

[54] **METHOD OF CASTING BY POURING
METAL FROM A MELT SUPPLY THROUGH
A FEEDER INTO A MOLD**

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[58] Field of Search **164/129, 130, 136, 289,
164/290, 322, 323, 324, 325**

[56] **References Cited**

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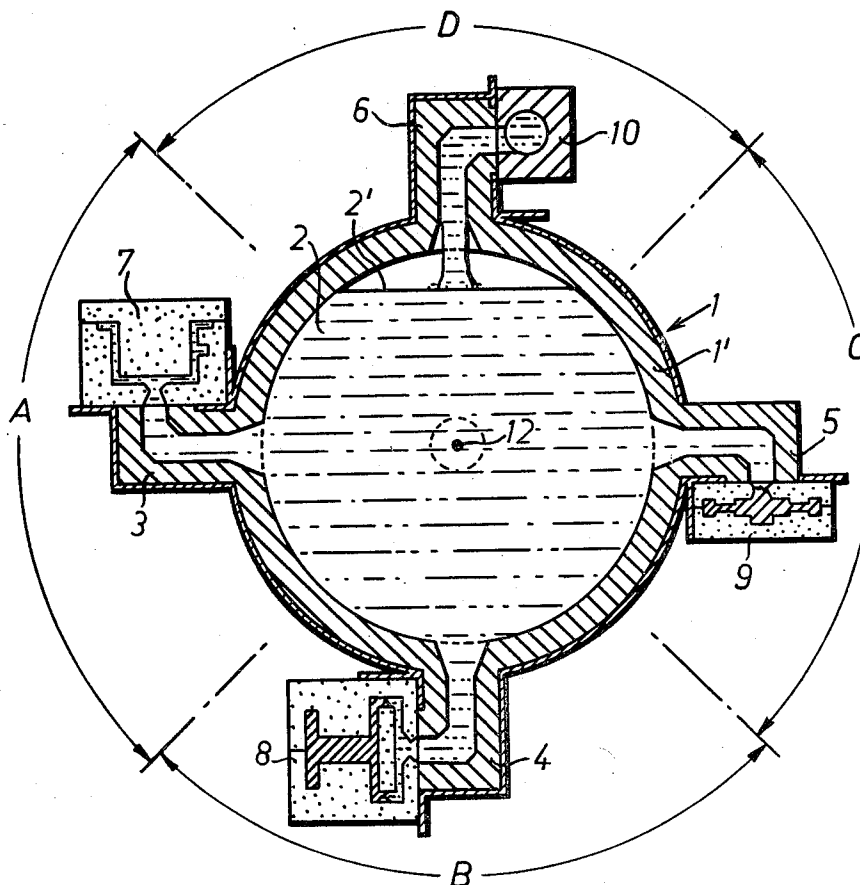
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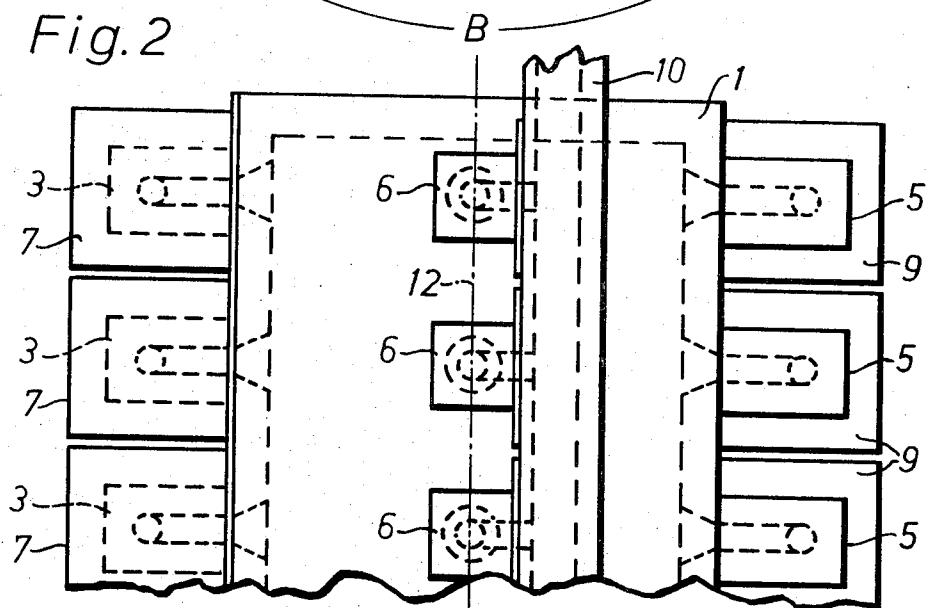
