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(19) **United States**(12) **Patent Application Publication**  
**Morikawa et al.**(10) **Pub. No.: US 2012/0325424 A1**(43) **Pub. Date: Dec. 27, 2012**(54) **TILT TYPE GRAVITY MOLDING DEVICE**(52) **U.S. Cl. .... 164/348; 164/271**(76) Inventors: **Shunichi Morikawa**, Higashiosaka-shi  
(JP); **Hirofumi Ide**, Higashiosaka-shi  
(JP); **Tadayuki Yano**, Higashiosaka-shi  
(JP)(57) **ABSTRACT**

To eliminate the need for a riser and for reduction in tilt speed and to enable molten metal contained in a mold to be pressurized by gas appropriately, a tilt type gravity molding device including a mold which can tilt between a fallen position and a standing position raised approximately 90 degrees from the fallen position, a pouring gate mold in which a pouring gate guiding the molten metal to a cavity of a molded article is formed, and a bowl-like member which stores the molten metal and pours the molten metal into the pouring gate in accordance with tilt of the mold includes closing means which is provided between the pouring gate and the cavity and can open and close the pouring gate, a gas inlet 9 which is provided at an upper portion of the mold at the standing position, prevents the molten metal from flowing out of the mold, and allows only gas to pass therethrough, and gas supplying means which allows high-pressure gas to be supplied to the gas inlet.

(21) Appl. No.: **13/521,149**(22) PCT Filed: **Jan. 22, 2010**(86) PCT No.: **PCT/JP2010/050812**

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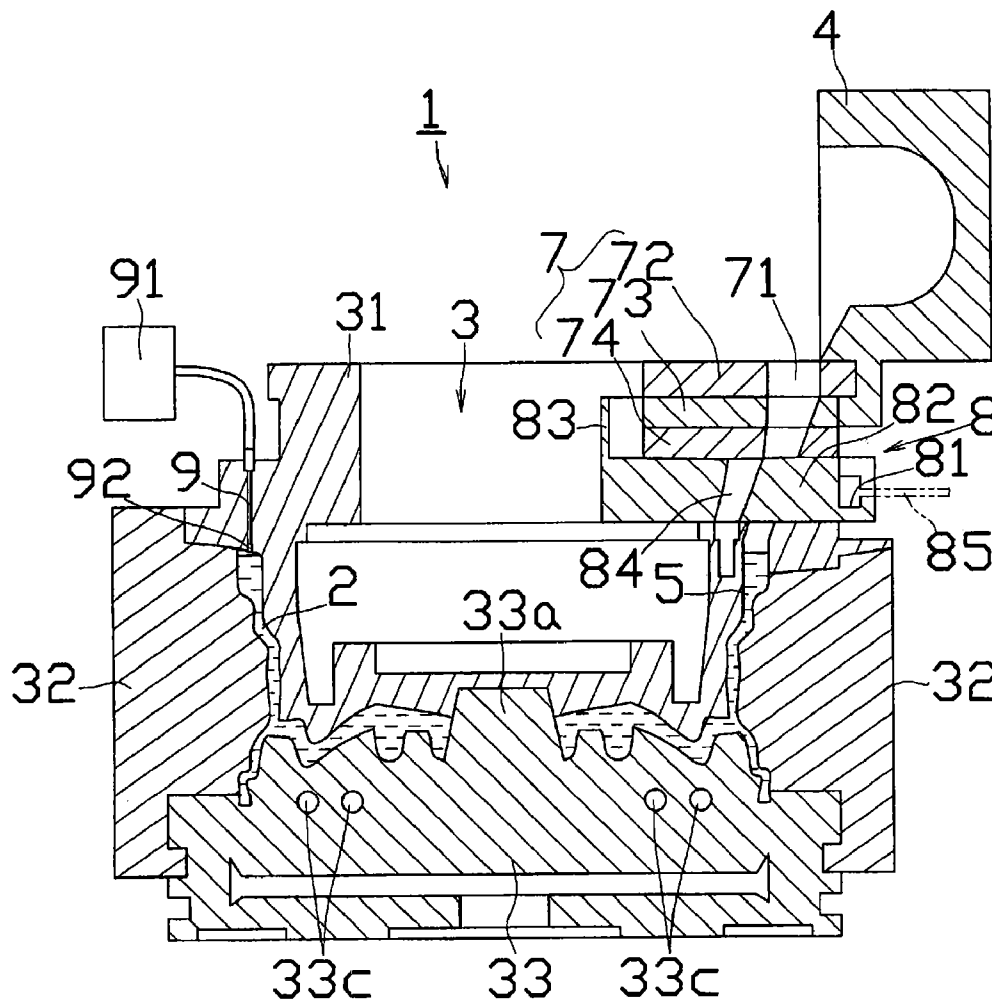
(2), (4) Date: **Jul. 9, 2012****Publication Classification**(51) **Int. Cl.****B22D 45/00** (2006.01)**B22C 9/00** (2006.01)**B22D 27/04** (2006.01)

