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(54) MACHINE AND METHOD FOR PRODUCING A PORTION OF A MOLD

(57) A machine (100) for producing a portion of a mold comprises an upper compacting system (110), a frame (150) for an upward directed moving in a lifting direction (z), and at least a first stroke device (160) and at least a second stroke device (170). The frame (150) comprises at least a first support section (154), at least a second support section (155) and a pattern receiving section (151). The pattern receiving section (151) is configured to receive at least a pattern (140), and during the upward directed moving a flask (130). The first stroke device (160) is connected to the first support section (154) and the second stroke device (170) is connected to the second support section (155). The frame (150) is moveable in the lifting direction (z) towards the upper compacting system (110) for producing the portion of a mold by extending the stroke devices (160, 170).

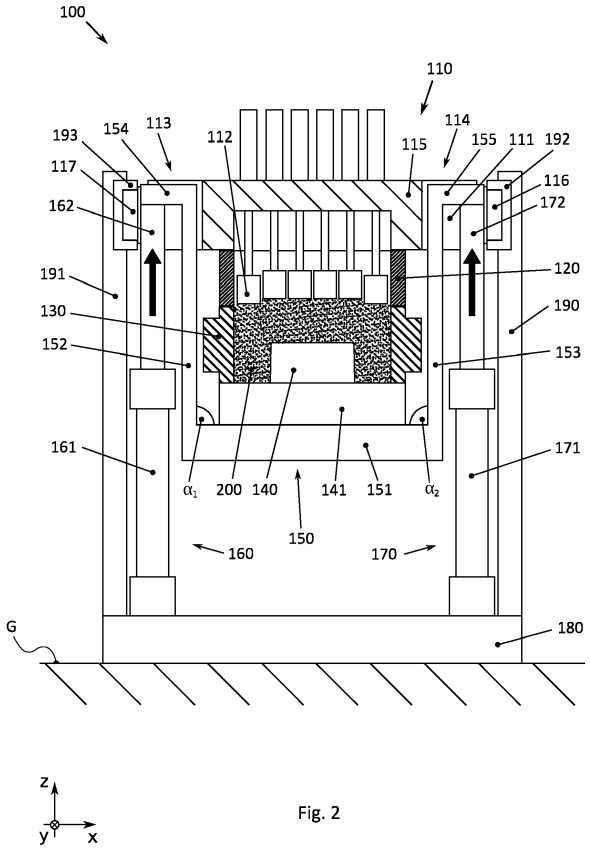

Fig. 2

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Description

[0001] The invention relates to a machine for forming molds, particularly, for forming a portion of a mold from molding material like molding sand (green sand). Additionally, a method for producing a portion or part of a mold is provided.

[0002] Sand casting or sand molded casting is a metal casting method well known in the art for producing metal components, and a commonly used method as molds made of sand are comparatively cheap (e.g. compared to permanent forms), and are sufficiently refractory even for steel foundry use.

[0003] For producing a component with sand casting a model or pattern of the to-be produced component is used. The pattern is an equivalent of the to-be produced (metal) component and is typically split up into two halves. Additionally, the pattern, or rather a half of the pattern, can comprise an integrated gating system. The gating system can also be a stand-alone component or can comprise several components, which together with the pattern, determine the inner shape of the sand mold.

[0004] The process for producing a sand mold comprises essentially the steps of placing one half of the pattern (and the gating system) into a box (flask), filling the flask with molding sand or material, and compacting the molding sand in the flask with a compacting tool. The molding sand is compacted until the mold half has sufficient strength (hardness). After compacting the molding sand, excess molding sand and the pattern (plus gating system) is removed, leaving a negative of the pattern in the compacted molding sand, thereby, providing a first finished half of the sand mold. The top half of a sand mold is called cope and the bottom half of a sand mold is called drag. Cope and drag put together form the complete sand mold, which then can be used in a casting process step.

[0005] **A problem to be solved** by the invention is to provide a machine for producing a portion of a mold, which can be installed and maintained with reduced effort, while at the same time improved compaction of a molding material of a portion of a mold is provided.

[0006] **The problem is solved** by a machine for producing a portion of a mold according to claim 1 and a method for producing a portion of a mold according to claim 12.

[0007] A machine for producing a portion of a mold comprises an upper compacting system, a frame for an upward directed moving in a lifting direction and at least a first stroke device and at least a second stroke device. The frame comprises at least a first support section, at least a second support section and a pattern receiving section. The pattern receiving section is configured to receive at least the pattern, and during the upward directed moving a flask and preferably a filling frame. The first stroke device is connected to the first support section and the second stroke device is connected to the second support section. The frame, and thereby the pattern and the flask, is moveable in the lifting direction towards the upper compacting system for producing the portion of a mold by extending the stroke devices.

[0008] The first support section and/or the second support section can be orthogonal to the lifting direction.

[0009] The first support section and/or the second support section can be parallel to the pattern receiving section.

[0010] The first support section and the second support section can be parallel to each other. The first support section and/or the second support section can have an angle of between ± 30.0° from horizontal, preferably ±5.0°.

[0011] The pattern receiving section can be connected via a first connecting section to the first support section and via a second connecting section to the second support section.

[0012] The first support section and the first connecting section can enclose an angle. The angle enclosed between the first support section and the first connecting section can be between 80.0° and 100.0°, preferably between 85.0° and 95.0°, most preferred the angle between the first connecting section and the first support section can be 90.0° (orthogonal).

[0013] Analogously, the second support section and the second connecting section can enclose an angle. The angle enclosed between the second support section and the second connecting section can be between 80.0° and 100.0°, preferably between 85.0° and 95.0°, most preferred the angle between the first connecting section and the first support section can be 90.0°.

[0014] The first connecting section and/or the second connecting section can be parallel to the lifting direction. The first and the second connecting section can each have an angle between ±30.0° from vertical, preferably ±5.0°.

[0015] The first connecting section and/or the second connecting section can be orthogonal to the pattern receiving section.

[0016] The first connecting section and the pattern receiving section can enclose an angle. The angle between the first connecting section and the pattern receiving section can be between 80.0° and 100.0°, preferably between 85.0° and 95.0°.

[0017] The same can apply for the second connecting section and the pattern receiving section. An angle between the second connecting section and the pattern receiving section can be between 80.0° and 100.0°, preferably between 85.0° and 95.0°.

[0018] The pattern receiving section, the first connecting section and the second connecting section can form a u-shaped section of the frame, when viewed in a cross-section of the frame.

[0019] The pattern receiving section can be of quadratic, rectangular, octagonal or circular basic form.

[0020] The pattern receiving section can be configured to receive patterns of different shapes and/or sizes.

[0021] The pattern receiving section can be at least

300.0 cm^2 in size, preferably the pattern receiving section is greater than 400.0 cm^2, more preferably greater than 500.0 cm^2.

