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(54) A METHOD FOR GRINDING AND POLISHING GLASS SHEETS

(57) A succession (8) of glass sheets (2) is fed in a longitudinal direction (6A) at a predetermined speed and through a grinding station (13), in which a perimeter surface (5) of the glass sheets (2) is first ground by means of one or more grinding wheels (22) and then polished by means of one or more polishing wheels (27); during the grinding and the polishing, the current absorbed by each of the electric motors (23)(28) rotating the wheels (22)(27) is detected, compared with a corresponding predetermined limit value of current that can be absorbed by the electric motor (23)(28) and, when above this, continuing to feed the succession (8) of glass sheets (2) in the longitudinal direction (6A), reducing at least one of either the relative sheet-wheel speed and the thrust action of the polishing wheels (27) against the glass sheet (2) being processed.

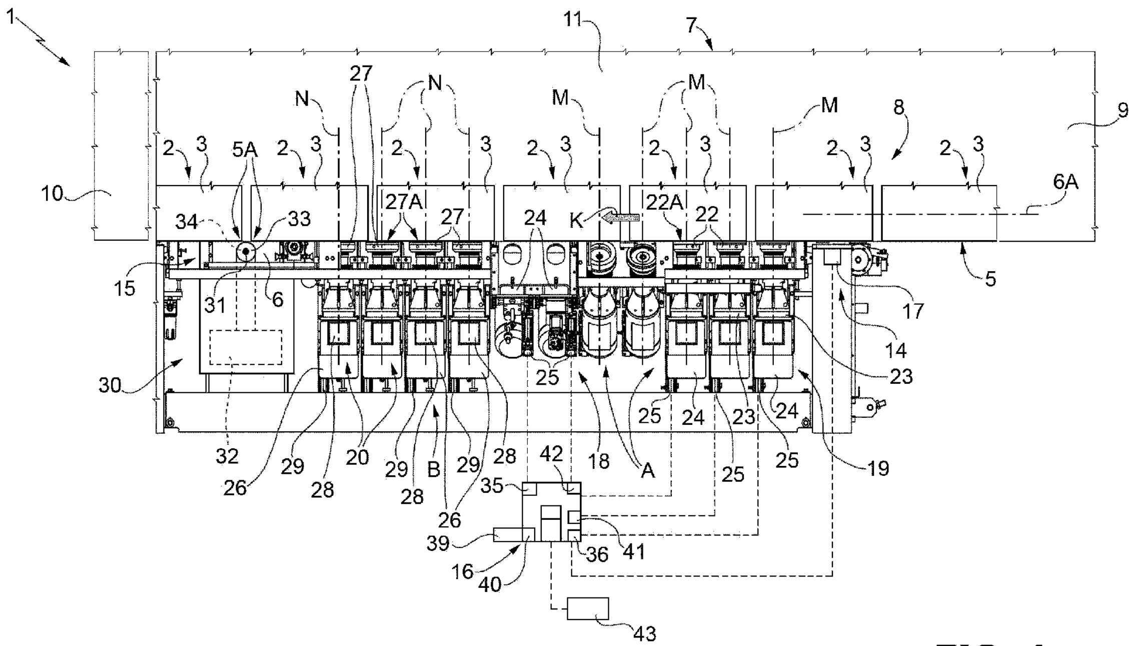

FIG. 1

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian patent application no. 102019000001427 filed on 31/01/2019.

TECHNICAL FIELD

[0002] This invention relates to a method for grinding and polishing glass sheets.

[0003] In particular, this invention relates to a method for grinding and polishing perimeter or lateral surfaces of a glass sheet, i.e. those surfaces that extend orthogonally to the extended surfaces of the same glass sheet.

BACKGROUND ART

[0004] As is known, two types of machines are known for use in processing the above-mentioned perimeter surfaces. On the one hand, the so-called "bilateral" machines belong to a first type. With these, the sheets are fed flat and the opposite perimeter surfaces thereof are ground simultaneously and progressively by two rows of grinding wheels, which face each other and are arranged in a grinding station of the machine.