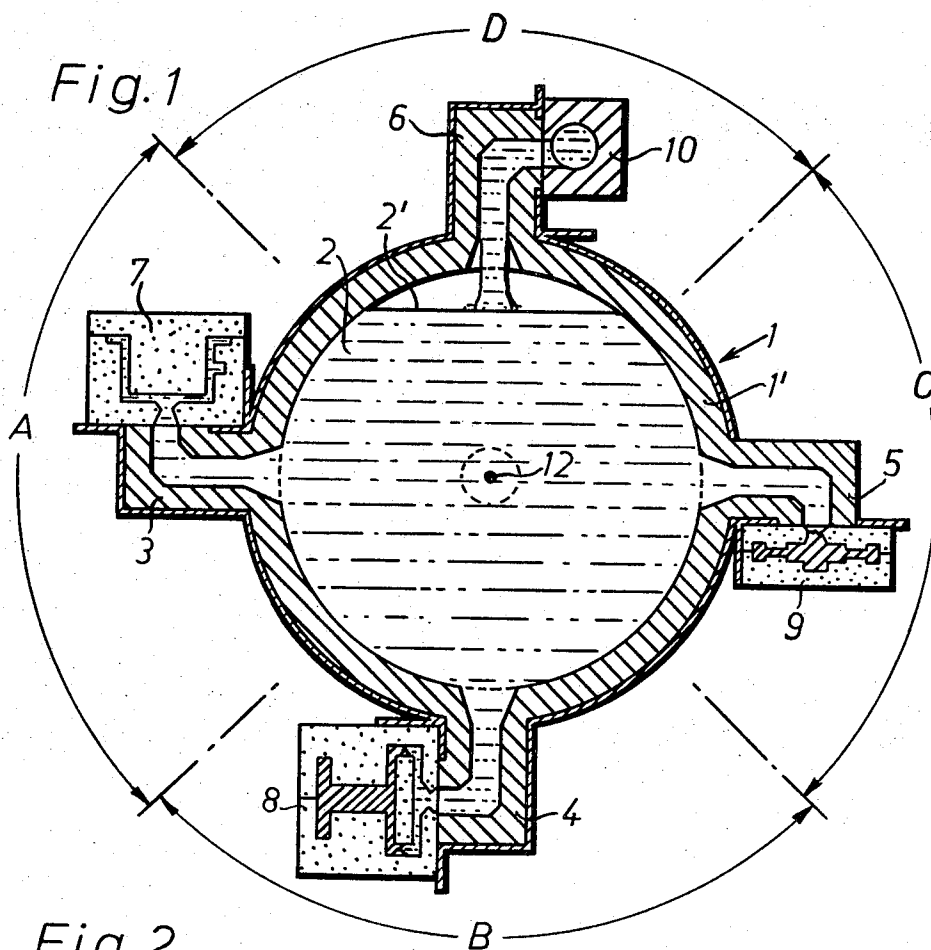
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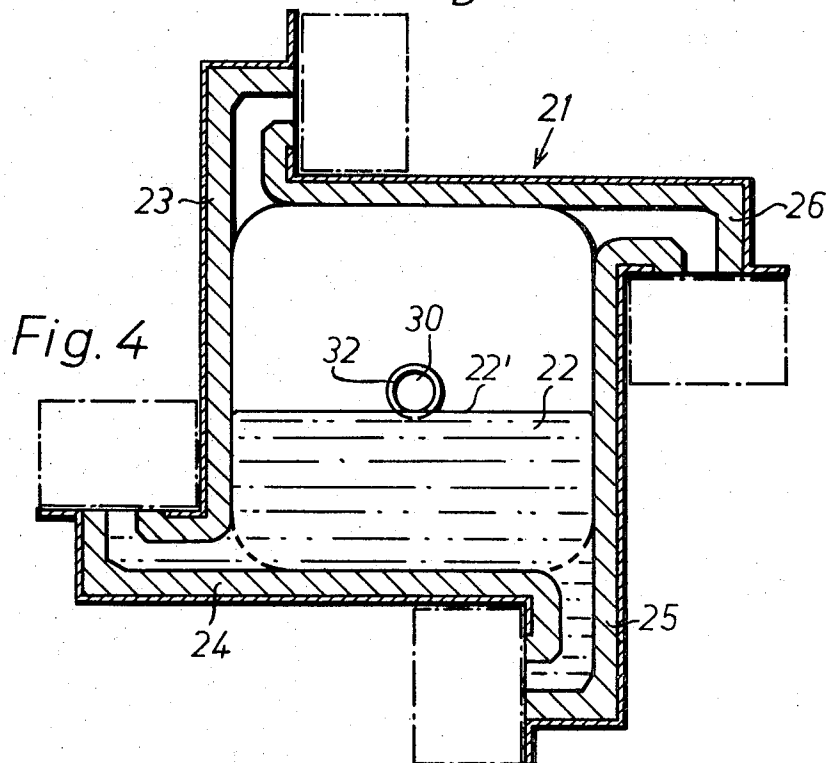
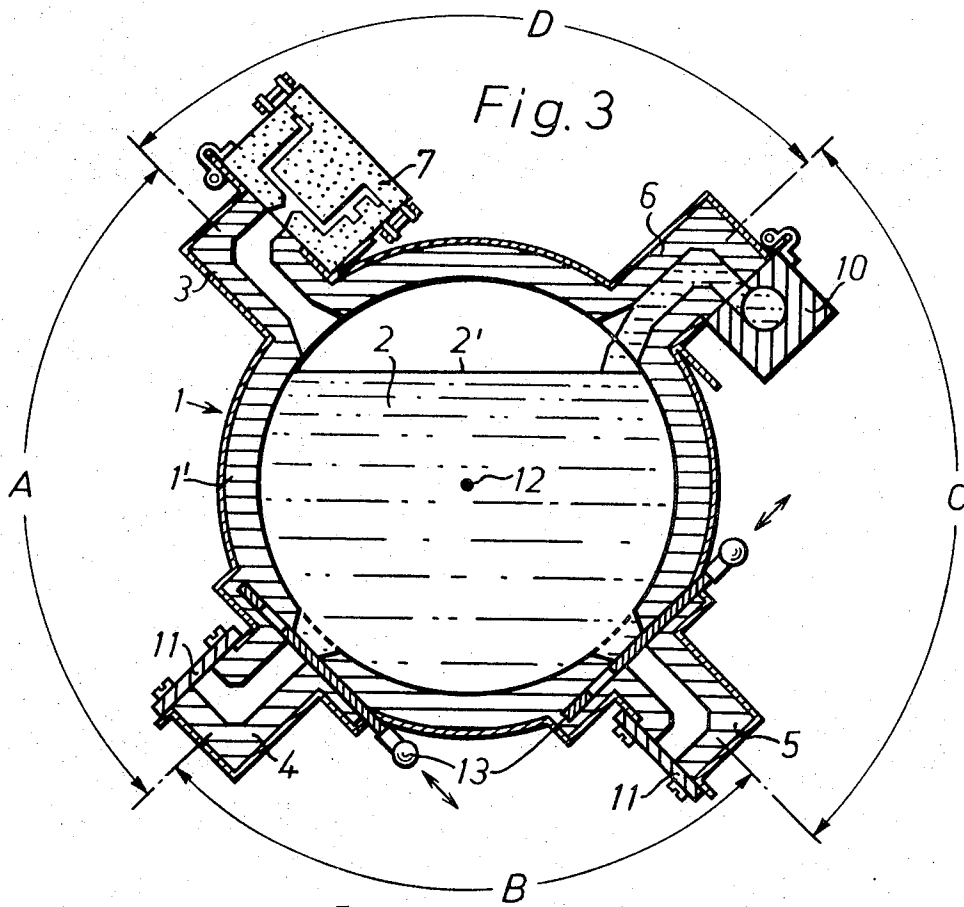
[57] **ABSTRACT**

