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(54) EDGE GRINDING MACHINE

(57) A grinding machine (20,40) of slab elements (T) which comprises at least an abrasive tool (24,44) able to come into contact with a surface (T1,T2) of the slab element (T) and an optical group (25,45) located in proximity of the abrasive tool (24,44) configured for detecting an image of a contact zone between the surface (T1 ,T2) and the abrasive tool (24,44).

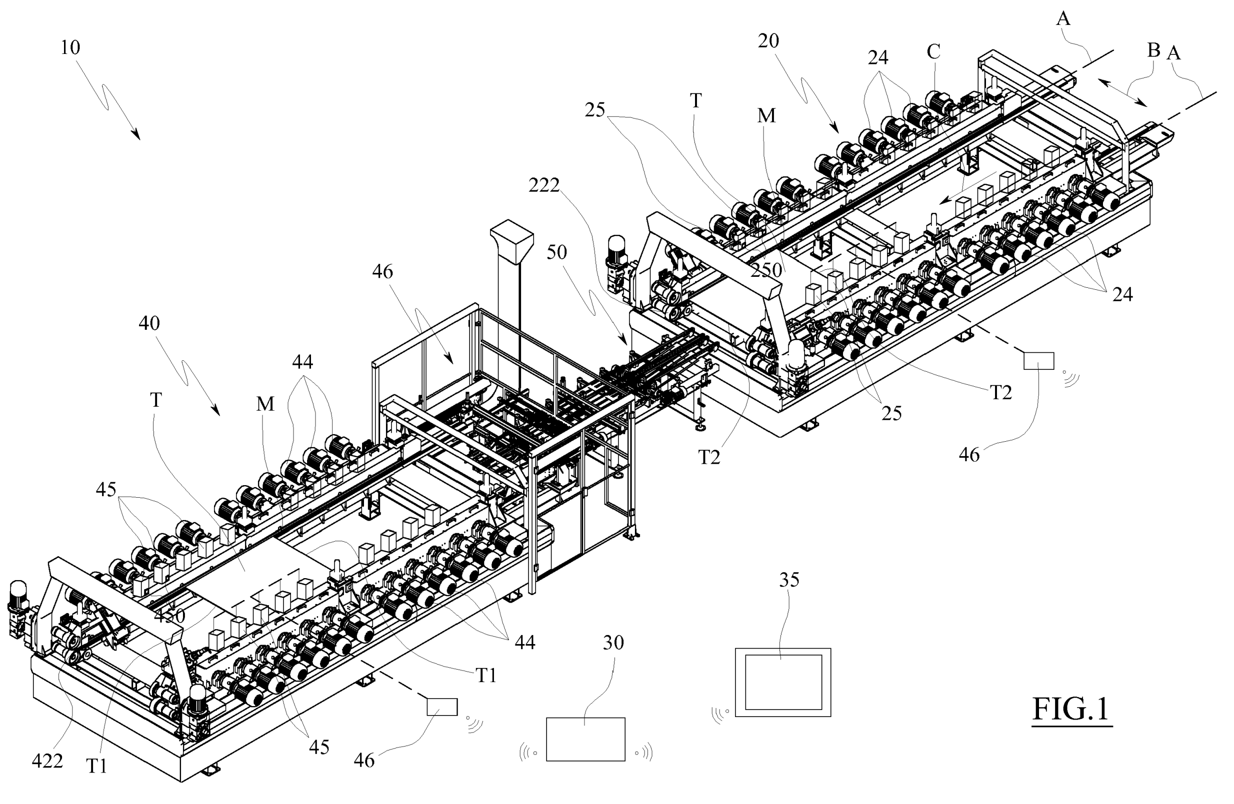

FIG.1

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Description

TECHNICAL FIELD

[0001] The present invention relates to a grinding machine for slab elements, such as for example ceramic slabs, slabs of natural stone, glass slabs or the like. More in particular, the grinding machine is a squaring machine or a machine for surface finishing, such as for example sanding and/or lapping and/or polishing, for example for dry working of the slab elements.

PRIOR ART

[0002] As is known, the slab elements, such as ceramic slabs (flooring or cladding tiles), natural stone slabs, glass slabs or the like, can require grinding operations, for example of the in-view surface, for example polishing and/or lapping and/or polishing and/or of the lateral surfaces, such as for example squaring which serves to bring two opposite sides of the slab elements to be substantially parallel and the adjacent sides substantially squared to the first.

[0003] This operation is generally carried out by means of grinding machines, which machine a plurality of slab elements that advance in succession on a movement plane, for example horizontal.

[0004] During the advancement on the movement plane a surface of the slab elements encounters a succession of rotary abrasive tools, which remove the excess material by smoothing the surface.

[0005] The contact between the abrasive tools and the surface of the slab element must occur correctly in order to be able to carry out an efficient machining of the surface; therefore a necessity of grinding machines is that there must be a systematic control to make sure that each of the abrasive tools carries out an optimal machining, i.e. enters into contact with the surface of the slab element to be worked in the correct way, i.e. removes a correct quantity of material from the slab element being machined.

[0006] An aim of the present invention is to satisfy this requirement, with a solution that is simple, effective, systematic and rational.

[0007] The aims are attained by the characteristics of the invention as reported in the independent claim. The dependent claims delineate preferred and/or particularly advantageous aspects of the invention.

DESCRIPTION OF THE INVENTION

[0008] The invention discloses in particular a grinding machine of slab elements which comprises at least an abrasive tool able to come into contact with a surface of the slab element and an optical group, for example a television camera and/or a camera, located in proximity of the abrasive tool configured for detecting an image of a contact zone between the surface and the abrasive tool, that is a zone that includes at least the surface profile of the slab element being processed, having contact points between the abrasive tool and the surface and, for example, at least a first unprocessed surface zone (e.g. upstream of the contact points) and a second processed zone (e.g. downstream of the contact points).

[0009] It has been found that from such image of the profile of the slab element being processed it is possible to accurately diagnose whether the abrasive contact is done correctly and therefore by monitoring that image it is possible to make a timely intervention so as to modify the contact conditions when an incorrect type of image is encountered.

[0010] In particular, with this solution it is possible to rapidly recognise the degree of material removal by each single abrasive tool by using the detected image of the rubbing contact zone between the abrasive tool and the slab element.

[0011] Thanks to this it is possible to reduce the volume of slab elements eliminated at the end of machining, since because the corrective intervention can be made in good time it is possible to maintain a constant and accurate control over the wear on the abrasive tools being used, optimise the working life and the performance of the abrasive tools, improve the quality standard of the slab elements machined and reduce working hours required for controlling the functioning of the grinding machine.

[0012] The grinding machine can advantageously comprise an electronic control unit operatively connected to the optical group and configured for determining an amount of material removed by the abrasive tool from the surface of the slab element based on image detected by the optical group.

[0013] With this solution, by analysing the detected image, it is possible to obtain an objective and reliable measure of the amount of material removed from the slab element by each abrasive tool.

[0014] In a further aspect of the invention, that the image of the contact zone includes a first surface zone not yet come into contact with the abrasive tool (that is, placed upstream of the abrasive tool in the advancement direction of the slab element with respect to the abrasive tool itself - namely their relative motion) and a second surface zone already come into contact with the abrasive tool (that is, placed downstream of the abrasive tool in the advancement direction of the slab element with respect to the abrasive tool itself - namely their relative motion).

[0015] Thanks to this solution, the image can accurately define the second surface zone rectified by the abrasive tool with respect to the first surface zone, allowing the exact definition of the measure of the amount of material removed by abrasion as proportional to the lateral height difference of the two surface zones.

[0016] Advantageously, in fact, the electronic control unit can be configured to calculate the amount of material removed by the abrasive tool from the surface of the slab element based on the difference between the first surface zone and the second surface zone.

[0017] The electronic control unit can advantageously be configured to generate an error signal if the amount of material removed by the abrasive tool is less than a predetermined reference value thereof, the electronic control unit, for example, is then operatively connected to a user interface configured for receiving the error signal and translate it into a signal that is perceptible by a user.

[0018] With this solution, the user, for example the operative controlling the grinding machine, can have the functioning of the abrasive tool under control without having to approach the abrasive tool itself, with a consequent greater safety and rapidity of viewing.

[0019] In a further aspect of the invention, the grinding machine can comprise a plurality of abrasive tools able to come into contact with the surface of the slab element and an optical group for each abrasive tool.

[0020] With this solution, the control of all the abrasive tools of the grinding machine can take place rapidly, contemporaneously, safely and comfortably for the personnel charged with controlling the machining.

[0021] Moreover, the optical group could comprise an illuminator adapted to illuminate the contact zone.

[0022] Thanks to this solution, the identification of the first and second surface zone is made easier and possible, facilitating the calculation of the amount of material removed by each abrasive tool.

[0023] For the same aims as described in the foregoing, a further aspect of the invention relates to a control method of a grinding machine of slab elements which comprises at least an abrasive tool able to come into contact with a surface of the slab element and an optical group located in proximity of the abrasive tool, wherein the control method comprises steps of:

- detecting an image of a contact zone between the surface and the abrasive tool by means of the optical group; and
- determining an amount of material removed by the abrasive tool from the surface of the slab element based on the image detected by the optical group.

[0024] The method could further provide the step of:

generating an error signal if the determined amount of the removed material is less than predetermined reference value thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Further characteristics and advantages of the invention will emerge from a reading of the following description, provided by way of non-limiting example with the aid of the figures illustrated in the appended tables of drawings.

Figure 1 is an axonometric view of a plant according to the invention.

Figure 2 is a lateral view of figure 1.

Figure 3 is a view from above of figure 1.

Figure 4 is a view from above of a first squaring machine according to the invention.

Figure 5 is a view from above of a rotation group of the plant of figure 1.

Figure 6 is a view from above of a second squaring machine according to the invention.

Figure 7 is a schematic view of an image detected by an optical group of the squaring machine according to the invention.

BEST WAY OF CARRYING OUT THE INVENTION

[0026] With particular reference to the figures, reference numeral 10 denotes in its entirety a plant for grinding, in particular for squaring, slab elements T, for example ceramic slabs, natural stone slabs, glass slabs or the like.

[0027] Each slab element T has a substantially a parallelepiped shape with a small height (thickness) and a substantially quadrangular base (in plan view), for example rectangular or square.

[0028] In practice, the slab element T has two first flanks T1 opposite one another and substantially parallel and two second flanks (T2) contiguous to the first flanks T1 and opposite one another and substantially parallel.

