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(54) DEVICE AND METHOD FOR COMPACTING POWDER MATERIAL

VORRICHTUNG UND VERFAHREN ZUR VERDICHTUNG EINES PULVERMATERIALS

DISPOSITIF ET PROCÉDÉ PERMETTANT DE COMPACTER UN MATÉRIAU EN POUDRE

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Description

TECHNICAL FIELD

[0001] The present invention regards a device for compacting a layer of powder material, mainly in the field of forming ceramic tiles or slabs.

BACKGROUND ART

[0002] There are known devices for forming ceramic tiles comprising a slidable transport surface on which there is progressively supplied a ceramic powder, so as to form a layer. The transport surface is generally defined by a slidable and fixable conveyor belt. The layer of powder is advanced by the transport surface through a compacting station of the continuous type, i.e. which is adapted to compact the layer of powder as it progressively advances on the transport surface.

[0003] The compacting station generally comprises two flexible compacting surfaces, mutually superimposed and both slidable in the same direction of the transport surface. Also the compacting surfaces are usually defined by a respective slidable and flexible belt. The lower compacting surface is arranged beneath and at contact with the transport surface, so that it supportingly rests thereon, while the upper compacting surface is arranged at a given height above the transport surface. At a predefined area, the compacting surfaces are guided to slide between special pressing means, for example between a pair of superimposed rollers, which maintain the upper compacting surface locally pressed towards the lower compacting surface, so as to press the layer of powders which is located on the transport surface. The compacting station usually also comprises two parallel lateral edges, which are adapted to laterally contain the layer of ceramic powder on the transport surface during compacting, so as to make the apparent density of the layer of powder more uniform in the direction of the width. These lateral edges are elastically yieldable, so as to be able to be compressed under the effect of the compacting surfaces. Downstream of the compacting station, the transport surface lastly advances the layer of compacted powder through a subsequent cutting station, which is adapted to divide it into single slabs of desired dimensions.

[0004] The compacting pressure that can be provided on the layer of powder with a forming device of the type outlined above is currently limited to relatively low values, about up to a maximum of 200 Kg/cm^2, which are usually insufficient to obtain the quality finished products. Thus, the slabs of compacted powder are usually also subjected to a second pressing step, usually by means of a conventional discontinuous die, so as to be able to reach higher and more suitable values of the compacting pressure, usually comprised between 250 Kg/cm^2 and 500 Kg/cm^2.

[0005] There are several reasons behind this technological drawback of the belt forming devices. One of these lies in the fact that, immediately downstream of the pressing means, the layer of compacted powder tends to expand spontaneously. Due to this spontaneous expansion, whose extent is generally proportional to the compacting pressure, the layer of powder may break and form cracks and/or fissures that make it entirely unusable, or however seriously faulty. In order to overcome this drawback, immediately downstream of the pressing means, the compacting station is usually also provided with means for contrasting the expansion of the layer of compacted powder. These contrast means have the function of "accompanying" the expansion, i.e. slowing it, so as to prevent the formation of cracks and/or fissures in the layer of compacted powder.

[0006] The means for contrasting the expansion may comprise a pair of superimposed plates, between which the compacting surfaces are guided to pass downstream of the pressing means. These plates have the function of maintaining the upper compacting surface pressed towards the lower compacting surface, so that the layer of compacted powder is subjected to a pressure for contrasting the expansion, lower than the compacting pressure exerted by the pressing means. In particular, the upper plate of the pair can be slightly inclined, so that the contrast pressure generated thereby progressively decreases as the forward advancement of the layer of powder moves away from pressing means. A variant of this solution provides for replacing the upper plate with a flexible plate, which is supported by a row of jacks arranged adjacent to each other in transverse direction with respect to the direction of advancement of the conveyor belt. In detail, each jack comprises a cylinder, obtained in a fixed support body, within which there slides a piston fixed to the flexible plate. A pressurised fluid, typically oil, is supplied in the cylinders so that the pistons maintain the flexible plate pressed towards the upper compacting surface. In particular, the fluid is supplied in the cylinder through a single manifold, so that each piston is always subjected to the same pressure. Thus, the flexible plate substantially acts as an isostatic buffer, which exerts a constant and uniform pressure on the underlying upper compacting surface. A solution of this type is fully described in the European patent number WO 2004/065085, to which reference shall be made.

[0007] Though this solution provides good results, it was observed that the effect for contrasting the expansion obtained with the flexible plate outlined above is not always uniform in the direction of the width of the layer of powder. In particular, it was observed that the expansion of the powders is more efficiently contrasted at the centre of the layer but at the lateral edges, hence leading to the fact that along said lateral edges there may still be unwanted cracks and/or fissures. This phenomenon can be due to the presence of the edges for laterally containing the layer of powders, having a coefficient of deformation different from the ceramic powder, and thus contrast the thrust exerted by the flexible plate differently, so that

the contrast pressure actually transmitted to the layer of powder is not constant in the direction of the width. A solution to the drawback above has been proposed by the document WO 02/076715, in the field of the manufacture of panels of wood chips.

[0008] This document discloses a double band press for the continuous production of chip comprising two metal press bands revolving in a vertical plane each supported by a rigid press plate and moving one on top of the other, at least one of said press plates being subjected to the action of at least one set of pressing means adjacent to one another in a row transversal to the movement of the bands, several parallel rows being provided under the press plate in the direction of movement, the pressing means of each row being independent one another. Said press comprises a device to subject at least one of said press plates to a selectable moment of flexion in the transverse plane of the plate orthogonal to the running direction of the bands.

[0009] Such an apparatus has not proved to be suitable for contrasting the expansion of the layer of compacted powder while subjecting the powder to a differentiated pressure in the transverse direction with respect to the direction of advancement.

DISCLOSURE OF THE INVENTION

[0010] An object of the present invention is to overcome, or at least efficiently reduce, this drawback of the prior art, through a simple, rational and inexpensive solution.

[0011] Such object is attained by the characteristics of the invention indicated in the independent claims. The dependent claims outline preferred and/or particularly advantageous aspects of the invention.

[0012] In particular, the invention provides a device for compacting a layer of powder material, with the features of claim 1.

[0013] Thus the pressure exerted by the contrast means can be advantageously regulated at the edges of the compacting surface differently from that exerted at the centre, with the aim of efficiently contrasting the expansion of the layer of powder material also along the sides. In particular, the pressure exerted by the contrast means can be advantageously regulated so as to ensure that the contrast pressure actually transmitted to the layer of powder material is substantially constant along the entire width of the layer.

[0014] According to an aspect of the invention, said transport surface and said compacting surface are singularly defined by a respective slidable belt.

[0015] According to the invention, said contrast means comprise at least one row of pistons, superimposed to the compacting surface and arranged adjacent to each other in transverse direction with respect to the direction of advancement, each of which is slidably received in a respective reception cavity, which is obtained in a support body and it is in communication with a supply system of a pressurised fluid for pushing the piston towards the underlying compacting surface, said supply system being configured for regulating the pressure of the fluid in the reception cavity of each piston of the row independently with respect to the pressure of the fluid in the reception cavity of the other pistons of the row.

