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SHAPING METHOD INCLUDING FIXING THE POSITION OF PREDETERMINED POINTS IN PARTICULATE MOLD MATERIAL

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Fig. 1

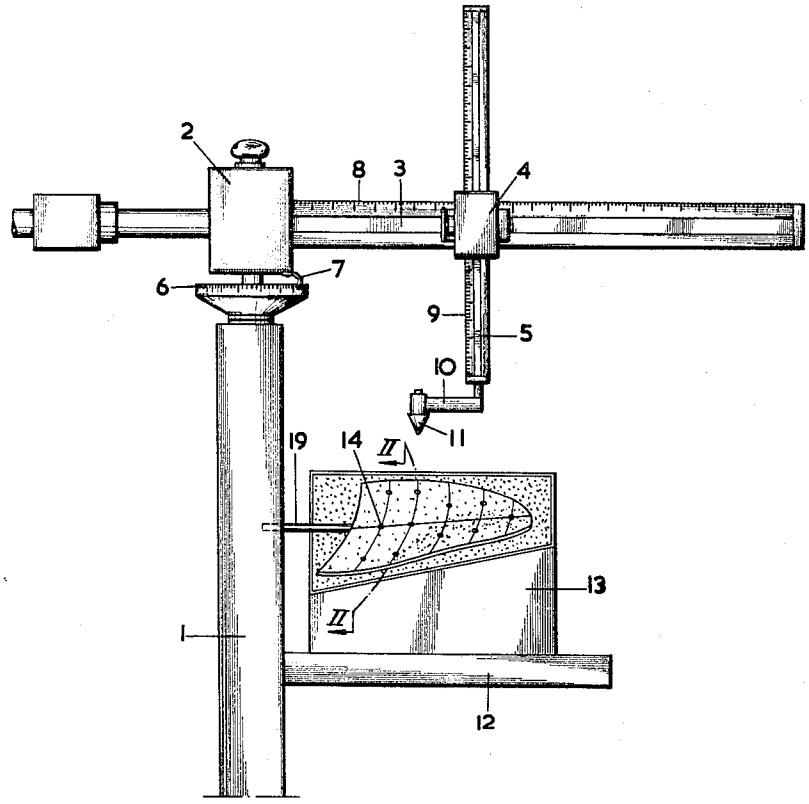
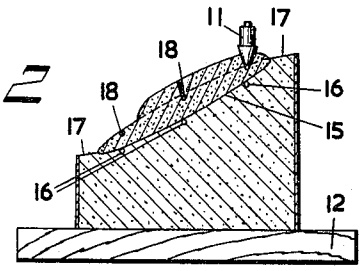


Fig. 2



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SHAPING METHOD INCLUDING FIXING THE POSITION OF PREDETERMINED POINTS IN PARTICULATE MOLD MATERIAL

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7 Claims. (Cl. 164—17)

ABSTRACT OF THE DISCLOSURE

A three-dimensional foundry mold is made from sand by pressing a pin downwardly into a body of sand in a number of different places so that the bottoms of the holes that are formed define the contour to be produced. A small ball is deposited in the bottom of each hole, and then the sand is scraped away down to the balls, which thus provide easily found indicia for establishing the desired contour. The pin is adjustable along graduated coordinates so as accurately to position its lower end in the sand.

This invention relates to a method for fixing the position of points in a quantity of material for molding, modelling or core making for foundry purposes, said points constituting points on a surface of a mold, model or core to be made, which material consists of separate particles, if desired with a binder.

The manufacturing of molds, models and cores for foundry purposes is not difficult for castings of simple shape, but causes many problems if the casting have an intricate shape, such as for ship's propellers, which usually have blades curved in more than one direction. It is therewith necessary to fix a large number of points in their correct position in space and to add or remove molding or like material until a surface of the correct shape and position is obtained. For more simple castings, also for more simple propellers, several surfaces could be made rather simply, e.g. by moving a straight ruler, positioned perpendicularly to an axis, along a helical line and therewith levelling molding material by said ruler during said movement, but for more intricate shapes this is not possible. It is often possible to make models of the propeller blades with the aid of gauge plates, but this is very expensive when making one propeller or a small series only of the same shape.

This invention aims at improving such known methods and to this end a method as given in the preamble is according to the invention characterized in that in the zone of and around a point of a surface of a mold, model or core to be made a quantity of such material not yet entirely bound is applied, that thereupon with the aid of a coordinate measuring or control system a pin is moved to said point so that the pin at least in the last part of this movement, which is substantially vertical, pushes away said material, that in the bottom of the impression made by the pin a body is introduced or a mark is made for fixing said point in said material, and that after thus fixing a number of points the superfluous material above said points is levelled by a wiper (doctor) or the like, which is guided over the fixing bodies or marks.

Preferably the pin makes an impression with a rounded end, in which as a fixing body a small ball is introduced.