[0029] The plant 10 comprises a first grinding machine 20, in particular a squaring machine, for example able to carry out a rectifying and/or chamfering operation on the two first flanks T1 of the slab element T.

[0030] The first grinding machine 20 comprises a base frame 21 comprising a base 210 provided with usual rests on a ground surface.

[0031] The base frame 21 comprises a pair of longitudinal parallel flanks 211 associated to the base 210, mobile in nearing and distancing from one another, along a sliding direction B that is perpendicular to the longitudinal axis A thereof.

[0032] For example, a sliding guide (not visible) is defined between the base 210 and each of the flanks 211 which sliding guide is able to keep the flanks 211 parallel to one another during the reciprocal sliding along the sliding direction B.

[0033] The base 210 advantageously supports a translating group of the flanks 210, which for example can comprise at least a motor fixed to the base 210 and drive transmission organs, for example of the cogwheel or belt type able to transfer the drive of a drive shaft of the motor to the flanks 211, for the translation thereof along the sliding direction B.

[0034] For example, the translating group can comprise a motor for each flank 211, so that the translation of a flank 211 is substantially independent of the translation of the other.

[0035] It is however possible for the translating group to comprise a single motor or alternatively for the translation of the flanks not to be automated.

[0036] Further it is possible for the translating group to comprise synchronising means of the translation of the flanks 211, thanks to which the flanks 211 are constrained to remain in parallel positions, symmetrically arranged with respect to a median plane perpendicular to the sliding direction B.

[0037] The base frame 21 supports a movement group 22 for moving the slab elements T.

[0038] The movement group 22 is configured for moving each slab element T so that it lies (with the large in-view or laying surfaces) on a movement plane M, for example substantially horizontal, and advances in an advancement direction C, for example parallel to the longitudinal axis A of the flanks 211 and/or substantially parallel to the first flanks T1 to be rectified.

[0039] The movement group 22 for example comprises a conveyor belt 200.

[0040] In particular, the movement group 22 comprises a pair of conveyor belts 220, each of which is supported at a respective flank 211.

[0041] Each conveyor belt 220 comprises a lower flexible organ 221, which has an upper branch parallel to the advancement direction C and defines a portion of a mobile movement plane M for the slab elements T.

[0042] The lower flexible organs 221 of the pair of conveyor belts 220, i.e. the respective upper branches, are substantially coplanar and together define the movement plane M (horizontal) for the slab elements T.

[0043] For example each lower flexible organ 221 comprises or is constituted by a loop-closed belt wound on at least a drive pulley 222, activated in rotation by a respective electric motor 223, and at least a driven pulley 224 (in the example a plurality of driven pulleys).

[0044] Each conveyor belt 220 comprises an upper flexible organ 225, which has a lower branch parallel to the advancement direction C and defines a portion of a mobile contact and pressure with the slab elements T.

[0045] Each upper flexible organ 225 is superposed, for example superposed in plan view and vertically aligned with the lower flexible organ 221 of the conveyor belt 220.

[0046] For example, each upper flexible organ 225 can be associated to the respective flank 211 in a vertically-calibrated way, so as to vary the dimension of the gap existing between the lower flexible organ 211 and the upper flexible organ 225, in particular between the upper branch of the lower flexible organ 221 and the lower branch of the upper flexible organ 225, according to the thickness of the slab elements T.

[0047] The lower flexible organs 225 of the pair of conveyor belts 220, i.e. the respective lower branches, are substantially coplanar and together define a contact and pressure (horizontal) plane able to contact and press on the upper surface (in-view) of the slab elements T.

[0048] For example each upper flexible organ 225 comprises or is constituted by a loop-closed belt and wound on at least a drive pulley 226, activated in rotation by a respective electric motor (for example being the electric motor 223), and at least a driven pulley (in the example a plurality of driven pulleys) that is not visible in the figures.

[0049] The electric motors 223 of both the conveyor belts 220 are activated in a synchronised way so as to enable advancement of the slab elements T along the advancement direction C with the first flanks T1 parallel to the advancement direction C.

[0050] The lower flexible organs 221, i.e. the upper branches thereof, have a greater length than the respective upper flexible organs 225, i.e. the lower branches thereof, so that an end of the lower flexible organs 221, advantageously the upstream end in the advancement direction of the slab elements T along the advancement direction A imparted by the movement group 22, is staggered with respect to the respective upper flexible organ 225.

[0051] In practice, the staggered end of the lower flexible organs 221 defines a free inlet portion of the movement group 22 on which the slab element T rests before wedging between the lower flexible organs 221 and the upper flexible organs 225 and be solidly pressed between the organs.

[0052] The variation of the interaxis of the flanks 211 of the base frame 21 in fact defines a corresponding variation of the interaxis of the conveyor belts 220 and, therefore, the variation of the size of the rest plane defined thereby as a function of the format of the slab elements T.

[0053] Further, the interaxis of the flanks 211 is defined, time by time as a function of the dimensions of the slab elements T, in particular the distance between the first flanks T1 thereof, so that the first flanks T1 of the slab elements T project laterally (by a modest amount) along a parallel direction to the sliding direction B, with respect to the movement plane M i.e. substantially projecting therefrom.

[0054] Each conveyor belt 220 can advantageously comprise a presser device (not illustrated) which is configured for pushing the upper branch of the lower flexible organ 221 and the lower branch of the upper flexible organ 225 in reciprocal nearing. For example, the presser device can comprise one or more support bars arranged internally of the loop defined by each flexible organ or by only the upper flexible organ 225 which support a plurality of aligned skates that are adjacent along the advancement direction C and pushed towards the other flexible organ by compression springs.

[0055] Further, the first grinding machine 20 comprises a centring group 23 configured for centring, with respect to a centring direction parallel to the sliding direction B, the slab element T on the movement plane M, i.e. on the conveyor belt 220.

[0056] The centring group 23 comprises, for example, a pair of sides, each slidably associated with respect to a respective flank 211 and activatable, for example by an electrical actuator, nearingly and distancingly to and from the movement plane M.

[0057] The first grinding machine 20 comprises an abrasive tool 24 positioned in proximity of the movement plane M, i.e. the upper branches of the lower flexible organs 221, and able to come into contact with a surface of the slab element T in transit along the advancement direction A, i.e. with one of the first flanks T1 thereof.

[0058] In practice, the abrasive tool 24 is located by a side of the movement plane B, for example supported by a flank 211 of the base frame 21.

[0059] In particular, the first grinding machine 20 comprises at least an abrasive tool 24 for each first flank T1 of the slab element T to be worked, i.e. located by the sides of the movement plane B, for example each supported by a respective flank 211 of the base frame 21.

[0060] For example each abrasive tool 24 is mobile nearingly/distancingly to/from the movement plane M, i.e. it is actionable in translation along a translation direction that is parallel to the sliding direction B.

[0061] Each abrasive tool 24 can advantageously comprise a rectifying grinder 240 splined on a drive shaft of a command motor 241.

[0062] The command motor 241 of each abrasive tool 24 is slidably associated, relative to the translation direction, to the respective flank 211, for example by means of a sliding guide and a regulating device 242 configured for adjusting a distance of the rectifying grinder 240 from the movement plane M.

[0063] The regulating device 242 might be of a manual type, for example a graduated bushing that is manually adjustable or remotely controllable or semi-automatic, for example of an endless screw and nut connecting type activated by a remote-controlled motor, for example by an operator.

[0064] It is possible for the regulating device 242 to be completely automated.

[0065] The first grinding machine 20 in the illustrated example comprises a plurality of abrasive tools 24 for each first flank T1 of the slab element T to be rectified.

[0066] For example, each abrasive tool 24 of one of the flanks 211 is substantially symmetrical with respect to a median plane perpendicular to the sliding direction B of an abrasive tool 24 of the other flank 211.

[0067] A group of the plurality of abrasive tools 24 of each flank 211 is configured for rectifying the respective first flank T1 of the slab element T.

[0068] The abrasive tools 24 of the group are arranged with the rotation axis horizontal and perpendicular to the advancement direction C.

[0069] That is, the drive shaft and therefore the rectifying grinder 240 of each abrasive tool 24 is activated in rotation with respect to a rotation axis that is substantially horizontal and perpendicular to the advancement direction C.

[0070] One (alone) of the abrasive tools 24 of each flank 211, for example the tool most downstream in the advancement direction of the slab elements T along the advancement direction A imparted by the movement group 22, is configured for carrying out a chamfering on the respective first flank T1 of the slab element T.

[0071] The chamfering abrasive tool 24 is arranged with the rotation axis thereof lying on an inclined plane with respect to the horizontal plane and in any case perpendicular to the advancement direction C.

[0072] That is, the drive shaft and therefore the rectifying grinder 240 of the chamfering abrasive tool 24 is activated in rotation with respect to a rotation axis lying on an inclined plane with respect to the horizontal plane and in any case perpendicular to the advancement direction C.

[0073] The first grinding machine 20 is for example a dry grinding machine (or squaring machine), i.e. the contact between the abrasive tool 24 (i.e. the abrasive wheel 240) and the surface of the slab element T takes place in a dry environment, i.e. in the absence of a cooling liquid and/or lubrication in the contact zone between the abrasive tool 24 and the slab element T.

[0074] The first grinding machine 20 comprises, in particular, an optical group 25 located in proximity of the abrasive tool 24, preferably in proximity of the contact zone of the abrasive tool 24 with the respective first flank T1 of the slab element T.

[0075] The optical group 25 is for example fixed, for example adjustably, to the respective flank 211 so as to enable viewing the contact zone between the abrasive tool 24 and the first flank T1 of the slab element T.

[0076] For example, the optical group 25 is positioned above the respective abrasive tool 24, so as to have a top view of the contact zone between the first flank T1 of the slab element T and the abrasive tool 24, preferably in a gap defined between the flank 211 and the abrasive wheel 240.

[0077] In particular, the first grinding machine 20 comprises at least an optical group 25 for each abrasive tool 24, for example each supported by a respective flank 211 of the base frame 21.

[0078] For example, each optical group 25 is provided with an illuminator 250 configured to illuminate the visual space of the optical group 25 (or a portion thereof) with a light, such as a continuous light (such as of lower intensity than the intensity of the spark triggered by friction contact between the abrasive tool and the flank of the slab element being processed).

[0079] For example, the illuminator 250 is fixed to the optical group 25 or for example it is integrally connected thereto.

[0080] For example, the illuminator 250 is adapted to illuminate the contact zone between the abrasive tool 24 and the respective first flank T1 of the slab element T.

