, for automatically programming the work cycle implemented by the automated line.

Polishing station

[0019] Referring now in particular to figures 2A, 2B and 3A, 3B, the polishing station P comprises an independent section of the conveyor line 2 including two or more belt conveyors 2A which are also movable in the vertical direction. This is obtained, in the specific case of the illustrated example, in that the support structure 22A of the belt conveyors 2A which are present in the station P is connected to a stationary base structure 4 by means of a quadrilateral system, including articulated arms 5. Each arm 5 is articulated at 5A to the stationary base structure 4 and at 5B to the support structure 22A of the belt conveyors 2A. The position of the articulated arms 5 controlled by actuators 6, for example in the form of fluid actuators, so that repair of belt conveyors 2A associated to the polishing station P can be vertically moved between a raised position, which is at the same height as the belt conveyors 2A which are arranged upstream and downstream of the polishing station P (figure 3A) and a lowered position (shown in figure 3A). As an alternative to what is illustrated, the belt conveyors 2A can be rendered vertically movable with the use of the hydraulic cylinders.

[0020] When a new plate to be machined is fed into the polishing station P, the belt conveyors 2A of the station P are at their raised position. In this condition, these belt conveyors are activated, as also activated or the belt conveyors 2A of the loading station L, so that a new plate can be caused to advance from the loading station L up to a position inside of the polishing station P.

[0021] For determining the work position of the plate, the station can be provided that with a sensor for detecting the front and the end of the plate, for example a contact sensor, which is activated when the plate is being transferred by being brought to an upright position with respect to the general plane of the plate, and when the head of the plate reaches the sensor, this causes a stop of the plate.

[0022] In this operating mode, the station can be also provided with an element constituting a so-called "line of faith" or "zero-line" which is positioned parallel to the belts 2A and spaced apart from, in order to define a lateral support for the plate which ensures proper alignment of the plate during the advancement stage, for feeding the plate into the station. The element constituting the zero-line is vertically movable by actuator means, so that once the plate has reached its proper position in the station, this element can be lowered for enabling the edge of the plate to be machined.

[0023] Once the plate is in the proper position in the station, the belt conveyors are de-activated and the section of the belt conveyors which is associated to the polishing station P is lowered so as to release plate PL on a plurality of locking devices D arranged at the polishing station P.

[0024] In another embodiment, the machine can be provided also or exclusively with a detecting system (such as a mechanical contact detector and/or an optical detector) which is able to determine the position and/or the orientation of the plate, once the plate has been locked on the locking devices. In this manner, the electronic controller can adapt automatically the machining program to the position detected by the plate. The locking devices can be provided with a sensor able to detect the presence of the piece and the activation of the locking function. Also in this case the machine can be provided with a "zero-line" or a "line of faith" although it is not absolutely essential. In the preferred embodiment which is illustrated herein, the locking devices are suction-cup-locking devices which can be activated by vacuum. The detail of construction of these devices are not described nor shown herein, since they can be made in any known way.

[0025] In a simplified embodiment, the locking devices B can be stationary. However, preferably, the locking devices B are adjustable in position, at least in the direction of the conveyor line 2. For example, with reference to the plan view of figure 3B, if an aligned series of locking devices B is provided, the locking device B which is located centrally in the series can be stationary, whereas the remaining locking devices B can be movable each parallel

to the conveying direction, in one direction or the other. The locking devices B can be also movable in a direction transverse with respect to the longitudinal conveying direction. For example, three parallel rows of conveyor devices B can be arranged, with the conveyor devices over the central row which are movable only in the longitudinal direction, and the locking devices of the outer rows which are movable both in the longitudinal direction and in a direction orthogonal to their two.

[0026] In case the movement for adjustment of the position of the locking devices B is motorized, the actuator devices dedicated to this adjusting function can be of any type. For example, each locking device B can have a structure engaged in a slideable manner on a rectilinear guide along which the locking device is movable, for example through the use of a fluid actuator, or with the aid of an actuator including an electric motor and a screw-and-nut system. In the case in which a locking device is adjustable in position along two directions which are orthogonal to each other, the structure of the device can be slidably guided along a first direction on a slide which on its turn is slidably guided along a second direction, each of these two movements being associated to a respective actuator device. With reference to the embodiments illustrated, the polishing station P includes a breach-like-cross-member T1 arranged at an elevated position with respect to the position of the plate PL in the station and guided on two stationary shoulders S1 in a horizontal direction Y, orthogonal to the longitudinal directions X of the breach-like-cross-member T. A carriage C1 is slidably mounted in said longitudinal direction X on a breach-like-crosses-member T1. A slide V1 is slidably mounted in the vertical direction Z on carriage C1.

[0027] The vertically movable slide V1 supports a polishing head H1, which a multi-tool aggregate unit TU1 is associated.

[0028] As will be illustrated in detail in the following, the tool unit TU1 is pivotally mounted around a horizontal axis 60 (see figure 2B) - through an angle range which can be greater than 90°, such as up to 180° - on a fork-like-structure 70 of the polishing head H1. On its turn, the structure 70 is rotatably mounted around the vertical axis 80 below slide V1.

[0029] In figures 2A, 2B, by undotted lines different positions of the polishing head H1 are shown, which the head can reach due to the possibility of being displaced along the three axis X, Y, Z and also due to the possibility of being rotated around the horizontal axis 60 and around the vertical axis 80. Due to the above mentioned degrees of freedom, the polishing head can be displaced with respect to the plate PL which is held locked in predetermined position at the station P, so as to be able to machine any side of the plate, with no need of rotating the plate.

[0030] Naturally, although the example illustrated herein shows the case of a polishing station P including a single polishing head H1, nothing excludes that on the breach-like-crosses-member T1 that can be mounted

more carriages C1 with respective polishing heads H1 or also that on the stationary shoulders S1 there are mounted more breach-like-crosses-members T1.

[0031] Figures 3C and 3B show a preferred embodiment of the section of the conveyor line 2 which is associated to the polishing station. The supporting structure 22A of the conveyor line is vertically displaceable by means of a pair of vertical free cylinders 223 arranged at the ends of the section of the conveyor line, between the base structure 4 and two crossmembers 222 forming part of the structure 22A which carries the belt conveyor 2A. Naturally, the illustrated configuration of the structure 22A is given here in purely by way of example. Therefore, once that the conveyor line 2 has brought the plate to its position within the station, the entire structure 22A, with the two belt conveyors 2A, is vertically movable from the raised position of figure 3C to the lowered position of figure 3D, so that the plate is deposited on the cup-suction locking unit B.

[0032] As shown in figures 3C, 3D, 3E and 3F, in the actual embodiment which is illustrated herein there are provided five groups of suction-cup locking units B, each including a supporting body B1 and a suction-cup B2, as well as a system (not shown) for controlling the supply of a vacuum to the suction cup B2, this system of being of any known type. In the example illustrated herein, each unit B, except for that at the centre of the series of the units B, has a single degree of freedom, since it is movable only in the horizontal direction parallel to the longitudinal direction of the conveyor line 2. Therefore, except for the unit B arranged at the centre of the series of units B, the other suction-cup locking units B are guided in said longitudinal direction on the base structure 4. To this end, in the illustrated example, a guiding structure 400 (see figure 3F) secured to the base structure 4 guides a base portion of body B1 which has a configuration complementary to that of structure 400 and is further provided with two lateral guiding wheels 401 engaged along the sides of structure 400. Naturally, this configuration of the guiding system of units B is given herein purely by way of example.

[0033] In the specific example illustrated herein with no limiting purpose, the movement of the units B movable on one side and the other with respect to the central unit is driven by a motor B3 which drives two belts B4, B5 forming two endless configurations arranged in superimposed horizontal planes (figure 3F) adjacent to the base structure 4. The two belts B4, B5 are driven by two coaxial superimposed pulleys B6, B7 (figure 3E) driven by motor B3. Pulley B7 has a diameter which is the double of the diameter of pulley B6, so that belt B5 moves at double speed with respect to belt B4. The two units B adjacent to the central unit and arranged at the two sides thereof have their structure anchored to the slower belt B4, whereas the two units B at the ends of the series of units B are anchored to the faster belt B5. In this manner, the movable units can be moved symmetrically with respect to the central unit B, between the condition of the units

all adjacent to each other (figure 3C) at the condition of spaced apart units (figure 3D).

[0034] In a variant (figure 3G) each locking unit B comprises an additional suction cup B2a which is supported in a spaced position on one side of the suction cup B2, in a direction orthogonal relative to the direction of movement of the belts, to enable a plate to be supported having a width such as to require a double support. The distance of the secondary suction cup with respect to the main suction cup can be fixed or adjustable, through any positioning system B222 (figure 3H).

Multi-tool aggregate unit

[0035] Figure 7 of the annexed drawings shows, by way of example, an embodiment of a multi-tool aggregate unit T11 which can be coupled with the head H1. The tool unit TU1 includes a supporting structure 9 on which there are rotatably mounted around parallel axes a plurality of polishing tools 11, only one of which is shown in figure 7. The tools 11 are typically constituted by grinding wheels, such as cup-shaped grinding wheels having a front abrasive surface and/or tangential grinding wheels having an abrasive cylindrical surface. The tools 11 are arranged with their axes parallel and aligned along a direction IX of structure 9. The tools are arranged to carry out progressively finer machining operations on the plate edge, a tool 11 at one end of the series being arranged to carry out to the most coarse machine operation and a tool 11 arranged at the opposite end of the series arranged to carry out the thinnest machining operation. During the polishing operations, the head H1 is moved so as to arrange the series of tools 11 (see figure B) aligned with one side of the plate, after that the rotation of the tools is activated and the head H1 is moved parallel to this side of the plate so that each portion of the plate edge undergoes in sequence to a progressively finer machine operation, by coming in contact in sequence with all the tools of the series, starting from the tool for the most coarse machining operation up to the tool for the finest machining operation.

[0036] Still with reference to figure 7, in the case of the illustrated example, the rotation of all the tools 11 is driven by a single driving shaft 12 which is rotatably supported on structure 9 and coupled in rotation with the shafts of all the tools 11 by means of a transmission, which preferably is a gear transmission, including a pair of bevel gears 13 and a gear train 14.

[0037] With reference to figure 8, the head H1 has a structure 70 (which in the illustrated example has a fork-like shape) which is rotatably mounted around a vertical axis 80 on the vertically movable slide W1, which has been described above with reference to figure 2B. The structure 70 of the head H1 pivotally supports a spindle unit around a horizontal axis 60 (figure 8), which spindle unit includes a spindle-supporting body SP1 which supports in rotation a spindle (not shown) having an axis orthogonal to the horizontal axis 60. The spindle-support-

ing body SP1 also carries an electric motor for driving the rotation of the spindle. The multi-tool aggregate unit 9 can be coupled with the head H1 by coupling and end conical shank 12A of the shaft 12, which projects in a cantilever fashion from the supporting structure 9 (figure 7) within a corresponding conical receptacle (not shown) formed in the end surface of the spindle carried by the spindle-supporting body SP1. To the spindle-supporting body SP1 there is associated a device of any known type (not shown) for removably locking the conical shank 12A within its receptacle, in order to enable an automatic change operation of the tool unit.

