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(54) SQUARING MACHINE

(57) A squaring machine (20) of slab-shaped elements (T) comprising:
- a frame (21) defining a horizontal resting and moving plane (M) which comprises a moving group (22) for advancing the slab-shaped elements (T) supported by the moving plane (M) along a predetermined feed direction (C);
- a plurality of abrasive tools (24) supported by the frame (21) and each individually movable, following a travel path orthogonal to the feed direction (C), between a distal position from the slab-shaped element (T) supported by the moving plane (M) and a proximal position, wherein the abrasive tool (24) is adapted to come into contact with a surface (T1,T2) of the slab-shaped element (T);
- a plurality of optical groups (25) individually secured to the frame (21), wherein each optical group (25) is arranged in proximity to a respective abrasive tool (24) such that at least one portion of the respective abrasive tool (24) along at least one segment of the travel path thereof is arranged within a visual field of the respective optical group (25), and
- a plurality of reference bodies (27), wherein each reference body (27) is secured to the frame (21), is arranged along the travel path of a respective abrasive tool (24) and within a visual field of the respective optical group (25), such that at least one portion of each abrasive tool (24) is adapted to be interposed between the respective optical group (25) and the respective reference body (27) during the movement of the abrasive tool (24) along the travel path thereof.

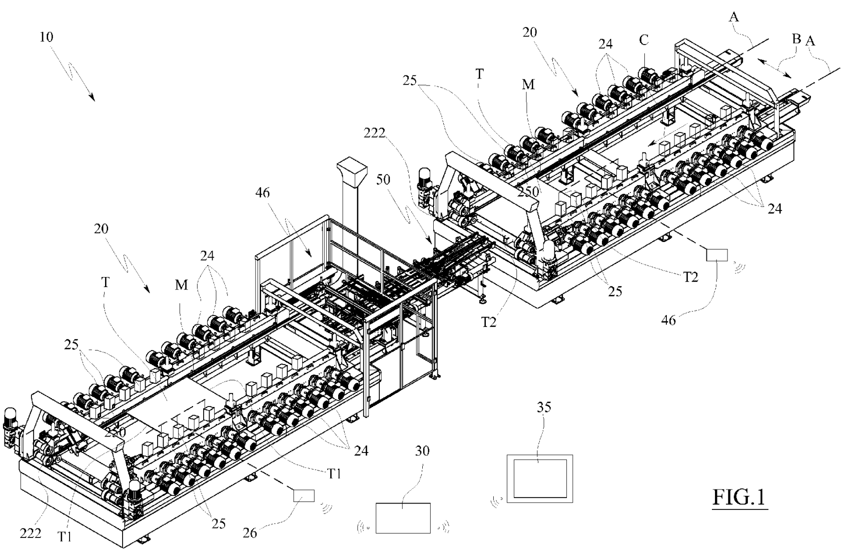

FIG.1

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Description

TECHNICAL FIELD

[0001] The present invention concerns a grinding machine for slab-shaped elements, like for example ceramic slabs, slabs of natural stone, slabs of glass or similar.

[0002] More in particular, the grinding machine is a squaring machine.

PRIOR ART

[0003] As known, slab-shaped elements, like ceramic slabs (paving or wall tiles), slabs of natural stone, slabs of glass or similar, can require grinding operations, for example of the side surfaces, like for example squaring that acts to bring two opposite sides of the slab-shaped element substantially parallel and the adjacent sides substantially square with the first ones.

[0004] Such an operation is generally carried out through grinding machines (so-called squarers), which work a plurality of slab-shaped elements advancing in succession on a moving plane, for example horizontal.

[0005] During the advancing on the moving plane a surface of the slab-shaped elements meets a succession of rotating abrasive tools, which remove the excess material, levelling the surface.

[0006] The contact between the abrasive tools and the surface of the slab-shaped element must take place correctly in order to be able to carry out an efficient processing of the surface.

[0007] Therefore, a requirement existing in such squaring machines is that of systematically controlling that each of the abrasive tools performs an optimal processing, i.e. enters into contact with the surface to be worked of the slab-shaped element in the correct manner, i.e. it removes a correct amount of material from the slab-shaped element being processed and that such a control takes the least time possible, since the time for equipping the squaring machine and the positioning of the abrasive tools in the correct work position is, in fact, an idle and non-productive time of the squaring machine itself.

[0008] A purpose of the present invention is that of satisfying these requirements, in a simple, effective, systematic and rational solution.

[0009] Such purposes are achieved by the characteristics of the invention given in the independent claim. The dependent claims outline preferred and/or particularly advantageous aspects of the invention.

DISCLOSURE OF THE INVENTION

[0010] The invention, particularly, provides a squaring machine of slab-shaped elements comprising:

- a frame defining a horizontal resting and moving plane that comprises a moving group for advancing the slab-shaped elements supported by the moving plane along a predetermined feed direction;
- a plurality of abrasive tools supported by the frame and each individually movable, following a travel path orthogonal to the feed direction, between a distal position from the slab-shaped element supported by the moving plane and a proximal position, wherein the abrasive tool is adapted for making contact with a surface of the slab-shaped element;
- a plurality of optical groups individually secured to the frame, wherein each optical group is arranged in proximity to a respective abrasive tool such that at least one portion of the respective abrasive tool along at least one segment of the travel path thereof is arranged within a visual field of the respective optical group, and
- a plurality of reference bodies, wherein each reference body is secured to the frame, is arranged along the travel path of a respective abrasive tool and within a visual field of the respective optical group, such that at least one portion of each abrasive tool is adapted to be interposed between the respective optical group and the respective reference body during the movement of the abrasive tool along the travel path thereof.

[0011] Thanks to such a solution, it is possible to define the reference position and/or the work position of each abrasive tool of the squaring machine individually and independently from the others, thereby making it possible to simultaneously equip and position all of the abrasive tools of the squaring machine with a substantial saving of time with respect to known manual and automatic squaring machines.

[0012] In particular, the idle times due to the positioning, the correction thereof and the equipping of the squaring machine are reduced even by about 80% with respect to known automatic squaring machines (from about 15 minutes for known squaring machines to about 3 minutes for the squaring machine object of the invention).

[0013] Preferably, the colour of each reference body can be a different and contrasting colour for the optics of the optical group with respect to the colour of the respective abrasive tool.

[0014] In this way, each optical group can easily identify both the reference body and the abrasive tool and, therefore, the mutual position thereof. Advantageously, the squaring machine can comprise an electronic control unit operationally connected to each optical group and to each abrasive tool. According to a preferred embodiment, in order to define the zero position of each abrasive tool, individually and simultaneously and independently, the electronic control unit (for each abrasive tool and respective optical group individually) can be configured for:

- controlling the movement of the abrasive tool along the respective travel path (starting) from the distal position towards the proximal position; and

- signalling a reference (or zero) position of the abrasive tool when the abrasive tool visually covers a predetermined first reference point arranged on the respective reference body.

[0015] In this way, it is possible to define, exactly and at any moment of the life of the abrasive tool, the reference position in which the anterior front of the abrasive tool and, thus, control the advancing of the anterior front of the abrasive tool until the correct pre-set work point whenever a repositioning of the abrasive tool itself is needed.

[0016] Alternatively or additionally, the electronic control unit (for each abrasive tool and respective optical group individually) can be configured for:

- maintaining the abrasive tool firmly along the respective travel path in the proximal position thereof; and
- signalling a first position error of an abrasive tool when the abrasive tool visually uncovers a predetermined second reference point arranged on the reference body corresponding to the proximal position of the abrasive tool.

[0017] Thanks to such a solution it is possible to dynamically recover in "*real time*" the wearing of the single abrasive tool during use thereof, in practice, allowing a substantial saving of time and a high quality and uniformity of processing for the slab-shaped elements of the same processing batch. Preferably, for each abrasive tool and respective optical group individually, the electronic control unit can be further configured for:

- correcting (instantaneously) the first position error of the abrasive tool controlling the movement of the abrasive tool along the travel path thereof from the distal position towards the proximal position until the respective abrasive tool again visually covers the second reference point.

[0018] Furthermore, for each abrasive tool and respective optical group individually, the electronic control unit can be configured for:

- controlling the movement of the abrasive tool along the travel path thereof from the distal position to an intermediate position between the distal position and the proximal position; and
- calculating a residual thickness of the respective abrasive tool based on a measured travel of the abrasive tool along the travel path thereof from the distal position to the intermediate position.

[0019] Thanks to such a solution it is possible to precisely define a residual use time of each abrasive tool and programme the replacement thereof efficiently for the entire production process.

[0020] Furthermore, the electronic control unit (for each abrasive tool and respective optical group individually) can be configured for:

- performing a control cycle of the correct position of the abrasive tool during the use thereof, wherein the control cycle provides the steps of:

    ◦ signalling a second position error of the abrasive tool when the abrasive tool covers a predetermined third reference point of the reference body further forward with respect to the second reference point along the travel path from the distal position to the proximal position; and
    ◦ controlling the movement of the abrasive tool individually along the travel path thereof from the proximal position towards the distal position to compensate for and correct the second position error.

[0021] Thanks to such a solution, it is possible to take into consideration and correct possible position errors of each abrasive tool (of the relative anterior front), for example caused by the thermal expansion of the abrasive tool during the use thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Further characteristics and advantages of the invention will become clearer from reading the following description provided as an example and not for limiting purposes, with the help of the figures illustrated in the attached tables.

Figure 1 is an axonometric view of a system according to the invention.
Figure 2 is a side 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 system of figure 1.
Figure 6 is a view from above of a second squaring machine according to the invention.
Figure 7a is a schematic view of a first image detected by an optical group of the squaring machine according to the invention.
Figure 7a is a schematic view of a second image detected by an optical group of the squaring machine according to the invention.
Figure 8a is a schematic view of a third image detected by an optical group of the squaring machine according to the invention.
Figure 8b is a schematic view of a fourth image detected by an optical group of the squaring machine according to the invention.
Figure 9a is a schematic view of a fifth image detected by an optical group of the squaring machine according to the invention.

Figure 9b is a schematic view of a sixth image detected by an optical group of the squaring machine according to the invention.

BEST WAY OF CARRYING OUT THE INVENTION

[0023] With particular reference to such figures, a system for grinding, in particular for squaring, slab-shaped elements T, for example ceramic slabs, slabs of natural stone, slabs of glass or similar has been globally indicated with 10.

[0024] Each slab-shaped element T has substantially a shape of a parallelepiped with low height (thickness) and with substantially quadrangular base (in plan), for example rectangular or square.

[0025] In practice, the slab-shaped element T has two opposite first flanks T1 that are substantially parallel and two second flanks T2 adjacent to the first flanks T1 and opposite and substantially parallel to one another.

[0026] The system 10 comprises a first squaring machine 20, in particular a squaring machine, for example adapted for performing a rectification and/or bevelling operation on the two first flanks T1 of the slab-shaped element T.

[0027] The first squaring machine 20 comprises a base frame 21 comprising a base block 210 equipped with common supports on the ground.

[0028] The base frame 21 comprises a pair of parallel longitudinal side walls 211 associated with the base block 210 in a movable manner towards and away from one another, along a sliding direction B orthogonal to the longitudinal axis A thereof.

[0029] For example, between the base block 210 and each of the side walls 211 a sliding guide (not visible) is defined adapted for keeping the side walls 211 parallel to one another during the mutual sliding along the sliding direction B. Advantageously, the base block 210 supports a translation group of the side walls 210, which for example can comprise at least one motor secured to the base block 210 and motion transmission members, for example of the type with toothed wheels or belts, adapted for transferring the motion of a drive shaft of the motor to the side walls 211, for the translation thereof along the sliding direction B.