[0022] The pattern receiving section can be orientated orthogonal to the lifting direction.

[0023] The pattern can be attached or connected to a pattern plate.

[0024] The pattern plate can be configured to receive the pattern.

[0025] The pattern plate can be of greater dimension than a greatest dimension of the pattern.

[0026] The pattern plate can be of quadratic, rectangular, octagonal or circular basic form.

[0027] The pattern plate can be configured to receive the flask.

[0028] The pattern receiving section can be configured to receive the pattern attached or connected to the pattern plate.

[0029] An outer dimension of the pattern plate can correspond to an outer dimension of a lower end of the flask, preferably the outer dimension of the pattern plate is equal to the outer dimension of the lower end of the flask.

[0030] The outer dimension of the pattern plate can be greater than the outer dimension of the lower end of the flask, preferably the pattern plate can be so much greater than the outer dimension of the lower end of the flask to accommodate a flask guiding system on the pattern plate.

[0031] The pattern or the pattern attached to the pattern plate can be attached or connected to the pattern receiving section.

[0032] The pattern or pattern plate can be configured to receive the flask.

[0033] The flask can be arranged above the pattern receiving section, preferably the flask can be arranged vertically above the pattern (attached to the pattern plate), held by a flask mount system of the machine, and during the upward lifting of the frame, the flask can be positioned on the pattern or pattern plate, when during upward movement in z-direction the flask is picked up.

[0034] The flask can be configured to receive the filling frame, preferably the filling frame is placeable or positionable on top of the flask, when during upward movement in z-direction the filling frame is picked up.

[0035] The filling frame can be arranged vertically above the pattern receiving section, preferably the filling frame can be arranged above the flask, held by a filling frame mount system of the machine.

[0036] The first stroke device and/or the second stroke device, or more pairs of them can be lifting cylinders. Preferably the distance from each other is equal (e.g. in x-direction).

[0037] The first stroke device and the second stroke device can be equal to each other.

[0038] An extension of the first stroke device can be equal to an extension of the first connecting section, when the first stroke device is in a retracted position, preferably the extension of the first stroke device can be greater than 5.0 % of the extension of the first connecting section, more preferably the extension of the first stroke device can be greater than 10.0 % of the extension of the first connecting section. In the same manner, an extension of the second stroke device can be substantially equal to an extension of the second connecting section.

[0039] The first stroke device and the second stroke device are configured to lift the frame, the pattern (pattern attached to the pattern plate), the flask, the filling frame and a molding material, filled in the flask and the filling frame, in the upward lifting direction towards the upper compacting system. Further, the first and the second stroke devices are configured to compact the molding material against the upper compacting system.

[0040] The first stroke device can be arranged parallel to the first connecting section and/or the second stroke device can be arranged parallel to the second connecting section.

[0041] The first stroke device and the second stroke device can be arranged parallel to each other, preferably a first axis of the first stroke device and a second axis (corresponding to the direction of action) of the second stroke device can be parallel to each other and a connecting line between the first and the second axis can form the shortest distance between the two axes.

[0042] The first stroke device and the second stroke device can form a pair. The first stroke device and the second stroke device can be operated in parallel.

[0043] The machine can have several first and several second stroke devices to operate in parallel. They are arranged as pairs, one of this pair on each side of the frame (or the pattern receiving section of this frame).

[0044] The first stroke devices can be each connected to a corresponding support section and each second stroke device can be connected to a corresponding second support section and all support sections can be connected to the pattern receiving section of the frame.

[0045] For example, the machine can comprise four stroke devices, forming two pairs of a first and a second stroke device. Each stroke device can be connected to a support section of the frame and the support sections, in total four of them in this example, can be connected via (four) connecting sections to the pattern receiving section.

[0046] The machine can comprise four stroke devices (as two pairs of first and second stroke devices). The machine may comprise six stroke devices (three pairs).

[0047] All stroke devices of the machine can operate in parallel.

[0048] The upper compacting system can comprise at least one compacting element, preferably more than one compacting element, a stationary compacting plate, or a combination of at least one compacting element and a stationary compacting plate.

[0049] The at least one compacting element can comprise a cylinder.

[0050] The upper compacting system can comprise at least four compacting elements, preferably more than

eight compacting elements, more preferably more than twelve compacting elements.

[0051] The pattern receiving section and the connecting sections can be at least partially surrounded by the stroke devices in a direction orthogonal to the lifting direction of the frame.

[0052] The partial surround can be given by the first or the second stroke device and the connecting sections extending in parallel to each other or next to each other, preferably the stroke devices can be cylinders and the connecting sections can extend at least 50.0 % along the cylinder in a non-extended status of a first (piston) rod of the first stroke device and a second (piston) rod of the second stroke device.

[0053] The machine can be installable on a flat ground defining a ground level and the frame can be moveable between an upper position and a lower position.

[0054] The pattern receiving section of the frame can be closer to the ground level in the lower position than in the upper position.

[0055] In the lower position, the first (piston) rod of the first stroke device and the second (piston) rod of the second stroke device can be in a (fully) retracted position of the first and the second stroke devices.

[0056] In the upper position, the first (piston) rod of the first stroke device and the second (piston) rod of the second stroke device can be extended at least 50.0 % of a first stroke path of the first and a second stroke path of the second stroke device, preferably the first and the second rods are extended at least 80.0 % of their respective stroke paths.

[0057] The upper compacting system can comprise a compacting head attached to a compacting system frame. The position of the compacting head relative to the ground level in the upper position can be equal to the position of the compacting head relative to the ground level in the lower position and/or the position of the compacting head can be unchanged, when the frame is moved from the lower position to the upper position (for compacting molding material to form the portion of the mold) and vice versa.

[0058] The compacting head can comprise the at least one compacting element, the stationary compacting plate or a combination of at least one compacting element and a stationary compacting plate.

[0059] The at least one compacting element can comprise a stroke device, preferably the at least one compacting element can be a stroke device (cylinder).

[0060] The at least one compacting element can be extendable towards the frame.

[0061] The at least one compacting element can be movable into a lower position and an upper position.

[0062] In the upper position of the at least one compacting element, a (piston) rod of the at least one compacting element can be in a (fully) retracted position.

[0063] In the lower position of the at least one compacting element, the (piston) rod of the at least one compacting element can be extended at least 50.0 % of a stroke path of the at least one compacting element, preferably the rod of the at least one compacting element can be extended at least 80.0 % of its stroke path.

[0064] The upper compacting system can further comprise a compacting system frame.

[0065] The compacting head can be attached to the compacting system frame.

[0066] The compacting system frame can comprise at least two compacting frame elements, to which the compacting head is attached to.

[0067] The compacting system frame can be configured to be moveable in a plane parallel to the ground level.

[0068] The compacting system frame can comprise at least two rolls (or wheels) for moving the upper compacting system parallel to the ground level, preferably the compacting system frame can comprise at least four rolls for moving the upper compacting system.

