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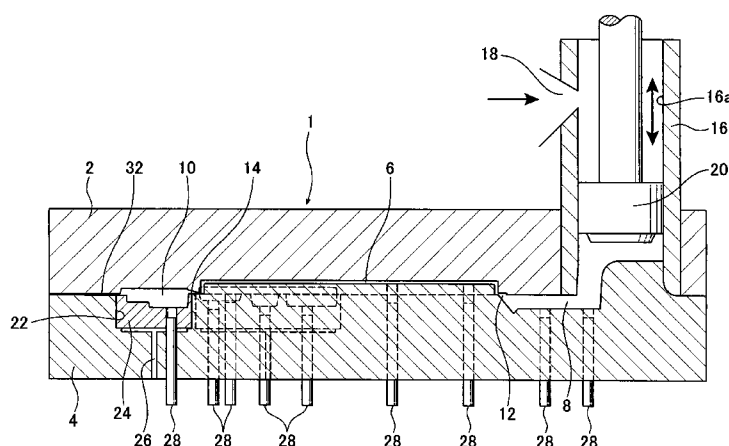
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(54) Title: DIE-CASTING DIE

FIG.2



(57) Abstract: A die-casting die capable of obtaining stable, high-quality die-casting products by reducing clogging is disclosed. The die-casting die for casting die-casting products by pressure filling molten metal into a cavity, comprises a fixed die; a moving die for forming a cavity at contacting surfaces of the fixed die and the moving die, the moving die being capable of approaching and separating from the fixed die; an overflow formed on at least either the fixed die or the moving die to communicate through an overflow gate with the cavity; a porous gas-permeable member, through which gas can pass without allowing molten metal in the overflow to pass, disposed on at least either the fixed die or the moving die so as to communicate with the overflow; and an exhaust path, one end of which communicates with the surface on the side of the gas-permeable member opposite that of the overflow, and the other end of which communicates with the outside of the fixed die or the moving die.

DESCRIPTION

Title of Invention

DIE-CASTING DIE

5

Technical Field

The present invention relates to a die-casting die used for die casting of aluminum or the like.

10 Background Art

Conventionally, there has been known a die in which gas is vented using a porous material (see JP-A-S58-47538 (Patent Document 1)). In the die in Patent Document 1, gas is vented by embedding a porous material in either the entire surface of a cavity for forming a product, or in portions of the cavity where gas is most prone to be generated or to accumulate.

15

Summary of the Invention

Technical Problems

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However, when a porous material is used to vent gas, the problem arises that in aluminum die casting, for example, clogging of the porous material occurs after about 10 shots, and the gas could not be vented.

It is therefore an object of the present invention to provide a

die-casting die capable of obtaining stable, high-quality die-casting products by greatly reducing clogging of porous gas-permeable members, and improving durability.

5 Solution to Problems

The above object is achieved according to the present invention by providing a die-casting die for casting die-casting products by pressure filling molten metal into a cavity, comprising: a fixed die; a moving die for forming a cavity at contacting surfaces of the fixed die and the moving die, said moving die being capable of approaching and separating from the fixed die; an overflow formed on at least either the fixed die or the moving die to communicate through an overflow gate with the cavity; a porous gas-permeable member, through which gas can pass without allowing molten metal in the overflow to pass, disposed on at least either the fixed die or the moving die so as to communicate with the overflow; and an exhaust path, one end of which communicates with the surface on the side of the gas-permeable member opposite that of the overflow, and the other end of which communicates with the outside of the fixed die or the moving die.

In the present invention thus constituted, because a porous gas-permeable member, through which gas can pass without allowing molten metal in the overflow to pass, is disposed to communicate with the overflow formed on at least either the fixed die or the moving die,

gas and molten metal are separated by the gas-permeable member in such a way that only gas is exhausted to the outside through the gas-permeable member, thereby preventing gas defects. In addition, the molten metal is cooled until it reaches the overflow, so viscosity rises; clogging of the gas-permeable member erected at the overflow is reduced, and durability of the gas-permeable member is greatly improved. The die-casting die of the present invention thus permits high-quality die-casting products to be obtained.

In the present invention, the gas-permeable member preferably has a flow path surface area contacting the molten metal, the flow path surface area being provided so that the average flow rate of gas flowing through the gas-permeable member is 0.2 - 1.0 m/sec.

In the present invention, the gas-permeable member preferably has a flow path surface area contacting the molten metal, and the flow path surface area is provided so that the average flow rate of gas flowing through the gas-permeable member is 0.05 - 0.2 m/sec, and the die-casting die further comprises a gas vent mechanism, disposed to communicate with the overflow, for exhausting gas directly to the outside without going through the gas-permeable member.

In the present invention, the gas-permeable member preferably contains a fiber reinforced metal compound material or a metal powder sintered body.

In the present invention, the gas-permeable member preferably has an average pore diameter thereof which is 3 - 30 μm .

In the present invention, a plurality of gas-permeable members are preferably provided.

In the present invention, at least one of the exhaust path is preferably provided for one of the gas-permeable member.

5 In the present invention, the die-casting die preferably further comprises at least one push-out pin on the overflow for parting the die-casting product from the fixed die and the moving die.