[0038] When the conical shank 12A is locked within the cooperating receptacle of the motorized spindle, the motorized spindle can drive in rotation all the tools 11 of the multi-tool aggregate unit TU1 and at the same time is able to support the weight of the multi-tool aggregate unit. The supporting structure 9 of the multi-tool aggregate unit TU1 is configured to engage the spindle-supporting body SP1 so as to prevent the rotation of the supporting structure 9 of the multi-tool unit T1 around the axis of the spindle. For this purpose, the structure 9 and the spindle-supporting body SP1 have respective engagement elements (not shown) which mutually engage at a point spaced apart from the axis of the spindle, so as to prevent re-rotation of the structure around the axis of the spindle.

[0039] A magazine of multi-tool units can be associated to the station P and the electronic controller of the station can be programmed to carry out an automatic change operation of the tool unit, by bringing H1 into the magazine for depositing the multi-tool aggregate unit carried thereby at an empty position of the magazine, and then for picking up a new multi-tool aggregate unit from another position of the magazine.

[0040] In the preferred embodiment, the configuration of the multi-tool aggregate unit is the following:

- in the first position a diamond tool is provided, having an axially fixed position, and projecting more forwardly with respect to the other tools of the unit. From the second position up to the seventh position there are provided abrasive and polishing tools having the possibility to move also axially, along their axis of rotation, to ensure that the tool is pushed against the surface of the plate. The axial travel of each tool can be for example driven by means of a pneumatic cylinder, whose air supply is controlled and adjusted by means of manually adjustable valves or electronically controlled proportional valves.

[0041] As already indicated, the possibility of orienting the multi-tool aggregate unit around the vertical axis 80 enables the array of tools of the unit to be aligned adjacent to any side of the plate. At the same time, the possibility of orienting the multi-tool aggregate unit TU1 around the horizontal axis 80, enables an edge of the plates to be machined while causing the multi-tool aggregate unit to

rotate around this edge, in order to impart any desired profile to the edge of the plate.

[0042] It is well understood that the multi-tool aggregate unit according to the invention could be used in polishing machine also different from that described herein. In the operation of the line, the polishing station P operates in the following manner.

[0043] When a new plate PL must be introduced into the station P, section 2A of the conveyor line associated to this station is located at its raised position. The section 2A of the conveyor line associated to the loading station L and the section 2A of the conveyor line associated to the polishing station P are actuated so that a plate PL which is initially supported on the belts of the conveying section of the loading station L is transferred above the belts of the section of the conveyor line associated to the station P. In passing through the detection station 3, an optical scanner detects the sides the dimensions of the plate (in the case of a quadriangular plate: length, width and thickness) and a bar code optical scanner detects the bar code on a label associated to the plate, which identifies the cycle of operations to be carried out. The signal coming from the detecting devices are sent to the electronic controller of the station which then is programmed automatically to generate the sequence of controls adapted to implement the desired work cycle. In the case the locking devices B have a motorized adjustment movement, the information on the dimensions of the plate obtained by the detection station 3 can be used also to cause an automatic displacement of the locking devices to positions having a distribution which is most suitable for the dimensions of the plate.

[0044] The movement of the belt conveyors 2A is stopped when the plate PL reaches the desired position in the station P.

[0045] In order to determine the work position of the plate, the station can be provided with a sensor for detecting the front end of the plate, such as a contact sensor, which is activated when the plate is being transferred, or carried in an upright position with respect to the general plane of the plate, and when the front end of the plate reaches the sensor, the latter causes a stop of the plate.

[0046] The station can be provided with an element constituting a so-called "line of faith" or "zero-line" which is positioned parallel to the two belts 2A and spaced apart there from, to define a lateral support for the plate which ensures proper alignment of the plate during the stage of advancement, for feeding the plate into the station. A bar constituting the line of faith is movable vertically by actuator means, so that once the plate has reached its proper position in the station, this bar can be lowered to enable the plate edge to be machined.

[0047] When the plate has reached its position in the station, section 2A of the conveyor line associated to station P is lowered, by activating the actuators 5 (figure 3A) so as to deposit plate PL on the locking devices B, which, as indicated, have been preliminarily arranged in the most suitable positions, depending upon the dimensions

and the shape of the plate to be machined. Also this last operation can be controlled automatically by the electronic controller, on the basis of the information relating to the configuration of the plate obtained by the detection station 3.

[0048] In another embodiment the machine can be additionally or only provided with a detector system (such as a mechanical contact sensor and/or an optical detector) which enables the position and/or orientation of the plate to be determined once the plate has been locked on the locking devices. In this manner, the electronic controller can automatically adapt the machining program to the position of the plate as detected. The locking devices can be provided with a sensor able to detect the presence of the piece and the activation of the locking function. Also in this case the machine can be provided with a "line of faith" or "zero-line", though this is not essential.

[0049] Once that the plate PL has been located in position and locked by activating the locking devices B (typically a suction-cup devices which can be activated by vacuum) the controller can activate the work cycle of the head H1 which carries the multi-tool aggregate unit TU1 in sequence in positions aligned with the various sides of the plate. The controller can move the unit along each side to carry out a progressive finishing operation of the edges. The movement of the head H1 with respect to the plate, along each edge of the plate, can be driven as a continuous movement, or as an intermittent movement, with stop stages and movement stages, depending upon the characteristics of the product to be obtained and depending upon the need of orienting the unit 9 around the horizontal axis 60 during the machining operation.

[0050] When the polishing operation is completed, the tool head H1 is moved away, the locking devices B are deactivated and section 2A of the conveyor line associated to station P is raised for carrying again thereon the plate PL. Once reached this condition, the different sections 2A of the conveyor line are again activated, to cause the machined plate to move out from the station P and if needed to bring simultaneously a new plate to be machined into the station P.

[0051] As it will become clearly apparent from the foregoing description, the polishing station according to the present invention constitutes an important improvement, also taken per se with respect to the present technology in the field of finishing processes of plates of marble, granite or synthetic material for the production of a kitchen tops of the like.

[0052] As already indicated, according to the conventional art, the polishing operation of the edges of the plate is performed by machines using an array of tools carried by a stationary structure, which require a movement of the plate with respect to the tools during the machining operation of each edge of the plate and which also require a rotation of the plate each time that a new side of the plate has to be machined.

Water jet cutting stations

[0053] With reference in particular to figures 1A, 1B and 4A, 4B, the automated line includes, for example, immediately downstream of the polishing station P which has been described in the foregoing, a waterjet cutting station WJ, for forming openings through the plate, which for example are to constitute the sink of a kitchen top and/or the opening for mounting a cooking top and/or the opening for mounting a tap.

[0054] In the case of the illustrated example, an independent section 2A of the automated conveyor line is associated also to the waterjet cutting station WJ, which independent section also in this case is constituted by a pair of belt conveyors which are spaced from each other. In figure 4B, reference numerals of the various components of section 2A of the conveyor line are the same as those used for example in figure 3A, for the polishing station.

[0055] One difference with respect to the polishing station lies in that in this case there is no provision of a section 2A of the conveyor line which has also the possibility of a movement in the vertical direction, since the water jet cutting of the plate PL is carried out while holding the plate PL in contact with the belt 20A of the conveyor devices.

[0056] In the embodiment illustrated herein by way of example, the water jet cutting station comprises a stationary structure including two portals 13 arranged astride the section 2A over the conveyor line and on their turn carrying two elevated shoulders S2, on which the ends of a bridge-like-cross-member T2 are slidably mounted along direction Y. A carriage C2 is movable along the cross-member T2 along direction X and carries a vertically movable slide V2 which at its lower end supports a waterjet cutting head H2 which, according to a technique known per se, has two further degrees of freedom by being able to be oriented through a rotation around a vertical axis as well as around an axis orthogonal to the latter.

[0057] Both for the polishing station which has been described above and for the waterjet cutting station which is described herein, the details of construction of the station are not shown, since they can be made in any known way. This applies for example to the motor devices which control the movement of the bridge-like-cross-member along direction Y, the movement of the carriage along direction X and the movement of the slide along the vertical direction, as well the movements for orienting the head. In the case of the waterjet cutting head H2 mentioned herein, the details of construction are also not described nor shown which relate to the supply of water to the head, or which relate to the supply of the abrasive material to be added to the waterjet. All the above mentioned details can be made according to any known way and do not fall, taken alone, within the scope of the invention.

[0058] To the stationary supporting structure of the

shoulders S2, there is also associated the structure of a tub V which is to be filled with water up to a level immediately adjacent to the lower surface of plate PL during the operation. According to a technique known per se, within the tub V there are provided sacrificial supports (SX) (see figure 4A), i.e. supports which are constitute of a material which can be attacked, arranged centrally between the two belts 20A for supporting the plate PL during a waterjet cutting.

[0059] The operation of the waterjet cutting station is as follows. A new plate PL to be machined is introduced into the station by activating the section 2A over the conveyor line associated to station WJ.

[0060] In order to determine the work position of the plate, the station can be provided with a sensor for detecting the plate front-end, such as a contact sensor, which is activated when the plate is being transferred, or which can be brought to an upright position with respect to the general plane of the plate, and when the front-end of the plate reaches the sensor, the latter causes a stop of the plate.

[0061] In this embodiment, the station can be also provided with an element constituting a so-called "line of faith" or a "zero-line" positioned parallel to the belts 2A and spaced apart them from, to define a lateral support for the plate which ensures a proper alignment of the plate during the advancing stage, for feeding the plate into the station. The element constituting the line of faith is vertically movable by means of actuator means, so that once the plate has reached its proper position in the station, this element can be lowered to enable the plate edge to be machined.

[0062] When the plate PL reaches the desired position in the station, the movement of the section 2A of the conveyor line is stopped. The sacrificial supports provided inside the tub V are raised, so as to support the plate PL which is always in contact with the belts 20A of the belt conveyors as well as with said sacrificial supports. The plate PL is also immediately adjacent to the upper level over the water contained within the tub V. Once the plate PL has been located in position by any system suitable for this purpose, the electronic controller activates the work cycle by moving the waterjet cutting head H2 over the plate PL and along a predetermined path, to form one or more openings through the plate, which openings have a predetermined configuration.

[0063] A gripping device G (see figure 4A) for example in the form of a suction-cap device, is also associated to the carriage C2, on the side opposite with respect to that carrying the head H2. This device is provided with the possibility of a vertical movement with respect to the carriage C2, which can be actuated by means of the fluid cylinder, carried by the carriage C2. In this manner, once a cutting operation has been carried out, the electronic controller can brought the gripping device G above the portion of the plate which constitutes the waste of the cutting operation. The gripping device G can then be lowered and activated for taking said waste portion on itself,

whereupon the electronic controller attends to moving the gripping device G in order to release the waste portion into any among a plurality of containers CO arranged adjacent to the station (figure 4A) and dedicated to containing the machining waste. Once this operation is carried out, the section 2A of the conveyor line can be activated for causing the machining plate to move out of the station and if needed to simultaneously bringing a new plate to be machined into the station.

Machine centre

[0064] With reference now to figures 1A, 1B and 5A, 5B, the automated line includes, for example downstream of the waterjet cutting station WJ, a numerical control machine centre MC for finishing the inner and outer profiles of the plate as well as for carrying out machining of the surfaces and/or auxiliary machining operations for forming depressed areas, engravings or other in the plate.

