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(54) MOULDING METHOD, EQUIPMENT FOR IMPLEMENTING SAID METHOD AND MOULD OBTAINED BY MEANS OF SAID METHOD

(57) The present invention relates to a molding method, equipment for carrying out said method and mold obtained by means of said method. The method comprises obtaining at least two semi-molds (23, 24), wherein each semi-mold (23, 24) is obtained outside the axis of advance (3) by sand blowing by means of horizontal molding on a pattern plate (15, 16) which is located horizontally during said molding, said pattern plate (15, 16) defining an impression on one face of each semi-mold (23, 24). The method comprises rotating 90° and vertically facing said at least two semi-molds (23, 24) to one another by the faces incorporating the impression to define a cavity (26) which can be filled with the molten material of the part to be obtained. The molding equipment comprises at least a shooting chamber (4, 5) comprising a sand blowing chamber (20), located outside the axis of advance (3), wherein the semi-mold (23, 24) can be obtained and rotating means (27) for rotating the pattern plate (15, 16) with the semi-mold (23, 24) 90° for the vertical arrangement thereof and transferring means (6,7) for transferring the semi-mold (23, 24) to a semi-mold assembly area (8) provided in the mold axis of advance (3). The mold obtained comprises two semi-sand molds (23, 24) comprising an impression on one face, such that once facing one another by the face of the impression they comprise a casting basin (21) the volume of which is at least 15% of the volume of the cavity (26) defined by the facing impressions of both semi-molds (23, 24).

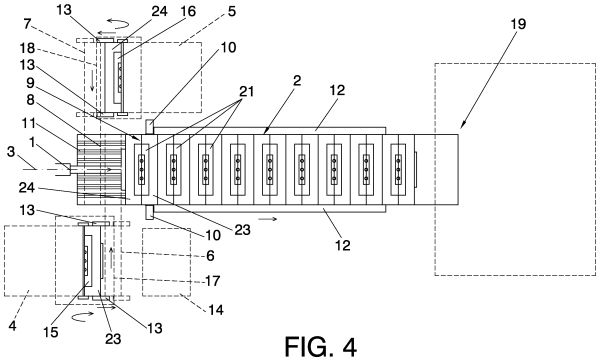

FIG. 4

EP 2 796 222 A1

Description

Technical Field of the Invention

[0001] The present invention relates to a molding method, as well as to equipment and a mold which are applicable in the casting industry, and more specifically in obtaining parts, preferably metal parts by waste mold or green sand mold shell casting obtained at high pressure and flaskless.

Background of the Invention

[0002] High pressure flaskless molding machines, so called due to the fact that the sand molds are obtained without a physical molding box, which entailed a real advancement in the casting industry and an increase in the productivity ratios appeared during the 1960's. An example of this type of equipment is described in the European patent no. EP-0817690-B1. From then on, these ratios have been improving slowly and, today, these ratios are generally about 9 hours per ton, per operator, in highly automated castings. One of the restraints which prevents further improvement is, on one hand, the limitations imposed by the casting systems and, on another, the use of a single molding and casting axis.

[0003] Molding sand consists of a mixture of silica sand, bentonite and coal which, after the corresponding mixing and wetting thereof in a mill or mixer, is transferred to a hopper located in the upper portion of a shooting chamber of the high pressure molding machine, also known as molding chamber. The sand is introduced into a molding chamber by vertical blowing with high pressure air. The molding chamber is closed at one end by a pattern plate and at the opposite end by a counter plate defining the impression and the counter-impression which will subsequently define the shape of the part obtained in said mold. The pattern plate is part of a hydraulic cylinder (closing piston) compressing the sand once it is blown into the molding chamber for compacting the mold obtained, also known as shell. Once the compaction ends, the counter plate, which during the previous process is located vertically, swivels upwards by means of a secondary piston to allow the passage of the formed mold while the hydraulic piston pushes said formed mold out of the molding chamber and it is moved until it is placed against a previously manufactured row of molds. Thus, the impression of the last mold located in said row is facing the counter-impression of the last mold manufactured, i.e., the next and last mold reaching the row, a cavity determining the shape of the part to be obtained with the mold being defined between said impression and said counter-impression. Once the mold is placed against each other, the piston recedes to start a new molding cycle. This operation, common in vertical molding machines, is so called due to the position of the pattern plate and the counter plate during the molding process, it requires a certain time during which the mold line is stopped and it is used to cast the metal to the mold in a safe and reliable manner.

[0004] In turn, after closing the molding chamber, and coinciding with the start of the casting, i.e., when the mold leaves the molding chamber and before it is placed against the row of molds, the cores are placed in the manufactured mold by means of interpositioning, in the mold line, a core mask located in an axis lateral to the mold line. The core mask enters the axis of advance of the molds and deposits the cores in their corresponding impression while at the same time the next mold is being manufactured in the molding chamber, therefore any incidence in this operation surely affects the molding machine cycle time. Furthermore, to visually control the mold quality and core placement, the production must be stopped because this operation can only be carried out by accessing the axis of advance of the molds. To that end, the machines have security systems preventing their automatic start-up in the event that the access gates for accessing the axis of advance are open. The lack of visibility of the mold and the core placement in automatic operating mode complicates the inspection of all the molds which generates a significant portion of final rejected parts because if the defects of the mold cannot be immediately detected, the mold is directly transferred to the casting station and it produces defective parts.

[0005] Subsequently, the row of molds formed move forward pushed by the closing piston and with the aid of a conveyor system, such as, walking beams for example, to the casting station. As the molds reach the casting station, the molten metal is poured into the chamber formed by the impression and the counter-impression of two contiguous molds. When said metal solidifies, the sand making up the mold is removed and the molded part is thus obtained.