In the present invention, the molten metal is preferably aluminum alloy.

10

Brief Description of Drawings

Fig. 1 is a plan view showing a die-casting die according to an embodiment of the present invention;

Fig. 2 is a cross sectional view seen along line II-II in Fig. 1;

15 Fig. 3 is a cross sectional view seen along line III-III in Fig. 1;

Fig. 4 is a plan view showing a die-casting product made by a die-casting die according to an embodiment of the present invention;

Fig. 5 is a front elevation sectional view showing a die-casting die according to a variant example of an embodiment of the present
20 invention; and

Fig. 6 is a front elevation sectional view showing a die-casting die according to another variant example of an embodiment of the present invention.

Description of Embodiments

Referring to Figs. 1 through 4, a die-casting die according to an embodiment of the present invention is explained. Fig. 1 is a plan view showing a die-casting die according to an embodiment of the present invention, Fig. 2 is a cross sectional view seen along line II-II in Fig. 1, Fig. 3 is a cross sectional view seen along line III-III in Fig. 1, and Fig. 4 is a plan view showing a die-casting product made by a die-casting die according to an embodiment of the present invention.

As shown in Figs. 1 through 3, the die-casting die 1 according to an embodiment of the present invention comprises a fixed die 2 and a moving die 4. A cavity 6 forming the shape of the product, a runner 8 serving as conduit for carrying the flow of molten metal to the cavity, and an overflow 10 for guiding the molten metal which runs ahead, gas, and the like are formed at the contacting surfaces of the fixed die 2 and the moving die 4. The runner 8 communicates with the cavity 6 through a gate 12, which is the flow inlet for molten metal from the runner 8 into the cavity 6. The cavity 6 communicates with the overflow 10 through an overflow gate 14, which is a conduit connecting the cavity 6 and the overflow 10, over which molten metal flows.

A substantially cylindrical injection sleeve 16 is disposed on the fixed die 2 to communicate with the runner 8. The injection sleeve 16 has a molten metal filling port 18 into which molten metal is poured, and a plunger 20 is slidably inserted into the inner cylinder 16a of the

injection sleeve 16. Molten metal is pressed into the runner 8 using the injection sleeve 16.

On the other hand, a depression 22 is formed on the moving die 4 to surround the overflow 10, into which the porous gas-permeable member 24 is embedded. Overflows 10a, 10b, and 10c are provided at three locations of the die-casting die 1 of the embodiment, as shown in Fig. 1, and gas-permeable members 24 are disposed at each of the overflows 10a, 10b, and 10c. A fiber reinforced metal compound material or metal powder sintered body is used for the gas-permeable member 24. Furthermore, an exhaust path 26 is bored into the moving die 4, one end thereof communicating with the surface opposite to overflow 10 of the gas-permeable member 24, and the other end thereof communicating with the outside of the moving die 4. At least one exhaust path 26 is provided for the gas-permeable member 24.

In addition, a push-out pin 28 is slidably inserted through the moving die 4 in order to part the die-casting product 30 (see Fig. 4) from the moving die 4.

Next, a method for molding a die-casting product 30 using the die-casting die 1 of the above-described embodiment of the present invention is explained. First, the moving die 4 is moved by a die-casting machine (not shown), and is combined with the fixed die 2, and the moving die 4 is tightened and affixed to the fixed die 2. Thereafter the molten metal poured in from the molten metal filling port 18 of the injection sleeve 16 is pressed by the plunger 20 into the

die-casting die 1 formed by the fixed die 2 and the moving die 4. The pressed-in molten metal flows through the runner 8, passes through the gate 12, and flows into the cavity 6.

Molten metal further pushed out from the cavity 6 flows out to the overflow 10 through the overflow gate 14. Because the gas-permeable member 24 is embedded in the overflow 10, gas generated during molding passes through the gas-permeable member 24 and is exhausted through the exhaust path 26 to the outside of the die-casting die 1 (having the fixed die 2 and the moving die 4).
10 Thereafter when the molten metal is cooled and solidified, the moving die 4 is removed from the fixed die 2 by the die-casting machine (not shown), and the die-casting die 1 (having the fixed die 2 and the moving die 4) is opened. The die-casting product 30 is then pushed out by the push-out pin 28 inserted through the moving die 4 and
15 parted from the moving die 4.

Next, the gas flow rate passing through the gas-permeable member 24 and the like is explained. In the die-casting die 1 according to the embodiment of the present invention, the gas-permeable member 24 is provided so that the average gas flow rate passing
20 through the pores thereof is in a range of 0.2 - 1.0 m/sec. Therefore when determining the capacity of the overflow 10, the flow path surface area, which is the surface area over which the gas-permeable member 24 contacts the molten metal in the overflow 10, is provided so that the average gas flow rate passing through the pores in the

gas-permeable member 24 is 0.2 - 1.0 m/sec. For this reason, in the die-casting die 1 according to the embodiment of the present invention, overflows 10a, 10b, and 10c are provided at three locations, and the gas-permeable member 24 is provided so as to surround the overflows
5 10a, 10b, and 10c.