[0065] Similarly to the polishing station P, also the machine centre MC has an independent section 2A of the automated conveyor line which is also provided with the possibility of moving vertically in order to deposit the plates to be machined on a plurality of locking devices B. In this respect, the machine centre MC is totally similar to the polishing station P. In figures 5A, 5B, the parts relating to the conveyor system have been designated by the same reference numerals. Also in this case, by way of example, the section 2A of the conveyor system comprises two belt conveyors whose supporting structure is connected to a stationary base structure by means of two articulated arms 5 controller by actuators 6. Also in this case the locking device B, for example in the form of suction-cup devices, are preferably adjustable in position, the adjustment movements being possible either only in the longitudinal direction X, or also in the transverse direction Y, in the way which has been described already with reference to the polishing station P.

[0066] Figure 5A is a plan view which shows the plate PL in the work position in the machine centre MC. As illustrated, the plate has through openings 14 which are formed in the previous waterjet cutting station. Also in this case, the stationary structure of the machine centre comprises two portals 13 arranged astride the conveyor devices and adapted to support two shoulders S3, on which the ends of a bridge-like crosses member T3 is guided in the direction Y. Also in this case, on the crosses-member T3 there is slidably mounted a carriage C3 carrying a vertically movable slide V3 to which there is associated a tool head H3. A tool unit is removably associated to the head H3, according to the conventional art. The coupling device is preferably coupling device of the type adapted to enable automatic tool change. With reference to the plan view of figure 5A, adjacent to the work position, the machine centre MC comprises a tool magazine M.

[0067] The operation of the machine centre MC is as

follows. A new plate PL to be machined is introduced into the machine centre MC by activating the section 2A of the conveyor line, this section being in the present stage in its raised position. In order to determine the work position of the plate, the station can be provided with a sensor for detecting the plate front end, such as a contact sensor, which is activated when the plate is being transferred or carried at an upright position with respect to the general plane of the plate, so that when the front and the end of the plate reaches the sensor, the latter causes a stop of the plate.

[0068] In this embodiment, the station can be also provided with an element constituting a so-called "line of faith" or "zero-line" positioned parallel to one of the two belts 2A and spaced apart there from, to define a lateral support for the plate which ensures proper alignment of the plate during the advancing stage, for feeding a plate into the station. A bar constituting the line of faith is vertically movable by means of actuator means, so that once the plate has reached its proper position in the station, this bar can be lowered, to enable the plate edge to be machined.

[0069] When the plate PL have reached the desired position, the movement of the belts of the conveyor device is interrupted and the structure of the conveyor device is lowered to deposit the plate PL on the locking devices B, which have been preliminarily arranged in the most suitable positions, depending upon the configuration and the dimensions of the plate. The plate PL is located in position by means of any suitable device and is locked in this position by activating the locking devices B.

[0070] In another embodiment, the machine can be provided also or exclusively with a detection system (such as a mechanical contact sensor and/or an optical sensor) which enables the position and the orientation of the plate to be detected, once the plate is locked on the locking devices. In this manner, the electronic controller can automatically adapt machining program to the position of the plate as detected. The locking devices can be provided with a sensor able to detect the presence of the piece and the activation of the locking function. Also in this case, the machine can be provided with a "line of faith" or "zero-line", although this is not essential.

[0071] Once the plate has been locked in position, it undergoes a work cycle by means of a movement of the work head H3. In case it is necessary to carry out different operations on a same plate by using different tools, the head H3 is able to carry out the tool change automatically, by positioning itself at the tool magazine H3 for depositing the tool carried thereon into the magazine and for picking up a new tool from another position of the magazine. Once the cycle of operations is completed, the work head H3 is carried to a position spaced from the plate PL, the locking devices B are deactivated and the structure of the conveyor device 2A is raised to take the plate PL on the belts of the conveyor device. At this point, the conveyor devices activated for causing the plate PL to move out from the machine centre MC and to advance towards

the unloading station UL of the line.

[0072] In another embodiment (figure 5C) the belt conveyor system for the plate inside the machine centre can be divided into two or more sections 200A, 200B, 200C, as to enable define different distances between the belts of each section. In this manner, it is possible to define a distance of the belts with respect to the left and right side of the plate (with reference to the direction of movement of the plate) which is greater at the areas where machining operations on the plate edges are to be carried out, and is instead lower in proximity of any plate indentations, to avoid that the belts are located inside said indentations.

[0073] Figure 5D shows a further variant of the machine centre MC. The general structure of the machine centre is identical to that shown in figures 5A, 5B, 5C (corresponding parts are designated by the same reference numerals). The stationary structure of the machine centre includes two lateral portions S3 which are spaced apart from each other, which define a work area of said machine centre and on which said bridge-like cross-member T3 is movable. The conveyor line 2 is carried by a supporting structure 2Z independent with respect to the stationary structure of the machine centre. The supporting structure 2Z of the conveyor line extends through apertures 13 of said lateral portion S3 of the stationary structure of the machine centre and through the work area. The conveyor line 2 comprises at least one independent section associated to the machine centre MC, including a slide top or a roller top RP, with freely rotatable rollers R, for guiding a plate in its advancing movement, in one or more gripping members (in the example two gripping members G10, G20) such as gripping members or suction-cup members, which can be activated to engage the plate and which are movable in a longitudinal direction (by means of actuator devices of any known type) for introducing the plate in said machine centre and/or for moving the plate out from the machine centre. In this case, the locking devices are vertically movable to engage the lower surface of the plate, once the plate has been carried in the work position.

[0074] Figure 6 of the annexed drawings shows the use of clamp-like locking devices 8', adapted to engage and clamp the edges of the plate PL, which can be used as an alternative to the suction-cup locking devices.

[0075] In the case that the line is not provided with a waterjet cutting station and openings through the plate being machined must be formed, the machine centre can be provided with a system for eliminating waste material. This variant is shown in figure 5C. On carriage C3, on the side opposite with respect to that carrying the head H3, in this case there is associated a gripping device G for example in the form of a suction-cup device (in another embodiment of the gripping device G is on the same side as the head H3). This gripping device is provided with the possibility of a vertical movement with respect to carriage C3, which can be actuated by means of a fluid cylinder, carried by the carriage C3. In this manner, once the cutting operation has been carried out by means of

the machine centre, the electronic controller can bring the gripping device G above the plate portion which constitutes the waste of the cutting operation. The gripping device G can then be lowered and activated for taking said waste portion thereon. Preferably the waste portion is also supported from below, by a locking device (not shown) which is also carried by the carriage C3. This locking device is adapted to deposit the piece in a final stage for eliminating the waste material which is controlled by the electronic controller. The latter attempts to move in the gripping device G in order to release the waste material into a container CO arranged adjacent to the station (figure 5C) and dedicated to containing the machining waste material. More waste collecting containers can be provided. The controller can also be programmed to let the waste material to fall on a belt W which automatically conveys the waste material from inside the station to a container CO.

[0076] Naturally, while the principle of the invention remains the same, the details of construction and the embodiments may widely vary with respect to what has been described and illustrated purely by way of example, without departing from the scope of the present invention as defined in the annexed claims.

Claims

1. Multi-tool aggregate unit (TU1) for a polishing head (H1) of an electronically-controlled polishing machine, for polishing edges of plates of stone material or synthetic material, for example for finishing operations in the mass production of kitchen tops or the like, said multi-tool aggregate unit (TU1) comprising:

- a supporting structure (9) for the multi-tool aggregate unit,
- an aligned series of polishing tools (11) which are rotatably mounted on said supporting structure (9) of the multi-tool aggregate unit (TU1) and adapted to carry out progressively finer machining operations, the tools being arranged according to an order corresponding to the progression of the machining operation, with a tool (11) for the most coarse machining operation which is arranged at one end of the series and a tool (11) for the finest machining operation which is arranged at the opposite end,
- wherein said supporting structure (9) for the multi-tool aggregate unit (TU1) rotatably supports a single driving rotating shaft (12) connected in rotation to all the tools (11) by means of a mechanical transmission (13,14),

said multi-tool unit (TU1) been **characterized in that**:

- the multi-tool aggregate unit does not include

a motor for actuating the rotation of the tools (11),

- said driving rotating shaft (12) has an end conical shank (12A) projecting from said supporting structure (9) and configured to be removably connected in rotation within one end conical receptacle of a motorized spindle of said machining head,

so that in the mounted condition of the multi-tool aggregate unit (TU1), said motorized spindle can drive in rotation all the tools (11) of said multi-tool aggregate unit (TU1) while at the same time supporting the weight of said multi-tool aggregate unit (TU1), and

- the supporting structure (9) of the multi-tool aggregate unit (TU1) is configured to engage a spindle-supporting body (SP1) which supports the motorized spindle so as to prevent a rotation of the supporting structure (9) of the multi-tool unit (TU1) around the axis of the spindle.

2. Multi-tool aggregate unit (TU1) according to claim 1, **characterized in that** one or more of said tools (11) are cup-shaped grinding wheels having a front abrasive surface and movable in the direction of their axis of rotation, to apply a force against the plates along said direction during machining.

3. Multi-tool aggregate unit according to claim 1, **characterized in that** said multi-tool aggregate unit (TU1) includes channels or conduits for distributing water inside and/or outside the multi-tool aggregate unit (TU1).

4. Multi-tool aggregate unit (TU1) according to claim 1, **characterized in that** said mechanical transmission is a gear transmission (13, 14).

5. Electronically controlled polishing machine provided with at least one multi-tool aggregate unit (TU1) according to any of the previous claims, said machine comprising:

- a polishing head which can be moved along three orthogonal directions with respect to a plate to be polished (PL) which is held in a fixed position in a work area,

- a spindle unit orientably mounted on said polishing head and including:

- a spindle supporting body (SP1),

- a spindle rotatably mounted within the supporting body (SP1), and

- an electric motor for actuating the rotation of the spindle, carried by said supporting body (SP1),

- wherein said multi-tool aggregate unit (TU1) has said end conical shank (12A) of its driving rotating shaft (12) which is coupled with a conical

receptacle provided at one end of the spindle, by means of a coupling device which is configured to enable automatic change of the multi-tool aggregate unit (TU1) on the polishing head (H1).

5

6. Polishing machine according to claim 5, **characterized in that** said spindle-supporting body (SP1) is orientably supported around a horizontal axis (60) orthogonal to the axis of the spindle, by a structure (70) of the polishing head (H1) which on its turn is rotatably supported around a vertical axis (80).

10

7. Polishing machine according to claim 6, **characterized in that** it includes:

15

- a bridge-like cross member (T1) arranged at an elevated position with respect to a work area which is to receive a plate (PL) to be machined,
- two stationary shoulders (S1) on which the bridge-like cross-member (T1) is movable in a horizontal direction (Y) orthogonal to the longitudinal direction (X) of the bridge-like cross-member (T1),
- a carriage (C1) slidably mounted on the bridge-like cross-member (T1) in said longitudinal direction (X),
- a slide (V1) slidably mounted on the carriage (C1) along a vertical direction (Z),
- said structure (70) of the polishing head (H1) being rotatably supported around said vertical axis (80) by said vertically movable slide (V1).

20

25

30

8. Polishing machine according to claim 5, **characterized in that** it comprises a magazine of multi-tool aggregate units and an electronic controller which is programmed for driving a movement of the polishing head (H1) towards and from the magazine, in order to replace the multi-tool aggregate unit carried by the polishing head (H1).