[0030] For example, the translation group can comprise a motor for each side wall 211, such that the translation of one side wall 211 is substantially independent from the translation of the other.

[0031] However, this does not rule out the possibility that the translation group can comprise a single motor or that, alternatively, the translation of the side walls is not automated.

[0032] Moreover, it is possible for the translation group to comprise synchronisation means of the translation of the side walls 211, thanks to which the side walls 211 are constrained to stay in parallel positions and symmetrically arranged with respect to a middle plane orthogonal to the sliding direction B.

[0033] The base frame 21 supports a moving group 22 for moving the slab-shaped elements T.

[0034] The moving group 22 is configured to move each slab-shaped element T so that it lies (with the large surfaces in view and/or for laying) on a moving plane M, for example substantially horizontal, and advances on a feed direction C, for example parallel to the longitudinal axis A of the side walls 211 and/or substantially parallel to the first flanks T1 to be rectified.

[0035] The moving group 22 for example comprises a belt conveyor 200.

[0036] In particular, the moving group 22 comprises a pair of belt conveyors 220 each of which is supported at a respective side wall 211.

[0037] Each belt conveyor 220 comprises a lower flexible member 221, which has an upper branch parallel to the feed direction C and defines a movable portion of a moving plane M for the slab-shaped elements T.

[0038] The lower flexible members 221 of the pair of belt conveyors 220, i.e. the respective upper branches, are substantially coplanar and, together, define the moving plane M (horizontal) for the slab-shaped elements T.

[0039] For example each lower flexible member 221 comprises or consists of a belt closed on itself in a loop and wound on at least one driving pulley 222, set in rotation by a respective electric motor 223, and at least one driven pulley 224 (in the example a plurality of driven pulleys).

[0040] Each belt conveyor 220 also comprises an upper flexible member 225, which has a lower branch parallel to the feed direction C and defines a movable contact and pressure portion with the slab-shaped elements T.

[0041] Each upper flexible member 225 juxtaposed, for example juxtaposed in plan and vertically aligned, with the lower flexible member 221 of the same belt conveyor 220.

[0042] For example, each upper flexible member 225 can be associated with the respective side wall 211 in a height-adjustable manner, so as to change the size of the gap existing between the lower flexible member 221 and the upper flexible member 225, in particular between the upper branch of the lower flexible member 221 and the lower branch of the upper flexible member 225, as a function of the thickness of the slab-shaped elements T.

[0043] The upper flexible members 225 of the pair of belt conveyors 220, i.e. the respective lower branches, are substantially coplanar and, together, define a (horizontal) contact and pressure plane adapted for making contact with and pressing on the (visible) upper surface of the slab-shaped elements T.

[0044] For example each upper flexible member 225 comprises or consists of a belt closed on itself in a loop and wound on at least one driving pulley 226, set in rotation by a respective electric motor (for example coinciding with the electric motor 223), and at least one driven pulley (in the example a plurality of driven pulleys), not visible.

[0045] The electric motors 223 of both of the belt conveyors 220 are actuated in a synchronised manner so as to allow the slab-shaped elements T to advance along the feed direction C with the first flanks T1 parallel to the feed direction C itself.

[0046] The lower flexible members 221, i.e. the upper branches thereof, have a greater length than the respective upper flexible members 225, i.e. the upper branches thereof, so that an end of the lower flexible members 221, advantageously the upstream end in the advancing direction of the slab-shaped elements T along the feed direction C imparted by the moving group 22, is offset with respect to the respective upper flexible member 225.

[0047] In practice, the offset end of the lower flexible members 221 defines a free inlet segment of the moving group 22 on which the slab-shaped element T rests before wedging between the lower flexible members 221 and the upper flexible members 225 and being firmly pressed between them.

[0048] The change of the distance between centres of the side walls 211 of the base frame 21 actually defines a corresponding change of the distance between centres of the belt conveyors 220 and, therefore, the change of the size of the resting plane defined by them as a function of the format of the slab-shaped elements T.

[0049] Moreover, the distance between centres of the side walls 211 is defined, on each occasion, as a function of the dimensions of the slab-shaped elements T, in particular of the distance between the first flanks T1 thereof, so that the first flanks T1 of the slab-shaped elements T project laterally (by a modest segment), along a direction parallel to the sliding direction B, with respect to the moving plane M. i.e. substantially cantilevered from it.

[0050] Advantageously, each belt conveyor 220 can comprise a pressing device (not illustrated), which is configured to push the upper branch of the lower flexible member 221 and the lower branch of the upper flexible member 225 towards one another. For example, the pressing device can comprise one or more support bars arranged inside the loop defined by each flexible member or by only the upper flexible member 225 that support a plurality of pads aligned and adjacent along the feed direction C and pushed towards the other flexible member by compression springs.

[0051] Moreover, the first squaring machine 20 comprises a centring group 23 configured for centring, with respect to a centring direction parallel to the sliding direction B, the slab-shaped element T on the moving plane M, i.e. on the belt conveyor 220.

[0052] The centring group 23 comprises, for example, a pair of side panels each slidably associated with respect to a respective side wall 211 and able to be actuated, for example by an electric actuator, towards and away from the moving plane M.

[0053] The first squaring machine 20 comprises an abrasive tool 24 arranged in proximity to the moving plane M, i.e. to the upper branches of the lower flexible members 221, and adapted for coming into contact with a surface of the slab-shaped element T transiting along the feed direction C, i.e. with one of the first flanks T1 thereof.

[0054] In practice, the abrasive tool 24 is arranged beside the moving plane B, for example supported by a side wall 211 of the base frame 21.

[0055] In particular, the first squaring machine 20 comprises at least one abrasive tool 24 for each first flank T1 of the slab-shaped element T to be worked, i.e. arranged at the sides of the moving plane M, for example each supported by a respective side wall 211 of the base frame 21.

[0056] For example each abrasive tool 24 is movable towards/away from the moving plane M, i.e. it can be set in translation along a (straight) travel path parallel to (and coinciding with) the sliding direction B.

[0057] Advantageously, each abrasive tool 24 comprises a rectifying wheel 240 fitted on a drive shaft of a first motor 241 for driving the rotation of the respective abrasive tool 24.

[0058] The rectifying wheel 240 is for example an annular grindstone with axis concentric to the rotation axis thereof.

[0059] The driving motor 241 of each abrasive tool 24 is slidably associated, with respect to the direction of translation, with the respective side wall 211, for example by means of a sliding guide and an adjustment device 242 configured to adjust the distance of the rectifying wheel 240 with respect to the moving plane M.

[0060] The adjustment device 242 could be of the manual type, for example a manually adjustable, remotely-actuated or semi-automatic scaled bush, for example of the worm screw and female screw type connection actuated by a remotely controlled motor, for example by an operator.

[0061] This does not rule out the possibility of the adjustment device 242 being able to be completely automated.

[0062] In this case, each abrasive tool 24 comprises a second motor 243, for example equipped with encoders, which is adapted for setting the respective abrasive tool 24, i.e. the respective rectifying wheel 240, in translation, in the two directions of travel along the respective travel path (parallel and coinciding with the rotation axis of the rectifying wheel 240).

[0063] Each second motor 243 is configured to actuate the respective abrasive tool 24, i.e. the respective rectifying wheel 240, between a distal position by the first flank T1 of the slab-shaped element T to be worked and supported by the moving plane M, for example defined by a (physical) rear end stop arranged at a predetermined axial position along the travel path, and a proximal position to the first flank T1 of the slab-shaped element T to be worked, wherein the abrasive tool 24, i.e. the rectifying wheel 240, is adapted for making contact with the first flank T1 of the slab-shaped element T to be worked itself.

[0064] In practice, the distal position is defined by a (non-physical) front end stop arranged in a variable or variably adjustable axial position as a function of the dimensions of the slab-shaped element T being processed and of the desired amount of material to be removed with such an abrasive tool 24, creating the so-called removal cone.

[0065] Such a front end stop defines the work point of the respective abrasive tool 24.

[0066] The first squaring machine 20 in this case comprises a plurality of abrasive tools 24 for each first flank T1 of the slab-shaped element T to be rectified. For example, each abrasive tool 24 of one of the side walls 211 is substantially symmetrical with respect to the middle plane orthogonal to the sliding direction B to an abrasive tool 24 of the other side wall 211.

[0067] A group of the plurality of abrasive tools 24 of each side wall 211 is configured to rectify the respective first flank T1 of the slab-shaped element T.

[0068] The abrasive tools 24 of such a group are arranged with horizontal rotation axis orthogonal to the feed direction C.

[0069] In other words, the drive shaft and thus the rectifying wheel 240 of each abrasive tool 24 is set in rotation with respect to a substantially horizontal rotation axis orthogonal to the feed direction C.

[0070] (Only) one of the abrasive tools 24 of each side wall 211, for example the one furthest downstream in the advancing direction of the slab-shaped elements T along the feed direction C imparted by the moving group 22, is configured to perform a bevelling on the respective first flank T1 of the slab-shaped element T.

[0071] Such an abrasive bevelling tool 24 is arranged with rotation axis lying on an inclined plane with respect to the horizontal plane and in any case orthogonal to the feed direction C.

[0072] In other words, the drive shaft and thus the rectifying wheel 240 of such an abrasive bevelling tool 24 is set in rotation with respect to a rotation axis lying on an inclined plane with respect to the horizontal plane, in any case orthogonal to the feed direction C.

[0073] The first squaring machine 20 is for example a dry squaring machine (or squarer), i.e. the contact between the abrasive tool 24 (i.e. the rectifying wheel 240) and the surface of the slab-shaped element T takes place in a dry environment, i.e. without refrigerating and/or lubricating liquid of the contact area between the abrasive tool 24 and the slab-shaped element T.

[0074] The first squaring machine 20 comprises, particularly, an optical group 25 arranged in proximity of each abrasive tool 24, preferably in proximity of the contact area of the respective abrasive tool 24 with the respective first flank T1 of the slab-shaped element T.

[0075] The optical group 25 is for example secured, for example adjustably, to the respective side wall 211 so as to view the contact area between the abrasive tool 24 and the first flank T1 of the slab-shaped element T.

[0076] For example, the optical group 25 is arranged above the respective abrasive tool 24 so as to have a view from above of the contact area between the first flank T1 of the slab-shaped element T and the abrasive tool 24, preferably in a gap defined between the side wall 211 and the rectifying wheel 240.

[0077] The optical group 25 is for example vertically aligned with a portion of the respective rectifying wheel 240, for example with a front portion thereof, i.e. proximal to the inlet segment of the moving group 22.

[0078] In detail, the optical group 25 looks downwards and defines an optical field, for example a visual cone, with substantially vertical optical axis.

[0079] Each optical axis, in particular, is juxtaposed in plan over an area of the first squaring machine 20 interposed between the lower flexible member 221 and the respective rectifying wheel 240.

[0080] For example, along the longitudinal direction of the first squaring machine 20, i.e. along the feed direction C imparted by the moving group 22, each optical axis is adapted for intercepting the travel path of the respective abrasive tool 24 (i.e. of the respective rectifying wheel 240), for example at a position (along the feed direction C) of least wearing of the rectifying wheel 240.

[0081] It has been observed that the position of least wearing of each rectifying wheel 240 is, with the use of annular grindstones, arranged at the inner perimeter of the rectifying wheel itself.

