

(19)



(11)

EP 3 539 686 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

26.01.2022 Bulletin 2022/04

(51) International Patent Classification (IPC):

B22C 7/04 (2006.01) **B22C 15/08** (2006.01)
B22C 15/02 (2006.01) **B22C 21/08** (2006.01)

(21) Application number: **19163208.2**

(52) Cooperative Patent Classification (CPC):

B22C 7/04; B22C 15/02; B22C 15/08; B22C 21/08

(22) Date of filing: **15.03.2019**

(54) **MOULDING MACHINE WITH A BOLSTER ARRANGEMENT AND METHOD FOR PRODUCING A MOULD**

FORMMASCHINE MIT EINER UNTERLAGENANORDNUNG UND VERFAHREN ZUR
HERSTELLUNG EINER FORM

MACHINE DE MOULAGE DOTÉE D'UN AGENCEMENT DE SOUTIEN ET PROCÉDÉ DE
FABRICATION D'UN MOULE

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **15.03.2018 EP 18162056**

05.07.2018 EP 18182048

(43) Date of publication of application:

18.09.2019 Bulletin 2019/38

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Description

[0001] The invention relates to a bolster arrangement for supporting a pattern in a moulding machine and a moulding machine with the bolster arrangement. Additionally a method for producing at least a portion or a part of a mould is provided.

[0002] Sand moulds for metal casting are well known in the art. Typically a model, called pattern, resembling the element, which is to be cast, is used for producing sand moulds. Usually, there are two patterns resembling two portions (often halves) of the element to be cast. Each pattern can then be placed into a box (flask) and sand is filled into the box. The sand is then compacted by a pressing tool until a sufficient strength of the compacted sand is achieved. Afterwards, the pattern is removed leaving a negative of the pattern in the compacted sand. Thereby, a first portion of a mould is produced. These steps are repeated for a second portion of a mould. A gating system is included in the mould portions as known in the art.

[0003] Often, the moulding material (e.g. green sand) is compacted by applying a force to the moulding material from the top, the top side being the side at which the sand was filled into the box to cover the pattern. Thereby, the surface to which the force was directly applied to is typically more compacted (harder) than the opposite surface at which the compacting process was limited by the pattern surface. An insufficient compaction of the moulding material at the pattern surface side can lead to unsatisfactory casting results.

[0004] Bolster arrangements for supporting a pattern in a mould producing machine are known in the art. These known bolster arrangements comprise an upper frame and a lower frame, wherein the two frame elements are coupled by a complex external (outside the bolster frames) guiding system. A movement of the known bolster arrangement lower frame towards the upper frame allows a compaction of the moulding material from the bottom, which is the side opposite to the side at which a moulding material was filled into the bolster arrangement. A sand filling frame is used to accommodate necessary moulding material, since such external guiding systems only allow relatively small room for accommodation of moulding material covering the pattern.

[0005] GB 2 031 767 A and WO 2016/203394 A1 disclose a method of compacting foundry moulding sand in moulding boxes, wherein a volume of moulding sand is relatively large in relation to the cavity volume of the moulding box, the sand is compacted first of all from below and then from above in the moulding box; the quantity of excess moulding sand is so dimensioned that, after the pressing from below is concluded, moulding sand still projects above the moulding box.

[0006] DE 44 08 748 A1 relates to a device for the production of sand moulds. The device comprises a pattern plate on a stroke device, a flask and a filing frame.

[0007] EP 0 126 857 A1 describes a method of pro-

ducing a sand mould.

[0008] The **problem to be solved** by the invention is to provide a machine for producing mould portions with reduced complexity while at least maintaining a good quality of the mould portions produced from it.

[0009] This problem is solved by a machine according to claim 1 and a method according to claim 9. Disclosed is a bolster arrangement for supporting a pattern in a mould producing machine. The bolster arrangement comprises a bolster frame and a bolster plate. The bolster plate and the bolster frame are movable in a direction relative to each other, such that the bolster plate is movable inside the bolster frame.

[0010] Preferably, the bolster plate is moved while the bolster frame remains in its position. The bolster plate can be lifted.

[0011] The bolster plate is to be understood as any element with a width of at least two times its height.

[0012] The bolster plate and the bolster frame can be moved relative to each other over a distance of at least 100 mm.

[0013] The bolster plate and the bolster frame can also be moved relative to each other over a distance of at least 150 mm or at least 200 mm.

[0014] Further moulding material is accommodated by a flask that is positioned on the bolster arrangement.

[0015] The bolster arrangement is also configured such that it is capable of receiving a moulding material with a bolster arrangement related filling height of at least 200 mm. The moulding material is thereby storable to be compacted by the relative movement.

[0016] The bolster frame can comprise an opening in a plane perpendicular to the movement direction. The area of the opening of the bolster frame can be equal to the area of the bolster plate in the same plane allowing a deviation of $\pm 20\%$ based on the area of the opening of the bolster frame.

[0017] The bolster plate and the bolster frame can be not coupled by at least one extendable and/or retractable cylinder element, outside the bolster frame.

[0018] An outer surface of the bolster plate can be coupled to an inner surface of the bolster frame for guiding the relative movement.

[0019] At least a portion of the outer surface of the bolster plate can comprise a first guiding structure and/or at least a portion of the inner surface of the bolster frame can comprise a second guiding structure.

[0020] A first guiding structure can be detachably connected to the outer surface of the bolster plate and/or a second guiding structure can be detachably connected to the inner surface of the bolster frame.

[0021] At least one of the first guiding structure and the second guiding structure can comprise a carbide material.

[0022] At least one of the first guiding structure and the second guiding structure can comprise carbon.

[0023] The first guiding structure can be made of a different material than the bolster plate. Additionally or al-

ternatively, the second guiding structure can be made of a different material than the bolster frame.

[0024] Specifically, the material of the first guiding structure can have a higher hardness than the material of the bolster plate. The hardness can be measured according to ISO 6508-1 (Rockwell hardness).

[0025] Additionally or alternatively, the material of the second guiding structure can have a higher hardness than the material of the bolster frame.

[0026] The material of the first guiding structure can have a lower hardness than the material of the second guiding structure. Thereby, wear of the second guiding structure is lower than of the first guiding structure which is advantageous if the first guiding structure can e.g. be replaced more easily than the second guiding structure.

[0027] The bolster arrangement can comprise a sealing member. The sealing member can be configured to seal between the bolster plate and the bolster frame.

[0028] Typically, there is a small gap between the bolster plate and the bolster frame to allow a movement relative to each other. As moulding material, which often has abrasive properties, can enter the gap, wear of the bolster plate and the bolster frame or the first guiding structure and the second guiding structure can be enhanced by moulding material between the bolster plate and the bolster frame. The sealing member can reduce the amount of moulding material that enters the gap and, therefore, reduce wear between the elements.

[0029] The sealing member can be a sealing lip. The sealing member (as sealing lip) can be fixed to the bolster plate.

[0030] A machine for producing a portion of a mould is also disclosed. The machine comprises a bolster arrangement with a bolster frame and a bolster plate. A pattern is positioned on the bolster plate in the bolster frame. The machine further comprises a flask and an upper compacting system. The pattern and the upper compacting system are movable towards each other by a movement of the bolster plate and the bolster frame relative to each other. The bolster frame can be positioned on a machine table and/or the bolster plate can be positioned on a stroke device.

[0031] Any herein disclosed bolster arrangement can be used in the machine.

[0032] Preferably, the bolster plate is moved while the bolster frame remains in its position. The bolster plate can be lifted.

[0033] A distance between an upper end of the pattern and a lower end of the flask is at least 5 mm. The distance is measured in a direction opposite to the movement direction and the distance is measured prior to the relative movement of the pattern and the upper compacting system towards each other.