35

40

45

50

55

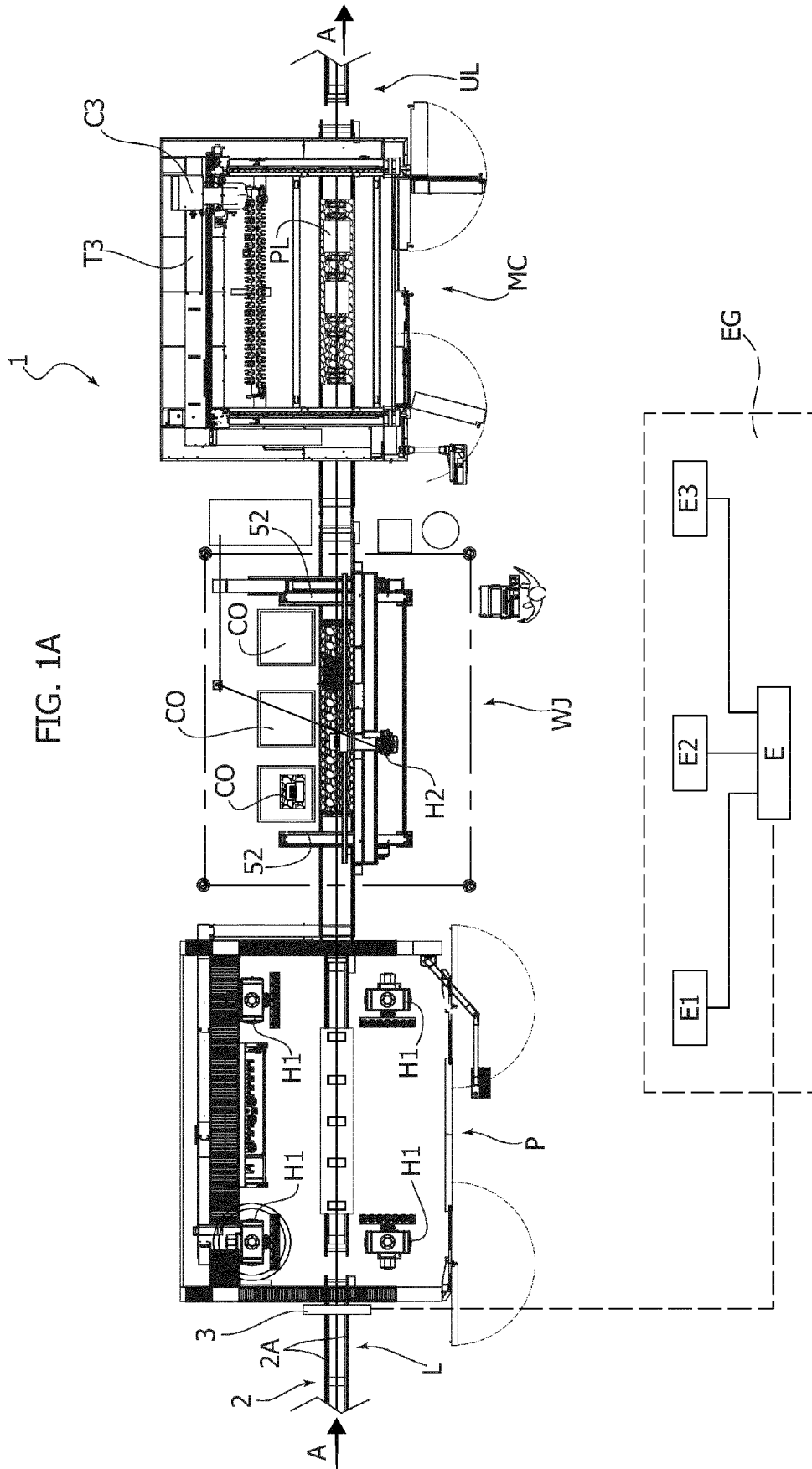


FIG. 1B

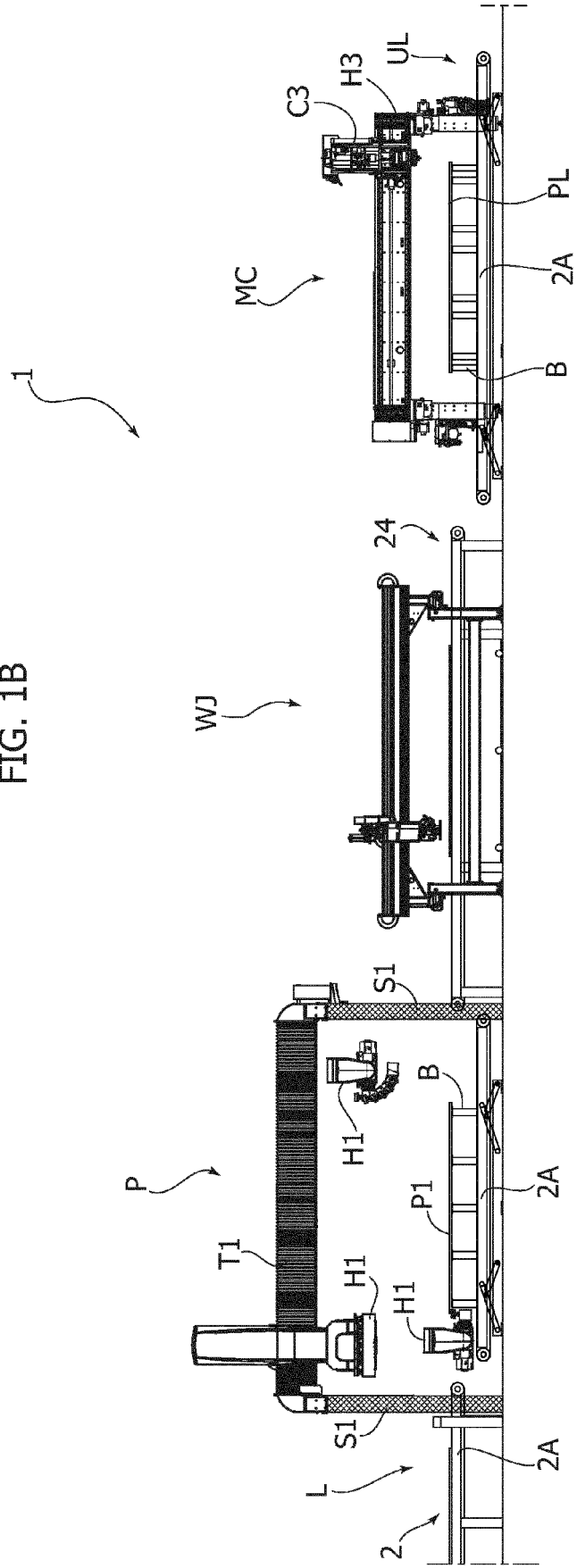


FIG. 2A

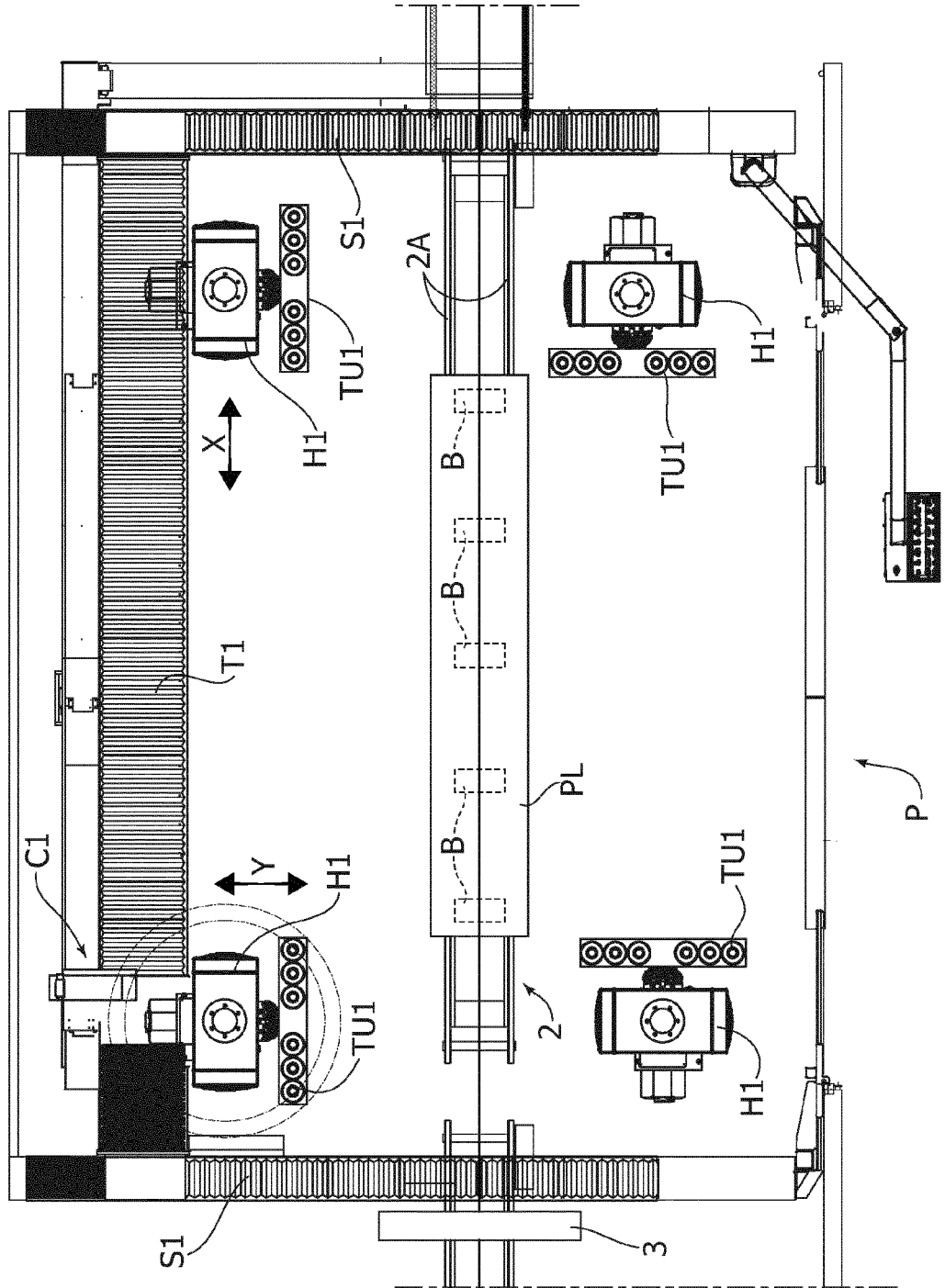


FIG. 2B

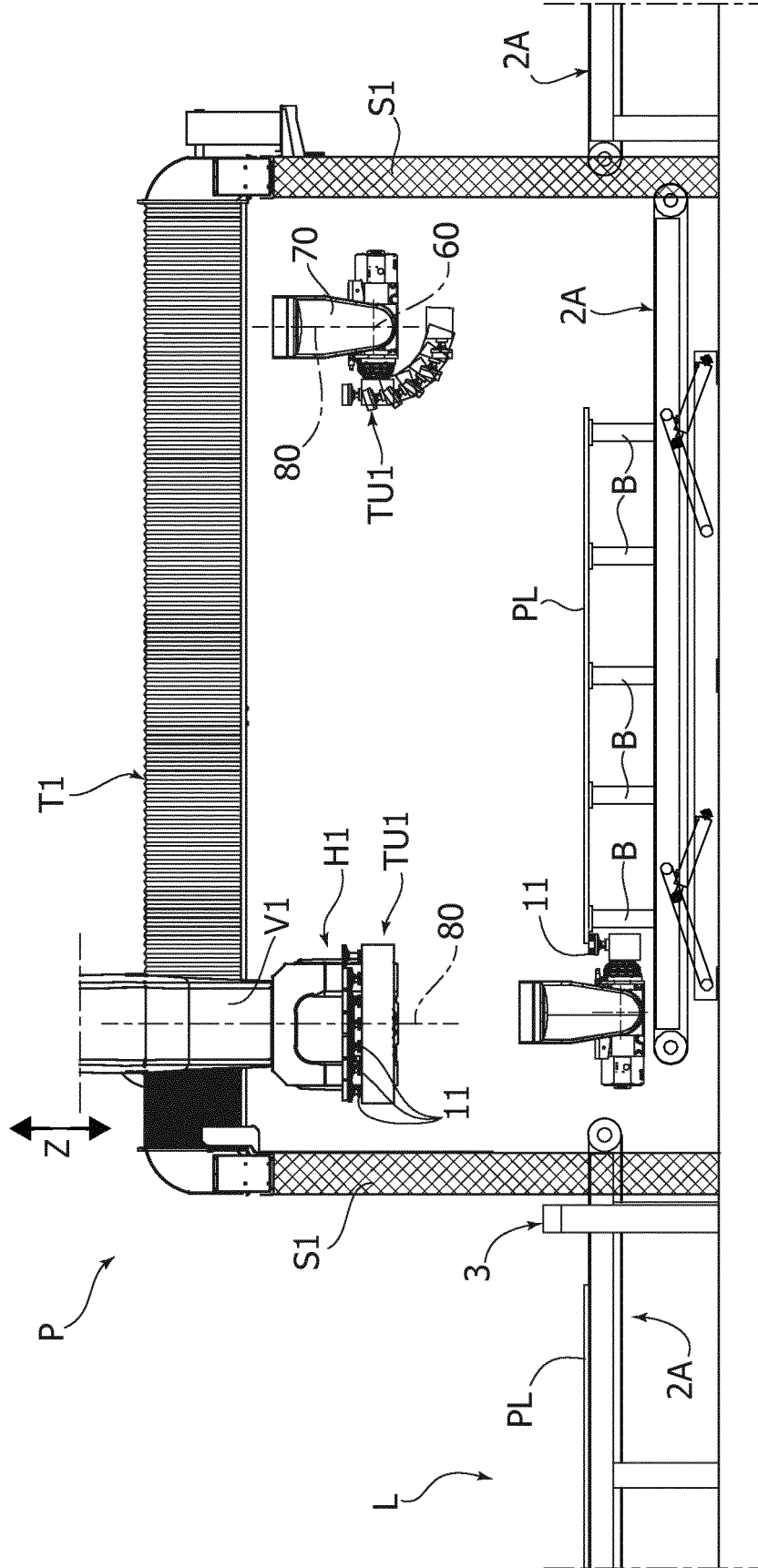


FIG. 3A

