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(71) Applicant: **SACMI Cooperativa Meccanici Imola Società Cooperativa**
40026 Imola (Bologna) (IT)

(72) Inventors:
- **Ricci, Claudio**
  40026 Imola, Bologna (IT)
- **Acerbi, Pierugo**
  48010 Casola Valsenio (Ravenna) (IT)

(74) Representative: **Corradini, Corrado et al**
Ing. C. Corradini & C. S.r.l.
Via Dante Alighieri 4
42121 Reggio Emilia (IT)

(54) **A method and a plant for manufacturing cladding slabs and cladding slab**

(57) A method for manufacturing cladding slabs, comprising at least steps of: preparing a layer (M) of ceramic powder containing one or more inserts (100), such that each of the inserts (100) is uncovered at a rear surface (F) of the layer (M) of ceramic powder, pressing the layer (M) of ceramic powder, such as to be able to obtain a slab (N) of compacted powder containing the inserts (100); subjecting the slab (N) of compacted powder to a step of firing.

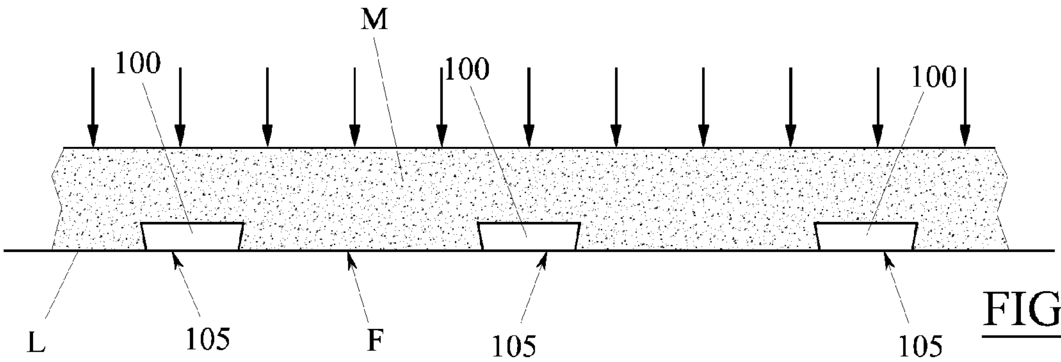


FIG.3

EP 2 762 284 A1

Description

[0001] The present invention relates to a method for manufacturing cladding slabs such as ceramic tiles and slabs. In more detail, the present invention relates to a method for manufacturing ceramic slabs destined to clad external walls of buildings, for example for realizing a type of wall known as "ventilated walls".

[0002] As is known, a ventilated wall is a special type of perimeter cladding which includes dry application, on an external wall of the building, of a series of panels destined to form a cladding layer which does not adhere to the wall but which is distanced therefrom by a gap. In this way, by predisposing openings at the base and top of the cladding layer, it is advantageously possible to obtain a natural circulation of air in the gap. This movement of air contributes to drying any infiltrations of water and to distancing the accumulated heat by solar radiation in the cladding layer, while at the same time improving the heat insulation and also the transpiration of the wall.

[0003] To realise a ventilated wall, an auxiliary support structure has first to be constructed. The support structure can be realized as framework of metal profiled members (uprights and crossbars), which are fixed to one another and anchored to the external wall of the building, for example by means of brackets and plugs. The panels of the cladding layer are then fixed to the framework, with the cladding layer hiding the support structure and remaining distanced from the wall of the building.

[0004] When the cladding panels are constituted by ceramic slabs, the fixing of the ceramic slabs to the support structure can be carried out using various systems, each of which in any case exhibits drawbacks which even with today's technology significantly limit the use of ceramic slabs in the realising of ventilated walls.

[0005] A first fixing system comprises realising, on the laying surface of the ceramic slabs, a series of blind holes having a smaller depth than the thickness of the slab. These blind holes are generally obtained by mechanical operations, for example by means of cutters or other appropriate diamond tools. A metal expanding plug is then inserted in the blind holes, which plug is provided with a screw causing expansion of the deformable body of the plug in the relative hole, which thus is anchored to the ceramic slab. In this way, the stem of the screw projects with respect to the laying surface of the ceramic slab, defining a threaded spur on which a bracket can be fastened for fixing the ceramic slab to the support structure.

[0006] A drawback of this solution consists in the fact that the mechanical working required for realising the blind holes normally requires a numerically-controlled machine, which makes it rather expensive both from the operative point of view and from the point of view of costs.

[0007] A further drawback is due to the fact that in order to be able to house the deformable body of the plug, the depth of each blind hole has to be quite significant, normally more than half the thickness of the ceramic slab. For this reason, the holed ceramic slabs are relatively fragile and can therefore be easily subject to breakage, both during the realization of the holes and during the anchoring of the plugs and the subsequent assembly thereof on the support structure, with a consequent increase in production waste and costs.

[0008] A further fixing system for ceramic slabs simply comprises using a series of metal staples, substantially U-shaped, which are fixed to the support structure and are able to grip the ceramic slabs at the corners thereof.

[0009] This system has the advantage of not requiring any mechanical working of the ceramic slabs, but exhibits the drawback that the metal staples are partially in view and therefore compromise the aesthetics of the whole system.

[0010] A further drawback of this solution further consists in the fact that the fixing staples are generally not suitable for mounting large-dimension ceramic slabs.

[0011] A third system comprises fixing the ceramic slabs to the support structure by means of metal connecting organs, such as for example eyelets or brackets, which are glued onto the laying surface of the ceramic slabs with structural adhesives.

[0012] The third system has the advantage of being invisible, as the connecting elements are hidden behind the ceramic slabs, but exhibits the drawback that the step of gluing implicates a high degree of uncertainty relating to the hold of the connection. In fact, in order to prevent detachment of the joint, the structural glues require a rigorous and strict control of the gluing process. Further, the joint obtained by gluing is susceptible over time to the external climatic conditions, which generally cause a progressive loosening thereof.

[0013] A fourth fixing system comprises using hooking elements, normally metal staples, which are fixed with known means to the support structure and hook to inside grooves or incisions that are realised in the ceramic slabs by means of diamond disc tools. These grooves or incisions can be realized along the perimeter edges of the ceramic slabs, or can have an oblique development and be realized on the laying surface, such that the hooking elements are completely hidden to view. This solution too, though configuring an invisible fixing system, exhibits drawbacks connected to the need to perform mechanical operations on the ceramic slabs. As mentioned above, these mechanical operations are in fact rather expensive, both from the operative point of view and in terms of costs, and tend to make the ceramic slabs more fragile (especially when realized on the laying surface) such that the ceramic slabs are more greatly subject to breakage. *The document* WO 93/00207 *discloses a method and an installation to manufacture ceramic slabs of the type referred to above, comprising the following steps:*

- *preparing a layer of ceramic powder comprising one or more inserts in a discountinuous mold* so *that each of said inserts is uncovered at the rear surface of the ceramic layer;*
- *pressing the layer of ceramic powder to get a slab*

of compacted power containing the inserts;

- *withdrawing the inserts from the ceramic slab to obtain cavities in the rear surface.*
- *After withdrawing the inserts fire the slab.*

[0014] *The document* JP 2009 096090 *discloses a method and an installation to manufacture ceramic slabs of the type referred to above, comprising the following steps:*

- *preparing in a ceramic mould one or more inserts of sintered magnetic powder suitable to block the insert to a metallic grid;*
- *add in the mould a layer of ceraminc powder to cover the inserts leaving uncovered the back surface of the inserts;*
- *press the ceramic layer to get a ceramic slab comprising the inserts;*
- *fire the compated layer to obtain the sintering of both the ceramic and the magnetic powder.*
- *The process does not provide to introduce in the mold solid inserts.*

[0015] An aim of the present invention is to provide a solution which enables solving or at least significantly reducing the mentioned drawbacks of the prior art.

[0016] A further aim is to attain the objective with a solution that is simple, rational and relatively inexpensive.

[0017] This and other aims are attained by the characteristics of the invention reported in the independent claims. The dependent claims delineate preferred and/or particularly advantageous aspects of the invention.

[0018] In particular, an embodiment of the present invention makes available a manufacturing method of cladding slabs, comprising at least steps of:

> preparing a layer of ceramic powder containing one or more inserts, such that each of the inserts is uncovered at a rear surface of the layer of ceramic powder,
> pressing the layer of ceramic powder, such as to be able to obtain a slab of compacted powder containing the inserts,
> subjecting the slab of compacted powder to a step of firing.

[0019] With this solution, the inserts integrated and sunken into the layer of ceramic powder can be advantageously exploited to simplify, after the firing step, the fixing of the finished ceramic slab to any support structure.

[0020] The inserts are further located only on the rear surface of the layer of ceramic powder, i.e. the layer which after the firing step defines the laying surface destined to be facing towards the surfaces to be clad, which therefore do not compromise the aesthetic aspect of the finished ceramic slab.

[0021] The adoption of these inserts further has a rather modest cost, generally lower than the cost of almost all the fixing systems known at present.

[0022] In an aspect of this embodiment of the invention, the step of preparing the layer of ceramic powder can in particular comprise:

> predisposing the inserts on a work plane, and
> depositing the layer of ceramic powder on the work plane such as to re-cover the inserts.

[0023] In this way the inserts can be sunken into the layer of ceramic powder quite simply and economically.

[0024] In particular, an embodiment of the invention comprises the work plane possibly being the surface of a sliding belt of a continuous forming plant.

[0025] This solution is advantageous as it enables applying the method of the invention to the traditional continuous forming processes of the ceramic slabs.

[0026] In this context, in an aspect of the invention the step of predisposing the inserts on the work plane can include:

> advancing the sliding belt,
> releasing at least an insert at a time onto the surface of the sliding belt.

[0027] This solution has the advantage of enabling an effective and relatively simple automation of the step of predisposing the inserts on the work plane.

[0028] A further aspect of this embodiment of the invention comprises in particular subjecting the layer of ceramic powder to a step of pressing on the surface of the sliding belt, such as to obtain a layer of compacted ceramic powders, and then cutting the layer of compacted powders into slabs singly provided with at least one of the inserts.

[0029] In this way it is advantageously possible to obtain, starting from a continuous layer of ceramic powder, the single slabs of compacted ceramic powder which will thereafter be subjected to firing and which thus will realize the finished ceramic slabs.

[0030] Possibly, before the firing step, the slabs into which the layer of compacted powder is subdivided can be subjected to a further pressing step, for example by inserting each single slab into a ceramic die associated to a discontinuous press. In a different embodiment of the present invention, the work plane can be a surface of a punch which delimits the forming cavity of a ceramic die.

[0031] This solution is advantageous as it enables applying the method according to the invention to the traditional discontinuous forming processes of the ceramic slabs. In this context, in an aspect of the invention the step of predisposing the inserts on the work surface can comprise further steps of:

> predisposing the inserts in a predetermined reciprocal position on a service plane, and

transferring the inserts from the service plane to the work plane maintaining the inserts in a reciprocal position to the position thereof on the service plane.

[0032] In this way it is advantageously possible to predispose the inserts on a service plane located for example externally of the ceramic die, in a relatively simple and easy way, and then simply to transfer the inserts from the service plane to the work plane located internally of the forming cavity of the die, for example by means of a robotic arm provided with adequate gripping means for the inserts.

[0033] In an aspect of the invention, the service plane can be the surface of a sliding belt, and the step of predisposing the inserts on the service plane can therefore include:

advancing the sliding belt, and
releasing at least an insert at a time onto the surface of the sliding belt.

[0034] This solution has the advantage of enabling an effective and relatively simple automation of the step of predisposing the inserts on the service plane. Returning to the inserts, in an embodiment of the invention the inserts can be destructible at a lower temperature or at the maximum temperature to which the compacted powder is heated during the firing step.

[0035] In this way, the inserts function substantially as forming cores which are destroyed, for example by burning, during the firing step, leaving cavities or blind holes in the finished ceramic slab, which can advantageously house fixing means of a conventional type, for example expanding plugs, with the advantage that the cavities do not require any mechanical working on the ceramic slab.

[0036] In a further embodiment of the present invention, the inserts can alternatively be resistant to the maximum temperature to which the slab of compacted powder is heated during the firing step.

[0037] In this way, after the firing step, the inserts are integral and solidly anchored to the finished ceramic slab, without having to carry out any subsequent work.

[0038] The inserts surface onto the ceramic material, so that they can advantageously function as connecting elements for the ceramic slab with a support structure.

[0039] In order to carry out this function, in an aspect of the invention the inserts can comprise at least a threaded organ, for example a threaded organ such as a sort of nut, which comprises an internally-threaded hole.

