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(54) **GRINDING OR POLISHING UNIT OF A SHEET, IN PARTICULAR A GLASS SHEET, AND METHOD FOR PROCESSING SHEETS USING SUCH UNIT**

(57) A perimetric surface (5) of a glass sheet (2) is ground and polished using a grinding or polishing unit (30) having a slide (33) that can move in a rectilinear direction (K) and a wheel head (31) carried by the slide (33) and designed to carry a grinding wheel (22) or a polishing wheel (27); the slide (33) being moved by an electropneumatic activation assembly (35) that has an electric motor (50) coupled to the slide (33) via a reversible mechanic transmission (45) for positioning the grinding wheel (22) and a pneumatic thrust cylinder (39) acting directly on the slide (33) to push the polishing wheel (27); a command and control unit (16) being envisaged for activating at least the pneumatic cylinder (39) when the polishing wheel (27) is mounted on the wheel head, and the electric motor (27) when a grinding wheel (22) is mounted on the same wheel head (31).

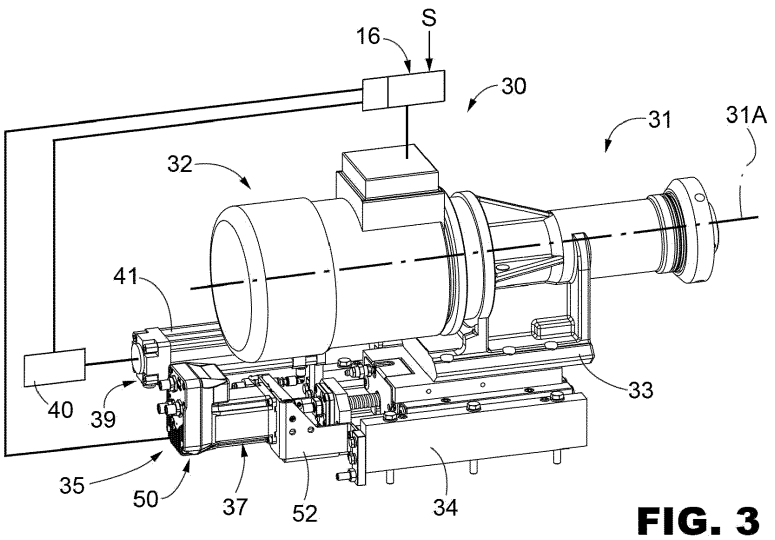

FIG. 3

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian patent application no. 102020000004819 filed on 6/03/2020.

TECHNICAL FIELD

[0002] This invention relates to a grinding or polishing unit of a sheet, in particular a glass sheet, and to a method for processing sheets using such a unit.

[0003] In particular, this invention relates to a grinding or polishing unit of a sheet, in general, and of a glass sheet in particular, to which the following discussion explicitly refers, without any loss of generality thereby.

BACKGROUND ART

[0004] In the field of glass-sheet processing, it is known to use grinding or polishing units particularly, but not necessarily, for processing perimeter surfaces, i.e. those perimeter surfaces that extend transversely to the extended surfaces of the glass sheet itself.

[0005] Two types of machines are known to be used for processing the perimeter surfaces of a glass sheet. On the one hand, the so-called "bilateral" grinding machines belong to a first type. With these, the sheets are fed sideways and the opposite perimeter surfaces thereof are ground simultaneously by two grinding-polishing groups, which face each other.

[0006] On the other hand, the so-called "rectilinear" grinding machines belong to a second type. With these, the sheets are fed on an almost vertical plane and are ground by feeding the perimeter surfaces on an underlying grinding-polishing group.

[0007] Irrespective of the type of machine used, each grinding-polishing group comprises a number of grinding units that are adjacent to each other and independent of each other to remove an determined amount of material from the sheet, and a number of polishing units that are also independent of each other and arranged adjacent to each other and downstream of the grinding units in the direction for feeding the sheets to polish the surfaces ground by the grinding units.

[0008] Each grinding unit comprises a corresponding grinding wheel, an electric motor for rotating the grinding wheel about its axis, and a device for positioning the grinding wheel in a given operating position for removal. Each positioning device comprises, in turn, a slide for supporting the grinding wheel and its corresponding drive motor and an electric motor for moving and positioning that slide.

[0009] Each polishing unit comprises a corresponding polishing wheel, which is also rotated around its axis by a corresponding electric motor and also mounted on a corresponding slide driven by a corresponding linear actuator designed to push the corresponding slide and, consequently, the corresponding polishing wheel against the ground surface of the sheet. Depending on the application, the slides carrying the polishing wheels are pushed by pneumatic cylinders or by mechanical springs with variable preload.

[0010] The known grinding machines of the type defined above are normally designed and manufactured on the basis of the customer's requirements and, in particular, according to the type of sheets to be processed but, above all, according to the processing to be carried out and the degree of precision/surface finish required. To do this, a given number of grinding units and a predefined number of polishing units are planned and installed during the design step.

