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(71) Applicant: **SCG Building Materials Co., Ltd.**
10800 Bangkok (TH)

(72) Inventors:
- **Jamrussamee, Terdwong**
  10800, BANGKOK (TH)
- **Himtong, Arag**
  10800, BANGKOK (TH)
- **Chuajiw, Wittaya**
  10800, BANGKOK (TH)
- **Phabutta, Watthanakun**
  10800, BANGKOK (TH)

(74) Representative: **Corradini, Corrado et al**
Ing. C. Corradini & C. S.r.l.
Via Dante Alighieri 4
42100 Reggio Emilia (IT)

(54) Apparatus and method for forming a pattern in ceramic tile or slab with prescribed thickness

(57) An apparatus for forming desired patterns on ceramic tile with prescribed staring from a slurry characterized by comprising
- means for preparing a slurry
- at least one slurry holding tank (100) for holding at least one type of slurry;
- at least one pattern forming tray (300);
- at least one means for connecting said at least one tank to at least one pattern forming tray (300) and
- a filter pressing unit (500)

wherein the pattern forming unit (200) dispenses a predetermined type, amount, colors of slurry at a predetermined order into the pattern forming tray (300) to form a desired pattern, said slurry with desired pattern is pressed with the filter pressing unit (500) to form ceramic tiles or slabs with a desired pattern running though its entire thickness.

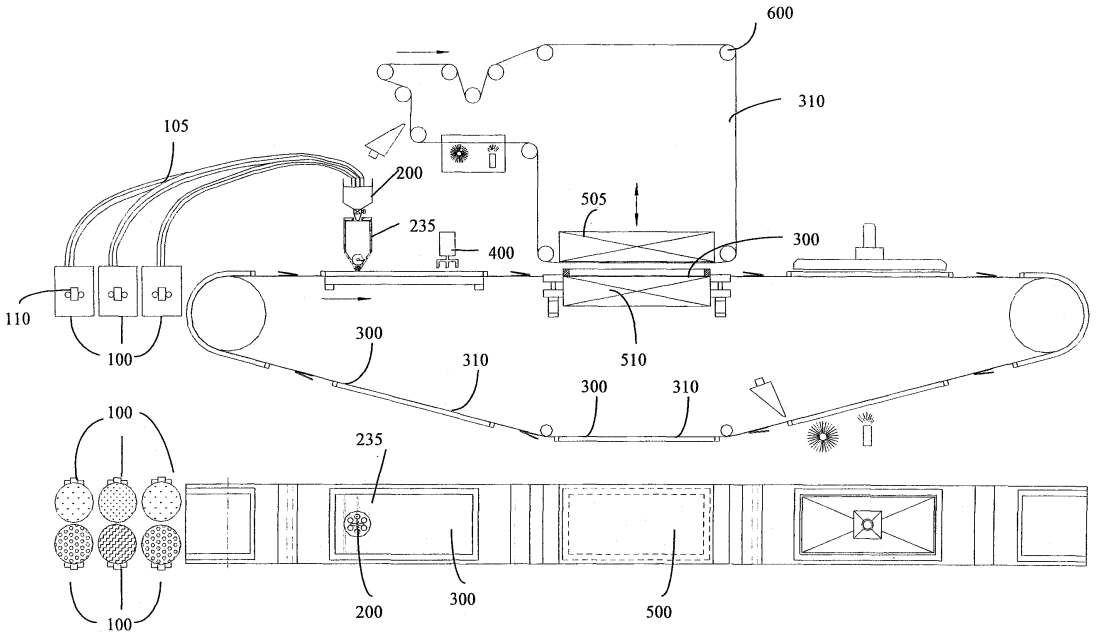

Fig. 9

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Description

Background of Invention

[0001] In the ceramic tiles industry, much effort is invested in developing technologies and methods for producing ceramic tiles with a desired pattern. The industry has moved from producing tiles with the desired pattern only on the top layer or only on the surface layer to producing tiles with the desired pattern running through the entire thickness of the tile.

[0002] One of the known methods of doing this is by loading dry soil powder inside a container and then discharging said content through the opening of discharging tubes of the said container into a vertical compartment forming layers of different types and colors of soil powder inside said compartment. The said compartment is then rotated 90 degrees to transfer the content to a horizontal mold. The content is then pressed together under high pressure forming it into a ceramic tile. Different layers of different types of soil powder and colors translate into the tile pattern. However, the problem associated with this method is that there are difficulties with controlling the amount of soil powder released into the compartment resulting in an inability to regulate and vary the width of color band. Thus, the patterns that can be obtained are limited. In addition, the rotation of the compartment causes the soil granules to shift, resulting in distortion of the pattern. Thus, the obtained tiles must be subjected to further surface treatment after firing to reveal the pattern.

[0003] European Patent No. EP1273408 and International Publication No. W02004071733 disclosed a technique to make continuous veining of patterns extending through the entire thickness of tiles or slabs. However, there remains the possibility that materials on the surface layer will mix together, causing the desired pattern to be distorted. There has been, therefore, a necessity to remove those mixed materials at the surface layer by suction before pressing in order to obtain patterns that are visible without having to polish the upper surfaces of ceramic tiles after firing.

[0004] European Patent EP 1334811 disclosed a technique for making patterns throughout the mass of the ceramic tiles which is characterized by a double-pressing that comprises of first a low pressure compacting. The compacted ceramic tiles are subsequently decorated by an ink-jet system to apply, according to the design, special ceramic colors which can penetrate into the tile mass. By this technique, however, appearance of the patterns in the tile mass is somewhat blurred or partial and the level of depth of pattern penetration is not deep enough to provide the pattern to the lowest layer of the tile mass.

[0005] All the known methods and apparatuses above comprise the compacting of material in powdery form.

Scope of the Invention

[0006] The scope of the invention is to provide an apparatus and method for forming a pattern in ceramic tiles with prescribed thickness, wherein the pattern runs through the entire thickness of the tiles or slabs. The method of forming the pattern imitates natural rock formation so that the obtained pattern closely resembles a pattern of natural rocks. The apparatus is equipped with means for controlling position, amount, and order of different types and different colors of slurry so as to form predetermined or desired patterns. Another objective of the invention is that by employing the apparatus according to the principles described herein, the tile or slab obtained will be of consistent thickness and size.

[0007] The scope is achieved by an apparatus and by a method having the characteristics recited in the independent claims.

[0008] A preferred embodiment of the invention is disclosed, with the help of the enclosed drawings where:

Fig. 1 shows side view and top view of an embodiment of the apparatus according to the invention
Fig. 2 shows an embodiment of the pattern forming set of the apparatus according to Fig. 1 distributing the slurry into a pattern forming tray
Fig. 3 shows further embodiment of the pattern forming set according to Fig. 2 wherein the pattern forming set is equipped with agitating means
Fig. 4 shows further embodiment of the pattern forming set according to Fig. 2 or Fig 3 wherein the pattern forming set is further equipped with pattern receiving tray
Fig. 5 shows further embodiment of the pattern receiving tray
Fig. 6 shows and embodiment of the pattern forming accessories.
Fig. 7 shows an embodiment of the pattern forming tray
Fig. 8 shows side view and top view of the embodiment of the apparatus according to Fig. 1 employing the pattern forming set according to Fig. 3
Fig. 9 shows side view and top view of the embodiment of the apparatus according to Fig. 1 employing the embodiment of the pattern receiving tray according to Fig. 5
Fig. 10 shows the pattern forming tray moving toward the filtered pressing unit
Fig. 11 shows filter pressing unit and its upper punch and lower punch
Fig. 12 shows the filter pressing unit in different operative positions.

Detailed Disclosure of the Preferred Embodiment of the Invention

[0009] The method of the invention provides the use of a material in slurry form instead of a material in powdery form.

[0010] The invention relates to an apparatus and method for forming a desired pattern on ceramic tiles with

prescribed thickness starting from a material in slurry form.

[0011] By employing the apparatus and method according to the invention, the desired pattern is achieved by controlling the position, amount, and order of different type and colors of a slurry wherein a predetermined amount and order of the slurry are deposited in a predetermined position in a pattern receiving tray. The slurry is then pressed in a filter press unit to form a green ceramic slab ready for further decoration and firing.

[0012] For the purposes of explanation, several embodiments of the apparatus and method according to the invention will be given by way of non limiting examples. Therefore the apparatus and method are not limited only to the specific embodiments described herein.

[0013] We will first describe the apparatus and then the method.

[0014] A preferred embodiment of the apparatus for forming desired patterns on ceramic tile with prescribed thickness (1) comprises slurry holding tanks (100), pattern forming unit (200) connected to the slurry holding tanks (100) by delivering tubes, pattern forming tray (300), pattern decorating accessories (400) and a filter press unit (500) which compatibly operates in a flow as shown in Fig. 1. wherein the pattern forming unit dispenses a predetermined type, amount, colors of slurry at a predetermined order into the pattern forming tray to form a desired pattern, said slurry with desired pattern is pressed with the filter pressing unit to form ceramic tiles or slabs with a desired pattern running though its entire thickness. Each component of the apparatus will now be described in detail.

Slurry Holding Tank (100)

[0015] The holding tank (100) is capable of holding soil slurry to be used to produce the tiles. There could be more than one holding tank (100) to contain different types and colors of the slurry. The holding tank (100) has a means to reduce precipitation of the slurry so as to promote flow or plasticity of the slurry to the patterning forming unit. For example, the inside of the tank may be equipped with at least one agitator (110) to encourage movement of the slurry, or the holding tank (100) may sit on a movable base (not shown) so that movement of the holding tank (100) causes the content inside to move continuously. In addition, to improve flow of the slurry, the holding tank (100), if required, may be equipped with heating unit (not shown) with a means to control the temperature of the slurry to a desired range so as to reduce viscosity of the slurry. The pressure inside the holding tank (100) is maintained. The holding tank (100) is connected to delivering tubes (105) to deliver the slurry to a pattern forming unit (200).

Pattern Forming Unit (200)

[0016] As shown in Fig. 2, the pattern forming unit (200) is connected to the slurry holding tank (100) by delivering tubes (105). The pattern forming unit (200) can accommodate more than one delivering tube (105) wherein the slurry under controlled pressure (or under controlled pressure and/or controlled temperature) is delivered. The delivering tube (105) at the pattern forming unit (200) is fitted with a valve (205) in order to regulate the amount and the color of the slurry to be dispensed into the pattern forming unit (200). The end of the delivering tube (105) inside the pattern forming unit (200) is fitted with removable end piece (210) with desired configurations and end configurations. Different configuration of the end piece (210) and its end contribute to vary the pattern being formed or to produce predetermined patterns.

[0017] The pattern forming unit (200) has a slurry holding portion (215) capable of holding the slurry dispensed from the delivering tubes (105). Different types and colors of the slurry are allowed to mix in this portion so as to create different lines and streaks. The end of the pattern forming unit (200) is fitted with a removable dispensing member (220). The opening end of the dispensing member (220) can be of any desired known configuration to create further variation of the lines and streaks once the slurry is dispensed into the pattern forming tray (300). In another embodiment, the dispensing member (220) maybe equipped with a valve (225) to regulate the amount and speed of the slurry being dispensed as shown in Fig. 2. In further embodiment, (not disclosed) the pattern forming unit (200) is fitted with more than one dispensing member (220). The dispensing member (220) is capable of rotating in a circular motion in accordance with the predetermined position and the colors of the slurry to be deposited into the pattern forming tray (300). In addition, the entire pattern forming unit (200) is also capable of moving in all directions, such as left, right, backward, and forward or in a circular motion relative to the shape and size of the pattern forming tray (300). There could be more than one pattern forming unit (200) dispensing the slurry into the same pattern forming tray (300) so as to deposit the slurry of desired type and colors combinations at a desired position to create a desired or predetermined pattern.

[0018] The movement of the pattern forming unit (200), the speed of the movement as a whole, the movement of the dispensing member (220), and the degree of opening of the valve (205) fitted at the delivering tubes and/or at the valve (225) end of the dispensing member (220) are regulated by a software application developed for this purposes wherein a desired pattern is pre-coded in the application.

[0019] In another embodiment of the pattern forming unit (200) as shown in Fig. 3, the pattern forming unit (200) is fitted with a means to promote or maintain flow of the slurry. The said means is defined as at least one agitator (230) situated inside the slurry holding portion (215). The agitator (230) not only promotes and maintains the flow of the slurry, but also helps with the-mixing and blending of the slurry. The configuration and the

speed of the movement of the agitator (230) also helps to create patterns with different characteristics as the size and speed of the agitator will affect the size of the lines and streaks of the slurry being dispensed therefrom.

