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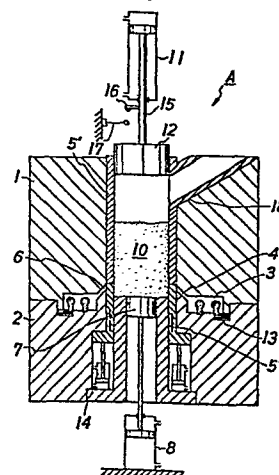
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54 Method and apparatus for vertical die casting.

57 A vertical die casting method comprising the steps of charging a molten metal (10) into a cavity (3) in a mold (1,2) by the weight of the molten metal itself and then charging completely the molten metal into the cavity (3) under pressure; and an apparatus to be used for said vertical die casting method.

FIG. 2



Title: METHOD AND APPARATUS FOR VERTICAL DIE CASTING

- 1 -

BACKGROUND OF THE INVENTION

(1) Field of the invention:

The present invention relates to a method and apparatus for properly charging the molten metal in a vertical die casting.

(2) Prior Art:

As is well known the die casting method has been widely employed owing to its high-precision performance among a variety of casting methods. Among them, in particular, the vertical casting method has been extensively used since it allows little amount of gas to be involved within the cast product.

According to the conventionally employed general vertical die casting as shown in Fig. 1, a pouring gate 9 is formed by a sleeve 5 that forms a sprue runner 4 connected to a cavity that is defined by the upper and lower molds 1 and 2, a counter plunger 7 is urged by a counter cylinder 8 to close the gate, a molten metal 10 is supplied in the state that the gate is closed, a pressure

plunger 12 is lowered by a pressure cylinder 11, and the counter plunger 7 is lowered by the counter cylinder 8, so that the molten metal 10 is charged into the cavity 3 through the sprue runner 4 which is opened.

5 To obtain satisfactory cast products, no gas should be caught in the molten metal 10 that is charged in the cavity 3, no cold shut should exist in the molten metal, so that the product should have a high specific gravity.

.0 In charging the molten metal 10 into the cavity 3, if the molten metal is charged only by the descending action of the counter plunger 7 while the pressure plunger 12 does not pressurize the molten metal 10 in the sleeve, cold shut will develop in the molten metal so that unsatisfactory products are obtained.

15 To cope with this problem, the gate 9 is closed by the counter plunger 7 in the initial stage, and the counter plunger 7 is allowed to descend after the molten metal 10 is pressurized by the pressure plunger 12. In this case, the descending rate of the pressure plunger 12 is set to be faster than that of the counter plunger 7 taking the charging rate into consideration, and the
20 speed of the plunger 12 is set to a high value.

Therefore, the pressure is exerted on the molten metal 10 by the pressure plunger 12 before the descending counter plunger 7 passes over the gate 9, i.e., before the gate is completely opened, whereby the molten metal is injected at high speeds into
25 the cavity 3 from the opening of the gate. Accordingly, the splashes of molten metal adhere to the interior of the cavity 3 before it is fully charged with the molten metal; i.e., a part of the molten metal solidifies early and does not fuse together with the subsequently charged molten metal, giving rise to the occur-
30 rence of cold shut.

Furthermore, since the charging of the molten metal does not take place uniformly, gas present in the cavity is stirred and caught by the molten metal. This fact also yields the unsatisfactory products.

In the conventional method, the casting conditions were unstable, and the defects tended to develop due to the above-mentioned causes.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide a method and an apparatus for production of cast products in a vertical die casting which are free from the defect such as gas-catching and cold shut. More specifically, an objection of the present invention is to provide a method and an apparatus for production of cast production which is characterized by smooth and continuous casting free from the gas-catching and cold shut.

According to the present invention, the molten metal is charged into the cavity due to its own weight at the initial stage, and then the charging of the cavity is completely effected by the pressurizing action of the pressure plunger.

These and other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description of the preferred embodiment when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram illustrating a vertical die casting according to a conventional art;

Figs. 2 and 3 are diagrams illustrating an apparatus and a manufacturing process according to the present invention.