[0082] The position of least wearing of each rectifying wheel 240 corresponds to an area of greatest thickness of the rectifying wheel 240 (along the travel path) and, therefore, defines an area (or anterior front) of the rectifying wheel 240 closest to the first flank T1 of the slab-shaped element T to be worked.

[0083] In particular, the first squaring machine 20 comprises an optical group 25 for each abrasive tool 24, for example each supported by a respective side wall 211 of the base frame 21.

[0084] Each optical group 25 is for example equipped with an illuminator 250, for example by LED, configured to illuminate the visual space of the optical group 25 (or a portion thereof) with a light, for example a continuous light (for example of lower intensity than the intensity of the spark arising from the rubbing contact between the abrasive tool and the flank of the slab-shaped element being processed).

[0085] The illuminator 250 is for example secured to the optical group 25 or is for example firmly connected to it.

[0086] The illuminator 250 is for example adapted for illuminating the optical field of the respective optical group 25, for example the contact area between the abrasive tool 24 and the respective first flank T1 of the slab-shaped element T.

[0087] Each optical group 25 is movable, by virtue of the movement of the respective side wall 211, towards/away from the moving plane M, i.e. it can be set in translation along a direction of translation parallel to the sliding direction B. Advantageously, the optical group 25 is a video camera (for example a micro video camera) and/or a photographic camera.

[0088] The first squaring machine 20 also comprises a reference body 27 arranged in proximity of each abrasive tool 24, preferably in proximity to the contact area of the respective abrasive tool 24 with the respective first flank T1 of the slab-shaped element T.

[0089] The reference body 27 is for example secured, for example adjustably, to the respective side wall 211 so as to (at least partially) enter into the visual field of the respective optical group 25.

[0090] For example, the reference body 27 is arranged below the respective abrasive tool 24, preferably at the gap defined between the side wall 211 and the rectifying wheel 240.

[0091] The reference body 27 is for example vertically aligned with respect to the respective optical group 25, i.e. the optical axis of the respective optical group 25 intercepts such a reference body 27.

[0092] Each reference body 27, in particular, is vertically aligned with the respective area of the first squaring machine 20 interposed between the lower flexible member 221 and the respective rectifying wheel 240.

[0093] In practice, each reference body 27 is arranged on the travel path of the respective abrasive tool 24, in the sense that the abrasive tool itself, i.e. the rectifying wheel 240, is at least partially juxtaposed in plan over at least one position of the reference body 27 during its stroke along the travel path from the distal position to any proximal position (or work point).

[0094] In practice, at least one portion of each abrasive tool 24, i.e. of rectifying wheel 240, is adapted for being interposed (vertically or in any case with respect to the direction of the optical axis) between the respective optical group 25 and the respective reference body 27 during the movement of the same abrasive tool 24 along the travel path thereof.

[0095] Advantageously, the reference body 27 defines an upper surface adapted for being intercepted by the optical axis of the respective optical group 25, wherein for example such an upper surface is substantially planar and arranged substantially horizontal, i.e. orthogonal to the optical axis.

[0096] The colour of each reference body 27 is, preferably, a different and contrasting colour for the respective optical group 25 that frames it with respect to the colour of the respective abrasive tool 24, i.e. of the respective rectifying wheel 240.

[0097] For example, the reference body 27 is substantially white (or light in general) whereas the rectifying wheel 240 appears substantially dark (for example dark grey or black) to the optical group 25.

[0098] The reference body 27 is for example made from or coated with (in its upper surface) an abrasion-resistant material, for example a ceramic material, like alumina or corundum or similar.

[0099] Each optical group 25 is configured to detect a respective image 11 or sequence of images I1 of the respective optical field.

[0100] At least one image I1 includes a representation of at least one portion of the reference body 27, at least one portion of the abrasive tool 24 (i.e. of the rectifying wheel 240, for example of its area of greatest thickness).

[0101] In the example, each optical group 25 can be connected, for example cabled, to a microcontroller 26 that receives the images I1 detected by the respective optical group 25.

[0102] For example, the system 10 and/or the first squaring 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.

[0103] The system 10 and/or the first squaring machine 20 comprises an electronic control unit 30, for example equipped with a memory and with a calculator, operationally connected to each optical group 25 of the first squaring machine 20 (directly or through the microcontroller 26).

[0104] The microcontrollers could not be provided, in which case it is possible to connect all of the optical groups 25 to the single electronic central control unit 30 passing for example through switches in the case of ethernet communication.

[0105] For example, the electronic control unit 30 is connected to each optical group 25 and/or microcontroller 26 of the first squaring machine 20.

[0106] The electronic control unit 30 is also operationally connected to each second motor 243 of each abrasive tool 24 (or to the control system that controls the position of the spindles supporting each abrasive tool 24) to individually control the movement thereof along the respective travel path.

[0107] In general, the electronic control unit 30 is configured to receive and analyse the image I1 and/or the sequence of images I1 generated by each optical group 25 individually.

[0108] Advantageously, with particular reference to figures 7a and 7b, the electronic control unit 30, for each abrasive tool 24 and each optical group 25 individually, is configured to predetermine a first reference point Ref1 arranged on the respective reference body 27, wherein the first reference point Ref1 is interposed between the area of greatest thickness of the rectifying wheel 240 and the distal position of the rectifying wheel itself along the travel path of the abrasive tool 24.

[0109] The first reference point Ref1, when the abrasive tool 24 is arranged in its distal position, is a point visible by the optical group 25, i.e. it is reproduced in the image 11. In other words the first reference point Ref1 is uncovered (not covered) by the rectifying wheel 240 (i.e. vertically offset with respect to it).

[0110] In practice, the first reference point Ref1, when the abrasive tool 24 is arranged in its distal position, is a point having the colour (white) of the reference body 27.

[0111] The first reference point Ref1 can for example be a fixed pixel (or a plurality of fixed pixels) of the image I1 (or of the sequence of images I1).

[0112] The electronic control unit 30, for each abrasive tool 24 and each optical group 25 individually, is then configured to control, through the second motor 243, the movement of the abrasive tool 24 along the respective travel path from the distal position towards the proximal position.

[0113] During the movement of the abrasive tool 24, the electronic control unit 30 is configured to monitor the colour of the first reference point Ref1.

[0114] In detail, during movement of the abrasive tool 24 the electronic control unit 30 is configured to signal a reference position for the abrasive tool 24, at the first reference point Ref1, when the abrasive tool 24 visually covers the first reference point Ref1, i.e. when the colour of the first reference point Ref1 passes from the colour (white) of the reference body 27 to the colour (black/dark) of the rectifying wheel 240.

[0115] In practice, for each abrasive tool 24 a fixed reference (or zero) position is defined, for example at an intermediate position between the distal position and the proximal position along the travel path.

[0116] The reference position precisely defines the position of the area of greatest thickness of the rectifying wheel 240 (so-called anterior front of the rectifying wheel 240) along the travel path and thus makes it possible to precisely define the contact point between the rectifying wheel 240 and the first flank T1 of the slab-shaped element T to be worked.

[0117] Indeed, once the reference position of the respective abrasive tool has been determined, the electronic control unit 30 is configured to control the movement of each abrasive tool 24 individually along the respective travel path from the reference position to the predetermined proximal position being able to precisely determine with how many pulses (angles of rotation) to control the second motor 243 to advance the rectifying wheel 240 up to the predetermined work point thereof.

[0118] Alternatively or additionally, it is possible to foresee for the electronic control unit 30 to be able to be configured to dynamically check that the area of greatest thickness (anterior front) of the rectifying spring 240 is always at a predetermined work point, i.e. a desired contact point between each rectifying wheel 240 and the first flank T1 of the slab-shaped element T to be worked.

[0119] Advantageously, with particular reference to figures 8a and 8b, the electronic control unit 30, for each abrasive tool 24 and each optical group 25 individually, is configured to predetermine a second reference point Ref2 arranged on the respective reference body 27, wherein the second reference point Ref2 is at the intersection between the area of greatest thickness of the rectifying wheel 240 and the proximal position of the rectifying wheel itself along the travel path of the abrasive tool 24, in practice corresponding to the proximal position of the rectifying wheel 240 in the most advanced point of the rectifying wheel 240 along the travel path thereof.

[0120] The second reference point Ref2, when the abrasive tool 24 is arranged in its proximal position, is a point not visible by the optical group 25, i.e. it is not reproduced in the image 11. In other words the second reference point Ref2 is covered by the rectifying wheel 240 (i.e. aligned in plan with respect to it).

[0121] In practice, the second reference point Ref2, when the abrasive tool 24 is arranged in its proximal position, is a point having the colour (black/dark) of the rectifying wheel 240.

[0122] Conversely, when the abrasive tool 24 is in any position different from the proximal position (of correct contact between the abrasive tool and the first flank T1 of the slab-shaped element T), the second reference point Ref2 is a point having the colour (white) of the reference body 27, i.e. it is uncovered (i.e. vertically offset with respect to it) and visible by the relative optical group 25.

[0123] The second reference point Ref2 can for example be a fixed pixel (or a plurality of fixed pixels) of the image I1 (or of the sequence of images I1).

[0124] The electronic control unit 30, for each abrasive tool 24 and each optical group 25 individually, is also configured, having previously controlled the positioning of the abrasive tool 24 along the respective travel path in the proximal position through the second motor 243, to maintain the abrasive tool 24 firm in its proximal position.

[0125] With the abrasive tool 24 in such a proximal position (i.e. with the second motor 243 inactive) the abrasive tool 24 can be set in rotation by the first motor 241 to perform the processing thereof on the first flank T1 of the slab-shaped elements T that progressively transit on the belt conveyor 220.

[0126] During such a (work and) parking step of the abrasive tool 24 in the proximal position, the electronic control unit 30 is configured to monitor the colour of the second reference point Ref2, for example in the range between a slab-shaped element T and the next one in the advancing sequence of various slab-shaped elements T along the feed direction C.

[0127] In detail, during such a (work and) parking step of the abrasive tool 24 the electronic control unit 30 is configured to signal a first position error of the abrasive tool 24, when the abrasive tool 24 visually uncovers the second reference point Ref2, i.e. when the colour of the second reference point Ref2 passes from the colour (black/dark) of the rectifying wheel 240 to the colour (white) of the reference body 27.

[0128] In practice, after the wearing u of the anterior front of the rectifying wheel 240 such an anterior front (with rectifying wheel 240 firmly along the travel path thereof) reverses along the travel path uncovering the second reference point 27 that becomes visible by the optical group 25.

[0129] Once the first position error has been signalled, the electronic control unit 30 can be configured to correct, instantaneously, such a first position error of the abrasive tool 24.

[0130] In practice, in order to correct such a first position error of the abrasive tool 24 the electronic control unit 30 can be configured to control the movement of the abrasive tool 24 along the travel path thereof from the distal position towards the proximal position until the respective abrasive tool 24 again visually covers the second reference point Ref2, i.e. until the colour (white) of the second reference point Ref2 goes back to the colour (dark/black) characteristic of the covering thereof by the overlying rectifying wheel 240. Furthermore, the electronic control unit 30 can be configured to calculate the residual thickness of each abrasive tool 24, i.e. of each rectifying wheel 240, after a wearing u thereof.

[0131] For example, by exploiting the identification of the first reference point Ref 1 or of the second reference point Ref2 of each reference body 27 it is possible to calculate the residual thickness of each abrasive tool 24.

[0132] For example, the electronic control unit 30, for each abrasive tool 24 and each optical group 25 individually, is configured to control, through the second motor 243, the movement of the abrasive tool 24 along the respective travel path from the distal position, towards the proximal position, up to the reference position identified by the first reference point Ref1 (i.e. when the anterior front of the rectifying wheel 240 reaches the first reference point Ref1).

