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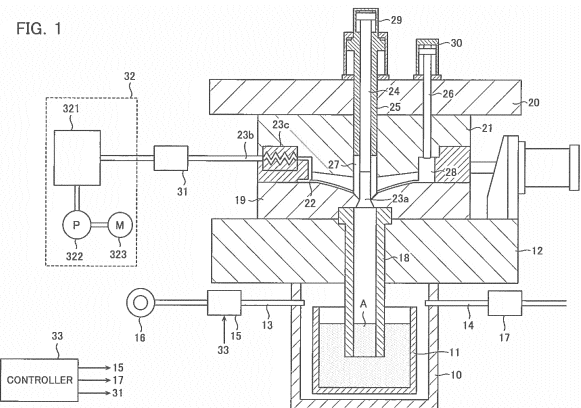
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(54) **CASTING DEVICE**

(57) A casting device includes: dies (19, 21) formed with a cavity (22) including an opening at a lower portion; a pressurizing chamber (10) disposed below the dies and containing molten metal (A) and further formed with a sealed space above the molten metal; a cylindrically-shaped stalk (18) having an upper end opening communicating with the opening of the cavity and a lower end opening immersed into the molten metal contained inside the pressurizing chamber; a pressurizing means (16) configured to supply a gas to the sealed space of the pressurizing chamber to pressurize the inside of the pressurizing chamber; a depressurizing means (32) configured to discharge a gas from the cavity to depressurize the inside of the cavity; and a control device (33). The control device, when the molten metal is provided to the cavity from the pressurizing chamber, pressurizes the inside of the pressurizing chamber by the pressurizing means until the molten metal reaches the opening of the cavity and depressurizes the inside of the cavity by the depressurizing means while continuing pressurizing the inside of the pressurizing chamber after the molten metal reaches the opening of the cavity.



Description

Technical Field

[0001] The present invention relates to a casting device.

Background Art

[0002] In the related art, there is a known casting device in which an aluminum composite product such as an aluminum wheel is manufactured by low-pressure die casting or low medium pressure die casting. According to this type of casting device, pressure inside a pressurizing chamber is increased by pressurizing in a state that molten metal is contained inside the pressurizing chamber (crucible), and further pressure inside of a cavity of a die is decreased by vacuum drawing. The molten metal is filled inside the cavity from the pressurizing chamber via a stalk by a pressure difference between the mentioned pressurizing and vacuum drawing (Patent Literature 1).

[0003] However, according to the casting device disclosed in Patent Literature 1, a gate piston pin is opened after making a molten metal side to positive pressure and a cavity side to negative pressure. Therefore, the molten metal may be splashed at the moment of opening the gate piston pin due to the pressure difference, thereby causing a flow mark and cold shut in a molded object. In other words, there may be a problem in which quality of the molded object is deteriorated.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 5-146864 A

Summary of Invention

Technical Problem

[0005] The present invention is made considering the above-described situation, and directed to providing a casting device capable of improving quality of a casting product by preventing molten metal from being splashed.

Solution to Problem

[0006] The casting device according to the present invention includes a die, a pressurizing chamber, a stalk, a pressurizing means, a depressurizing means, and a control device. The die is formed with a cavity including an opening at a lower portion thereof. The pressurizing chamber is disposed below the die, and contains molten metal, and further is formed with a sealed space above the molten metal. The stalk formed in a cylindrical shape has an upper end opening communicating with the open-

ing of the cavity, and a lower end opening immersed into the molten metal contained inside the pressurizing chamber. The pressurizing means pressurizes the inside of the pressurizing chamber by supplying a gas to the sealed space of the pressurizing chamber. The depressurizing means depressurizes the inside of the cavity by discharging the gas from the cavity. The control device, when the molten metal is provided to the cavity from the pressurizing chamber, pressurizes the inside of the pressurizing chamber by the pressurizing means until the molten metal reaches the opening of the cavity and depressurizes the inside of the cavity by the depressurizing means while continuing pressurizing the inside of the pressurizing chamber after the molten metal reaches the opening of the cavity.