[0005] The so-called "rectilinear" grinding machines, on the other hand, belong to a second type, wherein the sheets are fed edgeways and they are ground by progressively feeding the perimeter surfaces onto an underlying row of grinding wheels, which are also arranged in a grinding station of the machine.

[0006] Irrespective of the type of machine used, each row of wheels comprises a plurality of grinding wheels and a plurality of polishing wheels arranged downstream of the grinding wheels to polish the surfaces grounded by the grinding wheels.

[0007] Both the grinding and polishing wheels rotate around their respective rotation axes, each under the thrust of a corresponding electric drive motor.

[0008] Each grinding wheel is arranged in its own operative grinding position to remove a pre-set portion of glass from the sheet, while each polishing wheel is constantly thrust against a corresponding perimeter surface that has previously been ground so as to polish the corresponding perimeter surface itself.

[0009] Both grinding and polishing wheels are different both in terms of the abrasive capacity thereof and in terms of the abrasive material and/or matrix wherein this abrasive material is dispersed. This is due to the fact that each wheel supplier offers wheels of their own design and with their own features. The user generally uses wheels from different suppliers depending on the processing to be carried out on the glass sheet.

[0010] Obviously, both abrasive and polishing wheels progressively wear out over time but in a different way from each other, precisely because of their different designs.

[0011] During the grinding and subsequent polishing, however, unforeseeable critical working conditions often occur that are caused, for example, by mistakes made when entering input or instruction data or as a result of the replacement of the wheel. The above-mentioned critical conditions generally produce an increase in the amount of material to be removed or in the formation of imperfections on the processed surface. This mainly results from the lack of, or only partial, processing carried out by one or more wheels arranged upstream of a particular wheel, with inevitable peaks in the current absorbed by the motors concerned.

[0012] When such critical conditions occur, a machine safety device, or rather a protection device, for the electric motor(s) of the grinding wheel(s) concerned, automatically intervenes. This safety device isolates the electric motors and, at the same time, stops the entire machine, effectively blocking production.

[0013] Stopping the machine is absolutely to be avoided because the subsequent restart requires that all of the sheets, even a few dozen, present in the machine be removed. This removal, as well as requiring an extremely long time since the machine must first be secured and then brought into an "opening" or "processing sheets extraction" condition, leads, at the same time, to a considerable loss of sheets from the batch being processed. The sheets, all already partially processed, must, in fact, be thrown away and reintegrated with other sheets to ensure the expected number of sheets in the batch. All the operations described above significantly increase the batch’s production time and cost, with obvious economic losses.

[0014] Similar considerations also apply to edge grinding and polishing wheels, as the machine also has an edge grinding assembly.

DISCLOSURE OF INVENTION

[0015] The purpose of this invention is to provide a method for grinding and polishing glass sheets, which avoids the removal of sheets being processed on the machine and the discarding of sheets, or pieces of sheets, already partially processed due to the machine’s being unexpectedly stopped when abnormal grinding and/or polishing conditions occur.

[0016] According to the present invention, a method is provided for grinding and polishing glass sheets, the method comprising the steps of feeding a succession of glass sheets in a longitudinal direction at a given speed rate; progressively grinding at least one perimeter surface of the glass sheets by means of one or more grinding wheels independent of one another, the grinding comprising the step of rotating each grinding wheel about a rotation axis thereof by means of a respective grinding electric motor and by moving each sheet and the grinding wheel or wheels relative to one another at a given relative grinding speed; and polishing the ground surface with said grinding wheel or wheels by means of one or more polishing wheels rotated about the respective axes by respective polishing electric motors; the polishing comprising the step of exerting a predefined thrust action directed towards said glass sheet on each polishing wheel and moving each sheet or polishing wheel or wheels relative to one another at a respective polishing speed; the method further comprising a control step, in turn, comprising the step of detecting the current absorbed by at least a first of the electric motors during the processing of said sheets, and being characterized in that said control step comprises the operations of establishing, for at least the first of said electric motors, a respective absorbable current limit value, of comparing the respective said absorbable current limit value with the value of current absorbed by said first motor and of reducing at least one of either the speed or said thrust action when said measured current value exceeds said absorbable current limit value by continuing to feed the succession of glass sheets in said longitudinal direction.