[0011] Once made, it is normally no longer possible to vary the number of grinding and/or finishing units and, therefore, to convert or customise the machine for different processing, i.e. to carry out a different grinding and/or polishing program or, again, to obtain a different degree of polishing with the ground surfaces.

[0012] This rigidity makes it impossible to satisfy the emerging need among the users of these machines, which is to be able to have a basic machine but, at the same time, to be able to reconfigure the basic machine in an extremely short time and in a simple and inexpensive way without the need for specialised operators when the production needs or the degree of finishing required changes.

[0013] From the Italian patent application No. 10201900002941 filed by the same applicant, it is known to create a grinding machine provided with at least one configurable unit, i.e. able to use, according to need, a grinding wheel or a polishing wheel.

[0014] In the above configurable unit, either wheel is mounted on a wheel head arranged on a slide; in the case of the grinding wheel, it is brought to a predetermined grinding position by an electric displacement motor and kept in that predetermined position by an irreversible screw-nut screw transmission with a metric screw rotated by the same electric motor.

[0015] On the other hand, when the polishing wheel is mounted on the wheel head, the slide is constantly pushed against the surface to be polished by a pneumatic actuator arranged in series with the electric motor. Note the type of wheel on the slide, a pneumatic selection device interposed between the electric motor and the pneumatic actuator, connects the slide to the electric motor when there is a grinding wheel on the wheel head, keeping the pneumatic actuator deactivated, and activates the pneumatic actuator when the wheel used is a polishing wheel, isolating the electric motor.

[0016] Although appreciated by users, the known configurable unit defined above is relatively complex in terms of construction and, therefore, relatively high in cost and requires careful control during the configuration step. For these reasons, the above configurable unit does not find immediate and satisfactory application on any type/range

of grinding or polishing machines.

[0017] In addition to this, a brake assembly is always connected to the above configurable unit to counteract the thrust of the pneumatic actuator during the transition from one surface to be ground to another and thus maintain the polishing wheel in a predefined holding position without deactivating the pneumatic actuator.

[0018] Each brake assembly has relatively large dimensions for the already crowded area in which it is located and, in any case, a cost that affects the total cost of the machine if you consider that each polishing unit requires its own brake assembly.

[0019] Finally, in the known configurable unit of the type described above, controlling the wear of the polishing wheel is particularly complicated and, at times, difficult and inaccurate since it is mainly done visually or using position sensors, while it is always necessary to act on the electric motor for positioning the slide to control the wear of the grinding wheel. The control, mainly carried out by detecting the variation in current absorbed by the electric motor, is inaccurate due to the presence of the mechanical transmission driven by the same electric motor, whose elastic failures can distort the detection of the instant in which the wheel hits the expected fixed reference and, therefore, the resetting of the grinding wheel itself.

DISCLOSURE OF INVENTION

[0020] The purpose of this invention is to provide a grinding or polishing unit, which resolves, in a simple and inexpensive manner, the problems described above, and, in particular, which is, compared to the known solutions, simple and very quick to produce and configure/control and which is inexpensive and compact in size.

[0021] According to this invention, a grinding or polishing unit of a sheet, in particular a glass sheet, is provided; the unit comprising a fixed guide, a slide coupled with said guide to run in a rectilinear direction, a motorised head connected to said slide and configured to carry a grinding wheel or a polishing wheel, and a configurable electro-pneumatic assembly for movement of said slide in said rectilinear direction; the electro-pneumatic assembly comprising:

- an electric motor;
- a movement transmission operated by said electric motor and having a first movable member;
- a pneumatic actuator having a second movable member; and
- command and control means for activating said electric motor at least when said grinding wheel is mounted on the wheel head or at least said pneumatic actuator when said polishing wheel is mounted on said wheel head;

characterised in that said first and second movable member are both stably connected to said slide and in that reversible connection means are interposed between said electric motor and said first movable member.

[0022] In the above-defined unit, said reversible connection means preferably form part of said transmission.

[0023] This invention also relates to a method for processing a sheet.

[0024] According to this invention, a method for processing a sheet, as claimed in claim 9, is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The invention will now be described with reference to the accompanying drawings, illustrating a non-limiting embodiment thereof, in which:

Figure 1 illustrates, schematically and mainly in blocks, a preferred embodiment of a machine for grinding and polishing glass sheets according to this invention; and

Figures 2 and 3 illustrate, in perspective view and on an enlarged scale, two opposite side views of a grinding or polishing unit of the machine in Figure 1 produced according to the precepts of this invention;

Figure 4 is a perspective view, on an enlarged scale and with parts removed for clarity, of the unit in Figures 2 and 3; and

Figure 5 is similar to Figure 4 and illustrates, in cross-section, some details of the unit in Figure 4.

BEST MODE FOR CARRYING OUT THE INVENTION

[0026] In Figure 1, the reference number 1 indicates, as a whole, a machine for grinding and polishing glass sheets 2: flat, rectangular glass sheets with two opposing, extended, flat surfaces indicated with 3, and four consecutive, flat perimeter or lateral surfaces one of which is indicated with reference number 5, in the illustrated example.