[0040] In this way, the fixing of the ceramic slabs to the relative support structures can advantageously be rather simple, practical and relatively economical.

[0041] In a further aspect of the invention, each of the inserts has a different shape from a perfect solid of revolution.

[0042] For example, each insert can comprise at least a facet, i.e. a surface, among those located internally of the layer of ceramic powder, which surface is flat and not parallel to the rear surface of the layer of ceramic powder. Alternatively, the insert might comprise one or more recesses fashioned in the portion located internally of the layer of ceramic powder, or it might have a complex shape, for example oval or poly-lobed.

[0043] The advantage of these solutions is that it prevents or at least opposes the rotation of the insert internally of the ceramic material, after it has hardened following the firing step.

[0044] In a further aspect of the invention, each of the inserts can further comprise at least a surface, once more from among those located internally of the layer of ceramic powder, which is in undercut with respect to the rear surface of the layer of ceramic powder.

[0045] The surface in undercut has the advantage of preventing or at least opposing the separation by extraction of the relative insert with respect to the ceramic material of the slab, after the ceramic material has hardened following the firing step.

[0046] The present invention further makes available a plant for manufacturing cladding slabs, which in general terms comprises:

means for preparing a layer of ceramic powder containing one or more inserts in such a way that each of the inserts is uncovered at a rear surface of the layer of ceramic powder,
means for pressing the layer of ceramic powder, such as to be able to obtain a slab of compacted powder containing the inserts,
means for subjecting the slab of compacted powder to a step of firing.

[0047] The advantages of this plant are substantially the same as the method described previously, among which in particular the advantage of obtaining ceramic slabs which can be fixed to the relative support structure in a simpler and more effective way with respect to the prior art.

[0048] Naturally the apparatus of the invention can possibly be equipped with further means for carrying out all the accessory steps of the method that have been described herein above.

[0049] Lastly a further embodiment of the present invention makes available a cladding slab comprising a layer of ceramic material containing one or more inserts, each of which is uncovered at a rear surface of the layer of ceramic material.

[0050] As mentioned in the foregoing, the advantage of this embodiment is to disclose a ceramic slab which can easily be fixed to any support structure.

[0051] Further characteristics and advantages of the invention will emerge from a reading of the following description, provided by way of non-limiting example, with the aid of the figures illustrated in the accompanying tables of drawings.

Figures from 1 to 4 illustrate four steps of a method for manufacturing ceramic slabs according to the present invention.

Figure 5 is a lateral view of a first example of an insert which is destined to be used in the manufacturing method of the present invention.

Figure 6 is a plan view of the insert of figure 5.

Figure 7 shows the insert of figure 5 in the layer of ceramic powders of figure 2, the insert being section along plane VII-VII indicated in figure 6.

Figure 8 is a lateral view of a second example of an insert which can be used in the manufacturing method according to the present invention.

Figure 9 is a plan view of the insert of figure 8.

Figure 10 shows the insert of figure 8 in the layer of ceramic powders of figure 2, the insert being sectioned according to plane X-X shown in figure 9.

Figure 11 is a lateral view of a third example of an insert that can be used in the manufacturing method according to the present invention.

Figure 12 is a plan view of the insert of figure 11.

Figure 13 is the insert of figure 11 in the layer of ceramic powders of figure 2,the insert being sectioned along plane XIII-XIII shown in figure 12.

Figure 14 is a lateral view of a fourth example of insert, which is destined to be used in the manufacturing method of the present invention.

Figure 15 is a plan view of the insert of figure 14.

Figure 16 is the insert of figure 14 in the layer of ceramic powders of figure 2, the insert being section along plane XVI-XVI included in figure 15.

Figure 17 is a lateral view of a fifth example of insert which is destined to be used in the manufacturing method of the present invention.

Figure 18 is a plan view of the insert of figure 17.

Figure 19 shows the insert of figure 17 in the layer of ceramic powders of figure 2, the insert being section along plane IXX-IXX shown in figure 18.

Figure 20 is a schematic lateral view of a continuous forming plant equipped to carry out a method according to the present invention.

Figure 21 is a view from above of the plant of figure 20.

Figure 22 is a larger-scale detail of figure 20 which shows a station for depositing inserts.

Figure 23 is section XXIII-XXIII shown in figure 22.

Figure 24 is a schematic view from above of a discontinuous forming plant equipped to carry out a method according to the present invention, in which the ceramic press is shown sectioned along plane XXV-XXV indicated in following figure 25.

Figure 25 is a schematic front view of the ceramic press of the forming plant of figure 24.

Figure 26 is a larger-scale detail of figure 24 which shows an automatic device for arranging the inserts in a predetermined reciprocal position.

Figure 27 is a schematic lateral view of the device of figure 26.

[0052] The figures illustrate some embodiments of a manufacturing method of ceramic slabs starting from ceramic powders, for example semi-dry ceramic powders.

[0053] The ceramic powders are conventionally obtained from a predetermined ceramic mixture, which usually contains various percentages of clayey materials, such as for example kaolins, aggregate materials, such as for example quartz sands, fusing materials, such as for example feldspars. The ceramic mixture can be prepared internally of special grinding mills, such as to obtain a slip which can then be dried by atomization with the aim of obtaining the above-mentioned ceramic powders.

[0054] In general terms, an embodiment of the method of the invention first comprises making an orderly arrangement of a plurality of inserts 100 resting on a work plane L (see figure 1). A soft layer M of ceramic powders is then deposited on the work plane L (see figure 2), which powders completely cover the inserts 100, leaving only the surfaces 105 resting on the work plane L uncovered.

[0055] In this way, the inserts 100 are intimately sunken in the soft layer M of ceramic powder, with respect to which they are uncovered and emerge only at the rear surface F thereof which rests on the work plane L. In the present example, the rear surface F of the soft layer M defines the laying surface of the ceramic slab to be manufactured, i.e. the surface destined to be facing towards the surface to be clad.

[0056] The method of the invention then includes subjecting the soft layer M to at least a pressing step (see figure 3), such as to obtain an unfired slab N of compacted ceramic powders which comprises and surrounds the inserts 100 (see figure 4). After pressing, the unfired slab N can be subjected to the usual drying step and also possibly the decoration, before being subjected to a high-temperature firing step in a ceramic kiln, which enables the finished ceramic slab to be obtained. Returning to the inserts 100, these elements are in general compact bodies of solid material which are first realised.

[0057] With the aim of preventing possible dishomogeneity in the agglomerating of the ceramic powders and therefore consequent cracks on pressing and/or firing, the height h of the inserts 100 must be considerably less than the total height (thickness) H of the unfired slab N. In particular, the ratio between the height h of each insert 100 and the thickness H of the unfired slab N can be less than 0.7, for example preferably comprised between 0.3 and 0.6.

[0058] In an embodiment of the above-delineated method, the inserts 100 are resistant to maximum temperatures reached by the ceramic kiln during the firing step, which can reach and at times exceed 1200°C.

[0059] To obtain this effect, the inserts 100 can be made of a metal material, for example steel, and preferable low-carbon stainless steel. In particular, the inserts 1000 can be realized using steels classified as AISI 304L and AISI 316L. However the inserts 100 can also be realized with non-metal materials, as long as these materials are in all cases resistant to the maximum temperatures reached during the firing step.

[0060] With this solution, on terminating the firing step, the inserts 100 are substantially integral and solidly anchored to the ceramic matrix of the finished slab.

[0061] In this case, the inserts 100 can be conformed such as to function as connecting elements for the finished ceramic slab with a relative support structure, for example with a support structure for a wall of the type known as a "ventilated wall".

[0062] As illustrated in all the variants of from figure 5 to figure 16, each insert 100 can for example be provided with a threaded through-hole 110, preferably though not necessarily a threaded hole M6 or M8, which develops with an axis that is perpendicular to the flat surface 105 which is able to be directly rested on the work plane L.

[0063] In this way, the threaded hole 110 is exposed at the rear surface or laying surface of the finished ceramic slab or threaded connecting bar, by means of which it will thus be possible to connect the finished ceramic slab to the relative support structure.

[0064] To prevent the threaded hole 110 from filling up with ceramic powder during the deposition of the soft layer M, the threaded hole 110 can be priorly closed with a threaded grub screw, which can be removed and saved after the firing step, or can be made with an expendable material which is destroyed (for example melts) during the step of firing, completely freeing the threaded hole 110.

[0065] To enable an effective connection between the finished ceramic slab and the relative support structure, it is further necessary for each insert 100 to be intimately joined to the ceramic matrix of the finished slab. In particular, it is generally necessary that during the screwing-up of the respective screw or threaded connecting bar, the insert 100 cannot rotate on itself about the axis of the threaded hole 110. Further, it is generally necessary for an excessive screwing-up of the screw or threaded connecting bar, which would press on the ceramic matrix closing the bottom of the threaded hole 110, to be prevented from causing extraction of the insert 100.

[0066] To prevent rotation, each insert 100 can in general have a different shape from a perfect solid of revolution with a perpendicular axis to the rear surface F of the soft layer M of ceramic powder. For example, the part of the insert 100 that is located internally of the soft layer M of ceramic powder can comprise at least a recess or at least a faceted surface, i.e. a surface which is flat and not parallel with respect to the rear surface F resting on the work plane L.

[0067] In this way, at the end of the firing step, a shape constraint is formed between the surface of the recess and/or the faceted surface and the hardened ceramic material which covers them, which constraint effectively opposes rotation of the insert 100 about the axis of the threaded hole 110.

[0068] To prevent extraction, each insert 100 can comprise at least a surface, once more between the surfaces located internally of the soft layer M of ceramic powder, which is undercut with respect to the rear surface F which rests on the work plane L. In this way, at the end of the firing step, between the undercut surface of the insert 100 and the ceramic material which covers it a shaped constraint is realized which effectively opposes extraction of the insert 100 from the finished ceramic slab.

[0069] It is however stressed that this undercut must not be too great, in order to enable the ceramic powder of the soft layer M to completely surround the insert 100, without there being empty zones which would give rise to pressing defects. Taking account of the preceding considerations, it is clear that the inserts 100 can be realised in even very different shapes, some examples of which are described in the following.

[0070] In the illustrated embodiment of figures from 5 to 7, the insert 100 is conformed as a truncoconical body, the smaller base of which defines the flat surface 105 which can be rested on the work plane L. In this way, the lateral surface 115 of the truncoconical body defines a tapering which is in undercut with respect to the rear surface F of the soft layer M such that after the firing step the hardened ceramic material prevents the extraction of the insert 100.

[0071] The insert 100 illustrated in figures from 5 to 7 further comprises two axially-developing recesses 120, positioned on diametrically opposite sides, each of which defines three flat surfaces perpendicular to the surface 105 which is rested on the work plane L. In this way, during the deposition of the soft layer M the ceramic powders fill the recesses 120 and adhere to the relative flat surfaces thereof, such that after the firing step the hardened ceramic material realizes a sort of joint which prevents rotation of the insert 100 about the axis of the threaded hole 110.

[0072] In the embodiment illustrated in figures from 8 to 10, the insert 100 is substantially similar to the one described herein above, with the only difference being that the two recesses 120 are substituted by a single facet 130 fashioned on the conical surface 115, which defines a flat surface perpendicular to the surface 105 which is rested on the work plane L. In this way, during the depositing of the soft layer M, the ceramic powders adhere to the flat surface of the facets 130 such that, after the firing step, the hardened ceramic material obstructs the rotation of the insert 100 about the axis of the threaded hole 110. Also in the embodiment illustrated in figures from 11 to 13, each insert 100 is substantially alike to the one in the first example, with the only difference being that the two recesses 120 are replaced by six facets 135 fashioned on the conical surface 115 in proximity of the larger base, each of which defines a flat surface perpendicular to the surface 105 which is rested on the work plane L. In this case too, during the depositing of the soft layer M, the ceramic powders adhere to the flat surface of the facets 135 such that, after the firing step, the hardened ceramic material effectively obstructs the rotation of the insert 100 about the axis of the threaded hole 110.

[0073] The advantage of this third embodiment consists in the fact that the insert 100 in question can easily be realised starting from a threaded nut substantially of a commercially-available type, for example by means of a mechanical lathing operation.

[0074] In the embodiment illustrated in figures from 14 to 16, the insert 100 has a substantially cylindrical shape having a flat end able to define the surface 105 which is rested on the work plane L, and an opposite end which is provided with an annular flange 140 with an increased diameter. In this way, the annular flange 140 defines a surface which is undercut with respect to the rear face F of the soft layer M such that after the firing step the hardened ceramic material effectively opposes the axial extraction of the insert 100.