BRIEF DESCRIPTION OF THE DRAWING

[0017] The invention will now be described with reference to the attached figure, which shows a glass sheet grinding and polishing machine for the implementation of a preferred embodiment of the method for grinding and polishing glass sheets according to the principles of this invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0018] In the attached figure, 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.

[0019] 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, straight structure 6, and a motorized sheet conveying assembly 7, known in itself and partially visible in the attached figures, to feed a succession 8 of sheets 2 to be ground along a straight path 6A. In this particular case, the assembly 7 comprises an input conveyor 9 for the sheets 2 to be ground, an output conveyor 10 for the ground sheets, and an intermediate conveyor 11 for retaining and feeding sheets 2.

[0020] The conveyor 11 moves the sheets 2 to be ground through a station 13 for grinding and polishing the perimeter surfaces 5 arranged along the feeding path 6A, taking the sheets 2 from one entrance 14 to the station 13. The conveyor 11 also feeds the sheets 2 through an additional grinding and polishing station 15, which is arranged downstream of the station 13 in a feeding direction K for the sheets 2 and in which the edges 5A of the sheets 2 are ground and polished.

[0021] The conveyor 11 is commanded and controlled by an electronic command and control unit 16 for feeding the sheets 2 at a pre-set, constant speed chosen, for example, according to the thickness of the glass, the degree of finish, and the number of wheels used. The passage of a head and a tail of each of the sheets 2 entering the station 13 is detected by a presence sensor 17 connected to the electronic unit 16.

[0022] Again with reference to Figure 1, the station 13 houses a row 18 of abrasive assemblies, known in themselves, which are independent of one another and arranged side-by-side in a direction parallel to the path 6A. The row 18 of abrasive assemblies comprises a set A of grinding assemblies 19, and a set B of polishing assemblies 20, which polish the surfaces 5 ground by the set A.

[0023] Each of the grinding assemblies 19 is a unit independent of the other units and comprises a grinding wheel 22, which has an abrasive surface 22A thereof and is rotated about an axis M thereof that is orthogonal to the path 6A by a respective electric motor 23 commanded by the electronic unit 16.

[0024] Each abrasive wheel 22A is carried by a relative slide 24, which is slidably coupled to the frame 6 of the machine 1 and in opposite directions along the relative axis M under the thrust of a servomotor 25 controlled by the electronic command and control unit 16.

[0025] Each of the polishing assemblies 20 is an independent unit and comprises a respective polishing wheel 27, which has a polishing surface 27A thereof and is rotated about an axis N thereof that is orthogonal to the path 6A by a respective electric motor 28 commanded by the electronic unit 16. The wheel 27 of each assembly 20 is mounted on a relative mobile slide 26 in a direction parallel to the axes N. Each slide 26 is driven by its own actuator 29, for example, a pneumatic cylinder controlled by a proportional solenoid valve controlled by the electronic unit 16 to push the polishing surface 27A of the corresponding wheel 27 against the surface 5 of the sheets 2.

[0026] Again, with reference to the attached figure, the machine 1 comprises an edge 5A grinding and polishing assembly 30. The assembly 30, which is known in itself and not described in detail, comprises a shaft 31, which is driven by means of an electric motor 32 and has two wheels, known in themselves, that are coupled together. One of the latter is a grinding wheel, indicated with 33, and one a polishing wheel, indicated with 34. The shaft 31 is carried by a motorised slide, which is mobile in two directions orthogonal to each other and one of which is parallel to the path 6A to move the wheels 33,34 with respect to a sheet to be processed at a pre-set relative speed, which is generally constant. According to a different production method, the machine 1 does not have the assembly 30.

[0027] Again with reference to the attached figure, the electronic unit 16 comprises a detecting block 35 to detect the instantaneous absorbed current value for each of the electric motors 23, 28, and 32.