It is when applying this invention possible to move the pin with and with respect to the coordinates measuring and control system by hand or under control of a computer, punch belt, magnetic band or in other desired way so that the pin rapidly makes a number of impressions in the molding or like material, the pin compressing said material so that each time a solid bed is made for a fixing body to be introduced or for a mark to be made in the deepest point of the impression.

The body may be introduced easily into the impression after withdrawing the pin therefrom. If it is a small ball it could be introduced and allowed to fall by hand or from a mechanical feeding device. It is also possible to attach the body, e.g., by magnetism or pneumatically to the lower end of the pin, so that the body itself makes the impression and after reaching the correct position is released by breaking the magnetism or interrupting the suction through the hollow pin, so that the pin may be withdrawn while leaving the body behind. It is therewith possible to attach a new body to the pin each time after withdrawal thereof, either by hand or automatically.

If a fixing mark is used this may be, e.g., a drop of ink applied at the bottom of the impression.

After introducing all bodies or marks in a certain zone the molding or other material is levelled over the marks or over the upper surface of the bodies. Thus points on these upper surfaces should represent the required points in space.

The molding material may be of different kinds, e.g., a mixture of sand with cement, with a thermohardening resin or with water glass as a binder. In the molding material not yet bound it would be possible to initiate the binding already to some extent in the zones of the fixing bodies or marks, e.g., when using a thermohardening resin, by heating the pin and/or the fixing bodies and when using water glass by introducing locally a small quantity of carbon dioxide gas, e.g., through the pin made hollow, which is in that case provided with laterally opening apertures at its lower end, which gas could be introduced immediately after making the impression with the pin, but preceding the levelling of the molding material. Thereby the fixing body will rest upon more rigid and less easily deformable molding material, or the mark will be present in such more rigid material, so that the body or mark during the levelling has less chance to be displaced horizontally or vertically. Of course this preliminary binding or hardening should not be continued so far that the levelling will be hampered. Also without such preliminary binding or hardening the present invention gives good results and the fixing bodies or marks are normally not displaced during the levelling, among other reasons, because the pin when making the impression compresses the molding material in its way, so that it becomes more compact in the zones where it forms a bed for the fixing bodies or marks.

The invention will now be explained in more detail with reference to the enclosed diagrammatic drawing of a machine for applying the method of this invention.

FIG. 1 gives a diagrammatic vertical elevation of such a machine.

FIG. 2 gives in a plane development the cylindrical cross-section through the molding box (flask) present in the machine of FIG. 1 along the line II—II in FIG. 1.

The machine has a rigid vertical column 1, on top of which is a rotatable head 2 carrying a radial arm 3, along which a support 4 for a vertical arm 5 is movable horizontally. The arm 5 is movable up and down in the support 4. On the column 1 there is a scale carrying body 6 and the head 2 has a pointer 7 for indicating its angular position with respect to the column 1. The arm 3 is provided with a scale 8 for indicating the position of support 4 along it and vertical arm 5 has a scale 9 for indicating its vertical position wtih respect to support 4.

The vertical arm 5 at its lower end carries a short arm 10 with a conical pin 11 having a spherical lower end.

Fixed to or vertically movable and horizontally rotatable with respect to the column 1 a table 12 is provided, on which a molding box (flask) 13 of suitable dimensions may be placed. In this example the machine is used for making a mold for a blade of a ship's propeller. In the molding box 13 a quantity of molding material such as sand with waterglass is introduced. A table or graph gives an indication about the position of points of the mold surface. The starting reference could be one point on the mold surface, e.g., a point 14, which is given a good position with respect to the molding box 13 and the machine by raising or lowering the table 12. The table or graph gives the coordinates of the points, expressed in the angular position of the head 2 (scale 6), in the radial position of the support 4 and in the vertical position of the arm 5. For each point the angular position of the head 2 and the radial position of the support 4 are first adjusted. Thereupon the arm 5 is moved downwardly to the correct position. Therewith the conical pin 11 enters the molding material, making a conical impression therein and compressing the material below it, as shown in the right upper part of FIG. 2. In general, a number of points at the same radial distance from the center of the column 1 is given in the table or graph, as shown in FIG. 1. Thus the number of adjustments of the support 4 in radial distance along the arm 3 is restricted.

After making an impression by the pin 11 a ball is allowed to fall into the depression.

In FIG. 2 at first the lower mold face 15 of a blade is made by making impressions, introducing balls 16 and levelling the molding material by guiding a wiper or the like by hand over the tops of the balls 16. Thereupon a suitable separating material such as fine dry sand, graphite or a silicone liquid is put in a fine layer on the face 15 and on the levelled mold face 17 around the blade.