[0075] The flange 140 in turn exhibits three recesses 145, arranged angularly equidistantly about the central axis of the threaded hole 110, each of which defines three flat surfaces which are perpendicular to the flat surface 105 which is rested on the work plane L. In this way, during the depositing of the soft layer M, the ceramic powders fill the recesses 145 and adhere to the relative flat surfaces thereof such that after the firing step the hardened ceramic material realizes a sort of joint which prevents the rotation of the insert 100 about the axis of the threaded hole 110.

[0076] In a different embodiment of the present invention, the inserts 100 can alternatively be destructible (or are destroyed) at a lower than or equal temperature to the maximum temperature to which the unfired slab N is heated during the firing step.

[0077] To obtain this effect, the inserts 100 can be realized in a synthetic or natural material (wood fibre, polymers, resins, plastics etc.) which substantially retain the shape thereof during the step of pressing (possibly with a reduction of the volume thereof) but which during the following firing step, and preferably in the first instants of the firing step, burn or are completely destroyed.

[0078] In this way, a plurality of cavities will be defined on the rest surface of the finished ceramic slab, which cavities will, in negative, have the same shape as the inserts 100. The cavities can then advantageously be used to receive appropriate expansion plugs, by means of which the ceramic slab can be fixed to the relative support structure.

[0079] In this case, a possible geometry for the inserts 100 is illustrated in figures from 17 to 19. The inserts 100 in general exhibit a first cylindrical tract 155, a base of which defines the surface 106 able to be rested on the work plane L, and a following coaxial truncoconical tract 160, which is positioned on the opposite side to the surface 105 and exhibits a conicity which broadens in a distancing direction from the cylindrical tract 155. In this way, after the firing step, the truncoconical tract 160 of the insert 100 will leave, on the rest surface of the ceramic slab, a cavity in an undercut, which is able to effectively receive the deformable body of a connecting expansion plug of known type.

[0080] The manufacturing method, which has been defined in the foregoing in the general aspects thereof, can be effectively implemented on a large scale by means of a continuous forming apparatus for ceramic tiles or slabs, such as the one illustrated in figure 20.

[0081] The continuous forming plant 200 essentially comprises a flexible conveyor belt 205, which is closed-loop-wound about a plurality of horizontal-axis rollers 210, of which a series of idle relay rollers and at least a motorized drive roller able to activate the conveyor belt 205 in sliding. Along this closed-loop pathway, the conveyor belt 205 exhibits an upper tract 215 that is substantially horizontal and slidable in a predetermined advancement direction A, the surface of which defines the work plane L of this plant.

[0082] A depositing station 220 is installed above the upper surface 215 of the conveyor belt 205, which is able to release, in an ordered way, the inserts 100 on the advancing work plane L.

[0083] In the illustrated example, the depositing station 220 comprises a plurality of automatic dispensers 225, which are installed in a fixed position with respect to the upper tract 215 of the conveyor belt 105. As illustrated in figures 22 and 23, each automatic dispenser 225 comprises a collecting tube 230 having a vertical axis, which is able to receive a pile of inserts 100 which are reciprocally superposed and having the rest surfaces 105 thereof all facing downwards. The internal diameter of the collector tube 230 is a little bigger than the maximum external diameter of each single insert 100, such that the inserts 100 are guided to remain substantially coaxial with the collector tube 230. The inserts 100 can be supplied internally of the collector tube 230 by means of common automatic vibration orientation systems (not illustrated), which can be associated to the upper mouth of the collector tube 230. The lower mouth of the collector tube 230 is located above the upper tract 215 of the conveyor belt 205, from which it is separated by a distance of slightly greater than the height of a single insert 100. Obturator means are further associated to the collector tube 230, which obturator means 230 are able to selectively open and close the lower mouth, such as to enable depositing of an insert 100 at a time on the underlying upper tract 215 of the conveyor belt 205. In the illustrated example, the obturator means comprise a vertical-axis flat disc 235, which is located such as to intercept the lower mouth of the collector tube 230. The disc 235 is out-of-axis with respect to the collector tube 230 and is provided with a series of offset through-holes 240, each of which has a substantially equal diameter to the diameter of the lower mouth of the collector tube 230. The disc 235 is able to rotate about the vertical axis thereof, activated for example by an electric motor 245, such that the through holes 240 can align one at a time with the lower mouth of the collector tube 230.

[0084] As illustrated in figure 21, the automatic dispenser 225 of the depositing station 220 are reciprocally flanked, such that the lower mouths of the respective collector tubes 230 are aligned along a perpendicular direction to the advancing direction A of the upper tract 215 of the conveyor belt 205. During the continuous sliding of the upper tract 215 in the advancing direction A, a special electronic control system can monitor the advancing of the conveyor belt 205 with respect to the automatic dispensers 225. This monitoring can be carried out for example by means of an encoder (not illustrated), which can be applied to one of the motorized rollers 210 of the conveyor belt 205, such that the position thereof can be known very precisely, for example with a tolerance of +/- 0.5 mm. When the displacement of the upper tract 215 is of a predetermined quantity, the control system can rotate the discs 235 of each automatic dispenser 225, such as to bring a through hole 240 of each of them contemporaneously into an aligned position with the lower mouth of the respective collector tube 230. In this way, each automatic dispenser 225 contemporaneously releases an insert 100, which falls by force of gravity downwards up to resting with the rest surface 105 thereof on the upper tract 215 of the conveyor belt 205. The holes 240 remain aligned with the collector tube 230 only for the time that is strictly necessary for a single insert 100 to fall, after which the discs 235 newly rotate in order to move into a position in which they obstruct the passage of the inserts 100. Starting from each release, the electronic control system recommences counting the advancing of the conveyor belt 205, in order to repeat the above-described operations each time the upper tract 215 has moved by the predetermined quantity.

[0085] In this way, the depositing station 220 is overall aimed at releasing, on the upper tract 215 of the conveyor belt 205, a sequence of rows of inserts 100, in which the inserts 100 of each row are aligned in a transversal direction with respect to the advancement direction A, reciprocally separated by a distance T equal to the distance that separates the collector tubes 230 of the automatic dispensers 225, and in which the rows are separated from one another in the advancement direction A by a distance P equal to the advancing step fixed for the periodic opening of the collector tubes 230.

[0086] It follows that the arrangement of the inserts 100 can be regulated on the basis of production needs, simply by modifying the reciprocal distance in a transversal direction between the automatic dispensers 225 and/or the advancing step for the periodical opening of the collector tubes 230.

[0087] It is specified that although the illustrated example of the figures comprises only two automatic dispensers 225, the number might be greater as a function of the width of the loading front of the upper tract 215 of the conveyor belt 205. It is further specified that the discs 235 of the automatic dispensers 225 could be replaced by any other obturator means suitable for the aim, such as for example tilting shutters, slide shutters and others besides.

[0088] Downstream of the depositing station 220, with respect to the advancing direction A of the upper tract 215 of the conveyor belt 205, the forming plant 200 comprises a dispensing station 250 for the ceramic powder. In the illustrated example, the dispensing station 250 comprises a series of supply conduits 255, which are able to supply the ceramic powders internally of a hopper 260. The hopper 260 is provided with a discharge mouth 265 having an elongate shape, in the example having a rectangular shape, which is brought to a certain distance from the upper tract 215 of the conveyor belt 205 and develops in a transversal direction with respect to the advancing direction A (see figure 21). Special obturator means (not illustrated) can be associated to the hopper 260, for example a mobile shutter, which are able to selectively open and close the discharge mouth 265.

[0089] While the upper tract 215 of the conveyor belt 205 slides in the advancing direction A, the discharge mouth 265 of the hopper 260 is left open such as to continuously release the ceramic powders. In this way, the ceramic powders cover the inserts 100 previously predisposed on the upper tract 215 of the conveyor belt 205, progressively and continuously forming the soft layer M.

[0090] It has been experimentally observed that the inserts 100 released on the upper tract 215 remain stationary during the sliding of the belt 205 and during the dispensing of the ceramic powder.

[0091] Downstream of the dispensing station 250, with respect to the advancing direction A, the upper tract 215 of the conveyor belt 205, the forming plant 200 further comprises a pressing station 270 of a continuous type. In the illustrated example, the pressing station 270 comprises two flexible compacting belts, reciprocally superposed, of which a lower compacting belt 275 and an upper compacting belt 280.

[0092] The lower compacting belt 275 is closed-loop-wound about a pair of horizontal-axis rollers 285, of which an idle relay roller and a motorised drive roller. Along this closed-loop pathway, the lower compacting belt 275 exhibits an upper tract 290 that is substantially horizontal, which is located below and in direction contact with the upper tract 215 of the conveyor belt 205, such as to support it restingly. The upper tract 290 of the lower compacting belt 275 is activated to slide in the same advancing direction A and substantially at the same speed as the upper tract 215 of the conveyor belt 205, such as to accompany it without any reciprocal dragging.

[0093] The upper compacting belt 280 is in turn closed-loop-wound about a pair of horizontal-axis rollers 295, of which an idle relay roller and a motorized drive roller. Along this closed-loop pathway, the upper compacting belt 280 exhibits a lower tract 300, which is borne at a certain distance above the upper tract 215 of the conveyor belt 205. The lower tract 300 of the upper compacting belt 280 is activated to slide substantially in the same advancing direction A and substantially at the same velocity as the upper tract 215 of the conveyor belt 205. However, the lower tract 300 of the upper compacting belt 280 is inclined in a downwards direction in the advancing direction A, in such a way as to define, with the upper tract 215 of the conveyor belt 205, a gap having a progressively falling dimension along the advancing direction A. The inclination of the lower tract 300 can be regulated by means for varying the height of the roller 295 which is located more downstream than the advancing direction A.

[0094] With this solution, while the upper tract 215 of the conveyor belt 205 slides in the advancing direction A, the soft layer M of ceramic powders transits progressively below the lower tract 300 of the upper compacting belt 280, and is subject to a compacting in the width thereof which enables continuously obtaining a layer Q of compacted ceramic powders in which the inserts 100 are sunk.

[0095] Downstream of the pressing station 270 with respect to the advancing direction A of the upper tract 215 of the conveyor belt 205, the forming station 200 lastly comprises an unfired cutting station 305, which is able to subdivide the layer Q of compacted powders into single unfired slabs N having predetermined dimensions.

[0096] In the illustrated example, the cutting station 305 comprises three cutting organs, of which two cutting organs 310 which are located at the opposite sides of the conveyor belt 205, in such a way as to trim the external edges of the layer Q of compacted ceramic powders, and a cutting organ 315 which is provided with a movement in a transversal direction with respect to the advancing direction A, which is able to separate the single slabs N after the trimming. In particular, the movement of the cutting organ 315 can be activated by the electronic control system when the upper tract 215 of the conveyor belt 205 is in precise positions, such as to guarantee that each slab N exhibits a predetermined number of rows of inserts 100 and that the inserts 100 are at a predetermined distance from the edges of the slab N.

[0097] The slabs N of compacted ceramic powder can be subsequently loaded on a second conveyor line, which transfers a slab N at a time internally of a ceramic die associated to a high-tonnage discontinuous press, where each slab N is subjected to a second pressing step such as to reach the definitive compacting of the ceramic powders. The second conveyor line, the ceramic die and the press are not illustrated herein as they are of known type.

[0098] The slabs N obtained with the second pressing step can lastly be subjected to the usual drying, decoration and finally firing steps, which enable obtaining the finished ceramic slab.

[0099] Alternatively, the above-described manufacturing method can be effectively implemented on a large scale including with a discontinuous forming plant for ceramic tiles or slabs, such as the one schematically represented in figure 24.

[0100] The discontinuous forming plant 400 firstly comprises a ceramic press 405, for example a portal press. As illustrated in figure 25, the press 405 schematically comprises a lower bench 410, a fixed upper cross member 415 and a pair of lateral uprights 420 able to support the upper cross member 415 on the bench 410. The ceramic press 405 further comprises a mobile cross member 425, interposed between the upper cross member 415 and the bench 410, which is slidably coupled to the lateral uprights 420, and is associated to hydraulic activating means (not illustrated), which are able to move the mobile cross member 425 in a vertical direction, nearing and distancing it with respect to the bench 410.

[0101] A ceramic die 430 is mounted on the press 405, which comprises a lower part 435 fixed on a foot of the bench 410 and an upper part 440 fixed to the mobile cross member 425.

[0102] The lower part 435 comprises at least a forming cavity 445, which is defined by a matrix 450 conformed as a frame and a lower punch 455 inserted internally of the matrix 450. The upper surface of the punch 455 defines the bottom of the forming cavity 445 as well as the work plane L of the plant.