Advantageous Effects of Invention

[0007] According to the present invention, when the molten metal is filled into the cavity from the pressurizing chamber, the inside of the pressurizing chamber is pressurized by the pressurizing means until the molten metal reaches the opening of the cavity, and after the molten metal reaches the opening of the cavity, the inside of the cavity is depressurized by the depressurizing means while continuing pressurizing the inside of the pressurizing chamber. By adopting such pressurizing and depressurizing timing, the molten metal is prevented from being splashed and product quality can be improved in the present invention.

Brief Description of Drawings

[0008]

Fig. 1 is a schematic view illustrating a casting device according to an embodiment.

Fig. 2 is a plan view illustrating a cavity 22 according to the embodiment.

Fig. 3A is a schematic view illustrating filling operation according to the embodiment.

Fig. 3B is a schematic view illustrating the filling operation according to the embodiment.

Fig. 3C is a schematic view illustrating the filling operation according to the embodiment.

Fig. 3D is a schematic view illustrating the filling operation according to the embodiment.

Fig. 4 is a diagram illustrating changes of pressure P1 applied to a pressurizing chamber 10 from a pressurizing source 16, pressure P2 to vacuum the cavity 22 from a vacuum device 32, and differential pressure P3 between the pressure P1 and P2 (hereinafter referred to as filling differential pressure) with passage of time in the embodiment.

Fig. 5 is a diagram illustrating changes of pressure P1 applied to the pressurizing chamber 10 from the pressurizing source 16, pressure P2 to vacuum the cavity 22 from the vacuum device 32, and the filling

differential

pressure P3 with passage of time in a comparative example.

Description of Embodiments

[0009] In the following, an embodiment of a casting device will be described in detail with reference to the attached drawings.

[0010] Fig. 1 is a schematic view illustrating the casting device according to an embodiment. The casting device includes a pressurizing chamber (crucible) 10 to pressurize molten metal A as illustrated in Fig. 1. Inside the pressurizing chamber 10, a container 11 to keep the molten metal A is provided. An upper end opening of the pressurizing chamber 10 is closed with a stationary platen 12, and a sealed space is formed inside the pressurizing chamber 10. The sealed space (pressurizing chamber 10) is in communication with a gas supply passage 13 and a gas discharge passage 14. The gas supply passage 13 is connected to the pressurizing source 16 via a valve 15, and supplies an inert gas into the pressurizing chamber 10. The gas discharge passage 14 opens the pressurizing chamber 10 to atmosphere via a valve 17.

[0011] An upper end of a cylindrical stalk 18 is fixed at a center of the stationary platen 12, and both ends of the stalk 18 are opened. A lower end of the stalk 18 is immersed into the molten metal A contained inside the pressurizing chamber 10. A fixed die 19 is mounted on an upper surface of the stationary platen 12. Further, a movable die 21 is mounted on a lower surface of a moving platen 20 configured movable upward relative to the fixed die 19. When the fixed die 19 and movable die 21 are closed, a cavity 22 is formed. At the center portion of the fixed die 19, an opening 23a is formed at a gate portion communicating with the cavity 22, and the opening 23a is in communication with an upper end portion of the stalk 18. Further, a degassing passage 23b to degas a gas from the cavity 22 is connected to the fixed die 19, and chill vents 23c to avoid penetration of the molten metal A into the degassing passage 23b are disposed between the cavity 22 and the degassing passage 23b.

[0012] A gate seal pin 24, a center pressurizing pin 25, and a plurality of partial pressurizing pins 26 are mounted on the movable die 21. The gate seal pin 24 is formed movable back and forth relative to the opening 23a to open and close the opening 23a. The gate seal pin 24 is formed in a substantially bar-like shape. The center pressurizing pin 25 is formed movable back and forth relative to a molten metal basin 27 communicating with the cavity 22 and pressurizes the inside of the cavity 22. The center pressurizing pin 25 is formed in a cylindrical shape surrounding the gate seal pin 24. The partial pressurizing pin 26 is formed movable back and forth relative to a molten metal basin 28 communicating with the cavity 22, and pressurizes the inside of the cavity 22. The partial

pressurizing pin 26 is formed in a substantially bar-like shape.