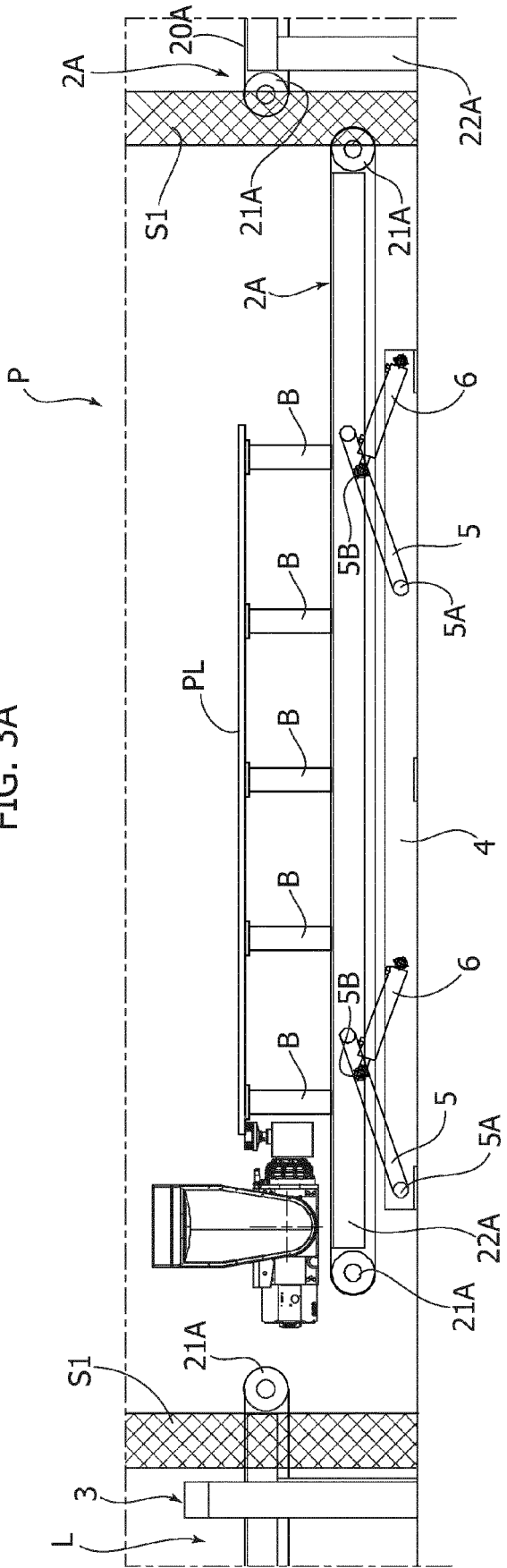


FIG. 3B

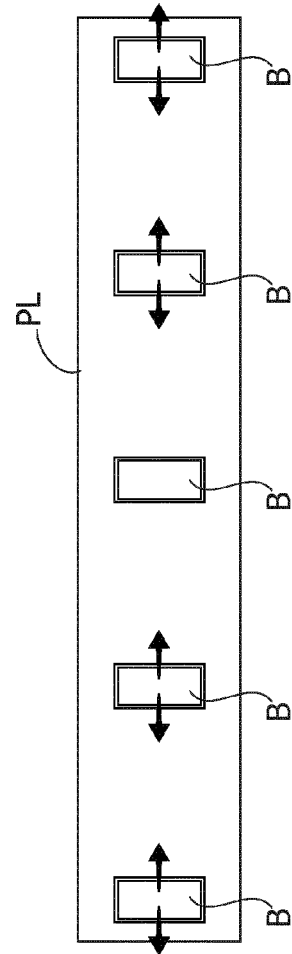


FIG. 3C

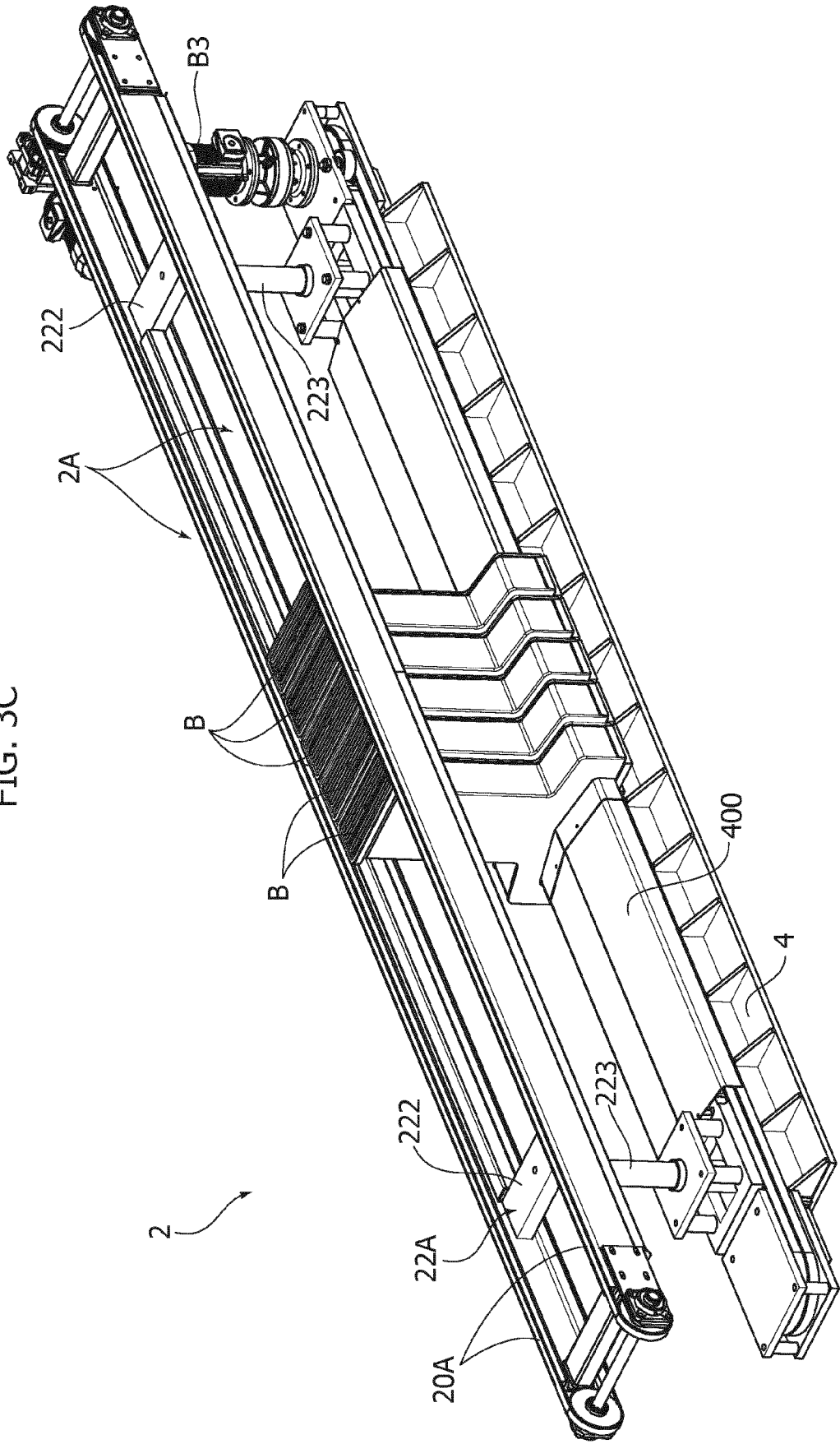


FIG. 3F

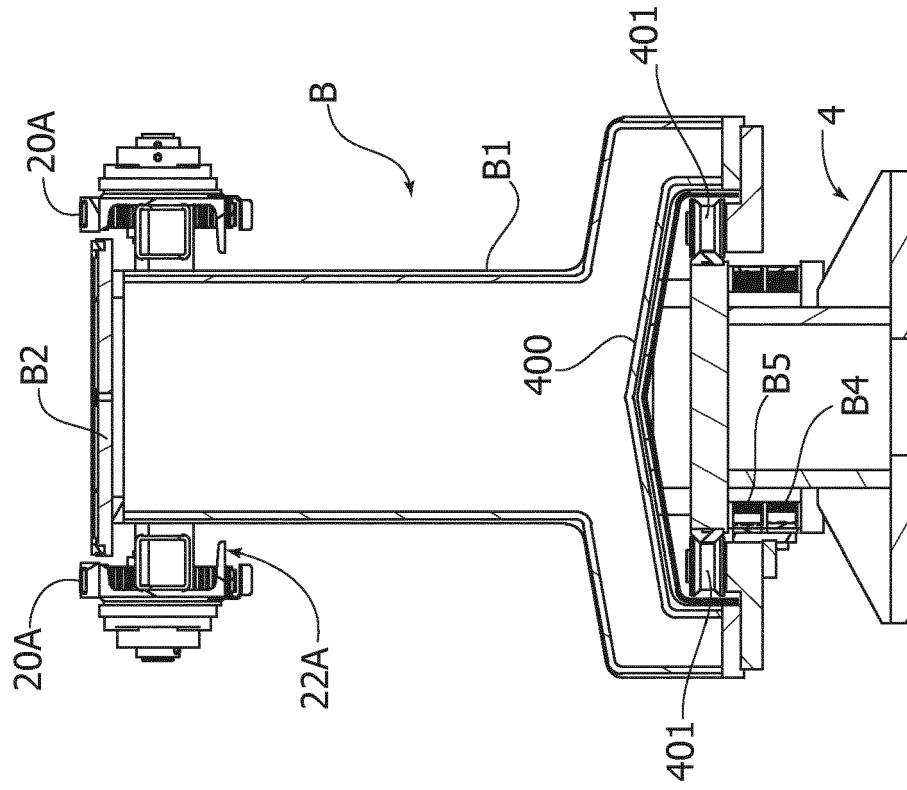


FIG. 3E