[0069] The compacting system frame can be configured to be used in an upper track system of the machine.

[0070] An upper end of the frame can be located above a lower end of the upper compacting system, when the frame is in the upper position. Preferably the upper end of the frame can be located above a lower end of the compacting head, when the frame is in the upper position.

[0071] The first and the second support section or all support sections can be located above the lower end of the upper compacting system, preferably the lower end of the compacting head, in the upper position of the frame.

[0072] The upper end of the frame can be located above a lower end of the at least one compacting element, when the frame is in the upper position and the at least one compacting element is in the lower position or the upper position.

[0073] The upper end of the frame can be located above an upper end of the flask, when the flask is positioned on the pattern receiving section of the frame, preferably when the frame is in the upper position and when the frame is in the lower position.

[0074] An extension of the connecting sections in the lifting direction can be greater than an extension of the flask in the lifting direction, when the flask is seated on the pattern receiving section.

[0075] The first and the second stroke devices or all stroke devices are arranged above a ground level, preferably arranged completely above the ground level.

[0076] The upper compacting system can be movable in the plane parallel to the ground level.

[0077] The machine can comprise a molding material supply.

[0078] The molding material supply can be moveable in the plane parallel to the ground level.

[0079] The molding material supply can be moved into a first position above the pattern receiving section.

[0080] The molding material supply can be moved in a second position different from the first position of the molding material supply, preferably the second position

can be a position such that the upper compacting system is moveable in a position above the pattern receiving section.

[0081] The molding material supply can be coupled to the upper compacting system.

[0082] The molding material supply can be moved in conjunction with the upper compacting system in the plane parallel to the ground level, preferably the upper compacting system and the molding material supply are movable along one direction in the plane parallel to ground level.

[0083] A method for producing a portion of a mold using a machine, preferably a machine for producing a portion of a mold as described above, having an upper compacting system, a frame, a number of stroke devices, the frame connected to the stroke devices and having a pattern receiving section for being moved upwardly in a lifting direction, comprises positioning a pattern and a flask on the receiving section of the frame, filling molding material into the flask, such that the molding material covers the pattern at least partially, extending the stroke devices in a lifting direction towards the upper compacting system from a lower position to an upper position of the frame, and compacting the molding material in the flask by the upper compacting system in the upper position of the frame.

[0084] The flask can be positioned on the pattern receiving portion before the upward lifting of the frame for compacting molding material.

[0085] The flask can be arranged or held above the pattern receiving section by a flask mount system. The flask can be positioned on the pattern receiving section during the upward lifting of the frame towards the upper compacting system from the lower position of the frame into the upper position of the frame.

[0086] A filling frame can be arranged or held above the pattern receiving section by a filling frame mount system, preferably above the flask, and can be positioned on the flask during the upward lifting of the frame.

[0087] In another embodiment the filling frame can be omitted for producing the portion of the mold.

[0088] A molding material supply can be moved above the pattern prior to moving the stroke devices into the upper position.

[0089] The molding material can be filled into the flask, and preferably at least partially into the filling frame, by a molding material supply.

[0090] The number of stroke devices can be two, one first and one second stroke device as lifting cylinders.

[0091] The number of stroke devices can be four.

[0092] The number of stroke devices can be six.

[0093] The stroke devices can be operated in parallel, i.e. can be extended in parallel.

[0094] The upper compacting system can comprise at least one, preferably more, compacting elements and the compacting elements can be retracted before compacting the molding material and can be extended for active compacting, or the compacting elements can be extended before compacting the molding material and can be at least partially moved in the lifting direction by the molding material in the flask for reactive compacting.

[0095] The upper compacting system can comprise a compacting head attached to a compacting system frame. The position of the compacting head can be unchanged, when the frame moves from the lower position to the upper position and when the frame moves from the upper position to the lower position.

[0096] When lifting the frame in the upper position, an upper end of the frame can pass the compacting head at least partially parallel.

[0097] The support sections of the frame can be located above, in the lifting direction, the pattern receiving section and/or above, in the lifting direction, an upper end of the flask during the lifting of the frame from the lower position to the upper position.

[0098] The upper compacting system can be laterally moved, before or after vertical alignment with the flask, into a first position vertically above the flask and the pattern, when the frame is moved towards the upper position thereof and/or a molding material supply can be laterally moved into a second position outside a vertical alignment with the flask and the pattern, preferably the molding material supply can be moved laterally together with the upper compacting system. The lateral movement is in one direction within the x,y-plane, and this plane is parallel to the ground level.

[0099] For a more complete understanding of the present invention, the objects and advantages thereof, reference is now made to the following descriptions taken in connection with the accompanying drawings in which:

Figure 1 depicts a machine 100 comprising an upper compacting system 110 with at least one compacting element 112 and a frame 150, the frame 150 being in a lower position;

Figure 2 depicts the machine 100 comprising the upper compacting system 110 with the at least one compacting element 112 and the frame 150, the frame 150 being in an upper position. Molding material 200, filled in earlier, is compacted against several compacting elements 112 of the upper compacting system 110;

Figure 3 depicts an alternate machine 100' comprising an upper compacting system 110 with a stationary compacting plate and the frame 150, the frame 150 being in the lower position as in Figure 1; and

Figure 4 depicts a flow chart of a method for producing a portion of a mold.

[0100] Figure 1 shows the machine 100 for producing a portion of a mold in a non compacting status or position.

[0101] The machine 100 of figure 1 comprises an upper compacting system 110, a frame 150, a first stroke device 160 and a second stroke device 170.

[0102] The upper compacting system 110 comprises a compacting system frame 111, a compacting head 115, and means for allowing horizontal movement of the upper compacting system 110, shown here as a roller system comprising rollers 116, 117.

[0103] The roller system can comprise more than two rollers 116, 117, preferably the roller system can comprise four or more rollers.

[0104] The compacting system frame 111 can comprise the roller system (i.e. rollers 116, 117). In another embodiment, the frame 111 may be omitted.

[0105] The compacting system frame 111 - as shown - can comprise two frame elements, each comprising two rollers.

[0106] The two frame elements can be attached to opposite sides of the compacting head 115.

[0107] The roller system can allow the upper compacting system 110 to move along a direction (y).

[0108] The compacting system frame 111 can comprise a first recess 113 and a second recess 114. When no frame 111 is present, no such recesses are present.

[0109] The first and the second recesses 113, 114 can be formed to allow the frame 150 to pass the compacting head 115 at least partially in an upwardly movement relative to the compacting head 115.

[0110] The compacting head 115 comprises at least one compacting element 112. In Figure 1 six compacting elements are depicted in x-direction. Preferably the compacting head 115 comprises more than six compacting elements, more preferably more than thirty compacting elements in x-y direction.

[0111] Each compacting element 112 can comprise an active pressing cylinder, or corresponding passive pressing cylinders.