Fig. 4 is a view illustrating the sprue runner of the embodiment in Figs. 2 and 3 on an enlarged scale; and

Fig. 5 is a diagram illustrating experimental data.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In a vertical die casting to which the present invention relates, the molten metal is supplied into a sleeve while the gate is closed, and the gate is then opened so that the molten metal is charged from the sprue runner into the cavity due to the descending motion of the pressure plunger and counter plunger. According to the present invention, the cavity is charged with the molten metal at two stages: after the molten metal is supplied into the sleeve, the molten metal is charged smoothly into the cavity via the runner at the initial stage through lowering a lower sleeve by a descending means, and then the cavity is completely charged with the molten metal while pressurized by the pressurizing action of the descending pressure plunger at a specified speed.

Namely, according to the present invention, the molten metal is supplied into the sleeve while the lower sleeve, at first, is brought into contact with the upper sleeve to close the gate, the lower sleeve is allowed to descend thereby to open the gate accompanying the descending motion of the pressure plunger, a predetermined amount of molten metal is allowed to smoothly flow due to its own weight, and the pressure plunger gives pressure upon the molten metal under the condition in which the flow of molten metal is not terminated, so that the molten metal is charged

into the cavity through the sprue runner, thereby to obtain a satisfactory product without splashes of molten metal, without containing gases, and without cold shut.

The present invention will be explained more in detail with reference to one embodiment shown in Figs. 2 - 4 which merely illustrative of this invention and is not intended to limit the present invention. In these figures, the same reference numerals represent the same as or similar to the parts in Fig. 1.

Symbol A denotes a vertical die casting apparatus as one embodiment according to the present invention which is used to produce a cast products free from the defect such as gas-catching and cold shut, in which a reference numeral 3 is a cavity which is defined by an upper mold 1 and a lower mold 2, a reference numeral 13 is a core secured within the cavity 3. As shown in detail in Fig. 4, the cavity 3 is located at a position lower than the gate 9, and a sprue runner 4' is downwardly tilted at, for example, 5° to 45° extending from the gate 9 to the cavity.

An upper sleeve 5' is secured to the upper mold 1, and a lower sleeve 5" which is vertically movable with respect to the lower mold 2 and coupled to a hydraulic cylinder 14 that works as a lowering and lifting means is brought into close contact with the lower end of the upper sleeve 5' at the gate 9 thereby to close the gate. A counter plunger 7 is slidably inserted inside the lower sleeve 5" and is connected to a counter cylinder 8 located at a lower position.

A pressure plunger 12 is fitted into the upper sleeve 5' and is coupled to a pressure cylinder 11 located at an upper position. A dog 16 provided on the rod 15 is designed to be able to come into contact with a limit switch 17 that is attached

to a frame (not shown). The limit switch is connected to a hydraulic pump actuating device and the hydraulic cylinder 14, if need be via a suitable relay (not shown).

For the purpose of convenience, the ratio of sectional area of the pouring gate to the volume of product (volume of the cavity) has been set to be 0.01 to 0.08 cm⁻¹.

The hydraulic mechanism on the pressurizing side of the pressure cylinder 11 is so designed that a pressure ratio determining device (not shown) may determine the relative pressure of the pressure plunger 12 relative to the counter plunger 7.

In the vertical die casting apparatus A, the lower sleeve 5" is raised during the initial stage by the lowering and lifting means 14 to come into intimate contact with the upper sleeve 5', thereby to close the gate 9.

Under this condition, the predetermined amount of the molten metal 10 from a molten metal inlet 18 is supplied into the upper sleeve 5', and a piston of the pressure cylinder 11 is actuated to lower the pressure plunger 12.

When the dog 16 of rod 15 of the pressure plunger 12 comes into contact with the limit switch 17 located at a preset position, the lowering and lifting means 14 is operated via the relay before the pressure plunger 12 reaches the molten metal 10, whereby the lower sleeve 5" is lowered to open the gate 9.

Since the pressure plunger 12 has not yet reached the state to exert the pressure onto the molten metal, the molten metal 10 flows by its own weight into the cavity 3 through the sprue runner 4' that is downwardly tilted at an angle α = from 5° to 45°.

In this case, the molten metal 10 flows naturally

through the sprue runner that is downwardly tilted. To obtain an optimum flow rate and flow capacity, however, the rate of cross sectional area of pouring gate to the volume of the product is preferably set to lie from 0.02 to 0.05 cm⁻¹.

Thus, the apparatus according to the present invention is so designed that when more than 10% of the molten metal to be charged into the cavity flows into the cavity by its own weight, the pressure plunger 12 comes into contact with the molten metal 10 lest the molten metal should cease to flow and the molten metal 10 is pressurized by the pressure plunger, so that it is charged into the cavity 3 through the sprue runner 4' under pressure.