[0006] The total cycle time for producing a mold is determined by the sum of manufacturing and transferring times plus the casting misalignment time if it does not overlap with the above. Although the molding times are constant and essentially depend on the sand supply, it must be considered that other factors described below intervene at the time of casting.

[0007] It must be taken into account that the sand has a water content ranging in a wide enough range so as to affect the final width of the mold. This is due to the fact that both the weight of the sand introduced into the chamber and its compaction capacity and compression strength vary depending on the water content of the sand which in turn depends on several variable factors during the manufacturing process, such as the water fed to the mill itself or the sand temperature, since the hotter the latter the greater the loss by evaporation. In addition to the foregoing, the aggregate or bentonite content, both of which are the components of the sand are added, also changes the water need and the final compression strength of the sand, and as a result molds of variable width requiring the frequent repositioning of the casting furnace, which delays the start of the casting itself.

[0008] In the molds, the molten metal accesses the cavities through one or several feed channels ending in a pouring cup arranged on the upper face of the mold. Obviously, to perform the casting, the casting machine must be perfectly centered with the pouring cup of the mold, therefore adjusting the position of the casting furnace is necessary since the pouring cup of the molds is not always in the same position because the size of the molds is not always the same, therefore these dimensional differences add up in the row of the molds, producing misalignments in the position of the pouring cups. This results in the prolongation of said operations such that they stop the forward movement of the piston with a new mold because it is mandatory to finish the casting before moving the mold line forward.

[0009] Furthermore, another aspect to be considered is that when the parts are large, the mold must remain under the casting machine until all the metal has entered the cavity. This means that, the casting time is generally greater than the molding time which is understood as the time necessary for forming the sand molds, therefore the productivity of these installations is limited by the casting time.

[0010] As seen in the European patent no. EP-0817690-B1, the mold is a rectangular cube on the vertical faces of which the drawings of the plate and counter plate are embossed. Attaching the two molds generates a cavity, space, hole or negative mold with the shape of the part which is filled with the metal introduced through a pouring cup or sprue located on the upper face of the mold. The objective of said pouring cup is to receive the metal from the ladle or casting furnace and to regulate the metal flow through the filling channels. Its filling requires skill and precision since, given its shape, with a horizontal upper plane, it can easily overflow with the resulting risk that it entails. The over flowing of the molten metal is one of the main causes of breakdown in the molding installations since the metal is introduced into the joints of the mechanical elements which tighten and convey the molds. In contrast, if a sufficient flow is not provided and the cup is not filled during the casting time, the slags contained in the metal enter the mold and the manufactured part can become useless. Due to these reasons, the casting times tend to be prolonged in time, such that a correct filling of the mold is assured, and it is here where the interruptions of the molding process occur. The mold manufacturing speed of the high pressure machines has reached a point the limitation of which is due to casting requirements. Delays are not only caused by the filling time, rather they include the times for centering the furnace with respect to the axis of the sprue or pouring cup.

[0011] In view of the above, it is understood that if the casting furnace is not perfectly aligned with the axis of the pouring nozzle, metal will spill out and flow over the surface of the mold. If it is taken into account that a new mold cannot move forward while the casting of the previous one has not ended, as a consequence, serious bottleneck will happen at the time of increasing the productivity of the molding equipment.

[0012] There are patent documents which provide partial solutions to the problems posed. Soviet patent application no. SU-1191170-A, for example, describes a vertical molding machine having two parallel working axes. The mold is produced with a dual-shooting chamber and dual-face molds which are attached in the same manufacturing axis are obtained. Once the mold is closed, it is transferred to the casting line, where it is attached to the molds which are prepared for their forward movement by means of the pushing piston. With this arrangement the problem of time adjustment between casting and molding is partially solved but the interference for placing the cores in the production line is not improved since the faces of the mold are in a hard-to-access blind area and a core mask is required, not shown in the patent application, which surely interferes in the manufacturing and transferring axis.

[0013] European patent application no. EP-0047507-A1 presents a solution having a dual-chamber and a single axis with the same limitations and with the further drawback of having only two pressure plates for two dual-face molds. The simultaneous forward movement of the two molds prevents placing the cores in the inner mold, which seriously limits the free programming of the production since reference without core is surely required.

[0014] The United States patent application no. US-2004/0238145-A1 presents a solution of simple vertical shooting chamber with a 90° rotation of the mold once manufactured for its horizontal casting. The existence of a single shooting chamber and a single axis of production and advance conditions and limits the production speed due to the fact that the mechanism for transferring the two semi-molds acts sequentially and in the same axis of production.

Description of the Invention

[0015] A first aspect of the present invention relates to a molding method, a second aspect relates to equipment for carrying out said method and a third aspect relates to a mold obtained by means of said method.

[0016] The molding method proposed by the invention comprises obtaining sand molds by means of pressure blowing, wherein said molds move forward (in vertical position) along an axis of advance of a mold line in order to pour the molten material in a cavity defined by said molds. The cavity defines a casting orifice on an upper face of the sand mold through which the molten metal accesses the cavity.

[0017] According to the invention, the method comprises obtaining at least two semi-molds, wherein each semi-mold is obtained outside the axis of advance by sand blowing by means of horizontal molding on a pattern plate which is located horizontally during said molding, said pattern plate defining an impression on one face of each semi-mold, and in that it comprises 90° rotation and ver-

tically facing said at least two semi-molds to one another by the faces incorporating the impression, to define a cavity which can be filled with the molten material of the part to be obtained.

[0018] The present invention proposes a multiple axis molding system in which the molds are manufactured in one or two side axes with horizontal molding, with respect to the that of the forward movement and casting, allowing the manufacturing of molds with pouring vessel or upper basin to speed up the filling process, being able to thus achieve total cycle times of the order of 60% of the current times.