[0034] The upper end of the pattern can be understood as an upper end of a portion of the pattern that shapes the mould geometry that will be present in the later finished casting prepared from the (portion of the) mould. The pattern can e.g. comprise components that form a

gating or gas venting system. Such components are necessary for the moulding process but are not related to the shape or geometry of a finished casting produced from the mould (portion). Preferably, such moulding process related components of the pattern (e.g. for a gating or venting system) are preferably not taken into account for the determination of the upper end of the pattern.

[0035] An upper end of the pattern can be (situated or positioned) at most 50 mm higher (above) than a lower end of the flask, preferably in the movement direction, prior to the relative movement of the pattern and the upper compacting system towards each other.

[0036] Especially, the upper end of the pattern can be (situated or positioned) not higher than 30 mm or 15 mm than (above) the lower end of the flask.

[0037] The sum of the maximum height of the pattern and the maximum height of the bolster plate can be smaller than the maximum height of the bolster frame.

[0038] The sum of the maximum height of the pattern and the maximum height of the bolster plate can also be not more than 50 mm higher than the maximum height of the bolster frame.

[0039] It is preferred, that the sum of the maximum height of the pattern and the maximum height of the bolster plate is not more than 30 mm or 15 mm higher than the maximum height of the bolster frame.

[0040] The bolster arrangement and the flask can be configured to receive at least 70 wt.-% of a moulding material, from which moulding material a portion of a mould is to be produced at least partially in the flask. The portion of the mould can also mainly be produced in the flask. The bolster arrangement and the flask can also be configured to receive at least 80 wt.-% or at least 90 wt.-% of the moulding material.

[0041] The bolster frame can be positioned on a machine table and the bolster plate can be positioned on a stroke device. The machine table and the stroke device can be movable relative to each other over a distance of at least 100 mm.

[0042] The stroke device can be moved (lifted) relative to the machine table and the bolster frame in order to compact the moulding material.

[0043] The bolster plate can be lifted by the stroke device while the bolster frame rests on the machine table, preferably while the bolster frame and the flask rests on the rest on the machine table

[0044] The machine table and the stroke device can also be movable relative to each other over a distance of at least 150 mm or at least 200 mm.

[0045] The bolster arrangement and the flask are configured to receive a moulding material with a filling height of at least 200 mm the moulding material storable to be compacted by the relative movement.

[0046] The bolster arrangement and the flask can also be configured to receive a moulding material with a filling height of at least 300 mm or at least 400 mm.

[0047] The bolster arrangement and the flask can be configured to receive or can receive a moulding material

with a filling height, which filling height is at least 1.5 times or at least 2.0 times a (maximum) height of the flask.

[0048] The bolster arrangement and the flask is also configured to receive or can receive a moulding material with a filling height, which filling height is not more than 4.0 times or not more than 2.5 times a (maximum) height of the flask.

[0049] The height of moulding material inside the bolster arrangement and the flask can be used to determine the filling height of moulding material, i.e. moulding material that extends over the upper end of the flask or below the lower end of the bolster arrangement is not taken into account for the determination of the filling height inside the flask and bolster arrangement.

[0050] For example, if the flask has a (maximum) height of 1 m, the filling height of moulding material inside the bolster arrangement and flask can be between 1.5 m and 4.0 m. In this case the filling height of moulding material inside the bolster arrangement and flask can also be between 2.0 m and 2.5 m.

[0051] Also disclosed is a method of producing a portion of a mould. A bolster arrangement is provided. The bolster arrangement comprises a bolster frame and a bolster plate. A pattern is positioned on the bolster plate. A moulding material covering the pattern is provided. The moulding material is compacted by moving the pattern relative to the bolster frame. Thereby, a portion of a mould is produced.

[0052] After a maximum movement of the pattern relative to the bolster frame or after the compacting step, an upper end of the bolster plate can be substantially at the same height as a lower end of a flask positioned on the bolster arrangement.

[0053] The upper end of the bolster plate may be at the same height ± 50 mm or ± 10 mm as the lower end of a flask.

[0054] After a maximum movement of the pattern relative to the bolster frame or after the compacting step, an upper end of the bolster plate may not be inside or may not be below a lower end of a flask positioned on the bolster arrangement.

[0055] Any herein disclosed bolster arrangement can be used within the method. Additionally or alternatively, any machine disclosed herein can be used within the method.

[0056] Preferably, the pattern is moved while the bolster frame remains in its position. The pattern can be lifted.

[0057] The relative movement of the pattern and the bolster frame can cover a distance of at least 100 mm.

[0058] The relative movement of the pattern and the bolster frame can also cover a distance of at least 150 mm or at least 200 mm.

[0059] The method can comprise a flask. The flask can be positioned at least partially on the bolster frame. The flask and the bolster arrangement can accommodate at least 70 wt.-% of the moulding material before compaction.

[0060] The flask and the bolster arrangement can also accommodate at least 80 wt.-% or at least 90 wt.-% of the moulding material before compaction.

[0061] The moulding material described herein can be sand, especially green sand.

[0062] Preferably, the machine for producing a portion of a mould does not comprise a (sand) filling frame.

[0063] It is preferred that the machine for producing a portion of a mould does not comprise a (sand) filling frame on the top of the flask.

[0064] The machine for producing a portion of a mould may not comprise a (sand) filling frame between the flask and the upper compacting system.

[0065] Preferably, not more than 50 mm, more preferably not more than 10 mm, of moulding material extends over the upper end of the flask prior to compaction of the moulding material.

[0066] Embodiments of the invention are described in more detail with regard to the drawings. The description of the embodiments is not to be construed as to limit the scope defined by the claims. Same reference signs of the figures describe same elements.

Figure 1a shows a mould producing machine 100 with a bolster arrangement 140.

Figure 1b shows the machine 100 of Figure 1a.

Figure 1c shows the machine 100 of Figures 1a and 1b.

Figure 2 shows a bolster arrangement 140.

Figure 3 shows a lower compacting system 170 comprising a machine table 172 and a stroke device 171.

[0067] Figure 1a depicts a mould producing machine 100 in two different states, which different states are separated by a vertical line in the middle of Figure 1a. The left side of Figure 1a shows the machine 100 in a state prior to compacting a moulding material 122 and the right side of Figure 1a shows the machine 100 in a state after compacting the moulding material 122 in order to obtain compacted moulding material 123.

[0068] The machine 100 of Figure 1a comprises an upper compacting system 110, a flask 121, a bolster arrangement 140 and a lower compacting system 170.

[0069] The lower compacting system 170 comprises a machine table 172 and a stroke device 171.

[0070] The bolster arrangement 140 is positioned on top of the lower compacting system 170 and comprises a bolster plate 141 and a bolster frame 144. Specifically, the bolster frame is positioned on the machine table 172 and the bolster plate is positioned on the stroke device 171.

[0071] Preferably, the stroke device 171 of the lower compacting system 170 is located outside (not surround-

ed by) the bolster frame 144, when the stroke device 171 is in a lower position.

[0072] It is preferred that an upper surface of the stroke device 171, onto which surface the bolster plate 141 can be positioned, is located in the same plane ± 50 mm (perpendicular to the plane), especially ± 20 mm (perpendicular to the plane), as the upper surface of the machine table 172, onto which surface the bolster frame 144 can be positioned, when the stroke device 171 is in a lower position.

[0073] In the lower position of the stroke device 171 moulding material in the bolster frame 144 and the flask can be (fully) uncompacted. In an upper position of the stroke device 171 moulding material in the flask 121 can be (fully) compacted.

[0074] The bolster plate 141 can be connected to the stroke device 171 via a hook like locking element 173, 174. The locking element 173, 174 can engage with a respective connecting element 146, 147 of the bolster plate 141.