Here, the above-mentioned problems seen in the conventional method arises if the molten metal gushes vigorously into the cavity. According to the present invention, therefore, the molten metal is charged under pressure at a speed which does not exceed four times speed at the gate at which the molten metal is allowed to flow by its own weight, and, preferably, does not exceed two times the speed at the initial stage.

By so constructing, the molten metal 10 is charged at a low rate into the cavity 3. Consequently, no cold shut is formed, gas is not agitated in the cavity, and no gas is captured in the molten metal, so that a die casted product is obtained satisfactorily.

Further, since the molten metal is charged at a low speed under a low pressure, the core is not damaged or bitten and even a sand core can be used.

When the charging of the molten metal is finished, the molten metal is pressurized at a predetermined pressure by the pressure plunger 12 and then, the molten metal is pressurized

again by the counter plunger 7.

Finally, the mold is split to take out the product. The mold is then reset, and the molten metal is supplied again.

Fig. 5 shows the comparison results between the embodiment of the present invention and the conventional art, in which the abscissa represents the pressure P (kg/cm^2) exerted on the molten metal by the pressure plunger, and the ordinate represents the specific gravity ρ of the die cast product. It will be understood that the product of the present invention represented by a curve C' has increased density compared with the product of the conventional art represented by a curve C , and therefore the present invention can provide a more excellent product having the compact structure.

As a matter of course, the embodiment of the present invention should not be limited to the above-mentioned example only. For instance, the core may be employed in the undercut type, and the sprue runner may be curved, not straight.

The invention can also be adapted for effecting complicated profile die casting without using a core.

The charging rate and the charging capacity of the molten metal by its own weight, the timing at which the pressure plunger comes into contact with the molten metal, the pressure to be exerted on the molten metal, and the charging rate under the pressure can be suitably determined. Further, the means for opening and closing the gate is not limited to the lower sleeve, but the gate may be opened and closed by the counter plunger.

According to the present invention as mentioned above, the molten metal is supplied into the sleeve while the gate is closed, and the gate is opened before the pressure is exerted on

the molten metal by the pressure plunger, so that the molten metal is charged into the cavity as smoothly as possible by its own weight. The molten metal is charged at a slow speed without being pressurized, and does not gush into the cavity to adhere to the interior surfaces thereof followed by hardening. Thus, the molten metal is charged into the cavity in the form of laminated layer. Therefore, no cold shut is formed, gas is not stirred up in the cavity, no gas is captured by the molten metal, so that the excellent die cast product is obtained.

Further, the molten metal is charged under pressure by the pressure plunger after the predetermined amount of the molten metal is allowed to flow into the cavity by its own weight without interruption. Therefore, the decrease of flow rate by the weight of the molten metal is compensated, and the molten metal is reliably charged at low speed; the satisfactory products can be obtained without cold shut and gas-catching.

Thus, according to the present invention, excellent products having undercuts and cavities can be obtained using a core without difficulty, and the merits of the vertical die casting method can be fully utilized.

In the casting apparatus of the present invention, as mentioned above, the lower sleeve is lowered from the upper sleeve by the lowering and lifting means so that the gate can be opened and closed, and the sprue runner which connects the gate to the cavity is so tilted that the molten metal flows into the cavity by its own weight. Therefore, as the gate is opened by the lower sleeve, the molten metal freely flows into the cavity by its own weight alone, and the excellent product is obtained without cold shut or without containing gas.

What is claimed is:

1. A vertical die casting method comprising the steps of:

— charging a molten metal into a cavity in a mold by the weight of the molten metal itself; and then
— charging completely the molten metal into the cavity under pressure.

2. The vertical die casting method claimed in Claim 1, wherein the speed at which the charging is carried out under pressure is less than four times the speed at which the charging is carried out by the weight of the molten metal itself.

3. The vertical die casting method claimed in Claim 1, wherein the speed at which the charging is carried under pressure is less than two times that at which the charging is carried out by the weight of the molten metal itself.

5 4. A vertical die casting apparatus comprising:

— an upper mold and a lower mold which defining a cavity;
— an upper sleeve and a lower sleeve which are positioned inside of said molds;

— means for lowering and lifting said lower sleeve;

0 — a gate which is opened and closed by said lower sleeve;

— a sprue runner which connects said gate and said cavity and which is tilted downwardly;

— a pressure plunger which serves to pressurize a molten metal to be charged into said cavity;

15 — a means for actuating said pressure plunger;

— limit means for actuating said lower sleeve-lowering and lifting means, said limit means being actuated by the movement of the pressure plunger;

— a counter plunger which serves to pressurize the molten metal after the pressure plunger-pressurizing is over; and

— a means for lowering and lifting said counter plunger.