[0027] The machine 1 can, equally, be a bilateral machine, i.e. with sheets 2 fed flat, or a straight machine, i.e. with sheets 2 fed edgeways. It comprises a stiff base 6, and a motorised sheet-conveying assembly 7, known in itself and partially visible in Figure 1, to feed a succession 8 of glass sheets 2 along a rectilinear path 9 and through a station 13 for grinding and polishing the perimetric surfaces 5.

[0028] The group 7 is commanded and controlled by an electronic command and control unit 16 for the whole machine 1.

[0029] Again with reference to Figure 1, the station 13 houses a row 18 of abrasive units that are independent of one another and arranged side-by-side in a direction parallel to the path 9.

[0030] The row 18 of abrasive units comprises a group A of known grinding units 19 and a group B of polishing units 20, which are also known, and which polish the surfaces 5 ground by the group A.

[0031] Each grinding unit 19 comprises a correspond-

ing grinding wheel 22, which is rotated by a corresponding electric motor 23 commanded by the electronic unit 16 and is carried by a corresponding slide 24.

[0032] The slide 24 is coupled to a guide 25 fixed to the base 6 and can slide orthogonally to the path 9 in opposite directions under the thrust of an electric motor 26, conveniently a servomotor controlled by the electronic unit 16.

[0033] Each polishing unit 20 comprises a corresponding polishing wheel 27, which is rotated about a corresponding axis by an electric motor 28 commanded by the electronic unit 16 and is mounted on a slide 29 driven by its own actuator 29', for example, a pneumatic cylinder controlled by a proportional solenoid valve that is, in turn, controlled by the electronic unit 16 to push the corresponding wheel 27 against the surface 5 of the sheets 2.

[0034] Still with reference to Figure 1, the row 18 of abrasive units comprises, finally, one or more bifunctional abrasive units 30 arranged between the groups A and B. Each bifunctional unit 30 can be controlled and set by means of the unit 16 to perform either a grinding operation or a polishing operation on the surfaces 5, as will be better described below.

[0035] According to a different configuration of the machine 1, the grinding assembly A comprises a single grinding unit 19, and the polishing assembly B comprises a single polishing unit 20.

[0036] Regardless of the number of abrasive units 19 and 20, each of the abrasive units 30 is independent of the other abrasive units, comprises a wheel head 31, on which a grinding wheel 22 or a polishing wheel 27 can be mounted.

[0037] The wheel head 31 is rotated about a corresponding axis 31A by an electric motor 32 commanded by the electronic unit 16. The electric motor 32 and the wheel head 31 are mounted on and moved by a slide 33. The slide 33 is coupled to a rectilinear guide 34 integral with the base 6 and is mobile orthogonally to the path 9 in a direction K parallel to the axis 31A under the thrust of an electropneumatic assembly, indicated by 35.

[0038] With reference to Figures 4 and 5, the electropneumatic assembly 35 comprises a pneumatic actuator device, indicated as a whole, with 36 and an electric actuator device 37.

[0039] The pneumatic device 36 comprises a double-acting pneumatic cylinder 39 connected to a compressed air source and a command block 40 that is connected and controlled by the unit 16.

[0040] The cylinder 39 comprises, in turn, a sleeve 41 stably connected to one end of the guide 34 by means of a bracket 42 and an outlet rod 43 having a free end stably connected to the slide 33 by means of a bracket 44 (Figures 2 and 4) .

[0041] Again with reference to Figures 2, 4, and 5, the electric actuator device 37 comprises a reversible or invertible mechanical transmission 45. The mechanical transmission 45 is, preferably, a recirculating ball screw-nut screw transmission and, for example, of the type identified by the HIWIN identification codes: 1R16-5-FSI-231-0.052-C7 and TRM: SFNHR01605C1D+SSR01605X231L. The term reversible or invertible refers to a transmission that fails under a load, i.e. a transmission that is unable to provide significant resistance to the axial thrust exerted by the wheels 22, 27.

[0042] The transmission 45 comprises a screw 46 and a nut or nut screw 47. The screw 46 has its own axis 46A coinciding with the axis K and is coupled to the guide 34 in a rotatable manner and in an axially fixed position. The nut screw 47 is, instead, stably connected to the slide 33 by means of a bracket 48.

[0043] The electric actuator device 37 comprises, then, an electric motor 50, which has a casing 51 stably connected to the guide 34 via a rigid structure 52 and a rotating output shaft 53 angularly and axially connected to one end of the screw 46 via a joint 55.

[0044] The electric motor 50 is electrically connected to the unit 16.

[0045] Depending on the operations planned for the processing cycle, each of the units 30 is configured by mounting a grinding wheel 22 or a polishing wheel 27 on its wheel head and the unit 16 informed accordingly.