FIG. 1

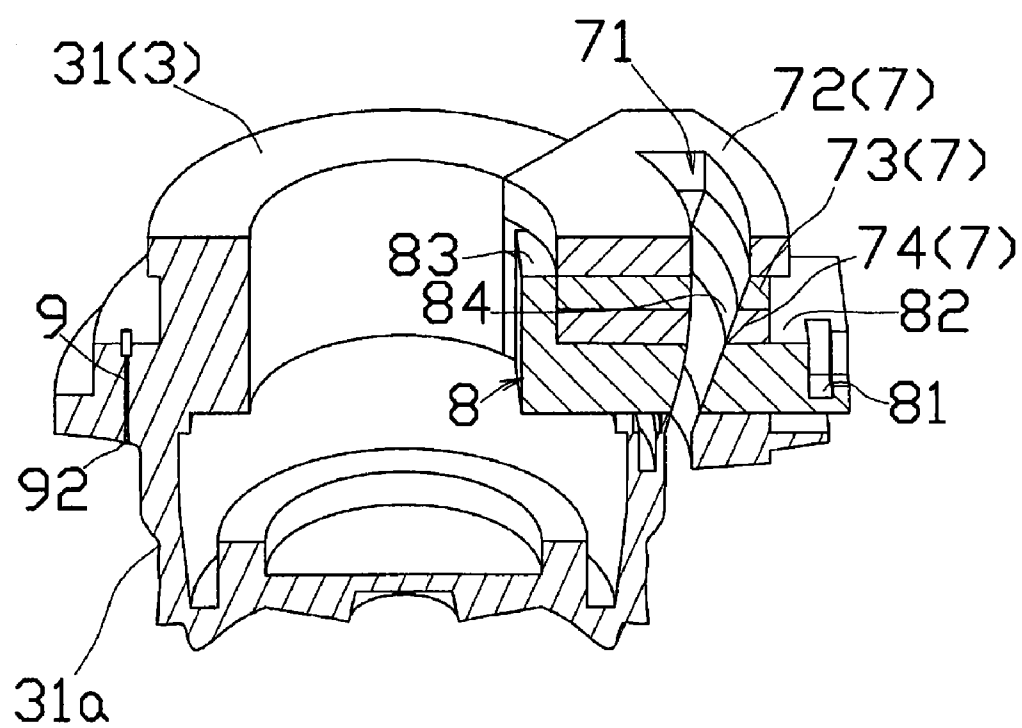


FIG. 2

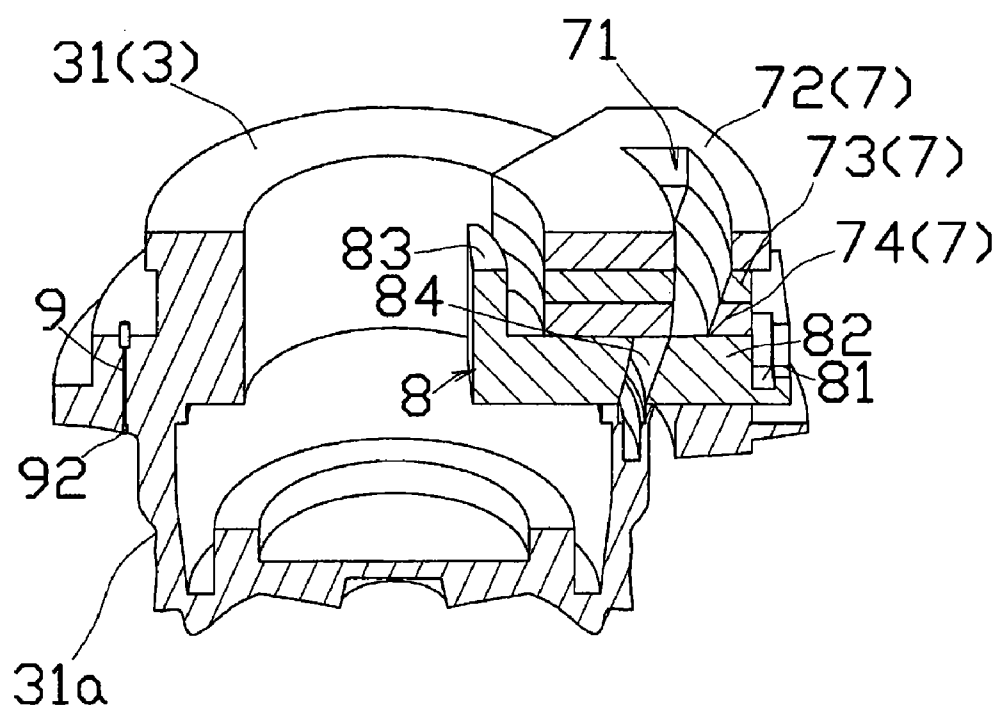


FIG. 3