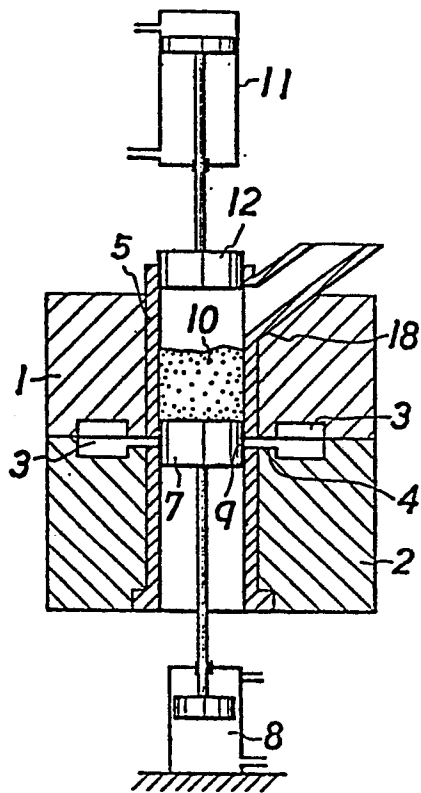
5 5. The vertical die casting apparatus claimed in Claim 4, wherein said runner is tilted downwardly at from 5° to 45° .

6. The vertical die casting apparatus claimed in any one of Claims 4 and 5, wherein the ratio of the sectional area of said gate to the volume of said cavity is $0.01 - 0.08 \text{ cm}^{-1}$.

10 7. The vertical die casting apparatus claimed in Claim 6, wherein said ratio is $0.02 - 0.05 \text{ cm}^{-1}$.

FIG. 1

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(Prior Art)