[0013] The gate seal pin 24 and the center pressurizing pin 25 respectively have upper end portions connected to a piston mechanism 29 as a driving means, and each one is movable in a vertical direction. In the same manner, the partial pressurizing pin 26 has an upper end portion connected to a piston mechanism 30 as a driving means, and is movable in a vertical direction.

[0014] Further, as illustrated in Fig. 1, the casting device includes a vacuum device 32 connected to the degassing passage 23b via a degassing valve 31, and a controller 33.

[0015] The vacuum device 32 discharges the gas from the cavity 22 via the degassing valve 31 and the degassing passage 23b, and depressurizes the inside of the cavity 22. The vacuum device 32 includes a vacuum tank 321, a vacuum pump 322 to perform vacuum drawing in the vacuum tank 321, and a motor 323 to drive the vacuum pump 322.

[0016] The controller 33 controls the valve 15 and the pressurizing source 16 to pressurize the inside of the pressurizing chamber 10. The controller 33 controls the valve 17 to open the pressurizing chamber 10 to the atmosphere. The controller 33 controls the valve 31 and the vacuum device 32 to discharge the gas contained inside the cavity 22, and depressurizes the inside of the cavity 22. The controller 33 controls the piston mechanism 29 to open and close the opening 23a by the gate seal pin 24. The controller 33 controls the piston mechanisms 29, 30 to pressurize the inside of the cavity 22 by the center pressurizing pin 25 and the partial pressurizing pin 26.

[0017] Next, referring to Fig. 2, positions of the gate seal pin 24, center pressurizing pin 25, and partial pressurizing pin 26 with respect to the cavity 22 will be described. Fig. 2 is a plan view illustrating the cavity 22. As illustrated in Fig. 2, the cavity 22 extends symmetrically in an X direction and a Y direction centering the gate seal pin 24 and the center pressurizing pin 25. In an example illustrated in Fig. 2, six partial pressurizing pins 26 are provided in the vicinity of end portions of the cavity 22.

[0018] Next, filling operation to fill the molten metal A in the cavity 22 from the pressurizing chamber 10 will be described with reference to Figs. 3A to 3D and Fig. 4. Figs. 3A to 3D are schematic views illustrating the filling operation. Fig. 4 is a diagram illustrating changes of pressure P1 applied to the cavity 22 from the pressurizing source 16, pressure P2 to vacuum the cavity 22 from the vacuum device 32, and differential pressure P3 between the pressure P1 and P2 (hereinafter referred to as filling differential pressure) with passage of time. Note that the filling operation is executed based on the passage of time in the present embodiment. For example, the time when a molten metal level of the molten metal A reaches the opening 23a is preliminarily measured, and filling operation is executed based on this measured time.

[0019] In the filling operation, the controller 33 first

opens the valve 15 at time t11 as illustrated in Fig. 3A. Then, the controller 33 supplies an inert gas to the sealed space of the pressurizing chamber 10 from the pressurizing source 16 via the gas supply passage 13. By this, the pressure P1 applied to the pressurizing chamber 10 from the pressurizing source 16 is increased from time t11 and forth as illustrated in Fig. 4. Therefore, the filling differential pressure P3 is increased as illustrated in Fig. 4, thereby raising the molten metal level of the molten metal A.