[0016] Due to this solution, the thrust exerted by each piston on the underlying compacting surface can be advantageously regulated independently from that of the other pistons of the row. For example, such pressures can be regulated so as to exert a lower thrust at the centre of the compacting surface and a greater thrust at the lateral edges. In particular, the thrusts exerted by the pistons can be selected so that, regardless of the presence of the lateral containment edges, the compacting surface is actually capable of transmitting to the powder material the same contrast pressure of the expansion along the entire width of the layer.

[0017] In order to make this effect particularly efficient, an aspect of the invention provides for that said row of pistons comprises at least three pistons.

[0018] According to another aspect of the invention, each piston of the row is substantially configured like a plate, which is received in the respective reception cavity so as to be adapted to slide in the direction of the thickness thereof.

[0019] This particular configuration of the pistons has the advantage lying in the fact that the pressure exerted by each of them is globally more uniform and substantially isostatic.

[0020] According to a further aspect of the invention, the pistons positioned at the ends of the row are singularly superimposed, at least partly, at a respective edge for laterally containing the layer of powder material.

[0021] Thus, the aforementioned end pistons may operate more efficiently at the edges of the layer of powder material.

[0022] A further aspect of the invention provides for that the means for contrasting the expansion also comprise a flexible plate, which is fixed to the pistons of the row so as to be interposed between the latter and the compacting surface.

[0023] The presence of this flexible plate makes the pressure exerted on the compacting surface by the overlying pistons more uniform.

[0024] Regarding the supply system of the pressurised fluid, an aspect of the invention provides for that it comprises a plurality of pumps, each of which is adapted to pump the fluid into the reception cavity of a respective piston of the row.

[0025] This aspect of the invention outlines a very simple solution for allowing regulating the pressure of the fluid in the different reception cavities independently.

[0026] According to another aspect of the invention, the supply system of the pressurised fluid may also comprise a plurality of pressure regulation valves, each of which is positioned along a connection conduit between a respective pump and the reception cavity of the corre-

sponding piston.

[0027] Thus, the pressure regulation in each reception cavity can be made more precise and stable.

[0028] A further aspect of the invention provides for that the supply system of the pressurised fluid also comprises a plurality of pressure sensors, each of which is in communication with the reception cavity of a respective piston of the row.

[0029] Thus the operators and/or the system for controlling the supply system may constantly control the level of pressure applied to each piston.

[0030] Returning more generally to the compacting device, an aspect of the invention provides for that the means for contrasting the expansion may comprise a plurality of rows of pistons like the one described above, arranged in succession along the direction of advancement of the transport surface. Thus, the contrast means substantially comprise a grid or matrix of pistons, distributed both in the direction of advancement of the transport surface and in the transverse direction, increasing and considerably improving the contrallability of the expansion of the layer of powder material.

[0031] Furthermore, the invention provides a method for compacting a layer of powder with the features of claim 10.

[0032] This embodiment of the invention substantially attains the same advantages of the device described beforehand, i.e. contrasting the expansion of the layer of powder material also along the sides more efficiently.

[0033] According to an aspect of this embodiment, said differentiated pressure is regulated so as to exert on the layer of powder material a constant pressure in the transverse direction with respect to the direction of advancement.

[0034] A layer of compacted powder of uniform quality can be obtained advantageously.

BRIEF DESCRIPTION OF DRAWINGS

[0035] Further characteristics and advantages of the invention will be apparent from reading the following description provided by way of non-limiting example, with reference to the figures illustrated in the attached drawings.

Figure 1 is a schematic lateral view of a device for compacting a layer of powder material.

Figure 2 is the section II-II of figure 1 in enlarged scale.

Figure 3 is the section III-III of figure 2 in small scale.

Figure 4 is the section of figure 3 according to a variant of the invention.

Figure 5 is a schematic view of a supply system of pressurised fluid associated to the device of figure 1.

BEST MODE FOR CARRYING OUT THE INVENTION

[0036] The mentioned figures show a device 100 for compacting a layer M of powder material, typically of ceramic powder within a method for forming ceramic tiles or slabs.

[0037] The device 100 comprises a flexible conveyor belt 105, which is closed-loop-like wound around a plurality of rollers 110 with horizontal axis, including a series of idle return rollers and at least one motorised drive roller adapted to actuate the conveyor belt 105 to slide. The conveyor belt 105 can be made of plastic material, so as to have a low cost, a low extent of dirtiness and an easy operating maintenance. The upper section of the conveyor belt 105, substantially horizontal, defines a slidable transport surface 106 adapted to support the layer M of powder material and advance it in a predefined direction of advancement A.

[0038] The layer M of powder material is advanced from said transport surface 106 through a compacting station 115 of the continuous type, which is adapted to compact the layer M of powder material progressively as it advances. The compacting station 115 comprises two flexible compacting belts, mutually superimposed, including a lower compacting belt 120 and an upper compacting belt 125. Both the compacting belts 120 and 125 may be made of plastic material, so as to have a low cost, a low extent of dirtiness and an easy operating maintenance.

[0039] The lower compacting belt 120 is closed-loop-like wound around a pair of rollers 121 with horizontal axis, including an idle return roller and a motorised drive roller adapted to actuate the compacting belt 120 to slide. The upper section of the compacting belt 120, substantially horizontal, defines a slidable compacting surface 122 which is arranged beneath and at direct contact with the transport surface 106, so that it supportingly rests thereon. The compacting surface 122 is further actuated to slide in the same direction of advancement A and substantially at the same speed as the transport surface 106, so as to prevent mutual friction.

[0040] The upper compacting belt 125 is in turn closed-loop-like wound around a pair of rollers 126 with horizontal axis, including an idle return roller and a motorised drive roller adapted to actuate the compacting belt 125 to slide. The lower section of the compacting belt 125 defines a slidable compacting surface 127 which is arranged above the transport surface 106, and it is spaced therefrom so as to leave defined an interspace for the passage of the layer M of powder material. The compacting surface 127 is actuated to slide substantially in the same direction of advancement A and substantially at the same speed as the transport surface 106, so as to prevent mutual friction with the layer M of powder material.

[0041] The compacting station 115 further comprises special pressing means, which are adapted to locally maintain the upper compacting surface pressed 127 towards the transport surface 106, so as to compress the layer M of powder material interposed therebetween. In the illustrated example, the pressing means comprise a

pair of mutually superimposed pressing rollers, including a lower pressing roller 130 and an upper pressing roller 135, having rotation axes horizontal and orthogonal with respect to the direction of advancement A. The lower pressing roller 130 is arranged beneath and at direct contact with the lower compacting surface 122, and it is positioned at a height such to maintain the planarity of the transport surface 106. The upper pressing roller 135 is instead arranged above and at direct contact with the upper compacting surface 127, and it is positioned at a height such to locally approach said upper compacting surface 127 towards the transport surface 106, so as to reduce the thickness of the interspace defined therebetween and thus compact the layer M of powder material. While the lower pressing roller 130 is mounted fixed, the upper pressing roller 135 is carried by jacks 136 that allow modifying the height thereof, i.e. the distance with respect to the lower pressing roller 130, for example as a function of the thickness of the layer M of powder material to be compacted and/or the compacting pressure intended to be applied thereon.