[0075] The bolster plate 141 can also be connected to the stroke device 171 via a magnetic force or a vacuum acting between the bolster plate 141 and the stroke device 171.

[0076] The bolster plate 141 comprises a first guiding structure 142 that extends on an outer surface, especially an outer rim, of the bolster plate and the bolster frame 144 comprises a second guiding structure 143 that extends on an inner surface, especially an inner rim, of the bolster frame 144.

[0077] The first and the second guiding structure 142, 143 can comprise a metal, for example a metal comprising carbide, specifically tungsten carbide. The first and the second guiding structure 142, 143 can be connected to the bolster plate 141 and the bolster frame 144, respectively, such that the first and the second guiding structure 142, 143 can be removed. The connection can be achieved via screws.

[0078] The first and the second guiding structure 142, 143 are coupled such that a movement of the bolster plate 141 relative to the bolster frame 144 is guided by the first and the second guiding structure 142, 143. Especially, the movement of the bolster frame 144 relative to the bolster plate 141 can be such, that the first guiding structure 142 of the bolster plate 141 slides along the second guiding structure 143 of the bolster frame 144 or vice versa.

[0079] The first and/or the second guiding structure 142, 143 can have a length (height) in the z-axis of at least 100 mm and/or a width in the z-axis of at least 5 mm.

[0080] Due to the described guiding (sliding) of the first and the second guiding structure 142, 143 on each other, these structures can be wear parts.

[0081] The bolster plate 141 further comprises a recess 145 (as can best be seen in Figure 2). The recess 145 is configured to receive a pattern 131 on a pattern plate 132. Preferably, the bolster plate 141 and the pattern plate 132 with the pattern 131 are connected via a

positive-locking connection.

[0082] The pattern 131 on the pattern plate 132 can also be connected to the bolster plate 141 via at least one screw.

5 **[0083]** The connection between the pattern 131 on the pattern plate 132 and the bolster plate 141 can be a positive-locking connection or a frictional connection.

[0084] The flask 121 is positioned on the bolster frame 144.

10 **[0085]** The upper compacting system 110 comprises an upper compacting system frame 112 and several upper compacting elements 111. The upper compacting elements 111 are retractable or extendable in the z-axis.

15 **[0086]** A moulding material 122 is accommodated by the flask 121 and the bolster arrangement 140 and covers the pattern 131.

20 **[0087]** For compacting the moulding material 122 the machine table 172, and thereby the bolster frame 144 and the flask 121, is moved towards the upper compacting system 110 until the flask 121 contacts the upper compacting system frame 112.

[0088] At the same time, the stroke device 171 can be moved towards the upper compacting system 110.

25 **[0089]** After the flask 121 is brought in contact with the upper compacting system frame 112, as described above, an enhanced mechanical stability of the machine 100 including the lower compacting system 170, the bolster arrangement 140, the flask 121 and the upper compacting system 110 is achieved. A (further) movement of the stroke device 171 towards the upper compacting system 110 causes the bolster plate 141, guided by the bolster frame 144, to be moved towards the upper compacting system 110. By this movement of the bolster plate 141, the pattern 131 on the pattern plate 132 and the moulding material 122 is moved towards the upper compacting system 110 until the moulding material 122 contacts the upper compacting system elements 111. A further moving of the bolster plate 141 in this direction causes the moulding material 122 to be compacted while the compacting system elements 111 can retract partially.

30 **[0090]** The upper compacting system elements 111 can be several independently retractable or extendable cylinders or a flat surface.

35 **[0091]** After compacting the moulding material 122 to a desired degree, compacted moulding material 123 is mainly formed or obtained in the flask 121.

40 **[0092]** The machine table 172 and the stroke device 171 can be moved to their initial positions and a portion of a mould is obtained in the flask 121 comprising the compacted moulding material 123 with a negative of the geometry of the pattern 131.

45 **[0093]** Preferably, the upper compacting system elements 111 are (passively) retracted only during a movement of the stroke device 171 towards the upper compacting system 110. It is preferred that the upper compacting system elements 111 are extended into their unretracted position (before the upper compacting system elements 111 are retracted) after the flask 121 has been

removed from the bolster frame 144.

[0094] With reference to Figure 1b several geometric details of the machine 100 shown in Figure 1a can be best understood.

[0095] The height h_{bf} of the bolster frame 144 corresponds to its extension in the z-axis. The maximum height h_{bf} of the bolster frame 144 corresponds to the extension in the z-axis of a portion of the bolster frame 144 with the largest value of the height h_{bf} of all portions of the bolster frame 144.

[0096] The height h_p of the pattern 131 corresponds to its extension in the z-axis. The maximum height h_p of the pattern 131 corresponds to the extension in the z-axis of a portion of the pattern 131 with the largest value of the height h_p of all portions of the pattern 131.

[0097] Especially, the maximum height h_p of the pattern 131 corresponds to the extension in the z-axis of a portion of the pattern 131 with the largest value of the height h_p of all portions of the pattern 131 that shape the mould geometry that will be present in the later finished casting prepared from the mould portion as described above.

[0098] The height h_{bp} of the bolster plate 141 corresponds to its extension in the z-axis. The maximum height h_{bp} of the bolster plate 141 corresponds to the extension in the z-axis of a portion of the bolster plate 141 with the largest value of the height h_{bp} of all portions of the bolster plate 141.

[0099] The filling height h_{fill1} of the moulding material 122 in the bolster arrangement 140 before compaction of the moulding material 122 is the height of the moulding material 122 in the z-axis (movement direction) that extends until a plane that is perpendicular to the z-axis, which plane is defined by the upper end (in the z-axis) of the bolster frame 144.

[0100] In the example of Figure 1b the filling height h_{fill1} of the moulding material 122 in the bolster arrangement 140 is equal to the height h_{bf} of the bolster frame 144 minus the height h_{bp} of the bolster plate 141.

[0101] The distance d_{fp1} can be determined between an upper end of the pattern 131 and a lower end of the flask 121.

[0102] In Figure 1c the machine 100 of Figures 1a and 1b is shown. The pattern 131 includes two cylindrical elements 190, 190' that extend in the direction of the z-axis above the upper end of the bolster frame 144.

[0103] The extension of the cylindrical elements 190, 190' above the upper end of the bolster frame 144 and inside the flask 121 can be determined as d_{fp2} . The extension of an element 190, 190' of the pattern 131 above the upper end of the bolster frame 144 can be measured in relation to the lower end of the flask 121. Typically, the height of an element 190, 190' of the pattern 131 that extends above the lower end of the flask 121 is relatively small (smaller than 50 mm).

[0104] Such an element 190, 190' of the pattern 131 can be used for creating a gating or venting system in the mould (portion) after compaction. This can be seen

on the right side of Figure 1c that shows the machine 100 after compaction of the moulding material 122, wherein the element 190' of the pattern 131 (slightly) extends above the upper end of the flask 121. After removing the pattern 131 and cutting the upper surface of the compacted moulding material 123, a channel that is accessible from the top surface of the compacted moulding material 123 is created. The channel can be used to pour liquid metal into the mould or to allow gas (steam) to exit the mould.

[0105] This channel is not directly related to the shape or geometry of a finished casting produced from the mould and any element 190, 190' of the pattern 131 that causes such channel in the compacted moulding material 123 is preferably not to be understood as being part of the pattern 131.

[0106] Additionally, a filling height h_{fill2} of the moulding material 122 in the flask 121 and the bolster arrangement 140 is shown in Figure 1c. The filling height h_{fill2} comprises moulding material 122 in the bolster arrangement 140 and in the flask 121 up to the upper end of the flask 121.

[0107] A sealing member 195 is positioned such that it seals between the bolster frame 144 and the bolster plate 141.