[0046] When a grinding wheel 22 is mounted on the wheel head 31, the unit 16 unloads the pneumatic cylinder 36 and activates the electric motor 50. This motor 50 rotates the screw 46 and translates the slide 33 until the grinding wheel 22 is brought into a predefined grinding position. During its translation, the slide 33 drags the rod of the pneumatic cylinder 39 with it. Once the predefined position has been reached, the electric motor 50 is controlled in position so as to keep the grinding wheel 22 stationary in that position along the axis K for as long as is necessary for grinding the sheet 2.

[0047] When, on the other hand, the polishing wheel 27 is mounted on the wheel head 31, again by means of the unit 16, the electric motor 50 is deactivated and the pneumatic cylinder 39 is activated, which, by dragging the nut screw 47 with it, constantly pushes the polishing wheel 27 against the surface 5 to be polished. Since the slide 33 drags the nut screw 47 with it and, therefore, rotates the screw 46 and with it the motor 50, using the encoder 50A connected to the motor 50, it is possible to determine the position of the slide 33 and the wear of the polishing wheel 27 in real time.

[0048] Moreover, by activating the motor 50 at the same time as activating the pneumatic cylinder 39 and controlling it in a pair, it is possible to integrate or vary, in an extremely precise manner, the thrust action exerted on the slide 33 and, therefore, on the polishing wheel 27.

[0049] Not only, but always controlling the electric motor 50, in a pair, during the thrust exerted on the polishing wheel 27 by the pneumatic cylinder 39, it is possible to exert on the same slide 33 an action that counters or opposes the one exerted by the pneumatic cylinder 39 and to raise this counter action until keeping the slide stationary and in equilibrium of forces along the direction

K. Such a condition is advantageously used to implement the so-called "brake function", i.e. to keep the slide 33 and, therefore, the polishing wheel 27 stationary during the sheet change, i.e. in the passage from one sheet 2 to another.

[0050] Finally, the pneumatic cylinder 39 may be used to move a grinding wheel 22 towards fixed, known positioning abutments to determine the actual wear and the consequent necessary repositioning of the same grinding wheel 22. In fact, the pneumatic cylinder is directly connected to the slide, i.e. without the interposition of transmissions that may yield elastically and differently depending on the conditions. This problem is solved by the pneumatic cylinder because the constancy of the thrust is ensured by the constancy of the pressure; consequently, the elastic yields are always the same.

[0051] In addition to this, it is impossible to reach a dangerous overload condition for the mechanical components, and, therefore, the repositioning procedure is faster.

[0052] From the foregoing, it is clear that the grinding or polishing unit 30 described has, with respect to the known reconfigurable units, an obvious simplicity in construction and control, and smaller dimensions resulting from the elimination of the polishing wheel 27 brake, since this function is performed by the electric motor 50.

[0053] In the unit 30 described, the reversibility of the transmission 45 makes it possible, then, to determine the wear of the polishing wheel 27 - in real time and through the encoder 50A - and to promptly intervene so as to always ensure the same quality of the finished product. According to a variant, the wear of the polishing wheel 27 is determined by detecting the position of the slide 33 along the axis K using, for example, a linear transducer interposed between the slide 33 and the corresponding guide 6.

[0054] The unit 30 can, moreover, be easily controlled and, above all, controlled with extreme precision as the pneumatic cylinder 39 and the electric motor 50 are actuators arranged in parallel with respect to the slide 33 and are independent of each other. For this, the action of one of the two actuators can be integrated or reduced with the other actuator to obtain the optimal working conditions.

[0055] From the foregoing, it is clear that the machine 1 could comprise a single unit 30 or a number of units 30 other than that illustrated and that can be chosen, in the design step, to obtain sheets with perimeter surfaces with different shapes, regardless of their thickness, and with a different surface finishes of the perimeter surfaces themselves.

[0056] Similarly, the unit 30 described may find application on grinding/polishing machines other than those indicated, and, in particular, on all those machines in which grinding and subsequent polishing of the ground sheet is required. Also included in the above-mentioned machines are those in which the glass sheet is kept stationary on a resting surface and the frame 6 of the unit 30 is mobile in relation to the same sheet.

[0057] Finally, it is clear that the unit 30 described, regardless of the context in which it is used, may comprise a reversible transmission other than the one described, for example, a belt transmission or a tooth transmission, or reversibility means, interposed between the electric motor 50 and the slide 33, may be provided.

[0058] Finally, as mentioned above, the unit 30 described can be used for grinding and polishing sheets other than glass sheets and, for example, sheets of stone material or sheets of agglomerated material or other material susceptible to being processed by grinding wheels and polished by polishing wheels chosen, on a case-by-case basis, according to the material to be processed.

Claims

1. A grinding or polishing unit of a sheet, in particular a glass sheet; the unit comprising a fixed guide, a slide coupled with said guide to run in a rectilinear direction, a motorized head connected to said slide and configured to carry a grinding wheel or a polishing wheel, and a configurable electro-pneumatic assembly for movement of said slide in said rectilinear direction; the electro-pneumatic assembly comprising:

   - an electric motor;
   - a movement transmission operated by said electric motor and having a first movable member;
   - a pneumatic actuator having a second movable member; and
   - command and control means for activating said electric motor at least when the grinding wheel is mounted on the wheel head or at least said pneumatic actuator when said polishing wheel is mounted on said wheel head; **characterized in that** said first and second movable member are both stably connected to said slide and **in that** reversible connection means are interposed between said electric motor and said first movable member.