[0112] Each compacting element 112 can be moveable between an upper position and a lower position.

[0113] In the upper position, the at least one compacting element 112 can be in a retracted position, i.e. a (piston) rod of the at least one compacting element 112 can be in a (fully) retracted position.

[0114] In the lower position, the at least one compacting element 112 can be in an extended position, preferably the (piston) rod of the at least one compacting element 112 can be extended 50.0 % of its stroke path, more preferably more than 80.0 %.

[0115] The upper compacting system 110 is arranged within or on a track system. The track system comprises tracks 192, 193. In tracks 192, 193 rollers 116, 117 of the compacting system frame 111 can be moved (y-direction).

[0116] The roller system can be configured to move the upper compacting system 110 in the horizontal plane (x,y-direction).

[0117] The track system is attached or connected to a support system comprising supporting elements 190, 191.

[0118] The upper compacting system 110 is held by the supporting elements 190, 191.

[0119] The supporting elements 190, 191 are attached to a base element 180 of the machine 100.

[0120] The base element 180 can be a flat platform to which several components of the machine 100 are attached to.

[0121] The base element 180 can be of rectangular base form.

[0122] The base element 180 can be installable on a (flat) ground defining a ground level G.

[0123] The first and the second stroke devices 160, 170 are attached to the base element 180.

[0124] The first and the second stroke devices 160, 170 are at least partially surrounded by the support elements 190, 191 of the support system, i.e. they are outside the stroke devices 160, 170.

[0125] The first and/or the second stroke devices 160, 170 can comprise devices that are configured to move and/or to allow movement of the frame 150 along a lifting direction (z-direction).

[0126] The first and/or the second stroke devices 160, 170 can be (lifting) cylinders, preferably electric cylinders or purely mechanical, such as toothed rack with a rotary gear wheel/pinion.

[0127] The first and the second stroke devices 160, 170 can be equal to each other.

[0128] The first stroke device 160 comprises a first body (barrel) 161 and a first (piston) rod 162.

[0129] Analogously, the second stroke device 170 comprises a second body (barrel) 171 and a second (piston) rod 172.

[0130] The first and the second rods 161, 171 are moveable along the lifting direction (z-direction).

[0131] The first and the second stroke devices 160, 170, or rather the first and the second rods 162, 172 can both be in a retracted position and in an extended position.

[0132] The first and the second stroke devices 160, 170 are configured to be operated in parallel.

[0133] The retracted position of the first and the second stroke device 160, 170 and corresponding rods 162, 172 can be a lower position and the extended position can be an upper position. In the lower position the pattern receiving portion 151 of the frame 150 is nearer to the ground level G than in the upper position.

[0134] In the lower position, the first and the second rod 162, 172 of the stroke device 160, 170 can be in a fully retracted position.

[0135] In the upper position, the first and the second rod 162, 172 can be at least extended 50.0 % of their respective stroke paths, preferably at least 80.0 %.

[0136] The frame 150 is attached via a first support section 154 to the first stroke device 160 and via a second support section 155 to the second stroke device 170.

[0137] By extending the first rod 162 and second rod 172 of the stroke devices 160, 170 (and thus the frame

150) is lifted in the upwardly lifting direction (in positive z-direction).

[0138] The upper position of the stroke devices 160, 170 and thus the frame 150 may be a compacting position for compacting the molding material 200 as seen in Figure 2.

[0139] The frame 150 comprises, in addition to the first and the second support sections 154, 155, a first connecting section 152, a second connecting section 153 and the pattern receiving section 151.

[0140] The pattern receiving section 151 is connected via the first connecting section 152 to the first support section 154 and via the second connecting section 153 to the second support section 155.

[0141] The first and the second support sections 154, 155 can be parallel to the ground level G.

[0142] The first and/or the second support section 154, 155 can each have an angle of between $\pm$ 30 ° from horizontal.

[0143] The first and the second connecting sections 152, 153 can be parallel to the lifting direction (z-direction).

[0144] The first and the second connecting sections 152, 153 can be orthogonal to the ground level G and/or to the pattern receiving section 151.

[0145] The first and/or the second connecting section 152, 153 can have an angle of between $\pm$ 30 ° from vertical.

[0146] The pattern receiving section 151 can be parallel to the ground level and/or base element 180.

[0147] A first angle α_1 can be enclosed between the pattern receiving section 151 and the first connecting section 152. The first angle α_1 can be between 85.0 ° and 100.0 °, preferably between 85.0 ° and 95.0°, most preferred α_1 can be 90.0 °.

[0148] A second angle α_2 can be enclosed between the pattern receiving section 151 and the second connecting section 153. The second angle α_2 can be between 85.0 ° and 100.0 °, preferably between 85.0 ° and 95.0°, most preferred α_1 can be 90.0 °.

[0149] The preferred shape thus is of u-shaped form, or may be of multiple u-shaped form for more than two opposed stroke devices 160, 170.

[0150] The pattern receiving section 151 can have a rectangle base form.

[0151] The pattern receiving section 151, the first and the second connecting sections 152, 153 can have a (substantially) u-shaped form, when viewed in a cross-section of the frame 150.

[0152] The first connecting sections 152 can have an extension substantially equal or smaller to an extension of the first stroke device 160 (z-direction). The extension of the first connecting section 152 can be 5.0 % smaller than the extension of the first stroke device. The same can apply to an extension of the second connecting section 153 and an extension of the second stroke device 170, respectively.

[0153] The pattern receiving section 151 is configured to receive a pattern 140.

[0154] The pattern 140 can be attached to a pattern plate 141.

[0155] The pattern receiving section 151 can be configured to receive the pattern 140 attached to the pattern plate 141.

[0156] The pattern 140 or pattern plate 141 can be configured to receive a flask 130.

[0157] The pattern receiving section 151 can at least be partially surrounded by the first and the second stroke devices 160, 170, i.e. the pattern receiving section 151 can be arranged or positioned between the first and the second stroke devices 160, 170.

[0158] Molding material 200 can be filled into the flask, when the flask 130 is positioned and/or attached to the pattern 140 and/or the pattern plate 141.

[0159] The machine 100 can comprise a flask mount system (not shown), which can be configured to hold the flask 130 vertically above the pattern receiving section 151 and/or pattern 140 positioned on the pattern receiving section 151. The pattern 140 can be attached to the pattern plate 141.

[0160] The flask mount system can comprise means for moving the flask 130 into the position vertically above the pattern 140 and out of the position vertically above the pattern 140, e.g. a (six-axis) robotic system, a track and/or roller system etc.

[0161] The flask 130 can be configured to receive a (sand) filling frame 120.

[0162] The machine 100 can comprise a filling frame mount system (not shown), which can be configured to hold the filling frame 120 vertically above the flask 130.

[0163] The filling frame mount system can comprise means for moving the filling frame 120 into the position vertically above the flask 130 and out of the position vertically above the flask 130, like a (six-axis) robotics systems, a track and/or roller system mentioned above.