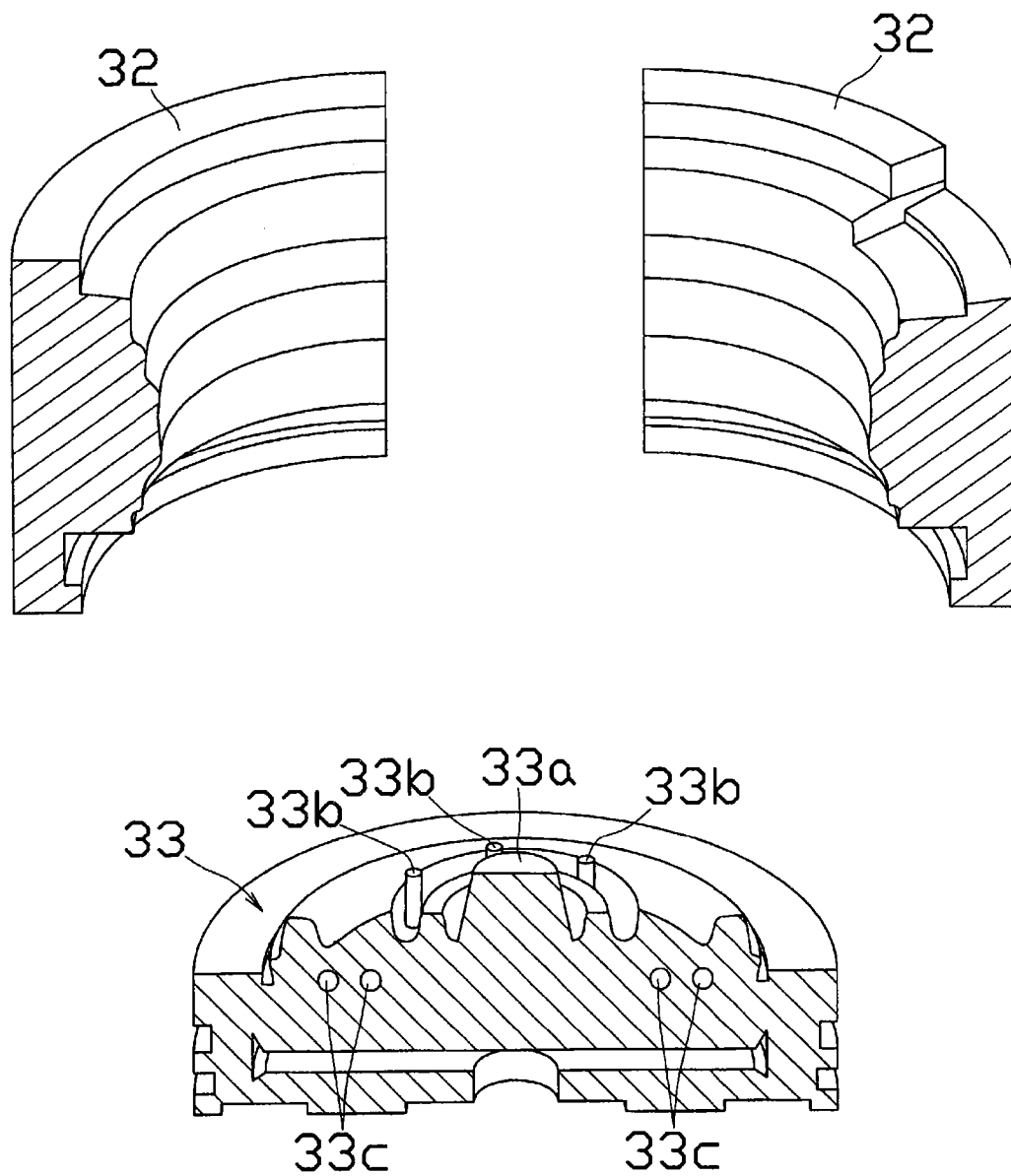


FIG. 4

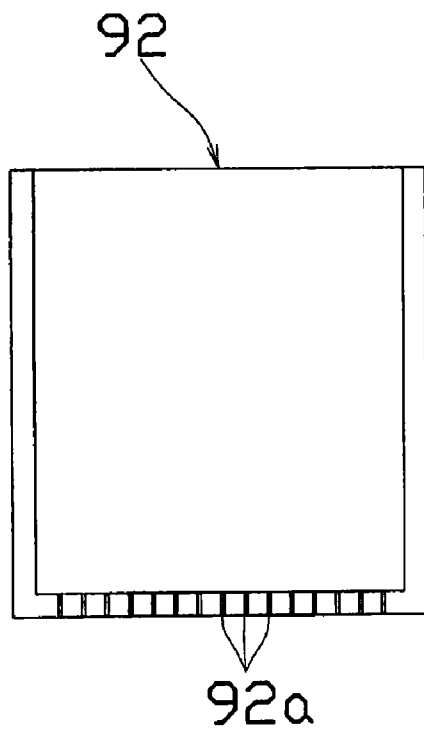
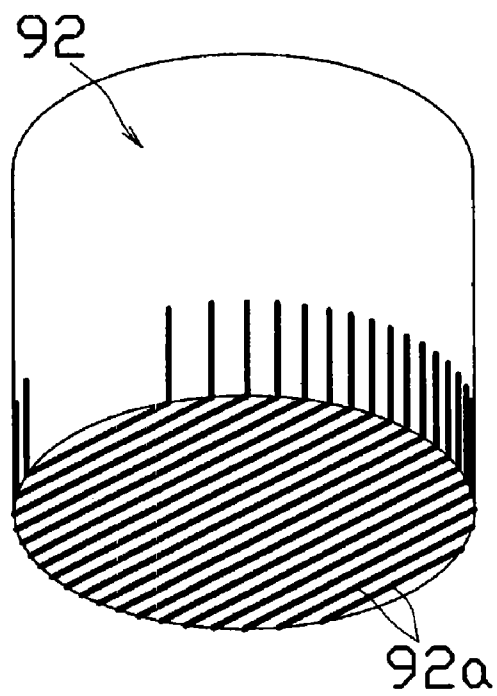