Thereupon a new quantity of the same or other molding material is put on the face 15 for making a sand model of the blade. The upper surface of this blade model is now made in the same way by making impressions with the pin 11 and by introducing balls 18 therein, after which this surface is levelled. The blade model may have a radial rod 19 introduced therein and extending through a suitable opening in the box 13.

Often many more points than shown in the drawing have to be fixed and this is particularly true for points along the edges of the blade.

Thereafter another molding box (flask) is put on top of the box 13, having a shape of its lower edge exactly fitting on the top edge of box 13 and allowing the rod 19 to pass. This box is filled with molding material which is thereafter made to cohere, after which this upper box is removed, the blade model is lifted from box 13 and the upper box is put in place on box 13 again. After making suitable runners, gates and risers this set of boxes is now suited for casting a blade of the same shape and dimensions as the removed blade model.

Another possibility is not to use an upper box, but to remove the blade model with rod 19 from the box 13, mounting it in a metal molding box, filling said box with molding material, allowing it to cohere in two mutually separate parts, taking one part away, removing the blade model and replacing the removed part to cast a blade therein, or also removing the other of the two separate parts and mounting them again on the first removed part to cast a blade therein outside the metal box, if desired after making more sets of such separate parts of molding material and assembling them to form a complete mold for a full ship's propeller. In the latter case a mold cavity for the hub should be made with the blade cavities joining the hub cavity in the correct points and positions.

Another possibility is to cast a blade model in the box 13 and an upper box as described and to use this blade model in making a mold for a ship's propeller.

The method and machine as described could be used to make immediately a mold for a full propeller or other intricate body.

Instead of moving the arms 3 and 5 by hand or through hand wheels and gears they may be moved by a computer, punch band or magnetic band. The fixing bodies or marks may be introduced or made automatically.

As stated the pin 11 when making the impressions will compress the material immediately underneath and if desired some means may be applied or some material may be introduced to give more coherence to the material in the bottom of the impression, e.g., by introducing some carbon dioxide gas into said bottom zone through the hollow pin or after withdrawing the pin through a separate small duct. The pin may carry a small ball to be introduced when making the impression, e.g., by magnetic means or air suction through the hollow pin.

The same apparatus as described may be used for measuring or checking intricately curved surfaces such as propellers or blades thereof by moving the pin or a sharply pointed pin replacing the described pin over the surface and measuring radial, circumferential and vertical coordinates.

In cases in which there are balls to fixed the points the correct points on the surface of the molds or the like should be the points in which the said surface is tangent to the surface of the balls, and the surface of the molds or the like is in most parts inclined to the horizontal and inclined differently in different zones. This should be taken into account when determining or calculating the amount of vertical movement of the pin 11. Thus by a calculating machine or computer the correct position of the centers of the balls could be calculated so that the surface of the mold or the like is tangent to the surface of the balls also in inclined parts of said mold surface and is nevertheless in the correct position. This is easily achieved by deriving from the mutual position of a number of points in the vicinity the desired inclination of the mold surface and to derive therefrom the positions of the centers of the balls by taking into account that the line perpendicularly to the inclined mold surface in the point where the ball surface is perpendicular to said mold surface intersects the center of the ball and has a length which is equal to the length of the vertical line through the ball center to the mold surface multiplied by the cosine of the angle between said lines.

What I claim is:

1. In a method for fixing the position of predetermined points in a quantity of material for molding, modeling or core making for foundry purposes, said points constituting points on the surface of a mold, model or core to be made, which material consists of separate particles and is penetrable; the improvement comprising moving a pin substantially vertically downwardly to a said point so that the pin at least in the last part of its downward movement pushes away said material to form a vertical hole in the material, withdrawing said pin substantially vertically upwardly out of said hole, depositing a small solid body in the bottom of the hole for fixing said point in said material, repeating the steps of pin penetration and pin withdrawal and small body deposit thus fixing a number of said bodies at a plurality of points disposed in a predetermined relationship to define said surface to be made, and removing the superfluous material above said points.

2. A method as claimed in claim 1, and forming the bottom of the holes with the same shape as the small body deposited therein.

3. A method as claimed in claim 2, in which said small body is a ball.

4. A method as claimed in claim 1, and binding the particles of said material together in small zones adjacent said bodies.

5. A method as claimed in claim 1, and thereafter placing on the surface defined by said small bodies a further quantity of penetrable material which is readily separable

from said surface, and repeating the steps of pin penetration and pin withdrawal and small body deposit at a plurality of second predetermined points and removal of excess material in connection with said further material thereby to establish a second surface so that the first and second surfaces may constitute opposed or opposite surfaces of a mold, model or core to be made.

6. A method as claimed in claim **1**, in which said small body is deposited in the bottom of the hole before said pin is withdrawn substantially vertically upwardly out of said hole.

7. A method as claimed in claim **1**, in which said small body is deposited in the bottom of the hole after said pin is withdrawn substantially vertically upwardly out of said hole.

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