[0019] The possibility that during the molding process, the pattern plate defines in each semi-mold, on one side face, a semi-basin is contemplated, such that a basin is defined once said at least two semi-molds are facing one another by the faces incorporating the impression. The basin defined by the two semi-molds is located in the upper face of the mold after the 90° rotation of the semi-mold, for their vertical arrangement facing another semi-mold by the faces incorporating the impression.

[0020] According to a preferred embodiment, the volume of the basin defined by each pair of semi-molds is at least 15% of the volume of the cavity defined by said semi-molds. The pouring of the metal into the mold can thus be sped up because the basin acts as an intermediate reservoir and the molten material is cast without delaying the production.

[0021] Obtaining said at least two semi-molds in two shooting chambers located outside the axis of advance is contemplated.

[0022] It is also contemplated that the method comprises using a single piston serving exclusively for assembling and pushing the semi-molds vertically facing one another according to the axis of advance. Thus, the forward movement of the piston is independent of the blowing, whereby the cycle time is reduced. In contrast in the machines of the state of the art, the piston is responsible for both tasks, i.e., obtaining the molds and the forward movement thereof, whereby it performs both tasks alternately with the resulting delay that it entails.

[0023] Finally, it is contemplated that the method comprises obtaining at least one male semi-core, which has a flange on the face opposite the impression, and at least one female semi-mold, which has a notch on the face opposite the impression configured for receiving the flange of the semi-mold by bridle joint attachment means.

[0024] As has been mentioned with the method of the invention, sand molds can be obtained which incorporate in their upper portion a large housing or basin, i.e., with dimensions such that said basin can house at least 15% of the total of liquid metal which the cavity of the mold can contain. For obtaining these large basins in the upper portion, it is not possible to manufacture the molds by molding and vertical sand blowing, since inserts would have to be arranged on the top for obtaining the casting basins in the mold, such that said inserts would complicate the sand blowing, since it would not leave physical space for it.

[0025] To solve this problem, the method of the invention has provided that the molds are made up of two semi-molds which are obtained individually in independent machines, arranged outside the line of advance of the row of shells, and are obtained by horizontal molding by means of vertical blowing. Thus, each semi-mold has only one impression on one face and incorporates a bridle joint in the other face so that it is placed against the row of green sand molds and does not move. The two semi-molds are placed against one another facing their respective impressions to form the cavity where the molten metal is poured into.

[0026] The semi-molds are obtained by blowing in horizontal position, such that the pattern plate is arranged in horizontal, the blowing thereon and the pressing of the sand occur. Then, the assembly is rotated 90° such that the semi-mold together with the pattern plate is vertical. The mold is secured by the top surface with a retainer and the pattern plate is detached to return it to the horizontal position. By means of moving means, the semi-mold is transferred to a semi-mold assembling area which is in the line of advance of the row of molds. The same is performed with the other semi-mold until it is facing the preceding semi-mold. One of the semi-molds is secured with a retainer and by means of a closing and pushing piston one semi-mold is pushed against another to form the mold. The retainer is removed and the piston pushes the mold until it is placed against the row of molds. Then, the row of molds moves forward by means of the conventional conveying system, for example, walking beams. When the molds reach the casting station, the molten metal is poured and the row can continue to move forward whereas the molten metal contained in the basin feeds the mold. The cycle time is thus considerably reduced.

[0027] The manufacturing of the semi-molds outside the axis of advance of the casting line provides the following operation advantages:

- The mold quality can be controlled in a unitary manner and prior to its introduction in the molding line since the mold is rotated 90° once formed until it is vertical and the pattern plate is detached such that the face of the mold with the impression can be visually verified.

[0028] The placement of cores is carried out in an open space, in the face of the mold with the impression which is visible and accessible, being able to remove the core mask.

[0029] It allows a complete freedom for designing the pouring cup adapting it to the casting needs.

[0030] The fact of separating the manufacturing of the mold into two semi-molds provides significant economical advantages derived from a better exploitation of the resources used. The end quality and the productivity increase due to the fact that in conventional manufacturing

with a dual-face mold any defect in one of the faces will render a complete mold useless. The manufacturing of two open semi-molds in parallel axes allows removing only the defective semi-mold.

[0031] The manufacturing of a dual-face mold in the axis of advance complicates the mold quality control during the machine cycle, therefore a defective mold can enter the molding line and is cast. With the solution proposed by the invention, all the semi-molds can be systematically verified in the machine cycle. All the molds entering the axis of advance are suitable to be cast.

[0032] It allows manufacturing molds which are up to 50% narrower than the current molds, leading to a better mold quality since the latter is denser and providing a greater dimensional stability. The duplication of the attachment joints confers a greater permeability to the mold, which facilitates the exit of gases during the casting. The placement of cores is performed in an area that can easily be visually controlled.

[0033] Molds in which the actual sprue or pouring cup is replaced with a basin with a discretional metal capacity can be manufactured. This facilitates the casting, reduces the filling time, prevents the overflowing of metal and increases the inoculation yield by 80% because the inoculant powder does not leave the basin since it is larger than the actual pouring cup in which portion of the inoculant powders tend to stay on the surface of the mold without penetrating the cavity and are wasted due to the small pouring cup section. The metal deposited in the basin fills the mold by gravity during its forward movement.

[0034] The forward movement of the molds is independent of the rest of the operations and it is not interfered with at any time of the cycle. The machine cycle time is reduced to the manufacturing time of a semi-mold and its transfer to the assembly area of the molding line.

[0035] The problems of demolding by the absence of uncast molds (in this case all the molds are cast) are eliminated and a greater temperature and moisture homogeneity is obtained in the return sand, resulting in a better quality in the molding sand.