[0020] Fig. 4 shows further embodiment of the pattern forming unit (200). In this embodiment, the pattern forming unit (200) is further equipped with a pattern receiving tray (235). This particular embodiment is suitable for producing a ceramic tile or slab with assorted colors or patterns or a tile or slab with different color tones. In this embodiment, the slurry is dispensed from the dispensing member (220) into a pattern receiving tray (235) and is subsequently dispensed into the pattern forming tray (300) instead of being dispensed directly into the pattern forming tray (300). When the slurry is dispensed into the pattern forming tray, the desired pattern is formed.

[0021] The pattern receiving tray (235) is movable across the pattern forming tray (300) and comprises a body (240) for containing the slurry, a means for mixing the slurry and driving the slurry toward the opening located at the bottom region of the pattern receiving tray (235),: said means is defined as a spiral screw (245) positioned across said opening in the bottom region. The bottom of the pattern receiving tray (235) is fitted with an open-close member (260) through which the slurry is dispensed into the pattern forming tray (300). Preferably, the size of the pattern receiving tray (235) should correspond with the size of the pattern forming tray (300),: more preferably, the length of the body (240) should be around the same size as the width of the pattern forming tray (300) if the slurry is to be distributed into the pattern forming tray (300) lengthwise.

[0022] The body (240) of the pattern receiving tray (235) may be divided into smaller compartments (250) using the zoning board (255) wherein each compartment (250) can hold the slurry with different colors or different combination of colors or combination of colors with various tones or different based patterns formed within the slurry holding portion (215). The zoning boards (255) are removably fixed to the body (240) so that the size of the compartment (250) may be adjusted by adding or removing the number of the zoning board (255) or by moving the zoning board (255) along the body (240). Zoning the body (240) of the pattern receiving tray (235) will improve the definition of the pattern as it reduces the degree that slurries with different colors and/or patterns mix with one another.

[0023] The spiral screw (245) which is located in the bottom region of the patter receiving tray (235) is set along the length of the body (240) of the pattern receiving tray (235). The spiral screw (245) is capable of turning on its axis. The number and size and distance of the spiral may be varied to create patterns with different sizes of color bands or streaks or lines or different variations of the pattern. The movement of the spiral screw (245) may be controlled by suitable electronic devices or precoded in the software application. The movement of the spiral screw (245) drives the slurry toward the opening at the bottom of the pattern receiving tray (235) for which the slurry is distributed in-to the pattern forming tray (300). The speed of the movement of the spiral screw (245) contributes to variation of the pattern being formed as well.

[0024] While the pattern forming unit (200), with or without the pattern receiving tray (235), dispenses the slurry into the pattern forming tray (300), the pattern forming unit (200) will move along and/or across the pattern forming tray (300) to evenly distribute the slurry. For the embodiment with the pattern receiving tray (235), while the slurry is being dispensed the spiral screw (245) will turn continuously, driving the slurry through the opening of the open-close member (260) (see Fig. 5) located at the bottom of the pattern receiving tray (235) which will be in its open state when the slurry is being dispensed. The amount of total weight of the slurry being dispensed is controlled by a weight sensor with the scale (not shown) underneath the pattern forming tray. That is, the pattern forming tray is positioned on a weighing device while the slurry is being distributed. The weighing device is linked to the software application. Once the amount of the slurry reaches the predetermined weight, the weighing device will activate and the dispensing unit (200) will temporarily withhold dispensing and the open-close member (260) will move to a closed state and the pattern forming unit (200) will resume its starting location. The pattern forming unit (200) will resume dispensing when a fresh pattern forming tray (300) moves into position. In addition, the amount of the slurry being dispensed from the dispensing member (220) into the pattern receiving tray (235) should correspond with the amount of the slurry being dispensed from the pattern receiving tray (235) to the pattern forming tray (300) so as to reduce the problem with overflow or shortage of the slurry.

[0025] Fig. 5 shows further embodiment of the pattern receiving tray (235). This embodiment of the pattern receiving tray (235) is larger in size and capable of holding a larger quantity of the slurry for producing larger ceramic tiles or slabs. In this embodiment, the large quantity of the slurry creates higher pressure inside the tray making it difficult to control the flow of the slurry. Therefore, in this embodiment, the pattern receiving tray (235) is further provided with an open-closed lid (265) and a high definition pneumatics system (270). After the desired quantity of the slurry is transferred into the pattern receiving tray (235), the open-close lid (265) is then closed, and the air inside the tray is removed to create a vacuum environment. The slurry is then dispensed by controlling the pneumatic system in combination with controlling the open-close member (260) at the bottom of the pattern receiving tray (235) to open and close as needed. The opening of the open-close member (260), the speed of the spiral screw (245), and the pressure inside the pattern receiving tray (235) is then regulated and maintained by the software application to achieve the desired pattern.

Pattern Forming Tray (300)

[0026] The pattern forming tray (300) acts as a mold for the tiles or slabs as its shape and size must correspond with the shape and size of the desired tile or slab. The pattern forming tray (300) comprises a frame (305) and a filter sheet (310) assembled on top of one another wherein the frame (305) forms into a border of the pattern forming tray (300). As shown in Fig. 6, a rectangular pattern forming tray (300) having an outer closed frame border is necessary to produce a rectangular tile or slab. In this embodiment, the pattern forming tray (300) comprises only an outer closed frame border. Fig. 7 shows further embodiment of the pattern forming tray (300) with an empty space in the middle of the tray. According to this embodiment the forming tray comprises also at least one inner closed frame border at designated position defining an empty space inside the tray. This embodiment of the pattern forming tray (300) is suitable for producing ready - to - use items, such as, sink counter or kitchen counter top, without having to modify the slab to suit the need. Of course, the additional empty space featured in the pattern forming tray (300) includes but is not limited to square, rectangular, circular, oval, and other desired free forms to suit the utilization of the tile or slab.

[0027] As mentioned, the pattern forming tray (300) comprises a frame (305) and a filter sheet (310) assembled on top of one another.

[0028] The frame (305) may be of any desired shapes assembled on top of the filter sheet. The frame (305) is made from a flexible material which can withstand high pressure and return to its original shape after the pressure is removed. The frame (305) may be made from the material or combination of materials selected from natural rubber, natural polymer, synthetic rubber, thermoplastic elastomer, silicone rubber, butadiene rubber, ebonite rubber, elevated temperature vulcanized rubber, urethane rubber, fluorine rubber, neoprene rubber and the like or metal specifically designed to flex under high pressure. The height of the frame (305) determines the maximum quantity of the slurry that can be held. Thus, the height of the frame (305) must be at least the height of the desired tile or slab.

[0029] The filter sheet (310) forming the bottom of the pattern forming tray (300) is a porous sheet capable of containing the slurry under normal conditions, but which allows water and particles smaller than the size of the pores of the filter sheet (310) to pass through when pressure or weight is applied. It is important that the filter sheet (310) should have suitably sized pores to prevent too many particles from passing through, resulting in the waste of the slurry. The materials for making the filter sheet (310) may be selected from wool fiber, nylon, metal wire mesh, polypropylene, polyester, polybuthylene, and polyamide.

[0030] Preferably, the pattern forming trays (300) should be connected to one another forming into a conveyer to support automatic or semi-automatic production. However, each pattern forming tray (300) should preferably be detachable and replaceable when replacement or maintenance is needed.

The Pattern Decoration Accessory (400)

[0031] After the predetermined quantity of the slurry has been distributed into the pattern forming tray (300), the integration or aggregation of the different types, colors, lines or streaks of the slurry will forms into the pattern of the tile or slab. However, to achieve the desired pattern or to create further variation on the already formed pattern, the pattern decoration accessory (400) may be used to achieve the desired pattern effects. The pattern decorating accessories (400) may operate synchronously with the pattern forming unit (200) or after the pattern forming unit (200) has completed its cycle of pattern formation. The pattern decorating accessory (400) can be of various forms and shapes and configurations as long as it can perform by dragging, dipping, stirring, mixing or sweeping across or into the formed pattern. Fig. 6 shows an example of the embodiment of the pattern decorating accessory (400). In this embodiment, the pattern decorating accessory (400) has a plurality of tooth - like extensions from a body. The body is connected to an electronic device (not shown) which is capable of controlling the movement of the pattern decorating accessory (400). The teeth may be connected to the body by simple locking or coupling elements or a snapped on joint so that the teeth may be replaced with a different configuration when needed. The movement of the pattern decorating accessory (400) may be controlled by being pre-coded in the software application as with the pattern forming unit (200) so as to achieve a predetermined pattern.

Filter Pressing Unit (500)

[0032] After pattern formation by the pattern forming unit (200) and/or the pattern decorating accessory (400) is completed, the formed pattern inside the pattern forming tray (300) is ready for pressing. The pattern forming tray (300) moves toward the filter pressing unit (500).

[0033] The filter pressing unit (500) as shown in Fig. 11, operates under the same principles as with a general hydraulic pressing machine, by applying pressure onto the object. The filter pressing unit according to this invention is a wet pressing unit. The objective is to remove as much excess water from the slurry as possible, leaving a green ceramic tile or slab with the water content commonly known in the ceramic tile industry to be suitable for drying.

[0034] Consequently, filtration is an integral element of the filter pressing unit (500). The filter pressing unit (500) comprises an upper punch (505), a lower punch (510), shape retaining frame (515), a vacuum pump (not shown), and may be further fitted with a heating and temperature control unit and a wind generator.

[0035] The upper punch (505) is made of metal, high

strength ceramic, or composite materials with a flat face. The surface of the flat face is porous, i.e. prepared with small holes distributed evenly throughout the face. The face is fitted with a shape retaining frame (515). The shape of the shape retaining frame (515) must correspond to the shape of the pattern forming tray (300). For example, as shown in Fig. 11, the shape retaining frame (515) is rectangular to correspond with the rectangular pattern forming tray (300). The upper punch (505) is prepared with a drain (not shown). The upper punch (505) operates under hydraulics and is capable of moving toward a fixed lower punch (510) so as to press the slurry contained in the pattern forming tray (300) positioned between them. Once the slurry is pressed, the excess water and slurry particles smaller than the pore size of the filter sheet (310) will escape through the pores of the filter sheet (310) and through the holes prepared on the face of the upper punch (505) and will be collected in the drain for disposal.

[0036] Similarly, the lower punch (510) is made of metal with a flat face. The surface of the flat face is porous, i.e. prepared with small holes distributed evenly throughout the face. The face is fitted with a shape retaining frame (515'). The shape of the shape retaining frame (515') must correspond to the shape of the pattern forming tray (300). The lower punch (510) is fixed to a position and is also provided with a drain.

[0037] The shape retaining frame (515) on the upper punch should be at the same position as the retaining frame (515') on the lower punch such that during pressing the face of the shape retaining frame on the upper punch (505) meets or almost meets with the face of the shape retaining frame (515') on the lower punch (510) when maximum pressure is applied enclosing the pattern forming tray (300).

[0038] As mentioned the shape of the shape retaining frames (515-515') must correspond to the shape of the pattern forming tray (300). However, the size of the shape retaining frames (515-515') should be slightly larger than the pattern forming tray (300) because, during the pressing, the pattern forming tray (300) is positioned inside the shape retaining frames (515-515'). During pressing, the frame of the pattern forming tray (300) which is made from flexible materials will distort under pressure which could cause distortion of the shape or the pattern of the tile or slab. Therefore, the shape retaining frames (515-515') will reduce this problem.

[0039] In addition, to allow the pattern forming tray (300) to move forward and into the position to be pressed and move forward after pressing is completed, the shape retaining frames (515-515') on the incoming direction and out-going direction should be able to move up and down or forward or backward such that it is level with the surface of the lower punch (510). For example, as the pattern forming tray (300) moves toward the filter pressing unit (500), the shape retaining frames (515-515') on the incoming direction will retract, allowing the pattern forming tray (300) to move into position., Once the pattern forming tray (300) meets the outgoing side (opposite the incoming side) of the shape retaining frames (515-515') the pattern forming tray (300) will stop moving and the incoming side of the shape retaining frames (515-515') will resume its position securing the pattern forming tray (300) inside. Once pressing is completed, the outgoing side of the shape retaining frames (515-515') will retract, allowing the pattern forming tray (300) to move forward out of the filter pressing unit (500). Thereafter, the incoming side of the shape retaining frames (515-515') will retract again to anticipate the incoming of the next pattern forming tray (300) and the out-going side will resume its position.

