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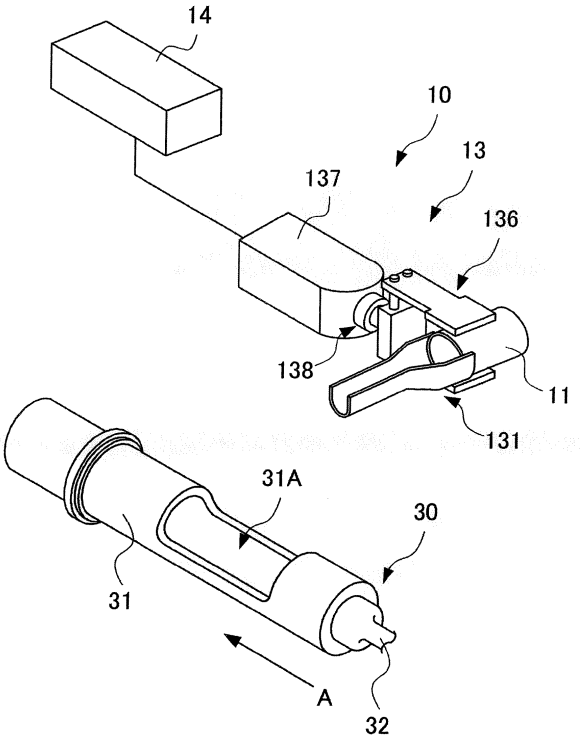
(54) Supply method and apparatus for semi-solid metal

(57) A supply apparatus supplies a semi-solid metal to a molding apparatus having an injection sleeve (31) formed with an opening portion (31A) and a plunger (32) provided progressively/regressively at an inner portion of the injection sleeve. The supply apparatus includes a crucible (11) in a shape of a cylinder containing a semi-solid metal, a carry arm (13) for grabbing to move the crucible (11), and a control apparatus for controlling the carry arm (13). The control apparatus inserts a front end portion (134) of a gutter (131) mounted to the crucible into (11) the opening portion (31A) of the injection sleeve (31) by a predetermined angle to inject the semi-solid metal to a side of a direction of advancing the plunger (32) more than at a position formed with the opening portion (31A) at inside of the injection sleeve (31).

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a supply method and a supply apparatus of a semi-solid metal.

[0002] JP-B2-3211754 discloses a method of preparing a semi-solid metal (slurry) in a solid-liquid coexisting state by cooling a metal in a molten state of aluminum or magnesium, or alloys of these or the like and producing a metal molded product by using the semi-solid metal.

[0003] According to the method shown in JP-B2-3211754, there is used a molding apparatus including an injection sleeve formed with an opening portion, and a plunger provided progressively/regressively at inside of the injection sleeve. Specifically, first, a semi-solid metal is supplied from the opening portion to the injection sleeve. Next, the semi-solid metal supplied to the injection sleeve is extruded by the plunger to be injected into a die connected to the injection sleeve. Next, the semi-solid metal injected into the die is cooled to solidify the semi-solid metal. A metal molded product in accordance with a shape of an inner portion of the die can be fabricated as described above.

[0004] Meanwhile, a viscosity of the above-described semi-solid metal is higher than that of the metal in the molten state. Therefore, a force which is going to maintain a current shape is large. Therefore, when a press force is applied in extruding the semi-solid metal by the plunger, the semi-solid metal is applied with a stress in a direction opposed to a direction of the press force to maintain the current shape. Therefore, the semi-solid metal is squeezed by the press force and the stress to considerably deform, and there is a case of jumping out from the opening portion of the injection sleeve to outside. As a result, a step of removing the jumped semi-solid metal is needed to pose a problem that a production step cannot be made to be efficient.

SUMMARY OF THE INVENTION

[0005] One or more embodiments of the present invention provide a supply method and a supply apparatus of a semi-solid metal capable of preventing the semi-solid metal from jumping out.

[0006] In accordance with one or more embodiments of the present invention, in a supply method of a semi-solid metal of the invention for supplying the semi-solid metal to a molding apparatus having an injection sleeve formed with an opening portion, and a plunger progressively/regressively provided at an inner portion of the injection sleeve, the supply method is provided with a first step of producing the a semi-solid metal from a molten metal at an inner portion of a vessel in a shape of a cylinder, anda second step of supplying the semi-solid metal contained in the vessel to the inner portion of the injection sleeve by inserting a front end of the vessel into the opening portion of the injection sleeve by a predetermined angle. At the second step, the semi-solid metal is injected to a side in a direction of advancing the plunger more than at the opening portion.

[0007] According to this case, the front end of the vessel is inserted into the opening portion of the injection sleeve by the predetermined angle and the semi-solid metal is injected to the side in the direction of advancing the plunger more than the opening portion by way of the front end of the vessel. Therefore, even when the semi-solid metal is extruded by the plunger, the semi-solid metal can be prevented from jumping out from the opening portion.

[0008] A gutter may be provided on a front end side of the vessel, and at the second step, a front end of the gutter may be inserted into the opening portion by the predetermined angle and the semi-solid metal may be injected from the front end of the gutter.

[0009] According to this case, the front end side of the vessel is provided with the gutter, the semi-solid metal is injected from the front end of the gutter, and therefore, the semi-solid metal can smoothly be supplied to the inner portion of the injection sleeve by increasing a flow rate of the semi-solid metal.