[0133] In any case, the electronic control unit 30 is configured to measure the linear travel of the abrasive tool 24 between the distal position and the first reference point Ref1.

[0134] In particular, the electronic control unit 30 is configured to repeat the measurement of the linear travel of the abrasive tool 24 for example cyclically. Advantageously, the electronic control unit 30 can be configured to carry out the measurements when the transiting slab-shaped element T does not appear (at all) in the image 11, thus either during a "gap" of the line or between one slab-shaped element T and the next one in the advancing sequence of various slab-shaped elements T along the feed direction C.

[0135] For example, it is possible for a first measurement of the linear travel to take place when the abrasive tool 24 is substantially still unused (new) and a second measurement is carried out after a certain usage time of the abrasive tool 24.

[0136] The electronic control unit 30 is thus configured to calculate the wearing of the abrasive tool 24 as the difference between the second measurement and the first measurement.

[0137] The electronic control unit 30 is also further configured to calculate the residual thickness of the abrasive tool 24 as the difference between the thickness of the abrasive tool 24 before use (new) and the calculated wear of the abrasive tool 24.

[0138] This does not rule out the possibility that the stroke of the abrasive tool 24 can take place, alternatively, between any two reference points that can be predetermined along the travel path of the abrasive tool 24 itself and that the calculation of the residual thickness (and of the wearing) can be based on such a stroke.

[0139] According to a further way of operating, the electronic control unit 30 can be configured to analyse and possibly recover the position error of the abrasive tool 24 due to the thermal expansion d (see figure 9a) thereof, for example due to the heating thereof during use.

[0140] In particular, the electronic control unit 30, for each abrasive tool 24, is configured to carry out, for example after a certain usage time of the abrasive tool 24 itself, a control cycle of the correct position of the abrasive tool 24 during use thereof.

[0141] Such a control cycle is aimed at verifying whether, after the positioning of the abrasive tool 24 at the second reference point Ref2 (work point), carried out as described above, for example positioning having taken place with abrasive tool 24 (i.e. rectifying wheel 240) substantially at room temperature (or in any case cold), the heating of the abrasive tool 24 has or has not caused an expansion thereof (of the rectifying wheel 240) such as to affect the correct and desired removal of material from the first flank T1 of the slab-shaped element T.

[0142] In particular, a thermal expansion of the abrasive tool 24 results in the travel of the anterior front of the rectifying wheel 240 forwards with respect to the second reference point Ref2, i.e. projecting more towards the slab-shaped element T, and thus generates a greater removal of material with respect to what is wanted.

[0143] With particular reference to figures 9a and 9b, the control cycle provides, for example, the step of determining, for each abrasive tool 24 and each optical group 25 individually, a third reference point Ref3 arranged on the respective reference body 27, wherein the third reference point Ref23 is more advanced with respect to the second reference point Ref2 (or to the first reference point Ref1) along the travel path of the abrasive tool 24 in the feed direction from the distal position to the proximal position.

[0144] The third reference point Ref3 is a predetermined distance away from the second reference point Ref2, for example a function of the expansion coefficient of the material from which the rectifying wheel 240 is made.

[0145] The third reference point Ref3, when the abrasive tool 24 is arranged in its distal position and at room temperature (cold), is a point visible by the optical group 25, i.e. it is reproduced in the image 11. In other words the third reference point Ref2 is uncovered by the rectifying wheel 240 (i.e. vertically offset with respect to it).

[0146] In practice, the second reference point Ref2, when the abrasive tool 24 is arranged in its distal position and at room temperature (cold), is a point having the colour (white) of the reference body 27.

[0147] Conversely, the third reference point Ref3, when the abrasive tool 24 (hot) is arranged in its distal position and at a greater usage temperature than room temperature (due to the heating by friction with the first flank T1 of the slab-shaped element T), is a point not visible by the optical group 25, i.e. it is not reproduced in the image 11. In other words, the third reference point Ref3 is covered by the hot rectifying wheel 240 (i.e. vertically aligned with respect to it).

[0148] In practice, the third reference point Ref3, when the abrasive tool 24 is arranged in its distal position and at the usage temperature greater than room temperature, is a point having the colour (black/dark) of the rectifying wheel 240.

[0149] The third reference point Ref3 can for example be a fixed pixel (or a plurality of fixed pixels) of the image I1 (or of the sequence of images 11).

[0150] The electronic control unit 30, for each abrasive tool 24 and each optical group 25 individually and maintaining the abrasive tool 24 firm along the respective travel path in its previously set proximal position, is configured to monitor the colour of the third reference point Ref3, for example in the range between one slab-shaped element T and the next one.

[0151] In detail, during such parking of the abrasive tool 24 the electronic control unit 30 is configured to signal a second position error of the abrasive tool 24, if and when the abrasive tool 24 visually covers the third reference point Ref3, i.e. if the colour of the third reference point Ref3 is/becomes equal to the colour (dark/black) of the rectifying wheel 240.

[0152] Once the second position error has been signalled, the electronic control unit 30 can be configured to compensate for/correct, instantaneously, such a second position error of the abrasive tool 24.

[0153] In practice, in order to correct such a second position error of the abrasive tool 24 the electronic control unit 30 can be configured to control the movement of the abrasive tool 24 individually along the travel path thereof from the distal position towards the proximal position, for example by a predetermined distance greater than the distance between the second reference point Ref2 and the third reference point Ref3.

[0154] In this way, the front of the rectifying wheel 240 is reversed behind the second reference point Ref2.

[0155] At this point, the electronic control unit 30 can be configured to control the movement of the abrasive tool 24 individually along the travel path thereof from the proximal position towards the distal position until, as described above, the front of the rectifying wheel 240 covers the second reference point Ref2 (leaving the third reference point Ref2 uncovered) being positioned in the correct work point.

[0156] The system 10 and/or the first squaring machine 20 can comprise a signalling user interface 35, which is operationally connected (for example in wireless mode) to the electronic control unit 30 for the emission of one or more perceivable signals, for example of the visible and/or sound type, by a user when the electronic control unit 30 generates the error signal S.

[0157] For example, the user interface 35 could be defined by a PC with monitor and, for example, be secured to the base frame 21 of the first squaring machine 20 or positioned remotely or be of the movable device type.

[0158] In the user interface 35 it is possible to provide one or more of the following pieces of information, including: the image I1 (*real time* and/or in *slow motion*) relative to each abrasive tool and/or an enlarged window relative to the respective reference points (first reference point Ref1, second reference point Ref2 and/or third reference point Ref3) and/or one or more error signals (first error signal and/or second error signal) and anything else useful for the visual control of the processing steps of the single abrasive tools 24.

[0159] For example, the system 10 can also comprise a second squaring machine 20, arranged downstream of the first squaring machine 20 in the advancing direction of the slab-shaped elements T, which for example is adapted for performing a rectifying and/or bevelling operation on the two second flanks T2 of the slab-shaped element T (orthogonal to the first flanks T1).

[0160] The second squaring machine 20 arranged downstream is totally analogous, if not identical, to the first squaring machine 20 arranged upstream, and therefore for the sake of brevity the structure thereof will not be described again, but refer to the description given above for the first squaring machine 20 with the sole difference that the flanks worked by this second squaring machine 20 are the second flanks T2 of the slab-shaped element T.

[0161] The second squaring machine 20 is operationally connected, like the first squaring machine 20, to the same electronic control unit 30 described above or to an equally programmed respective electronic control unit 30.

[0162] Between the first and the second squaring machine 20, for example immediately upstream of the second squaring machine 20 in the advancing direction of the slab-shaped elements T along the feed direction C thereof, a thrusting group 46 is associated, which is configured to exert a rear thrust on the slab-shaped element T entering the second squaring machine 20, for example in simultaneous actuation with the centring group 23 for the square positioning of the slab-shaped element T.

[0163] For example, the thrusting group 46 is adapted for positioning the slab-shaped element T on the moving plane M of the second squaring machine 20 so as to compensate for possible errors encountered in the difference between the diagonals of the same piece exiting the first squaring machine 20. The thrusting group 46 comprises a first thruster 461 and a second thruster 462, which are movable alternately, and independently, along the feed direction C and are adapted for making contact and thrusting (at a greater speed than the advancing speed of the slab-shaped elements T on the moving plane M) the rear first flank T1 in the advancing direction of the slab-shaped element T along the feed direction C of the slab-shaped element T entering the second squaring machine 20.

[0164] In practice, the first thruster 461 and the second thruster 462, i.e. their resting surface at the first flank T1, define a thrusting plane that is inclinable (according to the offsetting of the first thruster 461 with respect to the second thruster 462 in the feed direction C) with respect to a plane orthogonal to the feed direction C of the slab-shaped element T for the adjustment of the inclination of the rear side with respect to the plane orthogonal to the feed direction itself.

[0165] In particular, the thrusting group 46 comprises a first actuator 463 associated with the first thruster 461 and configured to operate the first thruster 461 in translation, along the feed direction C, and a second actuator 464 associated with the second thruster 462, for example independent from the first thruster 461, and configured to operate the second thruster 462 in translation, along the feed direction C.

[0166] Advantageously, the thrusting group 46, and in particular the first actuator 463 and the second actuator 464, are operationally connected to a control unit, which is configured to control the advancing of the first thruster 461 and of the second thruster 462 for the mutual positioning and the translation along the feed direction C (in synchrony with the actuation of the centring group 23).

[0167] Between the first squaring machine 20 and the second squaring machine 20, for example upstream of the thrusting group 46 in the advancing direction of the slab-shaped elements T imparted by the moving planes M of the respective squaring machines 20, the system 10 can comprise a rotation group 50, also called swivel nut, adapted for rotating the slab-shaped element T, for example by 90° with respect to a vertical rotation axis (orthogonal to the moving plane M), so that the second flanks T2 go into a position parallel with the feed direction C of the second squaring machine along the moving plane M. The rotation group 50 comprises, for example, a pair of belts 51 closed on themselves in a loop and respectively wound on a driving pulley, connected to a respective actuation motor 52, and a driven pulley.

[0168] The upper branch of the belts 51 defines a resting and moving plane for the slab-shaped element T, for the movement of the slab-shaped element T along a feed direction C, which can coincide with the feed direction C set by the moving plane M (of the first squaring machine 20 and/or of the second squaring machine 20).

[0169] The actuation motors 52 of each belt 51 can be operated independently from one another.

[0170] In particular, the mutual rotation speed of the two actuation motors 52 can be changed between a first configuration, in which the two actuation motors 52 are synchronous, i.e. they rotate the respective driving pulley at the same speed, and a second configuration in which the two actuation motors are asynchronous, i.e. they rotate the respective driving pulley at different speeds (for example also one in one direction of rotation and the other in another direction of rotation).

[0171] By actuating the actuation motors 52 in the second configuration, for a settable brief period, when the slab-shaped element T rests on the belts 51 the slab-shaped element T is rotated by 90° remaining substantially horizontal and in fact taking the second flanks T2 parallel to the feed direction C, so as to be able to be fed to the second squaring machine 20 for the rectification of the second flanks T2 themselves.

[0172] In light of what is described above, the operation of the system 10 is as follows.

[0173] The side walls 210 of the first squaring machine 20 are arranged a distance apart such as to define a moving plane M adapted for supporting, as described above, the slab-shaped elements T with the first flanks T1 parallel to the feed direction C.