[0103] The upper part 440 of the ceramic die 430 comprises in turn an upper punch 460, which is able to close the forming cavity 445. In the illustrated example, the upper punch 460 is of the mirror type and is able to close the forming cavity 445, going to rest on the matrix 450, which in turn is supported on the bench 410 by means of a plurality of hydraulic supports 465 which, during the pressing, enable it to move in a vertical direction with respect to the lower punch 455. In other embodiments, the upper punch 460 could however be of the inserting type, i.e. able to close the forming cavity 445 by also inserting in the matrix 450, which might therefore be fixed.

[0104] The forming plant 400 can further comprise a device, denoted in its entirety by 470 in figure 24, which can automatically deposit a plurality of inserts 100 in a predetermined reciprocal position above a service plane S.

[0105] As illustrated in figures 26 and 27, the device 470 can comprise a flexible conveyor belt 475, which is wound in a closed loop about a plurality of horizontal-axis rollers 480, of which a series of idle relay rollers and at least a motorized drive roller. Along this closed-loop pathway, the conveyor belt 475 exhibits an upper tract 485 that is substantially horizontal and slidable in a predetermined advancing direction B, the surface of which defines the service plane S.

[0106] A depositing station 490 is installed above the upper tract 485, which is able to release, in an ordered way, the inserts 100 on the upper tract 485 of the conveyor belt 475 which slides in the advancing direction B. In the illustrated example, the depositing station 490 is structurally entirely similar to the depositing station 220 described herein above and is able to function in the same way.

[0107] In particular, the depositing station 490 comprises a plurality of automatic dispensers 225 arranged in a fixed position above the upper tract 485 of the conveyor belt 475, such that the lower mouths of the respective collector tubes 230 are aligned in plan view along a perpendicular direction to the advancing direction B. For a detailed description of the automatic dispensers 225 reference is made to what has already been described herein above.

[0108] In order to predispose the inserts 100, a special electronic control system can activate the conveyor belt 475 in continuous sliding and contemporaneously monitor the advancing of the upper tract 485 with respect to the automatic dispensers 225. This monitoring can be carried out for example by an encoder (not illustrated), which can be applied to one of the motorized rollers 480 of the conveyor belt 475, such as to be able to know, with a high degree of precision, the position thereof, which can be applied to one of the motorized rollers 480 of the conveyor belt 475, such as to be able to know the position thereof with great precision, for example with a tolerance of +/- 0.5 mm. When the displacement of the upper tract 485 is equal to a predetermined quantity, the control system can rotate the disc 235 of each automatic dispenser 225, such as to contemporaneously to bring a hole 240 of each of the discs 235 into an aligned position with the lower mouth of the respective collector tube 230. In this way, each automatic dispenser 225 contemporaneously releases an insert 100, which falls by force of gravity downwards up to resting with the rest surface thereof 105 on the underlying upper tract 485 of the conveyor belt 475.

[0109] In this case too, the holes 240 are aligned with the relative collector tube 230 only for the time that is strictly necessary for the dropping of a single insert 100, after which the discs 235 rotate newly in order to move into a position in which they obstruct the passage of the inserts 100. Starting from each release, the electronic control system then recommences counting the advancing of the conveyor belt 475, so as to repeat the above-described operations each time the upper tract 485 has displaced by the predetermined quantity.

[0110] In this way, the depositing station 490 is overall able to release, on the upper tract 485 of the conveyor belt 475, a sequence of rows of inserts 100, in which the inserts 100 of each row are aligned in a transversal direction with respect to the advancing direction B, separated by a distance T equal to the distance that separates the collector tubes 230 of the automatic dispensers 225, and wherein the rows are separated from one another in the advancing direction B by a distance P equal to the fixed advancing step for the periodic opening of the collector tubes 230. In this case too, the depositing of the inserts 100 can then be regulated on the basis of production requirements, by simply modifying the reciprocal distance in a transversal direction between the automatic dispensers 225 and the set advancing step for the periodic opening of the collector tubes 230.

[0111] The weight thereof and the friction with the plane S are sufficient for the inserts 100 released on the upper tract 485 to remain stationary during the sliding of the conveyor belt 475.

[0112] When a predetermined number of rows of inserts 100 have been deposited on the upper tract 485, the electronic control system can halt the conveyor belt 475.

[0113] As illustrated in figure 24, the forming plant 400 further comprises a device, denoted in its entirety by 495, which is able to rigidly transfer the inserts 100 from the service plane S defined by the conveyor belt 475 to the work plane L, defined by the lower punch 455 of the ceramic die 430, maintaining them exactly in the reciprocal position in which they have been predisposed on the service plane S. In the illustrated example, the device 495 can comprise a robotic arm 500 provided with a special gripping organ 505 able to grip all the inserts 100 predisposed on the plane of the service plane S at the same time and then translate them rigidly, up to resting them and releasing them in a block on the upper surface of the lower punch 455, internally of the still-empty forming cavity 445 of the ceramic die 430.

[0114] So that the inserts 100 released on the upper surface of the punch 455 stay still, the punch 455 can be provided with means for generating a force of magnetic attraction which blocks the inserts 100 in the correct position.

[0115] At this point, the forming cavity 445 of the ceramic die 430 can be filled with a soft layer M of ceramic powders (not shown) in such a way as to completely cover the inserts 100. This loading of the ceramic powders can be done with any known system, for example a tray-loading system of conventional type.

[0116] Once the loading of the ceramic powders has been completed, the press 405 can be activated such as to close the ceramic die 430 and press the soft layer, such as to obtain a slab N of compacted ceramic powders in which the inserts 100 are sunk.

[0117] The slabs N obtained in this pressing step can lastly be subjected to the usual drying, decorating and finally firing steps, which enable obtaining the finished ceramic slab.

[0118] Obviously a technician of the sector can apply numerous modifications of a technical-applicational nature to the method and plants described above, without forsaking the scope of the invention as claimed in the following.

Claims

1. A method for manufacturing cladding slabs, comprising at least steps of:

   - positioning at least a solid insert (100) on a working plane (L):
   - covering with a layer (M) of ceramic powder the working plane (L) such that each of the inserts (100) is uncovered at a rear surface (F) of the layer (M) of ceramic powder,
   - pressing the layer (M) of ceramic powder, such as to obtain a slab (N) of compacted powder containing the inserts (100), uncovered in the

rear surface of the slab;
- subjecting the slab (N) of compacted powder comprising the inserts to a step of firing.

2. The method of claim 1, wherein the step of preparing the layer (M) of ceramic powder comprises:

predisposing the inserts (100) on a work plane (L), and
depositing the layer (M) of ceramic powder on the work plane (L) such as to cover the inserts (100).

3. The method of claim 2, wherein the work plane (L) is the surface of a sliding belt (205) of a continuous forming plant (200).

4. The method of claim 3, wherein the step of predisposing the inserts (100) on the work plane (L) comprises:

advancing the sliding belt (205),
releasing at least an insert (100) at a time onto the surface of the sliding belt (205).

5. The method of any one of claims 3 or 4, comprising steps of:

subjecting the layer (M) of ceramic powder to a pressing step on the surface of the sliding belt (205) such as to obtain a layer (Q) of compacted ceramic powders, and
cutting the layer (Q) of compacted powders into slabs (N) singly provided with at least one of the inserts (100).

6. The method of claim 5, comprising the step of subjecting the slabs (N) into which the layer (Q) of compacted powders is subdivided to a further pressing step.

7. The method of claim 2, wherein the work plane (L) is the surface of a punch (455) which delimits the forming cavity (445) of a ceramic die (430).

8. The method of claim 7, wherein the step of predisposing the inserts (100) on the work plane (L) comprises steps of:

predisposing the inserts (100) in a predetermined reciprocal position on a service plane (S), and
transferring the inserts (100) from the service plane (S) to the work plane (L) while maintaining the inserts (100) in a same reciprocal position in which they were on the service plane (S).

9. The method of claim 8, wherein the service plane (S) is the surface of a sliding belt (475) and wherein the step of predisposing the inserts (100) on the service plane (S) includes:

advancing the sliding belt (475),
releasing at least an insert (100) at a time onto the surface of the sliding belt (475).

10. The method of any one of the preceding claims, wherein the inserts (100) are destructible at a temperature of lower than or equal to the maximum temperature to which the slab (N) of compacted powder is heated during the firing step.

11. The method of any one of the preceding claims, wherein the inserts (100) are resistant to the maximum temperature to which the slab (N) of compacted powder is heated during the firing step.

12. The method of any one of the preceding claims, wherein the inserts (100) are able to function as connecting elements for the ceramic slab with a support structure.

13. The method of any one of the preceding claims, wherein the inserts (100) comprise at least a threaded organ.

14. The method of claim 11, wherein the threaded organ comprises an internally-threaded hole (110).

15. The method of any one of the preceding claims, wherein each of the inserts (100) has a different shape from a perfect solid of revolution.

16. The method of anyone of the preceding claims, wherein each of the inserts (100) comprises at least a surface (115, 140) in undercut with respect to the rear surface (F) of the layer (M) of ceramic powder.

17. A plant (200, 400) for manufacturing cladding slabs, comprising:

means for preparing a layer (M) of ceramic powder containing one or more solid inserts (100) in such a way that each of the inserts (100) is uncovered at a rear surface (F) of the layer (M) of ceramic powder,
means for pressing the layer (M) of ceramic powder, such as to be able to obtain a slab (N) of compacted powder containing the inserts (100),
means for subjecting the slab (N) of compacted powder to a step of firing.

18. A cladding slab comprising a layer of ceramic material containing one or more inserts (100), each of which is uncovered at a rear surface of the layer of ceramic material.