FIG. 2

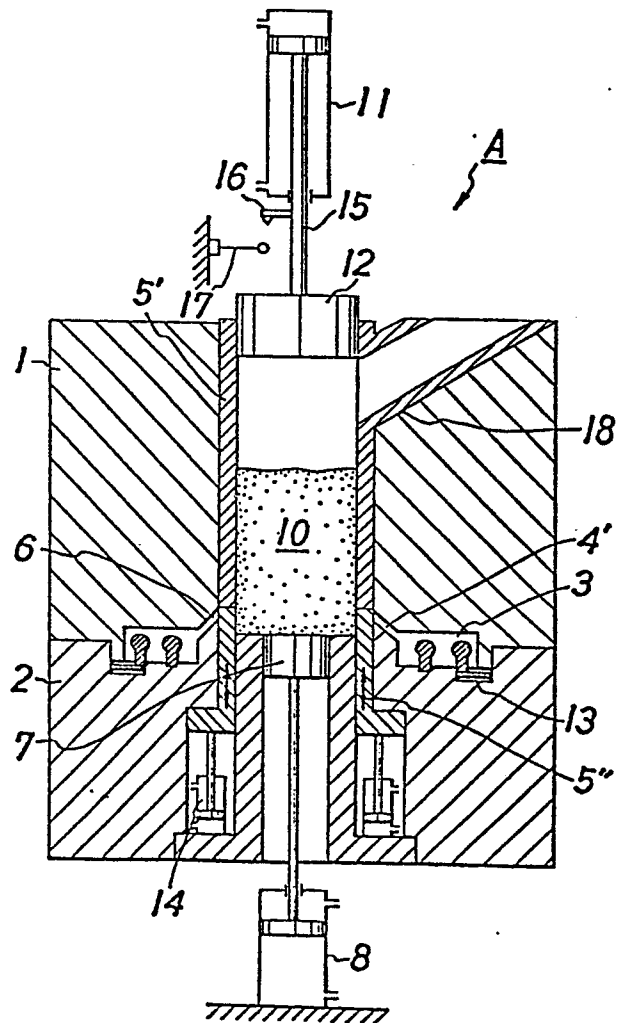


FIG. 3

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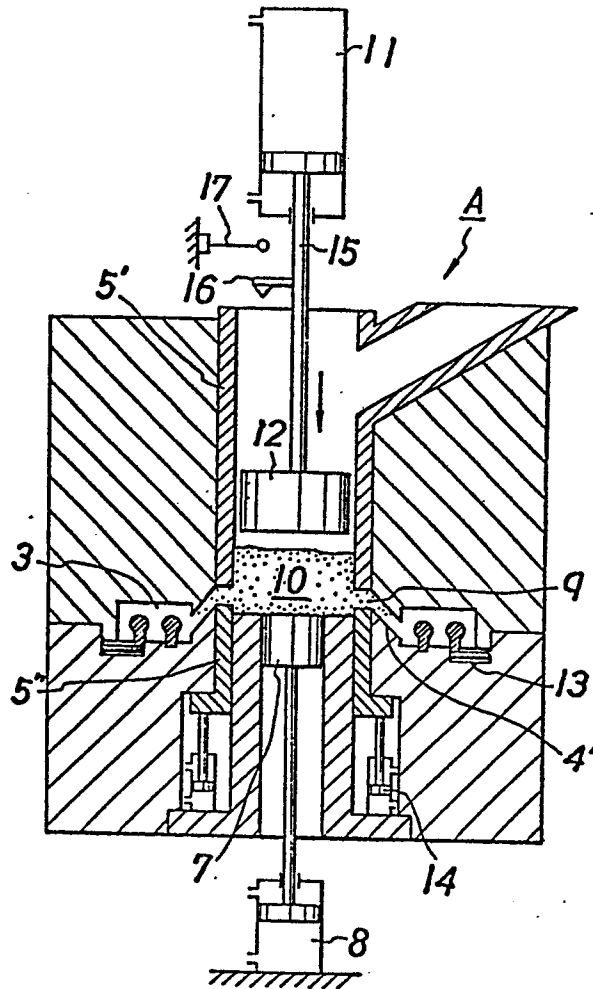


FIG. 4

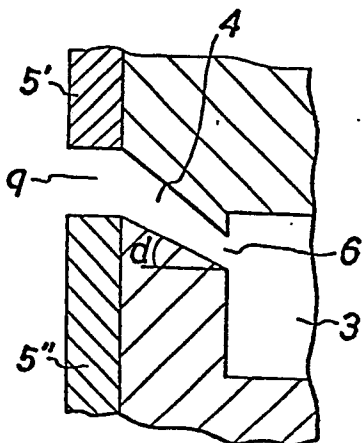
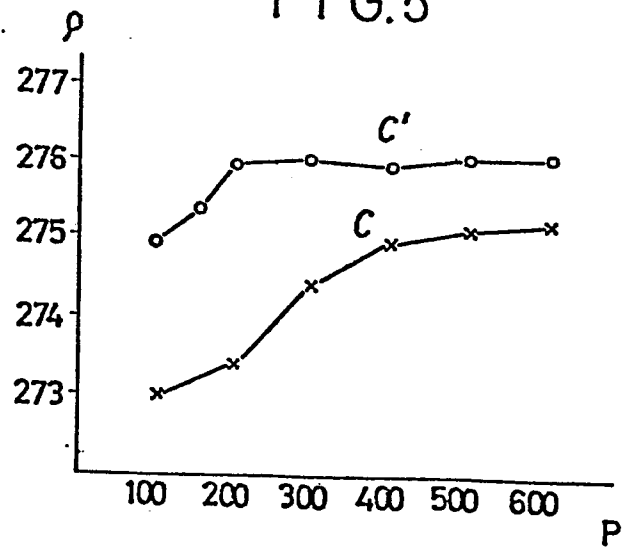


FIG. 5





European Patent
Office

EUROPEAN SEARCH REPORT

0085726

Application number

EP 82 10 0846.3

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	<u>DE - A1 - 2 714 305</u> (O. FRECH WERKZEUGBAU) * claim 1; fig. 1 * ---	1,4	B 22 D 17/12
A	<u>DE - B2 - 2 705 607</u> (UBE INDUSTRIES, LTD.) * claim 1 * ---	1	
A	<u>DE - A1 - 3 000 486</u> (NISSAN MOTOR CO. LTD.) * fig. 4 * & GB - A - 2 040 196 ----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
			B 22 D 17/00
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons
X The present search report has been drawn up for all claims			&: member of the same patent family, corresponding document
Place of search		Date of completion of the search	Examiner
Berlin		20-09-1982	GOLDSCHMIDT