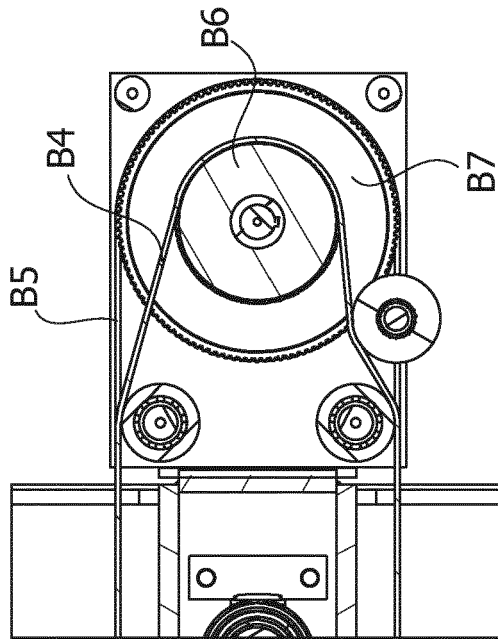


FIG. 3G

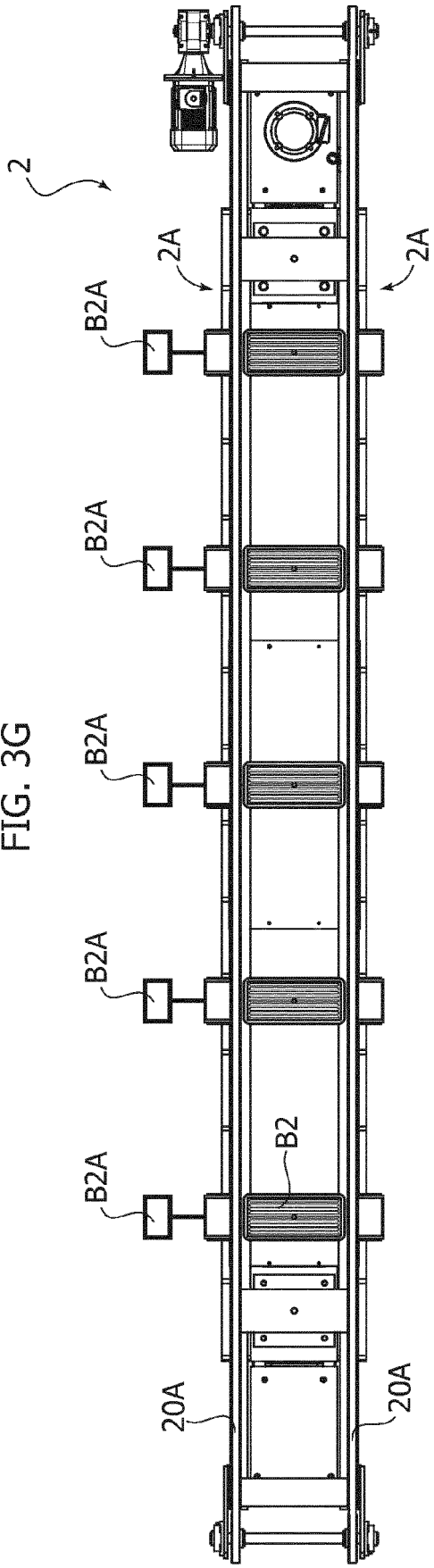


FIG. 3H

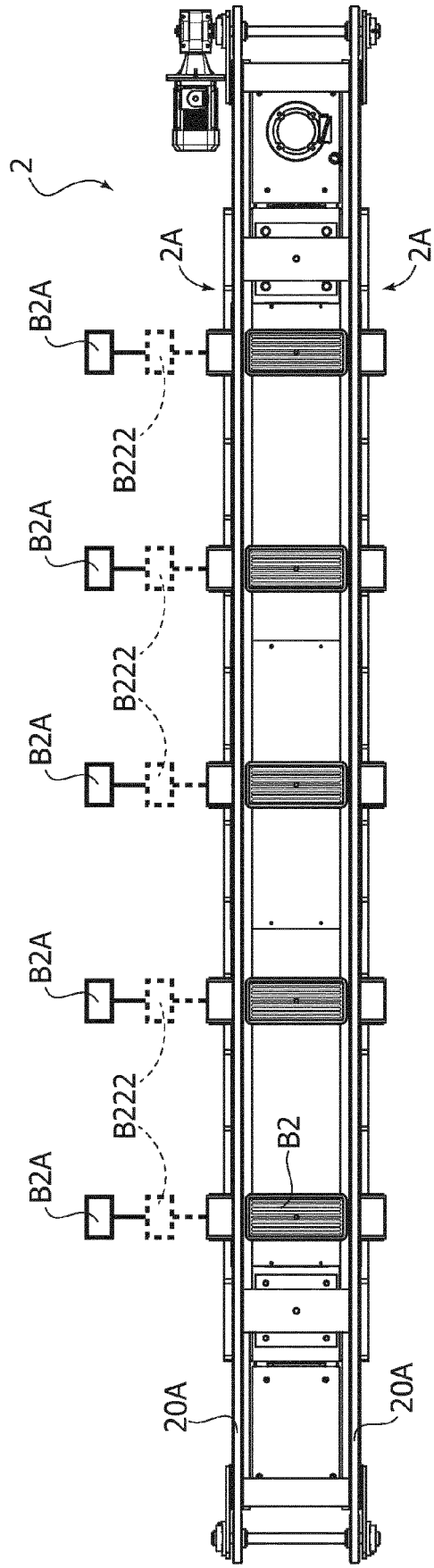


FIG. 4A

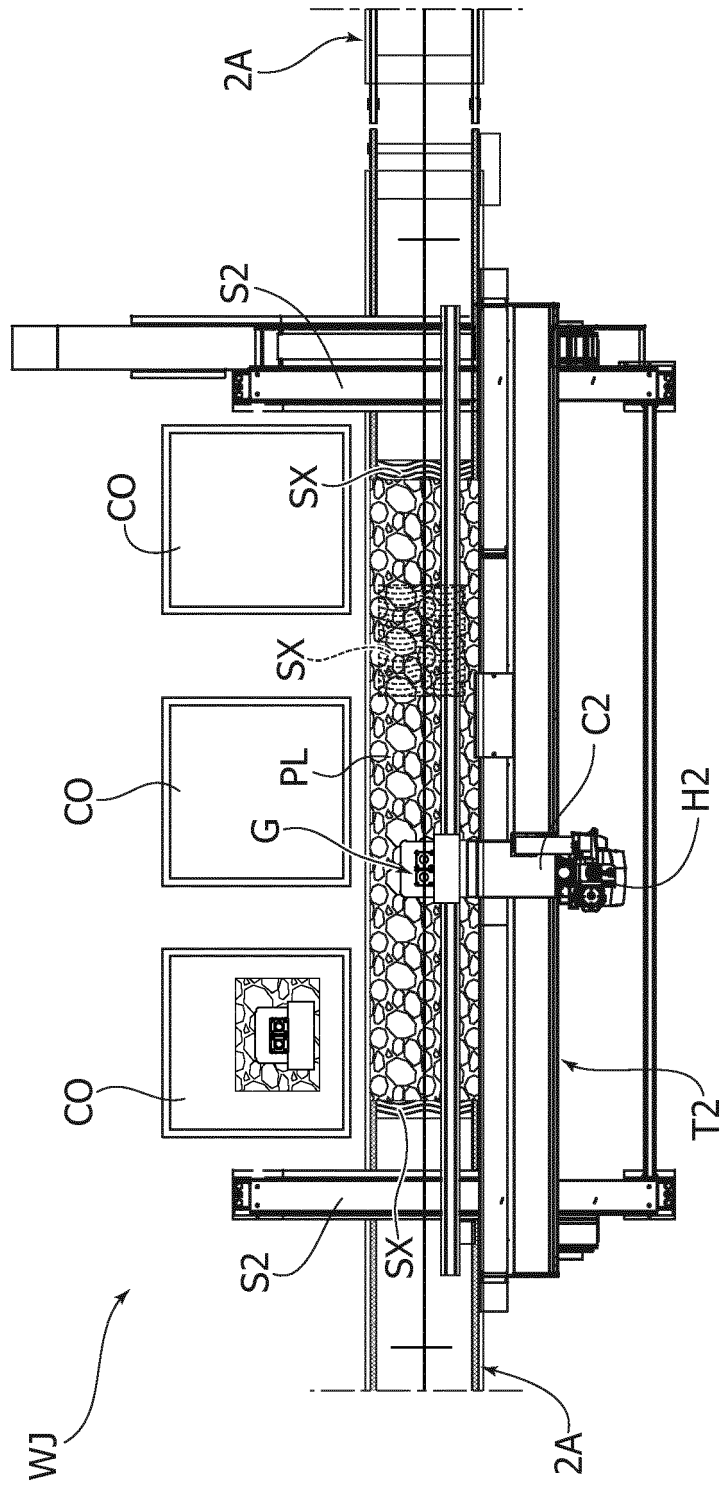
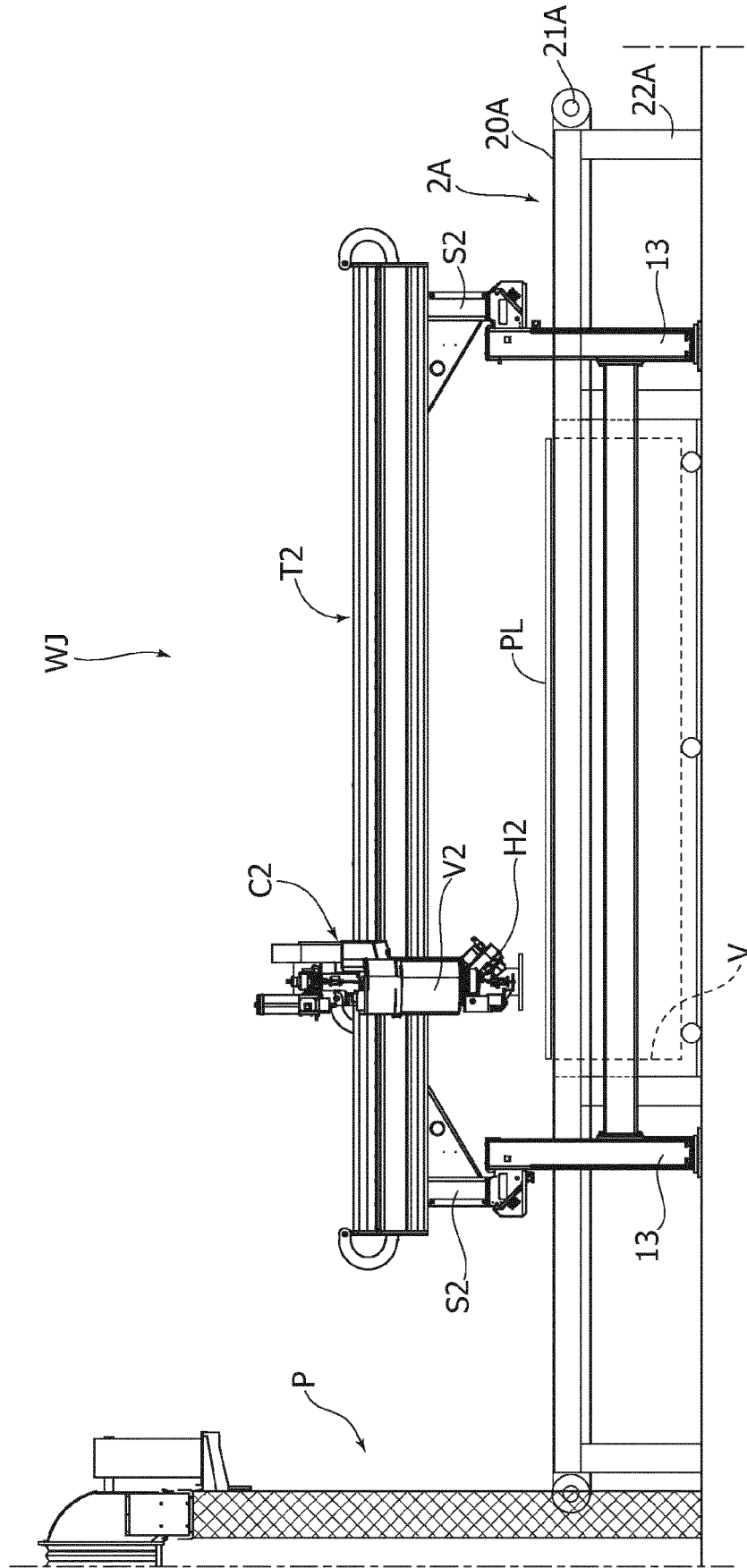