[0040] Further, in order to regulate or adjust the thickness of the tile or slab, the shape retaining frames (515-515') are prepared with a means to adjust it height. The height of the shape retaining, the height of the frame (305) of the pattern forming tray (300) and its ability to retract when pressed, the amount of the slurry contain inside the pattern forming tray (300) are all inter-dependent.

[0041] In general, the ability to retract or reduce the height of the frame (305) when pressed at maximum pressure is a known value. The height of the shape retaining frames (515-515') should be set at equal to or slightly lower than the height of the frame (305) after pressing so that during pressing the face of the upper punch (505) presses against the slurry contained in the shape forming tray (300) and against the frame (305). The pressure is gradually increased to a maximum pressure. At the maximum pressure the frame will reduce its height to a maximum level which is equal to or slightly higher than the height of the shape retaining frame (315') on the lower punch (510) and the face of the shape retaining frame (315) on the upper punch (505) will meet or almost meet with the face of the shape retaining frame on the lower punch (510) so that as much excess water is extracted from the slurry as possible.

[0042] When producing a new batch of tiles or slabs with different thickness, the height of the shape retaining frames (515-515') may be adjusted accordingly and the height of the frame (305) may be adjusted by using a frame (305) with a different height or switching to a frame made from different materials which possess different retraction values.

[0043] In addition, to increase the speed of extracting the water from the slurry, the shape retaining frames (515-515') as well as the frame (305) may also be prepared with holes as with the upper punch (505) and the lower punch (510) so that the water may pass through faster and shorten the time needed to extract the water out of the slurry. The shape retaining frame (515) is removable for maintenance and is replaceable when worn.

[0044] The excess water is collected in the drain of the upper punch (505) as well as in the drain of the lower punch (510). The water is then removed by the vacuum pump after pressing is completed. The wind generator helps to drive the excess water toward the drain.

[0045] During pressing, if required, the filter pressing

unit (500) may be equipped with a heating unit with a temperature control device so as to reduce viscosity of the slurry, making it easier to extract the excess water out of the slurry.

[0046] The apparatus further preferably comprises a cleaning station wherein after pressing is completed and the green tile or slabs has been removed the filter and the pattern forming tray is cleaned before re-entering the production system

[0047] By employing the above described embodiment of the apparatus, a method for forming a desired pattern on a ceramic tile or slab with the pattern running through the prescribed thickness will now be described below. The method described forthwith will be based on employing a specific embodiment of the apparatus according to the principle of the invention. It is not, however, our intention to limit ourselves to the method described hereafter.

[0048] The method of forming a desired pattern in ceramic tiles or slabs according to this invention comprises the followings steps:

- Preparing the slurry
  Raw materials for producing ceramic tiles or slabs are ground in a wet ball mill to achieve the slurry. Ceramic pigment or flakes are added to achieve desired colors. Additives or admixtures so as to reduce viscosity of the slurry or to improve strength of the tile or slabs are added as required. The obtained slurry is held in a holding tank separating slurry with different colors ready to be delivered to the pattern forming unit. If required, the slurry may be maintained under a controlled temperature.
- Forming a desired pattern
  The slurry under control pressure is delivered to the pattern forming unit where predetermined types, quantities, colors, order of colors, and position of the slurry is dispensed into a pattern forming tray to form a desired pattern. The predetermined types, quantities, colors, order of colors, and position of the slurry to be dispensed are pre-coded in a software application.
- Filter pressing

[0049] The slurry, in which a desired pattern has now formed, is pressed by a filter pressing unit.

[0050] Each step will now be described in detail as follows:

Preparing the slurry

[0051] Raw materials for producing ceramic tiles or slabs are ground in a wet ball mill to achieve the slurry. Preferably, the slurry comprise dry materials ranging from 30%-70% by weight to achieve slurry with suitable viscosity. Additives or admixtures such as deflocculant, dispersant, flocculant, defoaming agent, or surfactant may or may not be added into the slurry depending on the characteristics and properties of the raw materials. The particle size of the raw material after grinding, and the ratio of different types of raw materials are some of the factors to determine whether an additive or admixture is needed. The desired property of the ceramic tile or slab can sometimes play a role in considering whether an additive is needed as well. For example, if an extra-strong tile or slab is preferred, strength enhancing additives such as Polyvinyl alcohol (PVA), Polyvinyl acetate (PVAc), Carboxymethyl cellulose (CMC), Methylcelllulose, Ethylenevinyl acetate (EVA), starch, modified starch, cellulose fiber, organic fiber, inorganic fiber, etc., may be added into the slurry, preferably up to 5% per dry weight. If desired, the slurry may be heated so as to reduce viscosity and promote flow of the slurry as the heat drives the particles away from each other.

[0052] Ceramic pigments or flakes may be added to the slurry to achieve the desired colors. The pigment may be added during grinding or added into the slurry after grinding is completed. The latter is preferred as the slurry obtained will have consistent colors creating higher quality products.

[0053] The slurry is held in a holding tank (100) separating different colors. The pressure inside the tank is maintained. The slurry is maintained at room temperature and or if required may be heated up to 70 degree Celsius. The slurry is then continuously delivered to the pattern forming unit (200) by delivering tube while maintaining the pressure. The flow rate of the slurry from the holding tank (100) to the pattern forming unit (200) is regulated by the pressure inside the holding tank (100) in combination with regulating the valves (205) at the end of the delivering tubes (105) at the pattern forming unit (200). A predetermined quantity of the slurry in accordance with the predetermined values is then dispensed into the pattern forming unit (200). The surplus amount of the slurry is returned back to the holding tank to maintain the quality of the slurry and to reduce precipitation and clogging of the delivering tube.

Forming desired patterns

[0054] At this stage, different types and colors of the slurry are delivered to the pattern forming unit (200). More than one type or color of slurry may be delivered to the pattern forming unit (200) at any one time. Different types or colors of the slurry are allowed to mix inside the pattern forming unit (200). The amount of the slurry with different colors, order of the colors, and position to be distributed will affect the outcome of the patterns. Accordingly, the values of these parameters are controlled by pre-coding these values into a software application, in combination with controlling the pressure inside the delivering tubes (105) and the valves (205) fitted at the end of the delivering tubes (105) at the pattern forming unit (200). The slurry is then dispensed through the dispensing member (220) fitted at the bottom of the pattern forming unit (200). The amount of the slurry being dispensed may be further

controlled by regulating the valve fitted at the dispensing member (220). While dispensing the slurry, the pattern forming unit (200) will move in response to the pre-coded values to regulate movement of the pattern unit (200) in order to deposit and distribute the slurry to the predetermined position in the tray so as to achieve the desired pattern. The pattern forming unit may be moved left, right, backward, forward, and or in circular motion (or in, x, y, z axis).

[0055] While the pattern forming unit (200) is dispensing the slurry into the pattern forming tray (300), the differential in quantity, types, colors, lines, and streaks of the slurry will integrate to form a desired pattern. Accordingly, further and additional variation of the pattern may be achieved by varying the quantity, types, colors, lines, and streaks of the slurry to be deposit into the pattern forming tray (300). Figs. 2, 3 and 4 shows different embodiments of the pattern forming unit (200) so as to achieve different patterns.

[0056] One method of forming a desired pattern involves using the pattern forming unit (200) without an agitator as shown in Fig. 2. In this method, different types and colors of the slurry are delivered to the pattern forming unit (200). The slurries according to the pre-coded values are allowed to mix freely inside the slurry holding portion (215) of the pattern forming unit (200). The mixed slurry is then dispensed into the pattern forming tray (300) to form a desired pattern. Variation of the pre-coded values will results in different patterns. Further variation of the patterns according to this method can be achieved by changing the shapes and configurations of the end piece (210) fitted at the end of each of the delivering tube (105) or changing the shape and configurations of the dispensing member (220) or both.

[0057] Another method of forming a desired pattern according to the principles described herein involves using a pattern forming unit (200) with a means to further mixing the slurry inside the holding portion (215) of the pattern forming unit (200), i.e. a pattern forming unit (200) with an agitator (230) as shown in Fig. 3. This method works under the same principles and techniques as in the earlier described method. The difference is that, in this method, after slurries according to the pre-coded values are allowed to mix freely inside the slurry holding portion (215), the already mixed slurry is then purposely mixed further by the agitator (230). This techniques will derived a slurry mixes with finer lines and streaks resulting in finer and sharper pattern. Further variation of the patterns according to this method can be achieved by varying the speed of the agitator (230) or varying the speed of the agitator (230) in combination with varying the pre-coded values, or changing the shapes configurations of the end piece (210) and dispensing member (220) or both.

[0058] An additional method of forming a desired pattern according to the principles described herein involves using a pattern forming unit (200) further comprises a pattern receiving tray (235) as shown in Fig. 4. In this method, instead of the slurry being dispensed directly into the pattern forming tray (300), the slurry is dispensed into the pattern receiving tray (235) and subsequently into the pattern forming tray (300). For this method, the pattern forming unit (200) employs the same principles and techniques as in the earlier described method where the slurry is dispensed by the pattern forming unit (200) without the agitator (230). The distinct character of this method lies in the elements featured in the pattern receiving tray (235). In this method, the slurry is allowed to be mixed together first in the slurry holding portion (215) and subsequently in the pattern receiving tray (235) so that further variations and more intricate patterns can be created. In addition, this method is particularly, suitable for forming patterns in which various colors are formed into a desired pattern, or patterns with more than one sub-set of patterns, or patterns with several color tones or shades. In this method, the slurry is dispensed into compartment(s) (250) of the pattern receiving tray (235). A plurality of pattern forming units (200) may be dispensing the slurry into the pattern receiving tray (235) at any one time. Each compartment (250) may be filled with just one particular tone or shade, or a combination of shades, or a combination of sub-set (base) of patterns (different mixes of lines, streaks resulting from the mixing of the slurry inside the slurry holding portion (215).). The zoning boards (255) which divides the pattern receiving tray (235) into smaller compartments (250) help to reduce unwanted mix of the slurry so that pattern with higher definition (where two colors, or tones or sub-set of patterns meet) is achieved. The position, amount, combination, and colors/shades of the slurry dispensed into the pattern receiving tray are in accordance with the value pre-coded in the software application. The slurry in each compartment is then distributed into the pattern forming tray (300) by rotation of the spiral screw (245) feeding the slurry to the opening at the bottom of the pattern receiving tray (235) to form desired patterns. During the distribution of the slurry, the pattern forming unit (200) moves synchronously with the pattern receiving tray (235) relative to the width and length of the pattern forming tray (200). Further variation of the pattern according to this method involves variation of the size of the spiral, the size of the compartment, the speed of the spiral screw (245), and the speed of the movement of the pattern forming unit (200) and the pattern receiving tray (235).

[0059] One yet further method of forming desired patterns according to the principles described herein involves using the embodiment of the pattern receiving trays as shown in Fig. 5. This method employs similar techniques as with the embodiment of the pattern forming unit (200) shown in Fig. 4. However, in this method, the pattern receiving tray is larger in size and thus capable of holding a large bulk of slurry. This method is suitable for forming patterns to produce on larger tiles or slabs. In this embodiment, the pattern receiving tray (235) may or may not be fitted with the zoning boards (255). Due to the fact that a large quantity of the slurry is dispensed

into the pattern receiving tray (235), it creates higher pressure inside the tray making it difficult to control the flow of the slurry. Therefore, in this method, the distribution of the slurry involves using the pattern receiving tray (235) which is further provided with an open-closed lid (265) and a high definition pneumatics system (270). After the desired quantity of the slurry is transferred into the pattern receiving tray (235) the open-close lid (265) is then closed, and the air inside the tray is removed to create a vacuum environment. The slurry is then dispensed by controlling the pneumatic system (270) in combination with controlling the open-close member (260) at the bottom of the pattern receiving tray (235) to open and close as needed to form desired patterns.

