PATENT SPECIFICATION (11) 1559 888

1 559 888

(21) Application No. 4111/77 (22) Filed 1 Feb. 1977 (19)
(31) Convention Application Nos. 1273/76 (32) Filed 2 Feb. 1976
9519/76 26 July 1976
11636/76 14 Sept. 1976 in
(33) Switzerland (CH)
(44) Complete Specification published 30 Jan. 1980
(51) INT. CL.[3] B22C 11/00
(52) Index at acceptance
B3G 8J1 8J2

(54) A MACHINE FOR PRODUCING CASTING MOULD PARTS

(71) I, ERWIN BUHRER, a Swiss citizen, of Vögelingässchen 40, 8200 Schaffhausen, Switzerland, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a machine for producing casting mould parts.

The substantial increase in size of moulding boxes, in which mould parts are formed, in consequence of complete mechanisation of mould forming installations, has resulted in a substantial increase in resilient deformation or bulging-out of the moulding boxes during compaction of the mould-forming material within them. Furthermore, the resilient deformation of the moulding boxes during compaction is further increased due to the introduction of high-pressure moulding. Another cause of the increase in the resilient deformation of the moulding boxes during compaction is the employment of new methods of filling the mould-forming material, e.g. sand, into the moulding boxes, wherein, prior to compaction the sand filling is stripped on the upper side, in profiled manner adapted to the volume of the pattern.

The resilient deformation of the moulding box attains its maximum value during compaction, particularly when forming mould parts using patterns of large volume. The resilient deformation of the moulding box is accompanied by the disadvantage that, on separating the mould parts from the pattern device, it promotes the tearing-off of mould pieces and mould edges. It is a further consequence of the deformation of the moulding box that the occurrence of dislocations in the mould parts is increased and also the dimensional accuracy of the mould parts is impaired.

According to the present invention there is provided a machine for producing casting mould parts, comprising a moulding table for supporting a moulding box, a compaction press for compacting mould-forming material in the moulding box and at least one pair of mutually oppositely acting presser means arranged to engage respectively opposite sides of a moulding box when supported on the moulding table and to react against respective abutment members, the two abutment members for the or each pair of presser means being rigidly interconnected with each other, each presser means having a part which is movable in a plane parallel to the plane of the surface of the moulding table inwardly and outwardly relatively to the respective abutment member for engagement with and disengagement from a moulding box when supported on the moulding table, locking means being provided for locking the presser means positively against movement away from a moulding box supported on the moulding table when the presser means engages the moulding box.

Embodiments of the present invention reduce to an acceptable degree the resilient deformation of moulding boxes during compaction, without the need for special reinforcing measures on the moulding boxes and therewith without an increase in weight of the moulding boxes.

In a preferred embodiment of the present invention, the presser means are mounted in such a way as to be stationary relative to the moulding table, and therefore to the moulding box, during compaction.

The abutment members may be interconnected by a closed frame.

An especially advantageous embodiment of the invention consists in that the movable part of each of the presser means comprises a pin or bolt provided with actuating means for moving it into engagement with the moulding box. The actuating means may comprise a wedge element which is slidable in the respective abutment member in a direction perpendicular to the direction of movement of the pin.

A return spring is advantageously provided for moving the pin out of engagement with the moulding box. The wedge element may be actuable by a pneumatic or hydraulic cylinder and piston unit, preferably operating in the vertical direction.

Preferably, each wedge element is connected to the piston of the respective cylinder and piston unit by a lost motion connection, for example by making the height of the wedge element smaller than the distance between abutments on the piston rod for driving the wedge element. The abutment members may be rigidly connected to the moulding table, and they may comprise columns fast both with the moulding table and also with the press or cross-piece.

For a better understanding of the present invention, and to show how the same may be carried into effect, reference will now be made to the accompanying drawings, in which:

Figure 1 shows a first embodiment of a machine for producing mould parts as seen in the direction of the arrow I in Figure 2,

Figure 2 is a plan view of the machine of Figure 1,

Figure 3 is a sectional view taken along the line III–III of Figure 2,

Figure 3*a* shows a detail of Figure 3, drawn to a larger scale.

Figure 4 shows a sectional view taken along the line IV–IV of Figure 5,

Figure 5 is a sectional view taken along the line V–V of Figure 3,

Figure 6 shows a second embodiment of a machine for producing mould parts as seen in the direction of the arrow VI in Figure 7,

Figure 7 is a plan view of the machine of Figure 6,

Figure 8 shows a third embodiment of a machine for producing mould parts as seen in the direction of arrow VIII in Figure 9,

Figure 9 is a plan view of the machine of Figure 8,

Figure 10 shows a fourth embodiment of a machine for producing mould parts, partly sectioned along the line X–X of Figure 11, in a first operative condition,

Figure 11 is a plan view of the machine of Figure 10 partly sectioned along the line XI–XI of Figure 10,

Figure 12 is a sectional view taken along the line X–X of Figure 11, with the machine in a second operative condition,

Figure 13 is a partly sectional plan view of the machine in the second operative condition,

Figure 14 is a vertical sectional view taken along the line X–X of Figure 11, with the machine in a third operative condition,

Figure 15 is a partly sectioned plan view of the machine in the third operative condition,

Figure 16 is a longitudinal section of a modified form of the part illustrated in Figure 3, in one operative condition, and

Figure 17 shows the same part as Figure 16 in another operative condition.

The machine shown in Figures 1 and 2 has a moulding table 1, a compaction press 2, and two columns 3 and 4 which are rigidly interconnected and constitute a closed frame. A pattern device 7 on the moulding table 1 carries a moulding box 5 which is filled with mould-forming material such as moulding sand, and which has thereon a filling frame 8. The moulding table 1 is supported on a vibrating or jolting device 9 of known design. The press 2 has a press cylinder 12 in which is guided a press piston 11 carrying a press plate 10.

The machine shown in Figures 1 and 2 is adapted to execute a compacting process by simultaneous free-fall jolting and pressing according to German Auslegescrift No. 24 52 984.