[0108] E.g. when the bolster plate 141 is lifted towards the upper compacting system 110, a small amount of moulding material 122 can enter a gap between the bolster frame 144 and the bolster plate 141. As moulding material 122 typically has abrasive properties, a further lifting of the bolster plate 141 can damage the surface of the bolster frame 144 and the bolster plate 141 or the first guiding structure 142 and the second guiding structure 143.

[0109] The sealing member 195 can be a sealing lip that can be fixed to the bolster plate 141.

[0110] By using the sealing member 195, the amount of moulding material 122 that enters the gap between the bolster plate 141 and the bolster frame 144 can be reduced compared to the amount of moulding material 122 that enters the gap without the sealing member 195. Figure 2 depicts a bolster arrangement 140, usable in machine 100 of Figures 1a and 1b, in more detail.

[0111] The opening 149 of the bolster frame 144 can be seen.

[0112] Figure 3 depicts an upper compacting system 110 and a lower compacting system 170, both usable in machine 100 of Figures 1a and 1b, in more detail.

Claims

1. **Machine** for producing a portion of a mould, the machine (100) comprising:

(a) a bolster arrangement (140), having a bolster frame (144) and a bolster plate (141), wherein a pattern (131) is positioned on the bolster plate

- (141) in the bolster frame (144), and wherein the bolster frame (144) is positioned on a machine table (172) and the bolster plate (141) is positioned on a stroke device (171);
- (b) a flask (121); and
- (c) an upper compacting system (110);
- (d) wherein the pattern (131) and the upper compacting system (110) are movable towards each other by a movement of the bolster plate (141) and the bolster frame (144) relative to each other;
- (e) wherein a distance (d_{fp1}) between an upper end of a mould geometry shaping portion of the pattern (131) and a lower end of the flask (121) is at least 5 mm, the distance (d_{fp1}) in a direction opposite to the movement direction and the distance prior to the relative movement of the pattern (131) and the upper compacting system (110) towards each other; and
- (f) wherein the bolster arrangement (140) and the flask (121) are configured to receive a moulding material (122) with a filling height (h_{fill2}) of at least 200 mm, the moulding material (122) storable to be compacted by the relative movement.
2. Machine of claim 1, wherein an upper surface of the stroke device (171) is located in the same plane ± 50 mm as the upper surface of the machine table (172), when the stroke device (171) is in a lower position.
 3. Machine of any one of claims 1 or 2, wherein the stroke device (171) is located outside the bolster frame (144), when the stroke device (171) is in a lower position.
 4. Machine of any one of claims 1 to 3, wherein the flask (121) is positioned on the bolster frame (144).
 5. Machine of any one of claims 1 to 4, wherein no filling frame is positioned on the top of the flask (121).
 6. Machine of any one of claims 1 to 5, wherein the sum of the maximum height (h_p) of the pattern (131) and the maximum height (h_{bp}) of the bolster plate (141) is not more than 50 mm, preferably not more than 30 mm, more preferably not more than 15 mm, higher than the maximum height (h_{bf}) of the bolster frame (144).
 7. Machine of any one of claims 1 to 6, wherein the bolster arrangement (140) and the flask (121) are configured to receive a moulding material (122) with a filling height (h_{fill2}) of at least 300 mm, preferably at least 400 mm, the moulding material (122) storable to be compacted by the relative movement.
 8. Machine of any one of claims 1 to 7, wherein the bolster arrangement (140) and the flask (121) are configured to receive a moulding material (122) with a filling height (h_{fill2}), which filling height (h_{fill2}) is at least 1.5 times, preferably at least 2.0 times, a height (h_f) of the flask (121), preferably the filling height (h_{fill2}) is not more than 4.0 times, more preferably not more than 2.5 times, the height (h_f) of the flask (121).
 9. Method of producing a portion of a mould, wherein
 - (a) a bolster arrangement (140) is provided, the bolster arrangement (140) having a bolster frame (144) and a bolster plate (141),
 - (b) a pattern (131) is positioned on the bolster plate (141); and
 - (c) a flask (121) having a height (h_f) is positioned on the bolster frame (144); the method further comprising
 - (d) providing a moulding material (122) covering the pattern (131) such that the bolster arrangement (140) and the flask (121) receive moulding material (122) with a filling height (h_{fill2}), which filling height (h_{fill2}) is at least 1.5 times the height (h_f) of the flask (121) and is not more than 4.0 times the height (h_f) of the flask (121),
 - (e) compacting the moulding material (122) by moving the pattern (131) relative to the bolster frame (144), thereby producing a portion of a mould.
 10. Method of claim 9, wherein an upper end of the bolster plate (141) is not inside the flask (121) or not below a lower end of the flask (121) after the compacting step.
 11. Method of any one of claims 9 or 10, wherein the bolster frame (144) is positioned on a machine table (172) and the bolster plate (141) is positioned on a stroke device (171), wherein the bolster plate (141) is lifted by the stroke device (171) during the compacting step, preferably the bolster plate (141) is lifted by the stroke device (171) during the compacting step and the bolster frame (144) is lifted by the machine table (172) prior and/or during the compacting step.
 12. Method of any one of claims 9 to 11, wherein the relative movement of the pattern (131) and the bolster frame (144) covers a distance of at least 100 mm, preferably at least 150 mm, more preferably at least 200 mm.
 13. Method of any one of claims 9 to 12, wherein after a maximum movement of the pattern (131) relative to the bolster frame (144) or after the compacting step an upper end of the bolster plate (141) is at the same height as a lower end of the flask (121) posi-

tioned on the bolster arrangement (140), preferably an upper end of the bolster plate (141) is at the same height ± 50 mm, preferably ± 10 mm, as a lower end of the flask (121).

14. Method of any one of claims 9 to 13, wherein after a maximum movement of the pattern (131) relative to the bolster frame (144) or after the compacting step an upper end of the bolster plate (141) is not inside or below a lower end of the flask (121) positioned on the bolster arrangement (140).

Patentansprüche

1. Maschine zur Herstellung eines Teils einer Form, wobei die Maschine (100) Folgendes umfasst

(a) einen Modellplattenträger ("bolster", 140) mit einem Abstützrahmen (144) und einer Abstützplatte (141), wobei auf der Abstützplatte (141) im Abstützrahmen (144) ein Modell (131) positioniert ist, und wobei der Abstützrahmen (144) auf einem Maschinentisch (172) und die Abstützplatte (141) auf einer Hubeinrichtung (171) positioniert ist/sind;

(b) einen Kasten (121); und

(c) ein oberes Verdichtungssystem (110);

(d) wobei das Modell (131) und das obere Verdichtungssystem (110) durch eine Bewegung der Abstützplatte (141) und des Abstützrahmens (144) relativ zueinander oder aufeinander zu bewegbar sind;

(e) wobei ein Abstand (dfp1) zwischen einem oberen Ende eines die Formgeometrie formenden Abschnitts des Modells (131) und einem unteren Ende des Kastens (121) mindestens 5mm beträgt, der Abstand (dfp1) in einer Richtung entgegengesetzt zur Bewegungsrichtung und der Abstand vor der relativen Bewegung des Modells (131) und des oberen Verdichtungssystems (110) zueinander; und

(f) wobei der Modellplattenträger (140) und der Kasten (121) zur Aufnahme eines Formstoffes (122) mit einer Füllhöhe (hfill2) von mindestens 200mm ausgebildet sind, und der zur Verdichtung gespeicherte Formstoff (122) durch die Relativbewegung verdichtbar ist.

2. Maschine nach Anspruch 1, wobei eine obere Fläche der Hubvorrichtung (171) in derselben Ebene ± 50 mm wie die obere Fläche des Maschinentisches (172) liegt, wenn sich die Hubvorrichtung (171) in einer unteren Position befindet.