[0164] The extension of the first connecting section 152 can be greater than an extension of the flask 130, when the flask 130 is seated on the pattern plate 141 (or around the pattern 140). The same can apply to the second connecting section 153.

[0165] The extension of the first connecting section 152 can be greater than an extension of the filling frame 120, when the filling frame 120 is seated on the flask 130, the flask being seated around the pattern 140 (or positioned on the pattern plate 141). Analogously, the extension of the second connecting section 152 can be greater than an extension of the filling frame 120, when the filling frame 120 is seated on the flask 130, the flask being seated or positioned on the pattern plate 141 (or around the pattern 140).

[0166] Figure 2 shows the frame 150 of the machine 100 in the upper position, whereby compacting filled-in molding material 200 against the compacting element(s) 112 of the upper compacting system 110. The following statements can apply with regard to Figure 2 and the frame 150 being in the upper position accordingly.

[0167] An upper end of the frame 150 can be located above a lower end of the compacting system 110.

[0168] The upper end can be part of the first and/or second supporting sections 154, 155. The upper end of the frame 150 can be located above a lower end of the compacting head 115, preferably above a lower end of the at least one compacting element 112, when the at least one compacting element 112 is in its lower or upper position. Preferably the lower corner of the compacting head 115 serves as reference point (or line) for the (minimum) lifting height of the lifting frame 150. This will be higher than mentioned reference in the upper position of the stroke devices 160, 170.

[0169] The upper end of the frame 150 can at least partially surround the upper compacting head 115 of the upper compacting system 110 in a direction orthogonal to the lifting direction (z-direction) of the frame 150.

[0170] Figure 3 shows a similar machine 100' with a stationary compacting plate within the compacting head 115. The stationary compacting plate cannot move relative to the supporting head 115' along the lifting direction (z-direction).

[0171] The remaining description from figures 1 and 2 apply.

[0172] Figure 4 shows a flow chart of a method for producing a portion of a mold using the machine 100 comprising the compacting head 115 with the compacting element(s) 112 as described above with regard to figures 1 and 2.

[0173] Prior to compacting, the frame 150 of the machine 100 is in the lower position. The compacting element(s) 112 are retracted (in an upper position thereof).

[0174] In a further embodiment the frame 150 is in the lower position and the compacting element(s) 112 are (fully) extended (in a lower position) prior to compacting.

[0175] The pattern 140 (or pattern 140 attached to the pattern plate 141) can be positioned on and/or attached to the pattern receiving section 151 prior to compacting molding material 200.

[0176] In step 410 the pattern 140 (or pattern 140 attached to the pattern plate 141) is positioned on the pattern receiving portion 151. The flask may be positioned on the pattern 140 (or pattern plate 141). This may happen during the z-movement of the frame 150.

[0177] The flask 130 can be held by the flask mount system vertically above the pattern 140. The flask 130 can be positioned on the pattern 140 or pattern plate 141 by extending the first and the second stroke devices 160, 170 at least partially into a first intermediate position.

[0178] In step 420 the (sand) filling frame 120 is positioned on the flask 130. This may happen during the z-movement of the frame 150.

[0179] The filling frame 120 can be held by the filling frame mount system vertically above the flask 130 and/or flask mount system. The filling frame 120 can be positioned on the flask 130 by extending the first and the second stroke devices 160, 170 partially further from the first intermediate position into a second intermediate position.

[0180] In step 430 a molding material supply system is moved to a position vertically above the pattern 140, the flask 130 and the filling frame 120.

[0181] The molding material supply system can be configured to use the track system in order to move in the plane parallel to the ground level (x-direction or y-direction within the x,y-plane), and into the position vertically above the pattern 140. The upper compacting system 110 can be in another position, different from the position vertically above the pattern 140, when the molding material supply system is in the position vertically above the pattern 140.

[0182] The molding material supply system can be coupled to the upper compacting system 110 and can be moved in conjunction with the upper compacting system 110.

[0183] In step 440 molding material 200 is filled into the flask 130.

[0184] The filling frame 120 can be at least partially filled with molding material 200, preferably the filling frame 120 can be filled up to 80.0 % with molding material 200.

[0185] In step 450 the upper compacting system 110 is moved to a position vertically above the pattern 140 (y-direction) and the molding material supply system is moved into a position not vertically above the pattern 140.

[0186] In step 460 the first 160 and the second 170 stroke devices extend in the lifting direction (positive z-direction) towards the upper compacting system 110, thereby lifting the frame 150 in its upper position. The lifting speed thereof varies depending on the function. The lifting is also the lowering. The speed of the stroke devices depend on the "task" (their function) and vary during the lifting/lowering process. To couple the flask with the pattern and to "accomodate" the sand filling above the flask, shock/impact is avoided. Thus, low speed is required. To separate the pattern from mold very low speed is required. In opposite, all other movements can be as fast as possible if high productivity is intended.

[0187] The lifting speed may vary between 400.0 mm/s and 800.0 mm/s. The lowering speed may be between 600.0 mm/s and 1000.0 mm/s.

[0188] Acceleration in both directions (for lowering and lifting) should be between 2000.0 mm/s^2 and 3500.0 mm/s^2.

[0189] The compacting element(s) 112 can be retracted prior to compacting the molding material and can be extended for actively compacting the molding material 200 in the flask 130.

[0190] Alternatively, the compacting element(s) 112 can be extended before compacting the molding material 200 and can be at least partially moved in the lifting direction (z) by the molding material 200 in the flask for reactive compacting.

[0191] In step 470 the molding material 200 in the flask 130 is compacted by pressing the molding material 200 against the compacting element(s) 112 of the upper com-

pacting system 110.

[0192] Compacting element may in a variant be the plate of figure 3.

[0193] In step 480 the first and the second stroke devices 160, 170 are retracted (the first and the second rods 162, 172 are brought into their retracted/lower position) and the at least one compacting element 112 is retracted. Further, the compacted molding material 200 in the flask 130 (the finished portion of the mold) is removed.

[0194] The same process operates for the other half of the mold. The two halves are then assembled to form a full mold. The full mold is then filled with the casting material, see page 1.

Claims

1. **Machine (100) for producing a portion of a mold** comprising:

   an upper compacting system (110);
   a frame (150) for an upward directed moving in a lifting direction (z); and
   at least a first stroke device (160) and at least a second stroke device (170); wherein

   (a) the frame (150) comprises at least a first support section (154), at least a second support section (155) and a pattern receiving section (151), wherein the pattern receiving section (151) is configured to receive at least a pattern (140), and during the upward directed moving a flask (130) and preferably a filling frame (120);
   (b) the first stroke device (160) is connected to the first support section (154) and the second stroke device (170) is connected to the second support section (155); and
   (c) the frame (150), and thereby the pattern (140) and the flask (130), is moveable in the lifting direction (z) towards the upper compacting system (110) for producing the portion of a mold by extending the stroke devices (160, 170).