The machine has presser means 13 and 14 for engaging the moulding box 5. The presser means 13 comprises a pin 35 with locking means 65 and a pin 36 with locking means 66, while the presser means 14 comprises a pin 29 with locking means 63 and a pin 29*a* with locking means 64.

The presser means 14 are shown in detail in Figures 3 to 5. On the post or column 4 is fixed an abutment member 15 which serves as a support for a cylinder 19 in which is slidably mounted a piston or plunger 20 having a piston rod 21. A wedge element 22 is mounted on the piston rod 21 between two abutments 23 and 24. The spacing between the abutments 23 and 24 exceeds the height 25 of the wedge element 22, to afford a lost motion connection so that on actuating the piston rod 21 the latter displaces the wedge element 22 only after travelling through a pre-determined distance. The wedge element 22 is adapted to be displaced vertically from position 26 back into position 27 and is pressed by a helical return spring 28, acting through the pin 29, against a sliding face 30 of the abutment member 15. Instead of the helical return spring 28 it is also possible to employ a leaf spring or other resilient means to act on the pin 29. The position 26 of the wedge element 22 corresponds to the position 31 of the pin 29 and the position 27 of the wedge element 22 to the position 32 of the pin 29. The pin 29 has an end portion 92 which is adapted to be pressed against the face of the moulding box 5.

Reference numerals 19 to 32 and 92 relate to the pin 29 and the actuating means 63 disposed at a lower level whereas reference numerals 19*a* to 32*a* and 92*a* relate to the pin 29*a* and the actuating means 64 disposed at the upper level. Since both actuating means 63 and 64 operate in a

similar manner, only the lower actuating means 63 is described.

The operation of the machine shown in Figures 1 to 5 is as follows:

After placing on the moulding table 1 the pattern device 7 with the moulding box 5 filled with moulding sand and supporting the filling frame 8, the locking means 63, 64 and 65, 66 are operated. The pressure chamber 93 (see Figures 3 to 5) of the pneumatic or hydraulic cylinder 19 is supplied with fluid under pressure, thereby displacing the piston 20, the piston rod 21 and, by means of the abutment 24, the wedge element 22 in the direction of arrow 94, until the pin 29 reaches the position 31 and the portion 92 engages the moulding box 5 without, however, resiliently deforming the latter for example, by using a pressure which is sufficient only to cause compression of the spring 28. At the same time, the pressure chamber 97 of the pneumatic or hydraulic cylinder 19*a* is supplied with fluid under pressure to displace the piston 20*a* with the piston rod 21*a* and, by means of the abutment 24*a* the wedge element 22*a* in the direction of arrow 98, until the pin 29*a* reaches the position 31*a* in which it bears against the moulding box 5 without resiliently deforming the latter. The locking means 65, 66 are actuated at the same time as the locking means 63, 64 and in the same manner.

The angle 69 (see Figure 3*a*) between a plane 33 parallel to the slide face 30 and the plane of the inclined face 99 of the wedge element 22, or the corresponding angle for the inclined face 100 of the wedge element 22*a* so selected that the friction occurring between the faces 99 and 100 and the respective pins 29 and 29*a* prevents sliding-back of the wedge element 22 in the direction opposite to that of the arrow 94 and sliding-back of the wedge element 22*a* in the direction opposite to that of the arrow 98. The angles 67 and 68 are selected to be larger, in order that the control paths of the wedge elements 22 or 22*a* are not excessively long.

Once all the pins 29, 29*a*, 35, 36 engage the moulding box 5, the press 2 is put into operation and presses, via the press piston 11 and the press plate 10, the moulding sand disposed in the moulding box 5 and the filling frame 8. Thereupon, the jolting device 9 raises the moulding table 1 and all the components connected to it and allows it to fall freely several times onto a jolting cylinder 95, while the press 2 remains in operation. Experiment has shown that the maximum compaction of the moulding sand takes place on impingement of the moulding table 1 on the jolting cylinder 95, due to the inertia forces produced both in the moulding sand and in the press plate as well as to the pressing action of the press 2. Since, on impingement of the moulding table 1 on the jolting cylinder 95, there are set up also in the wedge elements 22, 22*a*, in the piston rods 21, 21*a* and in the pistons 20, 20*a* inertia forces which tend to press the support pins 29, 29*a* increasingly firmly against the moulding box 5, and an identical effect is also produced in the actuating means 65, 66, the positions of the actuating means 63 to 66 remain unchanged during maximum compaction of the moulding sand. Since the posts 3, 4 are designed to be so rigid that the forces acting on them during compaction of the moulding sand practically speaking produce no deformation and the pins 29, 29*a*, 35, 36 are subjected exclusively to compression stressing, no resilient deformation is possible at the supported locations of the moulding box 5 during compaction. After compaction has been completed, the press 2 is operated in reverse, the press piston 11 raises the press plate 10 and the cylinders 19, 19*a* of the locking means 63, 64 and also the cylinders of the locking means 65, 66 are also operated in reverse and raise the wedge elements 22, 22*a* and the wedge elements of the locking means 65, 66, whereupon (in a manner which has already been described) the support pins 29, 29*a*, 35, 36 are withdrawn.

Whereas Figures 1 and 2 show the application of the present invention to a machine for producing "high" mould parts having small moulding faces, the embodiment according to Figures 6 and 7 is an application of the present invention to a machine for producing relatively low mould parts having larger moulding faces. Figures 6 and 7 show columns 47, 48 rigidly fixed to a moulding table 46 and a press 49 to constitute a closed frame. Presser means 40, 41 bear at abutment members afforded by the columns 47, 48. Further columns 50, 51, which are rigidly fixed to the moulding table 46 and a second press 52, also afford abutments on which bear further presser means 44, 45. Further columns 53, 54, also rigidly fixed to the moulding table 46 are interconnected at their top ends by a crosspiece 55 to constitute a closed frame, and afford abutments on which bear further presser means 42, 43. On the moulding table 46 rests a pattern device 56, which supports a moulding box 57 filled with moulding sand, and a filling frame 58. Associated with the press 49 is a press plate 59 and with the press 52 a press plate 60. The moulding table 46 is supported on a jolting device 61.