[0010] The gutter may be configured to be attachable and detachable to and from the vessel.

[0011] When the semi-solid metal is produced from the molten metal at the inner portion of the vessel, it is necessary to cast the molten metal to the vessel and stir the molten metal. However, when the vessel is provided to the gutter, the molten metal is stirred by inserting a stir rod from the front end of the gutter, and therefore, it is difficult to uniformly stir the molten metal.

[0012] Hence, if the gutter is made to be attachable and detachable to and from the vessel, the gutter does not constitute a hindrance when the moltenmetal is stirred and the moltenmetal can uniformly be stirred.

[0013] In accordance with one or more embodiments of the present invention, in a supply apparatus of a semi-solid metal of the invention for supplying the a semi-solid metal to a molding apparatus having an injection sleeve formed with an opening portion, and a plunger progressively/regressively provided at an inner portion of the injection sleeve, the supply apparatus is provided with a vessel in a shape of a cylinder containing the semi-solid metal, a carry arm for grabbing to move the vessel, and a controlling apparatus for controlling the carry arm. The control apparatus inserts a front end of the vessel into the opening portion of the injection sleeve by a predetermined angle and injects the semi-solid metal contained in the vessel on a side in a direction of advancing the plunger more than at the opening portion.

[0014] According to this case, an effect similar to the above-described effect for the method is achieved.

[0015] The carry armmay include a gutter capable of being connected to the vessel, and the controlling apparatus may connect the gutter to the vessel, insert a front end of the gutter into the opening portion by a predetermined angle and inject the semi-solid metal from the front

end of the gutter.

[0016] According to this case, the gutter can be connected to the vessel by grabbing the vessel by the carry arm, and therefore, an effect similar to the above-described effect is achieved.

[0017] The gutter may be constituted by a shape of a groove.

[0018] According to this case, the gutter is constituted by the shape of the groove, and therefore, in comparison with the case in which the gutter is constituted by a shape of a cylinder, the atmosphere is easy to flow smoothly to the inner portion of the vessel and the semi-solid metal can smoothly be injected from the vessel.

[0019] According to one or more embodiments of the present invention, the front end of the vessel is inserted into the opening portion of the injection sleeve by the predetermined angle and the semi-solid metal is injected to the side in the direction of advancing the plunger more than at the opening portion by way of the front end of the vessel. Therefore, even when the semi-solid metal is extruded by the plunger, the semi-solid metal can be prevented from jumping out from the opening portion.

[0020] Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig.1 is a perspective view showing a supply apparatus and a molding apparatus supplied with a semi-solid metal by the supply apparatus acording to an exemplary embodiment of the invention.

Fig.2 is a perspective view of a gutter provided at the supply apparatus.

Fig.3 is a perspective view of a crucible and a stirrer provided to the supply apparatus.

Fig.4 is a view for explaining a procedure of subjecting a semi-solid metal to injection molding by using the supply apparatus.

Fig. 5 is a view for explaining a procedure of subjecting the semi-solid metal to injection molding by using the supply apparatus.

Fig.6 is a perspective view of a crucible and a stirrer according to a modified example of embodiments of the invention.

Fig.7 is a perspective view of a crucible and a stirrer according to a modified example of the embodiments of the invention.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0022] An exemplary embodiment of the invention will be explained in referenced to the drawings as follows.

[0023] Fig.1 is a perspective view showing a supply apparatus 10 and a molding apparatus 30 supplied with a semi-solid metal by the supply apparatus 10 acording to the exemplary embodiment of the invention.

[0024] The molding apparatus 30 includes an injection sleeve 31 in a cylindrical shape, and a plunger 32 provided progressively/regressively at inside of the injection sleeve 31.

[0025] The injection sleeve 31 is connected to a die, not illustrated. An upper face of the injection sleeve 31 is formed with an opening portion 31A.

[0026] When the semi-solid metal is supplied from the opening portion, the molding apparatus 30 injects the semi-solid metal from a front end of the injection sleeve into the die by making the plunger 32 progress.

[0027] The supply apparatus 10 includes a crucible 11 in a shape of a cylinder, a carry arm 13 carrying to move the crucible 11, and a control apparatus 14 for controlling the carry arm 13. Further, although in Fig. 1, the crucible 11 in the shape of the circular cylinder is illustrated, a crucible in a shape of a square cylinder will do. The circular cylinder shape is simply fabricated and easy to stir a molten metal stored at inside of the crucible by a cooling block 121 (refer to Fig.3) to be along an inner wall of the crucible 11.

[0028] The carry arm 13 is a movable arm of an articulated robot a whole content of which is not illustrated, and the articulated robot includes 6 axes of movable shafts and includes an arm 137 and a hand 136.

[0029] The hand 136 is pivoted centering on a rod 138 relative to the arm 137 by way of a rod 138, or relatively rocked by constituting a base point by a base end side of the rod 138. The hand 136 is provided with a gutter 131 an upper half of which is opened.

[0030] Further, although an example of 6 axes of the articulated robot is shown as an example as described above, there may be constituted moving means including a moving unit moving in 3 axes orthogonal to each other, that is, X axis-Y axis-Z axis, including the rod having the function of pivoting and rocking at a front end, and having the hand 136 on a front end side of the rod.

[0031] Fig.2 is a perspective view of the gutter 131.