However, when a flow path surface area has been obtained at which the average flow rate of gas flowing through the gas-permeable member 24 is 0.2 - 1.0 m/sec, it is not necessary as described above to provide the gas-permeable member 24 to contact (surround) one
10 entire surface of the overflow 10, therefore the gas-permeable member 24 may also be provided to contact only a partial region of one of the surfaces of the overflow 10.

If the average gas flow rate exceeds 1.0 m/sec, gas-venting pressure losses increase, and sufficient gas-venting effect cannot be
15 achieved. Also, while a gas-venting effect is obtained by reducing the average gas flow rate passing through the pores in the gas-permeable member 24, the volume of the overflow 10 increases and yield decreases due to the necessity for widening the surface area over which the gas-permeable member 24 contacts the molten metal in
20 order to remove gas. This is therefore not economical below 0.2m/sec.

In the die-casting die 1 according to the embodiment of the present invention, as shown in Figs. 1 through 3, a gas vent mechanism 32, which is an auxiliary gas-venting mechanism, may be provided on the overflow 10 as needed. Provision of the gas vent

mechanism 32 allows for a flow path surface area producing an average gas flow rate through the gas-permeable member 24 pores of 0.05 - 0.2 m/sec, without increasing the volume of the overflow 10 more than necessary. Even when a gas vent mechanism 32 is provided
5 on the overflow 10, a flow path surface area may be adopted with which the average gas flow rate passing through pores in the gas-permeable member 24 is 0.2 - 1.0 m/sec.

In the die-casting die 1 according to the embodiment of the present invention, the diameter of pores in the gas-permeable member
10 24 is 3 - 30 μm , but more preferably 3 - 20 μm . If the pore diameter of the gas-permeable member 24 is too small, gas-venting resistive pressure losses are high, and although clogging due to the molten metal is diminished, the gas-venting effect is reduced. When the pore diameter is too large, the gas-venting effect is large, but clogging by
15 the molten metal occurs within a short period, and durability declines.

In the die-casting die 1 according to the embodiment of present invention, blowing a parting agent on the gas-permeable member 24 causes clogging, so it is not desirable to use a parting agent on the overflow 10 in which the gas-permeable member 24 is embedded.
20 Because of the need to avoid using the parting agent on the overflow 10, it is preferable to provide one or more push-out pins 28 for die parting purposes on the overflow 10 as well in the die-casting die 1.

Next, referring to Figs. 5 and 6, variant examples of the embodiment of the present invention are explained. Fig. 5 is a front

elevation cross sectional view showing a die-casting die according to a variant example of an embodiment of the present invention, and Fig. 6 is a front elevation cross sectional view showing a die-casting die according to another variant example of an embodiment of the present invention.

As shown in Fig. 5, in a variant example of an embodiment of the present invention, the gas-permeable member 24 and exhaust path 26 are disposed not on the moving die 4, but on the fixed die 2 only.

Also, in another variant example of an embodiment of the present invention shown in Fig. 6, the gas-permeable member 24 and exhaust path 26 are disposed on both the fixed die 2 and the moving die 4.

Examples

Next, examples of die casting using a die-casting die according to an embodiment of the present invention.

Example 1

In the die-casting die of Example 1 of the present invention, die temperature was 190°C, molten metal temperature at time of injection was 690°C, total cross sectional surface area of gate 12 was 0.4 cm², cross sectional surface area of overflow gate 14 was also 0.4 cm², and injection speed was 0.5 m/sec.

A SINTOKOGIO-manufactured Porcerax II (trademark of SHINTOKOGIO, LTD.) with a porosity of approximately 25% and an average pore diameter of 7 μm was used as the gas-permeable member (porous permeable metal) 24, embedded in a depression in the overflow 10 to create an approximately 30 cm^2 flow path surface area. The flow path surface area, as described above, is the surface over which the gas-permeable member 24 contacts molten metal which has flowed into the depression 22 in the overflow 10. The flow path surface area is the same in Examples 2 through 5. In this case, the average gas flow rate passing through the gas-permeable member 24 is 1.0 m/sec.

Therefore, in Example 1, no clogging was observed even after more than 1000 molding shots, and the amount of gas contained in the die-casting product 30 was approximately 10 cc/100 g-AL.

Example 2

Molding conditions were the same as in Example 1, die temperature was 190°C, molten metal temperature at time of injection was 690°C, total cross sectional surface area of gate 12 was 0.4 cm^2 , cross sectional surface area of overflow gate 14 was also 0.4 cm^2 , and injection speed was 0.5 m/sec.

A SINTOKOGIO-manufactured Porcerax II with a porosity of approximately 25% and an average pore diameter of 7 μm was used as the gas-permeable member (porous permeable metal) 24,

embedded in a depression in the overflow 10 to create an approximately 100 cm² flow path surface area. In this case the average gas flow rate passing through the gas-permeable member 24 is 0.3 m/sec.

5 Therefore, in Example 2 as well, no clogging was observed even after more than 1000 molding shots, and the amount of gas contained in the die-casting product 30 was approximately 4 cc/100 g-AL.

10 Example 3

 Molding conditions in Example 3 were the same as in Example 1.