The mode of operation of the machine shown in Figures 6 and 7 corresponds to that of the machine of Figures 1 to 5 and is therefore not once again described.

Figures 8 and 9 show a further embodiment in accordance with the present invention. This embodiment comprises a machine for compacting the mould parts by pressing only. A moulding table 71 is supoprted on a foundation 72 by four posts 70. The moulding table 71 carries, on two posts 73 and 74, a cross-piece 75 supporting a press 76. An element of the moulding table 71 is designed as a bowed member or bracket 77 having on one side presser means 78 which has a pin 79 and on the other side presser means 80 which has a pin 81. A further element of the moulding table 71 is also designed as a bowed member 82 and has on one side presser means 83 having a pin 84 and on the other side presser means 85 having a pin 86. The press 76 is connected via a press piston 87 with a press plate 88. On the moulding table 71 rests a pattern device 89. Supported on the latter is a moulding box 90 filled with moulding sand and on the moulding box rests filling frame 91.

The machine shown in Figures 8 and 9 operates in the following manner:

After a transport device (not shown) has placed the pattern device 89, the moulding box 90 filled with moulding sand and the filling frame 91 on the moulding table 71, the presser means 78, 80, 83, 85 are actuated on the manner already described with reference to Figures 1 to 5. The pins 79, 81, 84, 86 are put into engagement with the moulding box 90 and, at the supported locations of the moulding box 90, prevent (in the manner already described) resilient deformation of the moulding box 90 during compaction of the mould parts. Compaction of the mould parts is effected by pressing only, the press 76 being put into operation and thereby, via the press piston 87, pressing the press plate 88 thereon, for compacting the moulding sand. After compaction has been effected, the press plate 88 is (in the manner already described with reference to Figures 1 and 2) raised and, due to actuation of the presser means 78, 80, 83, 85, the pins 79, 81, 84, 86 are withdrawn.

The presser means described hereinabove, which supports the moulding box of the mould parts on a machine element which does not vary its position relative to the moulding box during compaction, can be used on known moulding machines producing mould parts by compaction.

The machine shown in Figures 10 to 15 comprise a support 101 having a lower support element 102 and a projecting upper support element 103. Mounted on the lower support 102 is a compaction cylinder 104 the compaction piston 105 of which is hydraulically or pneumatically actuable. The upper end of the compaction piston 105 is rigidly connected to a moulding table 106 on which a pattern plate 108 equipped with patterns 107 is releasably secured. Adapted to be applied on the pattern plate 108 is a moulding box 110 formed with dowel bores 109, 109*a* and which is retained accurately in position by centreing means on the moulding table 106. Depending on the compacting method employed, it is also possible to provide for the moulding box 110 a known holding-down (press pad) arrangement.

Provided coaxially with the compaction cylinder 104, above the moulding table 106, is a pres plate 111 shaped to fit into the free internal cross-section of the moulding box 110 and connected to be raised and lowered by means of a hydraulically or pneumatically actuable cylinder and piston unit comprising a piston 112 and a feed cylinder 113. The feed cylinder 113 is releasably inserted into receiving means 114 arranged in the upper support element 103. For introducing a moulding substance (for example moulding sand 121), a filling frame 122 adapted to be located on the moulding box 110 is provided. The compaction cylinder 104, the compaction piston 105, the moulding table 106, the pattern plate 108, the press plate 111 and the feed cylinder 113 having the piston 112 form, together, a pre-compacting unit.

Arranged on each side of the feed cylinder 113, on the upper support element 103, are supports 115, 115*a* provided for receiving the cylinders 116 of hydraulically or pneumatically actuable lifting jacks 117. Extending from the cylinders 116 are piston rods 118 connected at their lower ends, via articulation elements 119, with a closed frame 120. By means of the lifting jacks 117, the frame 120 can be raised and lowered and is supported in an articulated manner by the articulation elements 119. There are four lifting jacks 117 in the present embodiment but, depending on the shape of the moulding box, fewer or more than four lifting jacks 117 may be provided for the vertical movement of the frame 120.

The articulation element 119 is a combination of a cup-shaped member 123 connected with the piston rod 118 and a retaining ring 124 co-operating with the member 123, in combination with a spring 126 housed partially within the member 123 and guided on a pin 125. The member 123 has an outwardly projecting rim adapted to engage a collar formed on the retaining ring 124 and projecting radially inwardly. The retaining ring 124 and the pin 125 are fixed to the frame 120. The spring 126 (for example a compression spring) bears at one end on the member 123 and at the other end on the frame 120.

The closed frame 120 is designed to ex-

tend around the moulding box 110 by both positive and force-locking engagement, and it has actuating means 127 arranged around the sides of the generally rectangular frame 120 which afford abutment members. The actuating means 127 are constituted by hydraulically or pneumatically actuable cylinder and piston units comprising cylinders 127*a* and pistons having piston rods 128 which are movable towards and away from the moulding box wall. By means of lines (not shown) conveying a pressure medium, the cylinders 127*a* and the lifting jacks 117 are connected with a central control installation from which the compaction cylinder 104 and the feed cylinder 113 are also controlled.

The end projecting out of the cylinder 127*a*, of each pressure piston 128 is connected in an articulated manner with a presser plate 129 adapted to be applied at the mould box 110. The presser plate 129 is designed for transmitting and taking up forces to and from the moulding box wall. Each presser plate 129 and the respective actuating means 127 constitute presser means.

Instead of the fluid actuable presser means 127*a*, 128, 129, it is also possible to provide such means in the form of a mechanically actuable device or a combination of the two. Similarly, instead of the machine shown, the present invention can be applied to an automatic mould-forming machine having one or more moulding stations.

The mode of operation of the machine shown in Figures 10 to 15 is as follows:

At commencement of manufacture of a casting or ingot mould part (Figures 10 and 11) the compaction piston 105 of the compacting cylinder 104 is relieved of pressure, under the control of the control device during controlled development of the process, and the press plate 111 is, via the piston 112 of the feed cylinder 113, brought into position over the filling frame 122. The frame 120 is lifted above the mould 110 by means of the lifting jacks 117. The presser plates 129 of the actuating means 127 are relieved of pressure and abut, in their rear position, on the frame 120. In this condition of the machine, the moulding box 110 is accurately positioned on the pattern plate 108 and the filling frame 122 is set down on the moulding box 110. Subsequently, the moulding box 110 is filled with a dosed quantity of moulding sand 121.