[0060] The principle of forming the desired pattern according to the invention is to allow the slurry according to types and colors and/or combination of colors or sub set of pattern to mix at pre-coded values at controlled parameters employing the apparatus according to the invention. It is very important the mixing of the slurry of more than one types, colors, or combination of colors at any one point during pattern formation is not allowed to be homogeneous prior to dispensing the resultant slurry into the pattern forming tray (300), but still maintaining individual colors, lines, or streaks to the extent that the desired pattern is formed from the integration of mixed colors and lines, streak of individual colors. This is achieved by combined means of controlling the pressure of the slurry, the viscosity of the slurry, the speed of the agitator (230) inside the pattern forming unit (200), and or the spiral screw (245) at the pattern receiving tray (235) and time of transferring the resultant slurry mixture into the pattern receiving tray (300). In addition, the slurry is dispensed into the pattern forming tray (300) simultaneously with the operation of the agitator (230) and/or the spiral screw (245) so that the slurry will not become homogeneous. An example of one of the method of forming a desired pattern according to the invention is that the agitator runs at 30-100 rpm while the pattern forming unit (200) continuously dispensed the slurry into the pattern forming tray (300). Consequently, the slurry will remain in the pattern forming unit (200) for only about 5-10 seconds so that the slurry will not become homogeneous. Of course, the speed of the agitator will be regulated and varied corresponding to the pre-coded values in accordance with the desired pattern.

[0061] As mentioned, the slurry is dispensed into a pattern forming tray (300) to form a desired pattern. The dispensed slurry is contained within the frame (305) of the pattern forming tray. Accordingly, the shape and size of the frame (305) will determine the shape and size of the tile or slab. In addition, the height of the frame (305) will determine the maximum quantity of the slurry which can be contained, which will in turn determine the maximum thickness of the tile or slab. In operation, the pattern forming tray (300) is fed into the manufacturing system and is positioned at the weighing station or scale prior to the slurry is being dispensed into it. A predetermined amount of the slurry is then dispensed into the pattern forming tray (300). Once it reaches the predetermined weight, a weighing sensor will activate causing the pattern forming unit (200) or the pattern receiving tray (235) to temporally withhold dispensing so that each tile or slab will have consistent thickness and consistent quality.

[0062] The formed patterns may be further decorated or modified by using the pattern decorating accessory (400) previously described. The pattern decorating accessory (400) performs by dragging, dipping, stirring, mixing or sweeping across or into the formed pattern. The motion of the pattern decorating accessory (400) may be controlled by a suitable electronic device or this maybe performed manually. In addition, the pattern decorating accessory (400) may perform in synchronously with the pattern forming unit (200) to achieve the desired patterns. After the pattern formation is completed, the pattern forming tray (300) moves to the next step of the production which is pressing.

Filter pressing

[0063] The slurry dispensed or distributed into the pattern forming tray (300) which now includes different types, lines, streaks, tones or shade will be pressed to extract and remove water from the slurry to form a green ceramic tile or slab. The different types, lines, streaks, tones, or shades will transform into a desired pattern extending through the entire thickness of the tile or slab.

[0064] In this step, the pattern forming tray (300) will position at the filter pressing unit (500), more specifically, on the lower punch (510) of the filter pressing unit (500). Thereafter, the filter sheet (600) which is formed into a conveyer like, will move into position so as to cover the pattern forming tray (300) prior to pressing and while pressing is in progress as shown in Figs 1, 7, 8. Thereafter, the slurry contained inside the pattern forming tray is pressed by the upper punch (505). Once the slurry is pressed, the excess water including slurry particles smaller than the pore size of the filter sheet (310) will escape through the pores of the filter sheet (310) and through the holes prepared on the face of the upper punch (505) or in alternative embodiment, through the holes on the shape retaining frame (515) as well. The upper punch continues to press to extract as much water as possible until it reaches a predetermined values (the height of the frame (305) the height of the shape retaining frame (315), the ability to retract of the frame (305) or pressure value per square inch) such that during pressing at maximum pressure, the shape retaining frame (515) on the upper punch should be at the same position with the retaining frame (515') on the lower punch and that the face of the shape retaining frame on the upper punch (505) meets or almost meets with the face of the shape retaining frame (515') on the lower punch (510) enclosing the pattern forming tray (300). During pressing, the shape retaining frames (515-515') will retain the shape of the flexible frame from becoming distorted upon application

of the pressure which could distort the shape and pattern of the tile or slab.

[0065] Upon pressing the water and slurry particles smaller than the pores of the filter sheet (310) will escape through such pores and through the hole prepared on the surface of the upper punch (505) and lower punch (510) and will be collected in the drain for disposal. During pressing, care is taken by gradually increasing pressure in order to distribute the pressure evenly so that water is removed evenly reducing distortion of the pattern and maintaining thickness consistency of the green tile or slab. Further, the water collected in the drain should be disposed by vacuum pump only after the pressing is completed so as to reduce clogging of the particle at the filter sheet (310, 600) as clogging could result in difficulties in extracting further water from the slurry. In addition, if the water is unevenly removed, it can cause separation of the slurry and results in inconsistency of tile or slab thickness. If required, during pressing, the slurry may be heated and maintain the temperature at suitable level so as to ease water removal and shorten the pressing time.

[0066] The shape and configuration of the pattern forming tray (300) will also determined the shape and configuration of the final products. Accordingly, the pattern forming tray (300) may be modified as needed to obtain the desired shape, configuration, and size of the final products. The pattern forming tray (300) may be modified to contain empty space at designated position for suitable utilization. For example, the empty space can be selected from square, rectangle, oval, circle, and desired free-form shapes. The same effect may be achieved by placing a soft flexible mold (made of the same material or possessing the same property as with the frame (305) and is re-usable) of such shapes into the pattern forming tray (300) prior dispensing the slurry into the pattern forming tray (300). The soft flexible mold will take up space inside the pattern forming tray (300), thus leaving space of corresponding shape after pressing and the soft flexible mold is removed. The tile or slab produced according to this technique can be used as sink counter, kitchen countertop, etc. without having to cut or, drill or saw away certain portions as in conventional tiles or slabs.

[0067] After pressing is completed, the pattern forming tray (300) will move out of the filter pressing unit (500) and the green tile or slab is removed for further treatments as needed to achieve the desired effects such as surface decoration, cutting to size, firing, and/or polishing.

[0068] After the green tile or slab is removed, the pattern forming tray (300) continues to move and proceed to cleaning station to be cleaned and re-enter the production line. The filter sheet (600) is also moved to cleaning station in a similar manner.

Drying and Firing

[0069] After pressing is completed and a green tile or slab is obtained, they may be subject to further treatment to achieve desire effects. For example, they may be subject to surface decoration to give dimension, print, spray, paint, or apply ceramic pigments or flakes could be applied as needed. The process may be performed while the green tile or slab still contains high moisture content so as to ease the process and reduce damages. The products then are then dried and fired according to the standard developed to suit the property of the green tiles or slabs produced according to the invention.

[0070] The pattern of the ceramic according to the principle of the present invention is formed from the differential in quantity, types, colors, lines, and streaks of the slurry which will integrate to form a desired pattern. As the tile or slab is formed from the slurry of consistent quality and with the aid of the elements of the apparatus and while the method of forming the pattern when forming the tile or slab necessary precaution measures are taken. Such measures are such as the consistency of the pore size on the filter sheet as well as on flat surface of the upper punch (505) and lower punch (510) and the gradually increase of the pressure being applied by the filter press unit (500) so that water and particles will evenly escape so that the achieved green tile will have even thickness and moisture content. Consequently, the obtained tiles or slabs not only have the pattern extend to the entire thickness, the tiles or slabs also have consistent thickness and strength as well.

Claims

1. An apparatus for forming desired patterns on ceramic tile starting from a slurry **characterized by** comprising

   - means for preparing a slurry
   - at least one slurry holding tank for holding at least one type of slurry;
   - at least one pattern forming tray;
   - at least one means for connecting said at least one tank to at least one pattern forming tray and
   - a filter pressing unit

   characterized in that
   each holding tank is connected to the pattern forming unit by at least one delivering tube, the end of said delivering tube at the said pattern forming unit being fitted with a valve for controlling the delivery of the slurry into the pattern forming unit.

2. The apparatus according to claim 1 wherein each of the holding tanks has a means to regulate pressure inside the tank.

3. The apparatus according to claim 2 wherein each of the holding tanks has a means to reduce precipitation of the slurry and promote flow of the slurry is at least one agitator.

4. The apparatus according to claim **3** wherein a means to reduce precipitation of the slurry and promote flow of the slurry is by positioned the said holding tank on a moving base.

5. The apparatus according to claim 1 wherein the end of the delivering tube at the said pattern forming unit is fitted with a replaceable end piece capable of controllably dispensing the slurry into the pattern forming unit.

6. The apparatus according to claim 1 and 5 where in the pattern forming unit is capable of accommodating a plurality of delivering tubes and the replaceable end piece at each end of the delivering tube at the pattern forming unit has different shapes and configurations.

7. The apparatus according to claim 1 wherein the holding tank is fitted with a heating unit and a means to regulate temperature of the slurry contained therein.

8. The apparatus according to claim 1 wherein the pattern forming unit is movable along three orthogonal axis x, y, z,

9. The apparatus according to claim 8 wherein the pattern forming unit is fitted with a valve to control the amount of the slurry to be dispensed through the dispensing member.

10. The apparatus according to claim 1 wherein the pattern forming unit further comprises a means to mix the slurry contained in the said pattern forming unit.

11. The apparatus according to claim 1, 6, 8, 9, and 10 wherein the pattern forming unit is further comprises a pattern receiving tray.

12. The apparatus according to claim 11 wherein the pattern receiving tray comprises -a body for holding the slurry dispensed from the dispensing member of the pattern forming unit;

    - an open-close member on the bottom; and
    - a spiral screw lines on the bottom region of the pattern receiving tray, said spiral screw has even and/or uneven and is capable of turning on its axis so as to feed the slurry toward the open-close member so as to distribute the slurry into the pattern forming tray.

13. The apparatus according to claim 12 wherein the body of the pattern receiving tray is divided into compartments for containing different types, colors, combination of colors and or base patterns using zoning boards.

14. The apparatus according to claim 13 wherein the zoning boards are removably coupled to the body of the patterning receiving tray and that the number and/or size of compartments may be added or reduced by adding or removing the zoning boards and/or by increase the distance between each board.

15. The apparatus according to claim 12 wherein the pattern receiving tray is further comprise an open-close lid and a high definition pneumatics system so as to create a vacuum environment inside the pattern receiving tray and controllably dispense the slurry into the pattern forming tray.

16. The apparatus according to claim 1 wherein the pattern forming tray comprises a frame assembled on a filter sheet, each pattern forming tray having the shape corresponding to the shape of the desired tile or slab and being connected to form a conveyer like loop to support automatic or semi-automatic production environment.

17. The apparatus according to claim 16 wherein each pattern forming tray in the loop capable of holding the slurry dispensed from the pattern forming unit and each pattern forming tray is detachable for maintenance and replaceable when worn.

18. The apparatus according to claims 16 and 17 wherein the pattern forming tray comprises only an outer closed frame border

19. The apparatus according to claims 16 and 17 wherein the pattern forming tray comprises at least one second inner closed frame border inside the said outer closed frame to define an empty space at predetermined location in the tray, the shape of empty space being selected from square, rectangle, oval, circular and free-form shape.

20. The apparatus according to claim 16 wherein the frame is made from porous flexible materials capable to deform when pressure is applied and resume its original shape after pressure is removed

21. The apparatus according to claim 20 wherein the flexible porous frame is made from materials selected from natural rubber, natural polymer, synthetic rubber, thermoplastic elastomer, silicone rubber, butadiene rubber, ebonite rubber, elevated temperature vulcanized rubber, urethane rubber, fluorine rubber, neoprene rubber.

22. The apparatus according to claim 16 wherein the filter sheet is a porous material.

23. The apparatus according to claim 22 wherein the filter sheet is made from materials selected from wool

fiber, nylon, metal wire mesh, polypropylene, polyester, polybuthylene and poly amide.

24. The apparatus according to claim 1 wherein the filter pressing unit comprises an upper punch and a lower punch, the flat surface of the upper punch and the lower punch being porous.

25. The apparatus according to claim 24 wherein each of the upper punch and the lower punch is prepared with a drain for collecting excess water and particles escaping from pressing the slurry.

26. The apparatus according to claim 25 wherein at least one of the upper and lower punch comprise a shape retaining frame around its edge.

27. The apparatus according to claim 26 wherein a means for adjusting the height of the shape retaining frame is provided.

28. The apparatus according to claim 26 wherein the shape retaining frame on the lower punch on the incoming and out going directions of the pattern forming tray able to move up or down to allow incoming and out going of the pattern forming tray.