[0042] In order to make the compacting of the layer M of powder material more gradual, the pressing means may also comprise a pair of mutually superimposed roller units, including a lower roller unit 140 and an upper roller unit 145, which are positioned upstream of the pressing rollers 130 and 135 with respect to the direction of advancement A. Both roller units 140 and 145 comprise rollers having rotation axes horizontal and orthogonal to the direction of advancement A. The rollers of the lower roller unit 140 are arranged beneath and at contact with the lower compacting surface 122, they are arranged on a plane parallel to the direction of advancement A, and they are positioned at a height such to maintain the planarity of the transport surface 106. The rollers of the upper roller unit 145 are instead arranged above and at contact with the upper compacting surface 127, they are arranged on an up-down inclined plane with respect to the direction of advancement A, and they are positioned at a height such to progressively approach the upper compacting surface 127 towards the transport surface 106, so as to progressively reduce the thickness of the interspace defined therebetween and thus gradually compacting the layer M of powder material. In order to improve the compacting uniformity of the powder material in the direction of the width of the layer M, the compacting station 115 also comprises means for laterally containing the layer M of powder material. In the illustrated example, said containment means comprise a pair of slidable belts, respectively 150 and 155, which are both positioned above the conveyor belt 105. Each slidable belt 150 and 155 is flexible and it is closed-loop-like wound around a respective plurality of rollers 160 with horizontal axis, including a series of idle return rollers and possibly a motorised drive roller which allows the belt to slide. In particular, the slidable belts 150 and 155 are configured and actuated so that the lower section of each of them, substantially horizontal, is adapted to slide in the same direction of advancement A and substantially at the same speed as the transport surface 106. As illustrated in figure 2, said lower sections of the slidable belts 150 and 155 are both positioned resting on the transport surface 106, in an interposed position between the latter and the upper compacting surface 127, thus defining two parallel and mutually spaced edges 151 and 156 which are adapted to laterally contain the layer M of powder material during compacting. The slidable belts 150 and 155 are made of a quite yieldable material in the direction of the thickness, for example made of rubber or any other plastic material, so that the containment edges 151 and 156 defined thereby may be elastically compressed between the compacting surfaces 122 and 127.

[0043] Immediately downstream of the pressing means, the compacting station 115 is also provided with means for contrasting the expansion to which the layer M of powder materials is spontaneously subjected to after the compacting step. More in particular, these contrast means have the function of "accompanying" the expansion of the powder material, i.e. limiting the extent thereof and/or slowing it, so as to prevent the formation of cracks and/or fissures in the layer M after compacting.

[0044] As illustrated in figure 2, the means for contrasting the expansion comprise a lower plate 165, which is positioned beneath and at direct contact with the lower compacting surface 122. The lower plate 165 is substantially horizontal and it is positioned at a height such to maintain the planarity of the transport surface 106. The contrast means further comprise an upper plate 170, which is superimposed to the lower plate 165 and it is positioned above the upper compacting surface 127. While the lower plate 165 is fixed, the upper plate 170 is supported by means of jacks 175 of the hydraulic type which allow varying the distance thereof with respect to the transport surface 106, for example as a function of the thickness of the layer M of powder material. Furthermore, as observable from the figures, the upper plate 170 may oscillate with respect to the jacks 175 so as to be able to be inclined with respect to the transport surface 106. The upper plate 170 carries a row of at least three pistons 180, arranged in the transverse direction with respect to the direction of advancement A of the transport surface 106. Each piston 180 of the row is configured like a thin plate, substantially horizontal, in this case - in plan view - square-shaped (v. fig 3). In the illustrated example, the central piston 180 has a greater width with respect to the pistons 180 arranged at the ends of the row, which are preferably identical to each other. The end pistons 180 are singularly dimensioned and positioned so as to surmount a respective containment edge 151 and 156, while the central piston 180 is dimensioned and positioned so as to surmount the layer M of powder material alone. The row of pistons 180 in turn carries a flexible plate 185, substantially horizontal, which is adapted to be at direct contact above the upper compacting surface 127. The flexible plate 185 is preferably positioned and dimensioned so as to surmount both the layer

M of powder material and the lateral containment edges 151 and 156. The flexible plate 185 can be made of plastic material and be fixed to the lower faces of the pistons 180 by means of usual fastening means not illustrated.

[0045] Getting more in the detail, each piston 180 of the row is received in a respective cavity 190 of the upper plate 170, in which it is free to slide in the direction of the thickness thereof, i.e. in substantially vertical direction. As illustrated in figure 5, the reception cavities 190 are in communication with a system 200 adapted to supply a pressurised fluid, typically oil, therein so that the pressure of the fluid in the reception cavities 190 pushes the relative pistons 180, and thus the underlying flexible plate 185, downwards. Thus, the flexible plate 185 maintains the upper compacting surface pressed 127 towards the upper section of the conveyor belt 105, subjecting the layer M of powder material to a pressure for contrasting the expansion. Generally, this contrast pressure will be lower than the compacting pressure exerted by the pressing rollers 130 and 135, so that the powder material can still expand, but without causing the formation of cracks or fissures in the compacted layer M.

[0046] In order to allow the expansion of the powders to obtain the maximum uniformity in the direction of the width of the layer M, the supply system 200 comprises means that allow regulating the pressure of the fluid in each reception cavity 190 independently from the others. In the illustrated example, said means comprise three independent operating units 205, each of which is adapted to draw the fluid from a tank 210 and supply it pressurised into a respective reception cavity 190. Each operating unit 205 particularly comprises a pump 215, which is in communication with the tank 210 through an intake conduit 220 and with the respective reception cavity 190 through a delivery conduit 225, a pressure regulation valve 230 located along the delivery conduit 225, and a pressure sensor 235 located on the same delivery conduit 225 downstream of the pressure regulation valve 230. Each operating unit 205 is further connected with an electronic control unit 240, which is programmed for controlling the operation of the pumps 215 and/or of the pressure regulation valves 230, so as to ensure that the pressure of the fluid in each reception cavity 190 has a predefined value, regardless of the others. In particular, the electronic control unit 240 is programmed so that the pistons 180 are adapted to press the upper compacting surface 127, through the flexible plate 185, with a differentiated pressure in the transverse direction with respect to the direction of advancement A. For example, the pistons 180 arranged at the end of the row may be controlled to exert on the upper compacting surface 127 a different thrust (upper) with respect to that exerted by the central piston 180 so that, regardless of the contrast action offered by the underlying lateral containment edges 151 and 156, the powder material arranged at the sides of the layer M is subjected to the same contrast pressure the powder material arranged at the centre is subjected to.