[0036] The bridle joint shape of the closing faces of the semi-molds assures their correct alignment and they prevent any movement during the operation of transferring and closing the molds.

[0037] A second aspect of the invention in turn relates to equipment for carrying out the aforementioned method, i.e., a molding equipment for obtaining sand molds by means of pressure blowing, comprising an axis of advance of a mold line where molten material can be poured into a cavity defined by said molds.

[0038] According to the invention, the equipment comprises at least a shooting chamber, comprising a sand blowing chamber, located outside the axis of advance, in which a semi-mold can be obtained by means of horizontal molding, wherein said at least one shooting chamber comprises a pattern plate which is located horizontally during said molding, said pattern plate defining an impression on one face of the semi-mold. The equipment comprises rotating means for rotating the pattern plate with the semi-mold 90° for the vertical arrangement thereof and transferring means for transferring the semi-mold to a semi-mold assembly area provided in the mold axis of advance, such that the semi-molds are facing one another by the faces incorporating the impression, defining a cavity which can be filled with the molten material of the part to be obtained.

[0039] It is contemplated that during the molding process, the pattern plate defines in each semi-mold, on one side face, a semi-basin, such that once the two semi-molds are facing one another by the faces incorporating the impression, a basin is defined in the upper face. According to a preferred embodiment, the volume of the basin defined by a pair of semi-molds is at least 15% of the volume of the cavity defined by said semi-molds.

[0040] It is contemplated that the equipment comprises at least two shooting chambers, located outside the axis of advance, in which at least two semi-molds can be obtained. According to a preferred embodiment, the equipment comprises a single closing and pushing piston serving exclusively for closing the semi-molds vertically facing one another (one against another) according to the axis of advance of the row of molds to form the mold and then push the formed mold until it is placed against the row of molds. The row of molds then moves forward by means of the conventional conveying systems, for example, walking beams to the casting station.

[0041] A third aspect relates to a mold comprising two semi-molds of sand comprising an impression on one face, such that once facing one another by the face of the impression they comprise a casting basin the volume of which is at least 15% of the volume of the cavity defined by the facing impressions of both semi-molds.

[0042] According to a preferred embodiment, the mold comprises a male semi-mold, which has a flange on the face opposite the impression, and a female semi-mold, which has a notch on the face opposite the impression configured for receiving the flange of the male semi-mold by bridle joint attachment means.

[0043] According to a preferred embodiment, the equipment comprises two shooting chambers lateral and parallel to the axis of advance of the molds. Each chamber produces a semi-mold in one of which faces the impression of the part is embossed, whereas in the other a bridle joint shape is made to facilitate the subsequent assembly of both semi-molds to the row of molds. Once manufactured, each semi-mold is moved to the casting line where it is assembled with its other semi and to the preceding mold, being ready for the movement thereof to the casting area. Since each semi-mold must cross an open area in its path from the mold chamber to the casting line, the same is used to place the cores in an area which can be visually controlled accessible by the operator, in a manner similar to that currently used for the core mask, the latter being therefore replaced by the semi-mold itself. The manufacturing sequence of a mold by means of the

proposed crossing system is described below.

Description of the Drawings

[0044] To complement the description that is being made and for the purpose of aiding to better understand the features of the invention according to a preferred practical embodiment thereof, a set of drawings is attached as an integral part of said description in which the following has been depicted with an illustrative and non-limiting character:

Figure 1 shows a schematic perspective view of two semi-molds attached for obtaining a part.

Figure 2 shows a schematic view of the equipment of the invention during the obtaining of a male semi-mold, and its subsequent swivelling.

Figure 3 shows an elevational view of a semi-mold, the cavity in which the part is obtained and the basin located at the top can be seen.

Figure 4 shows a schematic plan view of a preferred embodiment of the molding equipment of the invention.

Figure 5 shows a longitudinal cross section of a semi-mold line located in the casting line, two pairs of semi-molds attached to one another for obtaining two parts being depicted.

Preferred Embodiment of the Invention

[0045] In view of the described drawings, it can be observed how in one of the possible embodiments of the invention the molding equipment proposed by the invention comprises the following elements: closing and pushing piston (1), located at the beginning of the mold line and centered in its own axis (3); shooting chamber (4) of a first pattern plate (15); shooting chamber (5) of a second pattern plate (16); rotating means (27) of the pattern plates (15,16) with the semi-mold (23,24), transferring means (6) of the first pattern plate (15); transferring means (7) of the second pattern plate (16); semi-mold assembly area (8); mold assembly area (9); sliding or walking beams (11); advancing clamping bars (12) and securing retainers for demolding (13). The manufacturing of the semi-molds starts with the filling of the shooting chambers (20) of the first pattern plate (15) and of the second pattern plate (16) by blowing with high pressure sand. Once the semi-molds are compacted, they are positioned in their respective demolding bases (17, 18) by means of rotating means (27) causing the movement by a 90° rotation of the pattern plates (15, 16). Once positioned, they are retained by the retainers (13) and the first and second pattern plate (15, 16) are removed to their initial position, the semi-molds being in a transfer condition. Then the semi-molds are pushed to the semi-mold assembly area (8) by means of the transferring means (6, 7), where they are retained by means of the securing means (10). Thus as soon as the transferring means (6,7) start to transfer the semi-molds (23, 24) to the semi-mold assembly area (8) the manufacturing of the next semi-molds (23, 24) can start. The semi-molds (23, 24) are aligned one after another such that they keep a sufficient safe distance with the mold line to guard the protruding geometry of the entering mold with respect to the mold line (2) and awaiting the forward movement of the walking beams (11) and advancing clamping bars (12). The transferring means (6 and 7) return to their position to start a new transferring sequence while the pushing piston (1) moves forward in its position to contact the closest semi-mold. The forward movement of the pushing piston (1) is initially slowed down to close the semi-molds. Once closed, the securing means (10) are removed and they release the mold so that the piston (1) continues its forward movement and takes it to the mold assembly area (9). At this point, the advancing clamping bars (12) receive the new mold and move forward together with the walking beams (11) to move the complete mold line forward to the casting area (19). The piston (1) recedes and starts a new cycle. The repetition of the cycle provides a mold line which is compact, verified, adjusted and suitable for the casting.