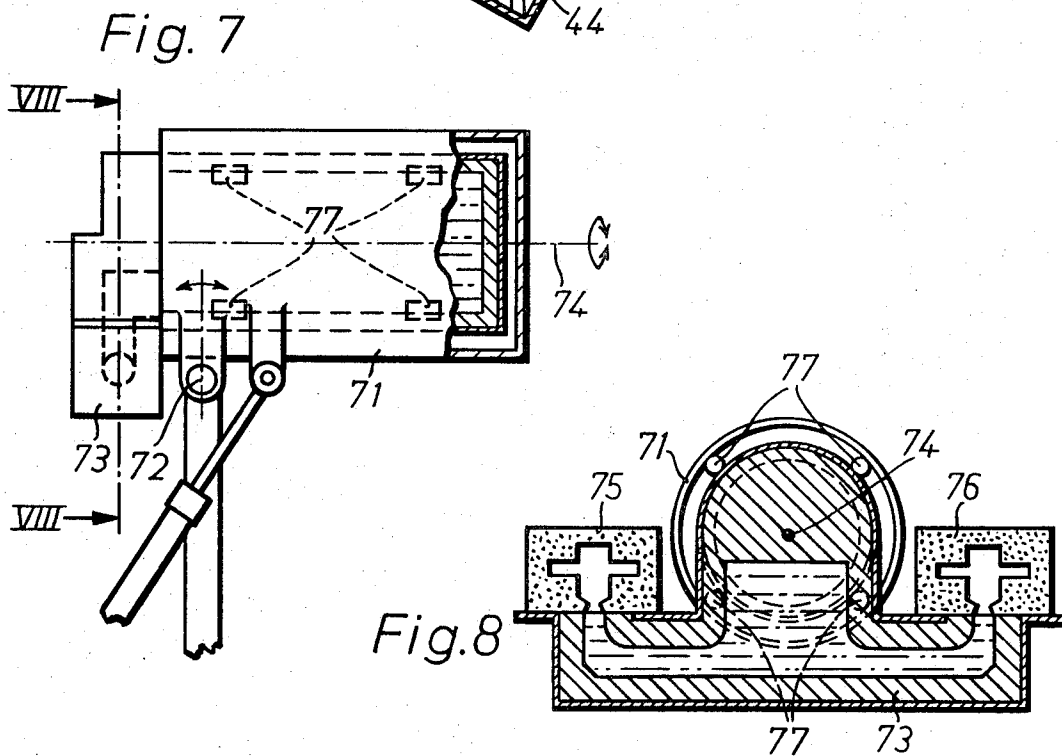
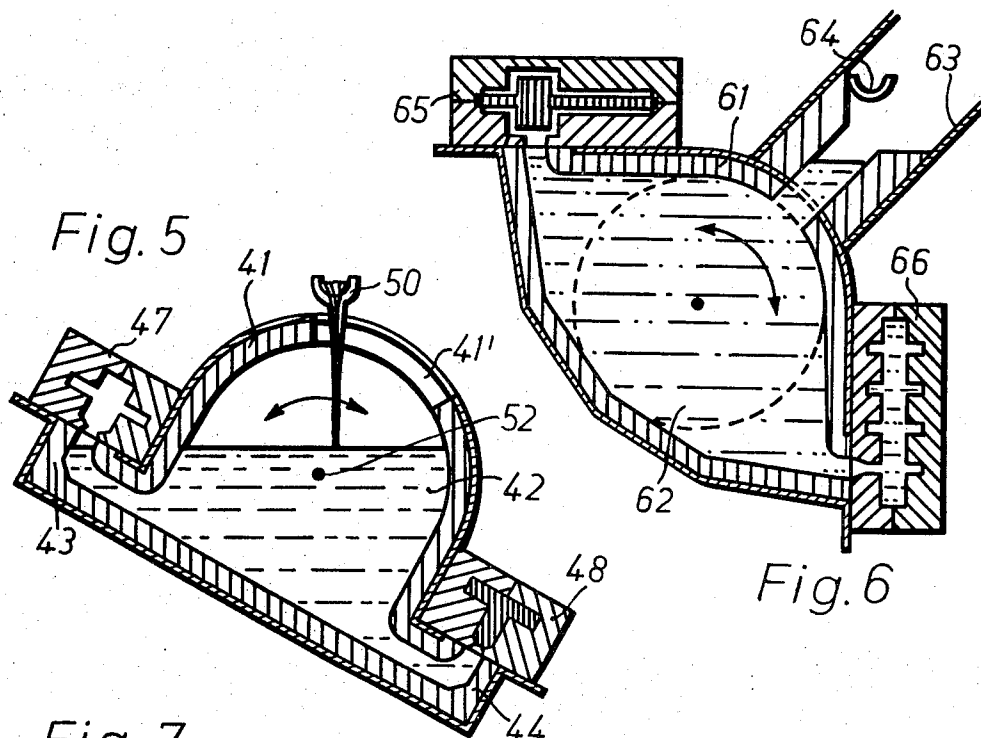
A method of producing castings from a melt in a tank comprises the steps of filling the mold while rotating or tilting the mold about an outside axis in a vertical plane through different positions relative to the direction of gravity with a pipe connecting the tank and the mold acting as the feeder still in connection with the melt supply. During the rotation after filling the solidification progresses in different main directions. After solidification the casting is removed either from the mold or together with the mold and the connecting pipe which is a part of the tank is moved back to its starting position. By the method of the varying direction of solidification the feeders remain constantly open, thereby — besides other advantages — improving considerably the structure and high density of the casting.