3. Maschine nach einem der Ansprüche 1 oder 2, wobei sich die Hubeinrichtung (171) außerhalb des Abstützrahmens (144) befindet, wenn sich die Hubein-

richtung (171) in einer unteren Position befindet.

4. Maschine nach einem der Ansprüche 1 bis 3, bei der der Kasten (121) auf dem

5. Maschine nach einem der Ansprüche 1 bis 4, bei der kein Füllrahmen auf der Oberseite des Kastens (121) angeordnet ist.

6. Maschine nach einem der Ansprüche 1 bis 5, wobei die Summe aus der maximalen Höhe (hp) des Modells (131) und der maximalen Höhe (hbp) der Abstützplatte (141) nicht mehr als 50mm, vorzugsweise nicht mehr als 30mm, besonders bevorzugt nicht mehr als 15mm, höher ist als die maximale Höhe (hbf) des Abstützrahmens (144).

7. Maschine nach einem der Ansprüche 1 bis 6, wobei der Modellplattenträger (140) und der Formkasten (121) zur Aufnahme eines Formstoffes (122) mit einer Füllhöhe (hfill2) von mindestens 300 mm, vorzugsweise mindestens 400 mm, ausgebildet sind, wobei der gespeicherte Formstoff (122) durch die Relativbewegung verdichtbar ist.

8. Maschine nach einem der Ansprüche 1 bis 7, wobei der Modellplattenträger (140) und der Kasten (121) zur Aufnahme eines Formmaterials (122) mit einer Füllhöhe (hfill2) konfiguriert sind, wobei die Füllhöhe (hfill2) mindestens das 1,5fache, vorzugsweise mindestens 2,0fache, einer Höhe (hf) des Kastens (121) beträgt, vorzugsweise beträgt die Füllhöhe (hfill2) höchstens das 4,0fache, besonders bevorzugt höchstens das 2,5fache, der Höhe (hf) des Kastens (121).

9. Verfahren zur Herstellung eines Teils einer Form, bei dem

(a) ein Modellplattenträger ("bolster", 140) vorgesehen ist, wobei der Modellplattenträger (140) einen Abstützrahmen (144) und eine Abstützplatte (141) aufweist,

(b) ein Modell (131) auf der Platte (141) angeordnet ist; und

(c) ein Kasten (121) mit einer Höhe (hf) auf dem Abstützrahmen (144) positioniert wird; das Verfahren umfasst ferner

(d) Bereitstellen eines Formmaterials (122), welches das Modell (131) abdeckt, so dass der Bolster (140) und der Kasten (121) Formmaterial (122) mit einer Füllhöhe (hfill2) aufnehmen, wobei die Füllhöhe (hfill2) mindestens das 1,5fache der Höhe (hf) des Kastens (121) und höchstens das 4,0fache der Höhe (hf) des Kastens (121) beträgt,

(e) Verdichten des Formmaterials (122) durch Bewegen des Modells (131) relativ zu dem Ab-

stützrahmen (144), wodurch ein Teil einer Form hergestellt wird.

10. Verfahren nach Anspruch 9, wobei sich ein oberes Ende der Abstützplatte (141) nach dem Verdichtungsschritt nicht innerhalb des Kastens (121) oder nicht unterhalb 5
11. Verfahren nach einem der Ansprüche 9 oder 10, wobei der Abstützrahmen (144) auf einem Maschinentisch (172) und die Abstützplatte (141) auf einer Hubeinrichtung (171) positioniert wird, wobei die Platte (141) während des Verdichtungsschrittes von der Hubeinrichtung (171) angehoben wird, vorzugsweise die Platte (141) während des Verdichtungsschrittes von der Hubeinrichtung (171) angehoben wird und der Abstützrahmen (144) vor und/oder während des Verdichtungsschrittes vom Maschinentisch (172) angehoben wird. 10 15 20
12. Verfahren nach einem der Ansprüche 9 bis 11, wobei die Relativbewegung des Modells (131) und des Abstützrahmens (144) einen Abstand von mindestens 100mm, vorzugsweise von mindestens 150 mm, noch bevorzugter von mindestens 200 mm, umfasst. 25
13. Verfahren nach einem der Ansprüche 9 bis 12, bei dem nach einer maximalen Bewegung des Modells (131) relativ zum Abstützrahmen (144) oder nach dem Verdichtungsschritt ein oberes Ende der Abstützplatte (141) auf der gleichen Höhe wie ein unteres Ende des auf dem Bolster (140) positionierten Kastens (121) ist, vorzugsweise ist ein oberes Ende der Abstützplatte (141) auf der gleichen Höhe $\pm 50\text{mm}$, vorzugsweise $\pm 10\text{ mm}$, wie ein unteres Ende des Kastens (121). 30 35
14. Verfahren nach einem der Ansprüche 9 bis 13, bei dem sich nach einer maximalen Bewegung des Modells (131) relativ zum Abstützrahmen (144) oder nach dem Verdichtungsschritt ein oberes Ende der Abstützplatte (141) nicht innerhalb oder unterhalb eines unteren Endes des auf dem Bolster (140) positionierten Kastens (121) befindet. 40

Revendications

1. Machine pour produire une partie d'un moule, la machine (100) comprenant : 50

(a) un support de plaque modèle (140), qui présente un cadre de support (144) et une plaque de support (141), dans lequel un modèle (131) est positionné sur la plaque de support (141) dans le cadre de support (144), et dans lequel le cadre de support (144) est positionné sur une table de machine (172) et la plaque de support 55

(141) est positionnée sur un dispositif de levage (171) ;

(b) un châssis (121) ; et

(c) un système de compactage supérieur (110) ;

(d) dans lequel le modèle (131) et le système de compactage supérieur (110) peuvent être déplacés l'un vers l'autre par un déplacement de la plaque de support (141) et du cadre de support (144) l'un par rapport à l'autre ;

(e) dans lequel une distance (d_{fp1}) entre une extrémité supérieure d'une partie de formage de géométrie de moule du modèle (131) et une extrémité inférieure du châssis (121) est égale à au moins 5 mm, cette distance (d_{fp1}) étant mesurée dans une direction opposée à la direction du déplacement et cette distance étant mesurée avant le déplacement réciproque du modèle (131) et du système de compactage supérieur (110) l'un vers l'autre ; et

(f) dans lequel le support de plaque modèle (140) et le châssis (121) sont configurés de manière à recevoir un matériau de moulage (122) avec une hauteur de remplissage (h_{fill2}) d'au moins 200 mm, le matériau de moulage (122) pouvant être stocké en vue d'être compacté par le déplacement réciproque.

2. Machine selon la revendication 1, dans laquelle une surface supérieure du dispositif de levage (171) se trouve dans le même plan $\pm 50\text{ mm}$ que la surface supérieure de la table de machine (172) lorsque le dispositif de levage (171) se trouve dans une position inférieure.

3. Machine selon l'une quelconque des revendications 1 ou 2, dans laquelle le dispositif de levage (171) est situé à l'extérieur du cadre de support (144) lorsque le dispositif de levage (171) se trouve dans une position inférieure.