The next step in the mould forming operation (shown in Figures 12 and 13) is the compaction of the ingot mould part, the frame 120 surrounding the moulding box 110 and being meanwhile lowered on to the moulding table 106. In this position, the frame 120 is displaceably retained by the articulation elements 119, and bears on the moulding table 106. Then a pressure medium (for example oil) is fed (with timed control) to the pressure cylinders 127*a* and therewith the presser plates 129 engage the moulding box 110. Since the moulding box 110 is relatively rigidly fixed in position on the moulding table 106, the frame 120 centres itself by means of the presser plates 129 on the moulding box 110, whereby the actuating elements 127 which have been put under pressure are able to act on the moulding box walls together.

Next, a pressure medium (for example pressure oil) is fed to the feed cylinder 113 and thereby the press plate 111 is lowered on to the moulding sand, for pre-compacting the moulding sand 121. For final compaction of the casting mould part, a pressure medium (for example pressure oil) is then fed to the compaction cylinder 104. Due to the force exerted by the mould compacting unit on the moulding sand 121, transverse forces relative to the moulding box wall are set up in the moulding sand. These transverse forces are resisted by the presser means.

When the casting mould is finally compacted and ready for transport to a further station for further processing of the mould, the press plate 111 and also the filling frame 122 are lifted above the moulding box 110 and the frame 120 is, when the presser plates 129 have been retracted to the starting positions, also lifted above the moulding box 110 (see Figures 14 and 15). Similarly, the compaction cylinder 104 is relieved of pressure and the moulding table 106 is, after removal of the finished casting mould part, prepared for receiving a further moulding box, thereby returning the machine to the condition shown in Figures 10 and 11.

Figures 16 and 17 show (in a detail of the machine shown in Figures 10 to 15) the frame 120 embracing a moulding box 110 and in which is provided an actuating means 127*b* for applying a presser element 129*a* to the moulding box 110. The arrangement of the actuating means 127*b* is so selected that the direction of operation thereof is perpendicular to the walls of the moulding box. The actuating element 127*b* is releasably retained in a sleeve 140 fast with the frame 120.

The actuating means 127*b* comprises a pressure housing 141 in one portion of which there is formed a centrally arranged cylindrical bore 142 opening into a larger bore 143 in the other portion directed towards the moulding box 110.

Inserted into the larger bore 143 is a pin 144 the end of which, directed towards the bore 142, is provided with a collar 145 of greater cross-section than the pin 144. The other end of the pin 144 carries the presser

element 129*a* and is so designed that the presser element 129*a* can be connected releasably and pivotably to the pin 144.

Sealing of the larger bore 143 is afforded by a flange 146 which is releasably connected to the pressure housing 141. Arranged centrally in the flange 146 is a guiding aperture 147 for the stem or shank of the pin 144.

A compression return spring bears at one end on the collar 145 of the pin 144 and at the other end on the flange 146. The spring 148 is preferably pre-stressed so that the pin 144 is always urged towards a predetermined rear position.

Inserted into the bore 142 is a piston 149 which abuts the pin 144 to drive the latter.

The end of the pressure housing 141 remote from the flange 146 is provided with locking means 150 which may be designed, as in this embodiment, as pneumatically or hydraulically actuable control valves. Alternatively, the locking means 150 may be a mechanically or electrically operated means or means operating in combination therewith.

Provided at right-angles to the axis of symmetry of the pressure housing 141, in the control valve provided as locking means 150, is a contniuous control bore 151 each of the ends of which are sealed by fluid-tight plugs 152, 153. Provided in the control bore 151 is a displaceable control piston 154. For actuating the control piston 154, there extends through each of the plugs 152, 153 in the control bore 151, at both ends of the control piston 154, a control line 155, 156 connected via known control means with a central control device.

To actuate the piston 149 by a pressure fluid (for example hydraulic oil), the control bore 151 is connected on the one hand via a pressure medium line 157 with a hydraulic unit constituting a pressure source and, on the other hand, via an aperture 158 with the bore 142.

The mode of operation of the arrangement described in Figures 16 and 17 is as follows:

The frame 120 (as described with reference to Figures 10 to 15) is brought into position over the moulding box 110. In this position (as shown in Figure 16) the pressure medium line 157 is controlled for return travel of the pressure medium and the support pin 144 and presser element 129*a* connected with the pin 144 are displaced, under the action of the compression spring 148, into the rear position thereof. The control piston 154 is set in the through-flow position to allow the pressure medium to flow back through the pressure medium line 157.

If a pulse or impulse is supplied from the central control device to the control means of the pressure medium feed, then, due to the supplied pressure medium the piston 149 is acted upon and the presser element 129*a* connected with the support pin 144 is moved in the direction towards the moulding box walls. As soon as the presser element 129*a* bears against the moulding box walls, a pulse or impulse is supplied from a pressure-dependent control means (for example a pressure monitoring means) to the control means of the control line 155, whereby the control piston 154 is displaced into the position shown in Figure 17. In this position, the pressure medium feed and, similarly, the pressure medium flow-back is blocked, and so the presser element 129*a* is locked in position abutting the mould box. To release the mould box 110, a pulse is applied to the control means of the pressure medium feed and also to the control means for the control line 156, whereby the control piston 154 is moved to the left and (under the influence of the compression spring 148) the presser plate 129*a* can be moved away from the moulding box 110 and displaced into the rearward position.

The advantages achievable with the device just described consist in particular in that, due to the energy supplied from the pressing procedure to the mould-forming material, full use can be made also in the edge regions of the moulding box for compacting the mould-forming material, whereby uniform compacting is made possible and dislocation-free mould parts are obtained.