10 Claims, 8 Drawing Figures









METHOD OF CASTING BY POURING METAL FROM A MELT SUPPLY THROUGH A FEEDER INTO A MOLD

BACKGROUND OF THE INVENTION

The invention relates to a method of casting molten material into molds for producing castings. More precisely the invention is directed to a casting method wherein the solidification process is purposely directed to progress in different main directions and to an apparatus for performing the method.

Of casting processes it is generally required that during the casting no products are generated which may render the melt impure and reduce the quality of the structure. Further, during the solidification process in the mold a true to measure work piece having a dense and fine-grained structure is expected to form. And, moreover, the production should be rationalized by a high degree of automation.

Most of the known methods of producing castings utilize the gravity of the melt by pouring the molten material in an open stream from a container into the mold. To this stream the atmosphere has full access which causes impurities in the melt such as oxides, nitrides and hydrogen and, consequently, a reduction of the quality of the casting. A further disadvantage resides in the froth which is caused by the turbulence of the melt in the inner space of the mold. After the mold has been filled further melt must be supplied to the solidifying casting in order to compensate for the shrinkage and to prevent the occurrence of shrink-holes in the casting.

Filling the mold with as little turbulence as possible and achieving at the same time sufficiently fine grain requires a considerable effort in labor and material in the gating and the feeding system. Owing to the very different shapes which castings may have this prevents to a great extent the automation of the production process and, if tried, very often does not produce the desired results.

A great number of known casting methods and devices have been introduced in an attempt to overcome these disadvantages. However, they have all met with only partial success.

The low pressure casting method as described, for example, in the German periodical "Giesserei," Vol. 56 (1969), No. 4, page 83-90, is adapted to achieve a filling of the mold with only little turbulence and a good dense feeding with only little material needed. It is, however, a disadvantage that the production process must be interrupted for refilling melt into the casting furnace which must not be emptied more than two-thirds of the original filling. A further disadvantage is the considerable amount of pressure gas which is needed for each casting cycle. This amount must be increased during the cycle in accordance with the reduction of the melt supply in the furnace, and in connection with the thermal expansion causes irregularities in the filling of the mold. Another problem is presented by the specific rising pipes (feed tubes) required when performing the method. They must be gastight and are exposed to the attack of the melt from the inner and outer side. This either makes most of the alloys unsuitable for the purpose or at least limits their durability.

It is therefore an object of the invention to overcome the above-described disadvantages and to provide a

new casting method which is suitable for the production of high quality castings. It is another object to provide a casting method which includes favorable casting conditions during the filling of the molds and mainly during the process of solidification. And it is a further object to provide a casting method which allows a particularly effective production.

SUMMARY OF THE INVENTION

The above stated objects are attained by a method of filling the molds from a tank which is tiltable or even rotatable through pipes connected to the tank and extending in a radial or tangential direction from the tank or in parallel to the tank axis, with the pipes supporting the molds on their outer ends. The tank may be lined with a heat resisting material and a plurality of molds may be attached to the pipes one behind the other not only in one vertical plane but also in different vertical planes.

The term 'horizontal axis of rotation' and 'vertical plane' are meant to include also those axes and planes which are only substantially horizontal and vertical respectively.

