

DESCRIPTION

MOLD APPARATUS FOR MOLDING METAL IN HIGH VACUUM ENVIRONMENT

5 **Technical Field**

The present invention generally relates to a mold device for forming metal. More particularly, the present invention relates to a mold device able to form metal in a high-level vacuum environment created within a metal-forming cavity.

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Background Art

Metal is formed by a variety of methods, typical examples of which include mold casting and forging. Casting and forging are suitable for mass production since metal can be
15 rapidly and accurately formed thereby.

A mold device for casting or forging has a cavity, a space in which a product is formed, formed by a movable mold and a fixed mold assembled together. After metal is melted by heating, resultant molten metal is injected into the cavity to
20 fill the cavity (casting) or is solidified by pressurizing the molten metal (forging). Afterwards, the movable mold is separated from the fixed mold, and a formed product is subsequently taken out.

In this case, the operation of taking out the formed
25 product is performed by removing the formed product from the

movable mold using ejector pins. When the movable mold is separated from the fixed mold, the formed product remains attached to the movable mold. Since the length of the ejector pins extends through the movable mold to the cavity, the
5 ejector pins are moved towards the cavity by a cylinder to push the formed product, thereby detaching the formed product from the movable mold.

In the process of forming molten metal, the molten metal rapidly oxides through contact with air, and at the same time,
10 impurities intrude into the molten metal, thereby forming dross. Although the dross reduces the contact of the molten metal with the air, the dross obstructs continuous stirring during melting of the metal, thereby making it difficult to continuously supply high-quality molten metal. In order to overcome this
15 problem, mold devices for forming metal in a vacuum environment have been proposed. An example was disclosed in Korean Patent Application Publication No. 10-2004-0103251 (December 8, 2004) *"DIE CASTING DEVICE FOR PROVIDING IMPROVED VACUUM LEVEL IN FORMING PROCESS."*

20 However, in the mold device for forming metal in a vacuum environment in which the ejector pins take out a formed product, it is difficult create a high-level vacuum environment within the cavity, which is problematic. This is because a minute gap must be formed between each of the ejector pins and a hole
25 through which the ejector pin extends such that the ejector pin

can reciprocate through the movable mold, and thus atmospheric air enters the cavity through the gap.

Disclosure

5 Technical Problem

Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide a mold device able to effectively prevent atmospheric air from entering a cavity through a gap between an ejector pin and a hole through which the ejector pin extends, whereby metal can be formed in a high-level vacuum environment maintained within the cavity.

Technical Solution

15 In order to accomplish the above object(s), the present invention provides packing between the ejector pin and the hole through which the ejector pin extends in order to prevent air from entering the cavity when creating a vacuum environment within the cavity.

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Advantageous Effects

According to the present invention, the metal can be formed in a high-level vacuum environment created in the metal-forming space. It is therefore possible to prevent the properties of the molten metal from changing through contact

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with the air and to minimize the damage in the packing caused by heat, the packing being disposed to prevent the atmospheric air from entering the metal-forming space. Since inexpensive packing may be used, the metal-forming operation can be
5 performed in an economic high-level vacuum environment.

Description of Drawings

FIG. 1 is an exemplary view schematically illustrating the configuration of a mold device according to the present
10 invention;

FIG. 2 is an exploded view of part "A" in FIG. 1;

FIG. 3 is a cross-sectional view of part "A" in FIG. 1;

FIG. 4 is a cross-sectional view of part "B" in FIG. 1;

FIG. 5 is a cross-sectional view of part "C" in FIG. 1;

15 FIG. 6 is an exemplary view schematically illustrating the configuration of a mold device according to another embodiment of the present invention; and

FIGS. 7 to 10 are exemplary views illustrating a process of forming a metal product using the mold device according to
20 the present invention.

Mode for Invention

The present invention provides a mold device able to effectively prevent atmospheric air from entering a cavity
25 through a gap between an ejector pin and a hole through which

the ejector pin extends, whereby metal can be formed in a high-level vacuum environment maintained within the cavity.