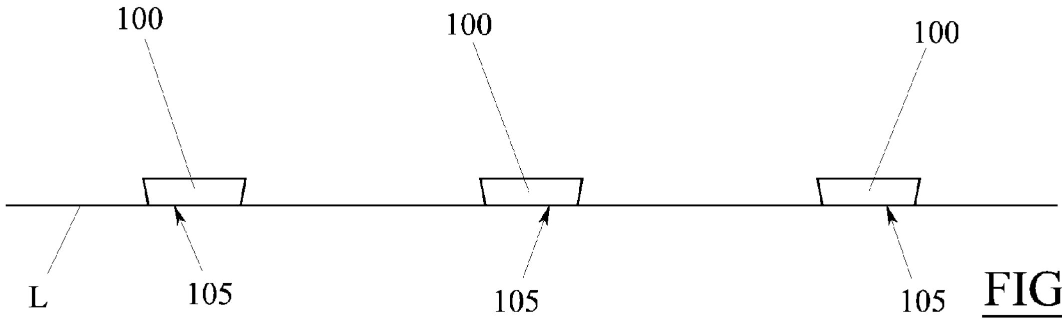


FIG.1

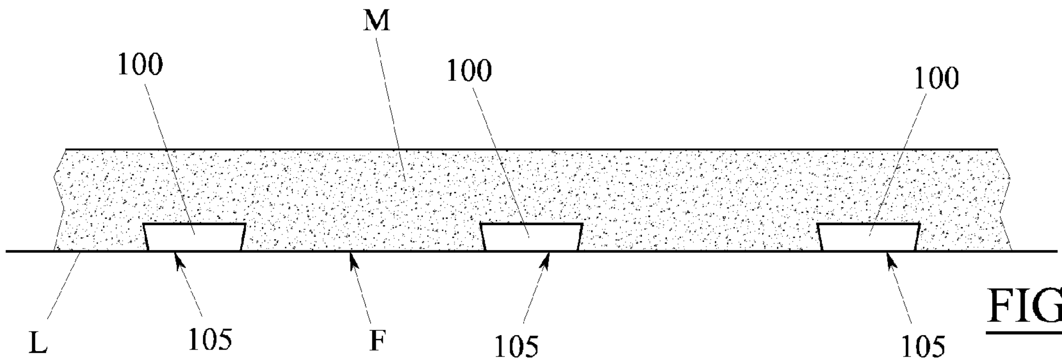


FIG.2

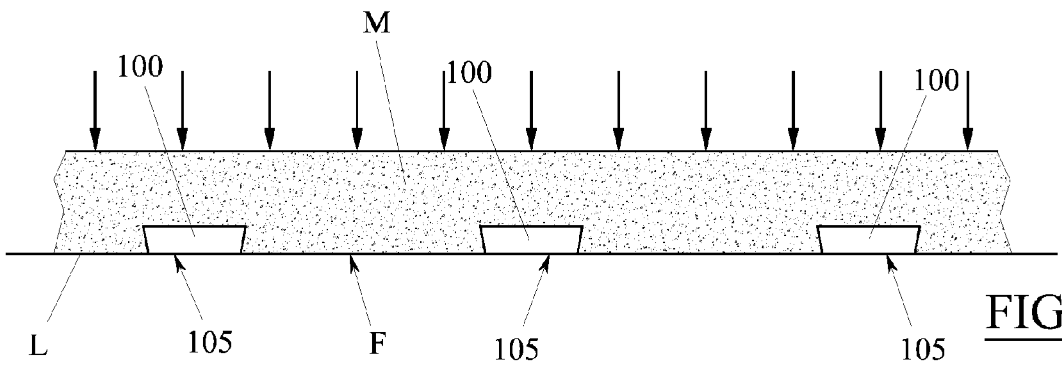


FIG.3

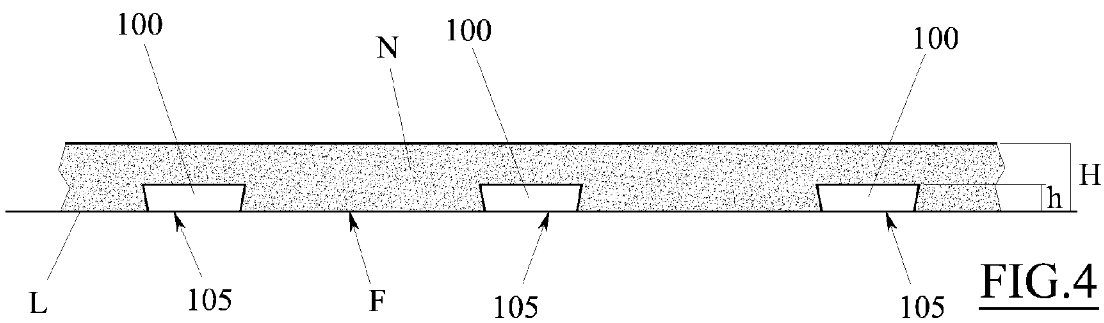


FIG.4

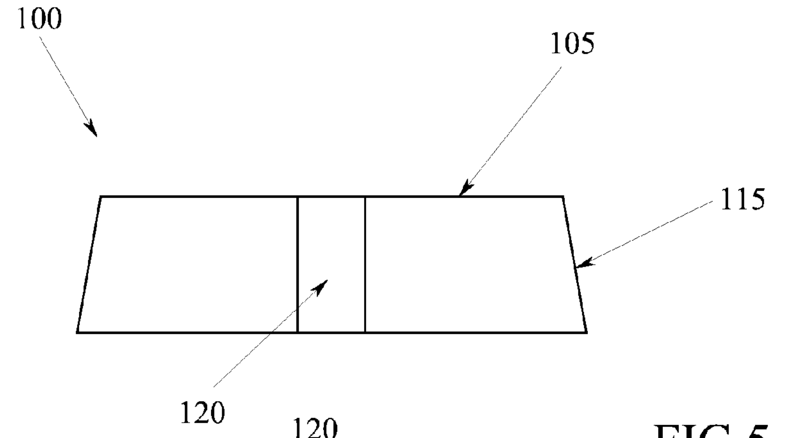


FIG.5

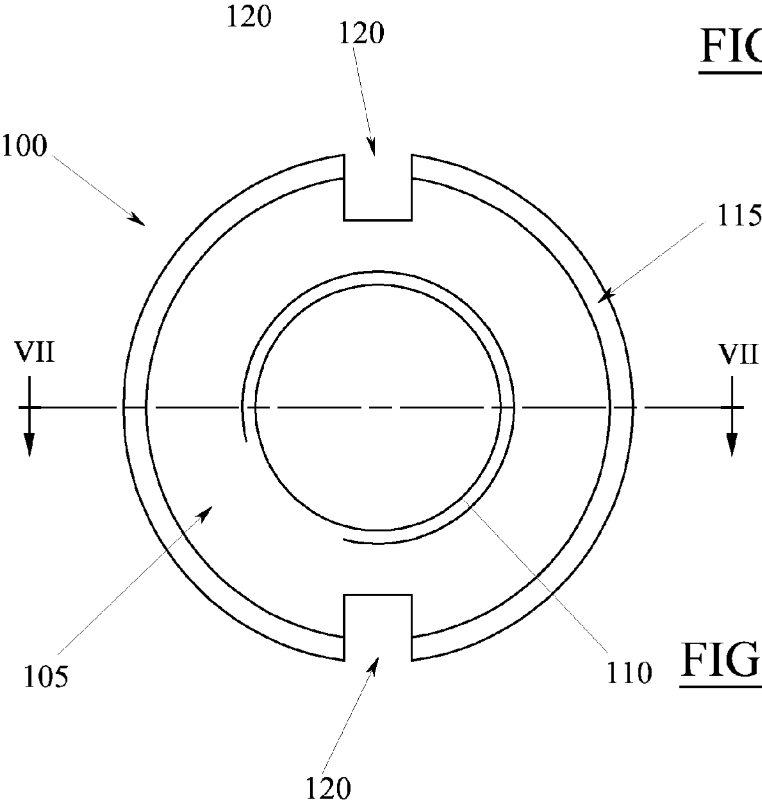


FIG.6

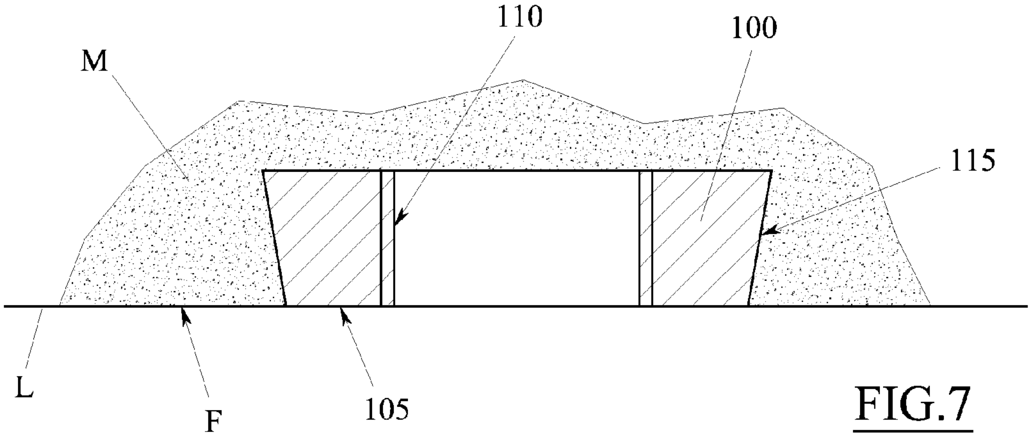


FIG.7

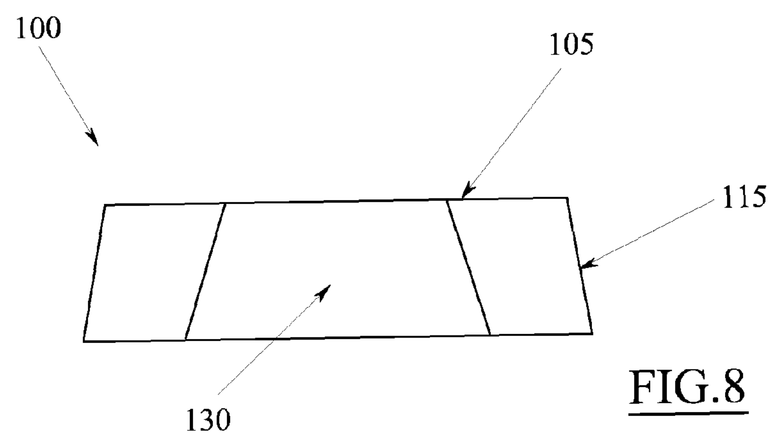


FIG.8

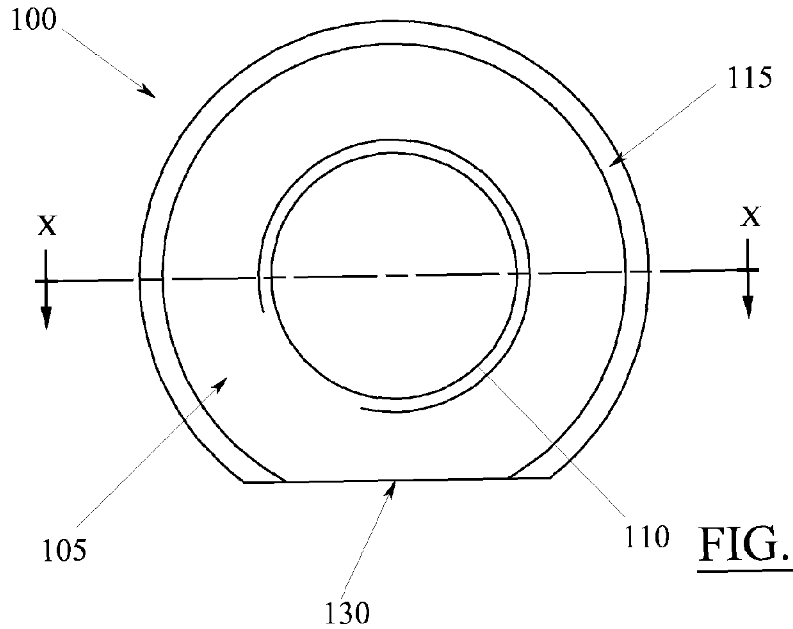


FIG.9

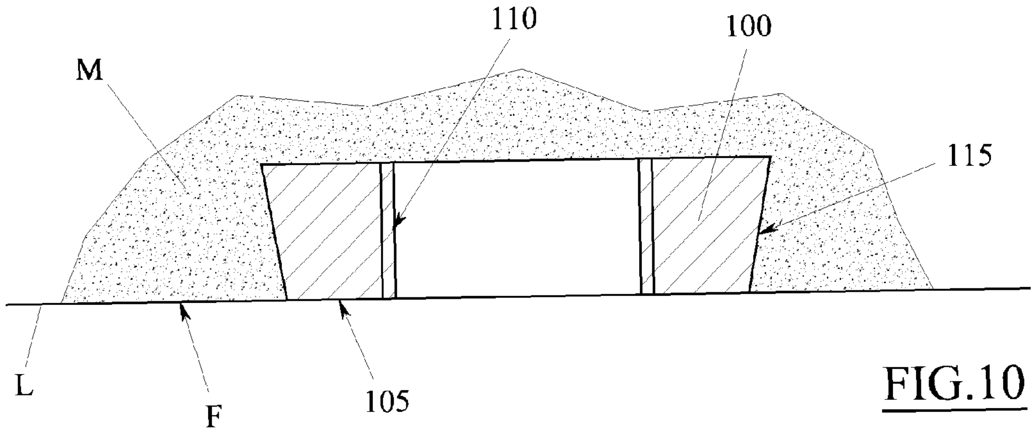