[0028] The electronic unit 16 also comprises a memory block 36 in which an absorbable current limit value of the respective electric motor is stored for each grinding wheel and for each polishing wheel. Each absorbable current limit value, both for the grinding and for the polishing wheels, is determined experimentally by considering the chemical-physical features of the glass sheets 2, the features of the wheels used, such as the type and concentration of the abrasive grain and/or the type of matrix wherein the abrasive material is included, and the expected amount of material to be removed in order to obtain an optimal ratio between abrasive/polishing activity and wear. For the polishing wheels, the absorbable current limit value also takes into account the value of the polishing wheel thrust force against the surface 5 of the sheet 2. In any case, the absorbable current limit values are all lower than a safety limit value, at the occurrence of which the machine 1 is stopped by a motor protection and machine safety device, indicated by the reference number 39. The thrust values of each of the polishing wheels are stored in a block 40 of the electronic unit 16.

[0029] Finally, the electronic unit 16 comprises a comparator block 41 that continuously compares the absorbed current value for each electric motor and the corresponding stored absorbable current limit value.

[0030] In use, starting from a condition wherein the sheets 2 are fed along the path 6A and progressively ground by the grinding assembly A and then polished by the polishing assemblies B, the electronic unit 16 detects the values of current absorbed by each of the motors 23 and 28. If, during a control step, none of the absorbed current values exceeds the corresponding stored absorbable current value, the grinding and polishing process continues in the ordinary manner.

[0031] When, on the other hand, and again during the control step, the value of current absorbed by at least one of the electric motors 23, 28 exceeds the corresponding absorbable current limit value, the electronic unit 16 continues the control step and intervenes, in an automatic manner, by reducing the speed rate of the sheets 2, if the threshold exceedance concerns a grinding wheel, or by reducing the thrust action of the wheel against the sheet 2, if the threshold exceedance concerns a polishing wheel. In practice, the reduction in the speed rate of the glass sheets 2 translates into a reduction in the quantity of material removed from the individual grinding wheel, since the removal capacity of a grinding wheel is expressed in cubic centimetres over the unit of time, which is equivalent to the wheel-sheet contact surface expressed in square centimetres for the speed rate of the glass sheets 2. Similarly, reducing the thrust action of the polishing wheels 27 is equivalent to reducing the aggressiveness of the polishing action.

[0032] In both cases, with the control step, the severity of the operation carried out by the wheel(s) is, in practice, reduced and this leads to an inevitable reduction in the value of current absorbed by the corresponding motors while the wheels continue to process the glass sheets. Similar considerations apply to the grinding and polishing wheels for the edges 5A.

[0033] The monitoring of the currents absorbed by the various electric motors avoids, therefore, an emergency absorbed current value's being reached, in the presence of which the motor protection device 39 on the machine is configured to intervene by electrically isolating all the electric motors and switching off the machine 1. It follows that reductions in the speed rate of the glass sheets 2, or in the thrust action of the polishing wheels, enables the processing of the glass sheets 2 to be continued and the glass sheets 2 already passing between the wheels to be finished, as planned by the processing cycle, without any of the glass sheets 2 that have passed the entrance 14 of the machine 1 needing to be discarded and, therefore, without creating a shortage in the batch of sheets in production, with obvious advantages in terms of costs.

[0034] From the above it is clear that the current absorption control could be carried out either on all the electric motors or only on some, for example on the one (or the ones) considered most critical, both for the stress to which they are subjected and for the specific features of the wheels associated with them.

[0035] In this respect, it is, then, clear that the same electric motor can always rotate the same wheel, or any wheel of a series or family of wheels that are equal or different in terms of size, and/or constructively different from each other with regard to the matrix, the abrasive material, and the concentration of the abrasive material itself in the matrix and, more generally, wheels from different wheel suppliers. In the latter case, for each electric motor, a plurality of identification codes is stored in the memory block 36, each of which identifies one of the wheels in the series of wheels and, for each of the same wheels, a corresponding absorbable current limit value for the electric motor is also stored.

[0036] Finally, the electronic unit 16 conveniently comprises a keyboard 42, by means of which an operator, noting the wheel associated with the electric motor, selects one of the stored identification codes and consequently communicates to the comparator block 41 the corresponding absorbable current limit value to be used in the comparison.