[0020] Next, as illustrated in Fig. 3B, the controller 33 continuously supplies the inert gas to the sealed space of the pressurizing chamber 10 from the pressurizing source 16 via the gas supply passage 13 even after the molten metal A reaches the opening 23a of the cavity 22 at time t12. Further, as illustrated in Fig. 3B, the controller 33 makes the cavity 22 communicate with the vacuum tank 321 by opening the valve 31. By this, the gas contained inside the cavity 22 is discharged to the vacuum tank 321 via the degassing passage 23b. Note that a sensor may be used to detect the molten metal A reaching the opening 23a of the cavity 22, or the time when the molten metal level reaches the opening 23a under a predetermined pressure is preliminarily measured and control may be executed based on this measured time.

[0021] As illustrated in Fig. 4, the pressure P1 applied to the cavity 22 from the pressurizing source 16 is continuously increased by the control illustrated in Fig. 3B even after time t12. However, an increasing speed of the pressure P1 is not constant depending on the shape of the cavity 22. Further, due to the control illustrated in Fig. 3B, a depressurizing (vacuum) degree inside the die is increased by discharge from the cavity 22 executed by the vacuum device 32. In other words, the pressure P2 applied to the cavity 22 is decreased in a minus direction as illustrated in Fig. 4. The filling differential pressure P3 is increased by the pressure P1, P2 as illustrated in Fig. 4.

[0022] Next, as illustrated in Fig. 3C, when the molten metal A is filled inside the cavity 22 at time t13, the molten metal A flows into the chill vent 23c located around the cavity 22 and solidifies therein, thereby completing a filling process. When the molten metal A solidifies in the entire chill vents 23c, the controller 33 closes the valve 31 to stop depressurizing. However, the pressure from the pressurizing source 16 is kept constant, and the molten metal A inside the cavity 22 solidifies under the constant pressure. Note that, at this point, the opening 23a is closed by pushing down the gate seal pin 24. Subsequently, as illustrated in Fig. 3D, the controller 33 opens the valve 17 to open the pressurizing chamber 10 to the atmosphere, thereby lowering the molten metal level of the molten metal A inside the stalk 18. At this point, the controller 33 may push down the center pressurizing pin 25 as illustrated in Fig. 3D and pressurize the inside of the cavity 22 so as to further increase the pressure. Additionally, pressurization by the partial pressurizing pin 26 may be combined as well. Further, the gate seal pin 24

and the center pressurizing pin 25 may be integrally formed, and in this case, gate closing and pressurizing are continuously operated by lowering a single cylinder. After solidification of the molten metal A inside the cavity 22, a product is taken out by moving up the movable die 21.

[0023] Here, according to the method in which the depressurized cavity 22 is blocked by the gate seal pin 24 to pressurize the inside of the pressurizing chamber 10, and the molten metal A is made to flow into the cavity 22 by utilizing the pressure difference between pressurization and depressurization by increasing the molten metal A up to just below the gate seal pin 24 and opening the gate seal pin 24, the molten metal A may rush into the cavity 22 like a jet flow, thereby causing a flow mark and cold shut in a molded object. In contrast, according to the present embodiment, the inside of the pressurizing chamber 10 is pressurized until the molten metal A reaches the opening 23a of the cavity 22 in a state that the gate seal pin 24 is opened as described above, and pressurizing the inside of the pressurizing chamber 10 is continued after the molten metal A reaches the opening 23a of the cavity 22, while the inside of the cavity 22 is gradually depressurized as illustrated in Fig. 4. This can gradually increase the filling differential pressure P3 when the molten metal flows into the die. Therefore, according to the present embodiment, the molten metal A is prevented from being splashed and the molded object can be prevented from causing the flow mark and cold shut.