2. The unit according to claim 1, **characterized in that** said reversible connection means constitute part of said transmission.

3. The unit according to claim 2, **characterized in that** said transmission comprises a reversible screw-nutscrew transmission.

4. The unit according to claim 3, **characterized in that** said screw-nutscrew transmission is a recirculating ball transmission.

5. The unit according to claim 3 or 4, **characterized in**

that said reversible transmission comprises a screw having an own axis coinciding with said rectilinear direction and revolving under the thrust of said electric motor.

6. The unit according to any one of the preceding claims, **characterized in that** it comprises position detection means configured to detect the position of said slide along said rectilinear direction with respect to said guide.

7. The unit according to claim 6, **characterized in that** said position detection means comprise an encoder associated with said electric motor.

8. The unit according to any one of the preceding claims, **characterized in that** said command and control means comprise detection means for continuously detecting the wear on the grinding wheel or polishing wheel; said wear detection means being arranged between said slide and said fixed guide.

9. A method for processing a sheet, in particular a glass sheet, using at least one grinding or polishing unit as claimed in claim 1; the method comprising a polishing operation; said polishing operation comprising the step of pushing said polishing wheel against the glass sheet by controlling the thrust of at least one pneumatic cylinder, and a rest step, wherein the polishing wheel is held stationary in the rectilinear direction by exerting a braking action opposite to said thrust action, **characterized in that** said braking action is performed by controlling the torque of an electric motor for the positioning of a grinding wheel.

10. The method according to claim 9, **characterized in that** said polishing operation comprises a wear detection step for detecting the wear on said polishing wheel, said wear detection being performed by controlling the position of a slide carrying the polishing wheel and translating in said longitudinal direction.

11. The method according to claim 10, **characterized in that** the wear detection of the polishing wheel is performed by detecting in a continuous manner the variation of the rotation angle of the electric motor.

12. The method according to claim 10, **characterized in that** the variation of the rotation angle is carried out by using an encoder of the electric motor.

13. The method according to any one of the claims from 9 to 12, **characterized in that** said thrust step is performed by using the electric motor in parallel with the pneumatic cylinder.

14. The method according to any one of the claims from 9 to 13, **characterized in that** it comprises a grinding operation; the grinding operation comprising detection of the wear on the grinding wheel; the detection of the wear on the grinding wheel comprising the step of moving the grinding wheel forward against a fixed abutment by means of the pneumatic cylinder.

15. A machine for grinding and polishing a sheet to be processed, in particular a glass sheet, the machine comprising a conveyor for moving forward the sheet to be processed and an assembly for grinding and polishing said sheet, **characterized in that** said grinding and polishing assembly comprises at least one grinding or polishing unit as claimed in claim 1.

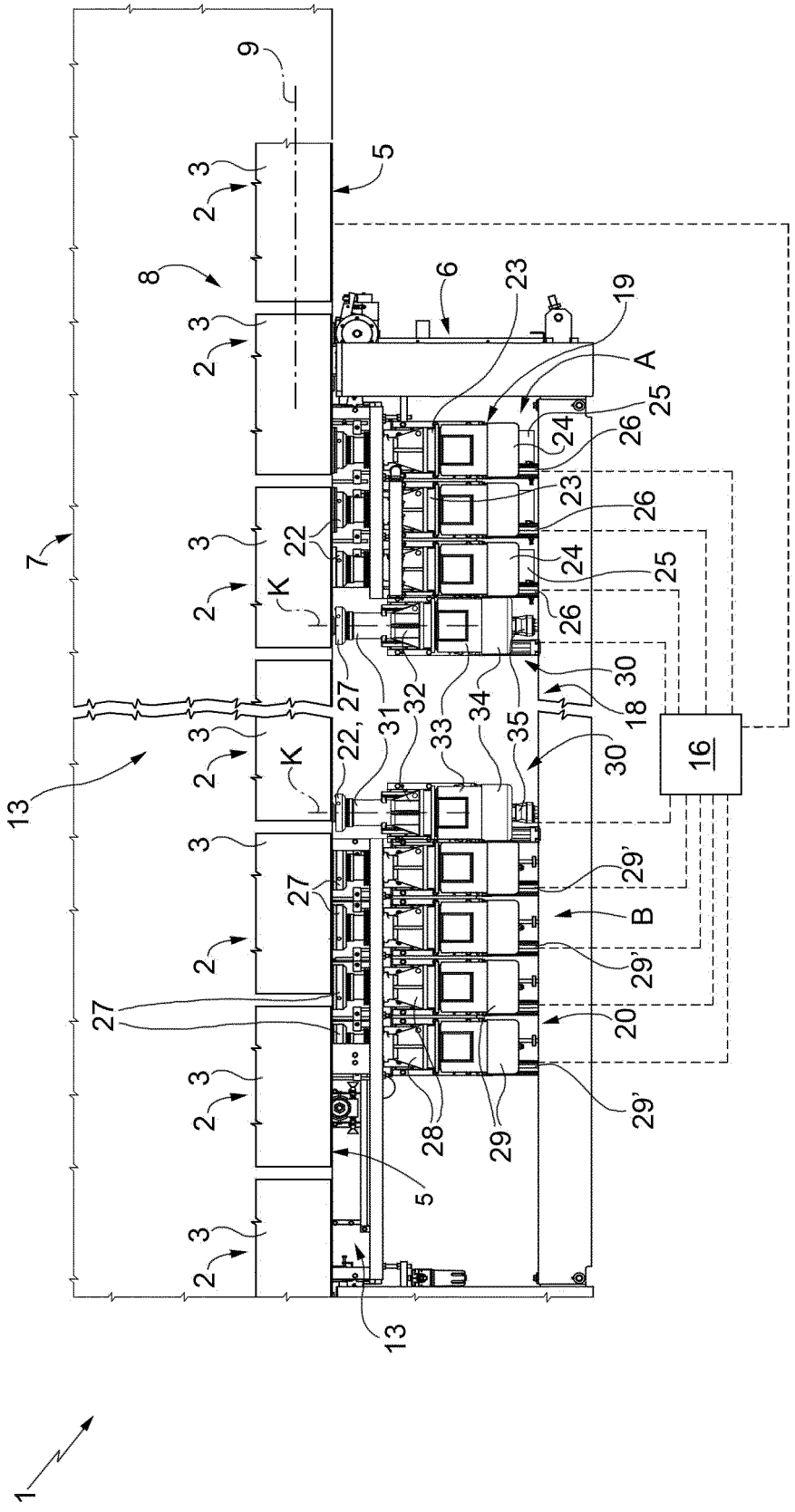
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FIG. 1