[0037] Alternatively, the electronic unit 16 itself comprises a detector block 43 that automatically and autonomously detects the wheel of the series of wheels driven by the electric motor and sends a corresponding signal to the comparator block 41.

[0038] Finally, it is clear from the foregoing that the reduction in thrust can also be applied to the polishing wheel 34 of the assembly 30 for processing the edges 5A, while an increase in the current absorbed by the motor 32 during the operation of the grinding wheel 33 can be limited by progressively reducing the speed at which the grinding wheel moves with respect to the sheet, i.e. by reducing the relative speed of the grinding wheel-sheet, which, for practical purposes, is equivalent to the slowing down of the glass sheets 2 in the grinding assemblies A for the surfaces 5A.

[0039] It is clear from the foregoing that the grinding and polishing method described above applies, irrespective of the devices used, either to adjust the position of the wheels 22 or to move the wheels 33 and 34 in relation to the sheet, and to push the wheels 27 or wheel 34 towards the ground surface and the surface to be polished. In particular, it is clear that grinding wheels 22 can be moved to and from the sheet by manual devices as well, while the polishing wheels 27, 34 can be thrust by mechanical springs, with the possibility of varying the preload thereof, or by torque controlled electric motors.

Claims

1. A method for grinding and polishing glass sheets, the method comprising the steps of feeding a succession of glass sheets in a longitudinal direction at a given speed rate; progressively grinding at least one perimeter surface of the glass sheets by means of one or more grinding wheels independent of one another, the grinding comprising the step of rotating each grinding wheel about a rotation axis thereof by means of a respective grinding electric motor and by moving each sheet and the grinding wheel or wheels relative to one another at a given relative grinding speed; and polishing the ground surface with said grinding wheel or wheels by means of one or more polishing wheels rotated about the respective axes by respective polishing electric motors; the polishing comprising the step of exerting a predefined thrust action directed towards said glass sheet on each polishing wheel and moving each sheet or polishing wheel or wheels relative to one another at a respective polishing speed; the method further comprising a control step, in turn, comprising the step of detecting the current absorbed by at least a first of the electric motors during the processing of said sheets, and being **characterized in that** said control step comprises the operations of establishing, for at least the first of said electric motors, a respective absorbable current limit value, of comparing the respective said absorbable current limit value with the value of current absorbed by said first motor and of reducing at least one of either the speed or said thrust action when said measured current value exceeds said absorbable current limit value by continuing to feed the succession of glass sheets in said longitudinal direction.

2. The method according to claim 1, **characterized in that** the reduction of said speed or of said thrust towards said glass sheet is carried out so as to restore the current absorbed by said first electric motor below the respective absorbable current limit value.

3. The method according to claim 1 or 2, **characterized in that** said control step is carried out for each of said electric motors.

4. The method according to one of the claims from 1 to 3, **characterized in that** said control step is carried out in a continuous manner during the processing of the sheet.

5. The method according to claim 1, **characterized in that** the detection of said absorbed current and the comparison with the respective absorbable current limit value are carried out in an automatic manner by means of a command and control unit of a grinding and polishing plant of the glass sheets; said absorbed current limit value being stored in a memory block of said command and control unit.

6. The method according to claim 5, **characterized by** storing in said memory block and for at least a first of said electric motors a plurality of said absorbable current limit values corresponding to a series of respective wheels all selectively rotatable by said first electric motor, and by selecting the absorbable current limit value upon variation of the grinding wheel instantaneously actuated by said first electric motor before comparing the same with said current value absorbed by said first electric motor.

7. The method according to claim 6, **characterized in that** the selection of said absorbable current limit value is carried out manually by an operator or directly by said command and control unit after detecting the wheel rotated by said electric motor.

8. The method according to any one of the preceding claims, **characterized by** maintaining said absorbable current limit value below an emergency absorbed current value, at which the electric motors are all electrically cut off and stopped.

9. The method according to any one of the preceding claims, **characterized in that** said speed is the speed rate of said sheets.

10. The method according to any one of the preceding claims, **characterized in that** said speed is the relative speed between sheet-wheel.