FIG. 5

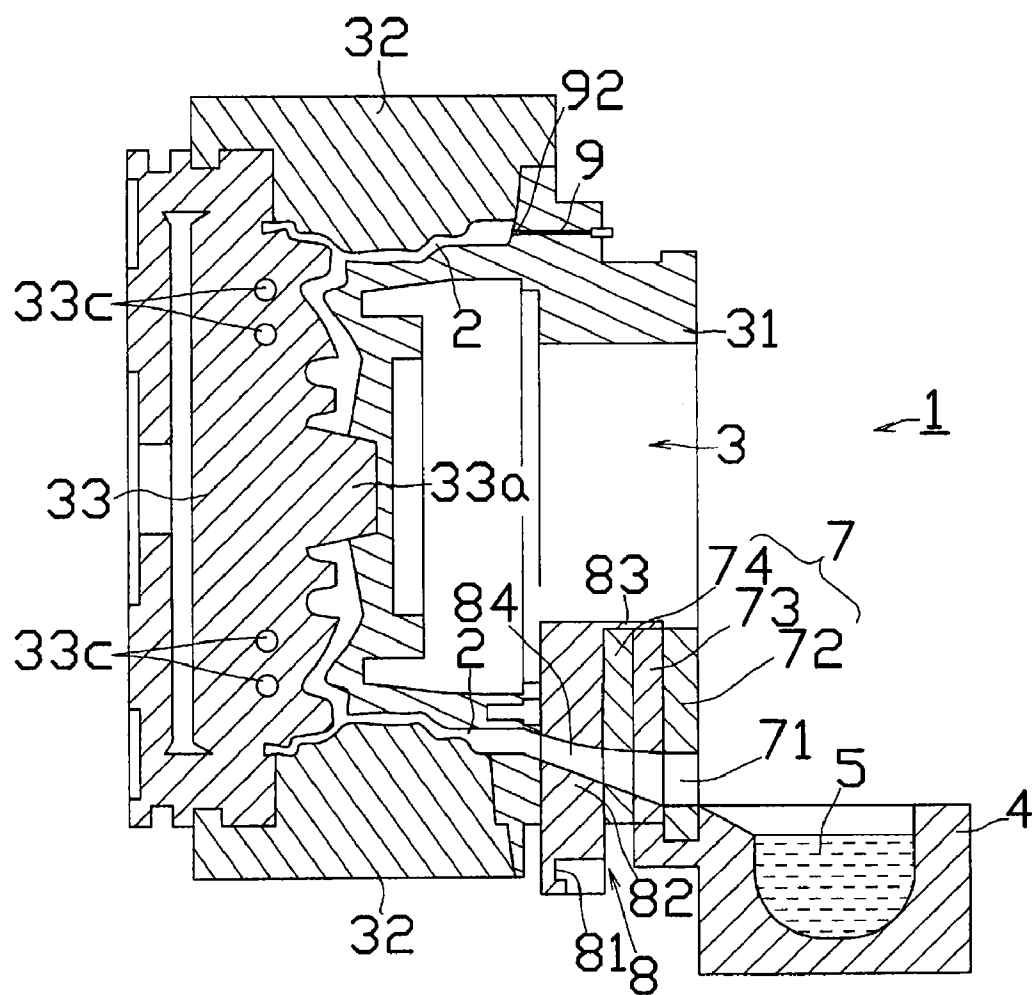


FIG. 6

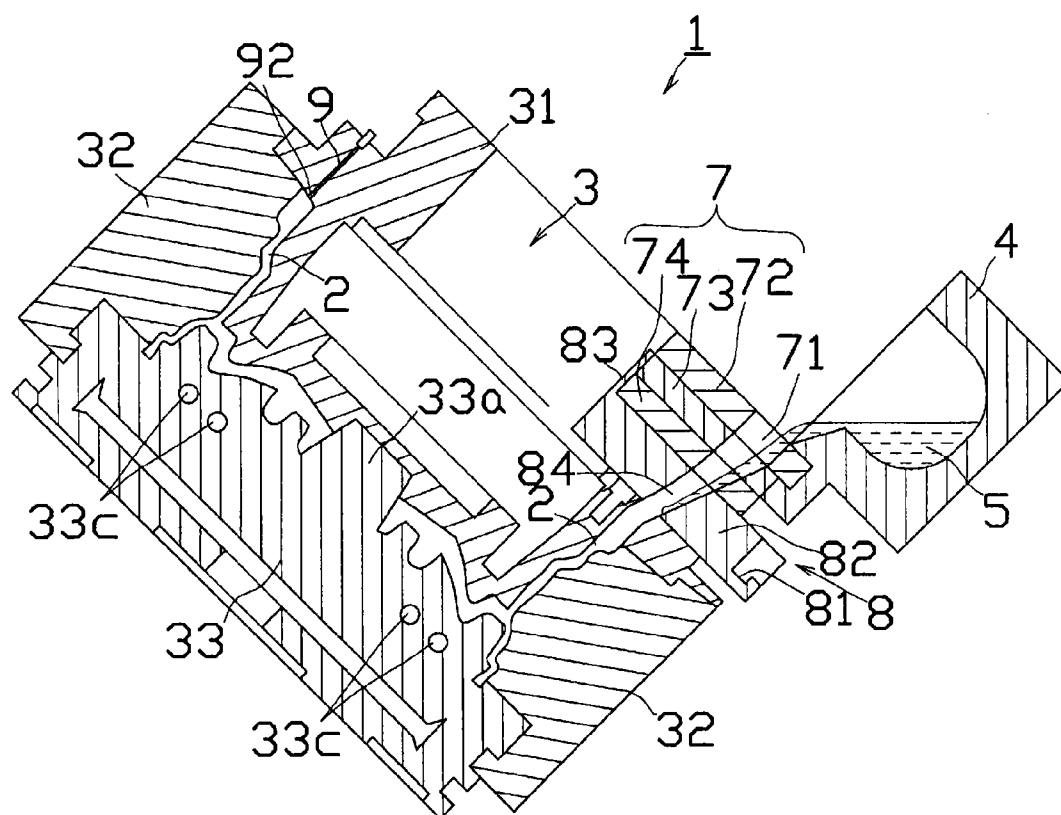


FIG. 7

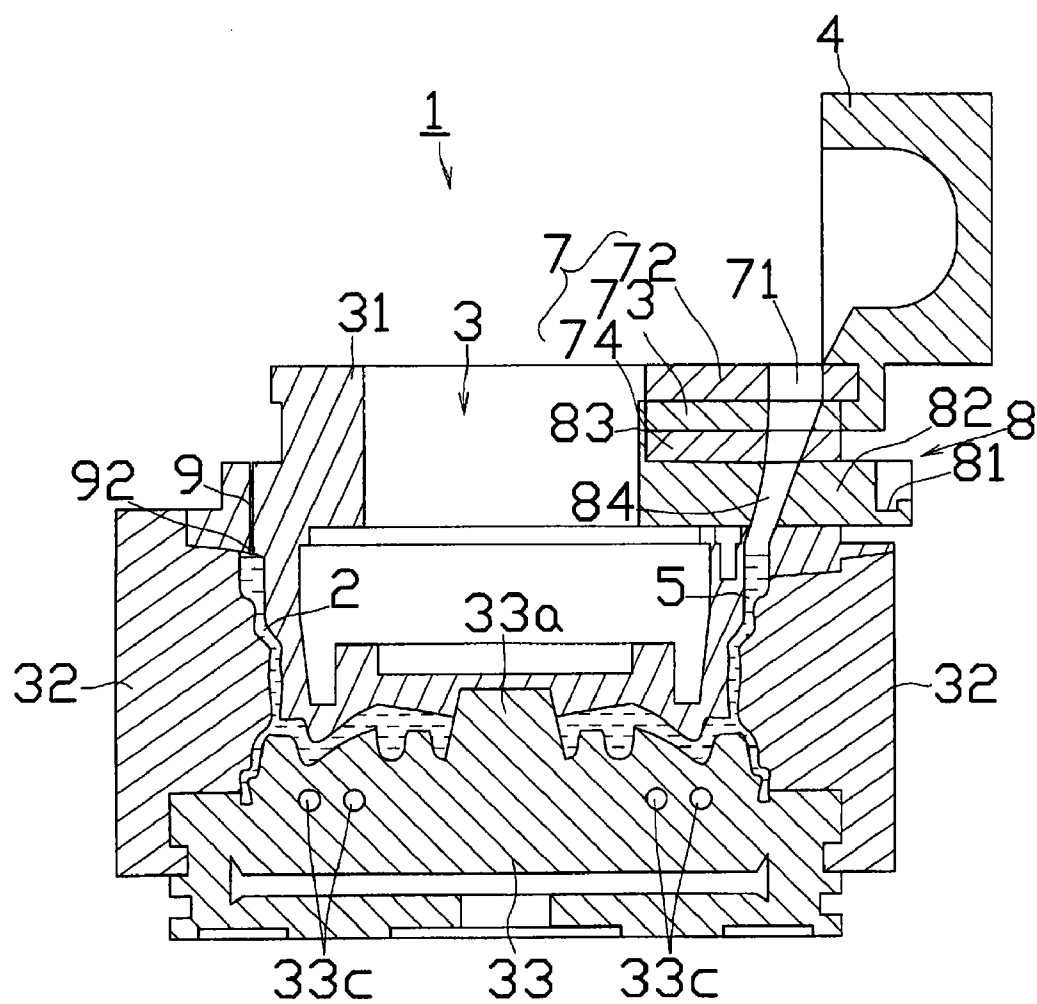


FIG. 8

FIG. 9

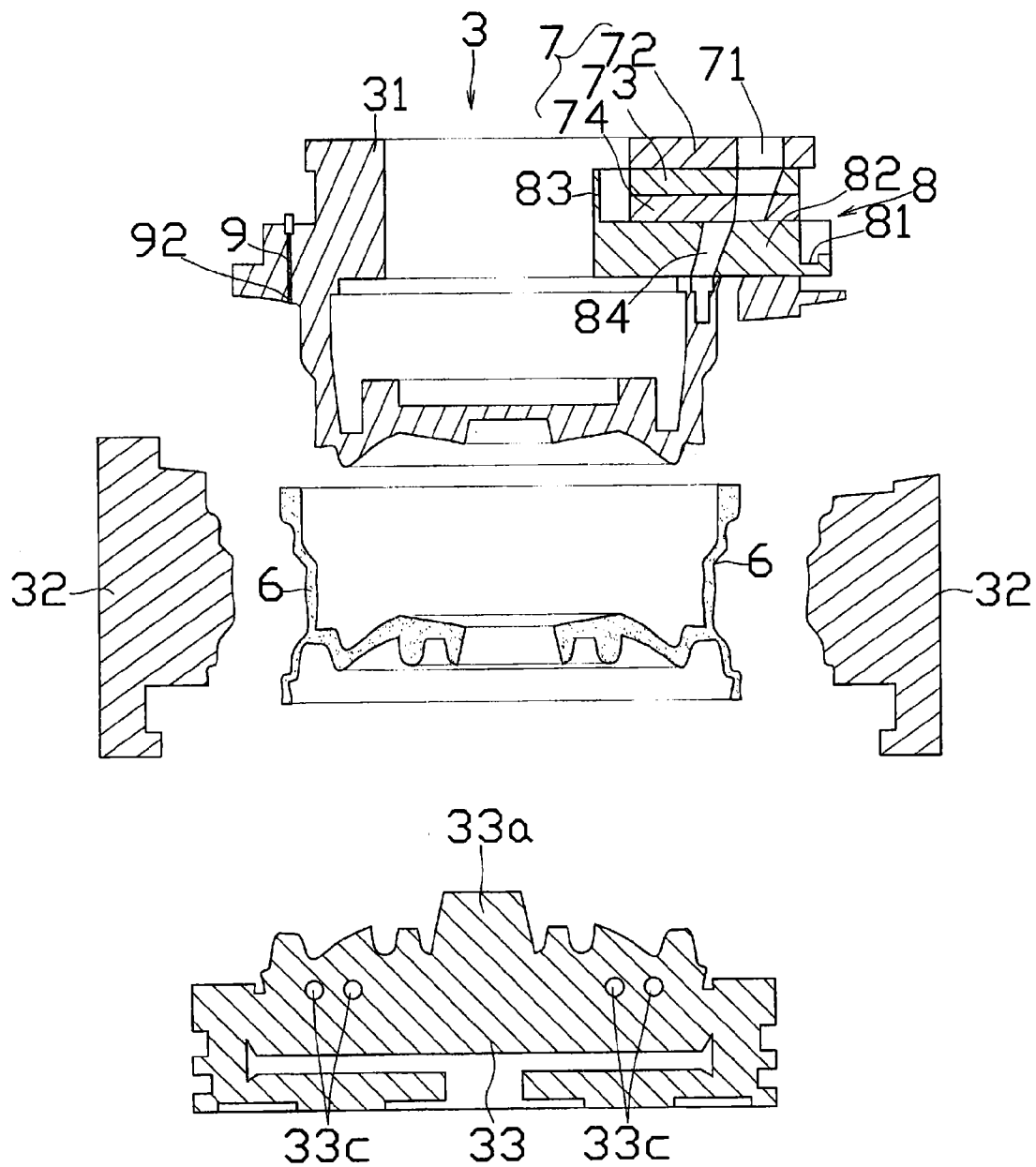


FIG. 10



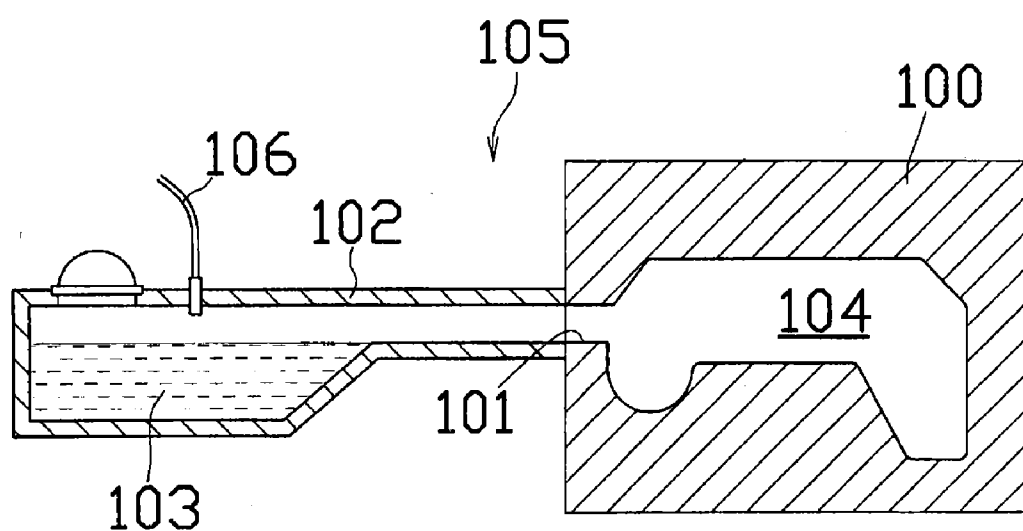


FIG. 12

## TILT TYPE GRAVITY MOLDING DEVICE

### CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is the 35 U.S.C. §371 national stage of PCT application PCT/JP2010/050812, filed Jan. 22, 2010, the disclosure of which is hereby incorporated by reference.

### TECHNICAL FIELD

[0002] The present invention relates to a molding device forming a molded article by pouring molten metal into a mold, and more specifically relates to a tilt type gravity molding device obtaining a molded article by pouring and solidifying molten metal contained in a bowl-like member into a mold in accordance with the tilt of the mold.

### BACKGROUND ART

[0003] A gravity molding device for molding by pouring molten metal into a mold from a pouring gate provided at the upper portion of the mold only with the gravity of the molten metal can raise cooling speed at the time of molding and can produce a precise molded article excellent in a molded surface and dimension accuracy, and the article is especially excellent in pressure resistance and mechanical features. However, such a gravity molding device requires a riser that compensates a decrease in volume at the time of solidifying the molten metal at the upper portion of the molded article and requires time to cool and solidify this riser in addition to time to solidify the molded article. Also, forming the riser requires extra amount of molten metal, extra cost for melting, and extra process cost for cutting of the riser.

[0004] On the other hand, as a molding device that hardly requires the riser is raised a low-pressure molding device. In this low-pressure molding device, molten metal is put in a closed container, is pressurized at a surface thereof by gas at relatively low pressure equal to or lower than 1 atmospheric pressure, is pressed up through a hot water supply tube in a direction opposed to gravity, and is supplied to a mold installed thereon to form a molded article (Non-Patent Document 1). In this device, since the molten metal is pressurized and pressed up, a decrease in volume at the time of solidification is slight, and no riser is required.