[0081] For example each optical group 25 is mobile, by virtue of the movement of the respective flank 211, nearingly/distancingly to/from the movement plane M, i.e. it is actionable in translation along a translation direction that is parallel to the sliding direction B.

[0082] The optical group 25 is advantageously a television camera (for example a micro television camera) and/or a camera.

[0083] Each optical group 25 is configured to detect a respective image I1 of a contact zone between the first flank T1 of the slab element T and the abrasive tool 24, or the rectifying grinder 240, wherein the detected contact zone comprises a first zone of the first flank T1 placed immediately upstream of the abrasive tool 24, or the rectifying grinder 240, in the advancement direction of the slab elements T along the advancement direction A imparted by the movement group 22 and a second zone of the first flank T1 placed immediately downstream of the same abrasive tool 24, or the rectifying grinder 240, in the advancement direction of the slab elements T along the advancement direction A imparted by the movement group 22.

[0084] In practice, the first zone and the second zone are placed in front of and behind the spark L, respectively, (shown in figure 7) triggered by contact between the abrasive tool 24 and the first flank T1 placed in the visual field of the optical group 25.

[0085] The first zone includes the profile to be rectified of an edge of the first flank T1 upstream of the contact zone between the first flank T1 and the abrasive tool 24; the second zone includes the rectified profile of the same edge of the first flank T1 placed downstream of the contact zone between the first flank T1 and the abrasive tool 24.

[0086] In practice, the profile to be rectified is visible as a first line (e.g. straight line) placed at a first (lateral) height in the image I1 detected by the optical group 25 and the rectified profile is visible as a second line (e.g. straight line and substantially parallel to the first line) placed at a second height in the image I1 detected by the optical group 25.

[0087] The first line and second line are axially separated by the contact zone between the abrasive tool 24 and the first flank T1, visible in the image I1 as spark L.

[0088] Each optical group 25 can be configured for also detecting a further respective image I2 of a spark L triggered by contact between the first flank T1 of the slab element T and the abrasive tool 24, i.e. the abrasive wheel 240.

[0089] For example, each further image I2 detected by the optical group 25 is an image, for example a high-definition colour image, which shows and/or possesses the following physical magnitudes of each spark L: light intensity of the spark, dimension of the spark, shape of the spark and colour of the spark. In the example, each optical group 25 can be connected, for example cabled, to a microcontroller 26 which receives the images I1 and/or 2 from the optical group 25.

[0090] For example, the plant 10 and/or the first grinding machine 20 can comprise a plurality of microcontrollers 26, each of which is for example connected to a plurality (for example 5-8 in number) of optical groups 25.

[0091] The plant 10 and/or the first grinding machine 20 comprises an electronic control unit 30, for example provided with a memory and a calculator, operatively connected to each optical group 25 of the first grinding machine 20 (directly or via the microcontroller 26).

[0092] For example, the electronic control unit 30 is connected in wireless mode to each optical group 25 and/or microcontroller 26 of the first grinding machine 20.

[0093] Advantageously, the electronic control unit 30 is configured to: determine the amount of material removed by the abrasive tool 24 (each of them) from the first flank T1 of the slab element T based on the image I1 detected by the optical group 25 (each of them).

[0094] In particular, the electronic control unit 30 can be configured to compare the first zone of the image I1 with the second zone of the image I1 and calculate the amount of material removed by the abrasive tool 24 (each of them) from the first flank T1 of the slab element T as a function of the comparison between the first zone and the second zone.

[0095] For example, since the distance between the first line and the second line (in the orthogonal direction to the advancement direction A, i.e. to the first flank T1, in particular transversely to the advancement direction A) is proportional to the amount of material removed by the abrasive tool 24 (each of them) from the first flank T1 of the slab element T, the electronic control unit 30 can be configured to calculate such a distance and determine (for example, multiply it by a correction factor, which for example takes into account the thickness of the slab element T and the length of the first flank T1) the amount of material removed by the abrasive tool 24 (each of them) from the first flank T1 of the slab element T, i.e. the volume of material removed by each abrasive tool 24 from the slab element T.

[0096] The electronic control unit 30 can also be configured for: calculating (for example measuring or calculating) a physical magnitude of the spark based on the image I2 detected by the optical group 25, comparing the determined physical magnitude with a predetermined reference I_{ref}, and generating an error signal if the physical magnitude differs from the predetermined reference I_{ref}.

[0097] The physical magnitude calculated by the electronic control unit 30 is selected from a group consisting in light intensity of the spark, dimension of the spark, shape of the spark and colour of the spark.

[0098] For example, the electronic control unit 30 can calculate one or more of these physical magnitudes (even all of them) and can compare them with a respective predetermined reference I_{ref}.

[0099] The predetermined reference I_{ref} is for example an image of a profile of a reference spark representing an optimal contact between the abrasive tool 24 (the one mounted on the first grinding machine 20) and the slab element T.

[0100] The reference I_{ref} can be predetermined by calibrating operations, for example carried out by making the first grinding machine 20 operate in optimal abrasive tool/slab element contact conditions and stored in the memory of the electronic control unit 30.

[0101] The reference I_{ref} can for example be redefined each time the mixture of the abrasive mixture making up the abrasive tool 24 and/or the mixture of the slab element

T are changed.

[0102] The electronic control unit 30 is therefore configured for generating an error signal S if the image I of the profile detected by the optical group 25 differs from the reference I_{ref}, for example by a predetermined significant error or one greater than the usual working tolerances applied in the specific field.

[0103] For example, it has been found that if the light intensity of the spark and/or the dimension of the spark is smaller than a determined threshold value (or respective calculated reference I_{ref}), the quantity of material removed by the abrasive tool 24 from the slab element T diminishes, for example is too low.

[0104] The electronic control unit 30 can be configured to generate an error signal S if the amount of material removed by the abrasive tool 24 (each of them) from the first flank T1 of the slab element T, calculated on the basis of the profile image I1 detected by the optical group 25, is different from a reference limit value Q_{ref} thereof, for example by a predetermined significant error, i.e. greater than the usual manufacturing tolerances applied in the specific field.

[0105] In practice, if based on the image I1 it was found that the amount of material removed by the abrasive tool 24 (each of them) from the first flank T1 of the slab element T is insufficient, for example, by comparing the value of the amount of material removed calculated using the predetermined limit reference value Q_{ref} (for example through calibration) for each abrasive tool 24, then it is possible that the electronic control unit 30 signals the error to proceed to its correction.

[0106] The (measured) amount of material removed thus calculated by each abrasive tool 24 can be compared with the (measured) amount of material removed by the other abrasive tools 24 of the first grinding machine 20, such as those immediately upstream and/or downstream thereof in the advancement direction A of the slab elements T; in that case, it is possible to optimize and/or correct the position of each abrasive tool 24 of the first grinding machine 20 (with respect to the others and with respect to the slab element T being processed).

[0107] In this case it is therefore necessary to redefine the contact conditions between the abrasive tool 24 and the first flank T1 of the slab element T, for example by modifying the distance between the flanks 211 of the first grinding machine 20 and/or the distance of the respective abrasive tool 24 from the first flank T1.

[0108] Also, for example, it has been found that if the shape of the spark is more irregular than a determined reference shape (or a determined respective reference I_{ref}), the abrasive tool 24 (i.e. the abrasive wheel 240) is not working correctly.

[0109] In this case it is therefore necessary to redefine the contact conditions between the abrasive tool 24 and the first flank T1 of the slab element T, for example by modifying the distance between the flanks 211 of the first grinding machine 20 and/or the distance of the respective abrasive tool 24 from the first flank T1.

[0110] Also, for example, it has been found that if the colour of the spark (for example tending to ochre) is significantly different from a determined reference colour (or a determined respective reference I_{ref}), for example a white colour or tending to white, this means there is a fault and the abrasive tool 24 (i.e. the abrasive wheel 240) is not working in the correct way.

[0111] In this case it is therefore necessary to redefine the contact conditions between the abrasive tool 24 and the first flank T1 of the slab element T, for example by modifying the distance between the flanks 211 of the first grinding machine 20 and/or the distance of the respective abrasive tool 24 from the first flank T1.

[0112] The plant 10 and/or the first grinding machine 20 can comprise a user interface 35 for signalling, which is operatively connected (for example in wireless mode) to the electronic control unit 30 for emitting one or more signals, for example of the visible and/or acoustic type, perceptible by a user when the electronic control unit 30 generates the error signal S.

[0113] For example, the user interface 35 might be defined by a PC with a monitor and, for example, be fixed to the base frame 21 of the first grinding machine 20 or positioned remotely or be of a mobile device type.

[0114] One or more of the following data can be made available in the user interface 35, among which: the amount of material removed by the abrasive tool 24 (each of them) from the first flank T1 of the slab element T and/or an value indicating how much the detected amount of removed material differs from the limit reference value Q_{ref} (of each abrasive tool 24) and/or the image of the spark, the light intensity of the spark and/or a value indicating how much the intensity detected differs from the respective reference, the dimension (area) of the spark and/or a value indicating how much the dimension detected differs from the respective reference, the shape of the spark and/or a value indicating how much the shape detected differs from the respective reference and the colour of the spark and/or a value indicating how much the colour detected differs from the respective reference. Further, a historical record of the errors detected and/or the measurements taken (for example the last 30 slab elements T machined) can be made available in the user interface 35, as well as a settable field in which the tolerance of the difference between the image and the reference I_{ref} can be selectable or compilable, a settable field in which the number of errors on consecutive slab elements T beyond which it is necessary to intervene can be selectable or compilable, for example requiring halting the machine.

[0115] For example, the plant 10 can further comprise a second grinding machine 40, located downstream of the first grinding machine 20 in the advancement direction of the slab elements T, which for example is able to carry out a rectifying and/or chamfering operation on the two second flanks T2 of the slab element T (perpendicular to the first flanks T1).

[0116] The second grinding machine 40 comprises a base frame 41 comprising a base 410 provided with usual rests on a ground surface.

[0117] The base frame 41 comprises a pair of longitudinal parallel flanks 411 associated to the base 410, mobile in nearing and distancing to and from one another, along a sliding direction B that is perpendicular to the longitudinal axis A thereof.

[0118] For example, the first grinding machine 20 and the second grinding machine 40 are aligned relative to the advancement direction C imposed on the slab elements T being machined.

[0119] For example, a sliding guide (not visible) is defined between the base 410 and each of the flanks 411 which sliding guide is able to keep the flanks 411 parallel to one another during the reciprocal sliding along the sliding direction B.