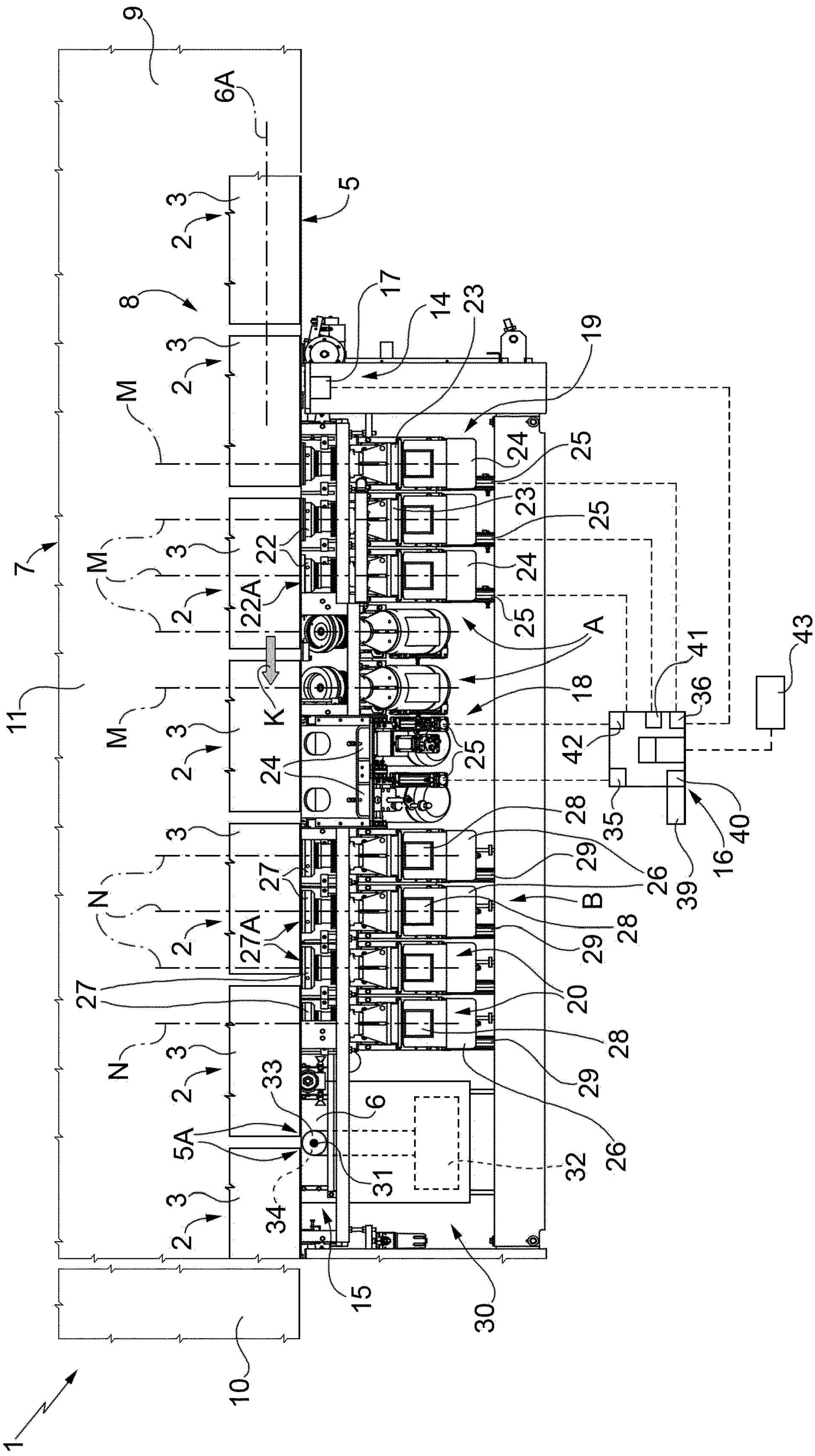
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FIG. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 20 15 5015

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TECHNICAL FIELDS SEARCHED (IPC)

B24B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 May 2020	Herrero Ramos, J

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CATEGORY OF CITED DOCUMENTS

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