FIG. 4B



MC

FIG. 5A

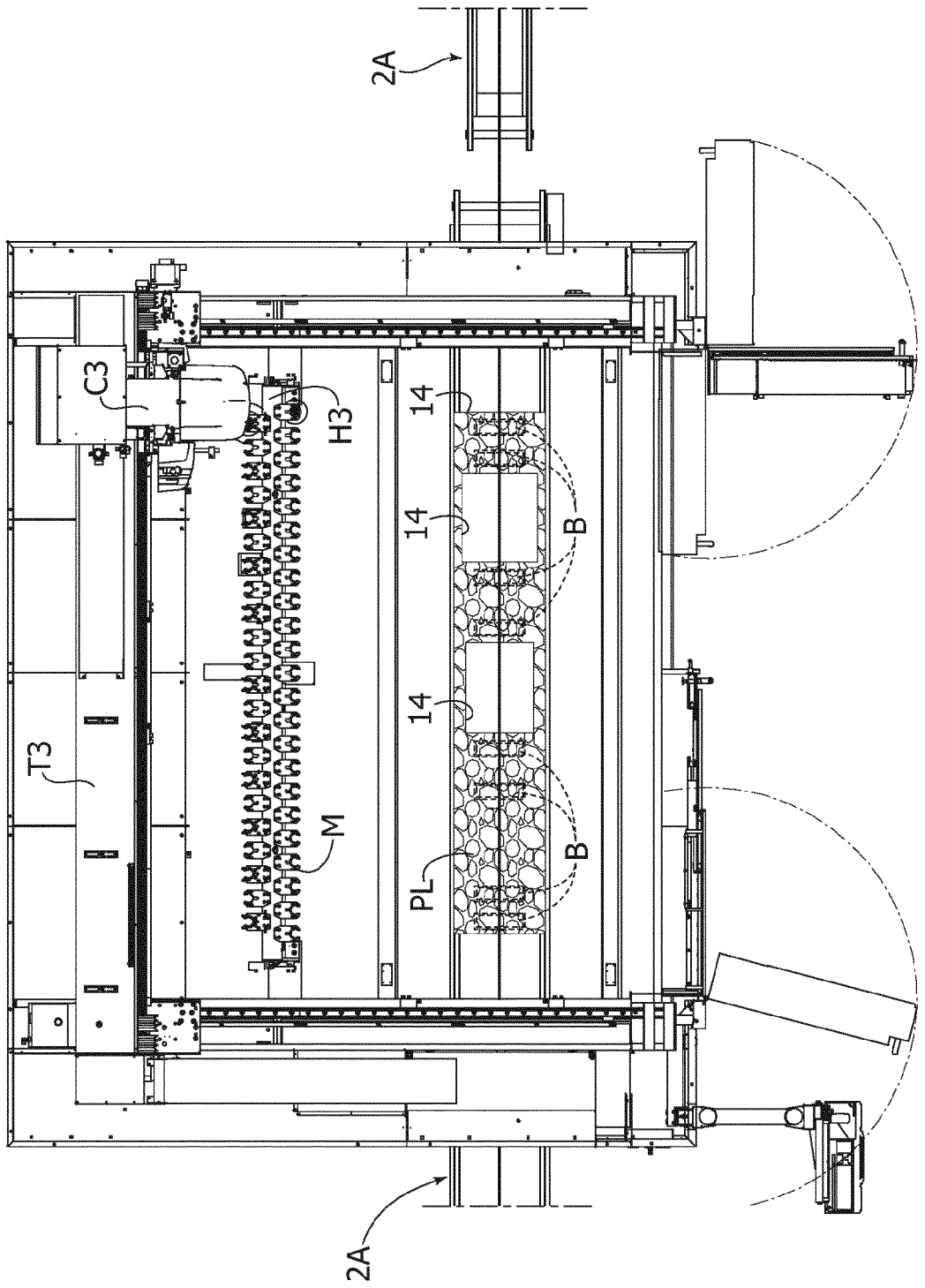


FIG. 5B

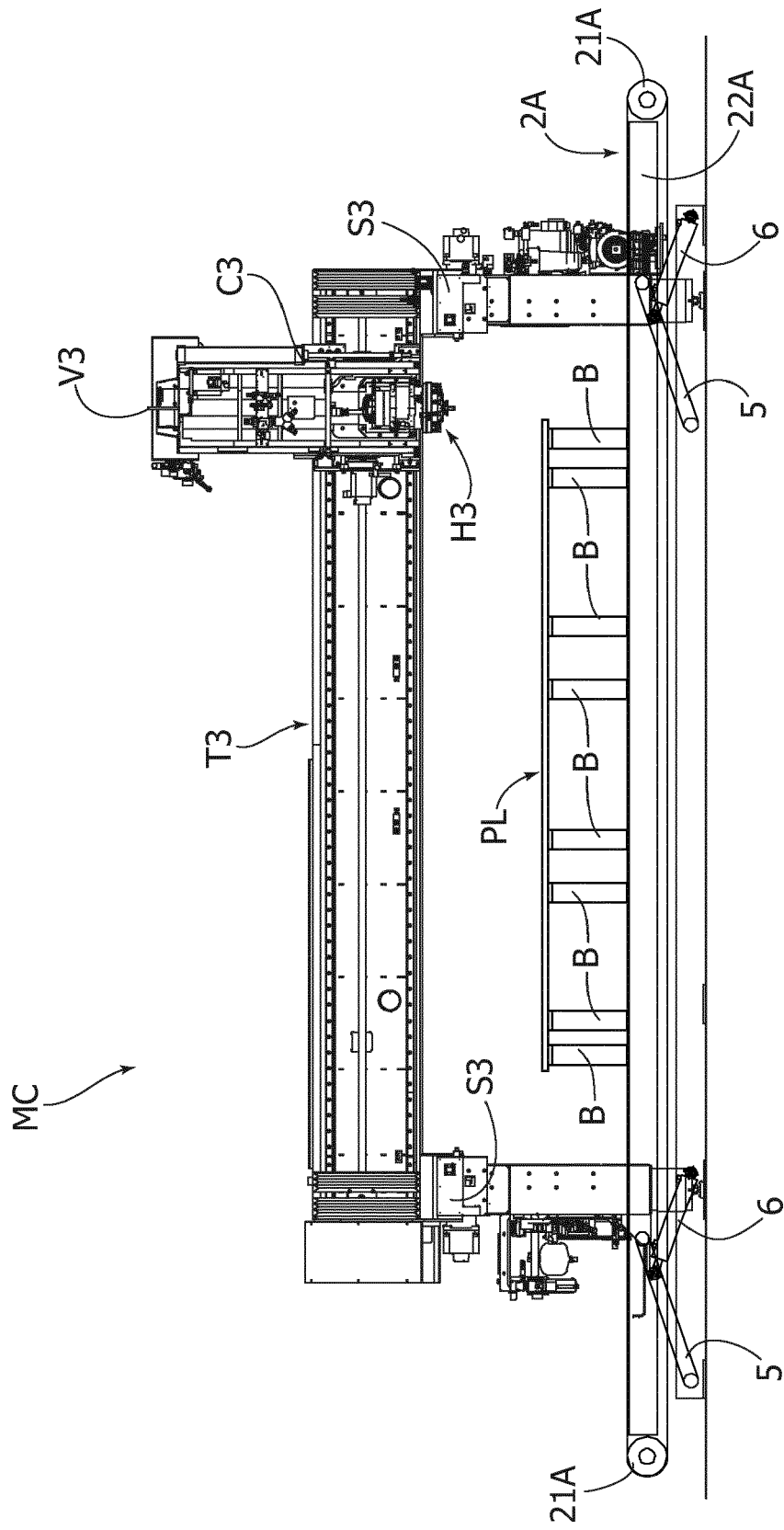


FIG. 5D

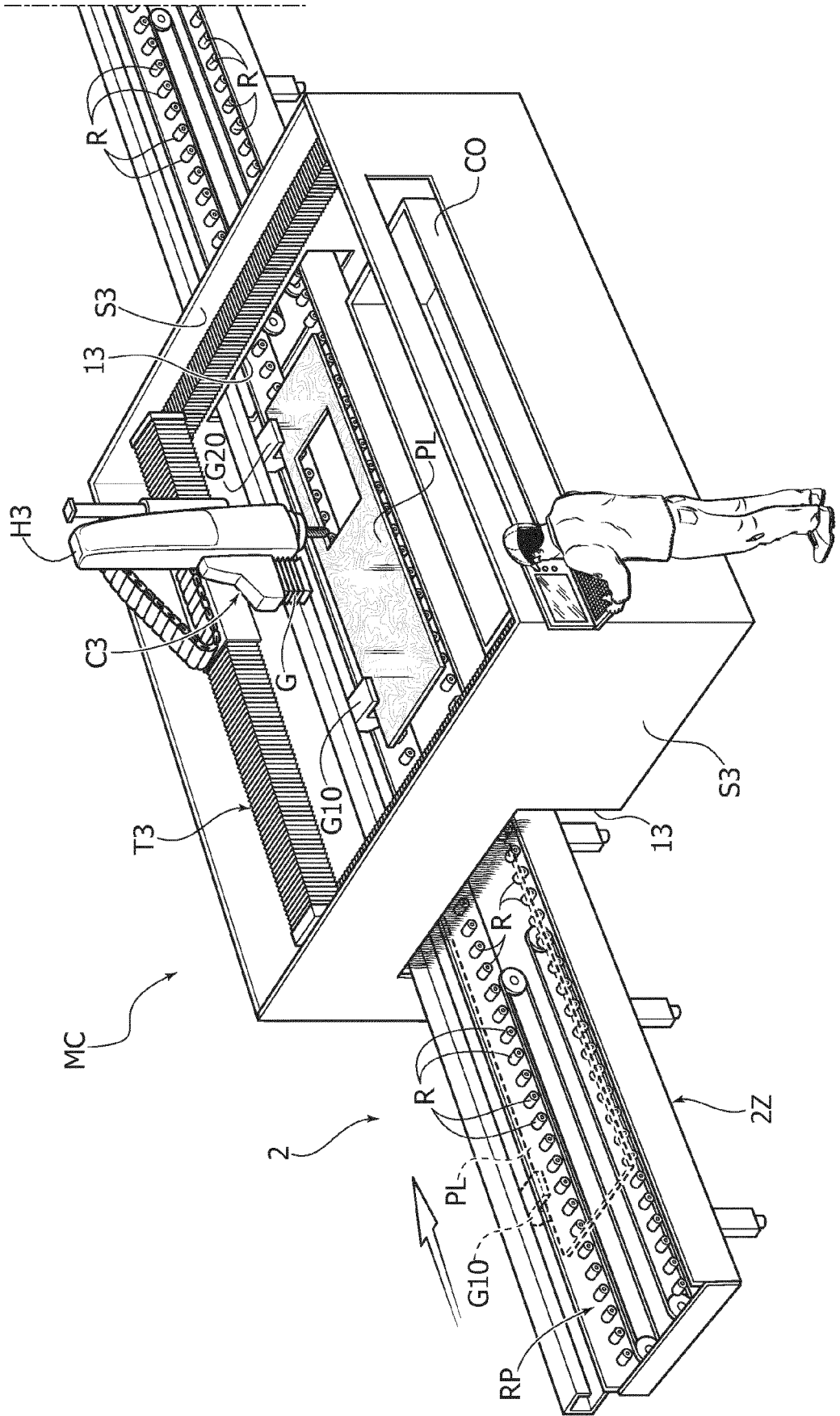


FIG. 6

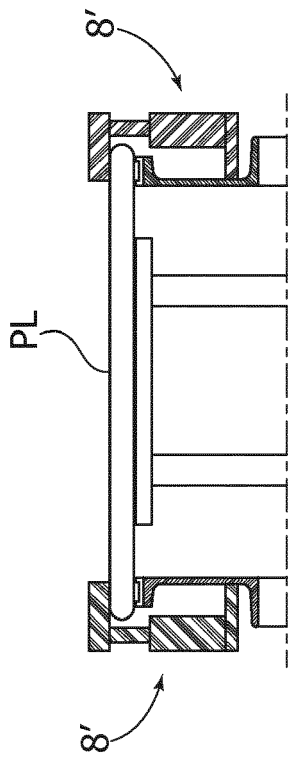


FIG. 7

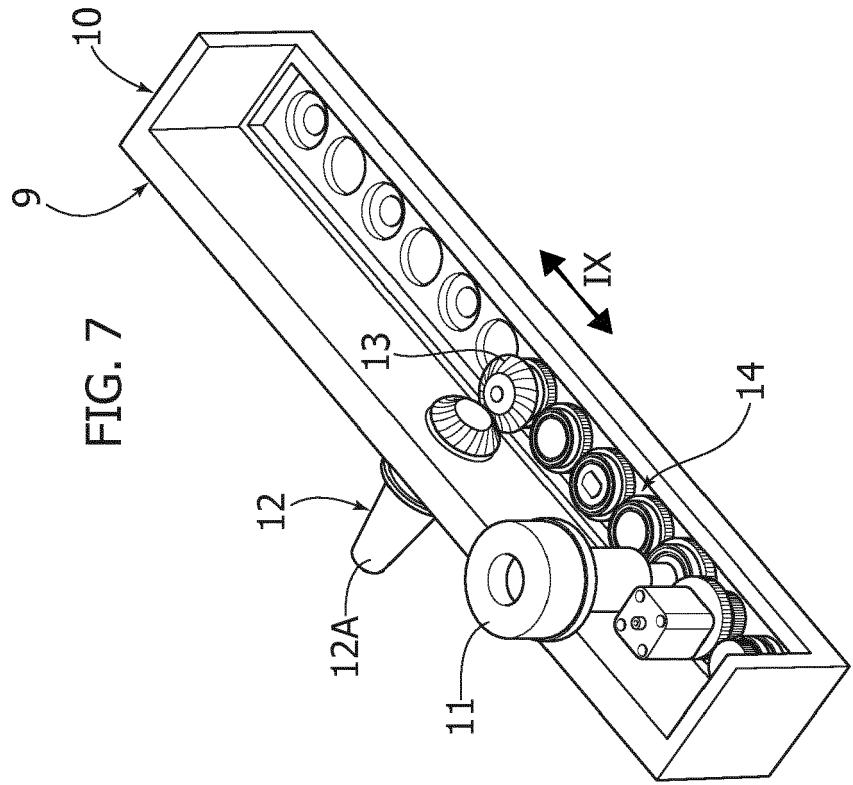
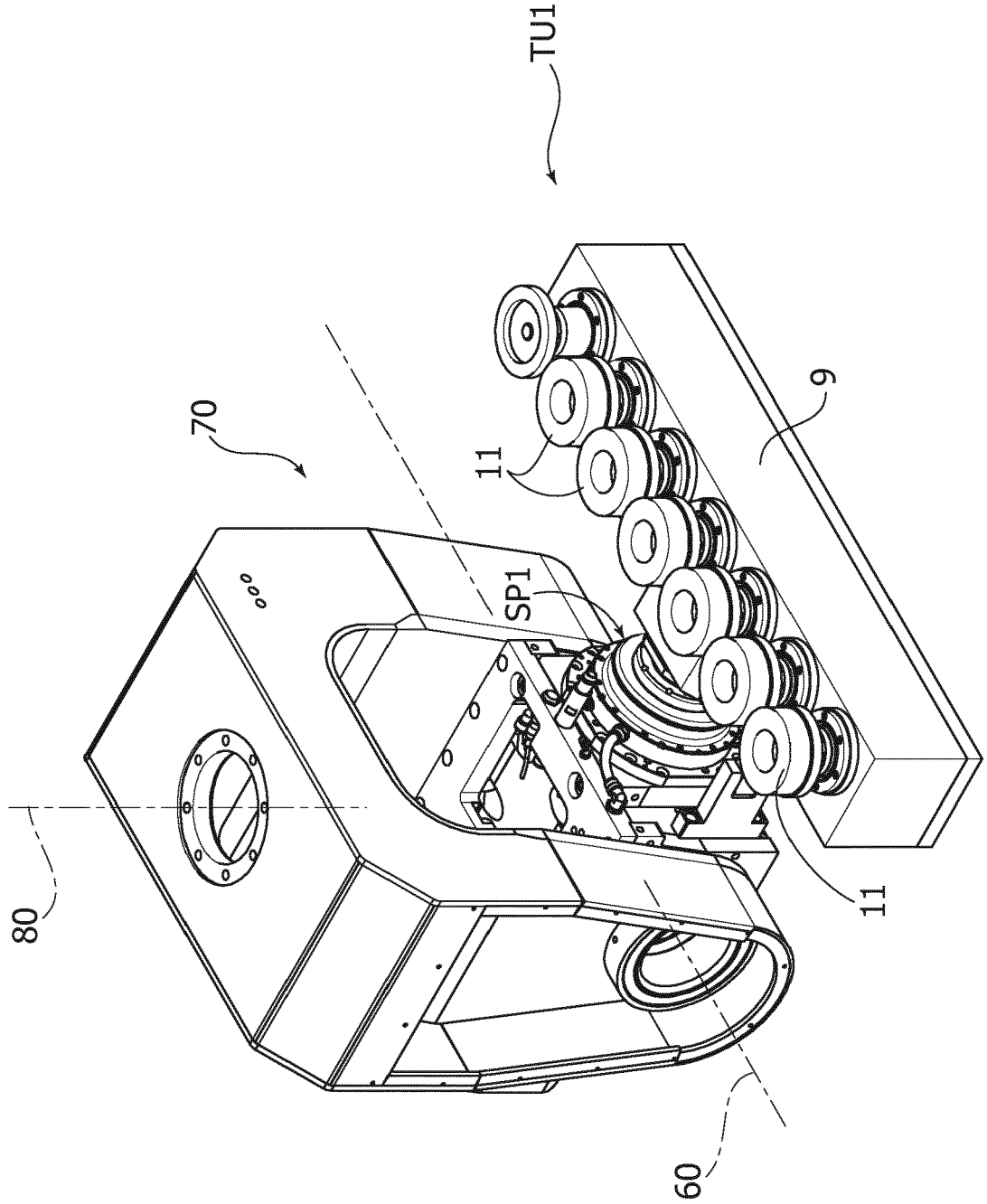


FIG. 8





EUROPEAN SEARCH REPORT

Application Number
EP 19 19 9610

5

10

15

20

25

30

35

40

45

50

55

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 9 289 872 B1 (ALTAMIRANO SILVANO [US]) 22 March 2016 (2016-03-22) * the multi-wheel grinder tool without the housing, showing an exemplary gear system and axles; figure 5 * * column 2, line 65 - column 3, line 43 * * claims 1, 15-17 * -----	1-8	INV. B24B27/00 B24B7/22 B24B9/06 B24B9/00 B24B47/12 B24B41/047 B24B55/02
A	CN 107 855 899 A (SHENZHEN YUANRONG INTELLIGENT MFG CO LTD) 30 March 2018 (2018-03-30) * abstract; figure 1 * -----	1-8	
A	EP 3 170 622 A1 (BIESSE SPA [IT]) 24 May 2017 (2017-05-24) * automatic change of tools; paragraphs [0005], [0016]; figure 2 * * paragraphs [0034] - [0038]; figure 6a * -----	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			B24B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 29 November 2019	Examiner Arhire, Irina
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p>			

1
EPO FORM 1503 03 82 (P04C01)

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

EP 19 19 9610

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-11-2019

10	Patent document cited in search report	Publication date	Patent family member(s)	Publication date
	US 9289872	B1	22-03-2016	NONE
	CN 107855899	A	30-03-2018	NONE
15	EP 3170622	A1	24-05-2017	NONE
20				
25				
30				
35				
40				
45				
50				
55				

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 9289872 B1 [0004]
- CN 107855899 A [0004]