**Title**: Mold apparatus for molding metal in high vacuum environment

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**Related Art**
US 2006/0254747 A1  
US 6808008 B2
The present invention relates to a mold apparatus for molding a metal in a high vacuum environment, the apparatus comprising: a fixed mold (110); a movable mold (120) which is in contact with the upper section of the fixed mold (110) so as to form a cavity (130); and an ejector pin (140) which is formed so as to pass through the movable mold (120) and reach the cavity (130). In a state that a vacuum environment is created by pulling out air from the cavity (130) by using an exhaust apparatus (190), a molten metal is filled and molded, and thereafter a molded product is pushed and demolded using the ejector pin (140). A sealing plate (150) is tightly laid on the upper section of the movable mold (120) so that the ejector pin (140) passes through the movable mold (120) and reach the cavity (130). A blocking space (180) is formed between the movable mold (120) and the packing (P1) which enables the metal to be molded in a state of forming, in a high vacuum, a space where the metal is molded, so that the physical properties of a molten metal can be prevented from being changed when the molten metal is in contact with air; can minimize damage due to heat caused by a packing (P1) during the molding process; and can prevent external air from flowing into the cavity (130) so that the physical properties of a molten metal can be preserved and is economical due to the use of the packing, which is less costly.
본 발명은 고도의 건강환경에서 금속을 성형하는 금형장치에 관한 것으로서, 고정금형(110)과 상기 고정금형(110) 상부에 달달아 캐비티(130)를 형성하는 가동금형(120) 및 상기 가동금형(120)을 형성하여 캐비티(130)에 이르게 형성되는 이젝트린(140)을 구비하여, 배기장치(190)로 상기 캐비티(130)에서 공기를 빼아내 건강환경으로 조성하면서 정착된 상태에서 금속 용량을 줄기시켜 성형한 다음 상기 이젝트린(140)으로 성형된 제품을 멀어 탈형하게 되며, 상기 가동금형(120) 상부에 달달의 금형장치(150)의 금형장치에 염적하게 이젝트린(140)이 상기 금형장치(150)와 가동금형(120)을 차례로 형성하고, 상기 금형장치(150)에서 이젝트린(140)이 존속하는 구멍에는 폐장(160)이 설치되어 외부 공기가 캐비티(130)로 유입되는 것이 방지되며, 상기 가동금형(120)과 폐장(160) 사이에는 차단공간(180)이 형성되어 폐장(160)으로 열이 전달되는 것을 차단하게 되며, 금속이 형성되는 공간을 고도의 건강상태로 형성한 상태에서 금속을 성형할 수 있게 되어 금속용량이 공기와 접촉하면서 물성이 변하는 것을 방지하여 줄 수 있게 되고, 외부 공기가 금속을 형성하는 공간으로 유입되는 것을 막아주기 위해 설치되는 폐장이 열에 의해 녹상되는 것을 최소화하여 줄 수 있게 되는데, 저기의 폐장 사용이 가능하게 하며 경제적인 고도의 건강환경에서 금속을 성형하는 금형장치에 관한 것이다.
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.

10 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 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 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 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 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, 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 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."

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 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

Object of the Invention

It is the object of the present invention to substantially overcome or at least ameliorate one or more of the above disadvantages or to provide a useful alternative.

Summary of the Invention

Accordingly, the present invention provides a mold device for forming metal in a high-level vacuum environment comprising:

- a fixed mold;
- a movable mold adjoining an upper portion of the fixed mold to form a cavity;
- an ejector pin extending through the movable mold to the cavity;
- an exhaust unit creating a vacuum environment within the cavity by drawing air therefrom, wherein, after the exhaust unit creates the vacuum environment within the cavity, molten metal is filled into the cavity, in which the molten metal is formed into a product, and the ejector pin pushes out the formed product; and
a closing plate closely placed on top of the movable mold such that the ejector pin sequentially extends through the closing plate and the movable mold, wherein packing is disposed in a hole of the closing plate through which the ejector pin extends, the packing preventing atmospheric air from entering the cavity, and a blocking space is formed between the movable mold and the packing to prevent heat from being transferred to the packing;

wherein the packing is disposed in an entrance of the hole in a bottom surface of the closing plate through which the ejector pin extends, a cylindrical rod is disposed within the blocking space, with an upper end thereof supporting and pressing the packing, and a lower end thereof being supported on the movable mold, and the ejector pin extends through the cylindrical rod.

**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
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 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 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;

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 the present invention.

**Mode for Invention**

The present invention provides 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.

In the mold device, a cavity is formed in the portion in which a movable mold adjoins a fixed mold, and an ejector pin 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.

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.

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, 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 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 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 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 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 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 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.

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 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 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 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 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 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 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 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 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 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 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 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 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 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.

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:

   a fixed mold;

   a movable mold adjoining an upper portion of the fixed mold to form a cavity;

   an ejector pin extending through the movable mold to the cavity;

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

   a closing plate closely placed on top of the movable mold such that the ejector pin sequentially extends through the closing plate and the movable mold, wherein packing is disposed in a hole of the closing plate through which the ejector pin extends, the packing preventing atmospheric air from entering the cavity, and a blocking space is formed between the movable mold and the packing to prevent heat from being transferred to the packing;

   wherein the packing is disposed in an entrance of the hole in a bottom surface of the closing plate through which the ejector pin extends, a cylindrical rod is disposed within the blocking space, with an upper end thereof supporting and
pressing the packing, and a lower end thereof being supported on the movable mold, and the ejector pin extends through the cylindrical rod.

2. The mold device according to claim 1, wherein the packing is disposed in an entrance of the hole in a top surface of the closing plate through which the ejector pin extends, the mold device further comprising a support plate placed on top of the closing plate, the support plate pressing the packing.

3. The mold device according to claim 1, wherein the packing is fitted into a packing recess formed in an entrance of a hole through which the ejector pin extends, and a washer ring is fitted into an entrance of the packing recess to prevent the packing from being dislodged.

4. The mold device according to claim 1, wherein the exhaust unit draws air from both the cavity and the blocking space.

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