[0024] Further, according to the present embodiment, the pressure inside the cavity 22 is controlled by the vacuum device 32 and the pressurizing chamber 10. Therefore, the present embodiment can provide a simple structure, compared to the case of controlling the pressure inside the cavity 22 by providing a plurality of pressurizing chambers. Further, compared to the case of controlling the pressure inside the cavity 22 only by the pressurizing chamber 10, a load applied to the pressurizing chamber 10 can be reduced and airtightness of the pressurizing chamber 10 can be secured in the present embodiment. For reference, Fig. 5 illustrates changes of the pressure P1 applied to the cavity 22 from the pressurizing source 16, pressure P2 of the cavity 22, and the differential pressure P3 between the pressure P1 and P2 with passage of time in a comparative example in which the vacuum device 32 is not combined. In the case of not depressurizing the cavity 22, back pressure is formed in a remaining portion as the molten metal A flows into the cavity 22 and filling progresses, and the back pressure is compressed at a last stage of filling and further increased, thereby hindering the molten metal to be filled into a final filling portion. Therefore, in the case of solving such a situation only by pressurizing of the pressurizing chamber, the applied pressure P1 is needed to be increased as illustrated in Fig. 5. However, in the case of increasing the pressure at a sealed container having a high-temperature system of 700°C, it is necessary to take some measures to enhance an airtight sealing portion and re-

duce a thermal load. In other words, not only providing heat-resistant sealing material but also some measures to prevent a sealing member such as a flange from thermal expansion and thermal deform are required, for example, by providing a cooling circuit in the vicinity of the sealing portion. Further, cost for material to be used is increased and further a facility becomes complex. These problems can be solved by the present embodiment.

[0025] Moreover, according to the present embodiment, a flow property of the molten metal A inside the cavity 22 can be improved because the back pressure inside the cavity 22 can be reduced by the vacuum device 32.

[0026] While the embodiment of the invention has been described above, the present invention is not limited thereto and various kinds of modifications and additions can be made within a scope without departing from the gist of the invention.

Reference Signs List

[0027]

- A Molten metal
- 10 Pressurizing chamber
- 11 Container
- 12 Stationary platen
- 13 Gas supply passage
- 14 Gas discharge passage
- 15 Valve
- 16 Pressurizing source
- 17 Valve
- 18 Stalk
- 19 Fixed die
- 20 Moving platen
- 21 Movable die
- 22 Cavity
- 23a Opening
- 23b Degassing passage
- 23c Chill vent
- 24 Gate seal pin
- 25 Center pressurizing pin
- 26 Partial pressurizing pin
- 27, 28 Molten metal basin
- 29, 30 Piston mechanism
- 31 Degassing valve
- 32 Vacuum device
- 33 Controller

Claims

1. A casting device, comprising:

a die formed with a cavity including an opening at a lower portion;
 a pressurizing chamber disposed below the die, containing molten metal, and further formed with

a sealed space above the molten metal;
 a stalk formed in a cylindrical shape, and having an upper end opening communicating with the opening of the cavity and a lower end opening immersed into the molten metal contained inside the pressurizing chamber;
 a pressurizing means configured to supply a gas to the sealed space of the pressurizing chamber to pressurize the inside of the pressurizing chamber;
 a depressurizing means configured to discharge a gas from the cavity to depressurize the inside of the cavity; and
 a control device, when the molten metal is provided to the cavity from the pressurizing chamber, configured to pressurize the inside of the pressurizing chamber by the pressurizing means until the molten metal reaches the opening of the cavity and configured to depressurize the inside of the cavity by the depressurizing means while continuing pressurizing the inside of the pressurizing chamber after the molten metal reaches the opening of the cavity.

2. The casting device according to claim 1, further comprising a gate seal pin formed movable back and forth relative to the opening, and configured to open and close the opening, wherein the control device closes the opening by the gate seal pin after the molten metal is filled in the cavity.

3. The casting device according to claim 1 or 2, further comprising a pressurizing pin formed movable back and forth relative to a molten metal basin communicating with the cavity, and configured to pressurize the molten metal filled inside the cavity.