During filling the molds according to the invented method the melt enters the molds through the pipes from beneath in a turbulence-free flow of which the speed may be regulated by the angular velocity of the tank. Thus the molds are filled with the level rising evenly. After completion of the filling of the mold a solidification will begin which progresses in a downward direction relative to the gravity vector towards the pipe and which acts as the feeder. From this first position of solidification the castings in the molds move continuously into a substantially horizontal main direction of solidification and finally into a preponderantly vertical one, at which time the solidification in the molds has been completed down to the connection point of the pipes. In special cases the direction of rotation may be reversed so that in a reversed order the mold is filled from the top and the solidification will end mainly in a downward direction.

In this manner it is possible to obtain a continuous casting and solidification cycle synchronously a plurality of molds. At the same time and without interruption of the production molten material is to be supplied in increments to the tank through the pipes when they are in a suitable position or the material is to be supplied continuously through an opening in the tank in the area of the axis of rotation.

If the latter method of supplying molten material to the tank is chosen it will prove expedient to use a tank having square cross section and comprising pipes in a tangential arrangement, so that a sufficient amount of molten material is in the tank in spite of the low level. The tangential arrangement of the pipes improves also the metallo-static pressure conditions.

By limiting the rotary movement accordingly, i.e., by only tilting the tank, the solidification of the castings may be caused to progress only in one main direction, e.g., in the vertical downward direction. Here again a continuous refilling of the tank with molten material is possible through an opening in the upper part of the tank without interrupting the production process.

The production of bigger castings may be achieved by attaching the mold to different pipes which may, for example, be arranged side by side in axial direction.

The same method of casting may also be practiced if permanent molds are used which remain constantly attached to the pipes.

An additional heating of the tank and melting of the solid charge in the tank is also possible. Further, the contents of the tank may be kept under the cover of a protective gas.

Still further, a modification of the device for performing the invented method may be attached as a pouring unit to the conventional tiltable and/or rotatable melting furnaces.

When practicing the invented method of producing castings the molds are transported to the casting apparatus by a suitable conveyor device and are then attached tightly to the pipes. Caused by the pivoting movement of the whole apparatus about its horizontal axis molds first move in a downward direction and are filled with melt. During the further travel of the mold the solidification progresses successively in the three main directions with continuous transition zones. After the solidification is completed the castings in the molds are separated from the melt at the pipe ends as soon as the latter are above the melt level. The castings are then transported away by a further conveyor system. On the rest of their way to the starting position the open pipes may now be connected to a supply system for replenishing of the melt supply in the tank. After a suitable position has been reached the supply system is detached from the pipes and on the latter are mounted new molds for a further casting and solidification cycle.

The advantages achieved by the invention first include an even and controllable filling of the mold from below which prevents any froth-causing turbulence in the pipes and in the inner space of the molds. Secondly the contents of the tank with the practically constant temperature of the melt acts via the pipes as a feeder for the solidification of the castings. In this connection it is a particular advantage, which has not yet been achieved by any other casting method, that the solidification successively progresses through the three main directions of solidification. In the beginning there prevails a solidification which progresses in a vertically downward direction during the so-called base feeding. As a consequence of the convectional currents occurring during the base feeding in the still liquid zones of the casting the feeding channels inside the casting will remain open longer which causes a considerable improvement of the dense feeding and of the grain structure of the casting. Also during the following mainly horizontally directed solidification the influence of the convectional currents is present which causes a dense structure in connection with the here prevailing maximum feeding pressure. In the then following last phase of the solidification process the convectional currents are reduced by the transition into the substantially vertical upward direction of solidification. This causes a reduction of the thermal flow through the pipes into the almost solidified castings and thereby a rapid termination of the solidification process and an easier dismounting of the molds from the pipes. This feature distinguishes the invention especially favorably over the known low pressure casting method wherein the mainly prevailing base feeding delays the solidification process and thereby reduces the productivity.

It is a further advantage of the invented method that both for filling of the molds and for generating a feeder pressure during the solidification no additional gas

pressure is needed which would require an extensive control mechanism. Also, with the invented method there do not occur any problems with the feed tubes so that all known suitable material may readily be cast.

Considerable significance must be attributed to the invented method and apparatus when regarding the degree of mechanization and productivity that may be achieved thereby. For example, a plurality of molds may be filled and the melt therein may solidify during one rotation, if the molds are connected to different pipes one behind the other in a direction parallel to the axis of rotation. A minimum of foundry returns for the gating and feeding systems will be produced, whereby the further machining of the castings is considerably facilitated. On account of the possibility of supplying continuously molten material to the tank a continuous production is ensured.