2. Machine (100) according to claim 1, wherein several first and several second stroke devices are provided to operate in parallel.

3. Machine (100) according to claim 2, wherein the first stroke devices (160) are each connected to a corresponding support section (154) and each second stroke device (170) is connected to a corresponding second support section (155) and all support sections are connected to the pattern receiving section (151) of the frame.

4. Machine (100) according to claim 1, wherein the pattern receiving section (151) is connected via a first connecting section (152) to the first support section (154) and via a second connecting section (153) to the second support section (155).

5. Machine (100) according to any one of claims 1 to 4, wherein the upper compacting system (110) comprises

   (a) at least one compacting element (112), preferably more;
   (b) a stationary compacting plate; or
   (c) a combination of (a) and (b).

6. Machine (100) according to any one of claims 1 to 5, wherein the pattern receiving section (151) and the connecting sections (152, 153) are at least partially surrounded by the stroke devices (160, 170) in a direction orthogonal to the lifting direction (z) of the frame (150).

7. Machine (100) according to any one of claims 1 to 6, wherein the machine (100) is installable on a flat ground defining a ground level (G) and the frame (150) is moveable between an upper position and a lower position, wherein the pattern receiving section (151) of the frame (150) is closer to the ground level (G) in the lower position than in the upper position.

8. Machine (100) according to the previous claim, wherein the upper compacting system (110) comprises a compacting head (115) attached to a compacting system frame (111), wherein the position of the compacting head (115) relative to the ground level (G) in the upper position is equal to the position of the compacting head (115) relative to the ground level (G) in the lower position
   and/or
   wherein the position of the compacting head (115)is unchanged, when the frame (150) is moved from the lower position to the upper position and vice versa.

9. Machine (100) according to any one of claims 1 to 8, wherein an upper end of the frame (150) is located above a lower end of the upper compacting system (110), preferably a lower end of the compacting head (115), when the frame (150) is in the upper position.

10. Machine (100) according to any one of claims 1 to 9, wherein an extension of the connecting sections (152, 153) in the lifting direction (z) is greater than the extension of the flask (130) in the lifting direction (z), when seated on the pattern receiving section (151).

11. Machine (100) according to any one of claims 1 to 10, wherein the first and the second stroke devices

(160, 170) or all stroke devices are arranged above a ground level (G), preferably arranged completely above the ground level (G).

12. **Method for producing a portion of a mold** using a machine (100), preferably a machine (100) according to any one of claims 1 to 11, the machine (100) having an upper compacting system (110), a frame (150), a number of stroke devices (160,170), the frame (150) connected to the stroke devices (160, 170) and having a pattern receiving section (151) for being moved upwardly in a lifting direction (z);
the method comprising the steps of:

positioning (410) a pattern (140) and a flask (130) on the pattern receiving section (151);
filling (440) molding material (200) into the flask (130), such that the molding material (200) covers the pattern (140) at least partially; and
extending (460) the stroke devices (160, 170) in a lifting direction (z) towards the upper compacting system (110) from a lower position to an upper position of the frame (150);
compacting (480) the molding material (200) in the flask (130) by the upper compacting system (110) in the upper position of the frame (150).

13. Method according to claim 12, wherein the number of stroke devices is two, one first and one second stroke device as lifting cylinders.

14. Method according to claim 12 or 13, wherein the upper compacting system (110) comprises at least one, preferably more, compacting elements (112) and the compacting elements

(a) are retracted before compacting the molding material (200) and are extended for active compacting; or
(b) are extended before compacting the molding material (200) and are at least partially moved in the lifting direction by the molding material (200) in the flask for reactive compacting.

15. Method according to any one of claims 12 to 14, wherein the upper compacting system (110) comprises a compacting head (115) attached to a compacting system frame (111), wherein the position of the compacting head (115) is unchanged, when the frame (150) moves from the lower position to the upper position and when the frame (150) moves from the upper position to the lower position.

16. Method according to any one of claims 12 to 15, wherein the support sections (154, 155) of the frame (150) are located above, in the lifting direction, the pattern receiving section (151) and/or above, in the lifting direction, an upper end of the flask (130) during the lifting of the frame (150) from the lower position to the upper position.

17. Method according to any one of claims 12 to 16, wherein the upper compacting system (110) is or was laterally moved (x,y) into a first position vertically above the flask (130) and the pattern (140), when the frame is moved towards the upper position thereof;
and/or
a molding material supply is laterally moved (x,y) into a second position outside a vertical alignment with the flask (130) and the pattern (140), preferably moved laterally together with the upper compacting system (110).

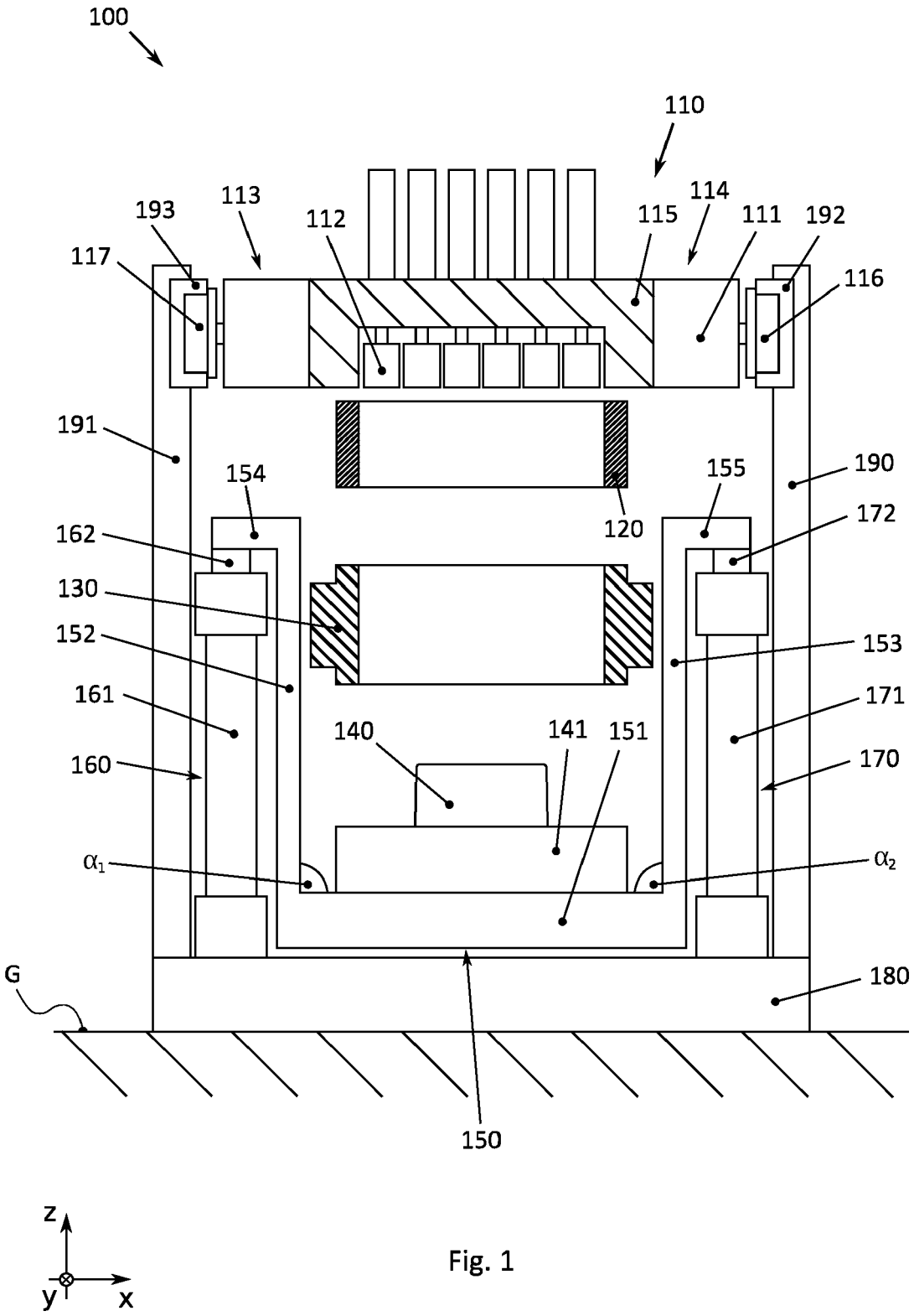
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Fig. 1