[0120] The base 410 advantageously supports a translating group of the flanks 410, which for example can comprise at least a motor fixed to the base 410 and drive transmission organs, for example of the cogwheel or belt type able to transfer the drive of a drive shaft of the motor to the flanks 411, for the translation thereof along the sliding direction B.

[0121] For example, the translating group can comprise a motor for each flank 411, so that the translation of a flank 411 is substantially independent of the translation of the other.

[0122] It is however possible for the translating group to comprise a single motor or alternatively for the translation of the flanks not to be automated.

[0123] Further it is possible for the translating group to comprise synchronising means of the translation of the flanks 411, thanks to which the flanks 411 are constrained to remain in parallel positions, symmetrically arranged with respect to a median plane perpendicular to the sliding direction B.

[0124] The base frame 41 supports a movement group 42 for moving the slab elements T.

[0125] The movement group 42 is configured for moving each slab element T so that it lies (with the large in-view or laying surfaces) on a movement plane M, for example substantially horizontal, and advances in an advancement direction C, for example parallel to the longitudinal axis A of the flanks 411 and/or substantially parallel to the second flanks T2 to be rectified.

[0126] The movement group 42 for example comprises a conveyor belt 400.

[0127] In particular, the movement group 42 comprises a pair of conveyor belts 420, each of which is supported at a respective flank 411.

[0128] Each conveyor belt 420 comprises a lower flexible organ 421, which has an upper branch parallel to the advancement direction C and defines a portion of a mobile movement plane M for the slab elements T.

[0129] The lower flexible organs 421 of the pair of conveyor belts 420, i.e. the respective upper branches, are substantially coplanar and together define the movement plane M (horizontal) for the slab elements T.

[0130] For example each lower flexible organ 421 comprises or is constituted by a loop-closed belt and wound on at least a drive pulley 422, activated in rotation by a respective electric motor 423, and at least a driven pulley 424 (in the example a plurality of driven pulleys).

[0131] Each conveyor belt 420 comprises an upper flexible organ 425, which has a lower branch parallel to the advancement direction C and defines a portion of a mobile contact and pressure with the slab elements T.

[0132] Each upper flexible organ 425 is superposed, for example superposed in plan view and vertically aligned with the lower flexible organ 421 of the conveyor belt 420.

[0133] For example, each upper flexible organ 425 can be associated to the respective flank 411 in a vertically-calibrated way, so as to vary the dimension of the gap existing between the lower flexible organ 421 and the upper flexible organ 425, in particular between the upper branch of the lower flexible organ 421 and the lower branch of the upper flexible organ 425, according to the thickness of the slab elements T.

[0134] The lower flexible organs 425 of the pair of conveyor belts 420, i.e. the respective lower branches, are substantially coplanar and together define a contact and pressure (horizontal) plane able to contact and press on the upper surface (in-view) of the slab elements T..

[0135] For example each upper flexible organ 425 comprises or is constituted by a loop-closed belt and wound on at least a drive pulley 426, activated in rotation by a respective electric motor (for example being the electric motor 423), and at least a driven pulley (in the example a plurality of driven pulleys) that is not visible in the figures.

[0136] The electric motors 423 of both the conveyor belts 420 are activated in a synchronised way so as to enable advancement of the slab elements T along the advancement direction C with the second flanks T2 parallel to the advancement direction C.

[0137] The lower flexible organs 421, i.e. the upper branches thereof, have a greater length than the respective upper flexible organs 425, i.e. the lower branches thereof, so that an end of the lower flexible organs 421, advantageously the upstream end in the advancement direction of the slab elements T along the advancement direction A imparted by the movement group 42, is staggered with respect to the respective upper flexible organ 425.

[0138] In practice, the staggered end of the lower flexible organs 421 defines a free inlet portion of the movement group 42 on which the slab element T rests before wedging between the lower flexible organs 421 and the upper flexible organs 425 and be solidly pressed between the organs.

[0139] The variation of the interaxis of the flanks 411 of the base frame 41 in fact defines a corresponding variation of the interaxis of the conveyor belts 420 and, therefore, the variation of the size of the rest plane defined thereby as a function of the format of the slab elements T.

[0140] Further, the interaxis of the flanks 211 is defined, time by time as a function of the dimensions of the slab elements T, in particular the distance between the second flanks T2 thereof, so that the second flanks T2 of the slab elements T project laterally (by a modest amount) along a parallel direction to the sliding direction B, with respect to the movement plane M i.e. substantially projecting therefrom.

[0141] Each conveyor belt 420 can advantageously comprise a presser device (not illustrated) which is configured for pushing the upper branch of the lower flexible organ 421 and the lower branch of the upper flexible organ 425 in reciprocal nearing. For example, the presser device can comprise one or more support bars arranged internally of the loop defined by each flexible organ or by only the upper flexible organ 425 which support a plurality of aligned skates that are adjacent along the advancement direction C and pushed towards the other flexible organ by compression springs.

[0142] Further, the second grinding machine 40 comprises a centring group 43 configured for centring, with respect to a centring direction parallel to the sliding direction B, the slab element T on the movement plane M, i.e. on the conveyor belt 41.

[0143] The centring group 43 comprises, for example, a pair of sides, each slidably associated with respect to a respective flank 411 and activatable, for example by an electrical actuator, nearingly and distancingly to and from the movement plane M.

[0144] The second grinding machine 40 comprises an abrasive tool 44 positioned in proximity of the movement plane M, i.e. the upper branches of the lower flexible organs 421, and able to come into contact with a surface of the slab element T in transit along the advancement direction A, i.e. with one of the second flanks T2 thereof.

[0145] In practice, the abrasive tool 44 is located by a side of the movement plane B, for example supported by a flank 411 of the base frame 41.

[0146] In particular, the second grinding machine 40 comprises at least an abrasive tool 44 for each second flank T2 of the slab element T to be worked, i.e. located by the sides of the movement plane B, for example each supported by a respective flank 411 of the base frame 41.

[0147] For example each abrasive tool 44 is mobile nearingly/distancingly to/from the movement plane M, i.e. it is actionable in translation along a translation direction that is parallel to the sliding direction B.

[0148] Each abrasive tool 44 can advantageously comprise a rectifying grinder 440 splined on a drive shaft of a command motor 441.

[0149] The command motor 441 of each abrasive tool 44 is slidably associated, relative to the translation direction, to the respective flank 411, for example by means of a sliding guide and a regulating device 442 configured for regulating a distance of the rectifying grinder 440 from the movement plane M.

[0150] The regulating device 442 might be of a manual type, for example a graduated bushing that is manually adjustable or remotely controllable or semi-automatic, for example of an endless screw and nut connecting type activated by a remote-controlled motor, for example by an operator.

[0151] It is possible for the regulating device 442 to be completely automated.

[0152] The second grinding machine 40 in the illustrated example comprises a plurality of abrasive tools 44 for each second flank T2 of the slab element T to be rectified.

[0153] For example, each abrasive tool 44 of one of the flanks 411 is substantially symmetrical with respect to a median plane perpendicular to the sliding direction B of an abrasive tool 44 of the other flank 411.

[0154] A group of the plurality of abrasive tools 44 of each flank 411 is configured for rectifying the respective second flank T2 of the slab element T.

[0155] The abrasive tools 44 of the group are arranged with the rotation axis horizontal and perpendicular to the advancement direction C.

[0156] That is, the drive shaft and therefore the rectifying grinder 440 of each abrasive tool 44 is activated in rotation with respect to a rotation axis that is substantially horizontal plane and perpendicular to the advancement direction C.

[0157] One (alone) of the abrasive tools 44 of each flank 411, for example the tool most downstream in the advancement direction of the slab elements T along the advancement direction A imparted by the movement group 42, is configured for carrying out a chamfering on the respective second flank T2 of the slab element T.

[0158] The chamfering abrasive tool 44 is arranged with the rotation axis thereof lying on an inclined plane with respect to the horizontal plane and in any case perpendicular to the advancement direction C.

[0159] That is, the drive shaft and therefore the rectifying grinder 440 of the chamfering abrasive tool 44 is activated in rotation with respect to a rotation axis lying on an inclined plane with respect to the horizontal plane and in any case perpendicular to the advancement direction C.

[0160] The second grinding machine 40 is for example a dry grinding machine (or squaring machine), i.e. the contact between the abrasive tool 44 (i.e. the abrasive wheel 440) and the surface of the slab element T takes place in a dry environment, i.e. absence of cooling liquid and/or lubrication in the contact zone between the abrasive tool 24 and the slab element T.

[0161] The second grinding machine 40 comprises, in particular, an optical group 45 located in proximity of the abrasive tool 44, preferably in proximity of the contact zone of the abrasive tool 44 with the respective second flank T2 of the slab element T.

[0162] The optical group 45 is for example fixed, for example adjustably, to the respective flank 411 so as to enable viewing the contact zone between the abrasive tool 44 and the second flank T2 of the slab element T.

[0163] For example, the optical group 45 is positioned above the respective abrasive tool 44 so as to have a top view of the contact zone between the second flank T2 of the slab element T and the abrasive tool 44, preferably in a gap defined between the flank 411 and the abrasive wheel 440.

[0164] In particular, the second grinding machine 40 comprises at least an optical group 45 for each abrasive tool 44, for example each supported by a respective flank 411 of the base frame 41.

[0165] For example, each optical group 45 is provided with an illuminator 450 configured to illuminate the visual space of the optical group 45 (or a portion thereof) with a light, such as a continuous light (such as of lower intensity than the intensity of the spark L).

[0166] For example, the illuminator 450 is fixed to the optical group 45 or for example it is integrally connected thereto.

[0167] For example, the illuminator 450 is adapted to illuminate the contact zone between the abrasive tool 44 and the respective second flank T2 of the slab element T.

[0168] For example each optical group 45 is mobile, by virtue of the movement of the respective flank 411, nearingly/distancingly to/from the movement plane M, i.e. it is actionable in translation along a translation direction that is parallel to the sliding direction B.

[0169] The optical group 45 is advantageously a television camera (for example a micro television camera) and/or a camera.

[0170] Each optical group 45 is configured to detect a respective image I1 of a contact zone between the second flank T2 of the slab element T and the abrasive tool 44, or the rectifying grinder 440, wherein the detected contact zone comprises a first zone of the second flank T2 placed immediately upstream of the abrasive tool 44, or the rectifying grinder 440, in the advancement direction of the slab elements T along the advancement direction A imparted by the movement group 42 and a second zone of the second flank T2 placed immediately downstream of the same abrasive tool 44, or the rectifying grinder 440, in the advancement direction of the slab elements T along the advancement direction A imparted by the movement group 42.