[0005] However, in the low-pressure molding device, since the hot water supply tube is installed on the lower side of the mold for pressurization to press up the molten metal from the lower side of the mold, a cooling unit cannot be provided on the lower side of the mold to raise cooling speed at the time of molding, and thus the molded article tends to be lower in strength than in the case of the gravity molding device.

[0006] Under such circumstances, a gravity molding device in which molten metal is poured into a mold, and thereafter gas is supplied to the mold to pressurize the molten metal contained in the mold is proposed. For example, this gravity molding device is a tilt type gravity molding device **105** of a type in which a hopper unit **102** is fixed at a pouring gate **101** formed in a mold **100**, and in which a molten metal **103** is stored in this hopper unit **102** and, when the mold **100** is tilted, the molten metal **103** is poured via the pouring gate **101** into a cavity **104** of the mold **100**, wherein the hopper unit **102** is provided with gas supplying means **106** supplying high-pressure gas, as illustrated in FIG. 12 (e.g., Patent Document 1 and Patent Document 2). In this device, by pouring the molten metal **103** in the hopper unit **102** into the cavity **104** of the

mold **100** and thereafter supplying high-pressure gas to the hopper unit **102**, the molten metal **103** in the cavity **104** is pressurized by gas through the pouring gate **101**, thereby achieving the gravity molding device **105** which requires no riser.

### PRIOR ART REFERENCES

#### Patent Documents

- [0007] Patent Document 1: JP 2008-100275 A
- [0008] Patent Document 2: JP 2008-100276 A
- [0009] Non-Patent Document 1: "Field Technique of Casting," edited and authored by Kenji CHIJIWA, Nikkan Kogyo Shimbun, Ltd., issued on Nov. 5, 1980, P270 to P271

### SUMMARY OF THE INVENTION

#### Problems to be Solved by the Invention

[0010] However, in the gravity molding device **105**, gas pressurization is performed from the pouring gate **101** for supplying the molten metal **103**, and thus adjustment of gas flow speed and the like at the time of gas pressurization is difficult. Also, the gravity molding device **105** is configured to supply the molten metal **103** from the pouring gate **101** while discharging air therefrom, and thus when the supply speed of the molten metal **103** is too high, the pouring gate **101** is covered with the molten metal **103**, which may prevent air in the cavity **104** from being discharged. Thus, tilt speed needs to be lowered.

[0011] It is an object of the present invention to provide a tilt type gravity molding device that dispenses with a riser, does not need to lower tilt speed, and can appropriately pressurize by gas molten metal contained in a mold.

#### Solutions to the Problems

[0012] A tilt type gravity molding device according to the present invention includes a mold which forms a cavity forming a molded article and can tilt between a fallen position and a standing position raised approximately 90 degrees from the fallen position, a pouring gate mold in which a pouring gate guiding molten metal to the cavity is formed, a bowl-like member which stores the molten metal and pours the molten metal into the pouring gate in accordance with the tilt of the mold, closing means which is provided between the pouring gate and the cavity of the mold and can open and close the pouring gate, a gas inlet which is provided at an upper portion of the mold at the standing position and has a gas valve preventing the molten metal from flowing out of the mold and allowing gas to pass therethrough, and gas supplying means which allows high-pressure gas to be supplied to the gas inlet.

[0013] Also, the tilt type gravity molding device according to the present invention further includes cooling means which can cool the mold.

[0014] Also, in the tilt type gravity molding device according to the present invention, a plurality of gas inlets, each of which is identical with the gas inlet, are provided at regular intervals from one another.

[0015] Also, in the tilt type gravity molding device according to the present invention, the molded article is a tire wheel.

[0016] Also, in the tilt type gravity molding device according to the present invention, the pouring gate can be divided at least into plural pieces.

## Effects of the Invention

[0017] With the tilt type gravity molding device according to the present invention, by supplying the molten metal from the bowl-like member via the pouring gate to the mold, thereafter closing the pouring gate by the closing means, and supplying high-pressure gas in the mold from the gas inlets by the gas supplying means, the molten metal contained in the mold can be pressurized by gas. Accordingly, since no riser needs to be provided, molding time can be shortened by time for cooling and solidifying the riser, thereby reducing cost for producing the molded article. Also, the amount of molten metal for forming the riser, the cost for melting, and the process cost for cutting of the riser can be reduced.

[0018] Also, when the mold is tilted to pour the molten metal into the mold from the bowl-like member, air in the mold can be discharged to the outside via the gas inlets, and thus the pouring gate can be used only for pouring of the molten metal, which can raise tilt speed.

[0019] Also, with the tilt type gravity molding device according to the present invention, since the molten metal poured in the mold can be cooled by the cooling means, hardness of the molded article can be enhanced. Further, cooling in this manner can contribute to shortening of solidification time and further reduction in molding cost.

[0020] Also, with the tilt type gravity molding device according to the present invention, since the plurality of gas inlets are provided at regular intervals from one another, gas can be applied to the molten metal more uniformly. Accordingly, a problem in which the molten metal around the gas inlets is solidified in a hollowed state can be restricted.

[0021] Moreover, with the tilt type gravity molding device according to the present invention, while uniform gas pressurization is difficult in a conventional gravity molding device since the molded article is an annular tire wheel, gas can be uniformly applied to the molten metal since the plurality of gas inlets are provided at regular intervals separately from the pouring gate.

[0022] Also, with the tilt type gravity molding device according to the present invention, the pouring gate can be divided into plural pieces, which facilitates removal of the molten metal by dividing the pouring gate even in a case where the molten metal is too much so that it is solidified in the pouring gate.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. 1 is a cross-sectional view illustrating an example of a gravity molding device according to the present invention.

[0024] FIG. 2 is a perspective view in which a half on the near side has been cut along a vertical plane for description of configurations of a pouring gate mold, closing means, and an upper mold.

[0025] FIG. 3 is a perspective view illustrating a state in which the closing means closes a pouring gate in the perspective view in FIG. 2.

[0026] FIG. 4 is a perspective view in which a half on the near side has been cut along a vertical plane for description of configurations of a side mold and a lower mold.

[0027] FIG. 5 is a perspective view and a cross-sectional view describing a gas valve provided in a gas inlet.

[0028] FIG. 6 is a cross-sectional view illustrating the tilt type gravity molding device in a fallen state in which the pouring gate is opened to be directed laterally.

[0029] FIG. 7 is a cross-sectional view illustrating a state in which the tilt type gravity molding device is being tilted by operating a tilt unit.

[0030] FIG. 8 is a cross-sectional view illustrating the tilt type gravity molding device in a standing state in which the pouring gate is opened to be directed upward.