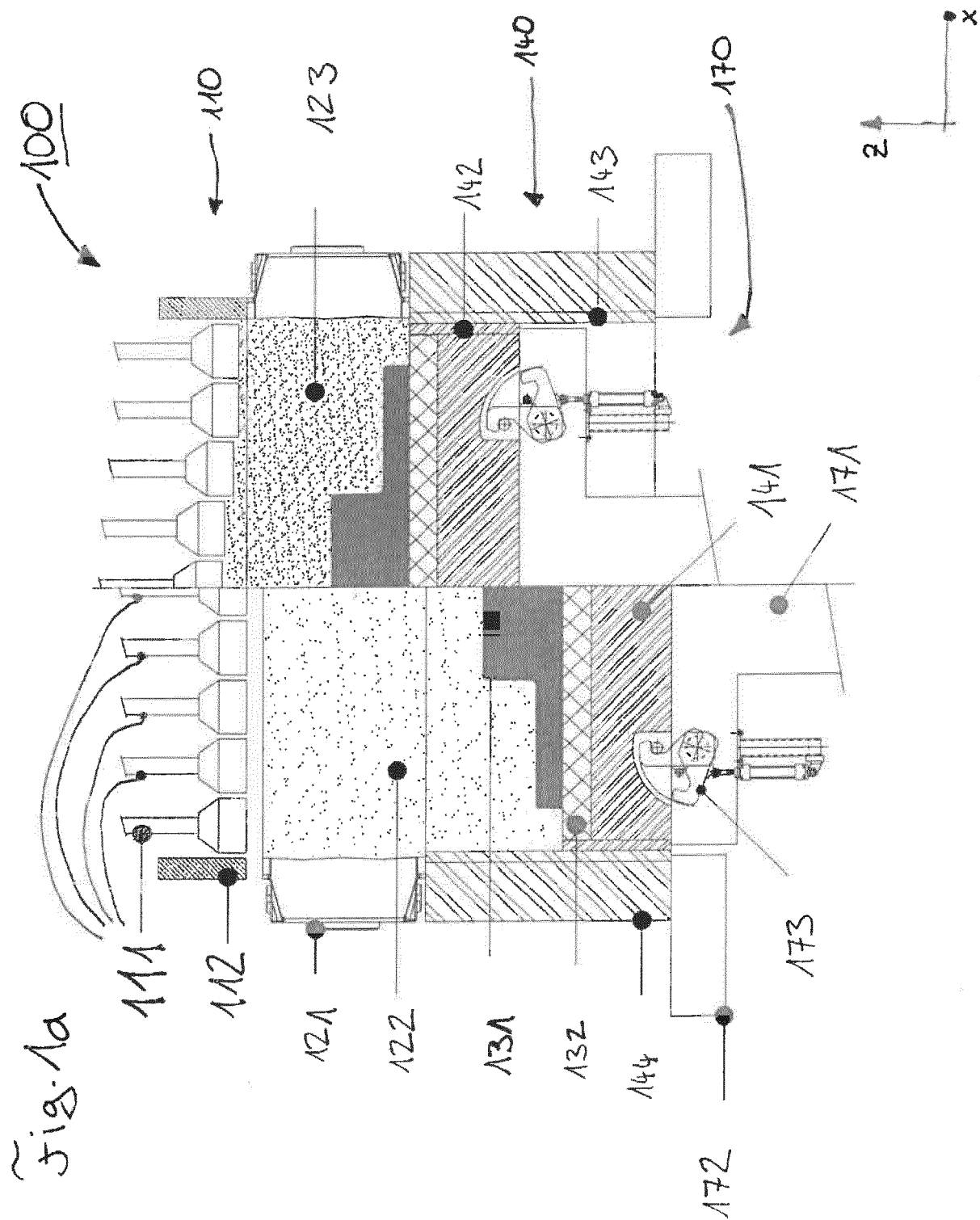
4. Machine selon l'une quelconque des revendications 1 à 3, dans laquelle le châssis (121) est positionné sur le cadre de support (144).

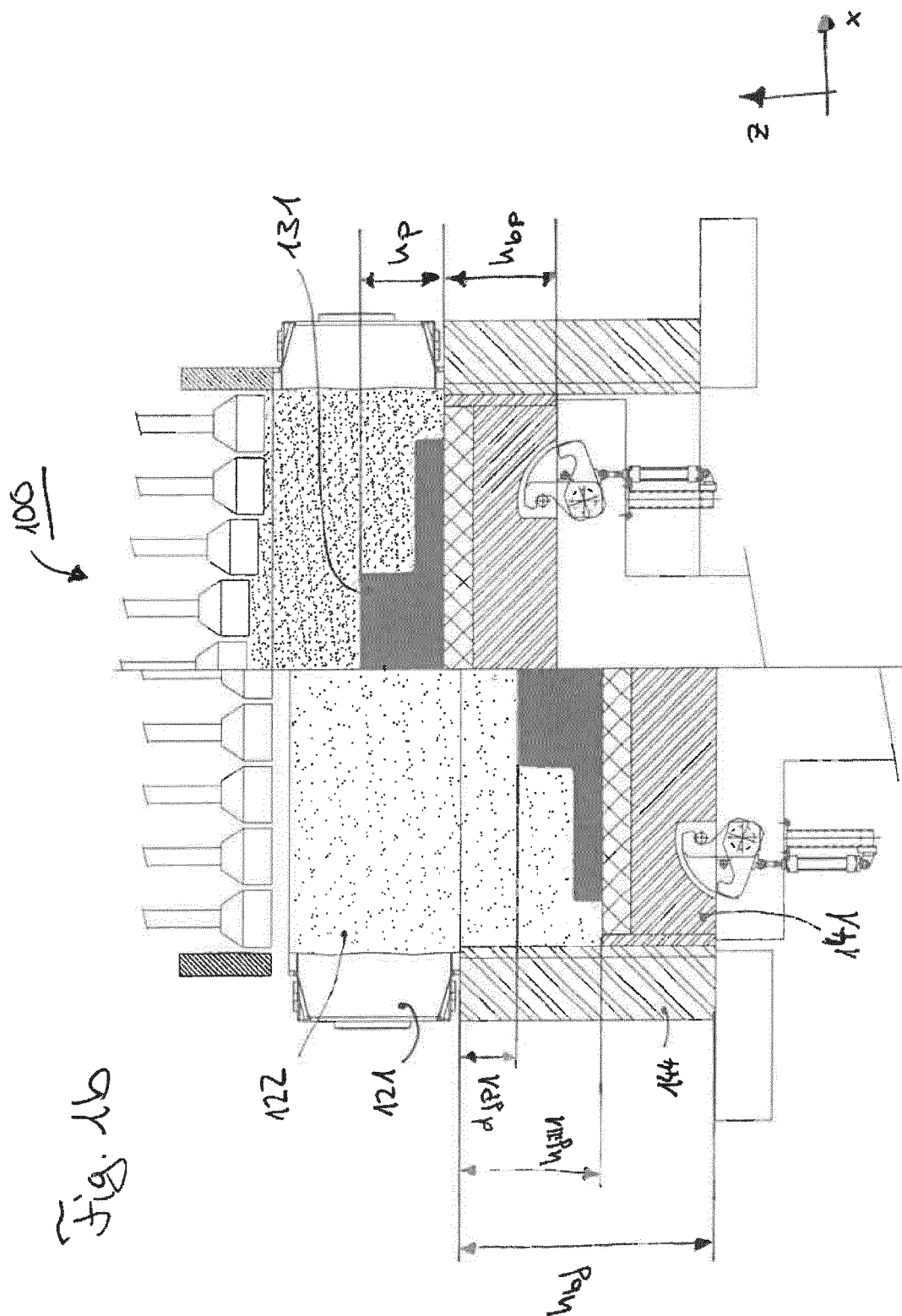
5. Machine de l'une quelconque des revendications 1 à 4, dans laquelle aucune rehausse de remplissage n'est positionnée au sommet du châssis (121). 45