Further, there are many possibilities of performing the invented method: the method may be employed with break molds as well as with permanent molds, ingot molds and continuous casting molds.

If for the casting of a small series the charge is molten directly in the tank or in a conventional furnace with a pouring unit attached thereto the casting may be done immediately after melting so that no conveyance of the melt is required as it is in the prior art methods.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more readily comprehended from the following description when taken in conjunction with the appending drawings, wherein:

FIGS. 1 and 3 are sectional views of a cylindrical supply tank in two different positions cut in a vertical direction, the tank having pipes extending in a radial outward direction,

FIG. 2 is a plan view of the tank in the position of FIG. 1,

FIG. 4 shows a vertical cut through a square tank having tangentially extending pipes,

FIG. 5 shows a vertical cut through a tank which is turnable through a limited angle of rotation,

FIG. 6 shows a vertical cut through a tank turnable through a greater angle of rotation and with a melt supply different from the one shown in FIG. 5,

FIG. 7 is a melting furnace with attached pouring unit, tilted to a horizontal position, and

FIG. 8 is a sectional view cut along the dash-dotted line VIII—VIII in FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the FIGS. 1 through 3, the drum-shaped supply tank 1 is lined with a suitable fireproof material 1' and is filled with the molten casting metal 2 up to the level 2'. The tank 1 is provided with pairs of four different pipes 3; 4; 5 and 6, one pair arranged behind the other in a plurality of vertical planes. The pipes extend in a radial outward direction and carry the molds 7; 8 and 9 on their sides in a console-like manner. To the pipe 6 there is attached the supply channel 10 for the melt.

The starting position of the apparatus is shown in FIG. 3. The pipes 3 and 6 mark the ends of an angle D while the pipes 4 and 5, closed by covers 11, mark the ends of an angle B. With the help of the movable supply channel 10 the tank may be filled through the pipe 6 with the melt 2 up to the level 2'. Prior to starting the

casting production the molds 7 are placed on the openings of the pipes 3 and sealed thereon. The rotary movement of the tank 1 is then started in a counter-clockwise direction about the axis 12 and the supply channel 10 is detached and removed from the pipe 6 at the end of the angle D. Simultaneously the molds 7 travel for casting through the angle A and for solidification through the angles B and C and will be removed from the pipe 3 after completed solidification at the end of angle C. Thereafter the tank will be refilled with melt through the pipe 3 in the angle D with the help of the supply channel 10. At the end of angle D new molds will be attached. The same procedure will subsequently be followed at the pipes 6; 5 and 4. Attaching and removing the molds as well as attaching the supply channel 10 may be accomplished during a short stop of the tank or even during rotation.

In order to facilitate the starting operation shut-off devices 13 for the melt may be provided in the pipes, as shown in FIG. 3.

Further there is the possibility to considerably minimize the extent of the apparatus by separating the pipes 3; 4; 5; 6, which in the FIGS. 1 - 3 are shown to be one-piece with the tank 1, from the tank and by connecting the pipes to the molds.

If expedient in the embodiment illustrated in the FIGS. 1 - 3 the overall quicker solidification may be caused to progress in one particular main direction, for example in the vertical downward direction. To this end the pipes 4 and 6, as shown in the FIGS. 1 - 3, can be omitted and the opening of the pipe 5 should be directed upwards in the same manner as that of pipe 3. By the help of a suitably controlled swivel movement of the tank 1 and the molds 7 and 9 through the angles A and C the casting and the solidification process progresses alternately in the molds. In an apparatus of this type melt may be continuously supplied in an especially simple manner through an arcuate slot in the tank in the area of the angle D.

In the embodiment shown in FIG. 4 the tank 21 is square shaped and provided with the pipes 23; 24; 25 and 26 in tangential direction. The melt 22 is supplied through the channel 30 which is arranged concentrically to the axis 32. The level 22 of the melt is below the axis 32.

In this embodiment the method of casting is the same as the method in the embodiment described with reference to the FIGS. 1 through 3.

In the embodiment illustrated in FIG. 5 the tank 41 is continuously filled with the melt 42 by means of the channel 50 through the arcuate opening 41'. The pipes 43 and 44 are connected to the sides of the tank near the bottom and support the molds 47 and 48. The swivel axis is designated 52.