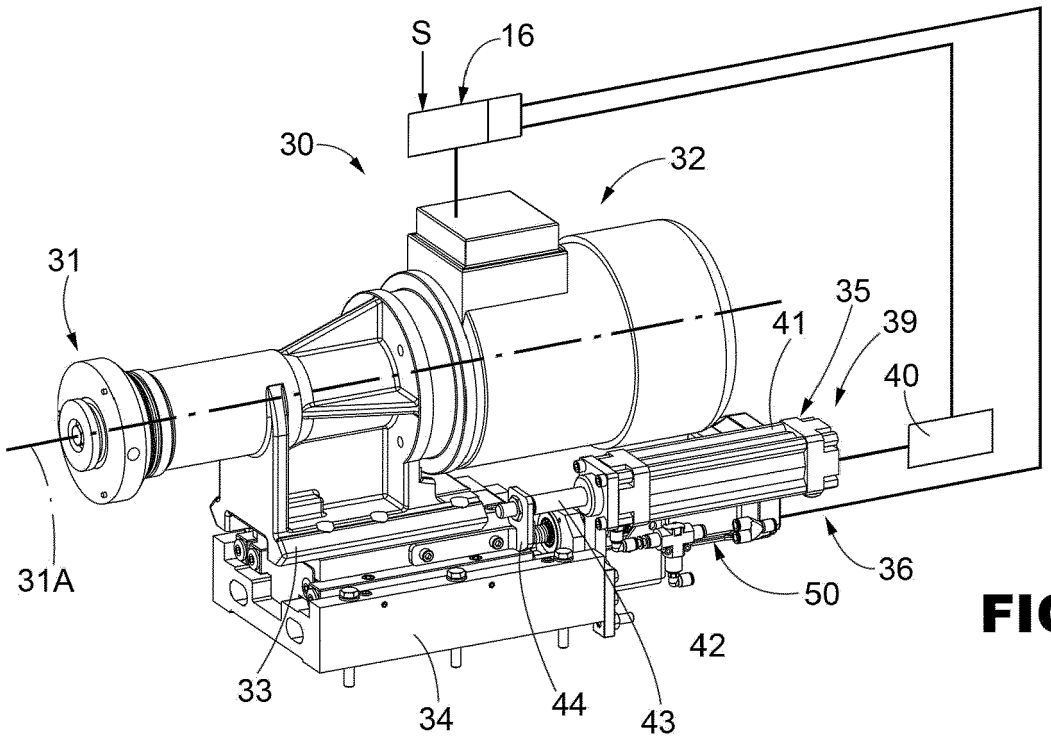
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FIG. 2