 A SINTOKOGIO-manufactured Porcerax II with a porosity of approximately 30% and an average pore diameter of 20 μm was used
15 as the gas-permeable member (porous permeable metal) 24, embedded in a depression 22 in the overflow 10 to create an approximately 100 cm² flow path surface area. In this case the average gas flow rate passing through the gas-permeable member 24 is 0.2 m/sec.

20 Therefore, in Example 3 as well, no clogging was observed even after more than 1000 molding shots, and the amount of gas contained in the die-casting product 30 was approximately 2 cc/100 g-AL.

Embodiment 4

Molding conditions in Embodiment 4 were the same as in Embodiment 1.

A SINTOKOGIO-manufactured Porcerax II with a porosity of
5 approximately 30% and an average pore diameter of 30 μm was used
as the gas-permeable member (porous permeable metal) 24,
embedded in a depression 22 in the overflow 10 to create an
approximately 100 cm^2 flow path surface area. In this case the
average gas flow rate passing through the gas-permeable member 24
10 is 0.2 m/sec.

Therefore, in Example 4 as well, while a tendency to clog was
manifested after approximately 1000 shots, the amount of gas
contained in the die-casting product 30 was approximately 2 cc/100
g-AL.

15 The porous gas-permeable metal was washed in alkali after
1000 shots to restore permeability and again embedded in the die,
where it was able to be used.

Example 5

20 Molding conditions in Example 5 were the same as in Example
1.

A SINTOKOGIO-manufactured Porcerax II with a porosity of
approximately 25% and an average pore diameter of 3 μm was used
as the gas-permeable member (porous permeable metal) 24,

embedded in a depression in the overflow 10 to create an approximately 100 cm² flow path surface area. In this case the average gas flow rate passing through the porous permeable metal is 0.3 m/sec.

5 Therefore in Example 5 as well, no clogging was observed even after more than 1000 molding shots, and the amount of gas contained in the die-casting product 30 was approximately 7 cc/100 g-AL.

Comparative Examples

10 Molding conditions in the comparative examples were the same as in Example 1.

A gas-permeable member with a porosity of approximately 25% and average pore diameter of 7 μm is embedded in the cavity 6 so as to cover a surface area of approximately 100 cm².

15 As a result, in the comparative example, clogging occurred at approximately the 10th shot, and a normal die-casting product was not obtained.

As explained above, when the die-casting die 1 according to
20 the embodiment of the present invention is used, molten metal is filled into the cavity 6, then passes through the overflow gate 14 and is filled into the overflow 10. At this point, molten metal pressed in at an initial injection temperature of 650°C or above is estimated to have been cooled down to 600°C or below when passing through the overflow

gate 14; this cooling raises the viscosity of the molten metal, so that clogging of the pores in the gas-permeable member 24 disposed at the overflow 10 is greatly decreased. This improves the durability of the gas-permeable member 24. As a result, the die-casting die 1
5 according to the embodiment of the present invention enables a stable, high-quality die-casting product 30 to be obtained.

Explanation of Reference Numerals

- 1: die-casting die
- 10 2: fixed die
- 4: moving die
- 6: cavity
- 8: runner
- 10: overflow
- 15 12: gate
- 14: overflow gate
- 16: injection sleeve
- 18: molten metal filling port
- 20: plunger
- 20 22: depression
- 24: gas-permeable member
- 26: exhaust path
- 28: push-out pin
- 30: die-casting product

32: gas vent mechanism

CLAIMS

1. A die-casting die for casting die-casting products by pressure filling molten metal into a cavity, comprising:

a fixed die;

5 a moving die for forming a cavity at contacting surfaces of the fixed die and the moving die, said moving die being capable of approaching and separating from the fixed die;

an overflow formed on at least either the fixed die or the moving die to communicate through an overflow gate with the cavity;

10 a porous gas-permeable member, through which gas can pass without allowing molten metal in the overflow to pass, disposed on at least either the fixed die or the moving die so as to communicate with the overflow; and

an exhaust path, one end of which communicates with the
15 surface on the side of the gas-permeable member opposite that of the overflow, and the other end of which communicates with the outside of the fixed die or the moving die.

2. The die-casting die according to claims 1, wherein the
20 gas-permeable member has a flow path surface area contacting the molten metal, the flow path surface area being provided so that the average flow rate of gas flowing through the gas-permeable member is 0.2 - 1.0 m/sec.

3. The die-casting die according to claim 1, wherein the gas-permeable member has a flow path surface area contacting the molten metal, and the flow path surface area is provided so that the average flow rate of gas flowing through the gas-permeable member is
5 0.05 - 0.2 m/sec, and the die-casting die further comprises a gas vent mechanism, disposed to communicate with the overflow, for exhausting gas directly to the outside without going through the gas-permeable member.

10 4. The die-casting die according to claim 1, wherein the gas-permeable member contains a fiber reinforced metal compound material or a metal powder sintered body.

5. The die-casting die according to any one of claims 1 through 4,
15 wherein the gas-permeable member has an average pore diameter thereof which is 3 - 30 μm .

6. The die-casting die according to any one of claims 1 through 4, wherein a plurality of gas-permeable members are provided.