[0171] In practice, the first zone and the second zone are placed in front of and behind the spark L, respectively, triggered by contact between the abrasive tool 44 and the second flank T2 placed in the visual field of the optical group 45.

[0172] The first zone includes the profile to be rectified of an edge of the second flank T2 upstream of the contact zone between the second flank T2 and the abrasive tool 44; the second zone includes the rectified profile of the same edge of the second flank T2 placed downstream of the contact zone between the second flank T2 and the abrasive tool 44.

[0173] In practice, the profile to be rectified is visible as a first line (e.g. straight line) placed at a first height in the image I1 detected by the optical group 45 and the rectified profile is visible as a second line (e.g. straight line and substantially parallel to the first line) placed at a second height in the image I1 detected by the optical group 45.

[0174] The first line and second line are axially separated by the contact zone between the abrasive tool 24 and the second flank T2, visible in the image I1 as spark L.

[0175] Each optical group 45 can be configured for also detecting a further respective image I2 of a spark triggered by contact between the second flank T2 of the slab element T and the abrasive tool 44, i.e. the abrasive wheel 440.

[0176] For example, each further image I2 detected by the optical group 45 is an image, for example a high-definition colour image, which shows and/or possesses the following physical magnitudes of each spark: light intensity of the spark, dimension of the spark, shape of the spark and colour of the spark. In the example, each optical group 45 can be connected, for example cabled, to a microcontroller 46 which receives the images I1 and/or I2 from the optical group 45.

[0177] For example, the plant 10 and/or the second grinding machine 40 can comprise a plurality of microcontrollers 46, each of which is for example connected to a plurality (for example 5-8 in number) of optical groups 45.

[0178] The plant 10 and/or the first grinding machine 40 comprises an electronic control unit 30 (which can be the same as described in the foregoing or a further one, for example connected to the first), for example provided with a memory and a calculator, operatively connected to each optical group 45 of the second grinding machine 40 (directly or via the microcontroller 46).

[0179] For example, the electronic control unit 30 is connected in wireless mode to each optical group 45 and/or microcontroller 46 of the second grinding machine 40.

[0180] Advantageously, the control unit 30 is configured to: determine the amount of material removed by the abrasive tool 44 (each of them) from the second flank T2 of the slab element T based on the image I1 detected by the optical group 45 (each of them).

[0181] In particular, the electronic control unit 30 can be configured to compare the first zone of the image I1 with the second zone of the image I1 and calculate the amount of material removed by the abrasive tool 44 (each of them) from the second flank T2 of the slab element T as a function of the comparison between the first zone and the second zone.

[0182] For example, since the distance between the first line and the second line (in the orthogonal direction to the advancement direction A, i.e. to the second flank T2, in particular transversely to the advancement direction A) is proportional to the amount of material removed by the abrasive tool 44 (each of them) from the second flank T2 of the slab element T, the electronic control unit 30 can be configured to calculate such a distance and determine (for example, multiply it by a correction factor, which for example takes into account the thickness of the slab element T and the length of the second flank T2) the amount of material removed by the abrasive tool 44 (each of them) from the second flank T2 of the slab element T, i.e. the volume of material removed by each abrasive tool 44 from the slab element T.

[0183] The electronic control unit 30 can be configured for: calculating (measuring or calculating) a physical magnitude of the spark based on the image 12 detected by the optical group 45, comparing the determined physical magnitude with a predetermined reference I_{ref}, and generating an error signal if the physical magnitude differs from the predetermined reference I_{ref}.

[0184] The physical magnitude calculated by the electronic control unit 30 is selected from a group consisting in light intensity of the spark, dimension of the spark, shape of the spark and colour of the spark.

[0185] For example, the electronic control unit 30 can calculate one or more of these physical magnitudes (even all of them) and can compare them with a respective predetermined reference I_{ref}.

[0186] The predetermined reference I_{ref} is for example an image of a profile of a reference spark representing an optimal contact between the abrasive tool 44 (the one mounted on the second grinding machine 40) and the slab element T.

[0187] The reference I_{ref} can be predetermined by calibrating operations, for example carried out by making the second grinding machine 40 operate in optimal abrasive tool/slab element contact conditions and stored in the memory of the electronic control unit 30.

[0188] The reference I_{ref} can for example be redefined each time the mixture of the abrasive mixture making up the abrasive tool 44 and/or the mixture of the slab element T are changed.

[0189] The electronic control unit 30 is therefore configured for generating an error signal S if the image I of the profile detected by the optical group 45 differs from the reference I_{ref}, for example by a predetermined significant error or one greater than the usual working tolerances applied in the specific field.

[0190] For example, it has been found that if the light intensity of the spark and/or the dimension of the spark e is smaller than a determined threshold value (or respective calculated reference I_{ref}), the quantity of material removed by the abrasive tool 44 from the slab element T diminishes, for example is too low.

[0191] The electronic control unit 30 is configured to generate an error signal S if the amount of material removed by the abrasive tool 44 (each of them) from the second flank T2 of the slab element T, calculated on the basis of the profile image I1 detected by the optical group 45, is different from a reference limit value Q_{ref} thereof, for example by a predetermined significant error, i.e. greater than the usual manufacturing tolerances applied in the specific field.

[0192] In practice, if, based on the image I1, it was found that the amount of material removed by the abrasive tool 44 (each of them) from the second flank T2 of the slab element T is insufficient, for example, by comparing the value of the amount of material removed calculated using the predetermined limit reference value Q_{ref} (for example through calibration) for each abrasive tool 44, then it is possible that the electronic control unit 30 signals the error to proceed to its correction.

[0193] The (measured) amount of material removed thus calculated by each abrasive tool 44 can be compared with the (measured) amount of material removed by the other abrasive tools 44 of the second grinding machine 40, such as those immediately upstream and/or downstream thereof in the advancement direction A of the slab elements T; in that case, it is possible to optimize and/or correct the position of each abrasive tool 44 of the second grinding machine 40 (with respect to the others and with respect to the slab element T being processed).

[0194] In this case it is therefore necessary to redefine the contact conditions between the abrasive tool 44 and the second flank T2 of the slab element T, for example by modifying the distance between the flanks 411 of the second grinding machine 40 and/or the distance of the respective abrasive tool 44 from the second flank T2.

[0195] Also, for example, it has been found that if the shape of the spark is more irregular than a determined reference shape (or a determined respective reference I_{ref}), the abrasive tool 44 (i.e. the abrasive wheel 440) is not working correctly.

[0196] In this case it is therefore necessary to redefine the contact conditions between the abrasive tool 44 and the second flank T2 of the slab element T, for example by modifying the distance between the flanks 411 of the second grinding machine 40 and/or the distance of the respective abrasive tool 44 from the second flank T2.

[0197] Also, for example, it has been found that if the colour of the spark (for example tending to ochre) is significantly different from a determined reference colour (or a determined respective reference I_{ref}), for example a white colour or tending to white, this means there is a fault and the abrasive tool 44 (i.e. the abrasive wheel 440) is not working in the correct way.

[0198] In this case it is therefore necessary to redefine the contact conditions between the abrasive tool 44 and the second flank T2 of the slab element T, for example by modifying the distance between the flanks 411 of the second grinding machine 40 and/or the distance of the respective abrasive tool 44 from the second flank T2.

[0199] The plant 10 and/or the second grinding machine 40 can comprise a user interface 35 (for example the same as described in the foregoing or a further interface connected for to the other one) for signalling, which is operatively connected (for example in wireless mode) to the electronic control unit 30 for emitting one or more signals, for example of the visible and/or acoustic type, perceptible by a user when the electronic control unit 30 generates the error signal S.

[0200] For example, the user interface 35 might be defined by a PC with a monitor and, for example, be fixed to the base frame 41 of the second grinding machine 40 or positioned remotely or be of a mobile device type.

[0201] One or more of the following data can be made available in the user interface 35, among which: the amount of material removed by the abrasive tool 44 (each of them) from the second flank T2 of the slab element T and/or a value indicating how much the detected amount of removed material differs from the limit reference value Q_{ref} (of each abrasive tool 44) and /or the image of the spark, the light intensity of the spark and/or a value indicating how much the intensity detected differs from the respective reference, the dimension (area) of the spark and/or a value indicating how much the dimension detected differs from the respective reference, the shape of the spark and/or a value indicating how much the shape detected differs from the respective reference and the colour of the spark and/or a value indicating how much the colour detected differs from the respective reference. Further, a historical record of the errors detected and/or the measurements taken (for example the last 30 slab elements T machined) can be made available in the user interface 35, as well as a settable field in which the tolerance of the difference between the image and the reference I_{ref} can be selectable or compilable, a settable field in which the number of errors on consecutive slab elements T beyond which it is necessary to intervene can be selectable or compilable, for example requiring halting the machine.

[0202] A pusher group 46 is associated to the second grinding machine 40, for example immediately upstream thereof in the advancement direction of the slab elements T along the advancement direction C, which pusher group 46 is configured for exerting a rear push on the slab element T in inlet to the second rectifying machine 40, for example in contemporary activation with the centring group 43 for the squared positioning of the slab element T.

[0203] For example the pusher group 46 is able to position the slab element T on the movement plane M of the second grinding machine 40 so as to compensate for any errors encountered in the difference between the diagonals of a same piece in outlet from the first grinding machine 20.

[0204] The pusher group 46 comprises a first pusher member 461 and a second pusher member 462 which are alternatively and independently mobile along the advancement direction C and are able to come into contact and push (at a greater velocity than the advancement direction velocity of the slab elements T on the movement plane M) the first flank T1 that is posterior in the advancement direction of the slab element T along the advancement direction C of the slab element T in inlet to the second grinding machine 40.

[0205] In practice, the first pusher member 461 and the second pusher member 462, i.e. the rest surface thereof on the first flank T1, define an inclinable pushing plane (according to the staggering of the first pushing member 461 with respect to the second pusher member 462 in the advancement direction C) with respect to a plane that is perpendicular to the advancement direction C of the slab element T for adjusting the inclination of the rear side with respect to the perpendicular plane to the advancement direction.

[0206] The staggering of the first pusher member 461 with respect to the second pusher member 462 is settable as a function of the error encountered in the difference D between the diagonals of the slab element T in outlet from the first grinding machine 20, so as to compensate for the error during and by the rectification of the second flanks T2 by the second grinding machine 40.

[0207] In particular, the pusher group 46 comprises a first actuator 463 associated to the first pusher member 461 and configured for translating the first pusher member 461 along the advancement direction C, and a second actuator 464 associated to the second pusher member 462, for example independent of the first pusher member 461, and configured for translating the second pusher member 462 along the advancement direction C.