[0047] Figure 4, illustrates a variant of the invention in which the upper plate 170 carries a plurality of rows of pistons 180, which are arranged in succession along the direction of advancement A of the transport surface 106, forming a kind of matrix or grid of pistons 180. Each row of pistons 180 of the matrix/grid is entirely analogous to that described previously, and it is associated to an analogous supply system 200 of the fluid. A respective flexible plate 185 can be fixed to each row of pistons 180 of the matrix/grid, or a single flexible plate 185 of greater dimensions can be fixed to all the pistons 180 of the matrix/grid. Due to this solution, each row of pistons 180 of the matrix/grid can be controlled for subjecting the layer M of powder material to a different contrast pressure, for example progressively decreasing in the direction of advancement A, so as to allow the powders to expand more gradually and slowly.

[0048] Obviously the compacting device 100 described above may be subjected - by a man skilled in the art - to numerous technical-applicational modifications without departing from the scope of protection of the invention according to the following claims.

REFERENCES

[0049]

100	compacting device
105	conveyor belt
106	transport surface
110	rollers
115	compacting station
120	lower compacting belt
121	rollers
122	lower compacting surface
125	upper compacting belt
126	rollers
127	upper compacting surface
130	lower pressing roller
135	upper pressing roller
136	jacks
140	lower roller unit
145	upper roller unit
150	belt
151	edge
155	belt
156	edge
160	rollers
165	lower plate
170	upper plate
175	jacks
180	pistons
185	flexible plate
190	reception cavity
200	supply system
205	operating unit
210	tank
215	pump

220 intake conduit
225 delivery conduit
230 pressure regulator valve
235 pressure sensor
240 electronic control unit
A direction of advancement
M layer of powder material

Claims

1. Device (100) for compacting a layer (M) of powder material, comprising a slidable transport surface (106) adapted to support and advance the layer (M) of powder material along a predefined direction of advancement (A), a slidable compacting surface (122) which is arranged beneath and at direct contact with the transport surface (106), a slidable compacting surface (127) flexible and superimposed to the transport surface (106) and substantially slidable in the same direction of advancement (A), pressing means (130, 135) adapted to press said compacting surface (127) towards the transport surface (106) so as to press the layer (M) of powder material interposed therebetween, means (150) for laterally containing the layer (M) of powder and means (170, 180, 185) for contrasting the expansion of the layer (M) of powder material downstream of the pressing means (130, 135), wherein said contrast means (170, 180, 185) are independent from said pressing means, and comprise a fixed lower plate (165), which is positioned beneath and in direct contact with the lower compacting surface (122) and an upper plate (170), which is superimposed to the lower plate (165) and it is positioned above the upper compacting surface (127), the upper plate being supported by means of jacks (175) of the hydraulic tipe, and comprising at least one row of pistons (180), superimposed to the compacting surface (127) and arranged adjacent to each other in transverse direction with respect to the direction of advancement (A), each of which is slidably received in a respective reception cavity (190), which is obtained in a support body (170) and it is in communication with a system (200) for supplying a pressurised fluid for pushing the piston (180) towards the underlying compacting surface (127), **characterised in that** said supply system (200) is configured for regulating the pressure of the fluid in the reception cavity (190) of each piston (180) of the row independently with respect to the pressure of the fluid in the reception cavity (190) of the other pistons (180) of the row.

2. Device according to claim 1 **characterised in that** said transport surface (106) and said compacting surface (127) are singularly defined by a respective slidable belt (105, 125).

3. Device (100) according to claim 1, **characterised in that** said row of pistons (180) comprises at least three pistons (180).

4. Device (100) according to claim 3, **characterised in that** each piston (180) of the row is substantially configured like a plate, which is received in the respective cavity (190) so as to be adapted to slide in the direction of the thickness thereof.

5. Device (100) according to any one of claims 1 to 4, **characterised in that** the pistons (180) positioned at the ends of the row are singularly superimposed at a respective edge (151, 156) for laterally containing the layer (M) of powder material.

6. Device (100) according to claim 1, **characterised in that** said system (200) for supplying the pressurised fluid comprises a plurality of pumps (215), each of which is adapted to pump the fluid into the reception cavity (190) of a respective piston (180) of the row.

7. Device (100) according to claim 6, **characterised in that** said system (200) for supplying the pressurised fluid further comprises a plurality of pressure regulation valves (230), each of which is positioned along a connection conduit (225) between the reception cavity (190) of a respective piston (180) of the row and the corresponding pump (215).

8. Device (100) according to claim 7 , **characterised in that** said supply system (200) further comprises a plurality of pressure sensors (235), each of which is in communication with the reception cavity (190) of a respective piston (180) of the row.

9. Device (100) according to the preceding claims, **characterised in that** said contrast means comprise a plurality of said rows of pistons (180), which are arranged in succession along the direction of advancement (A) of the transport surface (106).

10. Method for compacting a layer (M) of powder material, using the device according to the preceding claims comprising the steps of:

    - advancing the layer (M) of powder material along a predefined direction of advancement (A), by means of a slidable transport surface (106),
    - laterally containing the layer (M) while it advances on the slidable support surfaces (106)
    - compacting said layer (M) of powder material while it advances, by means of a slidable compacting surface (127) flexible, superimposed to the transport surface (106) and substantially slidable in the same direction of advancement (A), and by means of pressing means (130, 135)

adapted to press said compacting surface (127) towards the transport surface (106),
- contrasting the expansion of the layer (M) of powder material while it advances downstream of the pressing means (130, 135),

wherein said step of contrast comprises for pressing the compacting surface (127) and the means for laterally containing the layer (M) towards the transport surface (106) with a differentiated pressure in the transverse direction with respect to the direction of advancement (A),

11. Method according to claim 11, **characterised in that** said differentiated pressure is regulated so as to exert on the layer (M) of powder material a constant pressure in the transverse direction with respect to the direction of advancement (A).