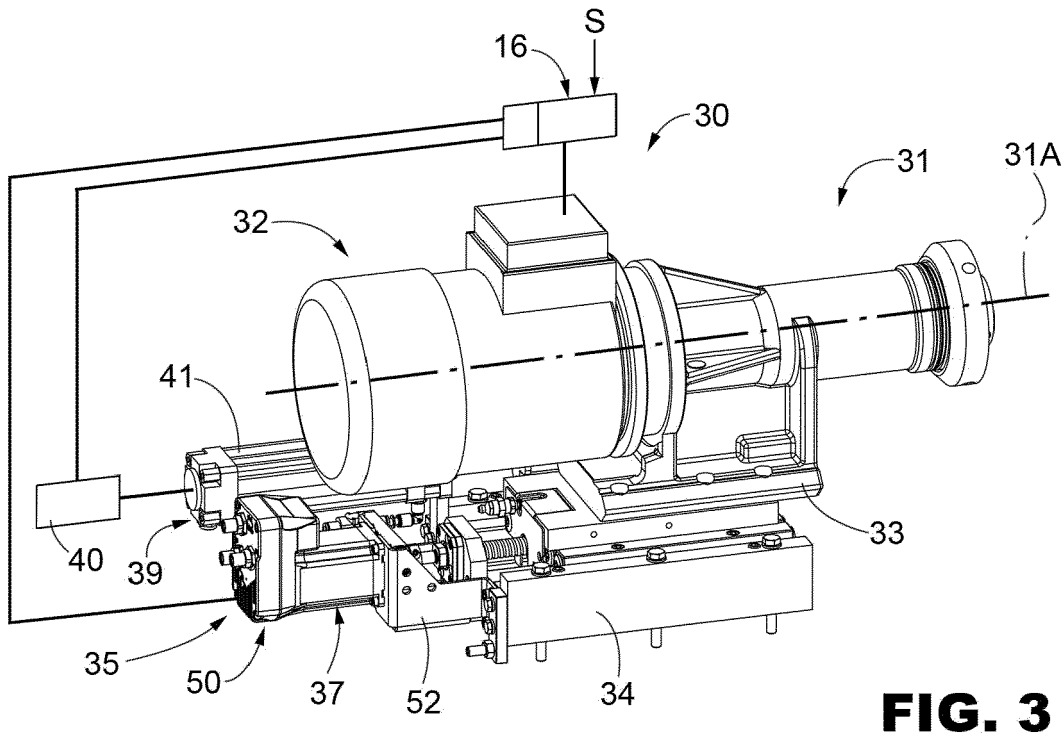
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FIG. 3