In the mold device, a cavity is formed in the portion in which a movable mold adjoins a fixed mold, and an ejector pin
5 extends through the movable mold to the cavity. After a vacuum environment is created within the cavity using an exhaust unit, molten metal is filled into the cavity where it is formed into a product. The ejector pin pushes out the formed product.

10 Packing is disposed between the ejector pin and a hole through which the ejector pin extends in order to prevent air from entering the cavity when creating a vacuum environment within the cavity. A blocking space is formed forward of the packing to block the transfer of heat to the packing.

15 The present invention will now be described in greater detail with reference to FIGS. 1 to 10.

FIG. 1 is an exemplary view schematically illustrating the configuration of a mold device according to the present invention, FIG. 2 is an exploded view of part "A" in FIG. 1,
20 FIG. 3 is a cross-sectional view of part "A" in FIG. 1, FIG. 4 is a cross-sectional view of part "B" in FIG. 1, and FIG. 5 is a cross-sectional view of part "C" in FIG. 1.

As illustrated in the drawings, the mold device according to the present invention includes a fixed mold 110 and a
25 movable mold 120. A cavity 130, or a space in which molten

metal is filled and formed, is defined in the portion in which the movable mold 120 adjoins the fixed mold 110. A pressing-melting part 132 in which metal is to be heated is provided in the lower part of the cavity 130. A pressing plunger 170 is
5 disposed in the pressing-melting part 132 in order to push molten metal produced in the pressing-melting part 132 into the cavity 130, such that the molten metal fills the cavity 130.

The fixed mold 110 is a mold that is fixed in position. The movable mold 120 is configured to move forwards, i.e. move
10 in the direction toward the fixed mold 110, or move backwards, i.e. move in the direction away from the fixed mold 110. When the movable mold 120 moves backwards, the cavity 130 is opened.

Ejector pins 140 serving to remove a formed product from the cavity 130 are provided on the movable mold 120. The
15 ejector pins 140 are in a rod shape, preferably, having a circular cross-section. One or a plurality of ejector pins may be provided. The ejector pins 140 extend through the movable mold 120, with the distal ends reaching the cavity 130. The ejector pins 140 are configured to move forwards in the
20 direction in which the distal ends protrude or move backwards in the opposite direction, such that the distal ends thereof protrude from the cavity 130 to detach the formed product from the movable mold 120.

The cavity 130 is subjected to a vacuum environment. Air
25 is drawn from the cavity 130 using an exhaust unit 190 that is

separately provided, thereby creating the vacuum environment. The exhaust unit 190 draws the air through at least one exhaust pipe, thereby creating the vacuum environment within the cavity 130.

5 Packing P3 is disposed along the outer circumference of the cavity 130, in the portion in which the movable mold 120 adjoins the fixed mold 110, as illustrated in FIG. 5. This configuration prevents atmospheric air from entering the cavity 130 during the process of creating a vacuum environment within
10 the cavity 130 or after the vacuum environment is created within the cavity 130.

 In addition, according to the present invention, packing P1 is disposed between each of the ejector pins 140 and a hole through which the ejector pin 140 extends. This configuration
15 can block air that would otherwise enter the cavity 130 through the hole, thereby creating a vacuum environment within the cavity 130.

 The packing P1 is disposed in the entrance of the hole through which the ejector pin 140 extends. In this case, as
20 illustrated in FIGS. 2 and 3, a packing recess 122 in which the packing P1 is seated is formed in the entrance of the hole, such that the packing P1 is accommodated in the packing recess 122 without being externally exposed. A washer ring 124 is fitted into the entrance of the packing recess 122 in order to
25 prevent the packing P1 from being dislodged from the packing

recess 122.

The packing recess 122 is in a funnel shape, with the diameter gradually decreasing from the wider entrance and remaining unchanged from a preset point. The packing P1 is
5 seated in the portion of the packing recess 122, the diameter of which remains unchanged. When the washer ring 124 is provided, the packing recess 122 is configured such that the washer ring 124 can also be seated therein. This configuration allows the packing P1 to be more easily fitted into the packing
10 recess 122.