Patentansprüche

1. Vorrichtung (100) zum Verdichten einer Schicht (M) pulverförmigen Materials, umfassend eine gleitfähige Transportfläche (106), die dafür eingerichtet ist, die Schicht (M) pulverförmigen Materials zu tragen und entlang einer vordefinierten Förderrichtung (A) zu befördern, eine gleitfähige Verdichtungsfläche (122), die unter und in direktem Kontakt mit der Transportfläche (106) angeordnet ist, eine gleitfähige Verdichtungsfläche (127), die flexibel ist und über der Transportfläche (106) liegt und im Wesentlichen in der gleichen Förderrichtung (A) gleitfähig ist, Pressmittel (130, 135), die dafür eingerichtet sind, die Verdichtungsfläche (127) derart hin zur Transportfläche (106) zu pressen, dass die dazwischenliegende Schicht (M) pulverförmigen Materials gepresst wird, Mittel (105) zum seitlichen Halten der Schicht (M) pulverförmigen Materials und Mittel (170, 180, 185) prozessabwärts der Pressmittel (130, 135), um der Ausdehnung der Schicht (M) pulverförmigen Materials entgegenzuwirken, wobei die Mittel (170, 180, 185) zum Entgegenwirken unabhängig von den Pressmitteln sind und eine feststehende untere Platte (165) umfassen, die unter der unteren Verdichtungsfläche (122) liegt und in direktem Kontakt mit selbiger steht, sowie eine obere Platte (170), die über der unteren Platte (165) liegt und über der oberen Verdichtungsfläche (127) positioniert ist, wobei die obere Platte von Hebeeinrichtungen (175) der hydraulischen Art getragen wird und mindestens eine Reihe von Kolben (170) umfasst, die über der Verdichtungsfläche (127) liegen und in Querrichtung zur Förderrichtung (A) angrenzend aneinander angeordnet sind, von denen jeder gleitfähig in einer entsprechenden Aufnahmeaussparung (190) aufgenommen ist, die in einem Tragekörper (170) enthalten ist und in Verbindung mit einem System (200) für die Zufuhr eines mit Druck beaufschlagten Fluids zum Drücken der Kolben (180) hin zur darunterliegenden Verdichtungsfläche (127) steht,
dadurch gekennzeichnet, dass das Zufuhrsystem (200) dafür gestaltet ist, den Druck des Fluids in der Aufnahmeaussparung (190) jedes Kolbens (180) der Reihe unabhängig vom Fluiddruck in der Aufnahmeaussparung (190) der anderen Kolben (180) der Reihe zu regeln.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Transportfläche (106) und die Verdichtungsfläche (127) durch ein entsprechendes gleitfähiges Band (105, 125) einzeln definiert sind.

3. Vorrichtung (100) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Reihe von Kolben (180) mindestens drei Kolben (180) umfasst.

4. Vorrichtung (100) nach Anspruch 3, **dadurch gekennzeichnet, dass** jeder Kolben (180) der Reihe im Wesentlichen wie eine Platte gestaltet ist, die derart in der entsprechenden Aussparung (190) aufgenommen ist, dass sie dafür eingerichtet ist, in Richtung der Dicke selbiger zu gleiten.

5. Vorrichtung (10) nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die Kolben (180), die an den Enden der Reihe positioniert sind, einzeln über einer entsprechenden Kante (151, 156), zum seitlichen Halten der Schicht (M) pulverförmigen Materials liegen.

6. Vorrichtung (100) nach Anspruch 1, **dadurch gekennzeichnet, dass** das System (200) zum Zuführen des mit Druck beaufschlagten Fluids mehrere Pumpen (215) umfasst, die jeweils dafür eingerichtet sind, das Fluid in die Aufnahmeaussparung (190) eines entsprechenden Kolbens (180) der Reihe zu pumpen.

7. Vorrichtung (100) nach Anspruch 6, **dadurch gekennzeichnet, dass** das System (200) zum Zuführen des mit Druck beaufschlagten Fluids ferner mehrere Druckregelventile (230) umfasst, die jeweils an einer Verbindungsleitung (225) zwischen der Aufnahmeaussparung (190) eines entsprechenden Kolbens (180) der Reihe und der entsprechenden Pumpe (215) positioniert sind.

8. Vorrichtung (100) nach Anspruch 7, **dadurch gekennzeichnet, dass** das Zufuhrsystem (200) ferner mehrere Drucksensoren (235) umfasst, die jeweils in Verbindung mit der Aufnahmeaussparung (190) eines entsprechenden Kolbens (180) der Reihe stehen.

9. Vorrichtung (100) nach den vorhergehenden Ansprüchen, **dadurch gekennzeichnet, dass** die Mittel zum Entgegenwirken mehrere Reihen von Kolben (180) umfassen, die in Folge entlang der Förderrichtung (A) der Transportfläche (106) angeordnet sind.

10. Verfahren zum Verdichten einer Schicht (M) pulverförmigen Materials unter Verwendung der Vorrichtung gemäß den vorhergehenden Ansprüchen, folgende Schritte umfassend:

    Befördern der Schicht (M) pulverförmigen Materials entlang einer vordefinierten Förderrichtung (A) mittels einer gleitfähigen Transportfläche (106),
    seitliches Halten der Schicht (M), während sie auf den gleitfähigen Trageflächen (106) befördert wird,
    Verdichten der Schicht (M) pulverförmigen Materials, während sie befördert wird, mittels einer gleitfähigen Verdichtungsfläche (127), die flexibel ist, über der Transportfläche (106) liegt und im Wesentlichen in der gleichen Förderrichtung (A) gleitfähig ist, und mittels Pressmitteln (130, 135), die dafür eingerichtet sind, die Verdichtungsfläche (127) hin zur Transportfläche (106) zu pressen,
    Wirken gegen die Ausdehnung der Schicht (M) pulverförmigen Materials, während diese prozessabwärts der Pressmittel (130, 135) befördert wird,
    wobei der Schritt des Entgegenwirkens das Pressen der Verdichtungsfläche (127) und der Mittel zum seitlichen Halten der Schicht (M) hin zur Transportfläche (106) in der im Verhältnis zur Förderrichtung (A) quer verlaufenden Richtung mit einem unterschiedlichen Druck umfasst.

11. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** der unterschiedliche Druck derart geregelt wird, dass auf die Schicht (M) pulverförmigen Materials in der im Verhältnis zur Förderrichtung (A) quer verlaufenden Richtung ein konstanter Druck ausgeübt wird.

Revendications

1. Dispositif (100) pour compacter une couche (M) de matériau en poudre, comprenant une surface de transport coulissante (106) adaptée pour supporter et avancer la couche (M) de matériau en poudre dans une direction d'avancement (A) prédéfinie, une surface de compactage coulissante (122) qui est agencée sous la surface de transport (106) et directement en contact avec celle-ci, une surface de compactage coulissante (127) flexible et superposée à la surface de transport (106), et coulissant substantiellement dans la même direction d'avancement (A), des moyens de compression (130, 135) adaptés pour compresser ladite surface de compactage (127) vers la surface de transport (106) de manière à compresser la couche (M) de matériau en poudre interposée entre elles, des moyens de contention latérale (150) de la couche de poudre (M), et des moyens d'opposition (170, 180, 185) qui s'opposent à l'expansion de la couche (M) de matériau en poudre en aval des moyens de compression (130, 135), dans lequel lesdits moyens d'opposition (170, 180, 185) sont indépendants desdits moyens de compression et comprennent une plaque inférieure fixe (165), qui est positionnée sous la surface de compactage inférieure (122) et en contact direct avec celle-ci, et une plaque supérieure (170), qui est superposée à la plaque inférieure (165) et qui est positionnée au-dessus de la surface de compactage supérieure (127), la plaque supérieure étant supportée à l'aide de vérins (175) de type hydraulique et comprenant au moins une rangée de pistons (180), superposés à la surface de compactage (127) et agencés de manière adjacente entre eux en direction transversale par rapport à la direction d'avancement (A), chacun étant reçu de manière coulissante dans une cavité de réception respective (190), qui est obtenue dans un corps de support (170) et est en communication avec un système (200) pour alimenter un fluide sous pression afin de pousser le piston (180) vers la surface de compactage (127) sous-jacente, **caractérisé en ce que** ledit système d'alimentation (200) est configuré pour réguler la pression du fluide dans la cavité de réception (190) de chaque piston (180) de la rangée indépendamment de la pression du fluide dans la cavité de réception (190) des autres pistons (180) de la rangée.