FIG.10

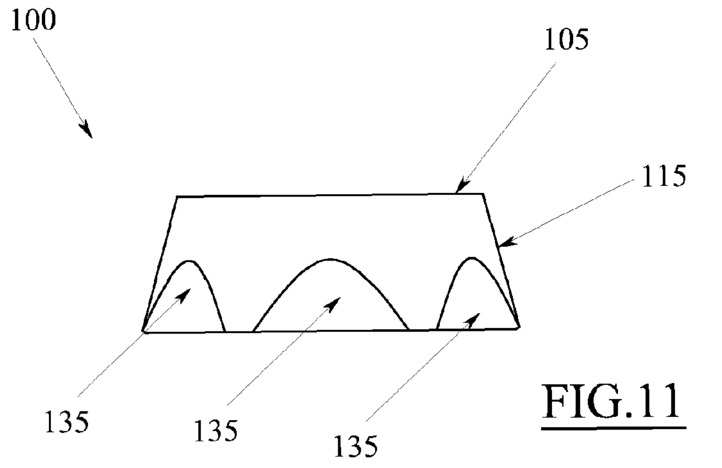


FIG.11

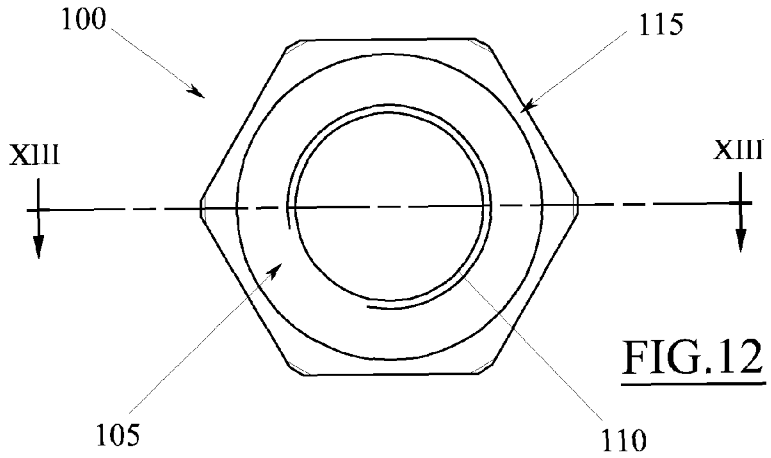


FIG.12

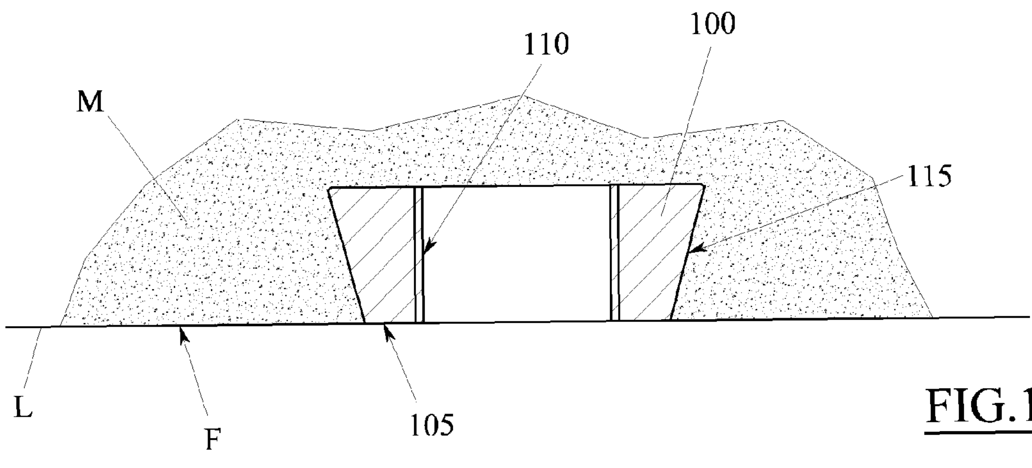


FIG.13

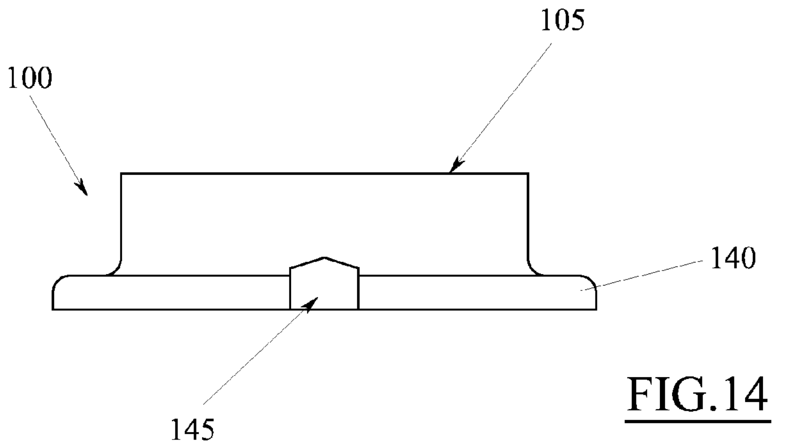


FIG.14

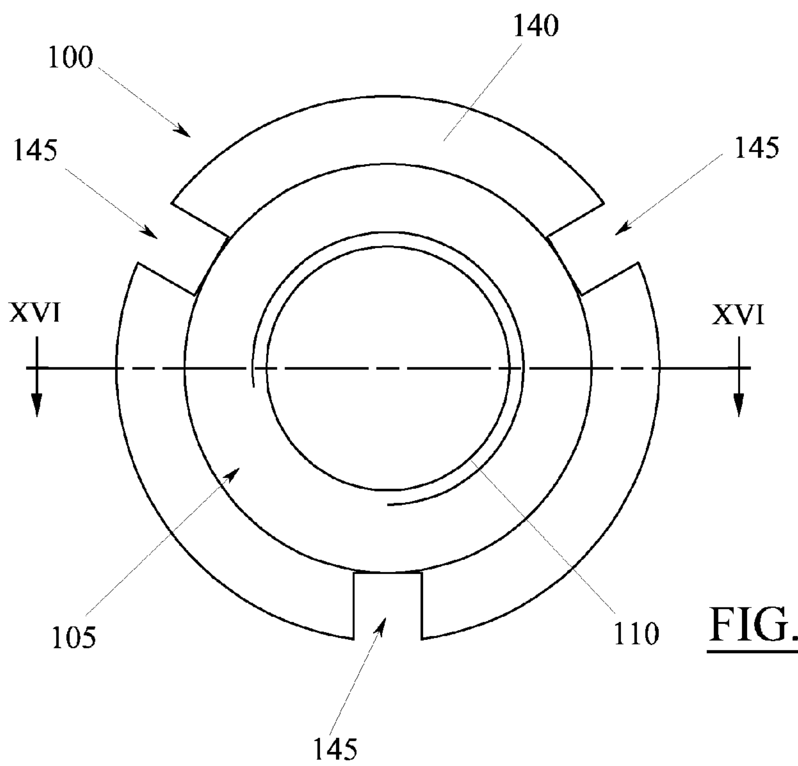


FIG.15

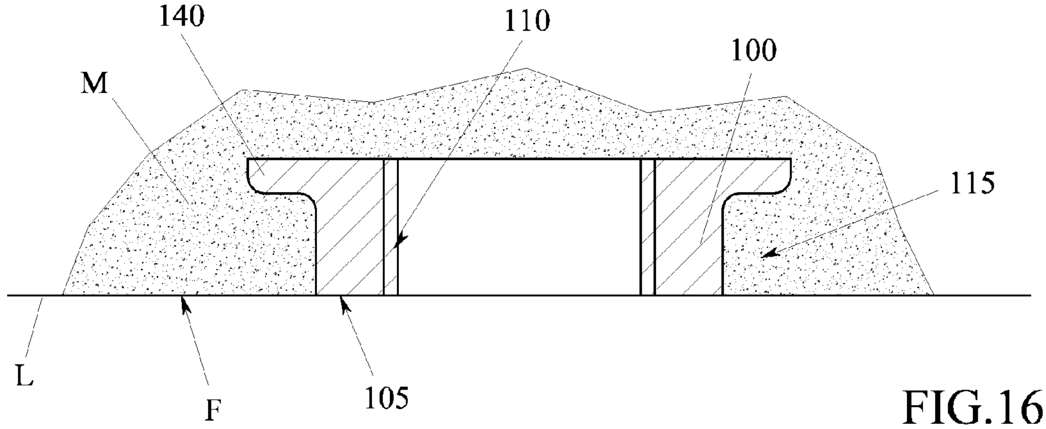


FIG.16

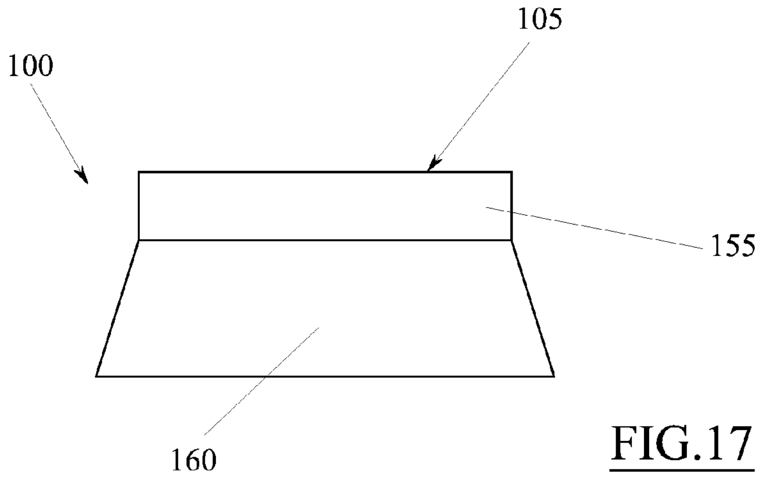


FIG.17

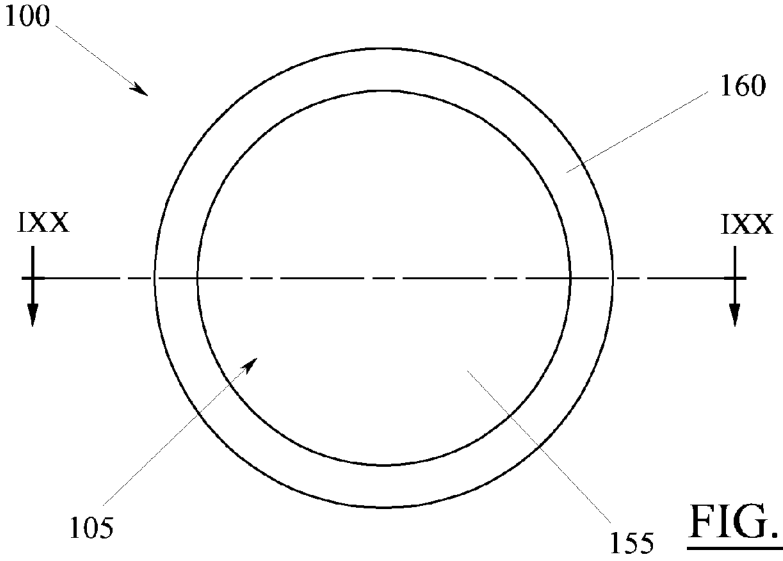


FIG.18

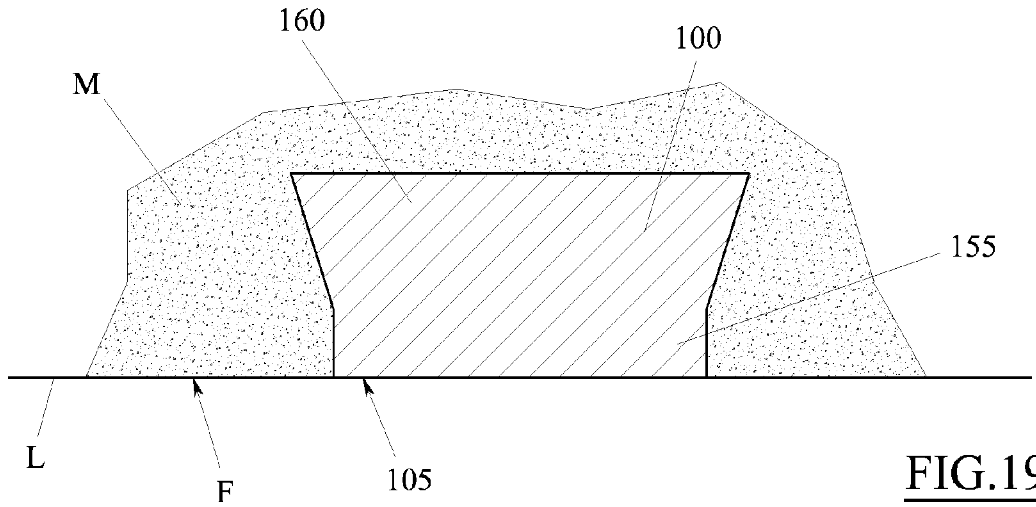
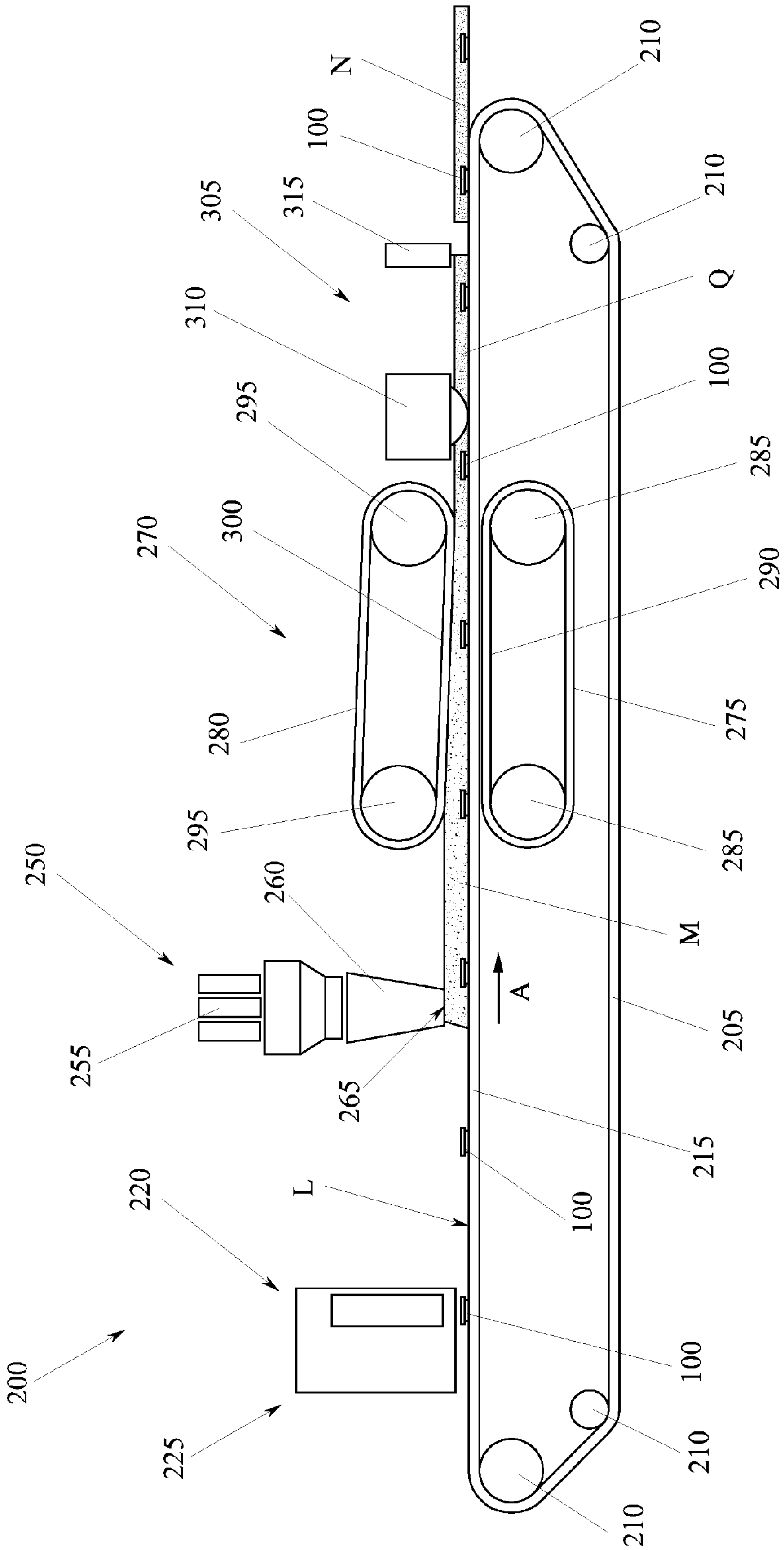