The advantages achievable with embodiments in accordance with the present invention consist in particular in that, whilst guaranteeing a high degree of rigidity during compaction, it becomes posible to employ light, inexpensive moulding boxes which, additionally, require simple transport devices. Due to the utilization of adjustable presser means, it is also possible to employ moulding boxes the external dimensions of which may vary within wide limits. Furthermore, the energy supplied from the pressing operation to the mould-forming material can be employed fully also in the edge regions of the moulding box for compacting the mould-forming material, thereby making uniform compacting achievable and making it posible to obtain dislocation-free moulds. A further advantage consists in that mould part rupture can be avoided.

WHAT I CLAIM IS:—

1. A machine for producing casting mould parts, comprising a moulding table for supporting a moulding box, a compaction press for compacting mould-forming material in the moulding box and at least one pair of mutually oppositely acting presser means arranged to engage respectively opposite sides of moulding box when

suported on the moulding table and to react against respective abutment members, the two abutment members for the or each pair of presser means being rigidly interconnected with each other, each presser means having a part which is movable in a plane parallel to the plane of the surface of the moulding table inwardly and outwardly relatively to the respective abutment member for engagement with and disengagement from a moulding box when supported on the moulding table, locking means being provided for locking the presser means positively against movement away from a moulding box supported on the moulding table when the presser means engages the moulding box.

2. A machine as claimed in claim 1, in which the locking means comprises pneumatically or hydraulically operated control valves.

3. A machine as claimed in claim 1, in which the locking means comprises mechanical and/or electrical locking devices.

4. A machine as claimed in any one of the preceding claims, in which the abutment members are rigidly connected to the moulding table.

5. A machine as claimed in claim 4, in which the two abutment members of the, or at least one of the, pairs of presser means comprise columns which are secured to the moulding table.

6. A machine as claimed in claim 5, in which the moulding table and the columns afford parts of a closed frame.

7. A machine as claimed in claim 5 or 6, in which the columns connect the moulding table to the press.

8. A machine as claimed in any one of claims 5 to 7, in which the columns are interconnected at their upper ends by a cross member and at their lower ends by the moulding table.

9. A machine as claimed in any one of claims 1 to 3, in which the abutment members comprise parts of the moulding table.

10. A machine as claimed in any one of the preceding claims, in which the movable part of each presser means comprises a pin and in which the locking means of each presser means comprises a wedge element which is displaceable on the respective abutment member in a direction perpendicular to the direction of movement of the respective pin.

11. A machine as claimed in claim 10, in which each wedge element is displaceable in the vertical direction.

12. A machine as claimed in claim 10 or 11, in which each wedge element is connected for displacement to a respective fluid-operable cylinder and piston unit.

13. A machine as claimed in claim 12, in which each wedge element is connected to the piston of the respective cylinder and piston unit by a lost motion connection.

14. A machine as claimed in any one of claims 10 to 13, in which each pin is provided with a return spring arranged to bias the pin out of engagement with the moulding box.

15. A machine as claimed in any one of the preceding claims, in which vibrating or jolting means are provided for enhancing the compaction of the mould-forming material.

16. A machine for producing casting mould parts, substantially as specifically described herein with reference to Figures 1 to 5, or to Figures 6 and 7, or to Figures 8 and 9 of the accompanying drawings.

17. A machine for producing casting mould parts, substantially as specifically described herein with reference to Figures 10 to 15 of the accompanying drawings.

18. A machine for producing casting moulding parts, substantially as specifically described herein with reference to Figures 16 and 17 of the accompanying drawings.

19. A casting mould part when produced using a machine in acordance with any one of the preceding claims.

HASELTINE, LAKE & CO.,
Chartered Patent Agents,
28 Southampton Buildings,
Chancery Lane,
London WC2A 1AT,
and
Temple Gate House,
Temple Gate,
Bristol BS1 6PT,
and
9 Park Square,
Leeds LS1 2LH.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1980.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