[0046] When the mold is located in the casting area (19) it is filled by means of pouring (28) the metal on the basin (21) formed on its upper face. This basin can have variable geometry and capacity such that it is adapted to the specific needs of the mold in terms of pouring speed and filling times required by the production process. The availability of this basin allows increasing the casting flow rate with respect to that of filling, such that the poured surplus accumulates in the basin and creates a liquid deposit which feeds the mold until its complete filling. This allows the forward movement of the mold from the time at which the weight of corresponding metal has been fed to the cast mold. Thus, if a reference with a total weight of 24 kg is manufactured in a conventional molding machine, for example, and its filling flow rate, by demands of the design, is limited to 4 kg/second, the total casting time will be 6 seconds. However, with the proposed solution, having a basin with a volume of 1.2 liters (which equals to a liquid steel storage capacity of 8.5 kg) a flow rate of 6 kg/second can be supplied, therefore the metal necessary for filling the mold would have been supplied in 4 seconds. The surplus metal will remain in the basin for two seconds and it will finish filling the mold during its forward movement.

[0047] Finally the basin can allow the use of several channels for direct feeding to the part (instead of the single feed channel commonly used) the filling time of the metal and therefore the cycle time being reduced.

[0048] In view of this description and set of drawings, the person skilled in the art will understand that the embodiments of the invention which have been described can be combined in many ways within the object of the invention. The invention has been described according to several preferred embodiments thereof, but for the person skilled in the art it will be evident that multiple varia-

tions can be introduced in said preferred embodiments without exceeding the object of the claimed invention.

Claims

1. Molding method which comprises obtaining sand molds by means of pressure blowing, wherein said molds move forward along an axis of advance (3) of a mold line (2) in order to pour the molten material (28) into a cavity (26) defined by said molds, **characterized in that** it comprises obtaining at least two semi-molds (23, 24), wherein each semi-mold (23, 24) is obtained outside the axis of advance (3) by sand blowing by means of horizontal molding on a pattern plate (15,16) which is located horizontally during said molding, said pattern plate (15,16) defining an impression on one face of each semi-mold (23, 24), and **in that** it comprises rotating 90° and vertically facing said at least two semi-molds (23, 24) to one another by the faces incorporating the impression, to define a cavity (26) which can be filled with the molten material of the part to be obtained.

2. Method according to claim 1, wherein during the molding process, the pattern plate (15,16) defines in each semi-mold (23, 24), on one side face, a semi-basin, such that a basin (21) is defined once said at least two semi-molds (23, 24) are facing one another by the faces incorporating the impression.

3. Method according to claim 2, wherein the volume of the basin (21) defined by each pair of semi-molds (23, 24) is at least 15% of the volume of the cavity (26) defined by said semi-molds (23, 24).

4. Method according to any of the preceding claims, wherein said at least two semi-molds (23, 24) are obtained in two shooting chambers (4, 5) located outside the axis of advance (3).

5. Method according to any of the preceding claims, which comprises using a single piston (1) serving exclusively for assembling and pushing the vertically facing semi-molds (23, 24) according to the axis of advance (3).

6. Method according to any of the preceding claims, which comprises obtaining at least one male semi-mold (23), which has a flange (22) on the face opposite the impression, and at least one female semi-mold (24), which has a notch on the face opposite the impression configured for receiving by bridle joint attachment means the flange (22) of the male semi-mold (23).

7. Molding equipment for obtaining sand molds by means of pressure blowing, comprising an axis of advance (3) of a mold line (2) wherein molten material (28) can be poured into a cavity (26) defined by said molds, **characterized in that** it comprises at least one shooting chamber (4, 5) comprising a sand blowing chamber (20), located outside the axis of advance (3), wherein a semi-mold (23, 24) can be obtained by means of horizontal molding, wherein said at least one shooting chamber (4, 5) comprises a pattern plate (15, 16) which is located horizontally during said molding, said pattern plate (15, 16) defining an impression on one face of the semi-mold (23, 24),and **in that** it comprises rotating means (27) for rotating the pattern plate (15, 16) with the semi-mold (23, 24) 90° for its vertical arrangement and transferring means (6,7) for transferring the semi-mold (23, 24) to a semi-mold assembly area (8) provided in the mold axis of advance (3) such that the semi-molds (23, 24) are facing one another by the faces incorporating the impression, defining a cavity (26) which can be filled with the molten material of the part to be obtained.

8. Equipment according to claim 7, wherein during the molding process, the pattern plate (15,16) defines in each semi-mold (23, 24), on one side face, a semi-basin, such that a basin (21) is defined once the two semi-molds (23, 24) are facing one another by the faces incorporating the impression.

9. Equipment according to claim 8, wherein the volume of the basin (21) defined by a pair of semi-molds (23, 24) is at least 15% of the volume of the cavity (26) defined by said semi-molds (23, 24).

10. Equipment according to any of claims 7 to 9, comprising at least two shooting chambers (4, 5), located outside the axis of advance (3), wherein at least two semi-molds (23, 24) can be obtained.

11. Equipment according to any of claims 7 to 10, comprising a single closing and pushing piston (1) serving exclusively for closing the vertically facing semi-molds (23, 24) according to the axis of advance (3) to form the mold and for pushing the formed mold until it is placed against the row of molds.