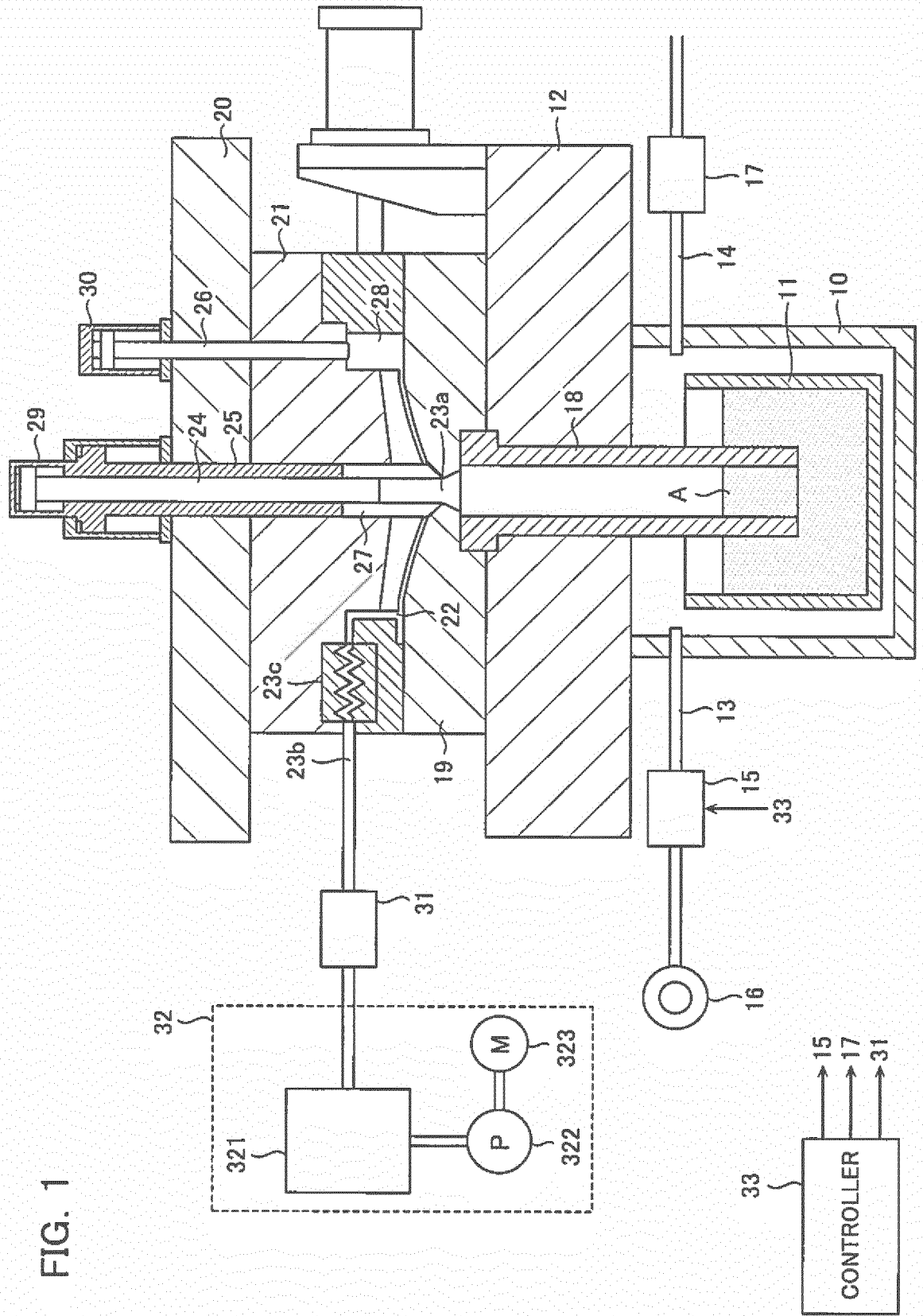


FIG. 1

FIG. 2