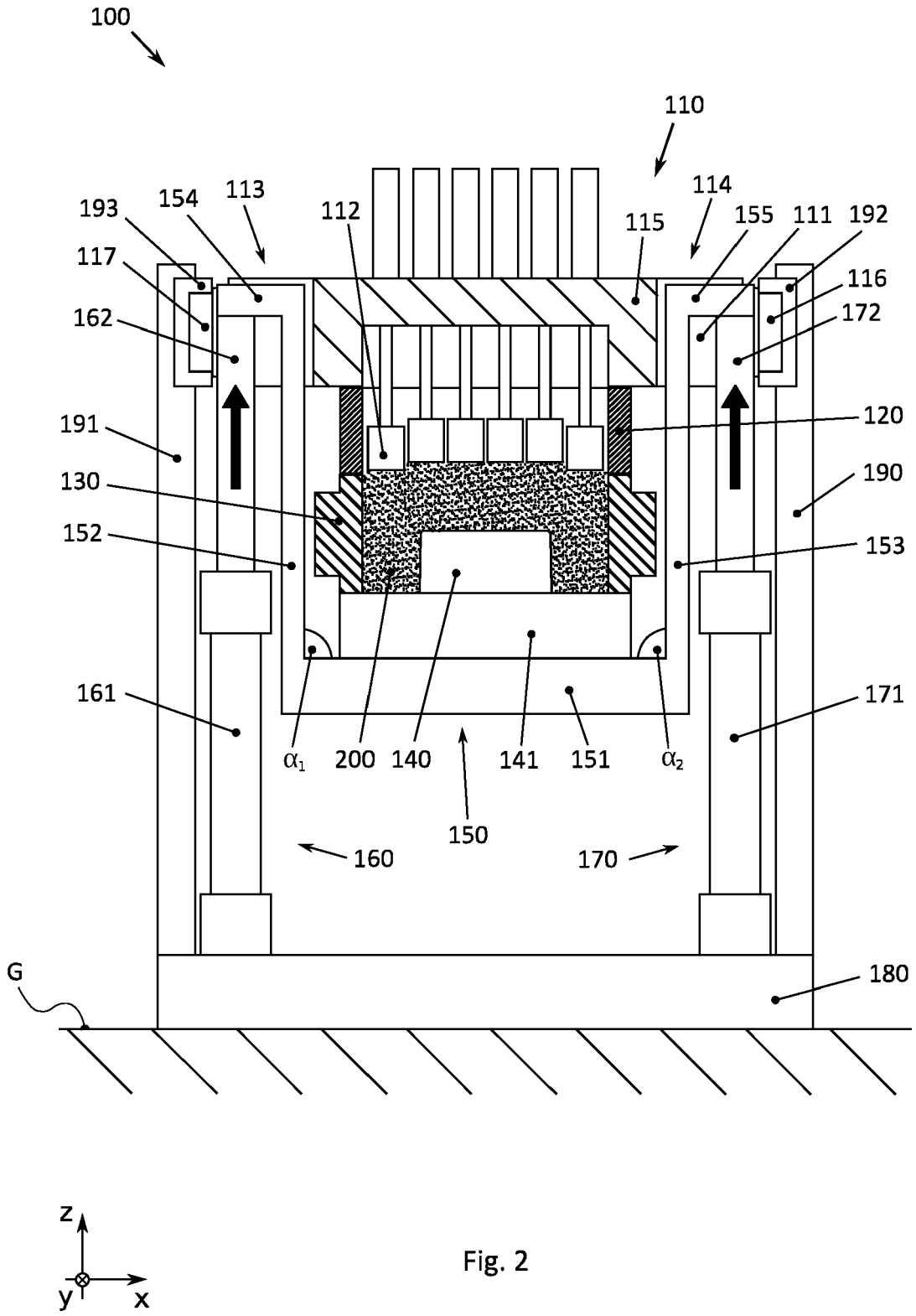
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Fig. 2