[0032] The gutter 131 includes a gutter main body 132 in a groove shape, and a front end portion 134 in a groove shape provided at a front end of the gutter main body 132.

[0033] An inner diameter of the front end portion 134 is made to be smaller than an inner diameter of the gutter main body 132. A taper portion 132 is constituted between the gutter main body 132 and the front end portion 134.

[0034] The gutter 131 is made to be attachable and detachable to and from the crucible 11 and is mounted to the crucible 11 when the crucible 11 is grabbed by the hand 136.

[0035] The semi-solid metal is contained in the crucible 11. The semi-solid metal is produced from a molten metal comprising a molten metal of aluminum or magnesium, or alloys of these or the like by using a stirrer 12. Further, the crucible 11 provided to a production line of fabricating the semi-solid metal is a bottomed heat insulating cruci-

ble supplied with an amount of 1 shot of a molten metal of the molding apparatus 30.

[0036] Fig.3 is a perspective view of the stirrer 12.

[0037] The stirrer 12 is for cooling and stirring the molten metal at inside of the crucible 11 and includes the cooling block (cooling member) 121 at a previously set temperature, a rotation drive source 122 for driving to rotate the cooling block 121, and a moving mechanism 125 for moving the cooling block 121 and the rotation drive source 122 on a horizontal face longitudinally and transversely, for example, moving in X, Y axis directions. That is, the cooling block 121 and the rotation drive source 122 are moved while being supported by a support member, not illustrated, specifically, a moving unit moved in X, Y axis directions having support rails orthogonal to each other, or an articulated robot of about 3 through 6 axes, not illustrated, or the like. The moving mechanism 125 is a moving mechanism for horizontally moving the cooling block 121 and the rotation drive source 122.

[0038] The cooling block 121 is constituted by a shape of a square pillar and is provided with a draft from a base end to a front end thereof. Further, an outer shape of the cooling block 121 may be constituted by a polygonal shape having one or more of corners, a faced polygonal shape having 3 or more of corners, a shape of an ellipse, or a shape of a compounded ellipse, thereby, a vortex is easy to be generated in stirring the molten metal, a stirring capacity can be promoted, and a crystal can be prevented from being produced at the inner wall of the heat insulating crucible. The cooling block 121 is constituted by a material which is not melted by the molten metal, and a temperature thereof is controlled by a temperature control portion, not illustrated.

[0039] The rotation drive source 122 is connected to the base end of the cooling block 121 by way of a rotating shaft 123 and a coupler 124 made of a ceramic for driving to rotate the cooling block 121 centering on the rotating shaft 123. The coupler 124 made of a ceramic is provided to the rotation drive source 122 to be able to remove the cooling block 121.

[0040] The moving mechanism 125 moves the cooling block 121 and the rotation drive source 122 in a vertical direction and moves the cooling block 121 and the rotation drive source 122 in a spiral shape in an arrow mark B direction in Fig. 3 on a horizontal plane. That is, the molten metal stored at inside of the crucible is cooled by way of the cooling block 121 cooled to a predetermined temperature equal to or lower than a temperature of the molten metal, and an amount of 1 shot of the molten metal is stirred in a horizontal direction to be along the crucible 11 and separated from the crucible 11 by the cooling block 121 while rotating the cooling block 121. Further, the cooling block 121 may be moved in a spiral shape in a horizontal direction. Thereby, the molten metal can effectively be stirred by hampering a directionality of cooling as less as possible. When moved in the spiral shape in the horizontal direction, the directionality of cooling can further be hampered as less as possible and the molten metal can swiftly be stirred.

[0041] An explanation will be given of a procedure of subjecting the semi-solid metal to injection molding by using the supply apparatus 10.

[0042] First, the molten metal is supplied to the crucible 11, and the cooling block 121 is dipped into the molten metal at inside of the crucible 11 by moving the cooling block 121 and the rotation drive source 122 in a vertical lower direction by rotating the cooling block 121 at a previously set temperature by a comparatively low speed centering on the rotating shaft 123 by the rotation drive source 122 of the stirrer 12. Next, a speed of rotating the cooling block 121 is increased by the rotation drive source 122 and the cooling block 121 and the rotation drive source 122 are moved in the spiral shape by the moving mechanism 125. Thereby, the molten metal is cooled and stirred swiftly.

[0043] Next, after stirring the amount of 1 shot to be separated from the crucible 11 in the horizontal direction to be along the crucible 11 by a previously determined time period, the cooling block 121 is pulled up from the molten metal at inside of the crucible 11 by moving the cooling block 121 and the rotation drive source 122 in a vertical upper direction by the moving mechanism 125 while rotating the cooling block 121 by the rotation drive source 122. Thereby, the molten metal at inside of the crucible 11 becomes a semi-solidmetal maintained at a constant temperature as a whole.

[0044] Next, as shown by Fig.4, the semi-solid metal is supplied into the injection sleeve 31 by grabbing the crucible 11 containing the semi-solid metal by the hand 136 of the carry arm 13 of an articulated robot or the like, not illustrated, and inserting the front end portion 134 of the gutter 131 mounted to the crucible 11 into the opening portion 31A of the injection sleeve 31 by a predetermined angle (arbitrary angle). Thereby, as shown by Fig. 5, the semi-solid metal at inside of the crucible 11 is injected from the front end portion 134 of the gutter 131 to a side in a direction of advancing the plunger 32, that is, a side in an arrow mark A direction in Fig.5 more than at a position formed with the opening portion 31A at inside of the injection sleeve 31.