29. The apparatus according to claim 25 wherein the filter pressing unit further comprises a vacuum pump to remove excess water and particles collected in the drain in the upper punch and lower punch.

30. The apparatus according to claim 25 wherein the filter pressing unit further comprises a wind generator for blowing excess water toward the drain.

31. The apparatus according to claim 25 wherein the filter pressing unit further comprises a heating unit and a means to control the temperature of the slurry being press so as to ease removal of excess water.

32. The apparatus according to claim 1 further comprises a scale controlled by a weighing sensor for controlling the amount of the slurry being dispenses into the pattern forming tray whereby activation of the sensor will cause the pattern forming unit to withhold dispensing.

33. The apparatus according to claim 1 further comprising cleaning station wherein after pressing is completed and the green tile or slabs has been removed the filter and the pattern forming tray continue to proceed to the cleaning station to be cleaned and reenter the production system.

34. A method for forming a pattern in ceramic tile or slab with prescribed thickness with the pattern running through the entire thickness comprises the following steps:

- Preparing at least one slurry whereby raw materials for producing ceramic tiles or slabs are grinded in a wet ball mill to achieve the slurry.
- Eventually add ceramic pigment or flakes to achieve desire colors.
- eventually add additives so as to reduce viscosity of the slurry or to improve strength of the tile or slabs are added as required.
- holding each obtained slurry in a separate tank
- feed at least one slurry to a pattern forming unit:
- Move the pattern forming unit over a forming tray to dispense the slurry to the tray according to a desired pattern
- subjecting the forming tray to filter pressing to remove excess water and to form green ceramic tile or slab with pattern running through the entire thickness.

35. The method according to claim 34 wherein the slurry comprises dry material ranges from 30-70% by weight.

36. The method according to claim 34 wherein eventual additives comprise additives selected from deflocculant, dispersant, flocculant, defoaming agent, surfactant.

37. The method according to claim 34 wherein eventual additives comprise up to 5% of tiles or slabs property enhancer and/or modifier selected from Polyvinyl alcohol (PVA), Polyvinyl acetate (PVAc), Carboxymethyl cellulose (CMC), Methylcelllulose, Ethylenevinyl acetate (EVA), starch, modified starch, cellulose fiber, organic fiber, inorganic fiber.

38. The method according to claim 34 wherein the slurry is maintained at room temperature and/or heated up to 70 Celsius

39. The method according to claim 34 wherein the slurry to be dispensed to form a desired patterns is dispensed according to the value pre-coded in the software application in combination with changing the shape and configuration of the dispensing member and/or in combination with changing the pressure inside the slurry holding tank and/or in combination with changing the speed of movement of the pattern forming unit and/or combined.

40. The method according to claim 34 wherein during forming the desired pattern the pattern forming unit moves forward, backward, left, right and in circular motion to distribute the slurry according to the value pre-coded in the software application at a predetermined speed.

41. The method according to claim 34 wherein the slurry is allowed to mix freely inside the pattern forming unit prior to being dispensed into the pattern forming tray to form a desired pattern.

42. The method according to claim 35 wherein the slurry is further mixed by using agitator operating at predetermined speed prior to being dispensed into the pattern forming tray to form a desired pattern.

43. The method according to claim 34 to 39 wherein the slurry is dispensed into a pattern receiving tray and subsequently dispensed into a pattern forming tray.

44. The method according to claim 42 wherein the slurry being dispensed into the pattern receiving tray is dispensed separately into separate compartments of the pattern receiving tray according to different types, colors, combination of colors and or based pattern, whereby rotation of the spiral screw the slurry is dispenses into the pattern forming tray through the open-closed end at the bottom of the pattern receiving tray.

45. The method according to claim 43 wherein the slurry being dispensed in vacuum environment controlled by a high definition pneumatic system in combination with regulating the open-closed end at the bottom of the pattern receiving tray.

46. The method according to claim 35 wherein during pressing the temperature of the slurry is maintained at room temperature and/or heated up to 70 degree Celsius.

47. The method according to claims 35 wherein during filter pressing a means to retain the shape of the tile or slab while being press is used to retain the shape and pattern of the green ceramic tile and or slab produced from the slurry being press.

48. The method according to claims 35 wherein prior to dispensing the slurry into the pattern forming tray a soft mold of desired shape is positioned at designated positioned in the pattern forming tray so as to produce a green ceramic tile or slab with an empty space corresponding to shape of the soft mold at designated position.

49. The method according to claims 48 wherein the soft mold is selected having shapes selected from square, rectangle, oval, circle, free-formed shape.

50. The method according to claim 35 further comprising a step of decorating and or variation of the pattern, being formed and/or after pattern forming is completed, by using the pattern decorating accessories, said pattern decorating accessories capable of dragging, dipping, stirring, mixing, and or sweeping to give the desired pattern with desired effects.

51. The method according to any one of claim 35-50 wherein green tile and/or slab with desired pattern is exposed to drying and firing according to the standard.