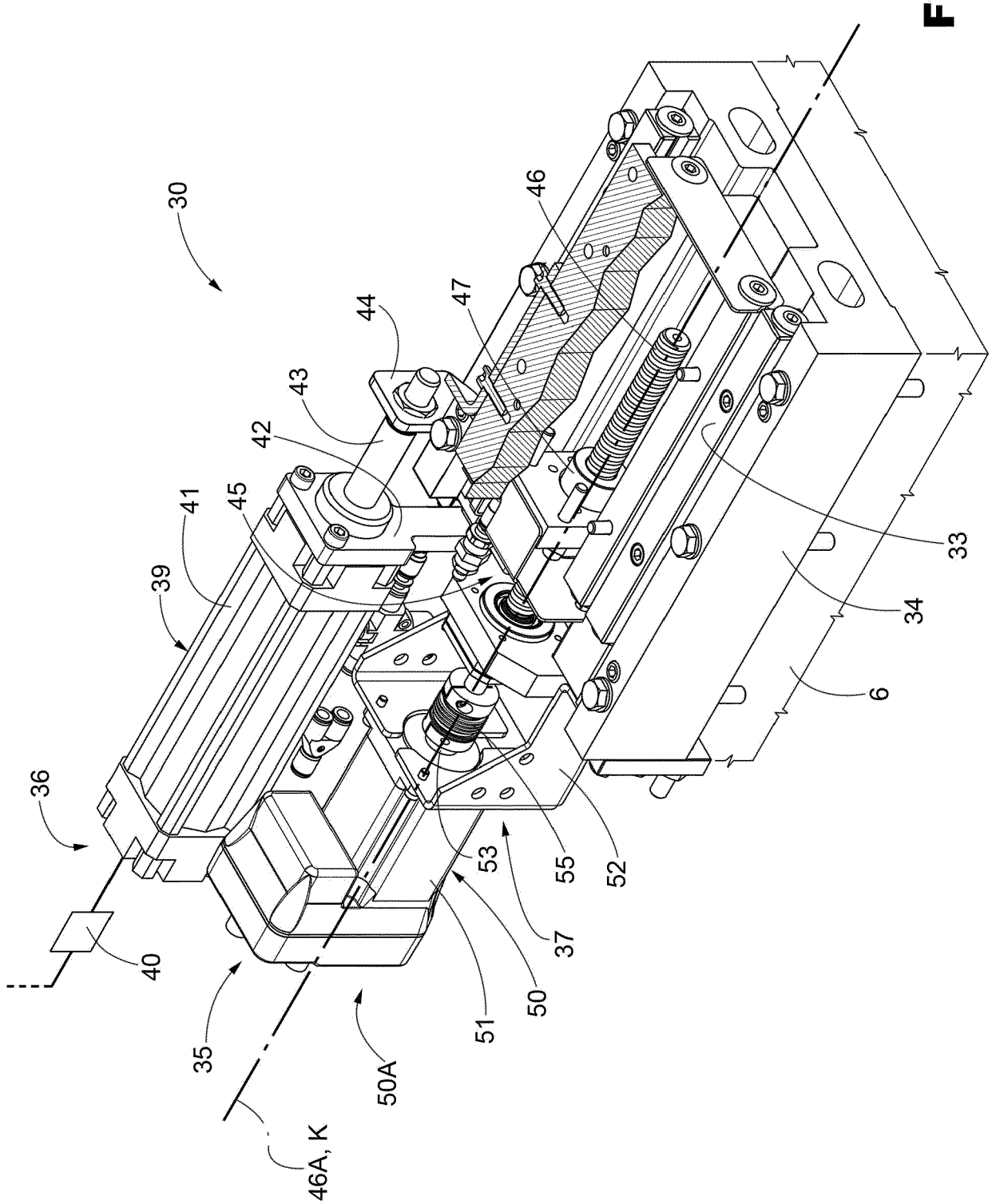
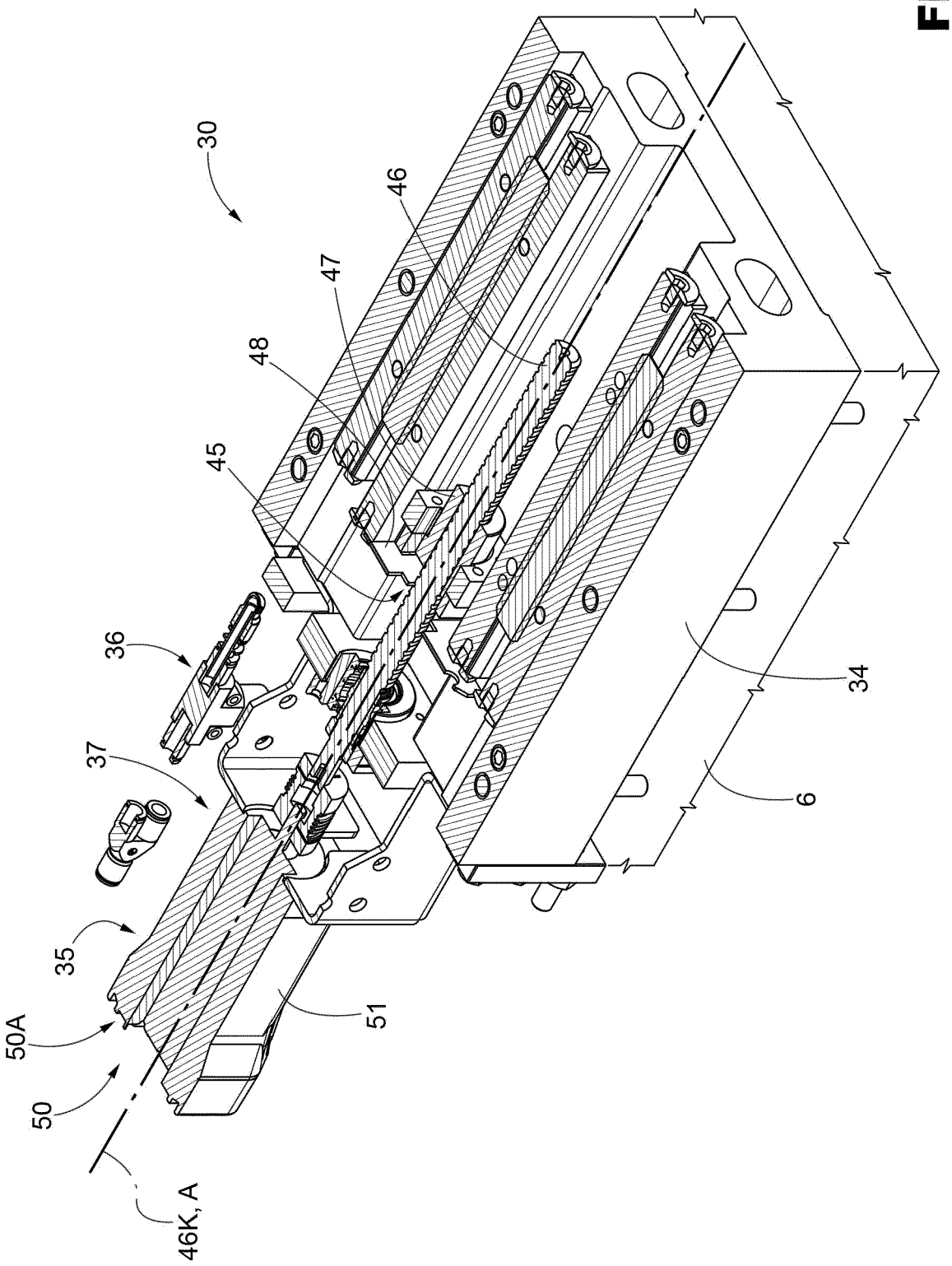


FIG. 4

FIG. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 21 16 1095

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	1 July 2021	Bonetti, Serena

CATEGORY OF CITED DOCUMENTS

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