[0045] Thereafter, the semi-solid metal supplied to inside of the injection sleeve 31 is extruded in the arrow mark A direction in Fig.5 by the plunger 32 and is injected to a die, not illustrated.

[0046] Further, the cooling block 121 after having been pulled up from the molten metal is first dipped into a cooling layer, not illustrated, to carry out a cooling treatment. Next, the cooling block 121 is subjected to an air blow treatment, removed of a solidified object of the semi-solid metal adhered to a surface of the cooling block 121, thereafter, coated with a ceramic material on the surface and is subjected to a drying treatment by drying means, not illustrated. Thereby, the surface of the cooling block 121 is prevented from reacting with the molten metal, and removal of the solidified object of the adhered to the

surface of the cooling block 121 is facilitated.

[0047] According to the exemplaryembodiment, the following effect is achieved.

(1) The crucible 11 is grabbed by the carry arm 13 and the gutter 131 is mounted to the crucible 11. Further, the front end portion 134 of the gutter 131 is inserted into the opening portion 31A of the injection sleeve 31 by the predetermined angle, and the semi-solid metal at inside of the crucible 11 is injected from the front end portion 134 of the gutter 131 to the side in the direction of advancing the plunger 32 more than at the position formed with the opening portion 31A at inside of the injection sleeve 31. Therefore, even when the semi-solid metal is extruded by the plunger 32, the semi-solid metal can be prevented from jumping out from the opening portion 31A.

(2) The gutter 131 is made to be attachable and detachable to and from the crucible 11, the semi-solid metal is injected from the front end portion 134 of the gutter 131, and therefore, the semi-solid metal can smoothly be supplied to the inner portion of the injection sleeve 31 by increasing a flow rate of the semi-solid metal.

(3) The gutter 131 is attachable and detachable to and from the crucible 11, and the gutter is mounted to a vessel by grabbing the vessel by the carry arm. Therefore, when the molten metal at inside of the crucible 11 is stirred by the stirrer 12, the gutter 131 does not constitute a hindrance by detaching the gutter 131 from the crucible 11, and the molten metal can uniformly be stirred. Further, when the molten-metal is supplied to the crucible 11, the gutter 131 does not constitute a hindrance by detaching the gutter 131 from the crucible 11, and the molten metal can easily be supplied.

(4) The gutter 131 is provided in the groove shape, and therefore, in comparison with a case in which the gutter 131 is constituted by a shape of a cylinder, when the semi-solid metal at inside of the crucible 11 is supplied to the injection sleeve 31 by way of the gutter 131, the atmosphere smoothly flows to the inner portico of the crucible 11, and the semi-solid metal can smoothly be injected from the crucible 11.

[0048] Further, the invention is not limited to the above-described embodiment but the invention includes a modification, an improvement or the like within a range of capable of achieving the object of the invention.

[0049] Although according to the above-described exemplary embodiment, the molten metal at inside of the crucible 11 is cooled and stirred by moving the cooling block 121 and the rotation drive source 122 of the stirrer 12 in the spiral shape by the moving mechanism 125, the invention is not limited thereto. For example, as shown by Fig.6, a crucible 11A is constituted by a shape of a parallelepiped, cooling blocks 121A and 121B and rotation drive sources 122A and 122B of a stirrer 12A may reciprocally be moved in a longitudinal direction (arrow mark C direction in Fig.6 of the crucible 11A by a moving mechanism 125A to thereby cool and stir the molten metal at inside of the crucible 11A.

[0050] That is, the rotation drive source 122A is connected to a base end of the cooling block 121A by way of a rotating shaft 123A and a coupler 124A to drive to rotate the cooling block 121A centering on the rotating shaft 123A. The coupler 124A made of a ceramic is provided to the rotation drive source 122A to be able to remove the cooling block 121A.

[0051] On the other hand, the rotation drive source 122B is connected to a base end of the cooling block 121B by way of a rotating shaft 123B and a coupler 124B made of a ceramic to drive to rotate the cooling block 121B centering on the rotating shaft 123B. The coupler 124B made of a ceramic is provided to the rotation drive source 122B to be able to remove the cooling block 121B.

[0052] The moving mechanism 125A moves the cooling blocks 121A and 121B and the rotation drive sources 122A and 122B in the vertical direction and reciprocally moves the cooling blocks 121A and 121B and the rotation drive sources 122A and 122B in the arrow mark C direction in Fig.6.

[0053] Further, as shown by Fig.7, a cooling block 121C and a rotation drive source 122C of a stirrer 12B may reciprocally be moved in a vertical direction (arrow mark D direction in Fig. 7) by a moving mechanism 125B and the molten metal at inside of the crucible 119 may be cooled and stirred.

[0054] That is, the rotation drive source 122C is connected to a base end of the cooling block 121C by way of a rotating shaft 123C and a coupler 124C made of a ceramic to drive to rotate the cooling block 121C centering on the shaft 123C. The coupler 124C made of a ceramic is provided to the rotation drive source 122C to be able to remove the cooling block 121C centering on the rotating shaft 123C.

[0055] The moving mechanism 125B reciprocally moves the cooling block 121C and the rotation drive source 122C in the arrow mark D direction of Fig.7.