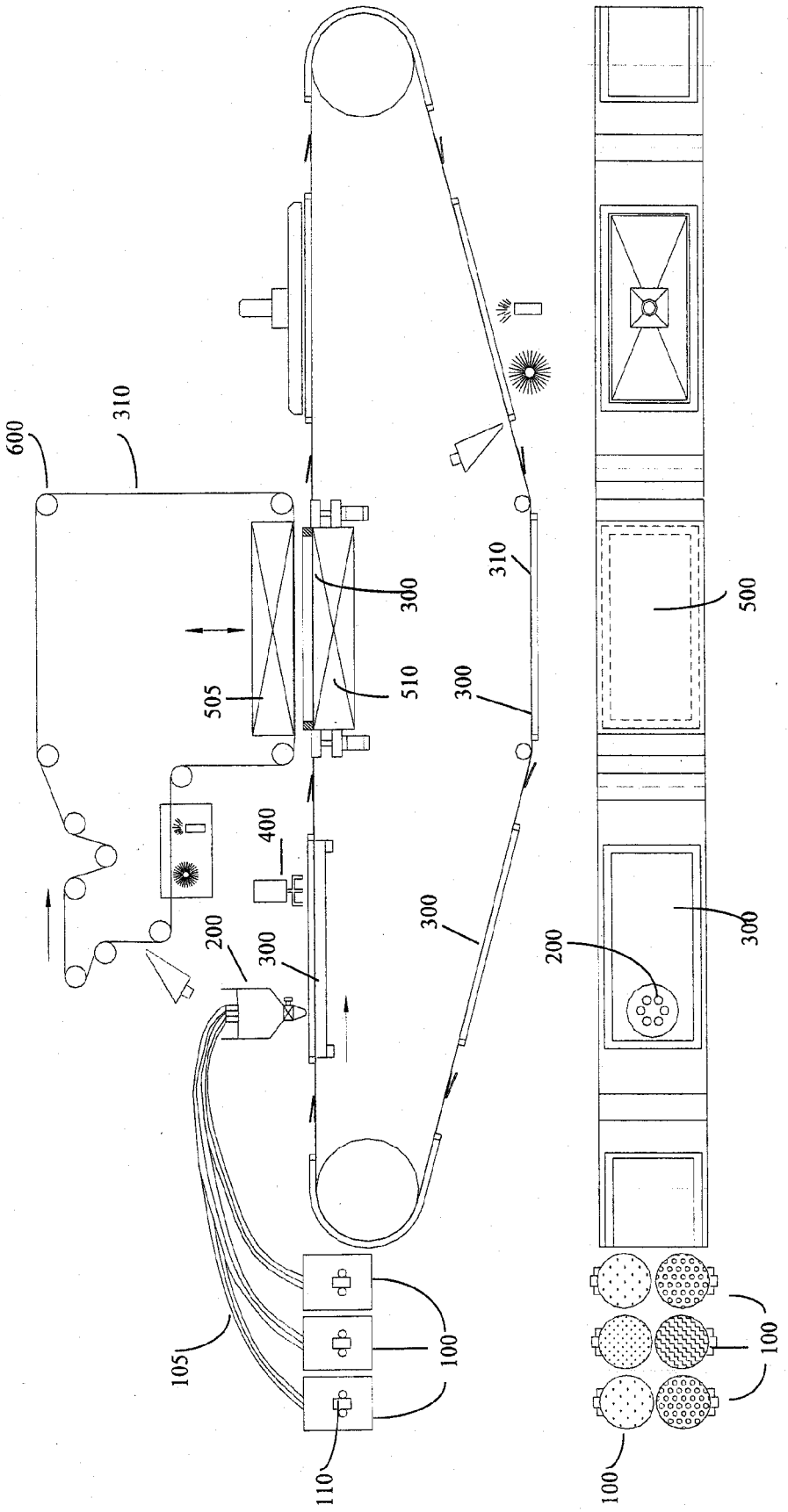

Fig. 1

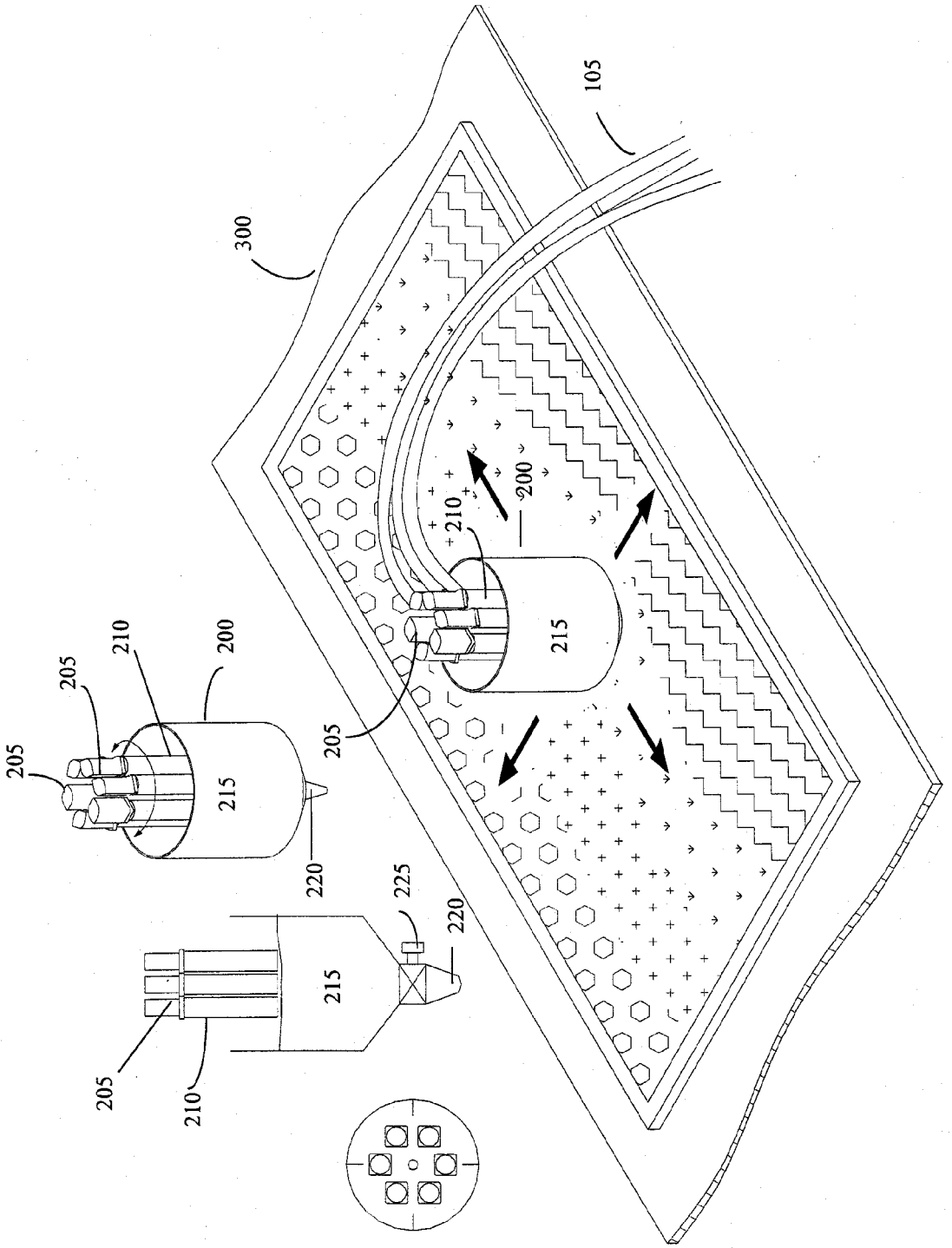

Fig. 2

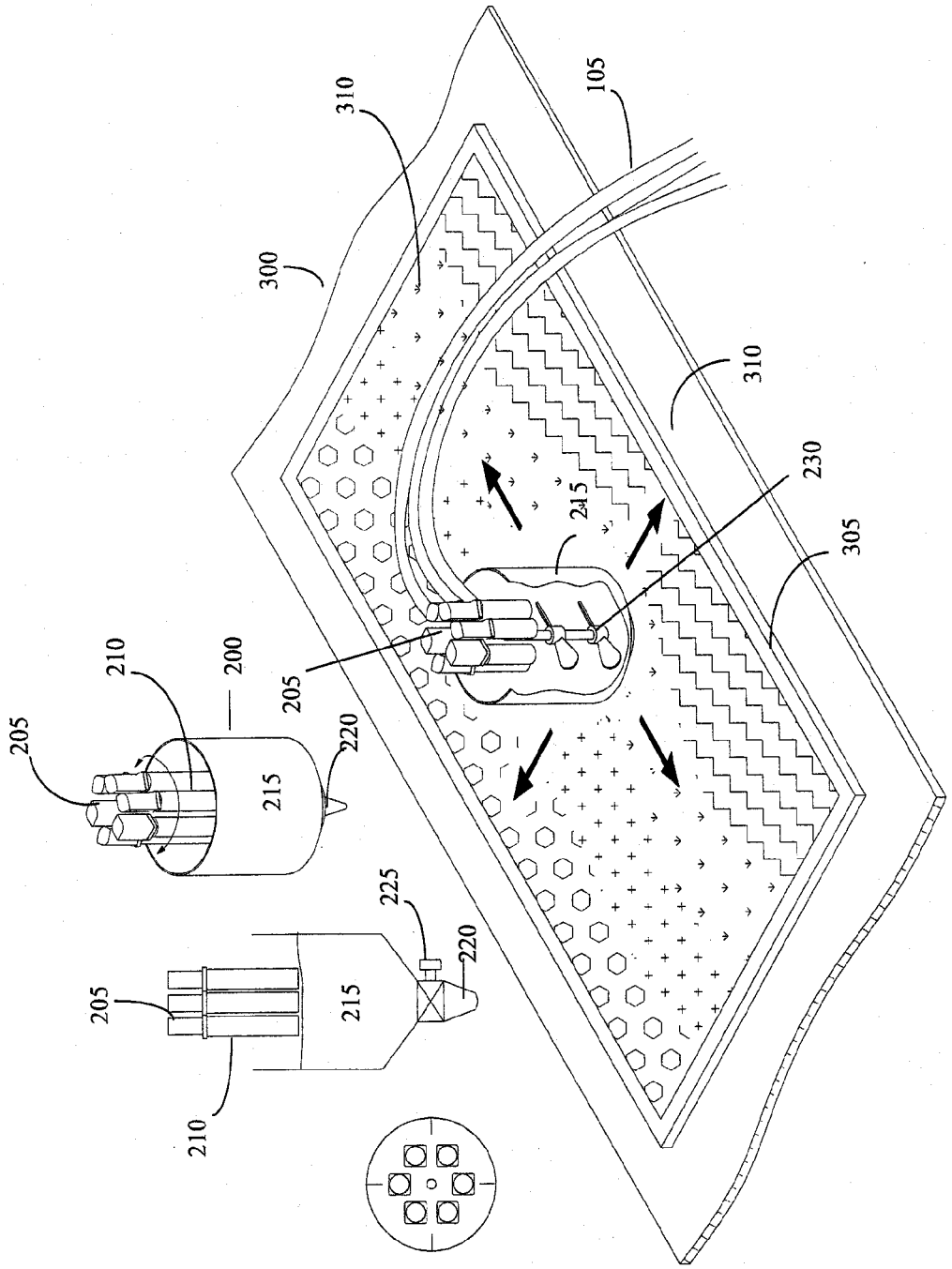
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Fig. 3

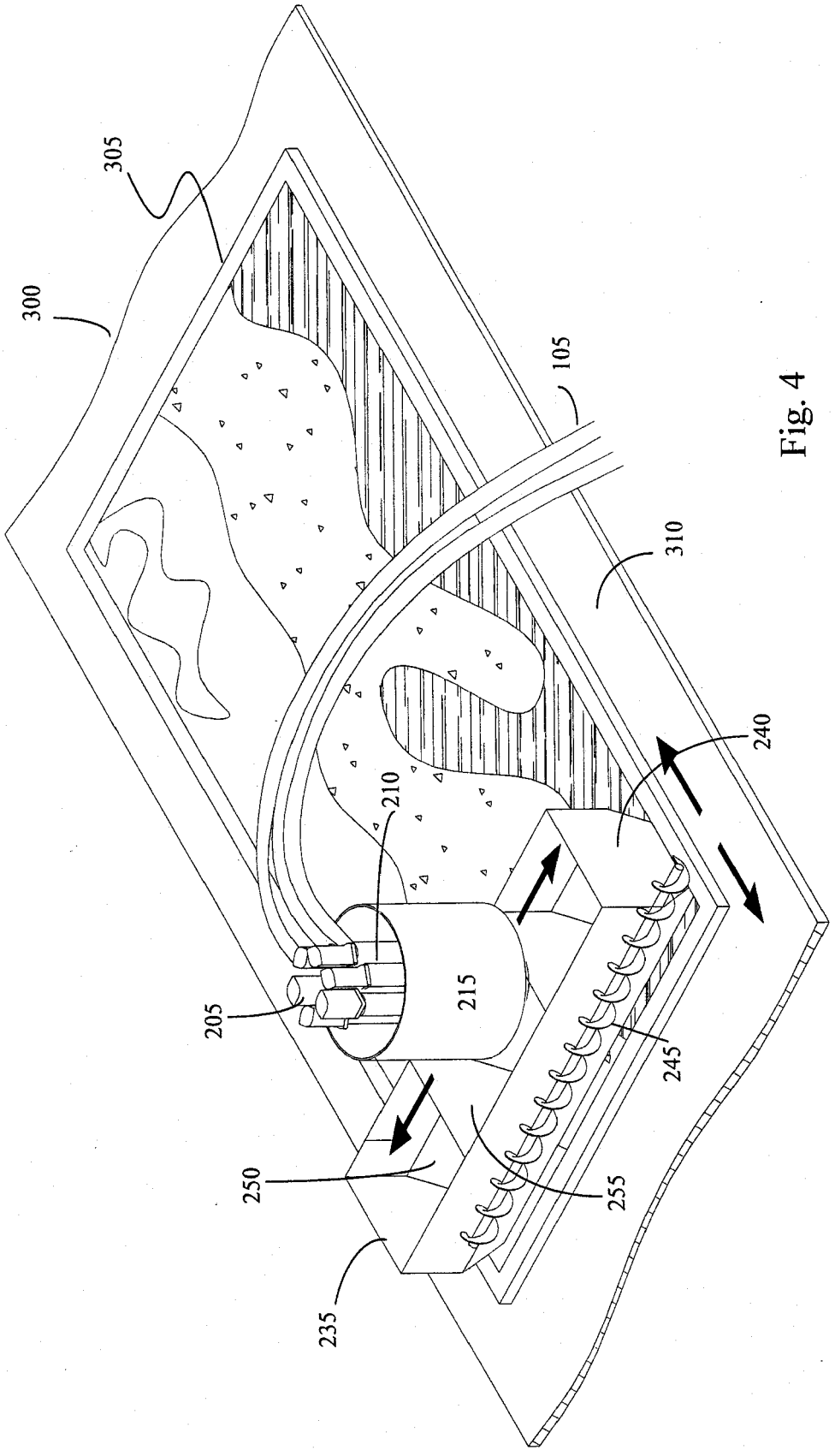
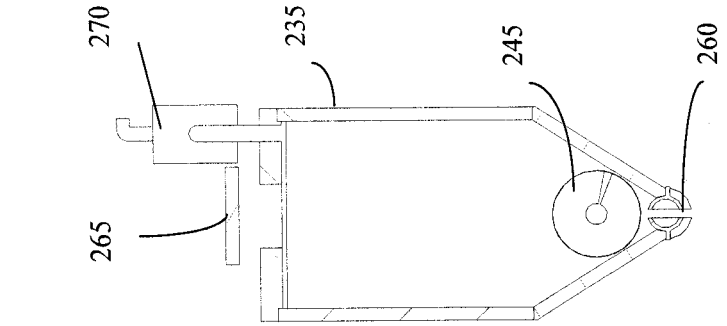