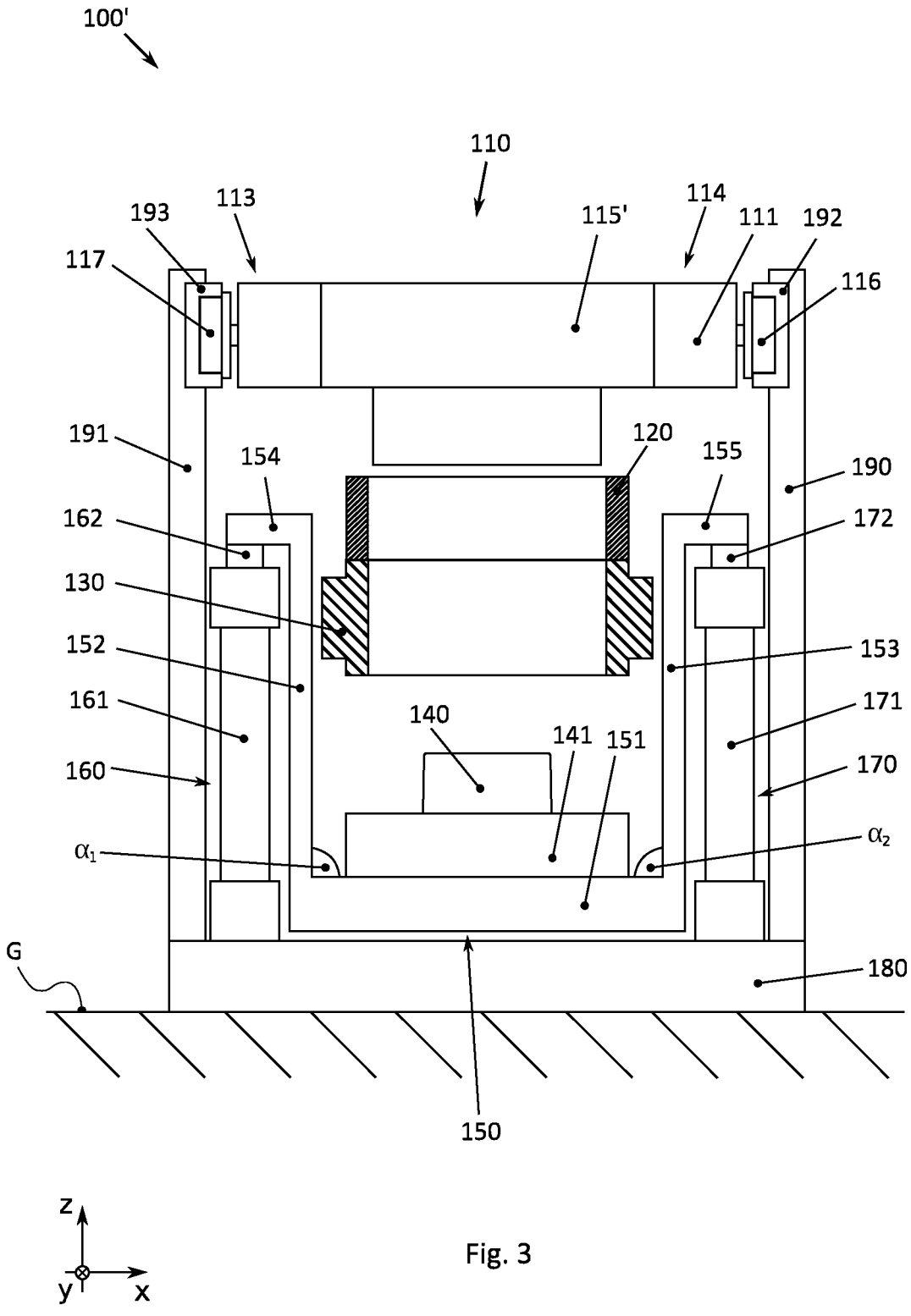
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Fig. 3

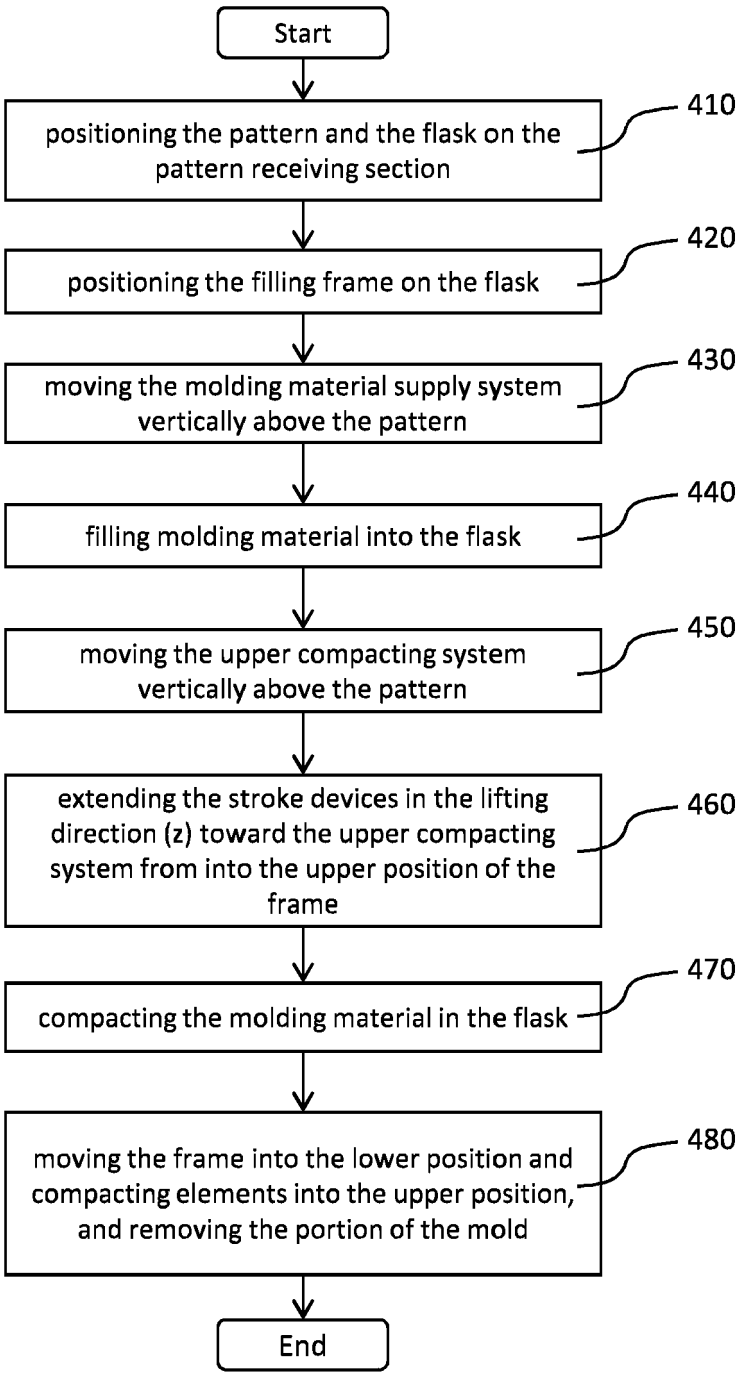
Start
positioning the pattern and the flask on the pattern receiving section
410
positioning the filling frame on the flask
420
moving the molding material supply system vertically above the pattern
430
filling molding material into the flask
440
moving the upper compacting system vertically above the pattern
450
extending the stroke devices in the lifting direction (z) toward the upper compacting system from into the upper position of the frame
460
compacting the molding material in the flask
470
moving the frame into the lower position and compacting elements into the upper position, and removing the portion of the mold
480
End

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 20 16 9500

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	EP 0 811 445 A1 (SINTOKOGIO LTD [JP]) 10 December 1997 (1997-12-10) * page 3, column 3, line 8 - page 4, column 5, line 45; figures 1-5 *	1-5,7,8, 11-15,17 6,9,10, 16	INV. B22C15/02
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 September 2020	Pipoli, Tiziana

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