[Descriptions of Reference Numerals and Signs]

[0056]

10..supply apparatus
11, 11A, 11B..crucibles
12, 12A, 12B..stirrers
13..carry arm
14..control apparatus
30..molding apparatus
31..injection sleeve
31A..opening portion
32..plunger
131..gutter

Claims

1. A supply method of a semi-solid metal for supplying the semi-solid metal to a molding apparatus (30) having an injection sleeve (31) formed with an opening portion (31A) and a plunger (32) progressively/regressively provided at an inner portion of the injection sleeve (31), the supply method comprising:

   a first step of producing the semi-solid metal from a molten metal at an inner portion of a vessel (11, 11A, 11B) in a shape of a cylinder; and
   a second step of supplying the semi-solid metal in the vessel (11, 11A, 11B) to the inner portion of the injection sleeve (31) by inserting a front end of the vessel (11, 11A, 11B) into the opening portion (31A) of the injection sleeve (31) by an arbitrary angle;

   wherein at the second step, the semi-solidmetal is injected to a side in a direction of advancing the plunger (32) more than at the opening portion (31A).

2. The supply method according to Claim 1, wherein a gutter (131) is provided on a front end side of the vessel (11, 11A, 11B); and
   wherein at the second step, a front end of the gutter (131) is inserted into the opening portion (31A) by the arbitrary angle and the semi-solid metal is injected from the front end of the gutter (131).

3. The supply method according to any of the preceding claims,
   wherein the gutter (131) is configured to be attachable and detachable to and from the vessel (11, 11A, 11B).

4. A supply apparatus (10) of a semi-solid metal for supplying the semi-solid metal to a molding apparatus (30) having an injection sleeve (31) formed with an opening portion (31A) and a plunger (32) progressively/regressively provided at an inner portion of the injection sleeve (31), the supply apparatus (10) comprising:

   a vessel (11, 11A, 11B) in a shape of a cylinder for containing the semi-solid metal;
   a carry arm (13) for grabbing and moving the vessel (11, 11A, 11B); and
   a controlling apparatus (14) for controlling the carry arm (13);

   wherein the control apparatus (14) inserts a front end of the vessel (11, 11A, 11B) into the opening portion (31A) of the injection sleeve (31) by an arbitrary angle and injects the semi-solid metal in the vessel on a side in a direction of advancing the plunger (32) more than at the opening portion (31A).

5. The supply apparatus (10) according to any of the preceding claims, wherein the carry arm (13) includes a gutter (131) capable of being connected to the vessel (11, 11A, 11B);
   wherein the controlling apparatus (14) connects the gutter (131) to the vessel (11, 11A, 11B), inserts a front end of the gutter (131) into the opening portion (31A) by the arbitrary angle, and injects the semi-solid metal from the front end of the gutter (131).

6. The supply apparatus (10) according to any of the preceding claims, wherein the gutter (131) is constituted by a shape of a groove.