2. Dispositif selon la revendication 1, **caractérisé en ce que** ladite surface de transport (106) et ladite surface de compactage (127) sont définies de manière unique par une bande coulissante respective (105, 125).

3. Dispositif (100) selon la revendication 1, **caractérisé en ce que** ladite rangée de pistons (180) comprend au moins trois pistons (180).

4. Dispositif (100) selon la revendication 3, **caractérisé en ce que** chaque piston (180) de la rangée est substantiellement configuré comme une plaque, qui est reçue dans la cavité respective (190) de manière à être adaptée pour coulisser en direction de son épaisseur.

5. Dispositif (100) selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** les pistons

(180) positionnés aux extrémités de la rangée sont superposés de manière unique à un bord respectif (151, 156) pour contenir latéralement la couche (M) de matériau en poudre.

6. Dispositif (100) selon la revendication 1, **caractérisé en ce que** ledit système (200) d'alimentation du fluide sous pression comprend une pluralité de pompes (215), qui sont adaptées chacune pour pomper le fluide dans la cavité de réception (190) d'un piston respectif (180) de la rangée.

7. Dispositif (100) selon la revendication 6, **caractérisé en ce que** ledit système (200) d'alimentation du fluide sous pression comprend en outre une pluralité de vannes de régulation de pression (230), qui sont positionnées chacune sur un conduit de connexion (225) entre la cavité de réception (190) d'un piston respectif (180) de la rangée et la pompe correspondante (215).

8. Dispositif (100) selon la revendication 7, **caractérisé en ce que** ledit système d'alimentation (200) comprend en outre une pluralité de capteurs de pression (235), qui sont chacun en communication avec la cavité de réception (190) d'un piston respectif (180) de la rangée.

9. Dispositif (100) selon les revendications précédentes, **caractérisé en ce que** lesdits moyens d'opposition comprennent une pluralité de dites rangées de pistons (180), qui sont agencées en succession en direction d'avancement (A) de la surface de transport (106).

10. Procédé de compactage d'une couche (M) de matériau en poudre utilisant le dispositif selon les revendications précédentes, comprenant les étapes suivantes :

- avancement de la couche (M) de matériau en poudre selon une direction d'avancement prédéfinie (A) à l'aide d'une surface de transport coulissante (106),
- contention latérale de la couche (M) pendant qu'elle avance sur les surfaces de support coulissantes (106),
- compactage de ladite couche (M) de matériau en poudre pendant qu'elle avance à l'aide d'une surface de compactage coulissante (127) flexible et superposée à la surface de transport (106), et coulissant substantiellement dans la même direction d'avancement (A), et à l'aide de moyens de compression (130, 135) adaptés pour compresser ladite surface de compactage (127) vers la surface de transport (106),
- opposition à l'expansion de la couche (M) de matériau en poudre pendant qu'elle avance en aval des moyens de compression (130, 135),

dans lequel ladite étape d'opposition comprend la compression de la surface de compactage (127) et des moyens de contention latérale de la couche (M) vers la surface de transport (106) avec une pression différenciée en direction transversale par rapport à la direction d'avancement (A).

11. Procédé selon la revendication 11, **caractérisé en ce que** ladite pression différenciée est réglée de manière à exercer sur la couche (M) de matériau en poudre une pression constante en direction transversale à la direction d'avancement (A).