[0031] FIG. 9 is a cross-sectional view illustrating a state in which the closing means is slid to close the pouring gate of the pouring gate mold.

[0032] FIG. 10 is a cross-sectional view illustrating a state in which the upper mold, the side mold, and the lower mold are respectively separated to take out a molded article.

[0033] FIG. 11 is a cross-sectional view illustrating a state in which the pouring gate mold is divided.

[0034] FIG. 12 is a cross-sectional view illustrating an example of a conventional gravity molding device.

## EMBODIMENTS OF THE INVENTION

[0035] Preferred embodiments of a tilt type gravity molding device 1 will be described with reference to the drawings. Although the present embodiment will be described taking as an example the tilt type gravity molding device 1 molding a tire wheel (molded article 6) made of an aluminum alloy, the tilt type gravity molding device 1 may be one molding another member such as an engine cylinder of an automobile. The tilt type gravity molding device 1 includes a mold 3 which forms a cavity 2 forming the molded article 6 by connecting by an oil hydraulic cylinder a plurality of metal materials that can be disassembled, the mold 3 being able to tilt between a fallen position and a standing position raised approximately 90 degrees from the fallen position, a bowl-like member 4 which stores molten metal 5 such as an aluminum alloy, a pouring gate mold 7 which is formed at the upper portion of the mold 3 at the standing position and in which a pouring gate 71 receiving the molten metal 5 is formed, closing means 8 which can open and close the pouring gate 71, gas inlets 9 which are formed at the upper portion of the mold 3 at the standing position separately from the pouring gate 71, and gas supplying means 91 which allows high-pressure gas to flow in the mold 3 from the gas inlets 9, as illustrated in FIG. 1.

[0036] The mold 3 is configured by an upper mold 31, a lower mold 33, and a side mold 32 which can be divided into four pieces. Movement of the upper mold 31, the lower mold 33, and the side mold 32 is respectively controlled by an oil hydraulic jack (not shown), and the oil hydraulic jack is controlled so that the respective molds may come into close contact with one another when they form the mold 3. The mold 3 as well as the oil hydraulic jack is fixed to a tilt unit (not shown) and can tilt at least up to 90 degrees.

[0037] The upper mold 31 is formed in a bowl shape so that an external surface 31a may form an inner circumferential surface of a rim and an inner surface of a disk of the tire wheel (molded article 6) as illustrated in FIGS. 1 and 2. At the upper end of this upper mold 31 is fixed the pouring gate mold 7 in which the pouring gate 71 enabling the molten metal 5 to be poured therein is formed, and on this pouring gate mold 7 is also fixed the bowl-like member 4. Also, at the upper portion of the upper mold 31 are annularly arranged the gas inlets 9 at predetermined intervals.

[0038] The lower mold 33 is formed so that the upper side may form a shape of an outer surface of the disk of the tire wheel (molded article 6) and is connected with the upper mold 31 by a hub hole forming portion 33a projected at the

center and wheel-fixing bolt hole forming portions **33b** provided around this hub hole forming portion **33a** as illustrated in FIGS. 1 and 4. Moreover, the lower mold **33** is provided inside with air-cooling type cooling means **33c**, which can cool the molten metal **5** at the time of molding. The side mold **32** has the inner circumference formed approximately in a cylindrical shape forming a shape of an outer circumferential surface of the rim of the tire wheel (molded article **6**) and is divided into four members almost equally. The lower part of this side mold **32** abuts on and is fixed to the outer circumference of the lower mold **33**.

[0039] The bowl-like member **4** is formed in a bowl shape and is fixed to the upper end of the upper mold **31** of the mold **3** in a 90-degree tilted state when the mold **3** is held in a standing state as illustrated in FIG. 1. Also, the pouring gate mold **7** is a metal member provided with the pouring gate **71** which receives the molten metal **5** and guides the molten metal **5** to the cavity **2** in the mold **3** as illustrated in FIGS. 2 and 7. This pouring gate mold **7** can be divided into three pieces: an upper member **72**, a middle member **73**, and a lower member **74**, and is formed by fixing them with a bolt, for example, as illustrated in FIG. 11. The pouring gate mold **7** is also fixed on the upper mold **31** with a bolt. The pouring gate mold **7** can be divided into three pieces in this manner, which facilitates removal of the molten metal **5** by dividing the pouring gate mold **7** even in a case where the molten metal **5** is too much so that it is solidified in the pouring gate **71** as illustrated in FIG. 11.

[0040] The closing means **8** is a metal member slidably installed between the pouring gate mold **7** and the cavity **2** of the mold **3** and has a connecting portion **81** which can connect thereto a oil hydraulic jack **85** (not shown) for sliding of the closing means, a main body portion **82** in which a through hole **84** communicated with the pouring gate **71** of the pouring gate mold **7** is formed at a center thereof, and a stopper **83** which can fix the closing means **8** in a state in which this through hole **84** is aligned with the pouring gate **71** of the pouring gate mold **7**, as illustrated in FIGS. 1, 2, and 9. When this closing means **8** is pulled with use of the oil hydraulic jack **85** for sliding of the closing means, the closing means **8** is pulled out to a position at which the stopper **83** abuts on the inner circumferential surface of the pouring gate mold **7** as illustrated in FIG. 2. At this time, the through hole **84** of the closing means **8** is in a state of being aligned with the pouring gate **71** of the pouring gate mold **7**, and thus the pouring gate mold **7** is communicated with the cavity **2**. Accordingly, the molten metal **5** received in the pouring gate mold **7** from the bowl-like member **4** can be guided to the cavity **2**. On the other hand, when the closing means **8** is pushed with use of the oil hydraulic jack **85** for sliding of the closing means, the pouring gate **71** of the pouring gate mold **7** is closed as illustrated in FIG. 3. This prevents the cavity **2** from being communicated with the pouring gate **71** and prevents gas in the cavity **2** from flowing out of the pouring gate **71**.

[0041] Meanwhile, as for the closing means **8**, the surface abutting on the lower member **74** of the pouring gate mold **7** is formed to be slightly sloped down toward the through hole **84** so that a portion around the through hole **84** may be fallen most. Further, the surface of the lower member **74** of the pouring gate mold **7** abutting on the closing means **8** is slightly inclined toward the pouring gate **71** so that a portion around the pouring gate **71** may be raised most. With this configuration, when the closing means **8** is slid to close the pouring gate **71** of the pouring gate mold **7**, the closing means

**8** and the lower member **74** of the pouring gate mold **7** will come into close contact with each other more tightly, which can prevent the molten metal **5** from entering between the closing means **8** and the pouring gate mold **7**.