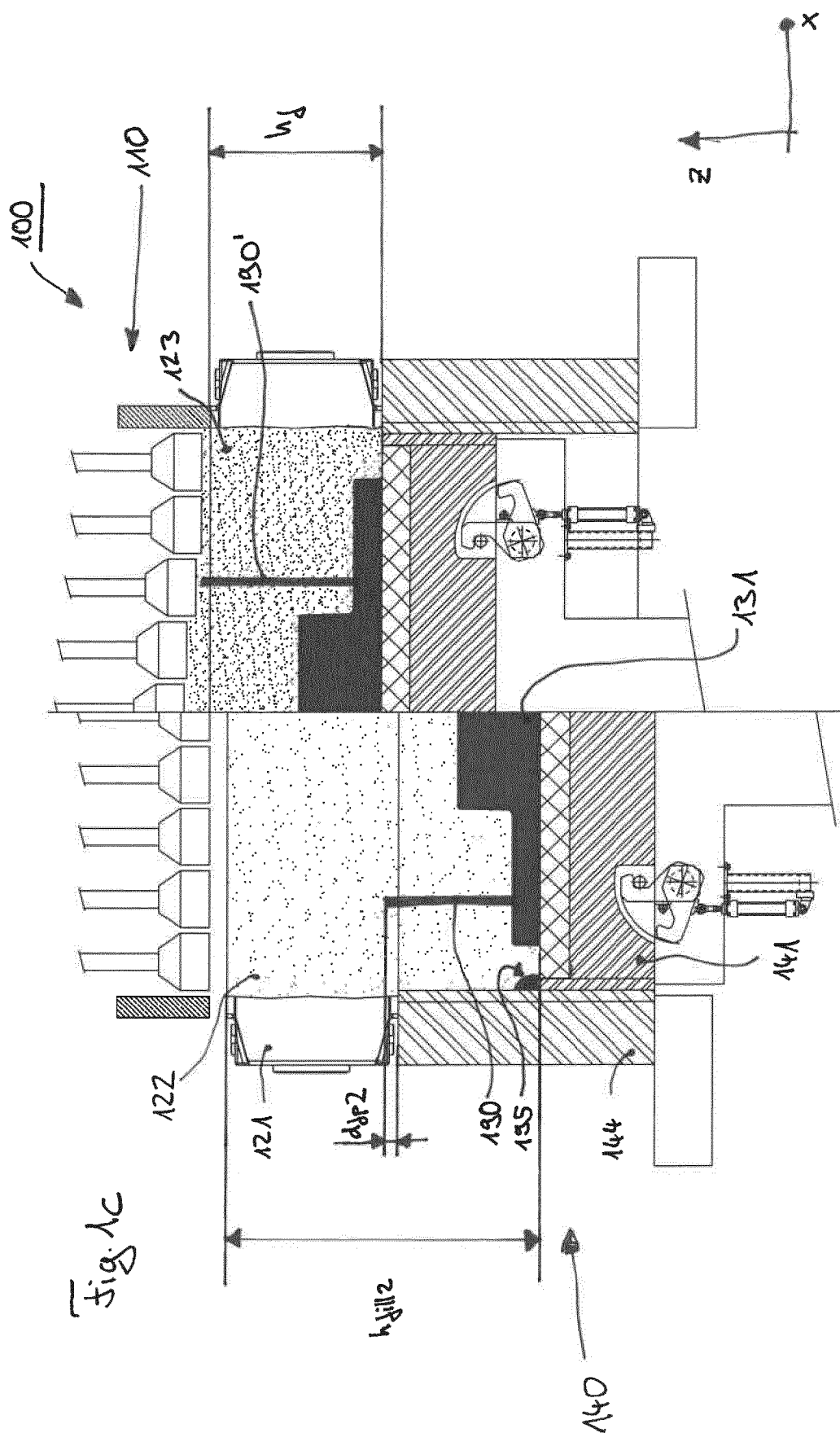
6. Machine selon l'une quelconque des revendications 1 à 5, dans laquelle la somme de la hauteur maximale (h_p) du modèle (131) et de la hauteur maximale (h_{bp}) de la plaque de support (141) n'est pas supérieure à 50 mm, de préférence pas supérieure à 30 mm, et de préférence encore pas supérieure à 15 mm à la hauteur maximale (h_{bf}) du cadre de support (144).

7. Machine selon l'une quelconque des revendications

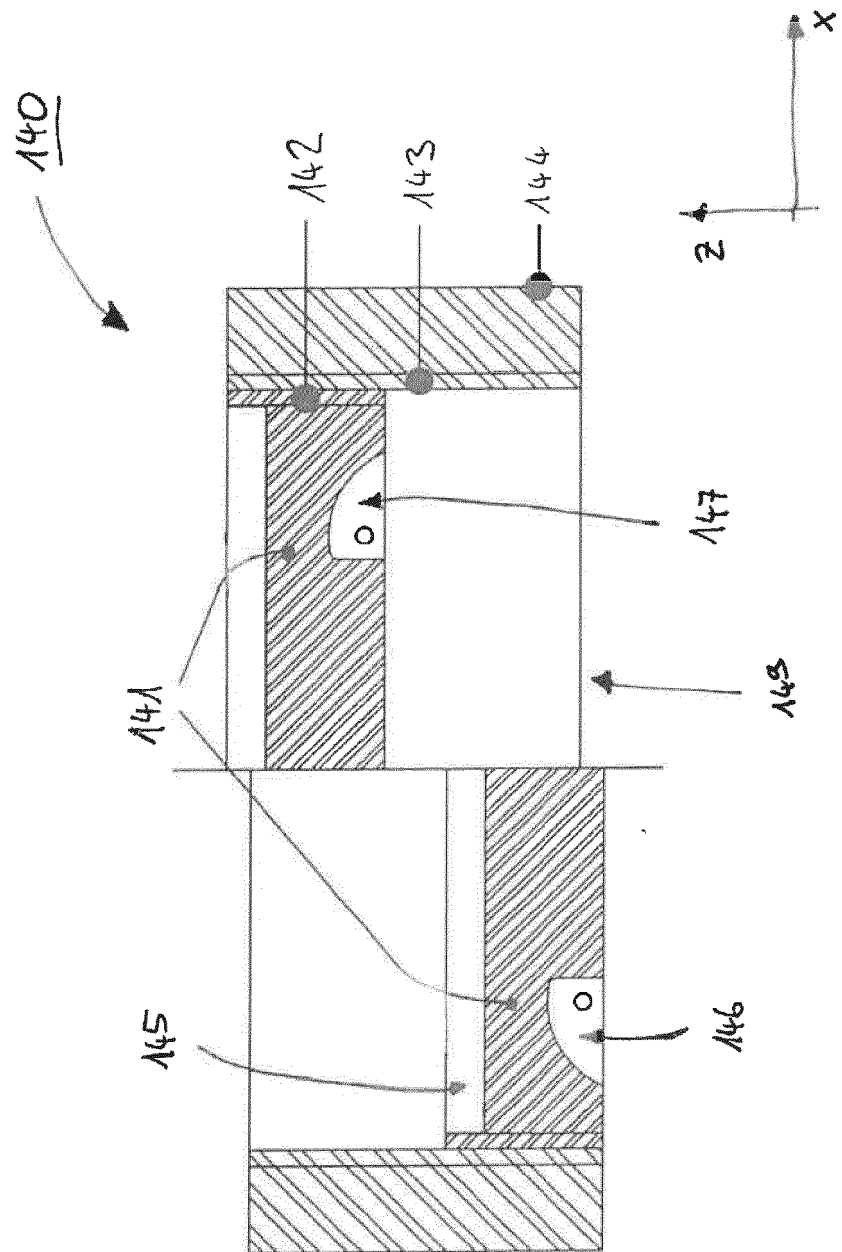
- 1 à 6, dans laquelle le support de plaque modèle (140) et le châssis (121) sont configurés de manière à recevoir un matériau de moulage (122) avec une hauteur de remplissage ($h_{\text{fill}2}$) égale à au moins 300 mm, et de préférence égale à au moins 400 mm, le matériau de moulage (122) pouvant être stocké en vue d'être compacté par le déplacement réciproque.
- 5
8. Machine selon l'une quelconque des revendications 1 à 7, dans laquelle le support de plaque modèle (140) et le châssis (121) sont configurés de manière à recevoir un matériau de moulage (122) avec une hauteur de remplissage ($h_{\text{fill}2}$), ladite hauteur de remplissage ($h_{\text{fill}2}$) étant au moins 1,5 fois, de préférence au moins 2,0 fois équivalente à une hauteur (h_f) du châssis (121), la hauteur de remplissage ($h_{\text{fill}2}$) n'étant de préférence pas plus de 4,0 fois, et de préférence encore pas plus de 2,5 fois équivalente à la hauteur (h_f) du châssis (121).
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9. Procédé de fabrication d'une partie d'un moule, dans lequel :
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- (a) un support de plaque modèle (140) est prévu, le support de plaque modèle (140) comprenant un cadre de support (144) et une plaque de support (141) ;
- (b) un modèle (131) est positionné sur la plaque de support (141) ; et
- (c) un châssis (121) qui présente une hauteur (h_f) est positionné sur le cadre de support (144), le procédé comprenant en outre les étapes consistant à :
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- (d) fournir un matériau de moulage (122) qui recouvre le modèle (131) de telle sorte que le support de plaque modèle (140) et le châssis (121) reçoivent le matériau de moulage (122) avec une hauteur de remplissage ($h_{\text{fill}2}$), ladite hauteur de remplissage ($h_{\text{fill}2}$) étant au moins 1,5 fois équivalente à la hauteur (h_f) du châssis (121) et n'étant pas supérieure à 4,0 fois la hauteur (h_f) du châssis (121) ; et
- 35
- (e) compacter le matériau de moulage (122) en déplaçant le modèle (131) par rapport au cadre de support (144), produisant de ce fait une partie d'un moule.
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10. Procédé de la revendication 9, dans lequel une extrémité supérieure de la plaque de support (141) ne se trouve pas à l'intérieur du châssis (121) ou ne se trouve pas en dessous d'une extrémité inférieure du châssis (121) après l'étape de compactage.
- 50
11. Procédé selon l'une quelconque des revendications 9 ou 10, dans lequel le cadre de support (144) est positionné sur une table de machine (172) et la plaque de support (141) est positionnée sur un dispositif de levage (171), dans lequel la plaque de support (141) est soulevée par le dispositif de levage (171) pendant l'étape de compactage, de préférence la plaque de support (141) est soulevée par le dispositif de levage (171) pendant l'étape de compactage et le cadre de support (144) est soulevé par la table de machine (172) avant et/ou pendant l'étape de compactage.
- 5
12. Procédé selon l'une quelconque des revendications 9 à 11, dans lequel le déplacement réciproque du modèle (131) et du cadre de support (144) couvre une distance égale à au moins 100 mm, de préférence égale à au moins 150 mm, et de préférence encore égale à au moins 200 mm.
13. Procédé selon l'une quelconque des revendications 9 à 12, dans lequel, après un déplacement maximal du modèle (131) par rapport au cadre de support (144) ou après l'étape de compactage, une extrémité supérieure de la plaque de support (141) se trouve à la même hauteur qu'une extrémité inférieure du châssis (121) positionné sur le support de plaque modèle (140), de préférence une extrémité supérieure de la plaque de support (141) se trouve à la même hauteur ± 50 mm, de préférence ± 10 mm qu'une extrémité inférieure du châssis (121).
14. Procédé selon l'une quelconque des revendications 9 à 13, dans lequel, après un déplacement maximal du modèle (131) par rapport au cadre de support (144) ou après l'étape de compactage, une extrémité supérieure de la plaque de support (141) ne se trouve pas à l'intérieur ou ne se trouve pas en dessous d'une extrémité inférieure du châssis (121) positionné sur le support de plaque modèle (140).
- 55