[0208] The pusher group 46, and in particular the first actuator 463 and the second actuator 464, are advantageously operatively connected to the control unit, which is configured for commanding the advancement of the first pusher member 461 and of the second pusher member 462 for reciprocal positioning thereof and translation along the advancement direction C (in synchrony with the activating of the centring group 43).

[0209] The plant 10 can comprise a rotation group 50 between the first grinding machine 20 and the second grinding machine 40, for example upstream of the pusher group 46 in the advancement direction of the slab elements T imparted by the movement planes M of the respective grinding machines 20 and 40, which rotation group 50 is able to rotate the slab element T, for example by 90° with respect to a vertical rotation axis (perpendicular to the movement plane M) so that the second flanks T2 are brought into a parallel position with the advancement direction C along the movement plane M (of the second grinding machine 40).

[0210] The rotation group 50 comprises, for example a pair of looped belts 51 that are wound respectively on a drive pulley, connected to a respective activating motor 52, and a driven pulley.

[0211] The upper branch of the belts 51 defines a rest and movement plane for the slab element T, for the movement of the slab element T along an advancement direction C, which can coincide with the advancement direction C imposed by the movement plane M (of the first grinding machine 20 and/or of the second grinding machine 40).

[0212] The activating motors 52 of each belt 51 can operate independently of one another.

[0213] In particular, the reciprocal rotation velocity of the two activating motors 52 can be varied between a first configuration, in which the two activating motors 52 are synchronous, i.e. they rotate the respective drive pulley at the same velocity, and a second configuration in which the two activating motors are asynchronous, i.e. they rotate the respective drive pulley at different velocities (for example also one in one rotation direction and the other in the other rotation direction).

[0214] By activating the activating motors 52 in the second configuration, for a brief settable period, when the slab element T is resting on the belts 51 the slab element T is rotated by 90°, remaining substantially horizontal and in fact bringing the second flanks T2 parallel to the advancement direction C, so as to be fed to the second grinding machine 40 for rectification of the second flanks T2.

[0215] In the light of the foregoing, the functioning of the plant 10 is as follows.

[0216] The flanks 210 of the first grinding machine 20 are set at a reciprocal distance that is such as to define a movement plane M able to support, as described in the foregoing, the slab elements T with the first flanks T1 parallel to the advancement direction C.

[0217] With this arrangement of the flanks 210, the optical groups 25 too are positioned in the optimal position for reading and scanning the contact zone between the first flanks T1 of the slab elements T and each of the abrasive tools 24.

[0218] The slab elements T are arranged resting on the movement plane M of the first grinding machine 20 with a surface thereof (lower or not in-view) in contact with the movement plane M and an opposite surface thereof (upper or in-view) to be machined facing upwards.

[0219] Once a slab element T is resting on the upstream end, in the advancement direction of the slab elements T along the advancement direction A imparted by the movement group 22, the lower flexible organs 221 of the first grinding machine 20, the slab element T is centred by the centring group 23 and, when centred, is wedged between the lower flexible organs 221 and the upper flexible organs 225 and, thus retained, is transported thereby along the advancement direction C.

[0220] As the slab elements T are progressively advanced along the advancement direction C on the movement plane M of the first grinding machine 20, the first flanks T1 are intercepted by the abrasive tools 24, i.e. the rectifying grinder 240, which smooth and rectify the surface and/or chamfer it.

[0221] When the first flank T1 comes into contact with the respective abrasive tool 24, the respective optical group 25 detects the relative image I1 and/or I2 in the rubbing contact zone between the abrasive tool 24 and the first flank T1 and makes it available, for example via the microcontroller 26, to the electronic control unit 30.

[0222] As mentioned, the electronic control unit 30 processes each image I1 and/or 12.

[0223] Each detected image I1 and/or I2 and/or each processing made by the electronic control unit 30 can be made available on the user interface 35, both when it corresponds to the respective reference and when it is different therefrom.

[0224] If an insufficient amount of material removed by the abrasive tool 24 o a significant or considerable difference is revealed between the image and the relative reference I_{ref}, then the user interface 35 can provide a visual or acoustic alarm triggered by the error signal S generated by the electronic control unit 30 and store this data in the memory.

[0225] When it is found that a predetermined number of slab elements T, for example consecutive or in a relevant percentage, lead to generation of a relative error signal S by the electronic control unit 30, a further alarm will be displayed on the user interface 35.

[0226] For example, after having detected a repeat of the error for a predetermined number of consecutive slab elements T, it is possible to act retrospectively (for example manually, semi-automatically or automatically) to change the position of one or more of the abrasive tools 24, for example the abrasive tool 24 that has generated the error, or to change the settings of the centring group 23 or replace the abrasive wheel 240 that has generated the error.

[0227] In any case the slab elements T that exit from the first grinding machine 20, when advancing along the advancement direction C, are rotated by the rotation group 50 and, once centred by means of the centring group 43 and pushed by the pusher group 46, wedge between the lower flexible organs 421 and the upper flexible organs 425 of the movement group 42 of the second grinding machine 40 for transporting along the advancement direction C.

[0228] As the slab elements T are progressively advanced along the advancement direction C on the movement plane M of the second grinding machine 40, the second flanks T2 are intercepted by the abrasive tools 44, i.e. the rectifying grinder 440, which smooth and rectify the surface and/or chamfer it.

[0229] When the second flank T2 comes into contact with the respective abrasive tool 44, the respective optical group 45 detects the relative image I1 and/or I2 of the rubbing contact zone between the abrasive tool 44 and the second flank T2 and makes it available, for example via the microcontroller 46, to the electronic control unit 30.

[0230] As mentioned, the electronic control unit 30 processes each image I1 and/or I2.

[0231] Each detected image I1 and/or I2 and/or each processing made by the electronic control unit 30 can be made available on the user interface 35, both when it corresponds to the respective reference and when it is different therefrom.

[0232] If an insufficient amount of material removed by the abrasive tool 44 or a considerable difference is revealed between the image and the relative reference I_{ref}, then the user interface 35 can provide a visual or acoustic alarm triggered by the error signal S generated by the electronic control unit 30 and store this data in the memory.

[0233] When it is found that a predetermined number of slab elements T, for example consecutive or in a relevant percentage, lead to generation of a relative error signal S by the electronic control unit 30, a further alarm will be displayed on the user interface 35.

[0234] For example after having detected a repeat of the error for a predetermined number of consecutive slab elements T, it is possible to act retrospectively (for example manually, semi-automatically or automatically) to change the position of one or more of the abrasive tools 44, for example the abrasive tool that has generated the error, or to change the settings of the centring group 43 or replace the abrasive wheel 440 that has generated the error.

[0235] The invention as it is conceived is susceptible to numerous modifications, all falling within the scope of the inventive concept.

[0236] Further, all the details can be replaced with other technically-equivalent elements.

[0237] In practice the materials used, as well as the contingent shapes and dimensions, can be any according to requirements, without forsaking the scope of protection of the following claims.

Claims

1. A grinding machine (20,40) of slab elements (T) which comprises at least an abrasive tool (24,44) able to come into contact with a surface (T1,T2) of the slab element (T) and an optical group (25,45) located in proximity of the abrasive tool (24,44) configured for detecting an image of a contact zone between the surface (T1,T2) and the abrasive tool (24,44).

2. The machine (20,40) of claim 1, **characterised in that** it comprises an electronic control unit (30) operatively connected to the optical group (25,45) and configured for determining an amount of material removed by the abrasive tool (24, 44) from the surface (T1, T2) of the slab element (T) based on the image detected by the optical group (25, 45).

3. The machine (20,40) of claim 1, wherein the image of the contact zone includes a first surface zone (T1, T2) not yet come in contact with the abrasive tool (24, 44) and a second surface zone (T1, T2) already come in contact with the abrasive tool (24, 44).

4. The machine (20, 40) of claim 3, wherein the electronic control unit (30) is configured to calculate the amount of material removed by the abrasive tool (24, 44) from the surface (T1, T2) of the slab element (T) based on the difference between the first surface zone (T1, T2) and the second surface zone (T1, T2).

5. The machine (20,40) of claim 2 or 4, wherein the electronic control unit (30) is configured to generate an error signal if the amount of material removed by the abrasive tool (24, 44) is less than a predetermined reference value thereof, the electronic control unit (30) being operatively connected to a user interface (35) configured for receiving the error signal and translating it into a signal that is perceptible by a user.

6. The machine (20,40) of any one of the preceding claims, wherein the optical group (25,45) is a television camera and/or a camera.

7. The machine (20, 40) of any one of the preceding claims, wherein the optical group (25, 45) comprises an illuminator (250, 450) adapted to illuminate the contact zone.

8. The machine (20,40) of any one of the preceding claims, which comprises a plurality of abrasive tools (24,44) able to come into contact with the surface (T1,T2) of the slab element (T) and an optical group (T) for each abrasive tool (24,44).

9. A control method of a grinding machine (20,40) of slab elements (T) which comprises at least an abrasive tool (24,44) able to come into contact with a surface (T1,T2) of the slab element (T) and an optical group (25,45) located in proximity of the abrasive tool (24,44), wherein the control method comprises steps of:

    - detecting an image of a contact zone between the surface (T1,T2), and the abrasive tool (24,44), by means of the optical group (25,45); and
    - determining an amount of material removed by the abrasive tool (24, 44) from the surface (T1, T2) of the slab element (T) based on the image detected by the optical group (25, 45).