Fig. 4



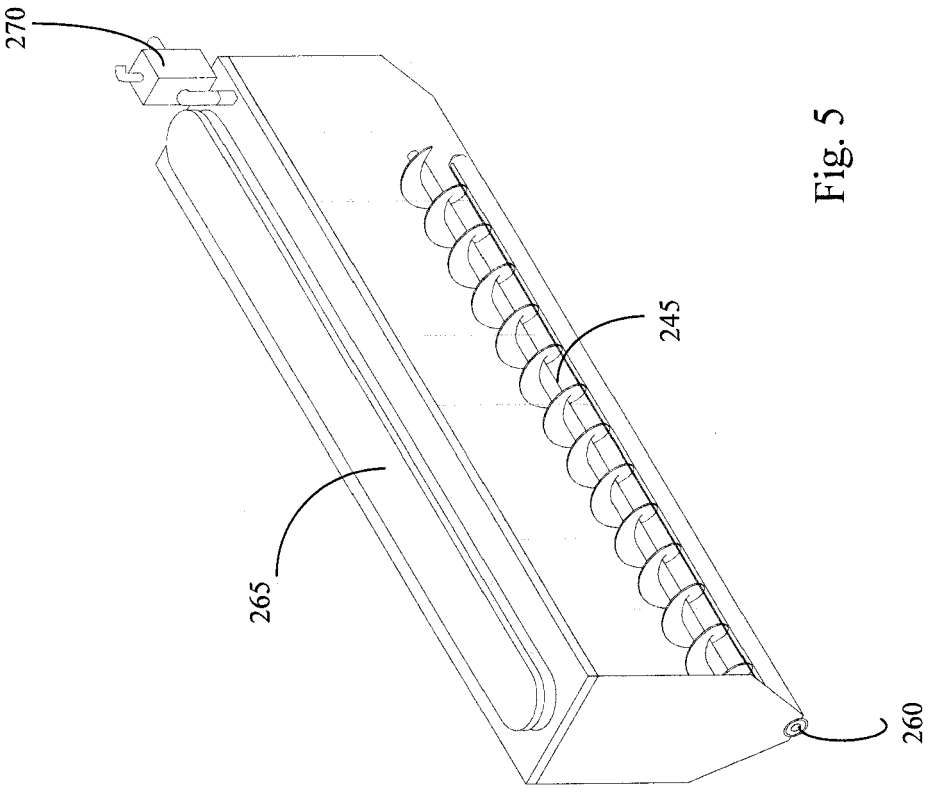


Fig. 5

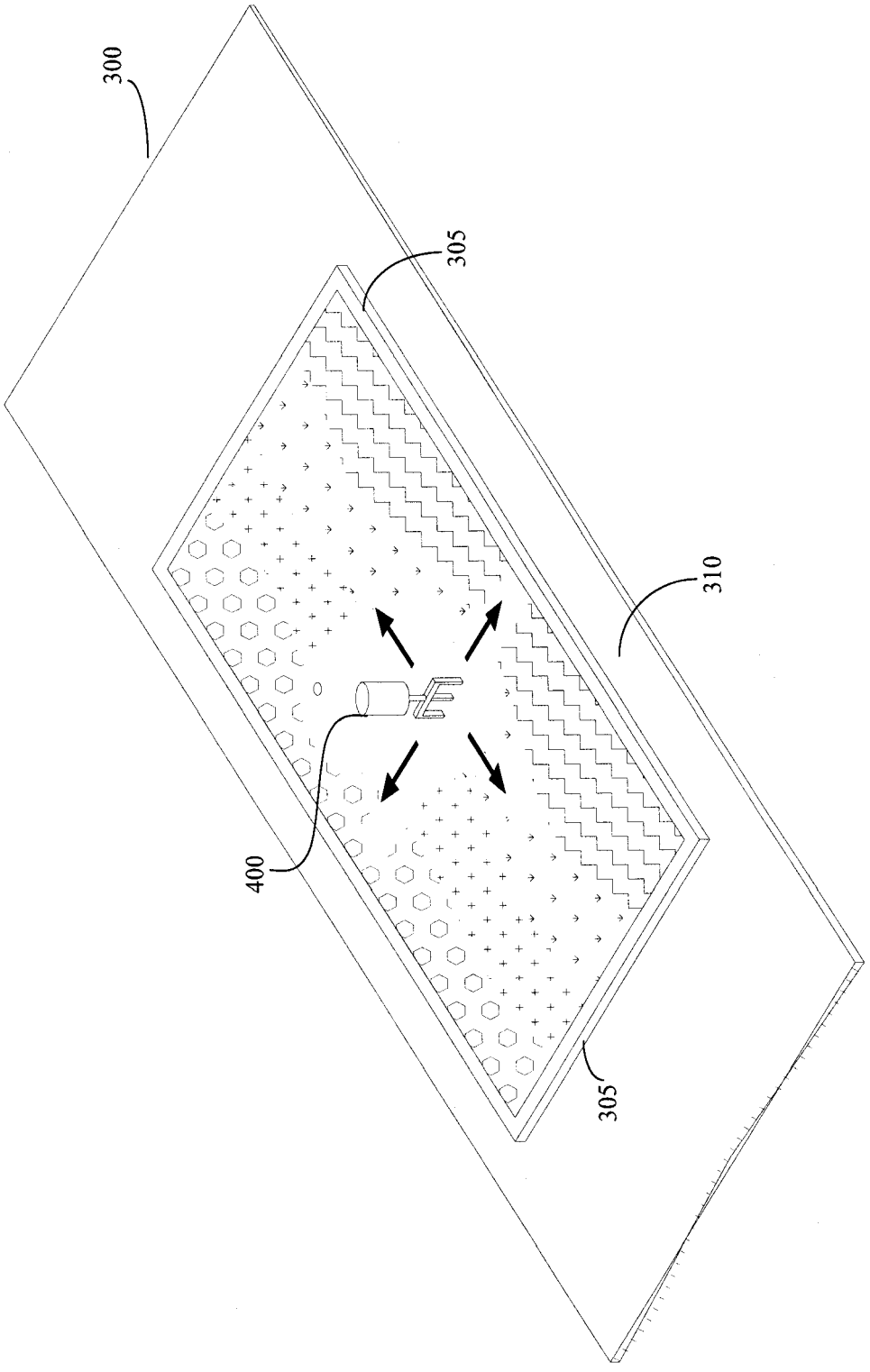


Fig. 6

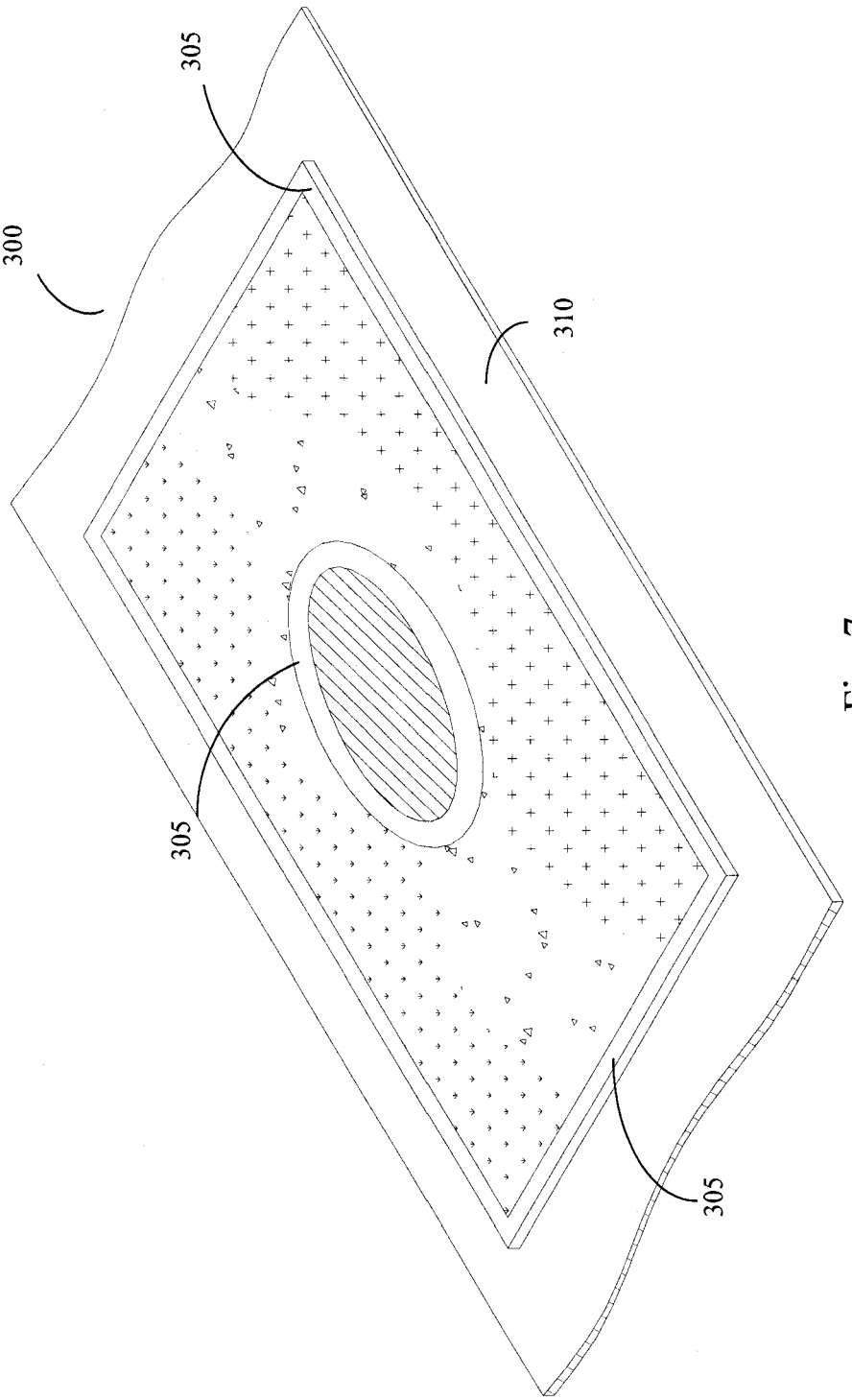


Fig. 7

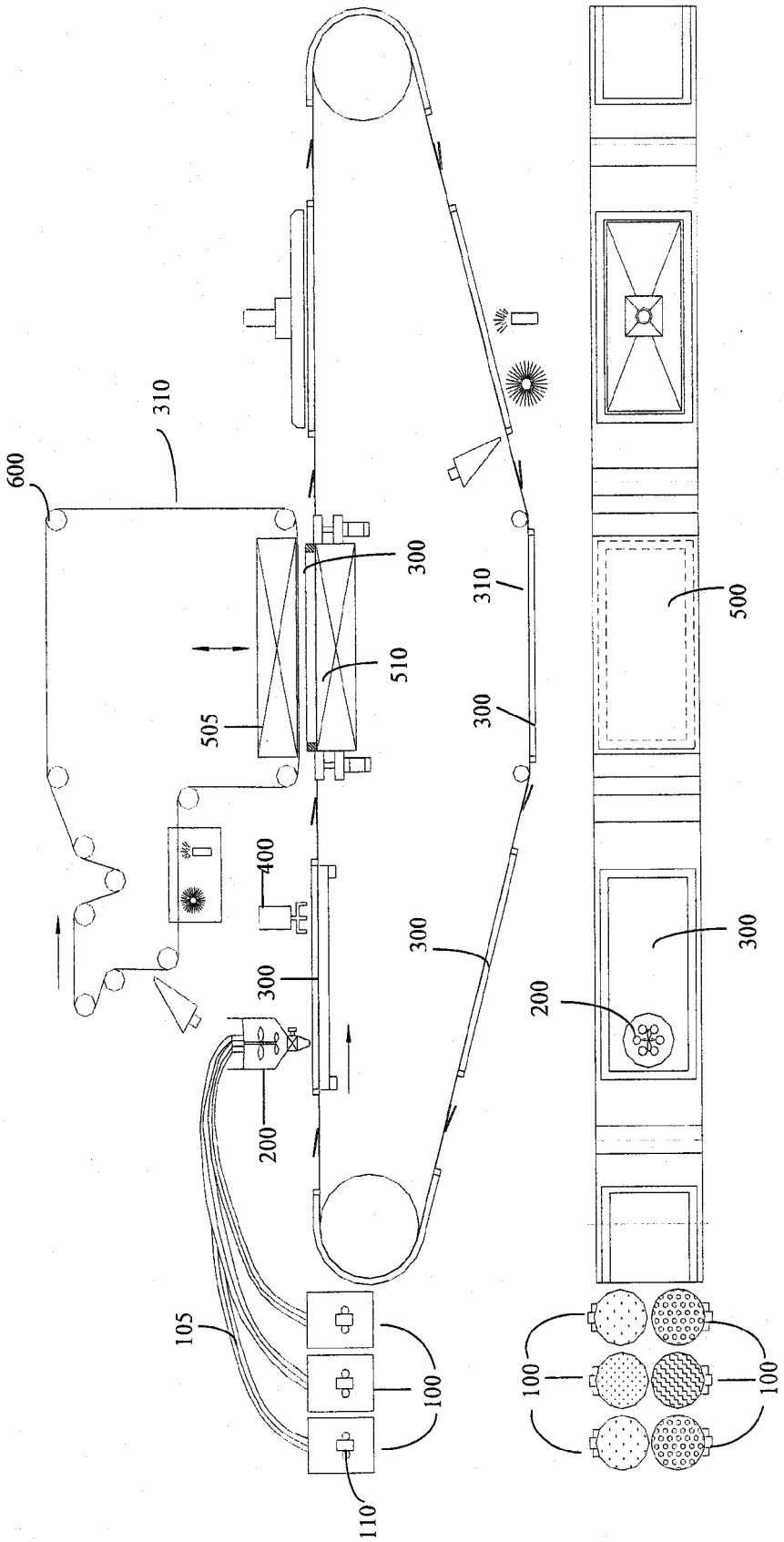

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Fig. 8

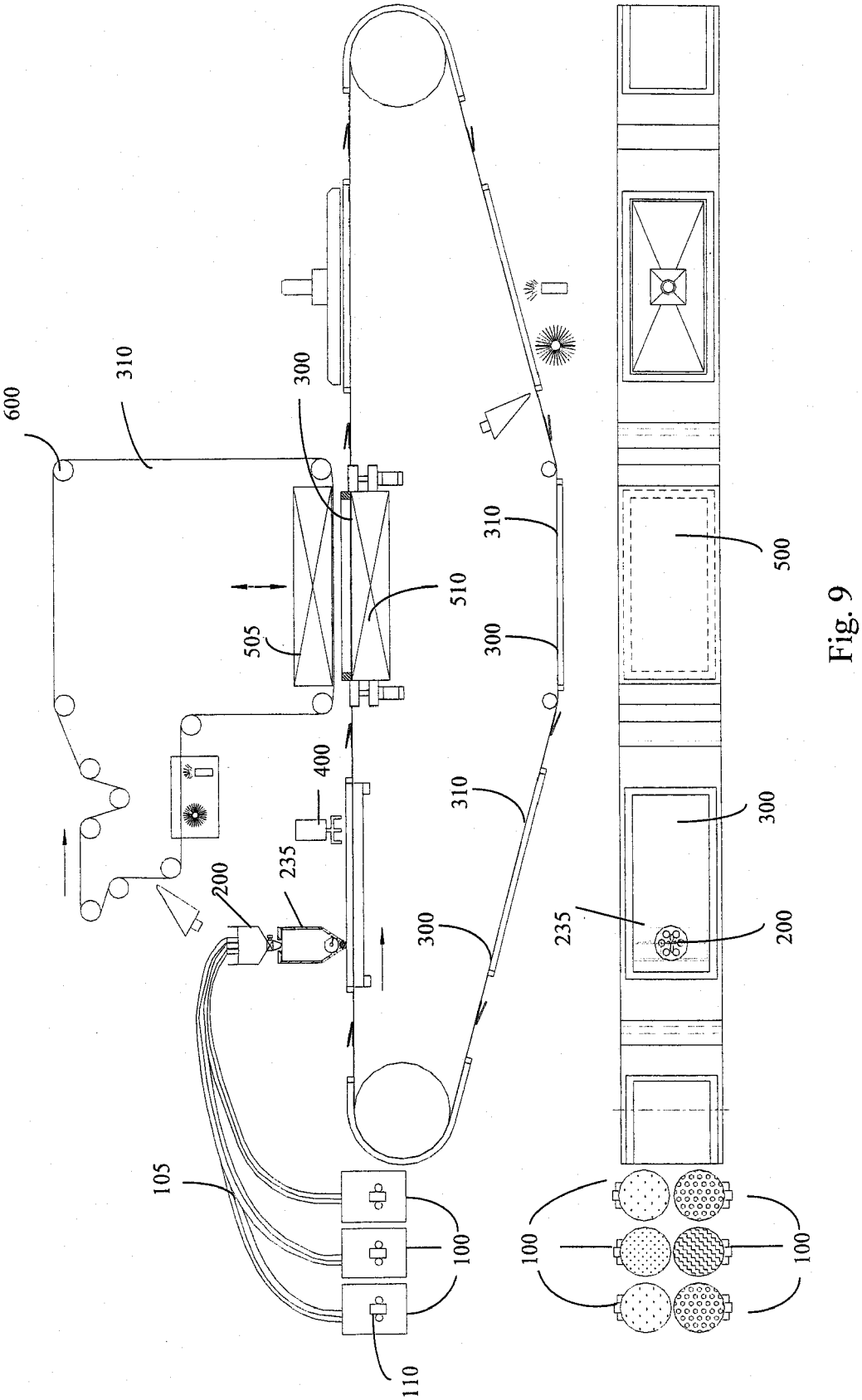
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Fig. 9