The apparatus is tilted in an upward and downward direction by a control device (not shown) so that filling of the mold and subsequent solidification is achieved during the downward movement and the following rest period. This apparatus is particularly suitable for a continuous supply of melt into the tank through the opening 41' which is directed in the upward direction.

In case more space is needed for the molds or permanent molds with mechanical control an embodiment of the invention as shown in FIG. 6 is suggested. The tank 61 is completely filled with the melt 62 and refilling is accomplished by means of the horizontally displaceable channel 64 through the nozzle 63. The material in

the nozzle serves at the same time to increase the static pressure of the melt in the mold. In the drawing the mold 65 is just about to be filled while in the mold 66 the casting solidifies. The angle of rotation of the apparatus is 90°.

In the FIGS. 7 and 8 it is shown how a furnace 71, which is tiltable about an axis 72, may be modified so as to perform the invented method by attaching a particular pouring unit 73. This requires, however, that the furnace is also rotatable about its middle axis 74. FIG. 8 shows the pouring unit 73 with two molds 75 and 76 mounted thereon. The rotary movement is made possible by rolls 77.

After the material has been molten the pouring unit 73 is tightly attached to the furnace 71. The furnace and the pouring unit are then tilted until both occupy the casting position shown in FIG. 7. A swivel movement about the axis 74 is then imparted to the furnace and the unit, which movement causes the casting of molten material alternately into the molds 75 and 76 similar to the methods illustrated in the FIGS. 5 and 6.

What I claim is:

1. The method of producing castings by pouring melt from a melt supply into a mold through a feeder, comprising the steps of:

- a. moving said mold and said feeder in a circular orbit in a vertical plane about a given point;
- b. maintaining a level of said melt in said melt supply vertically above said given point;
- c. further moving said mold for solidification in said vertical plane through a plurality of positions relative to the direction of gravity having said feeder in connection with said melt below said given point for filling said mold through said feeder below said melt level; and
- d. removing said casting from said mold connected with said feeder after solidification.

2. The method of claim 1 wherein said melt is molten metal.

3. The method claimed in claim 1, wherein the casting is moved in the vertical plane during its solidification in an upward and downward direction.

4. The method claimed in claim 1, wherein the casting during its solidification is subsequently rotated into a vertical downward, then into a horizontal and then into a vertical upward main direction of solidification.

5. The method claimed in claim 1, wherein the steps of the method are performed subsequently on at least two castings arranged one behind the other in the vertical plane.

6. The method claimed in claim 1, and further comprising the step of replenishing continuously the melt supply during all steps of the method.

7. The method of producing castings by pouring melt from a melt supply into a mold through a feeder, comprising the steps of:

- a. moving said mold and said feeder in a circular orbit in a vertical plane about a given point;
- b. maintaining a level of said melt in said melt supply vertically above said given point;
- c. further moving said mold for solidification in said vertical plane through a plurality of positions relative to the direction of gravity having said feeder in connection with said melt below said given point for filling said mold through said feeder below said melt level; and

d. removing said mold and said casting from said feeder.

8. The method of producing castings by pouring melt from a melt supply into a mold through a feeder comprising the steps of:

- a. moving said mold for filling in a vertical plane;
- b. further moving said mold for solidification in said vertical plane through a plurality of positions relative to the direction of gravity having said feeder still in connection with said melt supply;
- c. dismounting said mold from said feeder after said feeder has risen above the level of the melt supply; and
- d. attaching a supply channel to said feeder after said dismounting and maintaining said attachment until another mold is mounted on said feeder.

9. The method of producing castings by pouring melt from a melt supply into a mold through a feeder, comprising the steps of:

- a. moving said mold for filling from below in a vertical plane;
- b. further moving the mold for directed solidification in said vertical plane through a plurality of positions relative to the direction of gravity and changing

ing the positions of the feeder relative to said casting still in connection with said melt supply, beginning with said feeder position at the base of said casting and ending with said feeder position at the top of said casting; and

- c. removing said casting from said mold connected with said feeder after solidification.

10. The method of producing castings by pouring melt from a melt supply into a mold through a feeder, comprising the steps of:

- a. moving said mold for filling from below in a vertical plane;
- b. further moving the mold for directed solidification in said vertical plane through a plurality of positions relative to the direction of gravity and changing the positions of the feeder relative to said casting still in connection with said melt supply, beginning with said feeder position at the base of said casting and ending with said feeder position at the top of said casting; and
- c. removing said mold and said casting from said feeder.

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