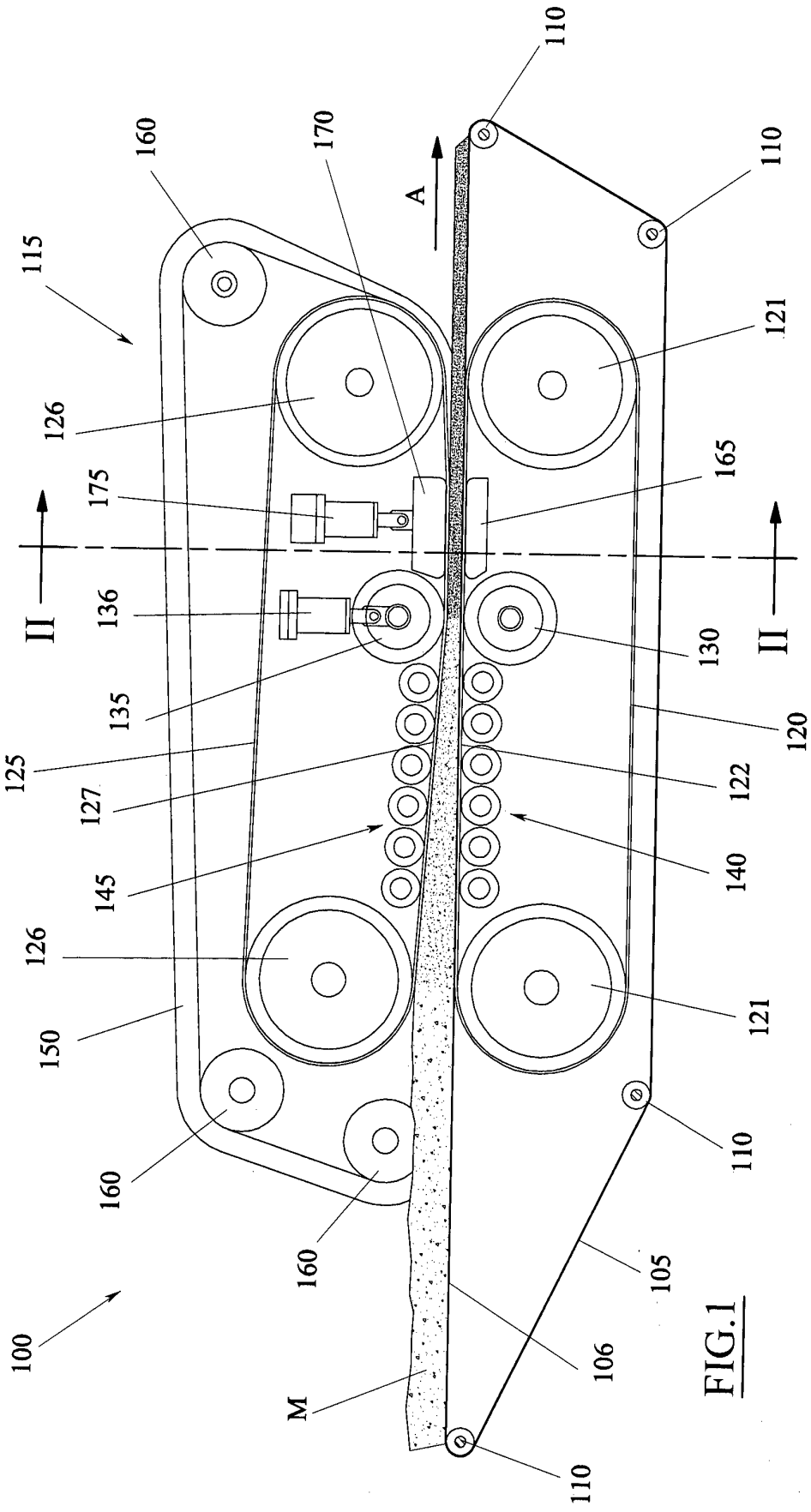

110
160
170
110
A
115
121
126
165
175
II
II
136
130
135
120
125
122
127
140
145
126
121
150
110
160
160
105
106
100
M
110