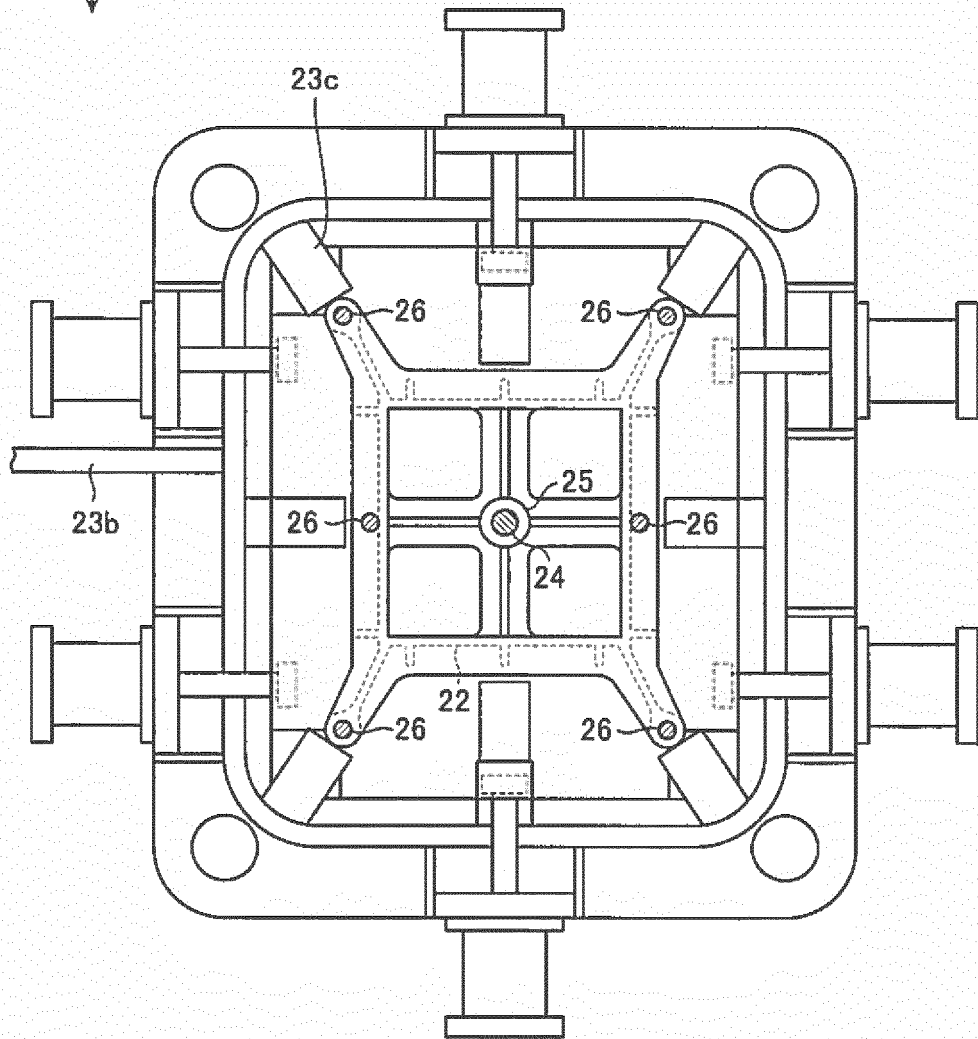
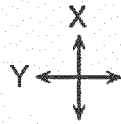