FIG. 1

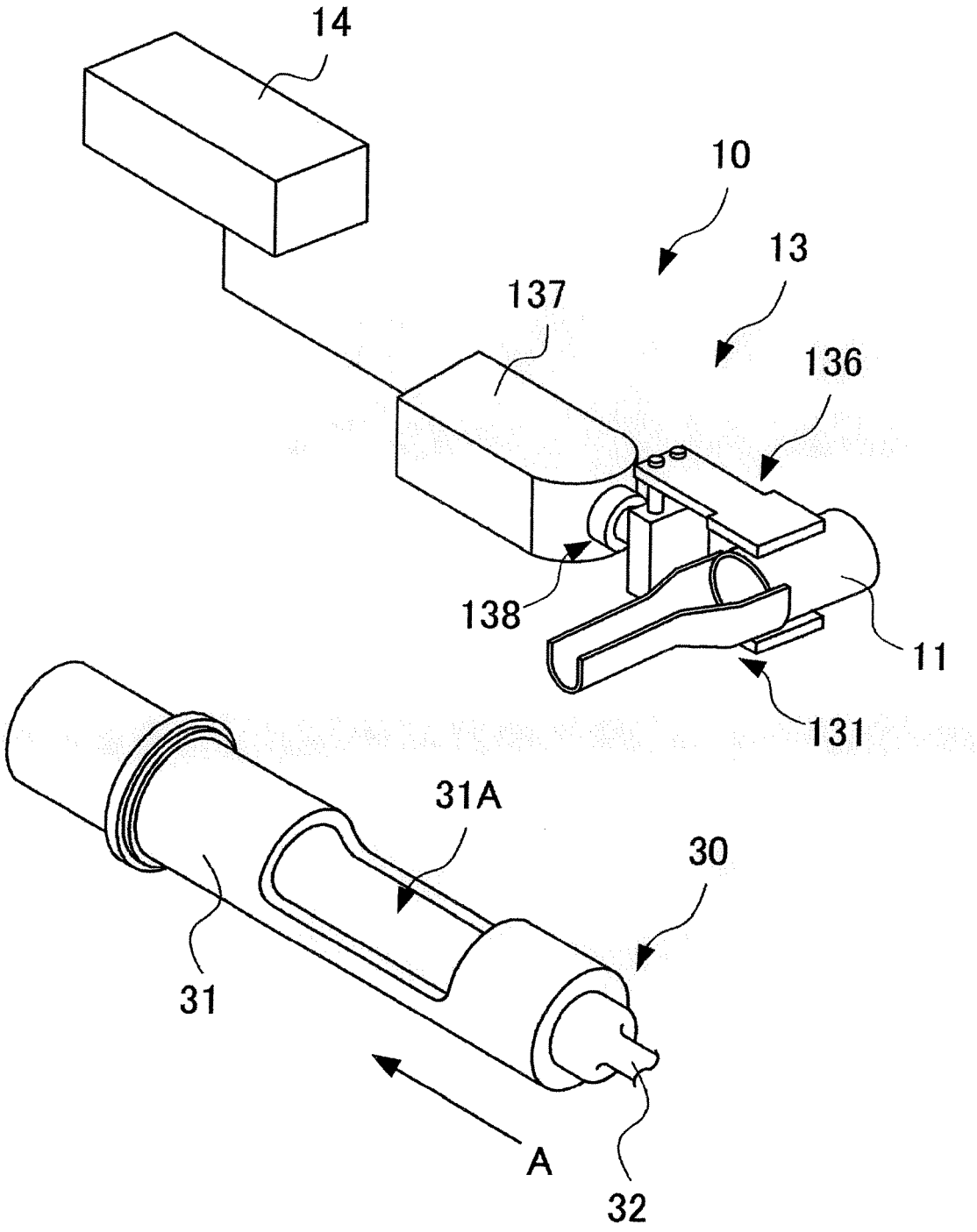


FIG.2

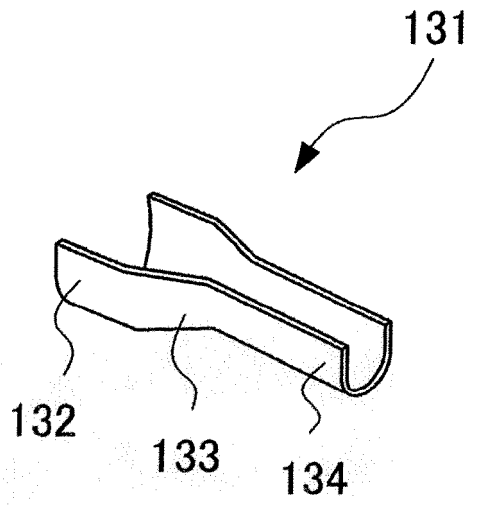


FIG.3

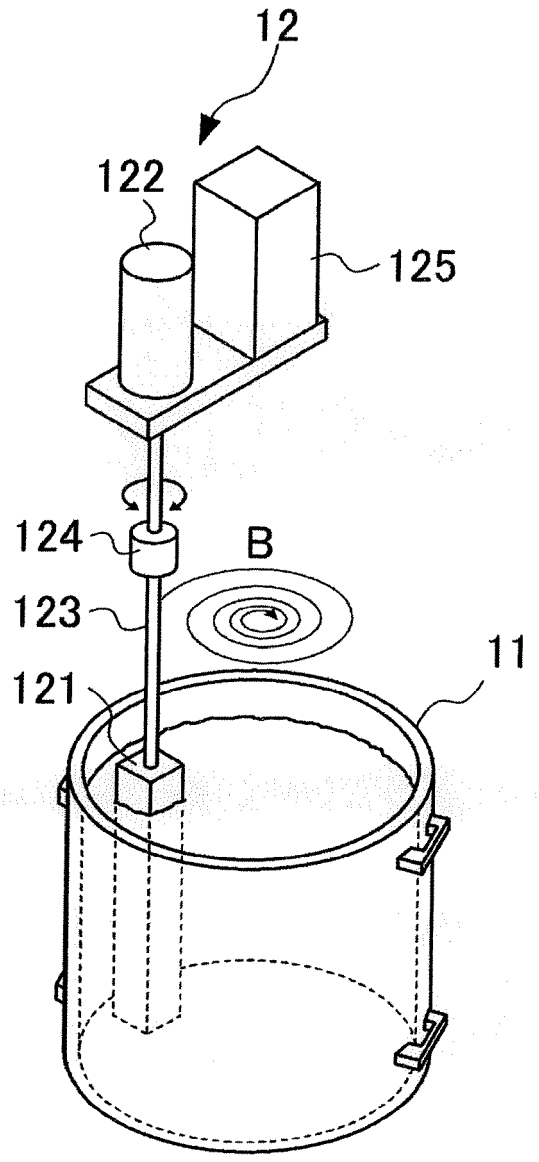


FIG.4

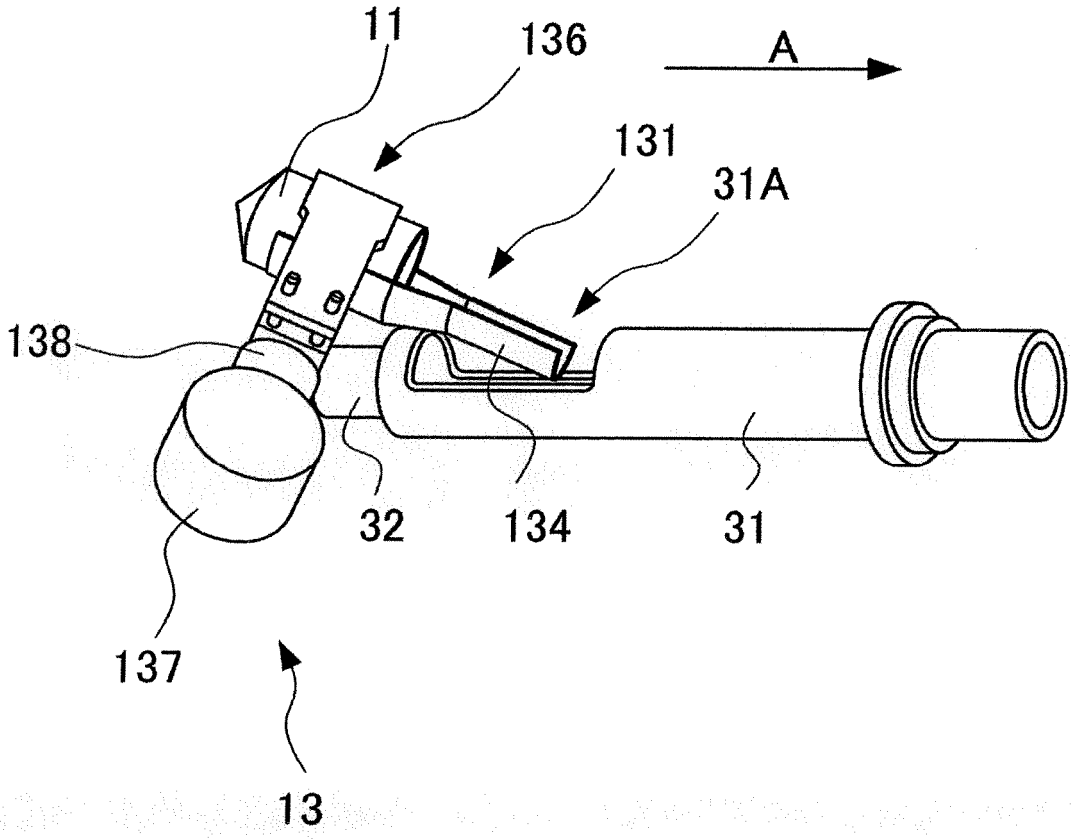


FIG.5

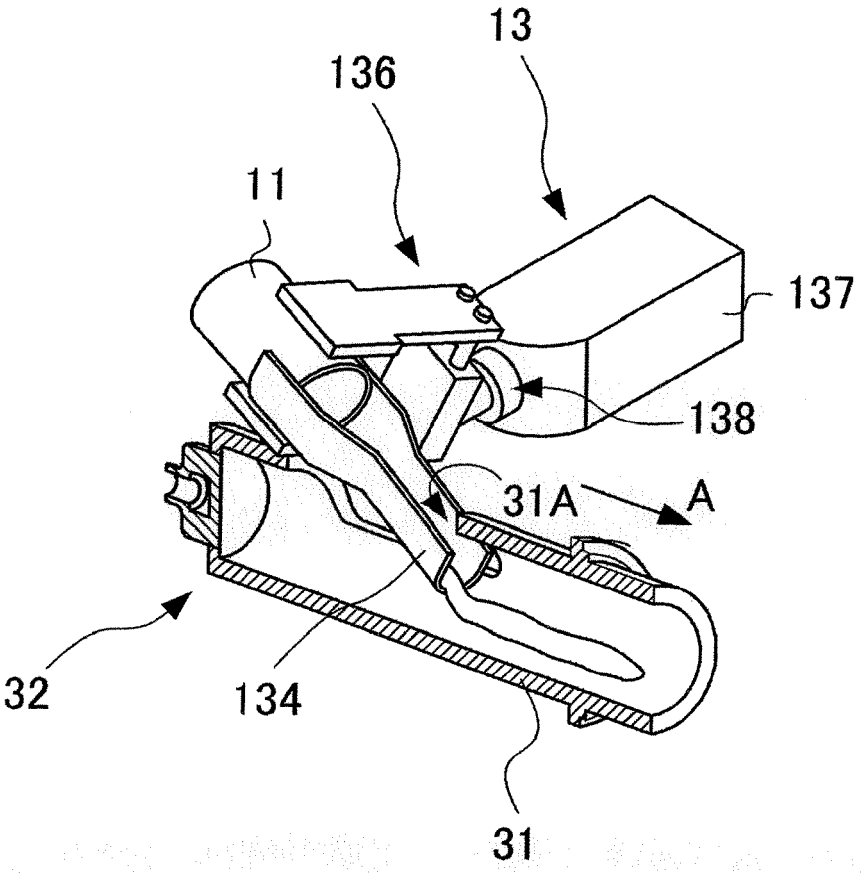


FIG.6

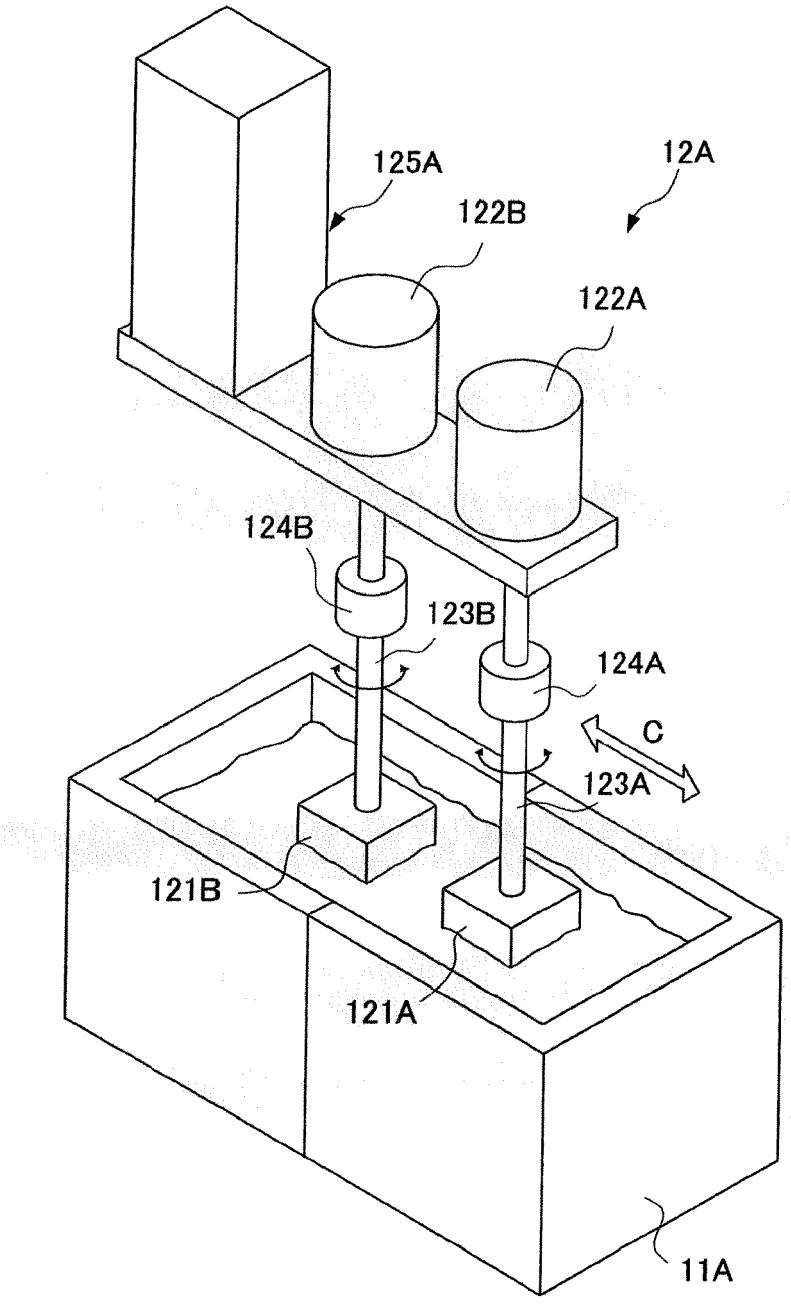
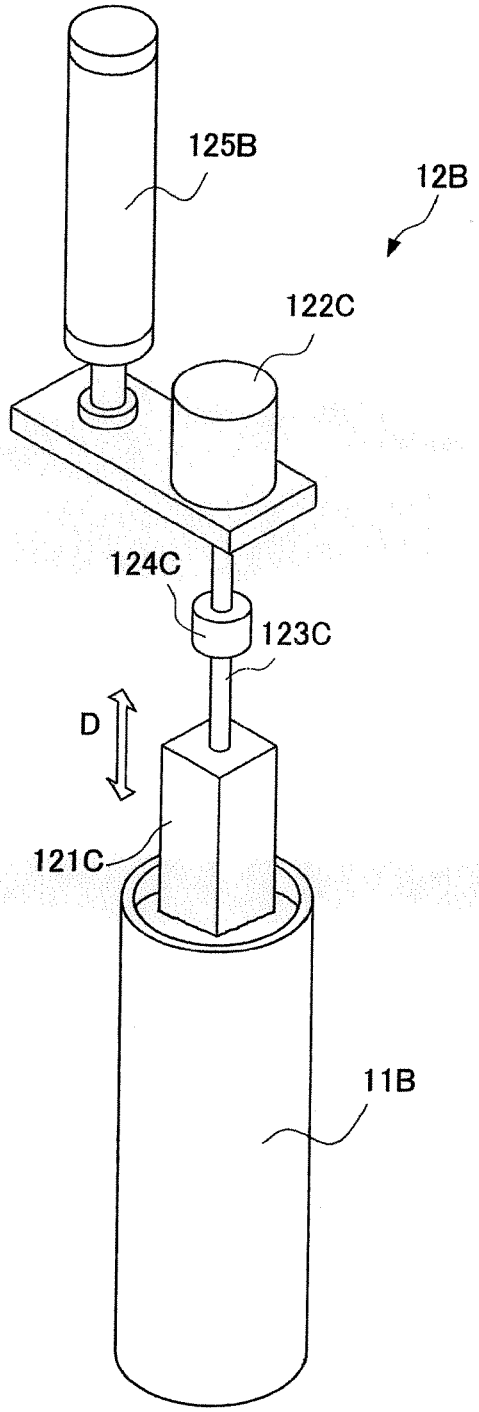


FIG. 7



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EUROPEAN SEARCH REPORT

Application Number
EP 08 15 2690

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	EP 0 903 193 A (UBE INDUSTRIES [JP]) 24 March 1999 (1999-03-24) * paragraphs [0051], [0057]; figure 9 *	1,4	
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TECHNICAL FIELDS SEARCHED (IPC)

B22D
C22C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23 June 2008	Hodiamont, Susanna

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 15 2690

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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23-06-2008

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