The mold device according to the present invention that forms a product by filling molten metal into the cavity 130 produces a significant amount of heat during the process of forming the product. In particular, the movable mold 120 is
15 heated to a high temperature ranging from 200 to 300°C when forming the product in order to prevent metal from being subjected to rapid thermal deformation. Heat produced in this process influences the packing P1 disposed in the hole through which the ejector pin 140 extends, such that the packing P1 is
20 damaged.

In order to prevent this problem, the present invention provides a blocking space 180 that can block heat from being transferred to the packing P1. The blocking space 180 is formed between the packing P1 and the movable mold 120 in order
25 to prevent the heat of the movable mold 120 from being

transferred to the packing P1.

The blocking space 180 can be formed using a closing plate 150. The closing plate 150 is in a plate shape placed on top of the movable mold 120, and the blocking space 180 is formed
5 between the movable mold 120 and the closing plate 150. For example, the blocking space 180 is a concave space formed in the portion of the closing plate 150 that the movable mold 120 adjoins.

It is preferable that the blocking space 180 formed as
10 above be sealed with packing P2. As illustrated in FIG. 4, the packing P2 is disposed along the outer circumference of the blocking space 180 between the closing plate 150 and the movable mold 120.

In the configuration in which the closing plate 150 is
15 disposed, the ejector pin 140 extends to the cavity 130 through the blocking space 180 and the movable plate 120. The packing P1 is disposed in the top surface of the closing plate 150, in particular, in the entrance of the hole through which the ejector pin 140 extends. The packing recess 122 is formed in
20 the portion of the closing plate 150 in which the packing P1 is disposed, and the washer ring 124 is fitted into the packing recess 122.

The exhaust unit 190 draws air from both the cavity 130 and the blocking space 180.

25 The blocking space 180 is a hollow space preventing heat

produced from the movable mold 120 from being transferred to the packing P1. Consequently, the packing P1 is prevented from being damaged by heat. The use of an inexpensive product having relatively-low heat resistance does not lower closing performance. Accordingly, costs can be reduced, which is economically advantageous.

A support plate 160 is placed on top of the closing plate 150 configured as above. The support plate 160 is in a plate shape. The support plate 160 is placed on top of the closing plate 150, and adjoins the closing plate 150. The support plate 160 can be separated from the closing plate 150 as required. Referring to the attached drawings, when the support plate 160 is moved upwards, the support plate 160 is separated from the closing plate 150. In this state, the packing P1 can be disposed in position or replaced with new packing.

The packing P1 is disposed between the closing plate 150 and the support plate 160 as described above, and is pressed by the support plate 160 such that the packing P1 is firmly supported. Consequently, the state in which the packing P1 is disposed can be firmly maintained.

FIG. 6 is an exemplary view schematically illustrating the configuration of a mold device according to another embodiment of the present invention.

As illustrated in FIG. 6, in the mold device according to another embodiment of the present invention, the closing plate

150 is closely placed on top of the movable mold 120. The blocking space 180 is formed between the movable mold 120 and the closing plate 150. The ejector pins 140 sequentially extend through the closing plate 150 and the movable mold 120. This configuration precludes the support plate 160 (see FIG. 1) from the former embodiment.

According to the present embodiment, the packing P1 is disposed in the bottom surface of the closing plate 150, in particular, in the entrance of the hole through which the corresponding ejector pin 140 extends. In this case, a cylindrical rod 126 is disposed in order to prevent the packing P1 from being dislodged. The cylindrical rod 126 is erected within the blocking space 180, with the upper end thereof supporting and pressing the packing P1, and the lower end thereof being supported on the movable mold 120. With this configuration, the ejector pin 140 extends through the cylindrical rod 126 to extend through the movable mold 120. The cylindrical rod 126 isolates the ejector pin 140 from the blocking space 180 while preventing the packing P1 from being dislodged.

It is preferable that the cylindrical rod 126 be formed of an insulating material, but this is not intended to be limiting.