[0174] Thanks to such an arrangement of the side walls 210 the optical groups 25 are also positioned in the optimal position for the reading and scanning of the contact area between the first flanks T1 of the slab-shaped elements T and each of the abrasive tools 24.

[0175] The slab-shaped elements T are arranged resting on the moving plane M of the first squaring machine 20 with a surface thereof (lower or not visible) in contact with the moving plane M itself and an opposite surface (upper or visible) to be worked facing upwards.

[0176] Once a slab-shaped element T rests on the upstream end, in the advancing direction of the slab-shaped elements T along the feed direction C imparted by the moving group 22, of the lower flexible members 221 of the first squaring machine 20 it is centred by the centring group 23 and, thus centred, wedges between the lower flexible members 221 and the upper flexible members 225 and, thus held, is transported by them along the feed direction C.

[0177] As the slab-shaped elements T progressively advance along the feed direction C on the moving plane M of the first squaring machine 20, the first flanks T1 are intercepted by the abrasive tools 24, i.e. by the rectifying grindstones 240, which level and rectify the surface and/or make the bevelling thereof along a predetermined removal cone.

[0178] Each optical group 25 captures the relative image I1 or sequence of images I1 of the respective optical field during the operation of the first squaring machine 20.

[0179] The electronic control unit 30, as stated above, processes each image I1 or sequence of images I1 and intervenes on the positioning of the abrasive tools 24 as described above.

[0180] The slab-shaped elements T that come out from the first squaring machine 20 advancing along the feed direction C are rotated by the rotation group 50 and, once centred through the centring group 23 of the second squaring machine and thrusted by the thrusting group 46, wedge between the lower flexible members 221 and the upper flexible members 225 of the moving group 22 of the second squaring machine 420 for transportation along the feed direction C.

[0181] As the slab-shaped elements T progressively advance along the feed direction C on the moving plane M of the second squaring machine 20 the second flanks T2 are intercepted by the abrasive tools 24, i.e. by the rectifying grindstones 240, which level and rectify the surface thereof and/or carry out the bevelling thereof according to a predetermined removal cone.

[0182] The electronic control unit 30, as stated, processes each image I1 and/or sequence of images I1 relative to each optical group 25 of the second squaring machine 20 as done for the first squaring machine 20 and intervenes on the positioning of the abrasive tools 24 as described above.

[0183] Thanks to the solution described above it is possible to proceed to the step of equipping each squaring machine in a simple, fast and automated or semi-automated manner and irrespective of the experience of whoever is in charge of the rectification.

[0184] Thanks to the solution described above it is also possible to have a control and recovery system of the wearing of the single abrasive tool and repositioning system of the worn abrasive tool in the correct work position as well as taking into consideration possible errors caused by the thermal expansion of the abrasive tool during use thereof.

[0185] The invention thus conceived can undergo numerous modifications and variants all of which are encompassed by the inventive concept.

[0186] Moreover, all of the details can be replaced by other technically equivalent elements.

[0187] In practice, the materials used, as well as the contingent shapes and sizes, can be whatever according to the requirements without for this reason departing from the scope of protection of the following claims.

Claims

1. A squaring machine (20) intended for slab-shaped elements (T) comprising:

- a frame (21) defining a horizontal resting and moving plane (M) which comprises a moving group (22) to advance the slab-shaped elements (T) supported by the moving plane (M) along a predetermined feed direction (C);
- a plurality of abrasive tools (24) supported by the frame (21) and each being individually movable, following a travel path orthogonal to the feed direction (C), between a distal position from the slab-shaped element (T) supported by the moving plane (M) and a proximal position, wherein the abrasive tool (24) is adapted to come into contact with a surface (T1 ,T2) of the slab-shaped element (T);
- a plurality of optical groups (25) individually secured to the frame (21), wherein each optical group (25) is arranged in proximity to a respective abrasive tool (24) so that at least one portion of the respective abrasive tool (24) along at least one segment of the travel path thereof is arranged inside a visual field of the respective optical group (25), and
- a plurality of reference bodies (27), wherein each reference body (27) is secured to the frame (21), is arranged along the travel path of a respective abrasive tool (24) and within a visual field of the respective optical group (25), such that at least one portion of each abrasive tool (24) is adapted to be interposed between the respective optical group (25) and the respective reference body (27) during the movement of the abrasive tool (24) along its travel path.

2. The squaring machine (20) according to claim 1, wherein the colour of each reference body (27) is a different and contrasting colour for the optical group (25,45) with respect to the colour of the respective abrasive tool (24).

3. The squaring machine (20) according to claim 1, **characterised in that** it comprises an electronic control unit (30) operationally connected to each optical group (25) and to each abrasive tool (24).

4. The squaring machine (20) according to claim 3, wherein, for each abrasive tool (24) and respective optical group (25) individually, the electronic control unit (30) is configured for:

- controlling the movement of the abrasive tool (24) along the respective travel path from the distal position towards the proximal position; and
- signalling a reference position of the abrasive tool (24) when the abrasive tool visually covers a predetermined first reference point (Ref1) arranged on the respective reference body.

5. The squaring machine (20) according to claim 3, wherein, for each abrasive tool (24) and respective optical group (25) individually, the electronic control unit (30) is configured for:

- maintaining the abrasive tool (24) firmly along the respective travel path in the proximal position thereof; and
- signalling a first position error of an abrasive tool (24) when the abrasive tool visually uncovers a predetermined second reference point (Ref2) arranged on the reference body corresponding to the proximal position of the abrasive tool (24).

6. The squaring machine (20) according to claim 5, wherein, for each abrasive tool (24) and respective optical group (25) individually, the electronic control unit (30) is configured for:

- correcting the first position error of the abrasive tool by controlling the movement of the abrasive tool (24) along the travel path thereof from the distal position towards the proximal position until the respective abrasive tool (24) again visually covers the second reference point (Ref2).

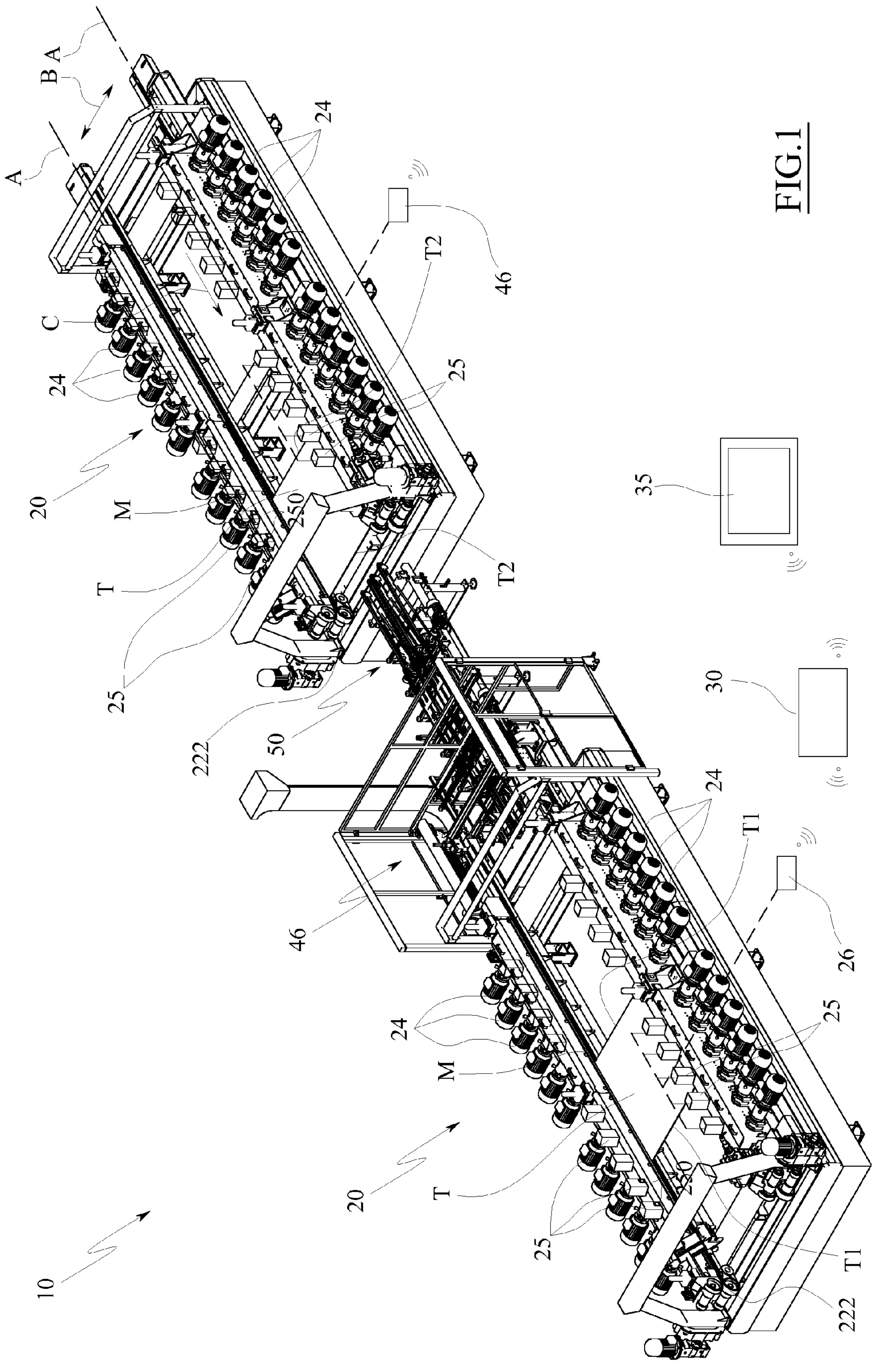
7. The squaring machine (20) according to claim 3, wherein, for each abrasive tool (24) and respective optical group (25) individually, the electronic control unit (30) is configured for:

- controlling the movement of the abrasive tool (24) along the travel path thereof from the distal position to an intermediate position between the distal position and the proximal position; and
- calculating a residual thickness of the respective abrasive tool (24) based on a measured travel of the abrasive tool (24) along the travel path thereof from the distal position to the intermediate position.