12. Mold obtained by means of a method according to any of claims 1 to 7, **characterized in that** it comprises two semi-molds (23, 24) of sand comprising an impression on one face, such that once facing one another by the face of the impression they comprise a casting basin (21) the volume of which is at least 15% of the volume of the cavity (26) defined by the facing impressions of both semi-molds (23, 24).

13. Mold according to claim 12, comprising a male semi-mold (23), which has a flange (22) on the face op-

posite the impression, and a female semi-mold (24), which has a notch on the face opposite the impression configured for receiving the flange (22) of the male semi-mold (23) by bridle joint attachment means.

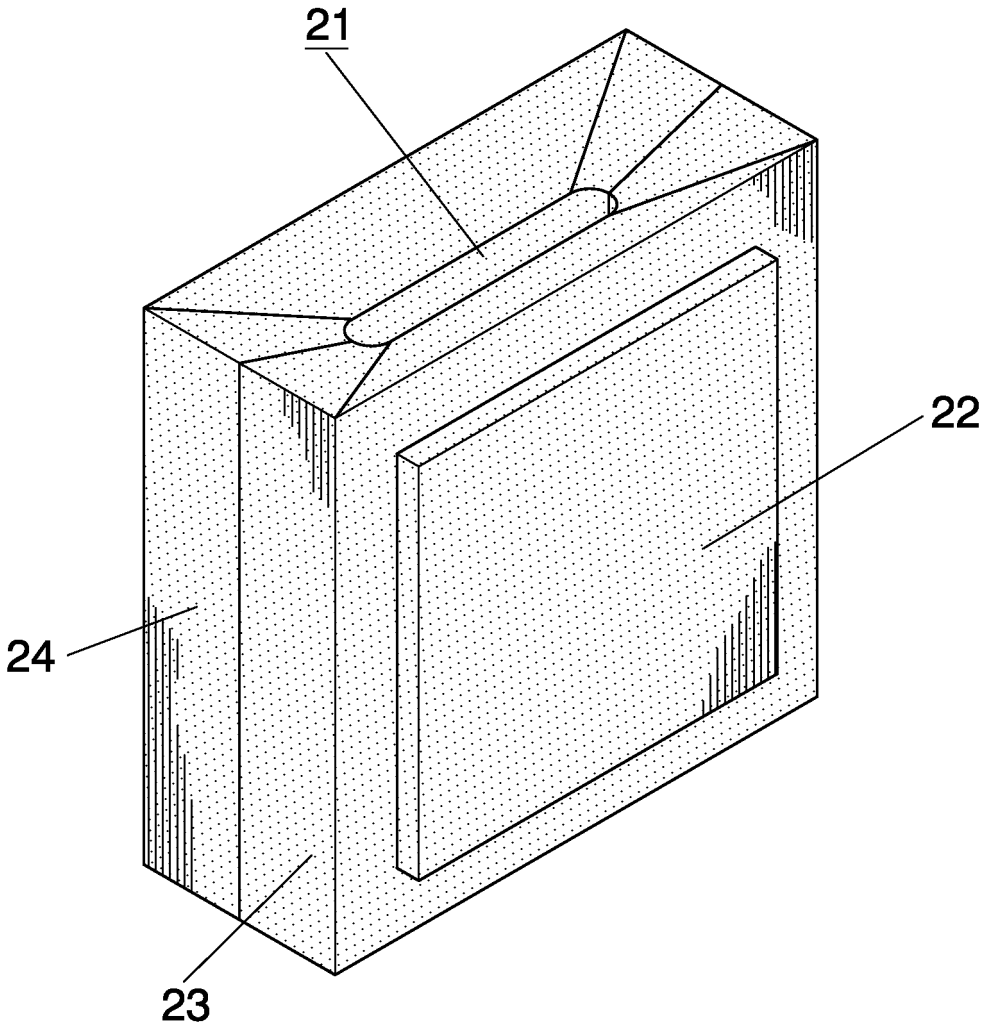

FIG. 1

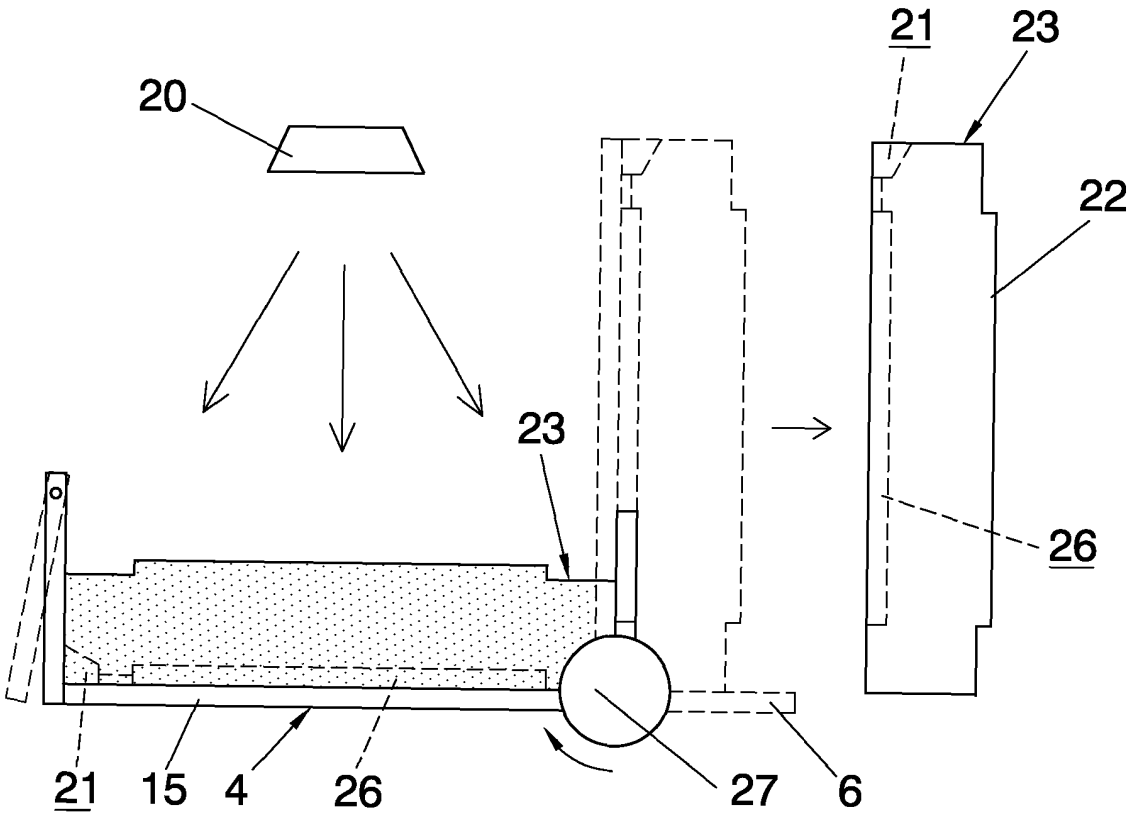

FIG. 2

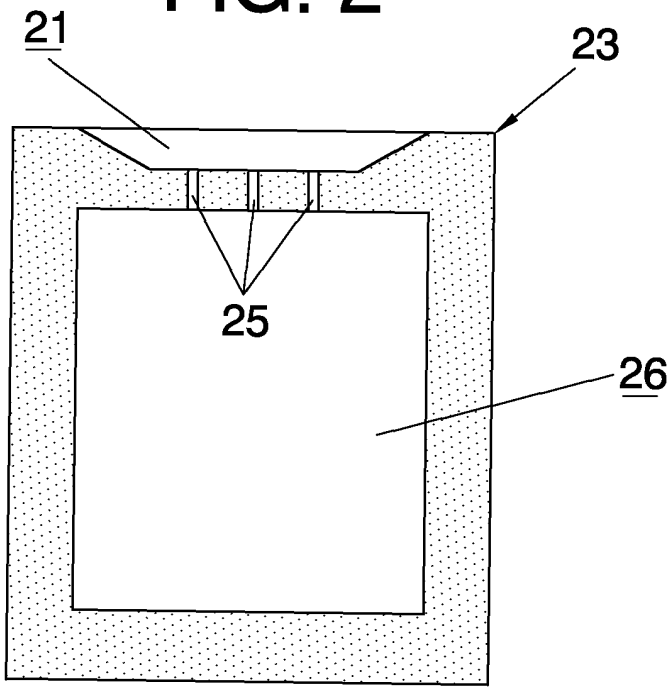