In FIG. 6, reference numerals that are not referred to indicate the same components as in the former embodiment, and descriptions thereof will be omitted.

Reference will now be made to a process of forming a product from molten metal using the mold device according to the present invention. FIGS. 7 to 10 are exemplary views illustrating the process of forming a metal product using the mold device according to the present invention.

First, as illustrated in FIG. 7, the movable mold 120 is moved upwards, and the cavity 130 and the pressing-melting part 132 disposed in the lower part of the cavity 130 are washed. Washing is performed by spraying water at a high pressure, and after the washing, a releasing agent and a lubricant are injected.

After the washing, metal is loaded into the pressing-melting part 132 while being heated, and the movable mold 120 is simultaneously moved downwards. Consequently, as illustrated in FIG. 8, the movable mold 120 is assembled to the fixed mold 110. The exhaust unit 190 is subsequently operated to draw air from both the cavity 130 and the blocking space 180. When the operation of drawing the air is completed, a valve is closed, thereby creating a high-level vacuum environment.

When the loaded metal is sufficiently heated to melt, as illustrated in FIG. 9, the pressing plunger 170 is moved upwards, thereby filling the molten metal into the cavity 130. Afterwards, the molten metal is left to cool in this state for a preset time, such that a metal product is formed in the shape of the mold cavity 130. Although the movable mold 120 is

heated to a preset temperature, the blocking space 180 blocks the transfer of heat produced from the movable mold 120.

Thereafter, cooling is completed, as illustrated in FIG. 10, and the movable mold 120 is moved upwards again. At this time, the formed product is moved upwards, attached to the movable mold 120. The formed product is removed from the movable mold 120 by moving the ejector pins 710 towards the formed product.

Finally, the product removed from the mold is finished through a post treatment process, such as polishing or painting. By repeating the above-described process, it is possible to continuously form metal in a high-level vacuum environment.

CLAIMS

1. A mold device for forming metal in a high-level vacuum environment comprising:

5 a fixed mold (110);

a movable mold (120) adjoining an upper portion of the fixed mold (110) to form a cavity (130);

an ejector pin (140) extending through the movable mold (120) to the cavity (130);

10 an exhaust unit (190) creating a vacuum environment within the cavity (130) by drawing air therefrom, wherein, after the exhaust unit (190) creates the vacuum environment within the cavity (130), molten metal is filled into the cavity (130), in which the molten metal is formed into a product, and the
15 ejector pin (140) pushes out the formed product; and

a closing plate (150) closely placed on top of the movable mold (120) such that the ejector pin (140) sequentially extends through the closing plate (150) and the movable mold (120), wherein packing (P1) is disposed in a hole of the closing plate
20 (150) through which the ejector pin (140) extends, the packing (P1) preventing atmospheric air from entering the cavity (130), and a blocking space (180) is formed between the movable mold (120) and the packing (P1) to prevent heat from being transferred to the packing (P1).

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2. The mold device according to claim 1, wherein the packing (P1) is disposed in an entrance of the hole in a top surface of the closing plate (150) through which the ejector pin (140) extends,

5 the mold device further comprising a support plate (160) placed on top of the closing plate (150), the support plate (160) pressing the packing (P1).

3. The mold device according to claim 1, wherein the
10 packing (P1) is disposed in an entrance of the hole in a bottom surface of the closing plate (150) through which the ejector pin (140) extends, a cylindrical rod (126) is disposed within the blocking space (180), with an upper end thereof supporting and pressing the packing (P1), and a lower end thereof being
15 supported on the movable mold (120), and the ejector pin (140) extends through the cylindrical rod (126).

4. The mold device according to claim 1, wherein the packing (P1) is fitted into a packing recess (122) formed in an
20 entrance of a hole through which the ejector pin (140) extends, and a washer ring (124) is fitted into an entrance of the packing recess (122) to prevent the packing (P1) from being dislodged.

25 5. The mold device according to claim 1, wherein the

exhaust unit (190) draws air from both the cavity (130) and the blocking space (180).