1559888 COMPLETE SPECIFICATION
9 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig.1

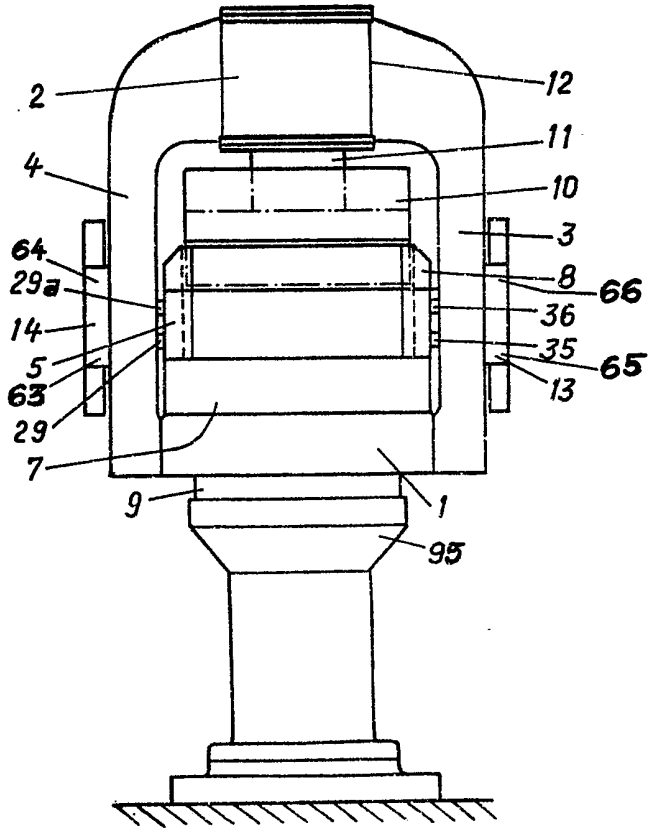


Fig. 2

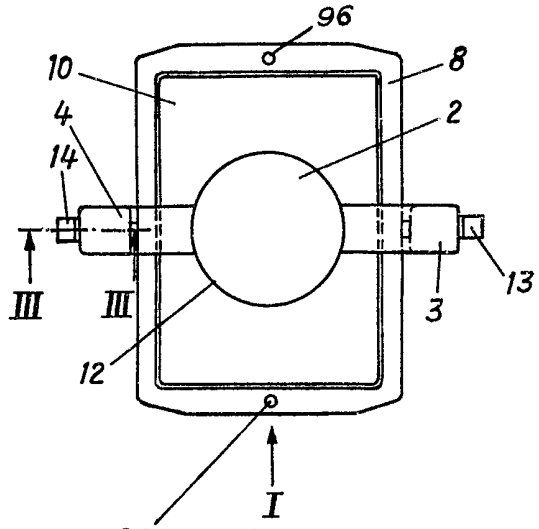

96
10
8
4
2
14
III
III
13
3
12
96
I

Fig. 7

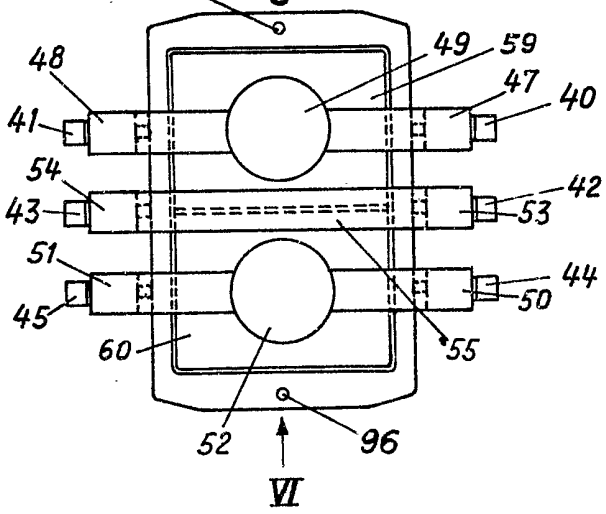

96
48
49
59
47
40
41
54
42
43
53
51
44
45
50
60
55
52
96
VI

Fig.3

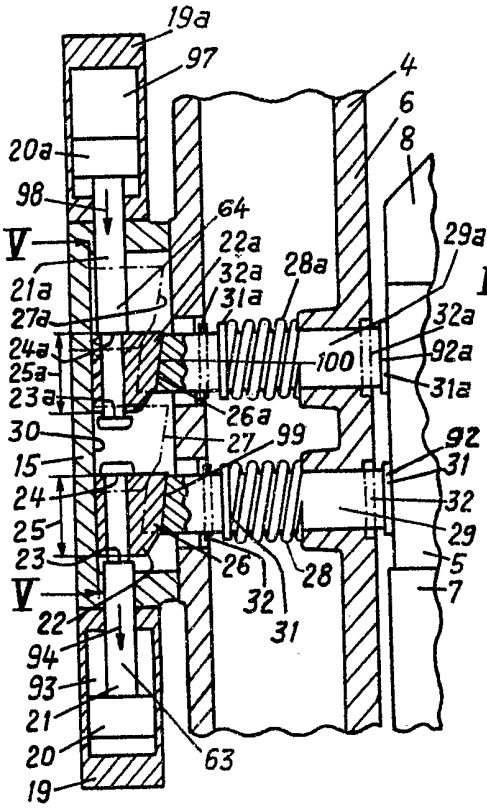


Fig.5

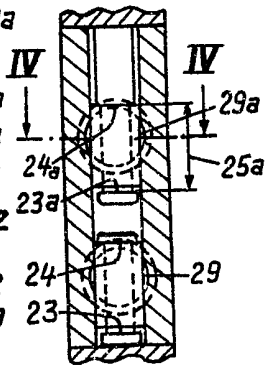


Fig.4

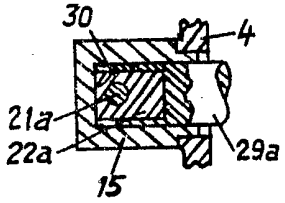


Fig.3a

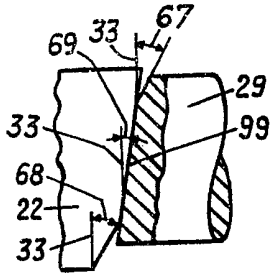


Fig. 6

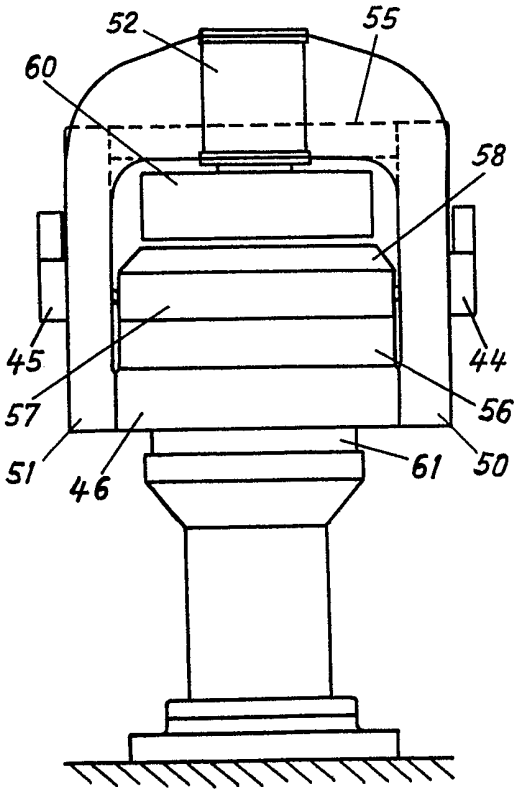


Fig. 8

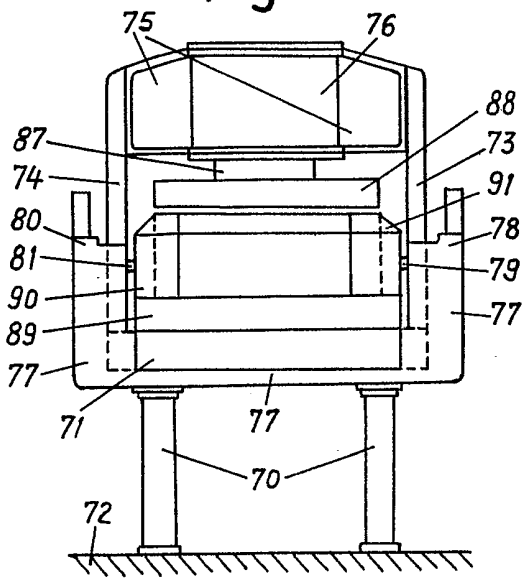