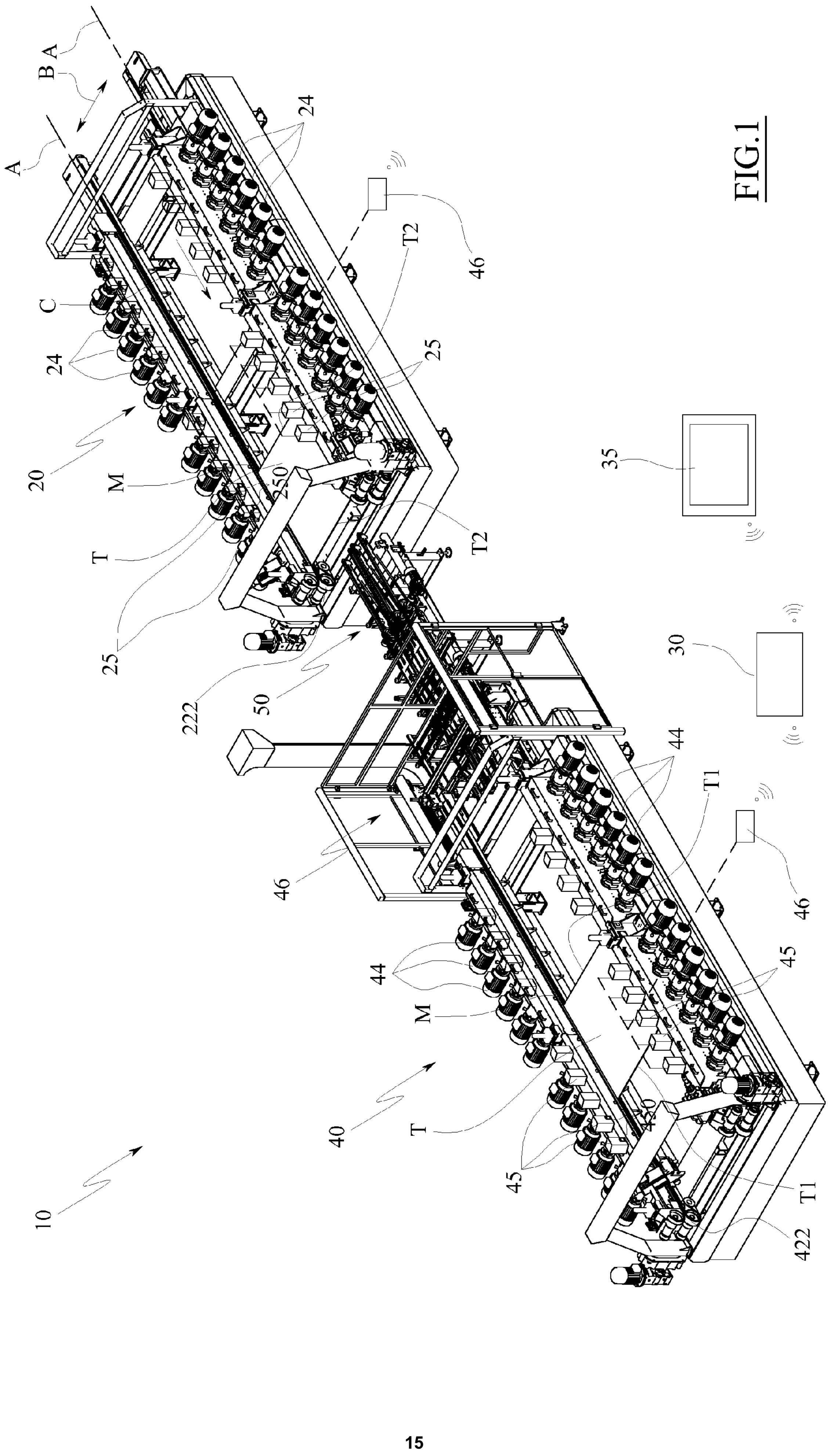
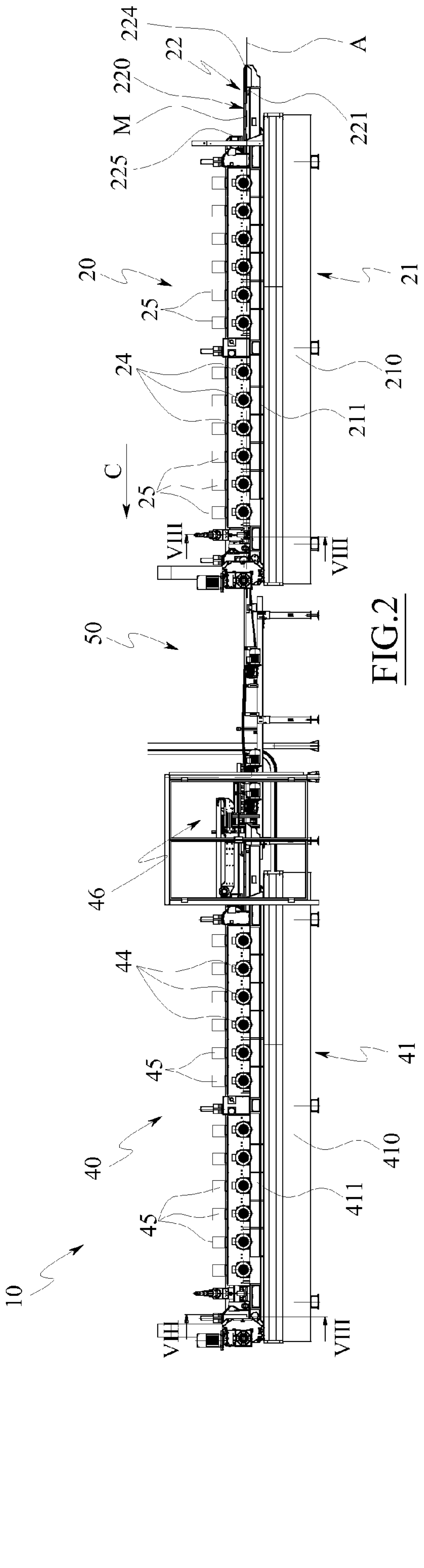


FIG.1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22
220
M
225
A
221
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210
211
C
VIII
50
46
44
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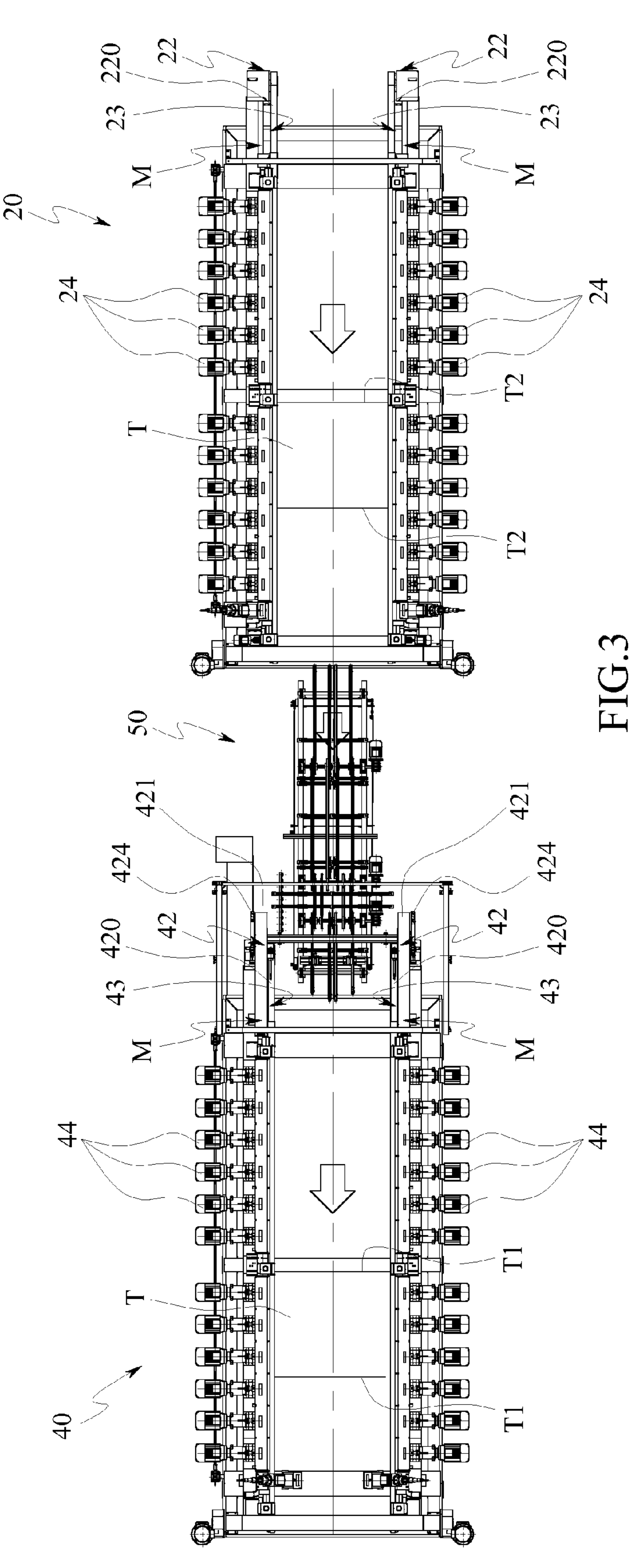
FIG.2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22
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M
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24
T
T2
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421
424
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44
T1
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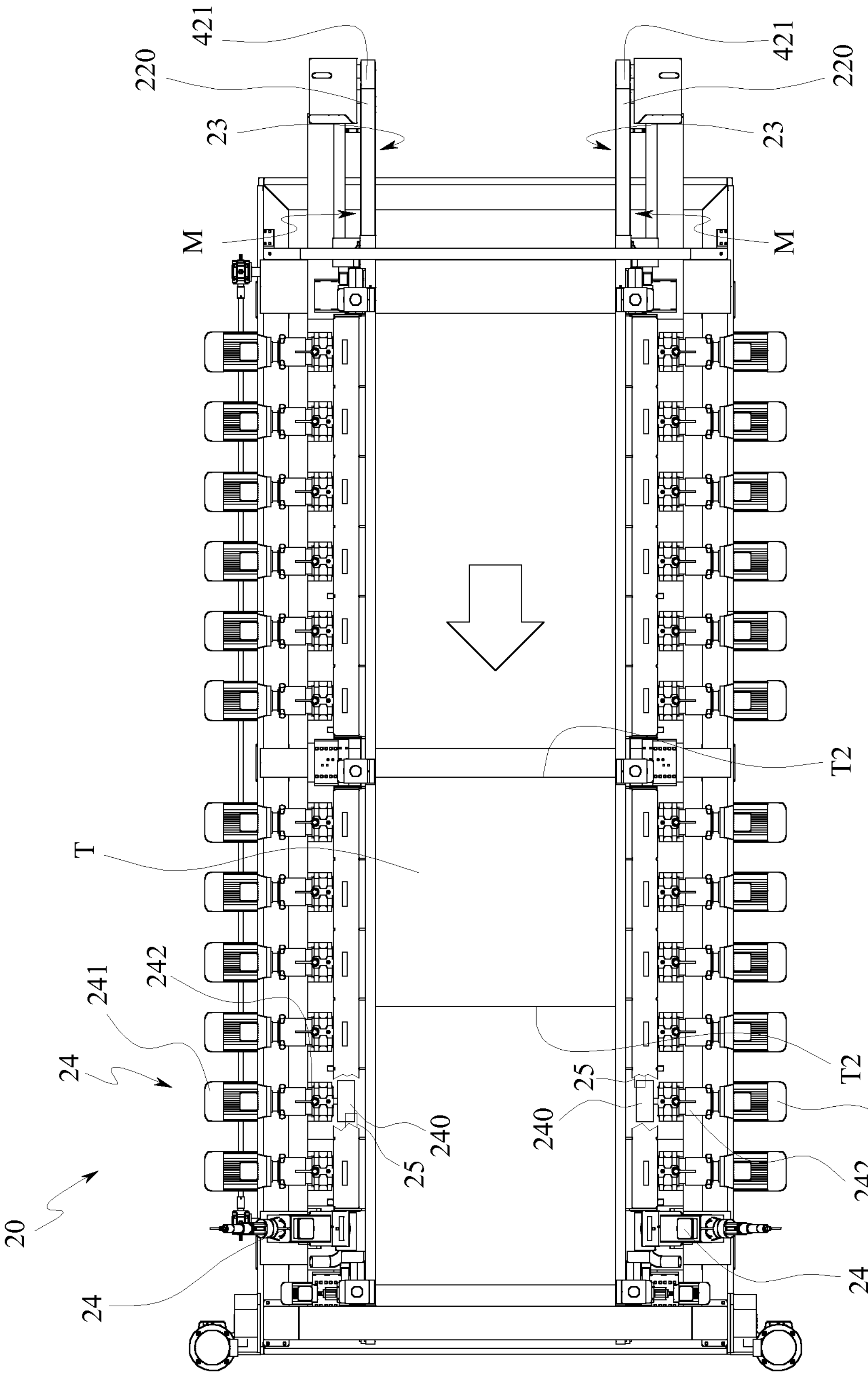
FIG.3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23
M
421
220
23
M
T2
T
T2
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FIG.4