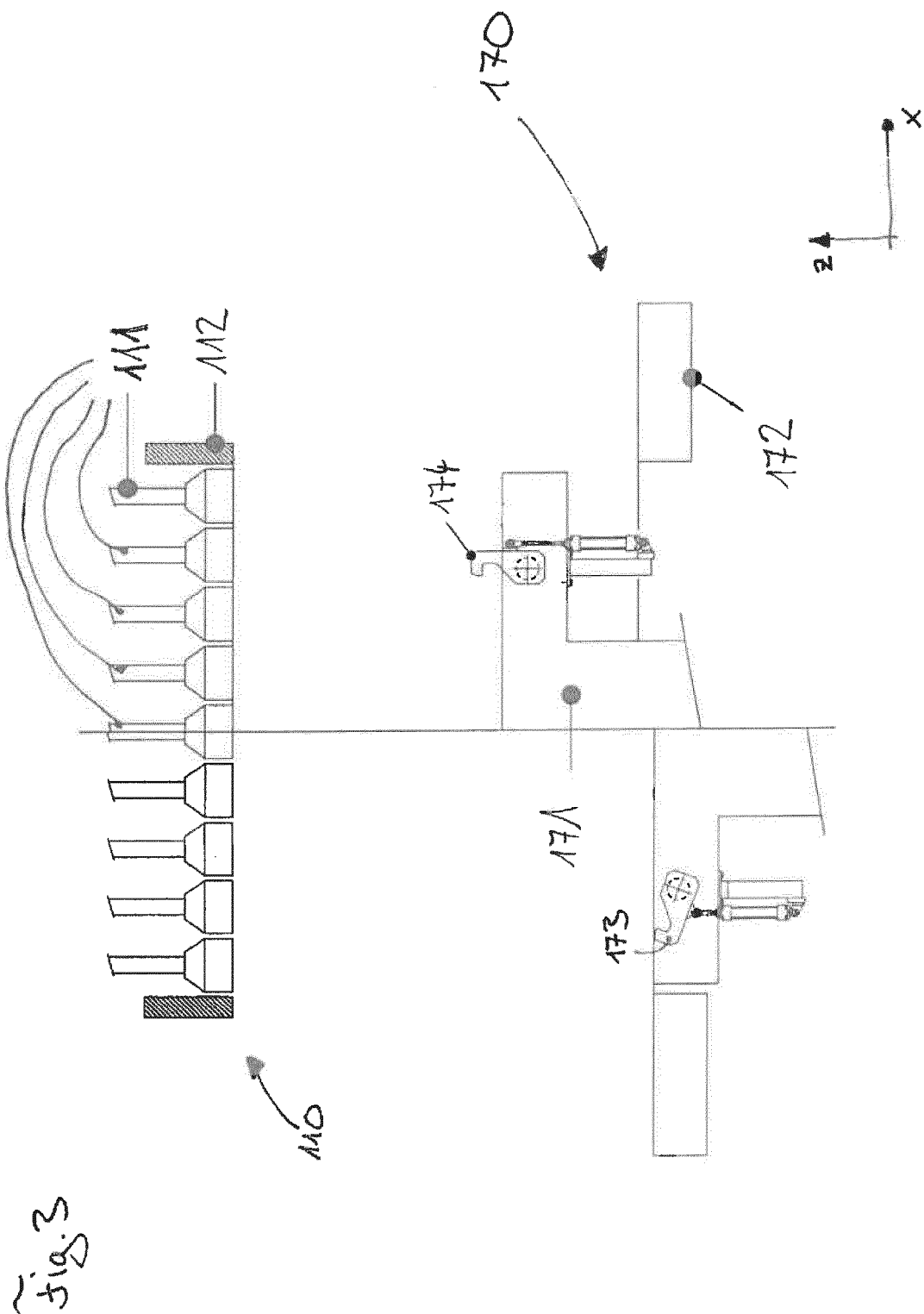






~fig. 2





REFERENCES CITED IN THE DESCRIPTION

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