75
76
88
87
73
74
91
80
78
81
79
90
77
89
77
71
77
70
72

Fig. 9

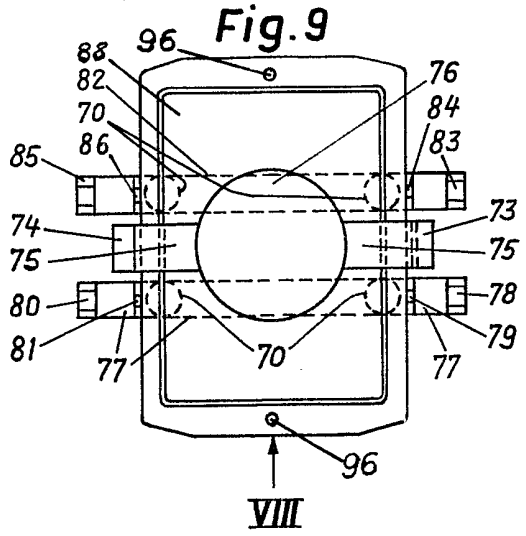

96
88
82
76
70
84
86
83
85
73
74
75
75
80
78
81
79
77
70
77
96
VIII

Fig. 10

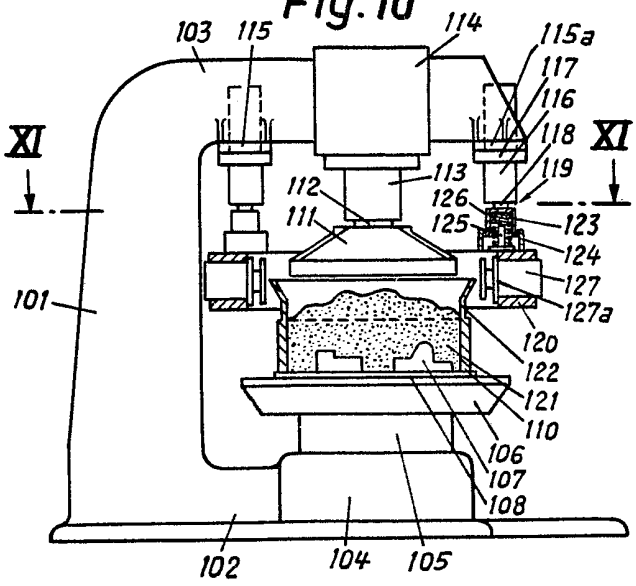

103
115
114
115a
117
116
118
119
XI
XI
112
113
126
111
125
123
124
127
127a
101
120
122
121
110
106
107
108
102
104
105

Fig. 11

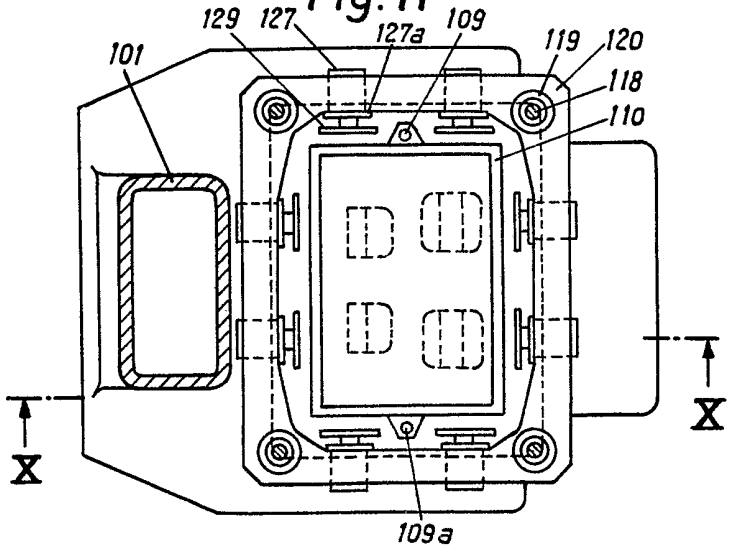

129
127
127a
109
119
120
101
118
110
X
X
109a

Fig. 12

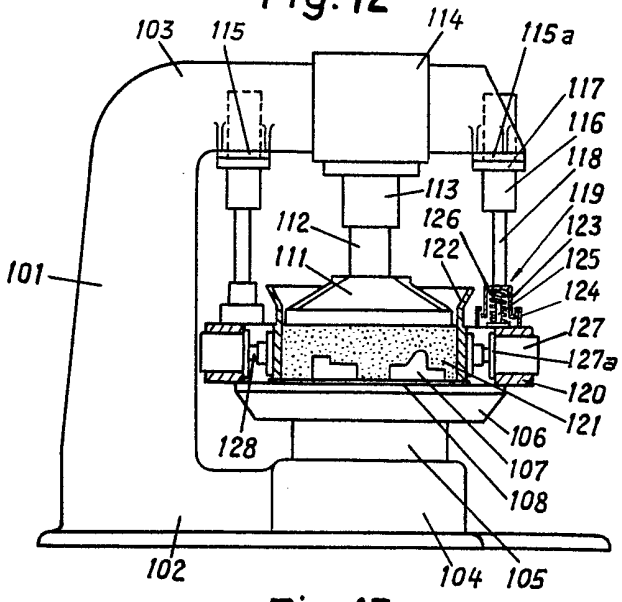

103
115
114
115a
117
116
118
119
123
125
124
127
127a
120
121
113
112
126
122
111
101
106
107
108
128
102
104
105