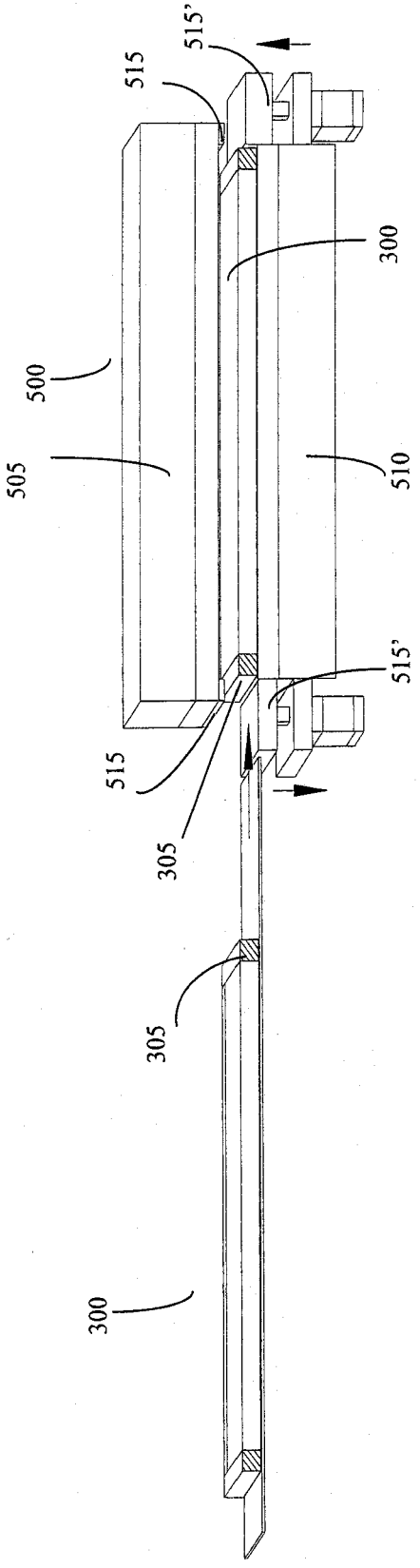
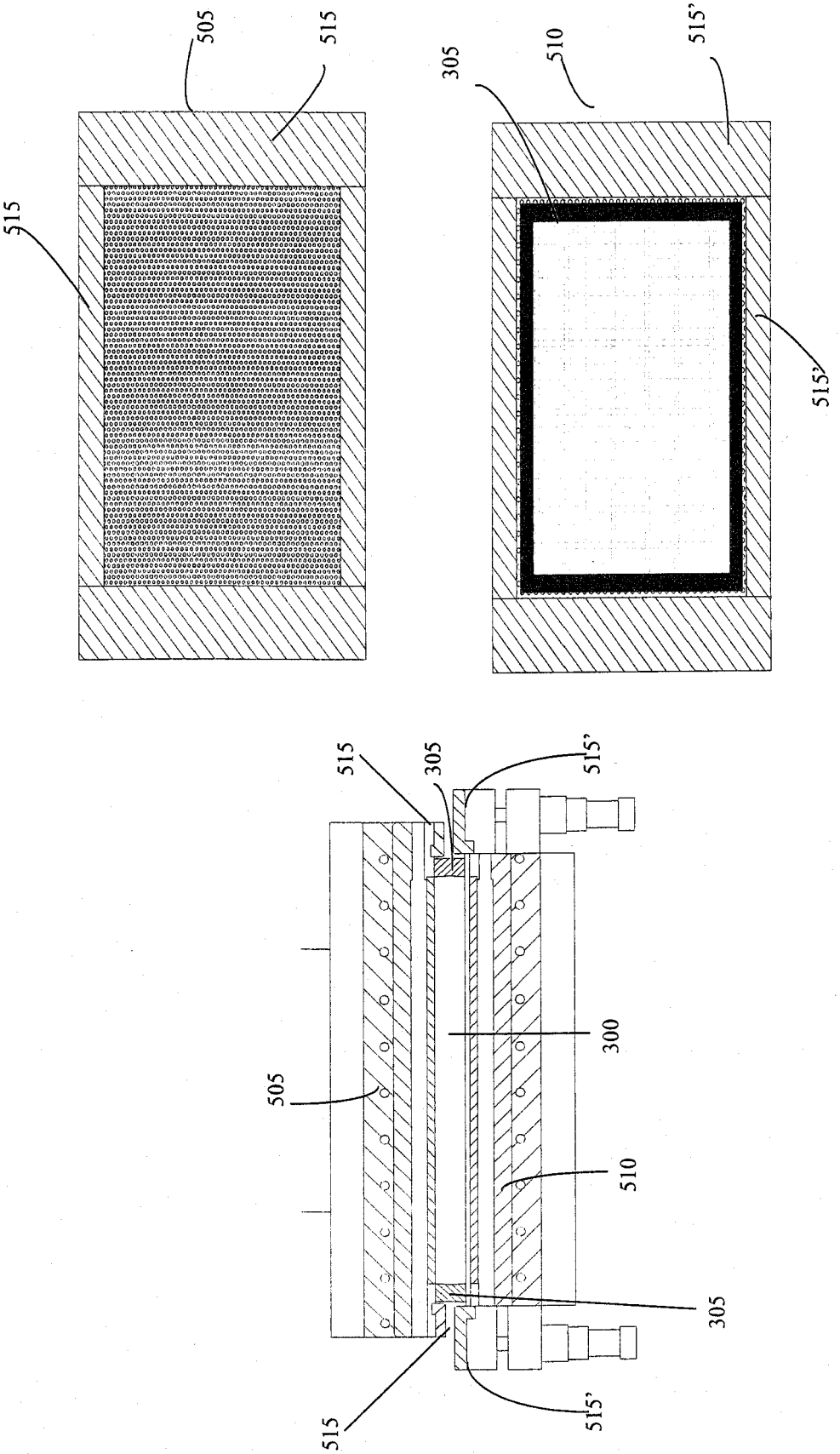


Fig. 10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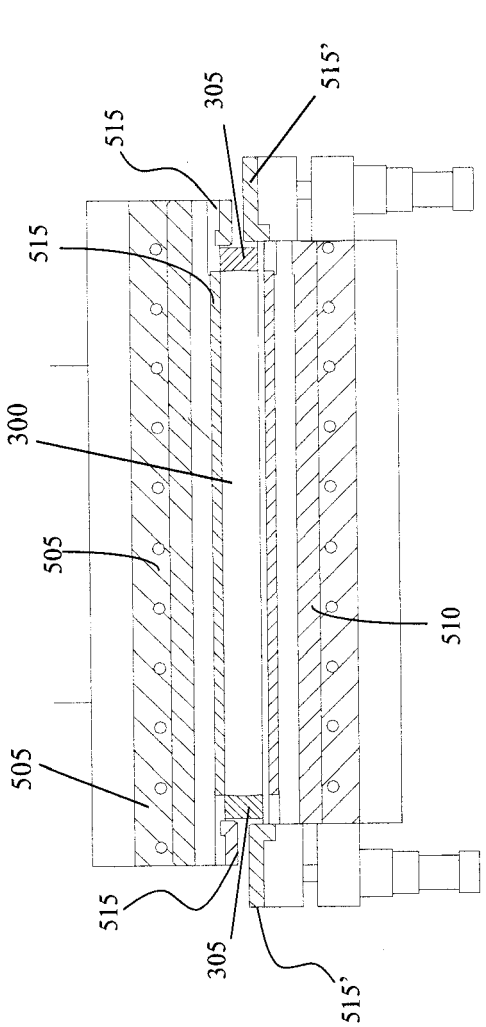
515'

Fig. 11


515'
305
515
515
300
505
510
505
515
305
515'

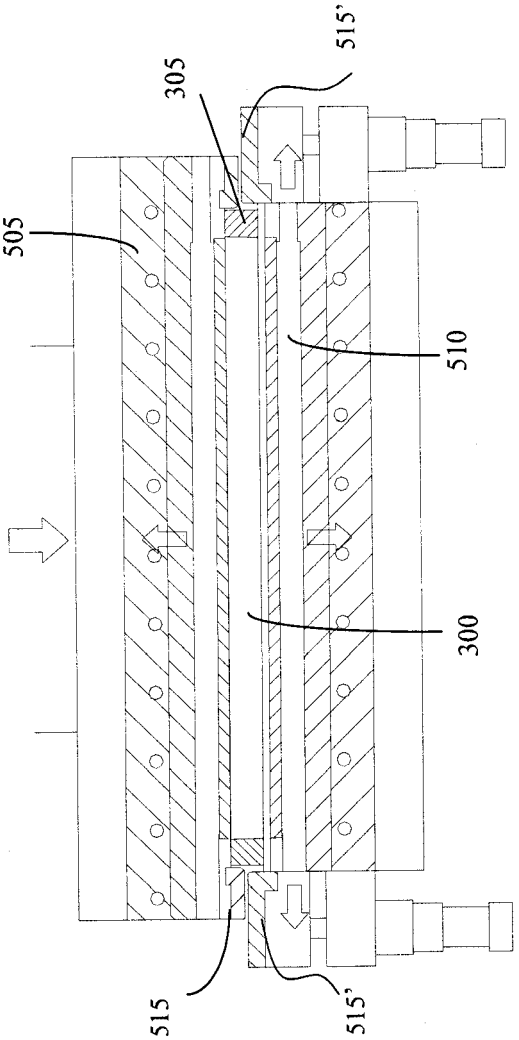

515'
305
505
510
300
515
515'

Fig. 12

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EUROPEAN SEARCH REPORT

Application Number
EP 07 11 6535

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	DE 26 08 133 A1 (BOER NV MASCHF DE) 1 September 1977 (1977-09-01) * pages 5-8; figures *	16-23	
Y	EP 0 756 922 A (SUMITOMO ELECTRIC INDUSTRIES [JP]) 5 February 1997 (1997-02-05) * pages 3-5; figures 1-3 *	24-31	TECHNICAL FIELDS SEARCHED (IPC) B28B
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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
The Hague	19 December 2008	Labre, Arnaud

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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Application Number
EP 07 11 6535

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 07 11 6535

The Search Division considers that the present European patentapplication does not comply with the requirements of unity of invention and relates to severalinventions or groups of inventions, namely:

1. claims: 1 (partially), 2-15, 32-51

   I:apparatus and method to improve the flow of a slurry for forming desired patterns on ceramic tile.

   ---

2. claims: 1 (partially), 16-23,

   II:apparatus for producing ready-to-use ceramic items with a desired pattern.

   ---

3. claims: 1 (partially), 24-31

   III:apparatus for removing excess water from a slurry for forming desired patterns on ceramic tile.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 11 6535

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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19-12-2008

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

REFERENCES CITED IN THE DESCRIPTION

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- EP 1334811 A **[0004]**