FIG.19



N
100
305
315
310
295
270
300
280
295
250
260
255
265
220
L
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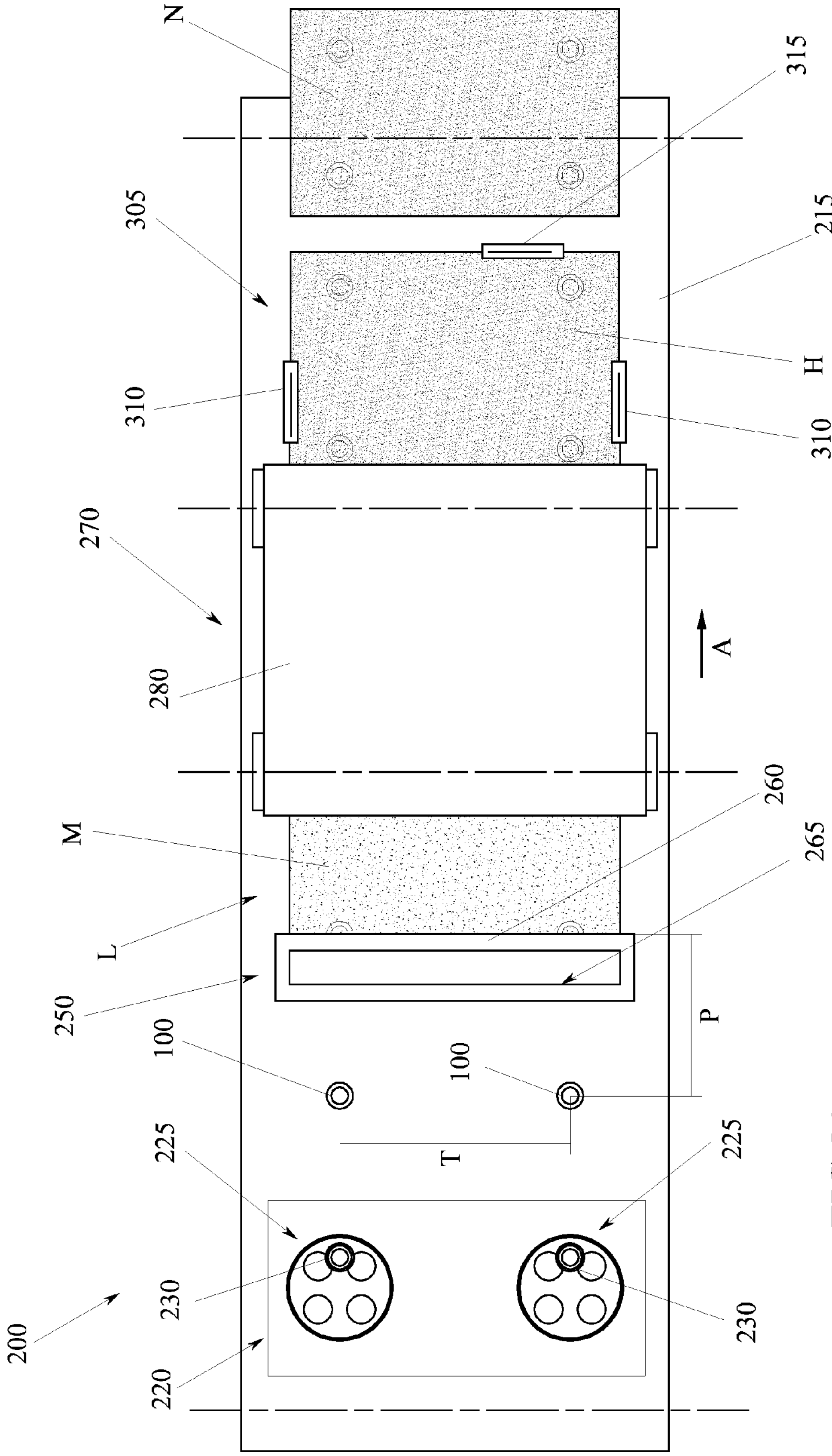
Q
100
285
290
275
285
M
A
205
215
100
100
210
210

FIG.20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H
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310
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P
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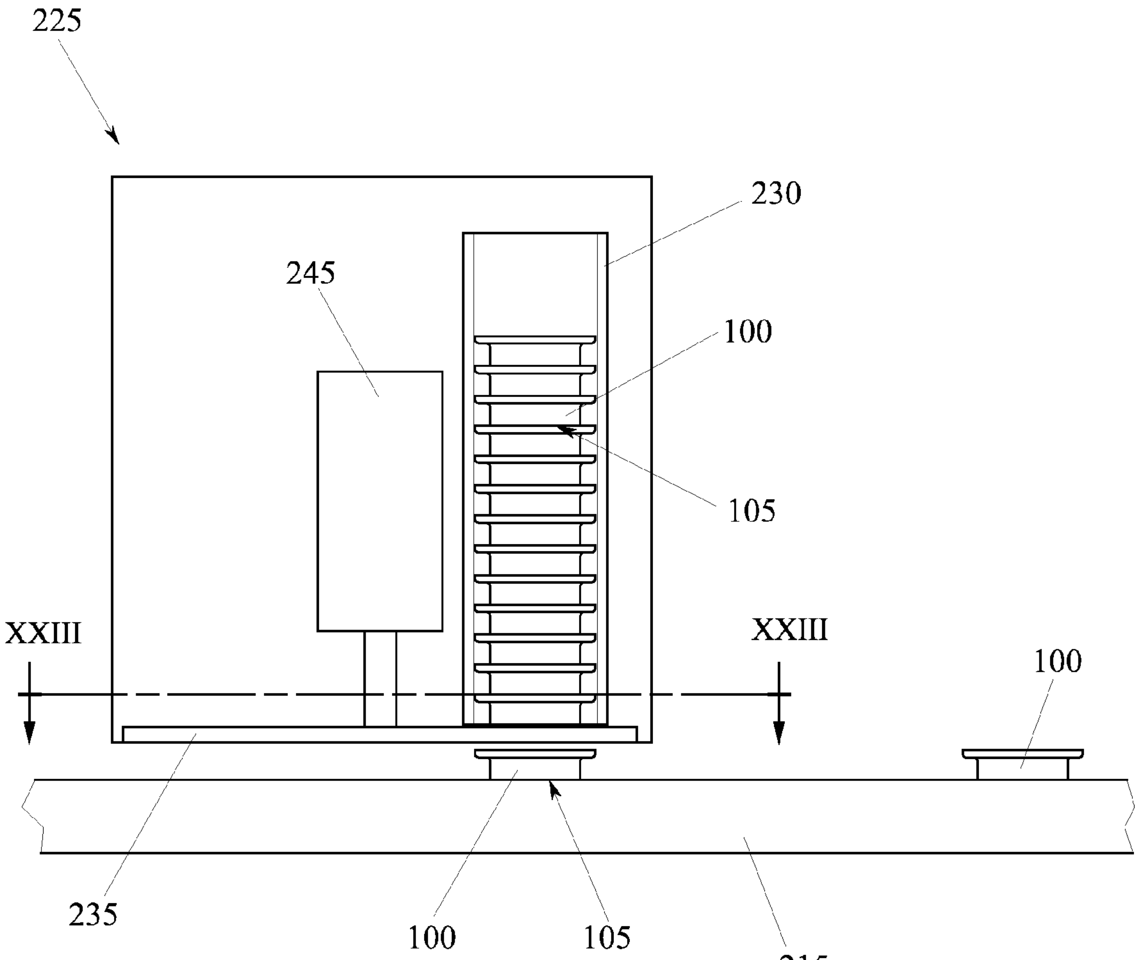
200
220

FIG.21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XXIII
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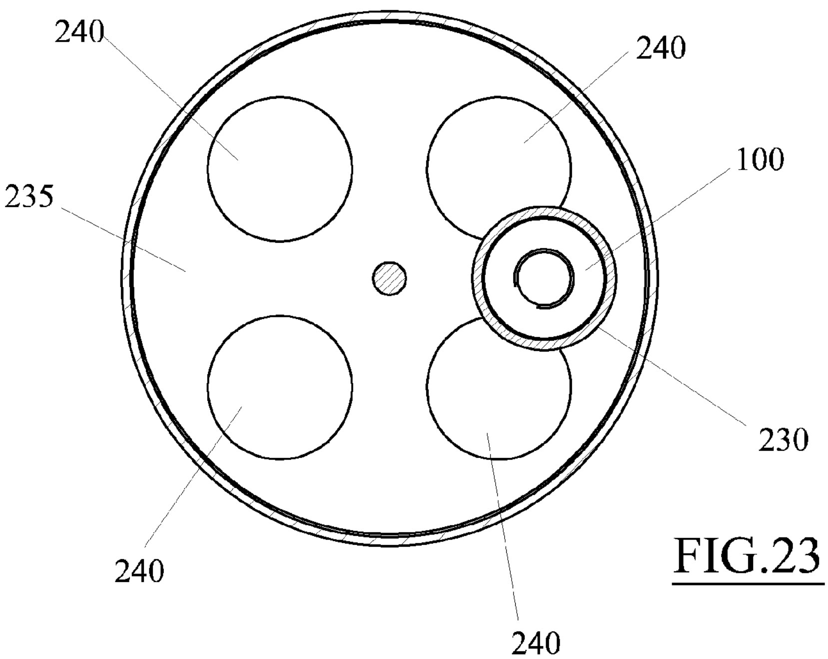
100
105
215