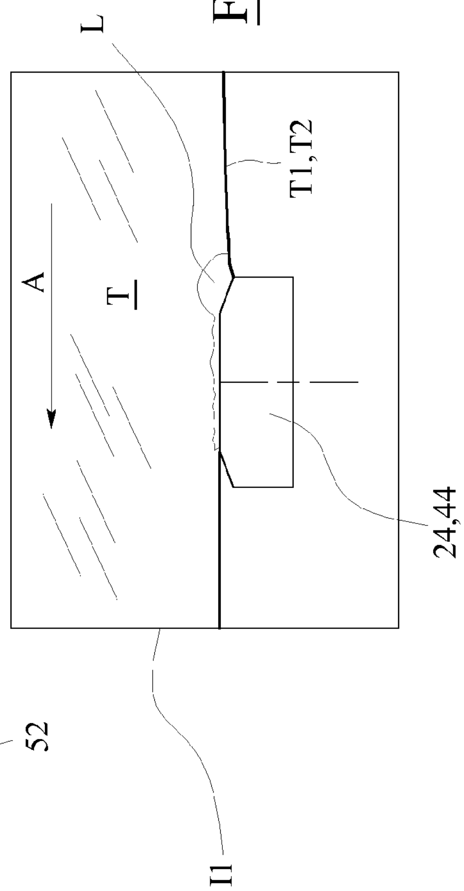


FIG.7

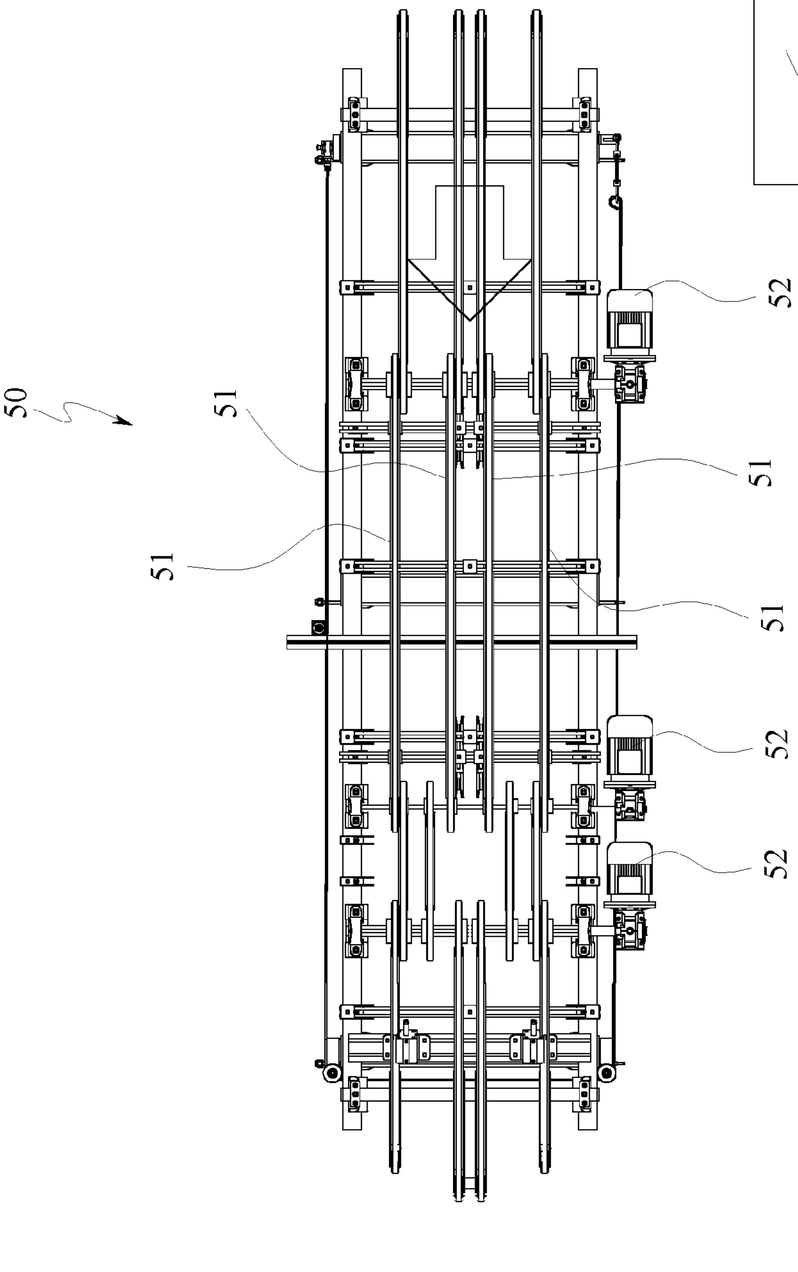
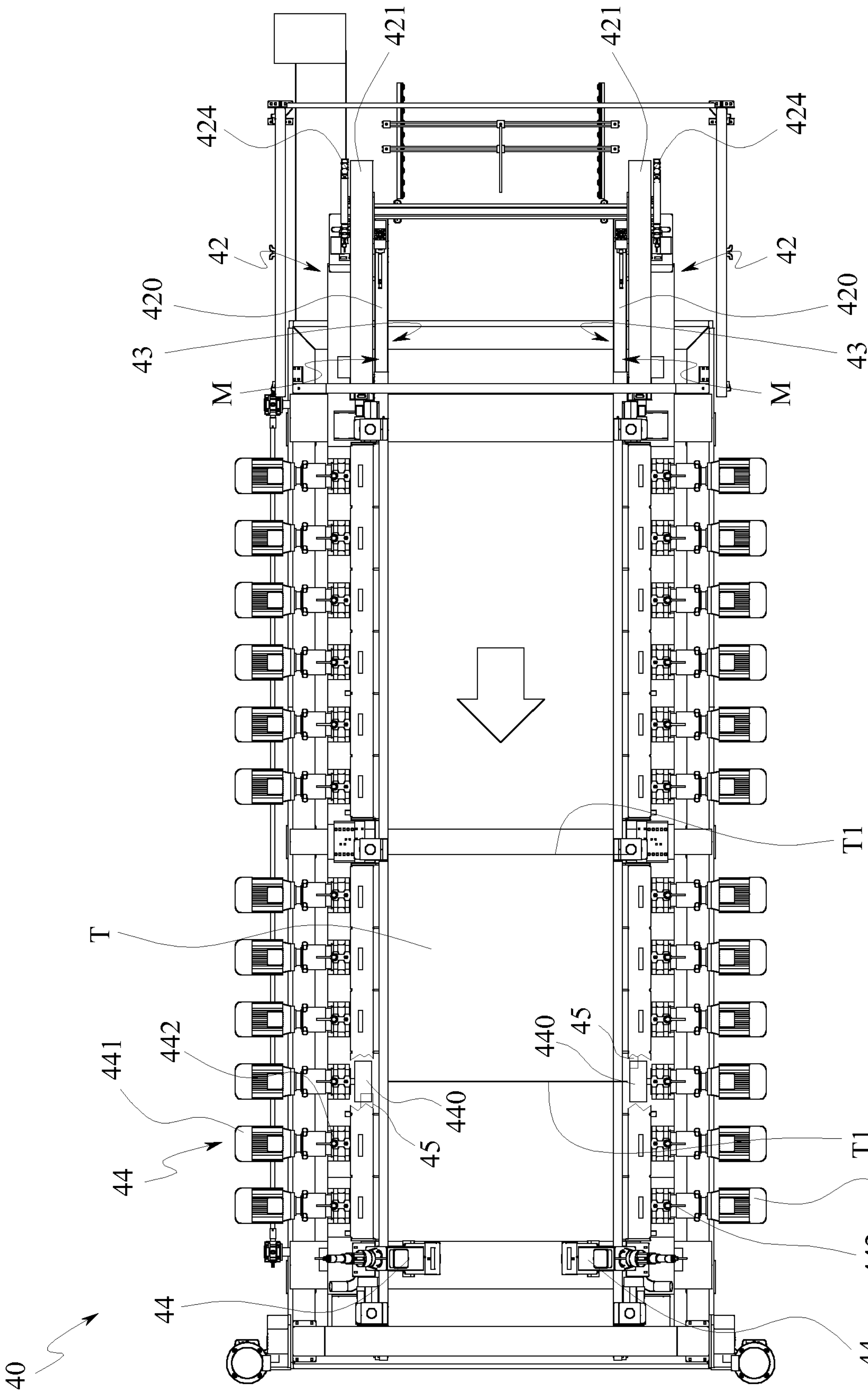


FIG.5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T1
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T1
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FIG.6

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EUROPEAN SEARCH REPORT

Application Number
EP 17 16 8150

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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	12 September 2017	Arhire, Irina

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CATEGORY OF CITED DOCUMENTS

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12-09-2017

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