FIG. 3

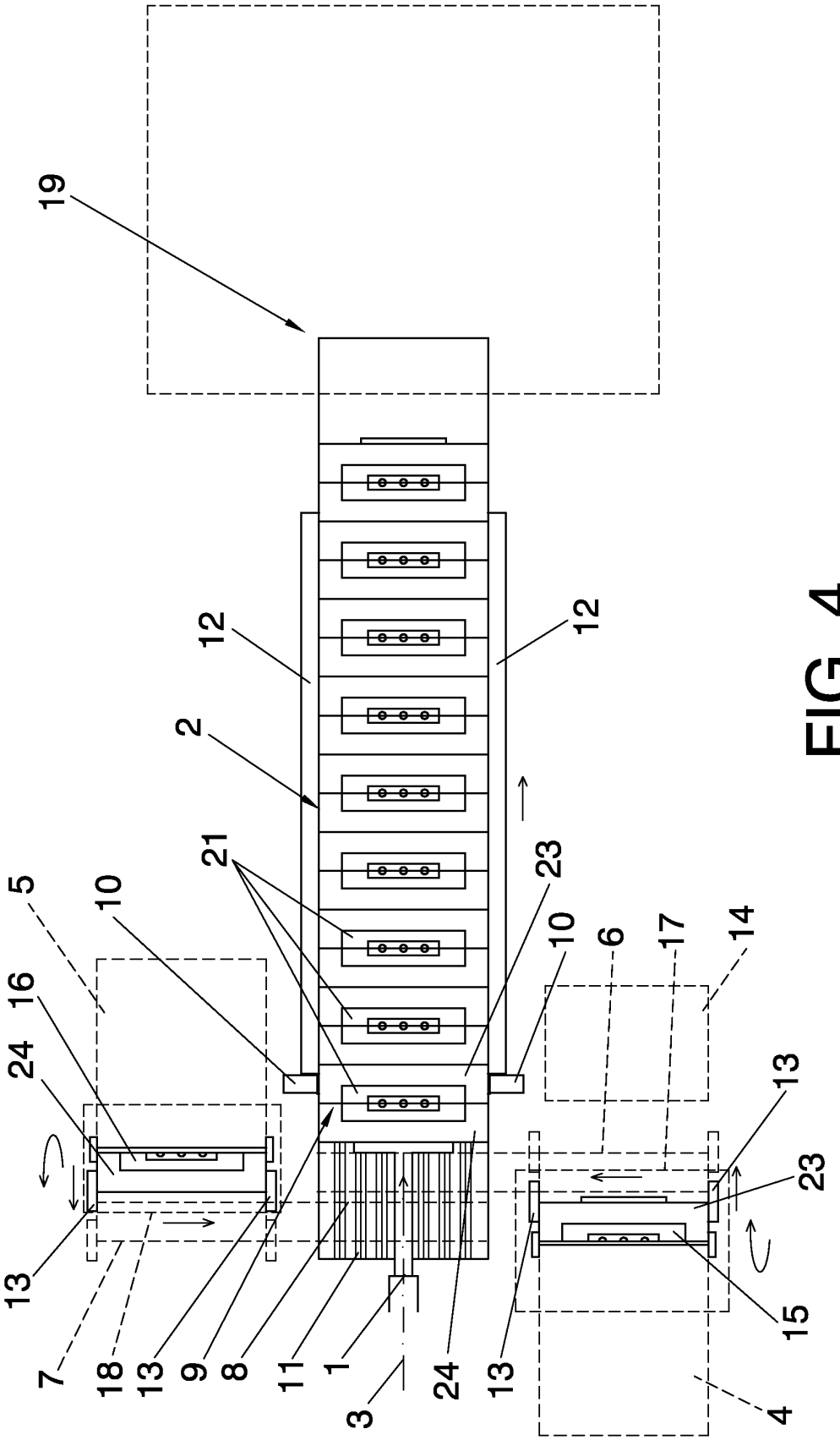

FIG. 4

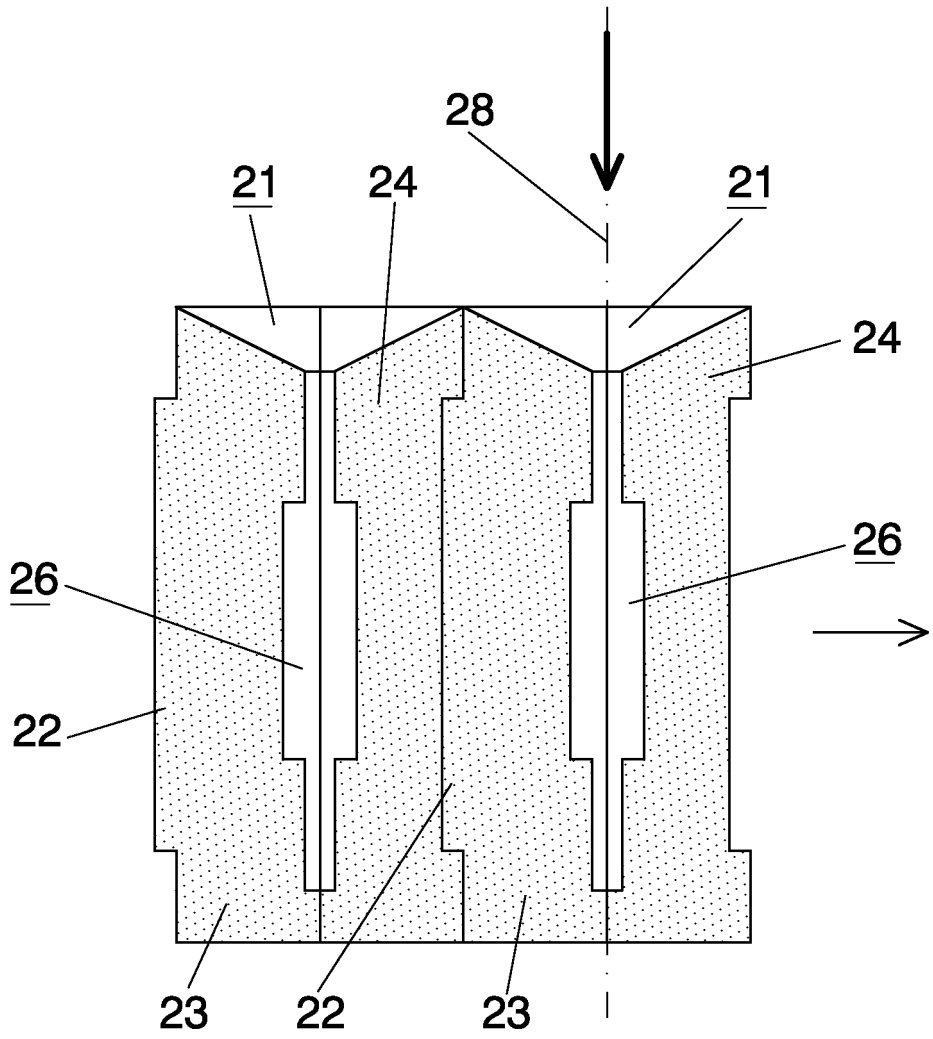

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/ES2011/070896

A. CLASSIFICATION OF SUBJECT MATTER
INV. B22C11/10
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 21 44 388 A1 (BANGOR PUNTA OPERATIONS INC.) 13 April 1972 (1972-04-13) the whole document	1,7
A	DE 20 04 699 A1 (BANGOR PUNTA OPERATIONS INC) 12 August 1971 (1971-08-12) the whole document	1,7

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 August 2012	15/01/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Scheid, Michael

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2011/070896

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

see annex

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2005)

International Application No. PCT/ ES2011/ 070896

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-11

method and equipment for obtaining sand mold characterized by rotating means for rotating the pattern plate and transferring means for transfering the mold halves from a place outside the axis of advance

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2. claims: 12, 13

Sand mold characterized by the volume of the pouring basin

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/ES2011/070896

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2144388 A1	13-04-1972	DE 2144388 A1	13-04-1972
		GB 1317999 A	23-05-1973
		US 3695339 A	03-10-1972
DE 2004699 A1	12-08-1971	NONE	

Form PCT/ISA/210 (patent family annex) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 0817690 B1 **[0002] [0010]**
- SU 1191170 A **[0012]**
- EP 0047507 A1 **[0013]**
- US 20040238145 A1 **[0014]**