FIG.22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240

FIG.23

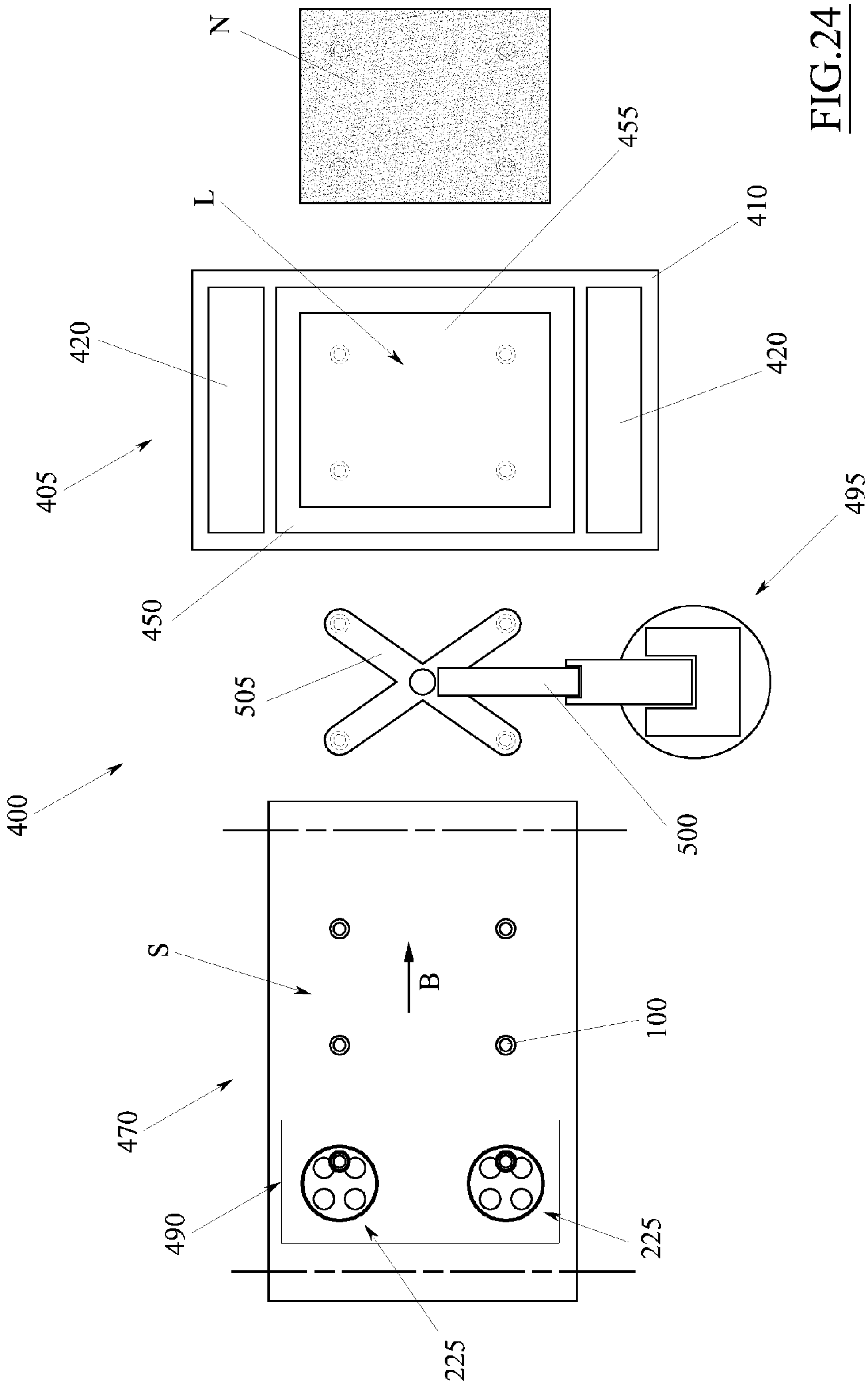
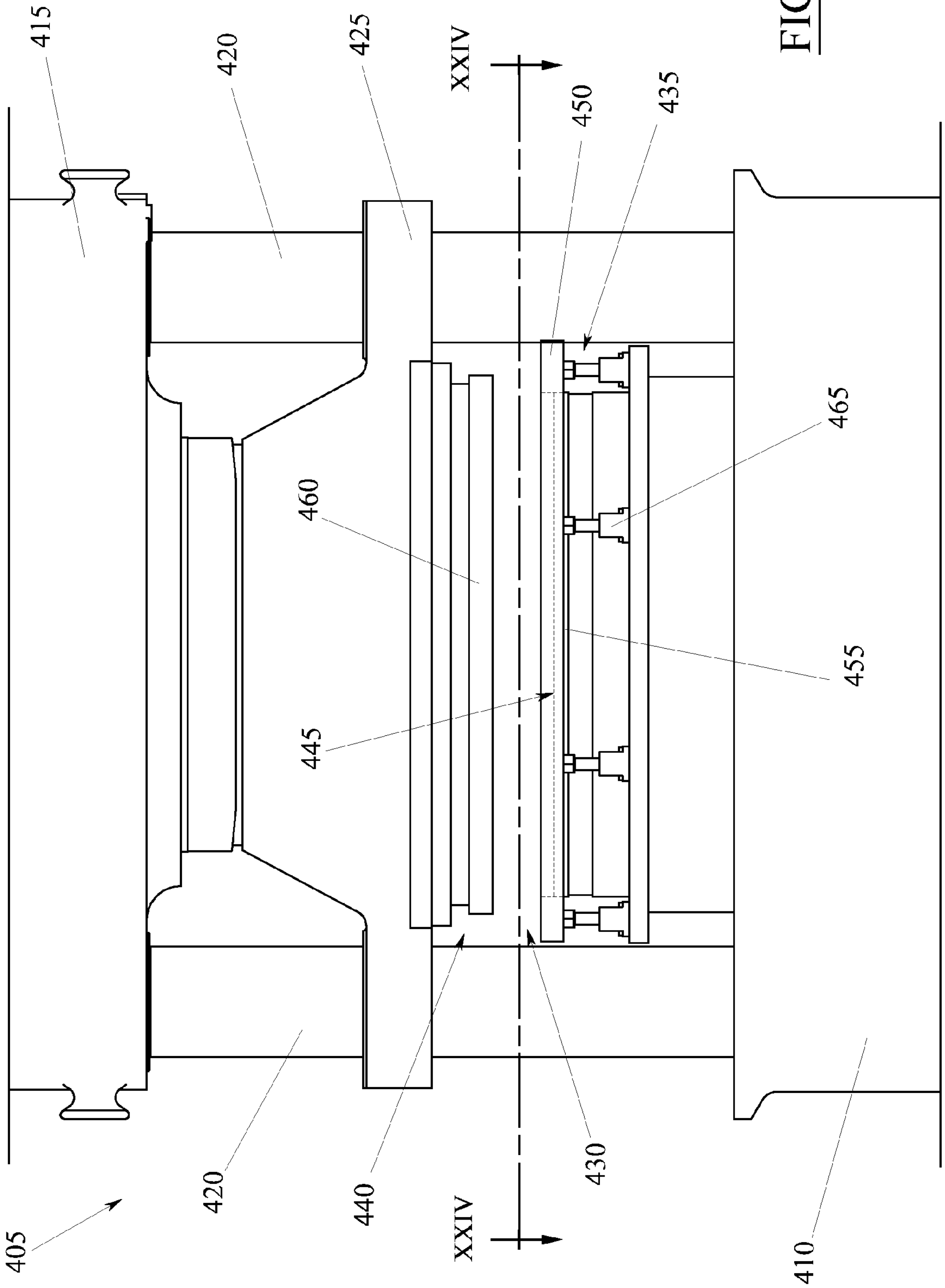


FIG.24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420
425
XXIV
450
435
465
460
455
445
405
420
440
XXIV
430
410

FIG.25

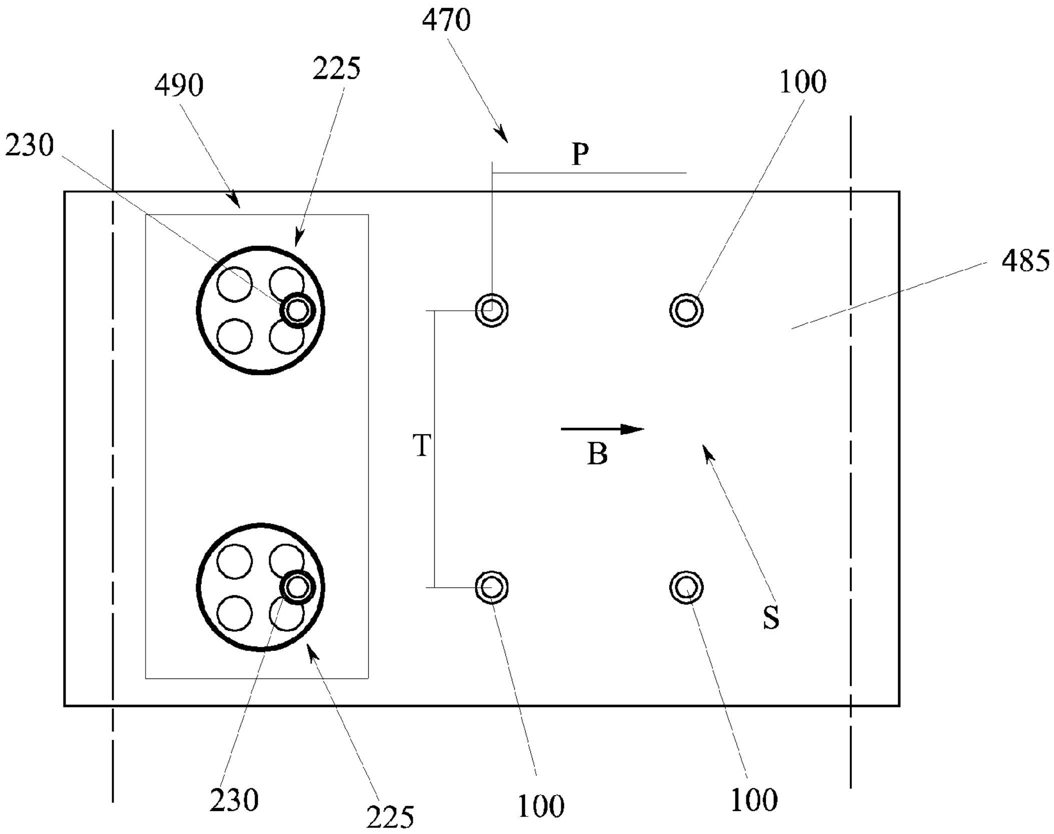
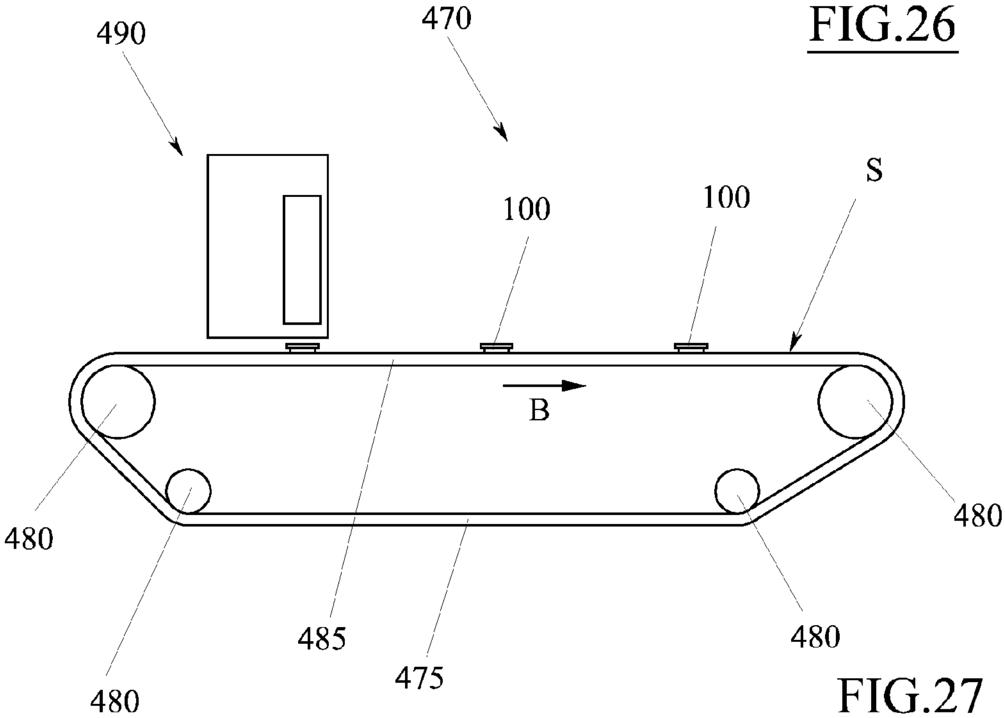

470
490
225
100
230
P
485
T
B
S
230
225
100
100

FIG.26


490
470
S
100
100
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480
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485
480
475
480

FIG.27

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EUROPEAN SEARCH REPORT

Application Number
EP 14 15 3374

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	24 March 2014	Orij, Jack

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