[0042] Each gas inlet **9** is an elongated hole communicating an outside with the cavity **2** formed in the upper mold **31** separately from the pouring gate mold **7** as illustrated in FIG. 1. The gas inlet **9** is provided on the side of the cavity **2** with a gas valve **92** which lets gas pass therethrough and prevents the molten metal **5** from flowing outside. The gas valve **92** is a bottomed cylindrical metal part and has formed on a bottom thereof a plurality of narrow slits **92a** as illustrated in FIG. 5. While gas such as air can freely pass through these slits **92a**, the molten metal **5** such as an aluminum alloy resists against passing of the molten metal **5** through the slits **92a** since the molten metal **5** has high surface tension and is difficult to attach to other objects, so that the molten metal **5** never pass through the gas valve **92**. The gas supplying means **91** is adapted to supply the cavity **2** with rare gas such as helium or argon or air via the gas inlets **9** with high pressure.

[0043] When a molded article is to be formed with use of the tilt type gravity molding device **1** configured as above, the oil hydraulic jack (not shown) is first controlled to hold the mold **3** in a fallen state. Here, the fallen state is a state in which the mold **3** is tilted so that a part provided with the pouring gate **71** may be directed laterally, and the pouring gate **71** is held to be located below the cavity **2**. At this time, the bowl-like member **4** is fixed on the pouring gate mold **7** in a state in which an upper portion thereof is opened. Also, the closing means **8** is held so that the pouring gate **71** of the pouring gate mold **7** may be in an opened state. Subsequently, the molten metal **5** of the aluminum alloy controlled at a predetermined temperature is poured and stored into the bowl-like member **4** by a ladle (not shown).

[0044] Subsequently, the tilt unit (not shown) is controlled to gradually tilt the mold **3** to reach the standing state. As illustrated in FIG. 7, the molten metal **5** stored in the bowl-like member **4** passes through the pouring gate **71** of the pouring gate mold **7**, also passes through the through hole **84** of the closing means **8**, and is poured into the cavity **2**, and in the standing state, the molten metal **5** is filled in the cavity **2** as illustrated in FIG. 8.

[0045] Subsequently, as illustrated in FIG. 9, the oil hydraulic jack **85** for sliding of the closing means is controlled to push the closing means **8** so as to close communication between the pouring gate **71** of the pouring gate mold **7** and the cavity **2**. Thereafter, as illustrated in FIG. 1, gas supply tubes are connected to all the gas inlets **9** formed in the upper mold **31**, and the gas supplying means **91** is controlled to supply high-pressure gas in the cavity **2**. Subsequently, the cooling means **33c** provided in the lower mold **33** is activated to cool the molten metal **5** contained in the cavity **2**.

[0046] When the molten metal **5** is cooled and solidified, the oil hydraulic jack (not shown) is controlled to separate the upper mold **31** upward from the molded article **6** and separate the side mold **32** in four directions. This molded article **6** is then detached from the lower mold **33**, and thus the molded article **6** can be obtained.

[0047] As described above, with the tilt type gravity molding device **1** according to the present embodiment, when the mold **3** is tilted to pour the molten metal **5** into the pouring gate **71** from the bowl-like member **4**, air in the cavity **2** can be discharged to the outside via the gas inlets **9**. Thus, the pouring gate **71** can be used only for pouring of the molten

metal **5**, and the molten metal **5** can be poured entirely into the pouring gate **71**, which can raise tilt speed of the mold **3**. Furthermore, by supplying high-pressure gas into the cavity **2** from the gas inlets **9** by the gas supplying means **91**, the molten metal **5** contained in the cavity **2** can be pressurized by gas, and no riser needs to be provided. Accordingly, molding time can be shortened by time for cooling and solidifying the riser, which can reduce cost for producing the molded article **6**. Furthermore, the amount of molten metal for forming the riser, the cost for melting, and the process cost for cutting of the riser can be reduced.

**[0048]** Further, since the molten metal **5** poured in the mold **3** can be cooled by the air-cooling type cooling means **33c** formed in the lower mold **33**, hardness of the molded article **6** can be enhanced, and the molded article **6** which exerts a desired strength with less amount of material and lower weight can be molded. Moreover, cooling in this manner can contribute to shortening of solidification time and further reduction in molding cost.

**[0049]** Since the gas inlets **9** are annularly provided at regular intervals in a successive manner in the upper mold **31**, gas can be applied to the molten metal **5** more uniformly, and a problem in which the molten metal **5** around the gas inlets **9** is solidified in a hollowed state can be restricted.

**[0050]** It is to be understood that embodiments of the present invention are not limited to the above embodiments and can be altered arbitrarily without departing from the scope and spirit of the present invention.

#### INDUSTRIAL APPLICABILITY

**[0051]** The tilt type gravity molding device **1** according to the present invention can be preferably used as a molding device which molds a molded article of an aluminum alloy, for example.

#### DESCRIPTION OF REFERENCE SIGNS

**[0052]** **1** tilt type gravity molding device  
**[0053]** **2** cavity  
**[0054]** **3** mold

**[0055]** **4** bowl-like member  
**[0056]** **5** molten metal  
**[0057]** **6** molded article  
**[0058]** **7** pouring gate mold  
**[0059]** **8** closing means  
**[0060]** **9** gas inlet  
**[0061]** **33c** cooling means  
**[0062]** **71** pouring gate

**1.** A tilt type gravity molding device comprising:

a mold which forms a cavity forming a molded article and tilts between a fallen position and a standing position raised approximately 90 degrees from the fallen position;

a pouring gate mold in which a pouring gate guiding molten metal to the cavity is formed;

a bowl-like member which stores the molten metal and pours the molten metal into the pouring gate in accordance with the tilt of the mold;

closing means which is provided between the pouring gate and the cavity of the mold and can open and close the pouring gate;

a gas inlet which is provided at an upper portion of the mold at the standing position and has a gas valve preventing the molten metal from flowing out of the mold and allowing gas to pass therethrough; and

gas supplying means which allows high-pressure gas to be supplied to the gas inlet.

**2.** The tilt type gravity molding device according to claim **1**, further comprising cooling means which can cool the mold.

**3.** The tilt type gravity molding device according to claim **1**, wherein a plurality of gas inlets, each of which is identical with the gas inlet, are provided at regular intervals from one another.

**4.** The tilt type gravity molding device according to claim **1**, wherein the molded article is a tire wheel.

**5.** The tilt type gravity molding device according to claim **1**, wherein the pouring gate is divided at least into plural pieces.

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