8. The squaring machine (20) according to claim 5, wherein, for each abrasive tool (24) and respective optical group (25) individually, the electronic control unit (30) is configured for:

- performing a control cycle of the correct position of the abrasive tool (24) during use of the same, wherein the control cycle provides the steps of:

  ◦ signalling a second position error of the abrasive tool (24) when the abrasive tool (24) covers a predetermined third reference point (Ref3) of the reference body further forward with respect to the second reference point (Ref2) along the travel path from the distal position to the proximal position; and
  ◦ controlling the movement of the abrasive tool (24) individually along the travel path thereof from the proximal position towards the distal position so as to compensate for and correct the second position error.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T2
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T1
222
10

FIG.1

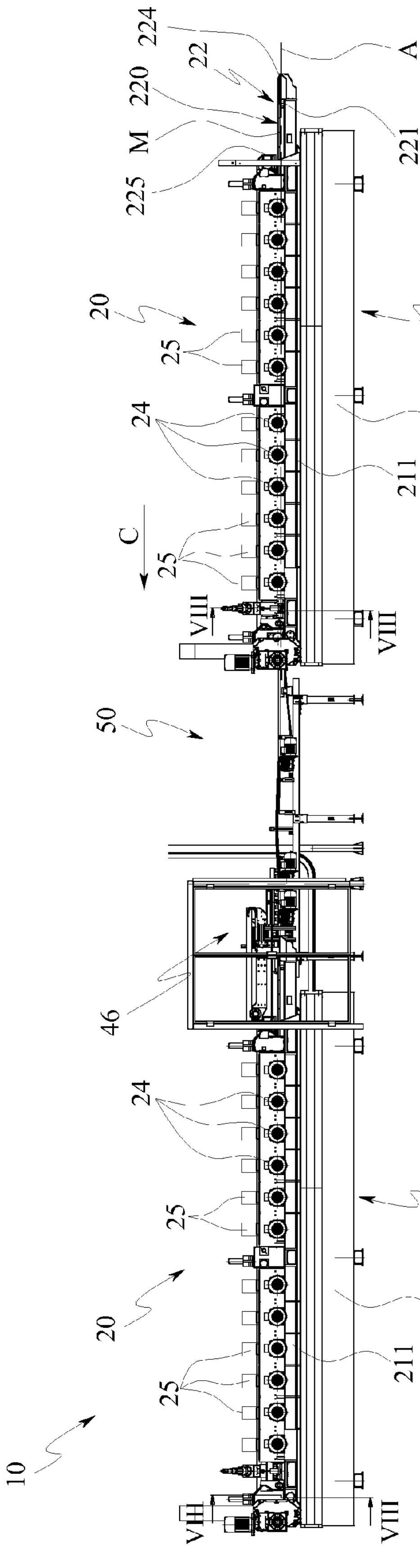


FIG.2

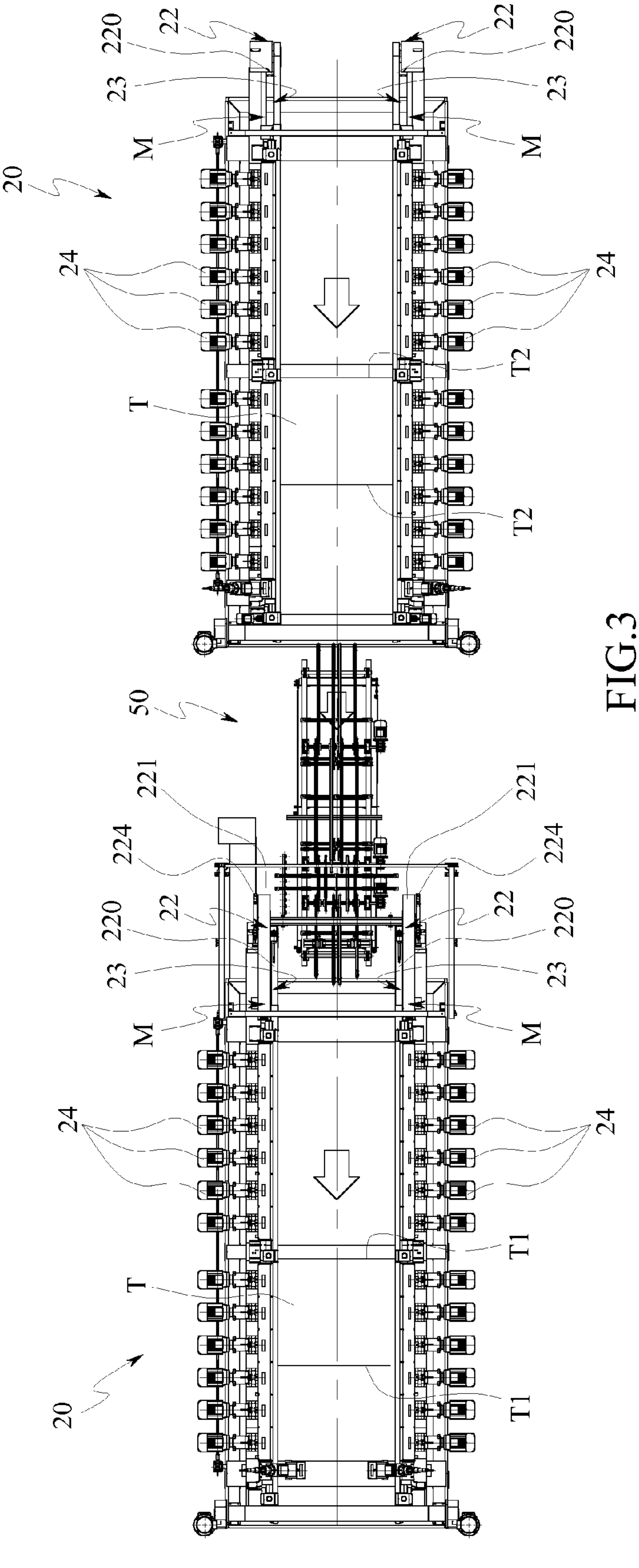


FIG.3

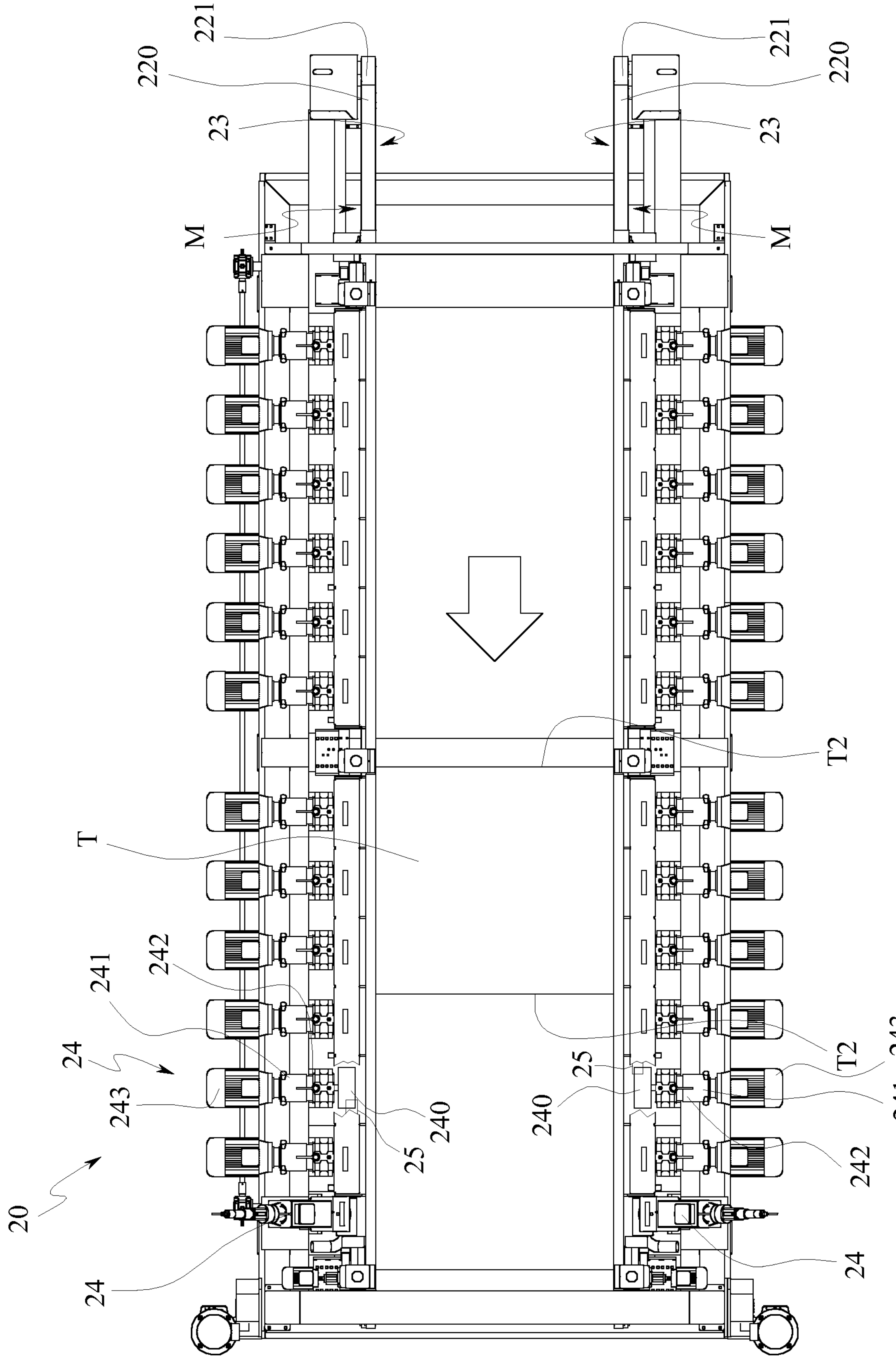


FIG.4

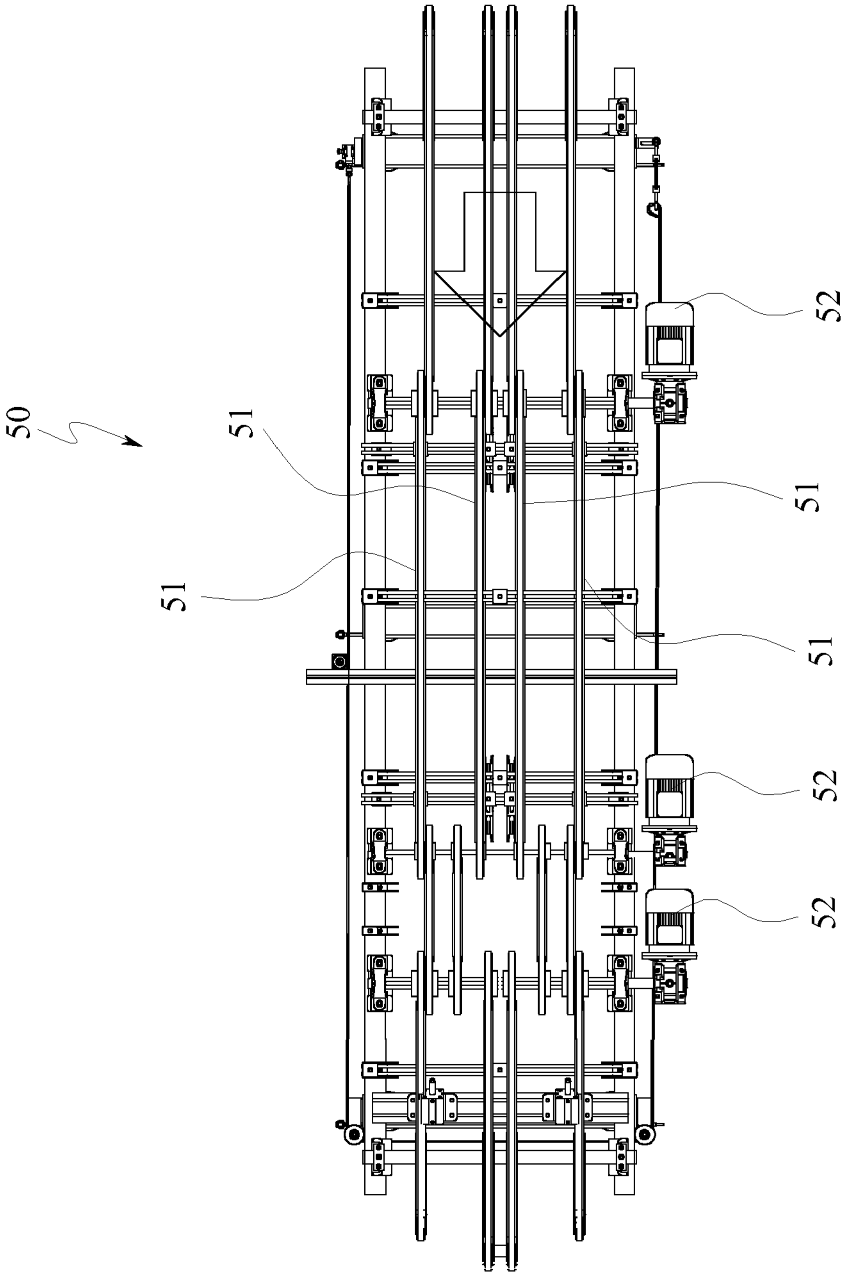
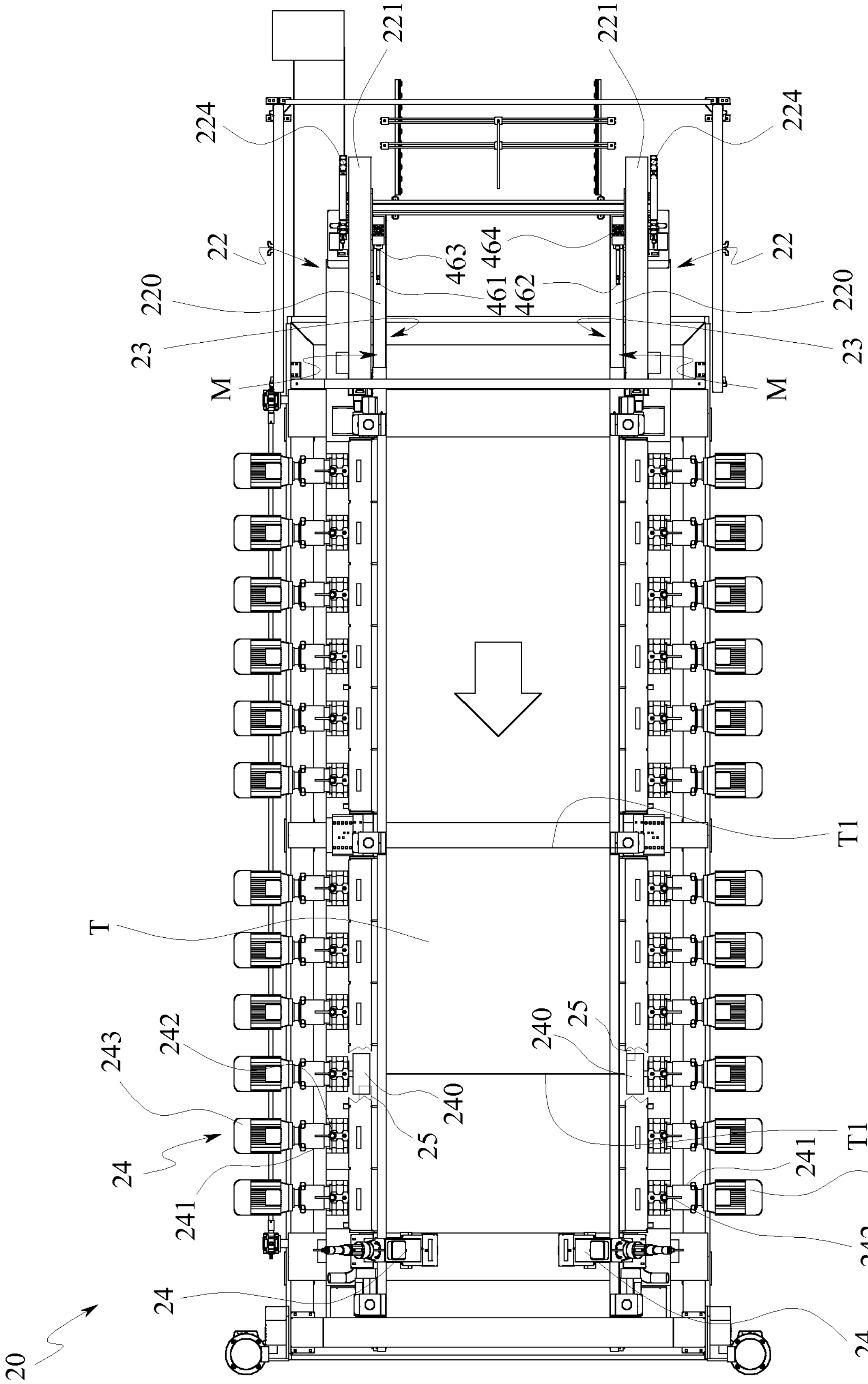