Fig. 13

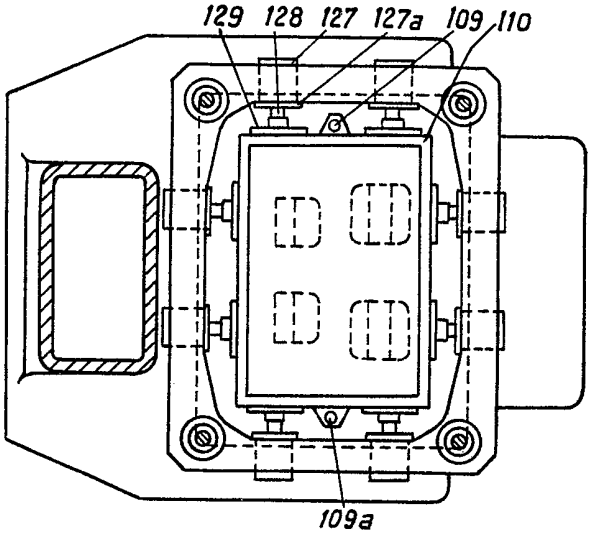

129
128
127
127a
109
110
109a

Fig. 14

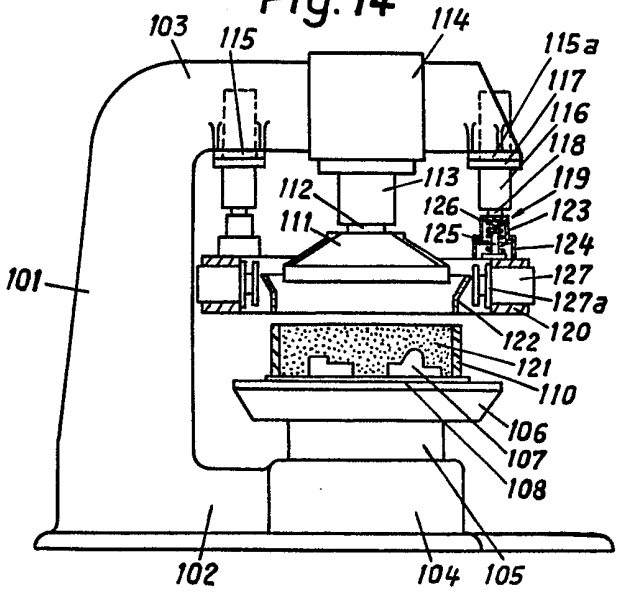

103
115
114
115a
117
116
118
119
123
124
127
127a
120
122
121
110
106
107
108
112
111
113
126
125
101
102
104
105

Fig. 15

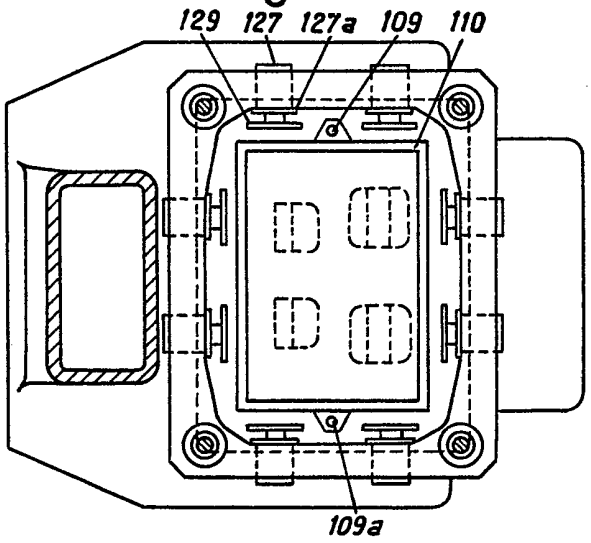

129
127
127a
109
110
109a

Fig. 16

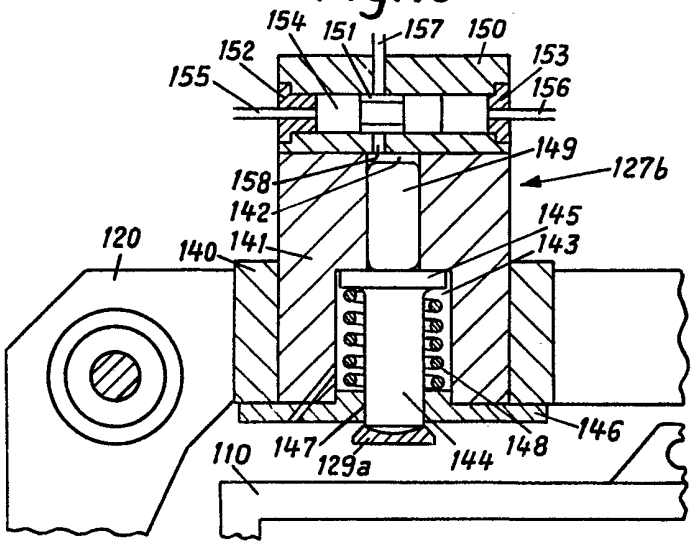
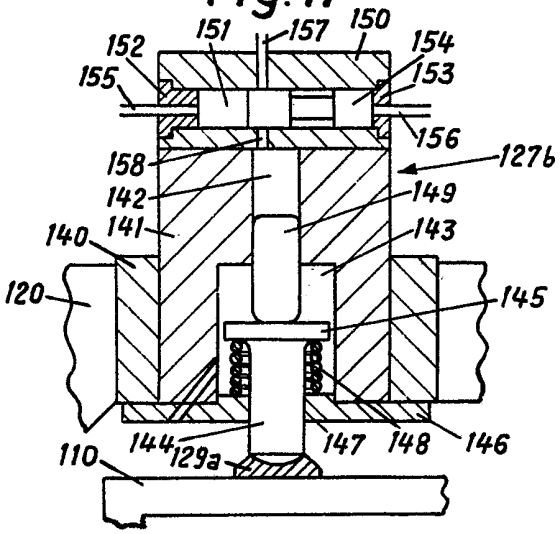

154
151
157
150
152
153
155
156
149
127b
158
142
145
120
140
141
143
146
110
147
129a
144
148

Fig. 17


151
157
150
152
154
155
153
156
158
127b
142
149
140
141
143
120
145
144
129a
147
148
146
110