FIG.1

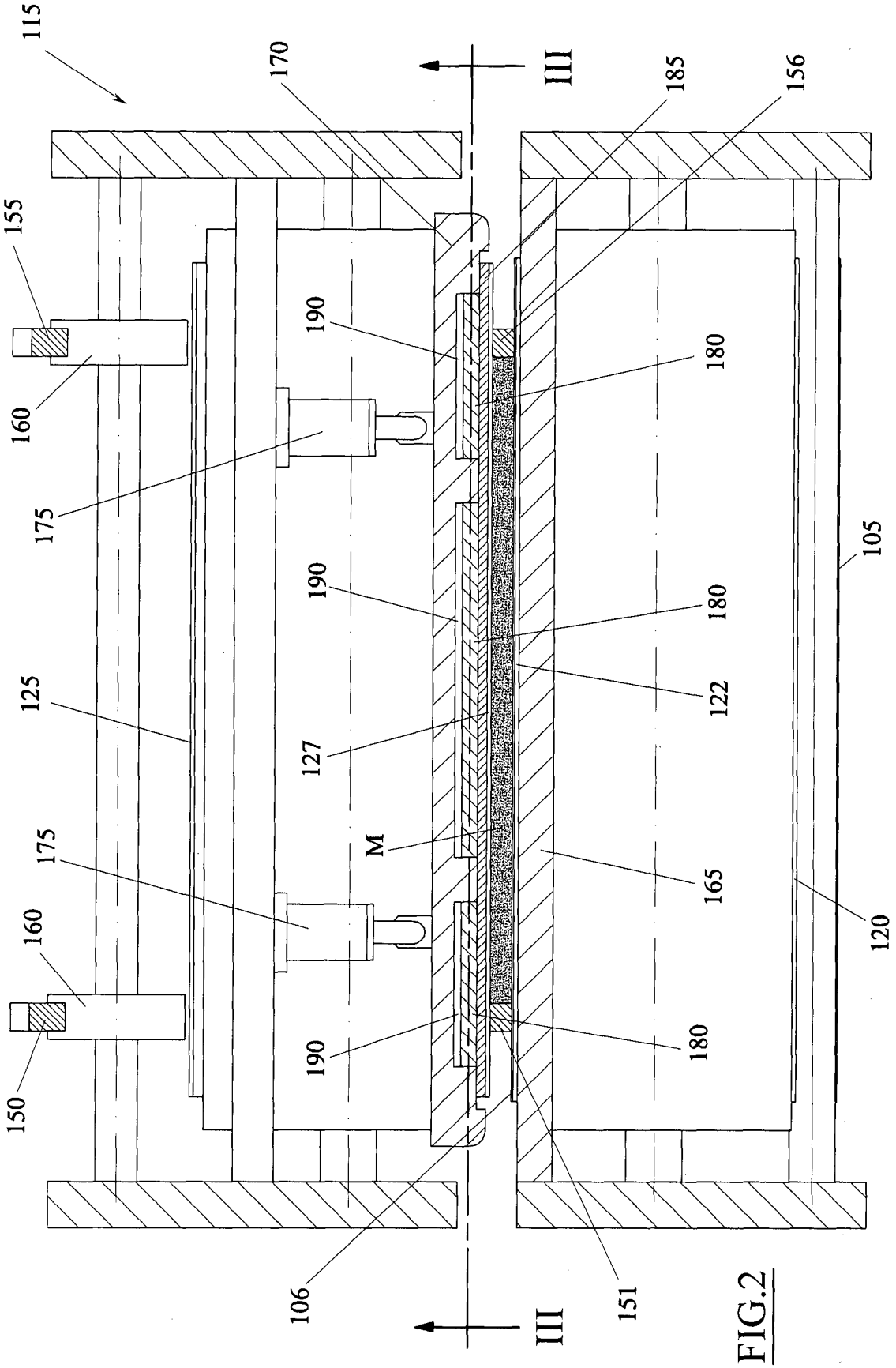

115
170
III
185
156
155
190
180
160
175
105
190
180
125
122
127
M
175
165
160
120
190
180
150
106
151
III

FIG.2

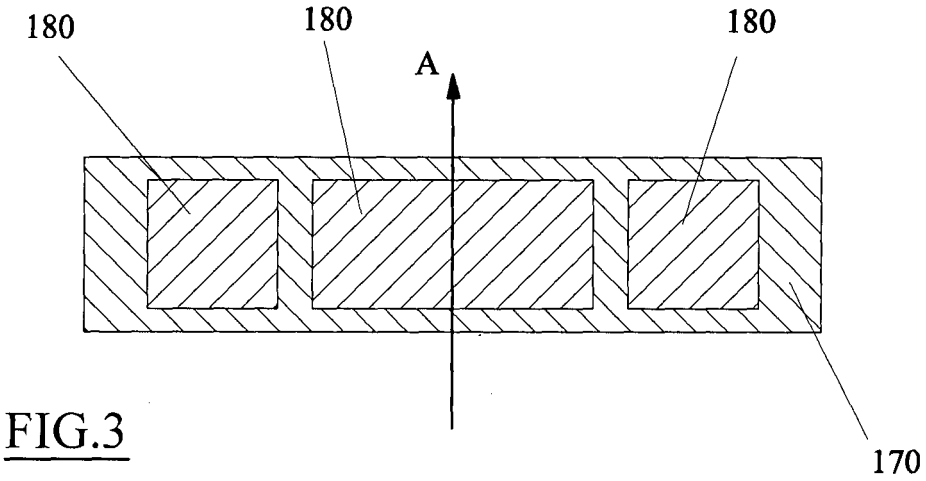


FIG.3

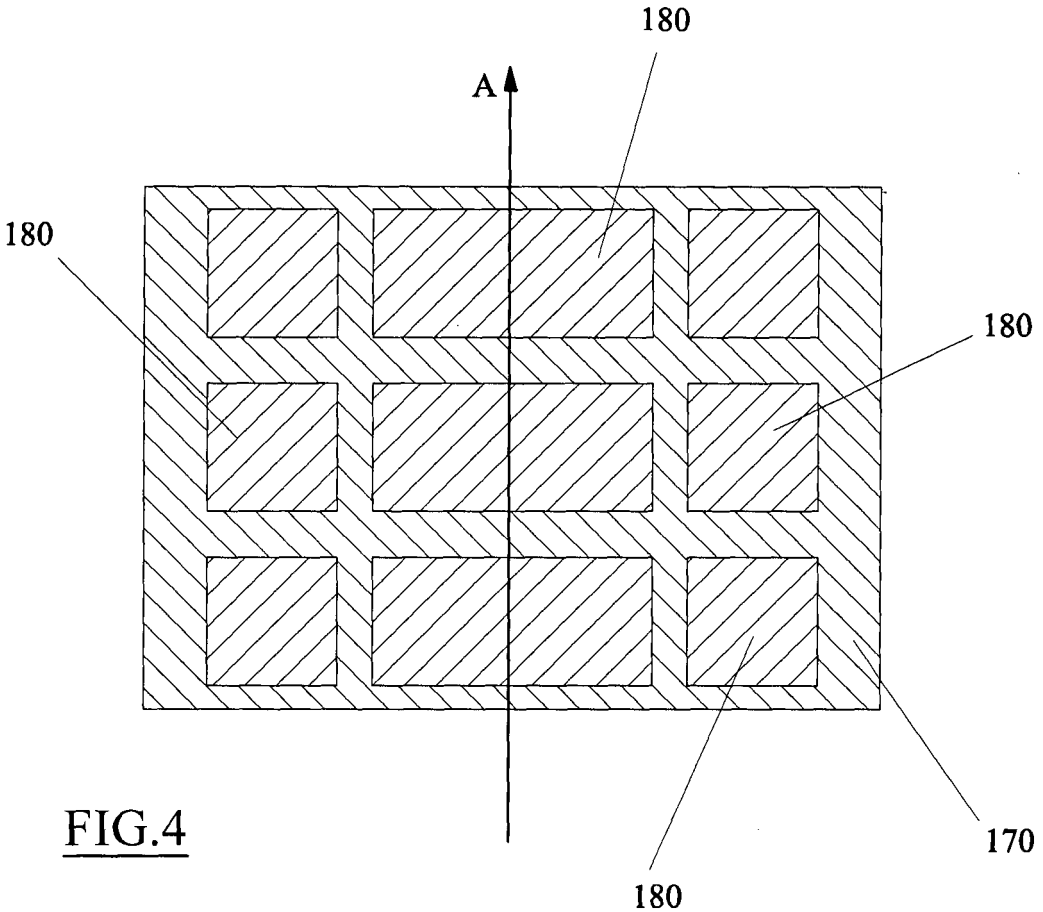


FIG.4

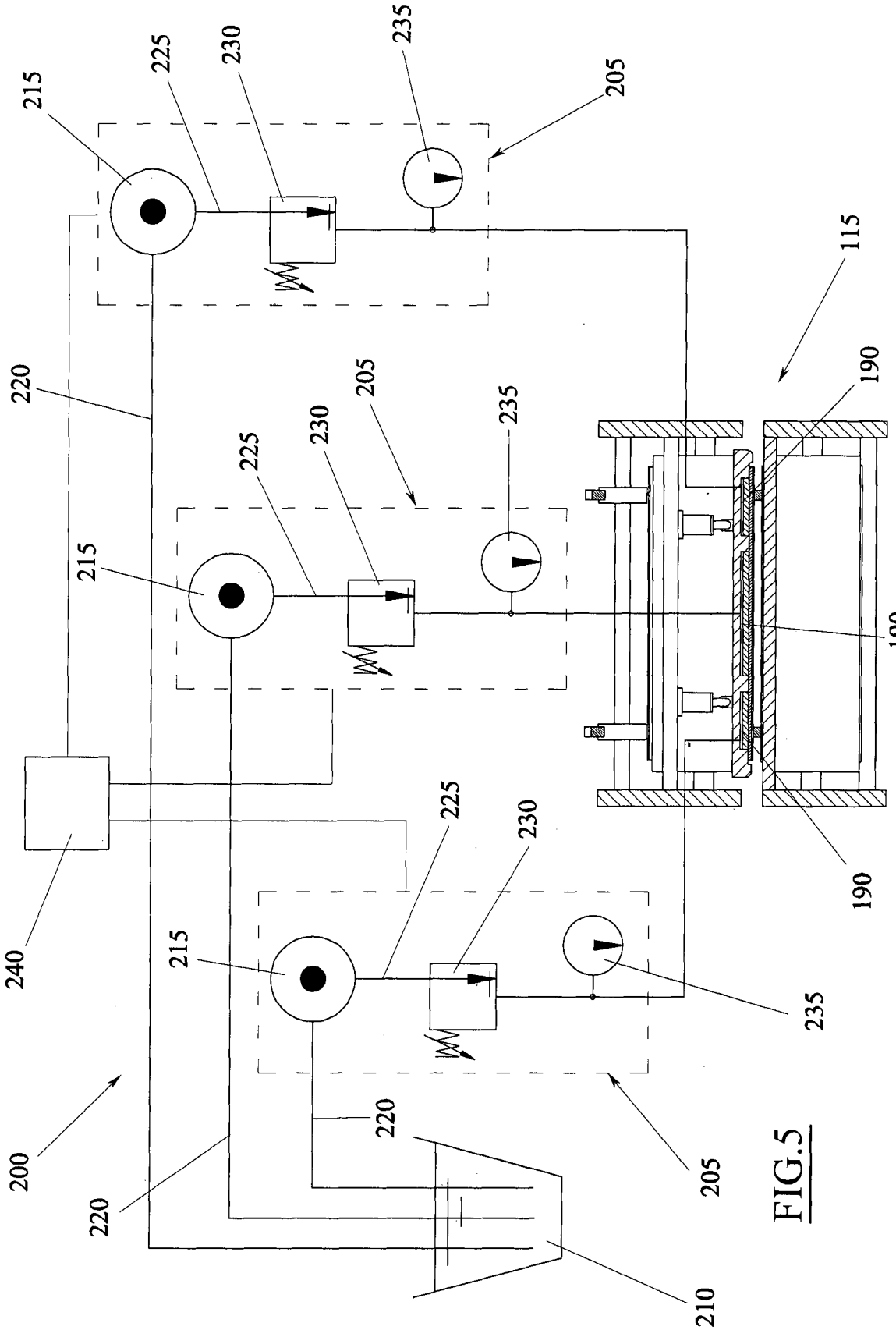


FIG.5

REFERENCES CITED IN THE DESCRIPTION

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