FIG.5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20

FIG.6

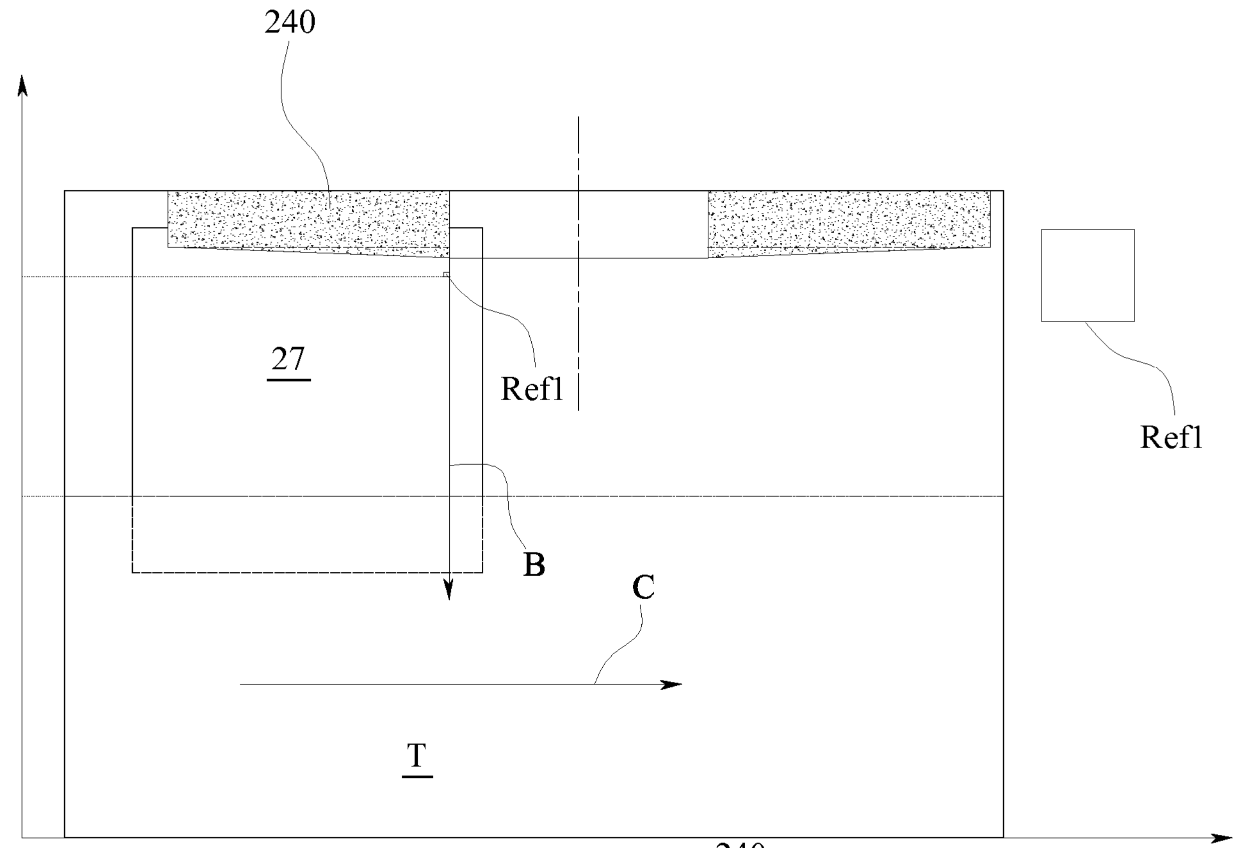

FIG.7a

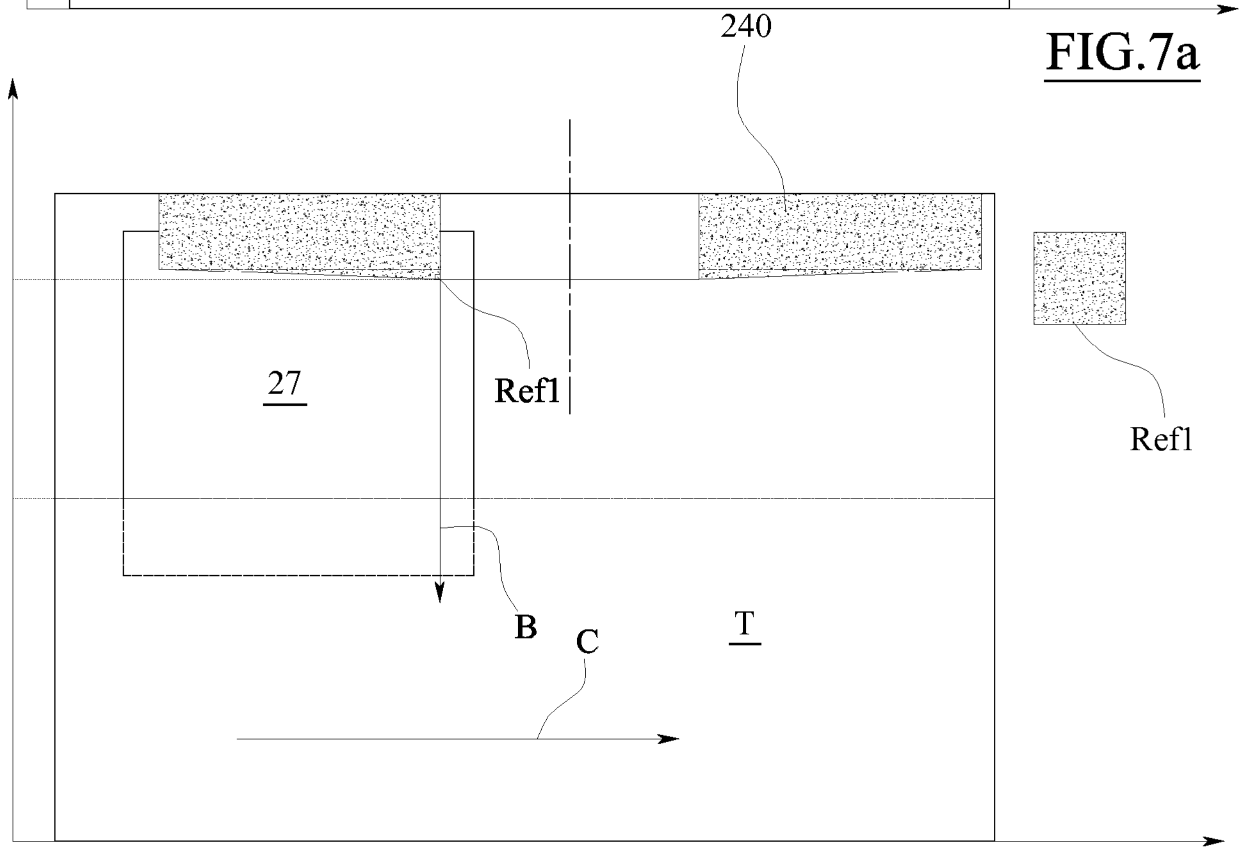

FIG.7b

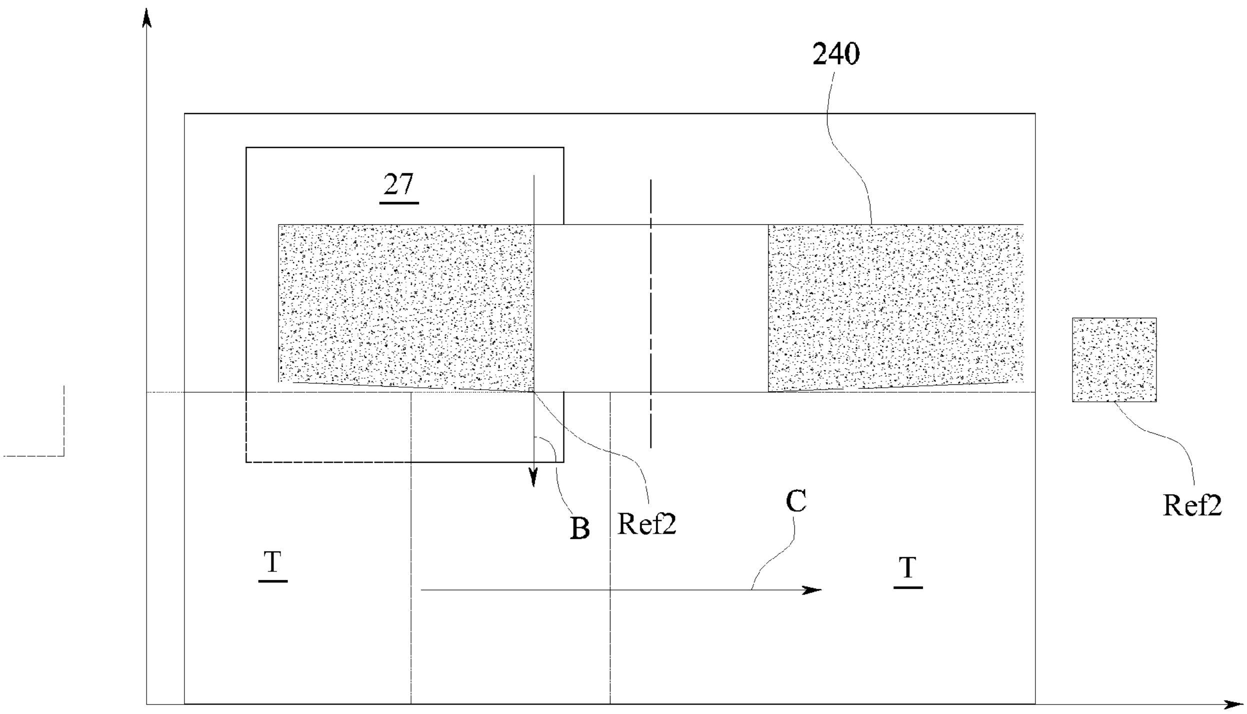

FIG.8a

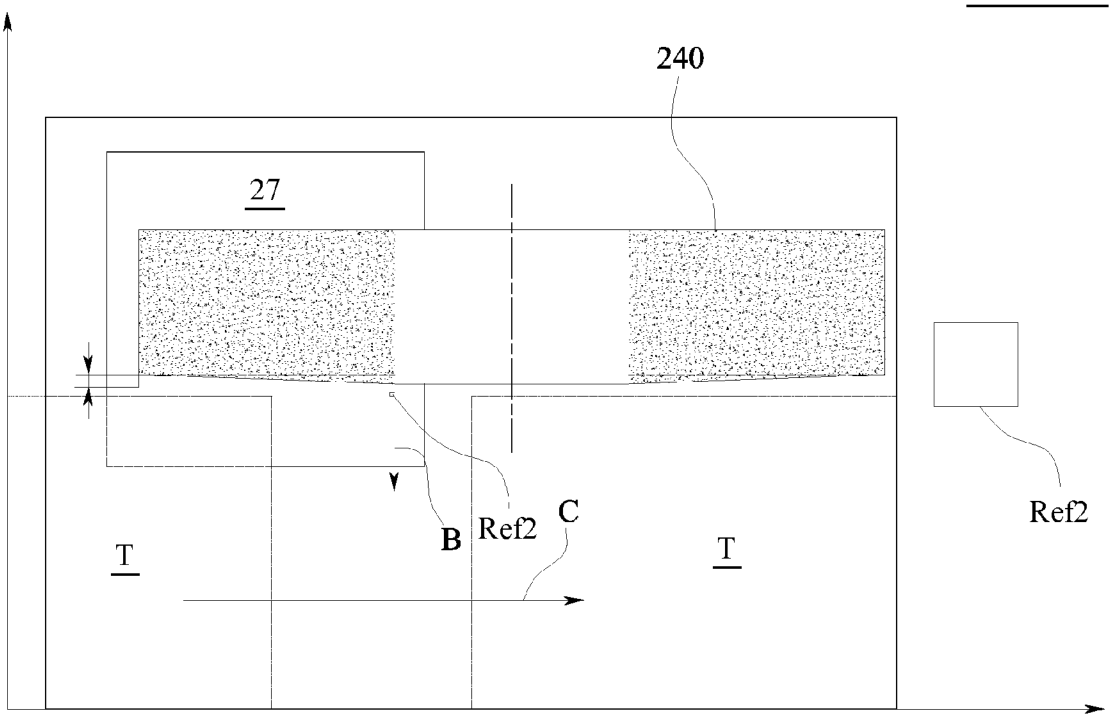

FIG.8b

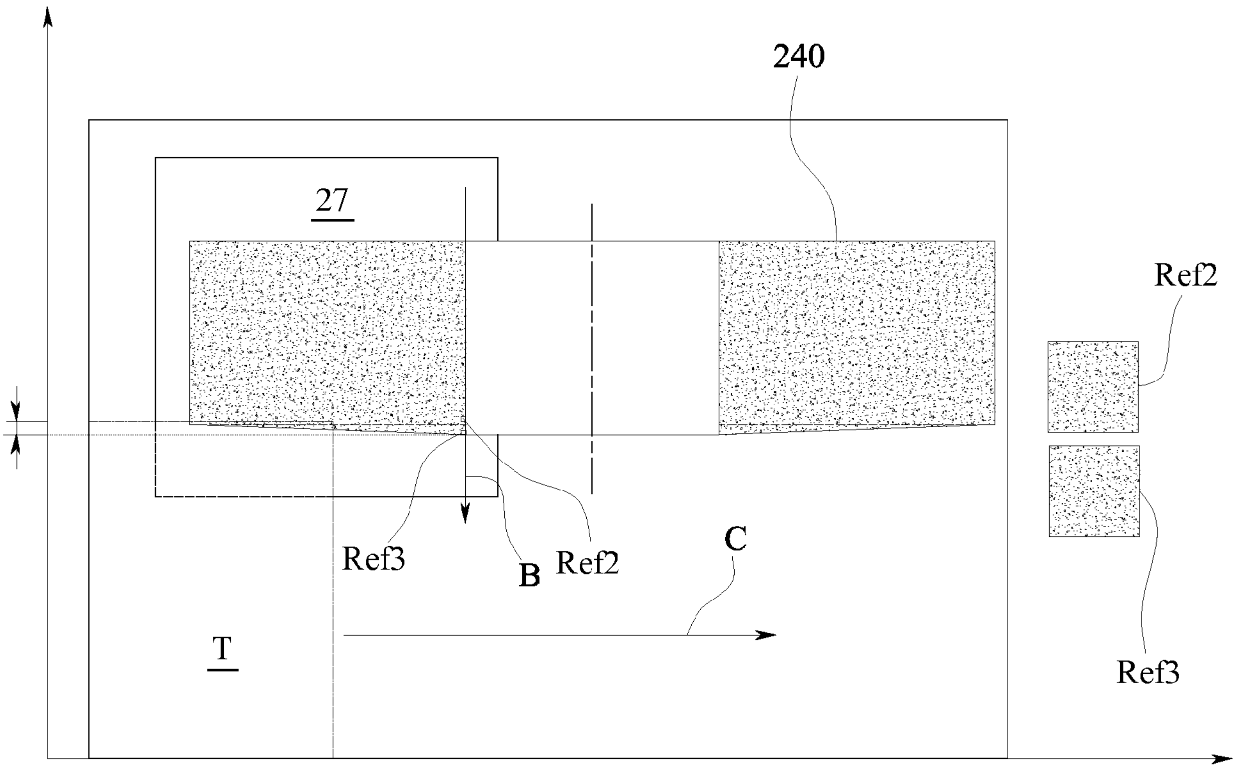

FIG.9a

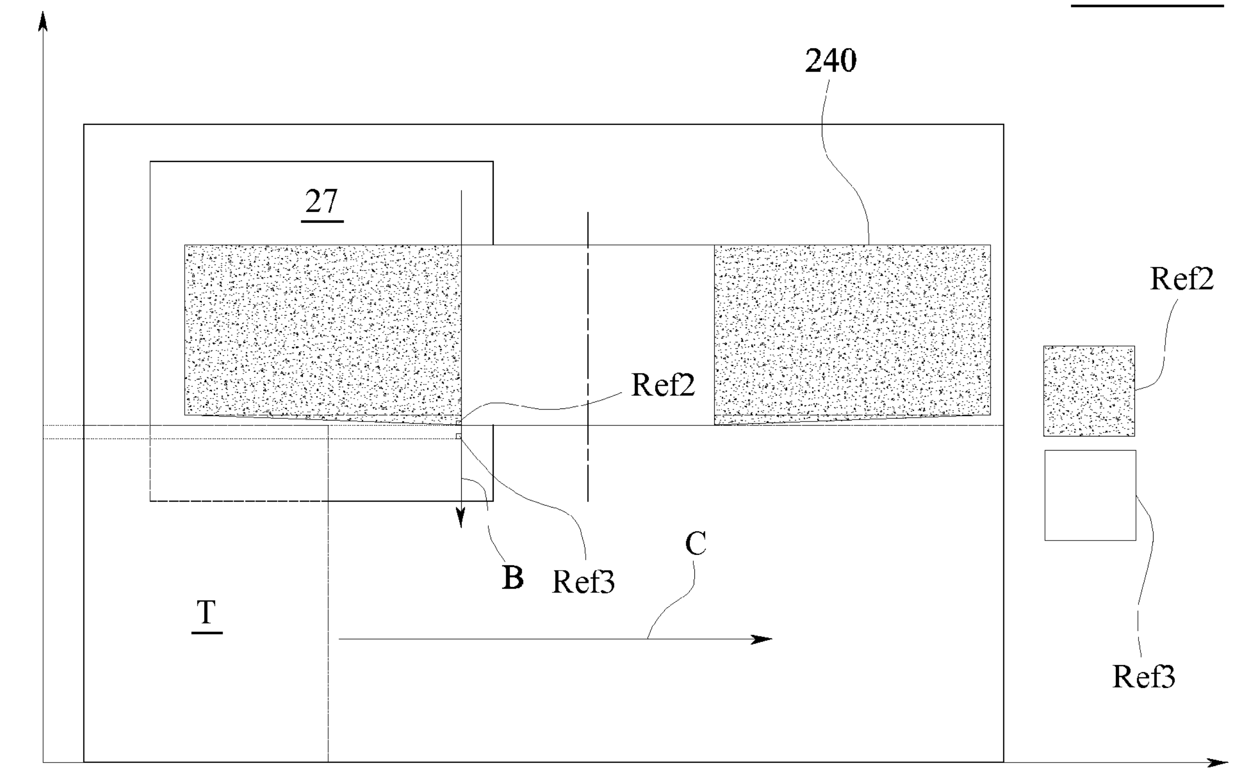

FIG.9b

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EUROPEAN SEARCH REPORT

Application Number
EP 18 19 4727

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Place of search	Date of completion of the search	Examiner
The Hague	25 January 2019	Chariot, David

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