20

7. The die-casting die according to any one of claims 1 through 4, wherein at least one of the exhaust path is provided for one of the gas-permeable member.

8. The die-casting die according to any one of claims 1 through 4, wherein, the die-casting die further comprises at least one push-out pin on the overflow for parting the die-casting product from the fixed die and the moving die.

5

9. The die-casting die according to any one of claims 1 through 4, wherein the molten metal is aluminum alloy.

FIG.1

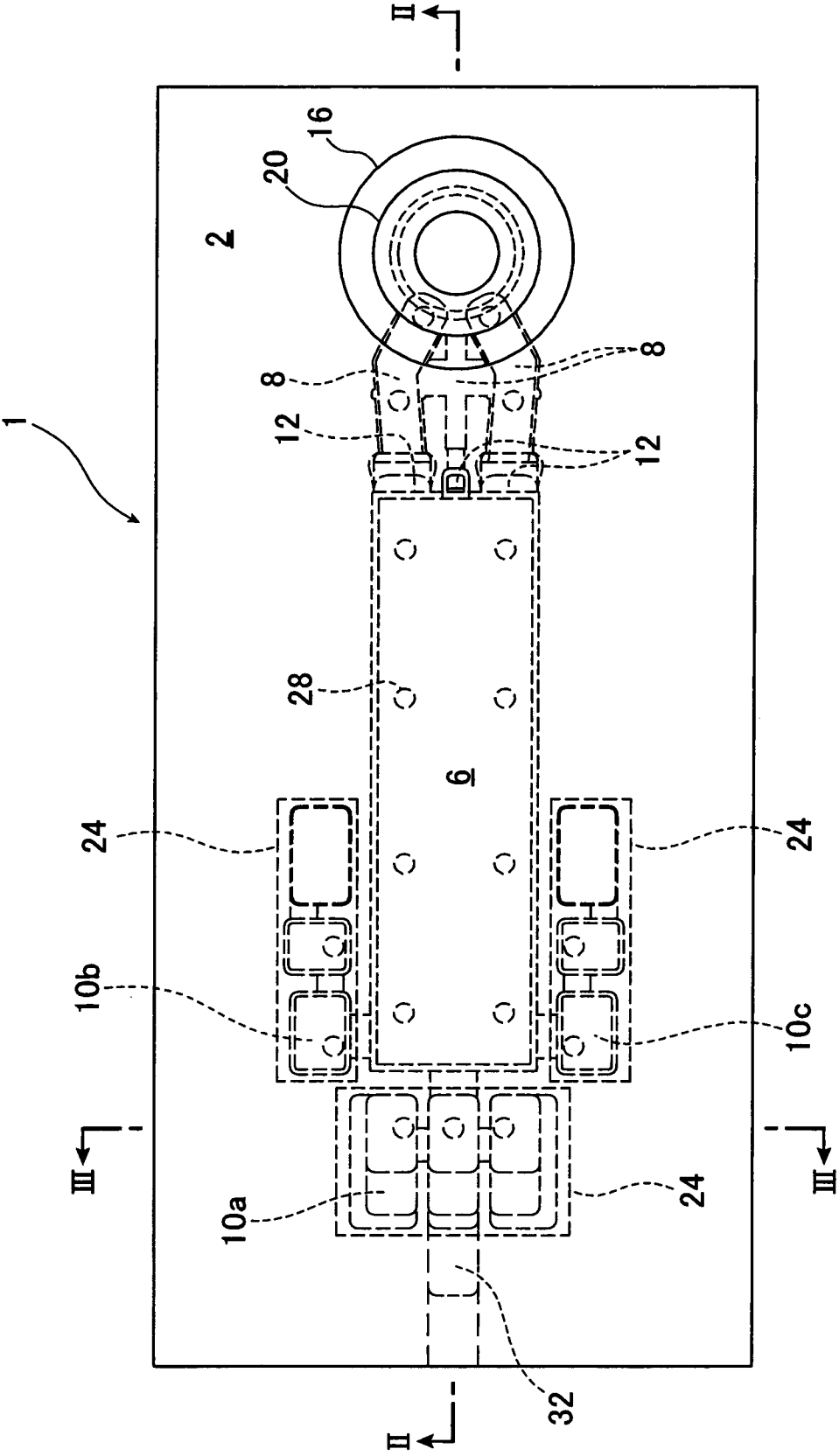


FIG. 2

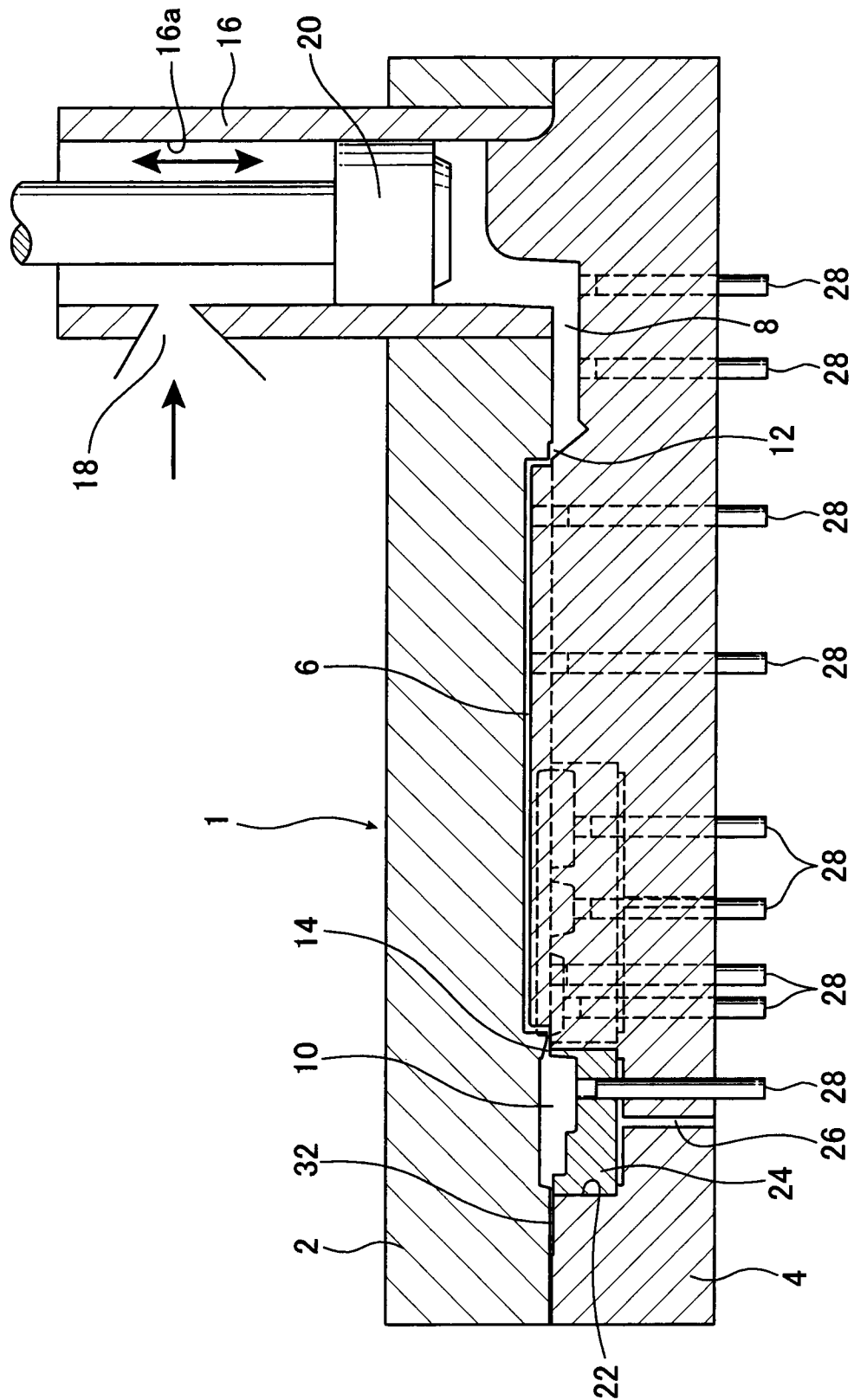


FIG.3

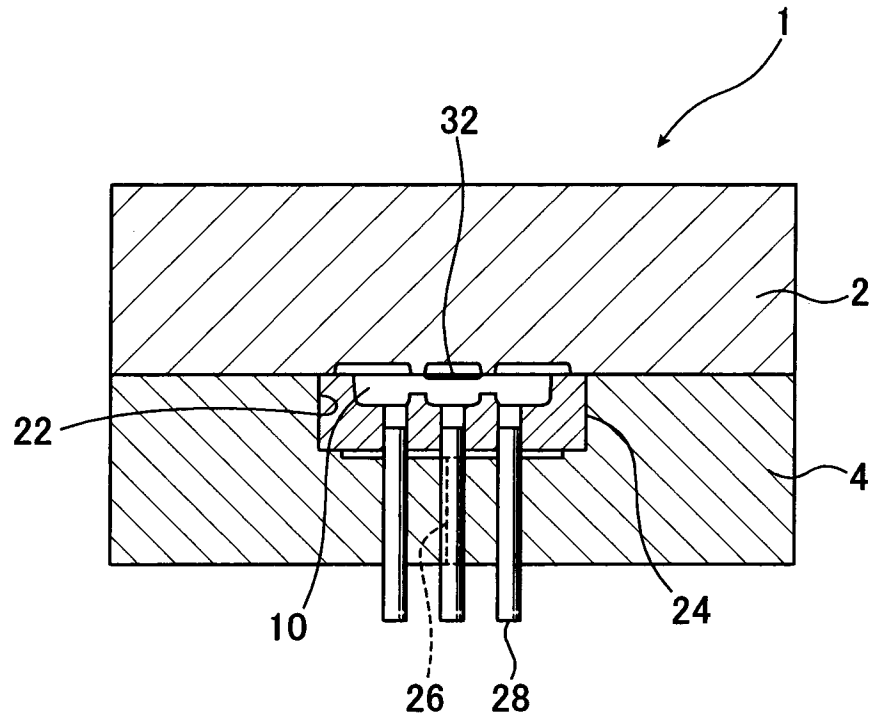


FIG.4

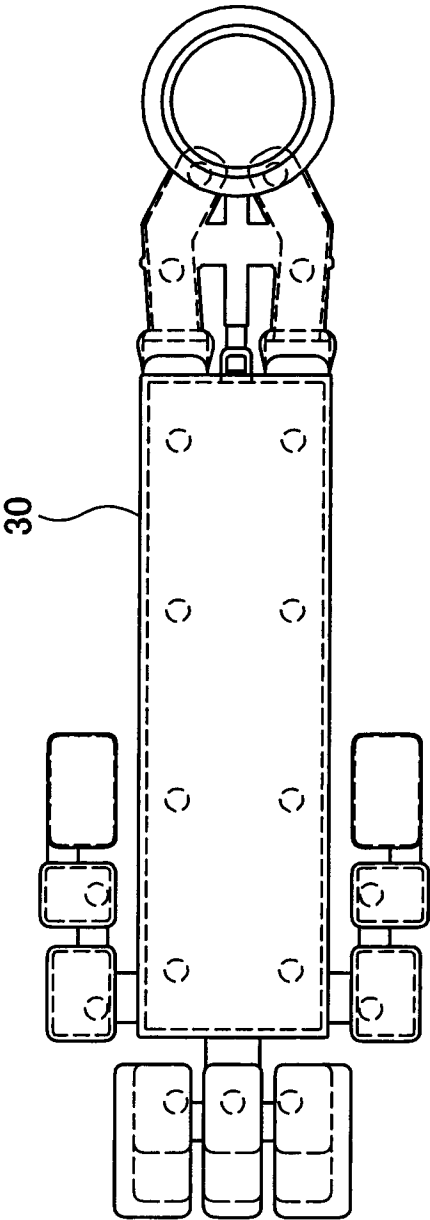


FIG.5

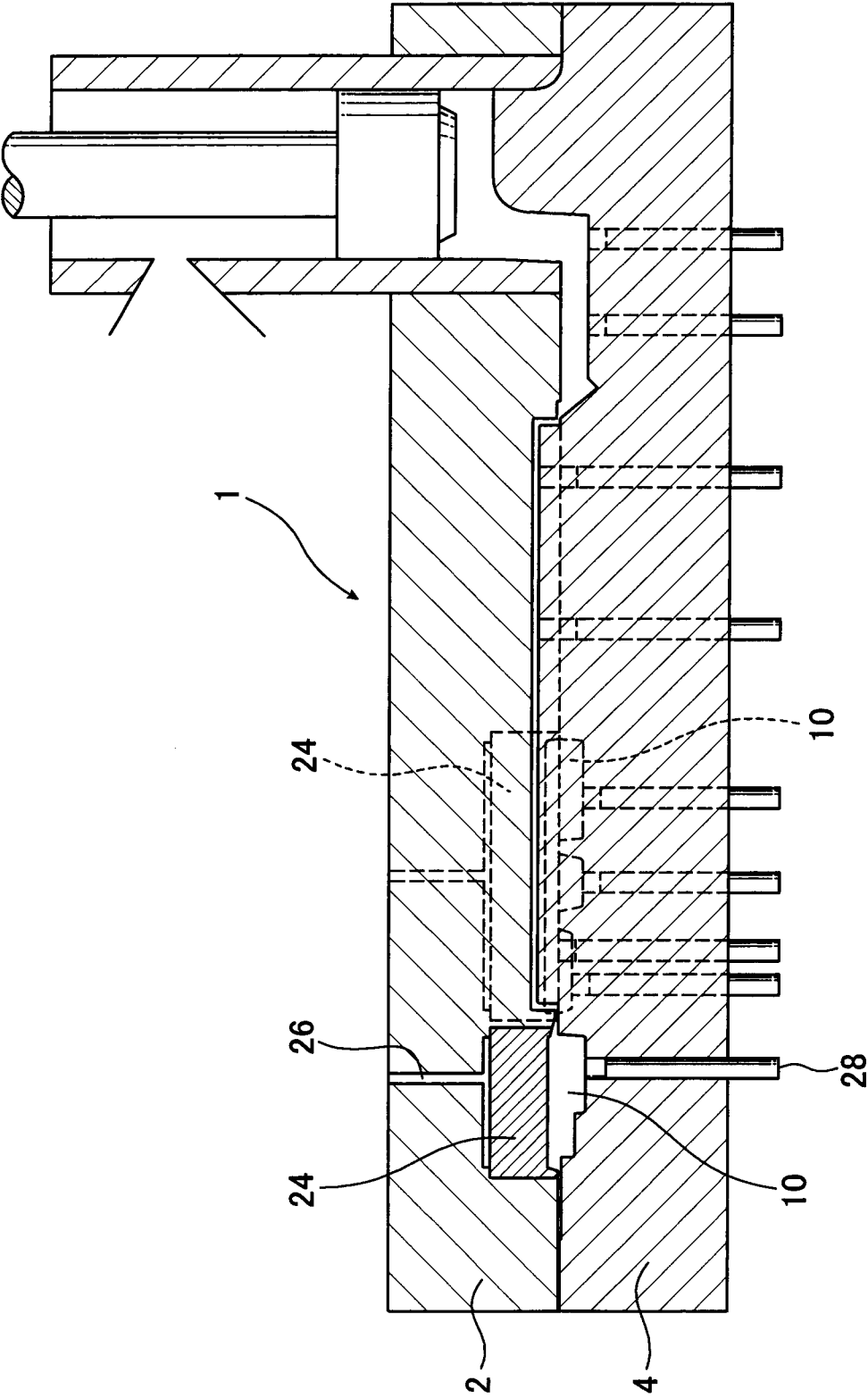
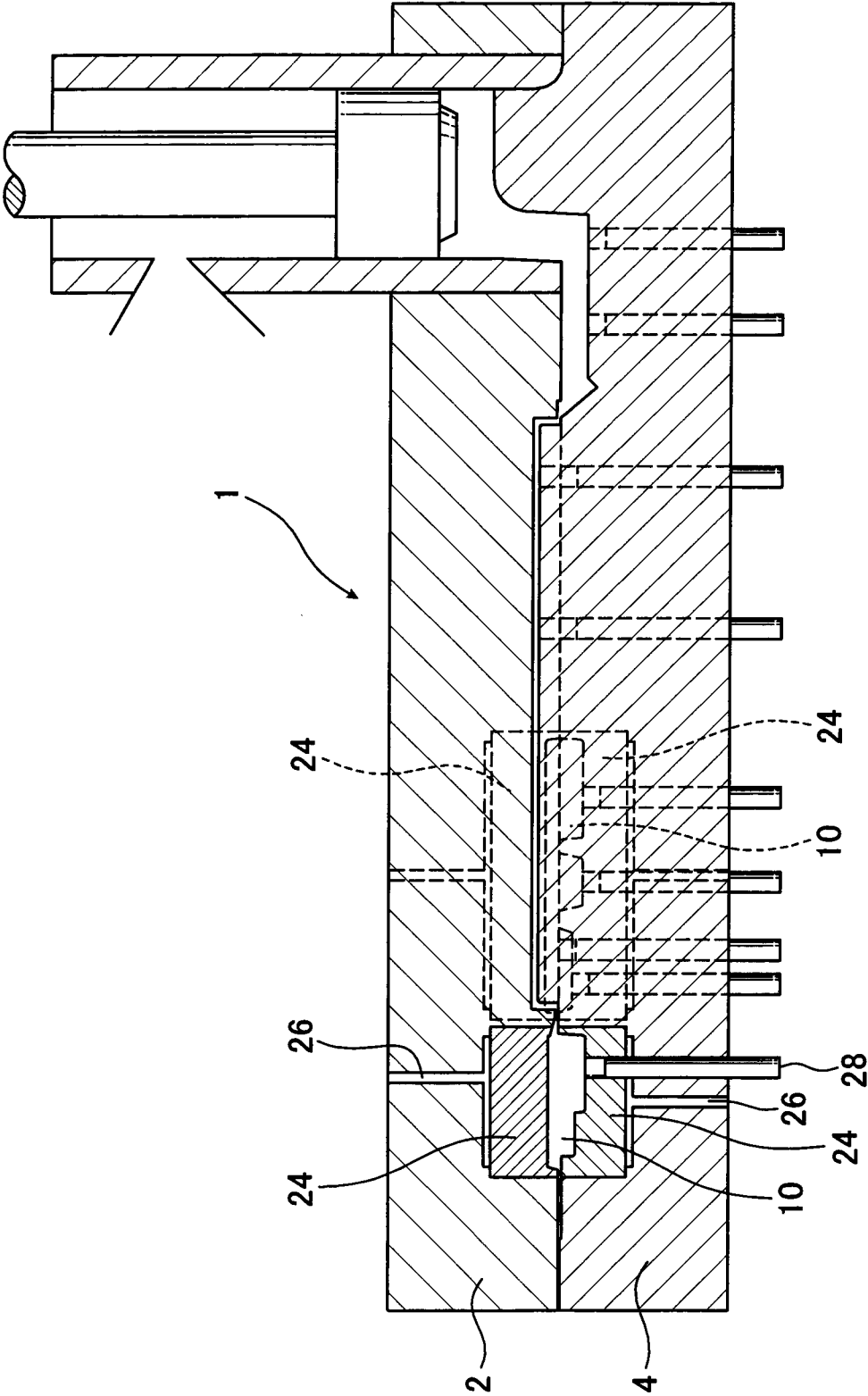


FIG.6



INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2012/055012

A. CLASSIFICATION OF SUBJECT MATTER
INV. B22C9/06 B22D17/14 B22D17/22
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B22C B22D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 60 083762 A (UBE INDUSTRIES) 13 May 1985 (1985-05-13) abstract; figures 1-3 -----	1,4-9
X	JP 63 076747 A (NAKANO AKIO) 7 April 1988 (1988-04-07) abstract -----	1,7,9
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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

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06/06/2012

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Baumgartner, Robin

INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2012/055012

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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