FIG. 3A

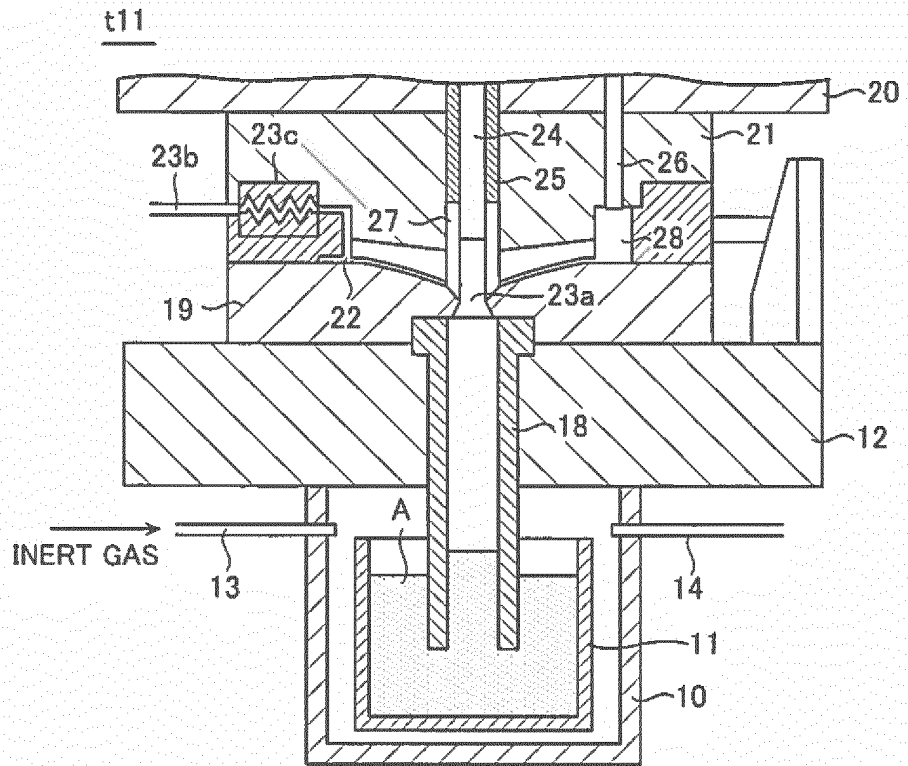


FIG. 3B

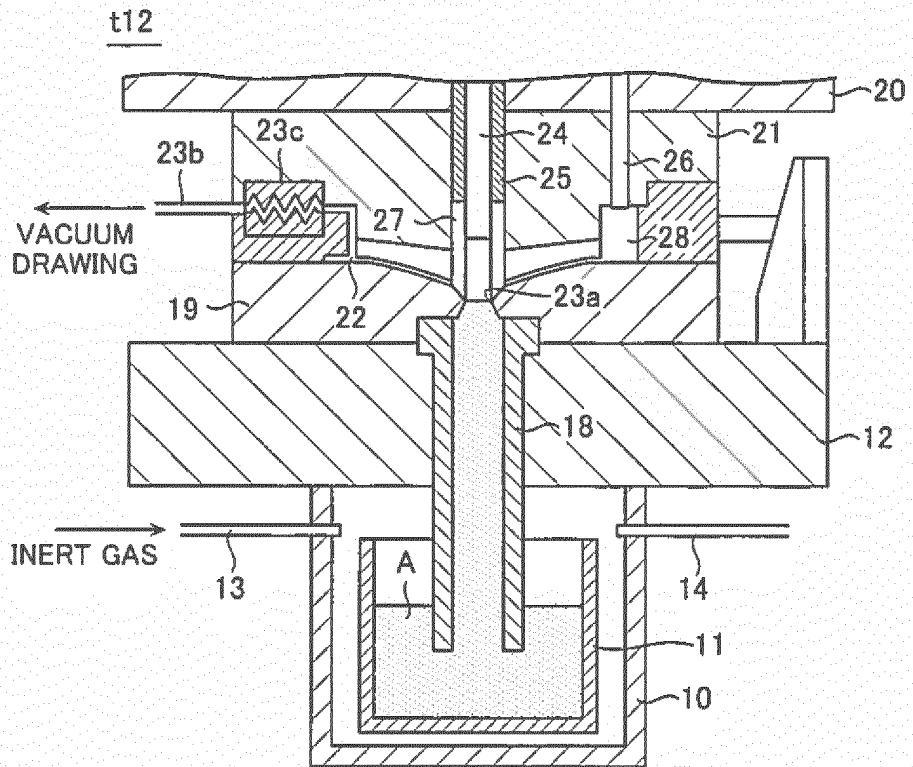


FIG. 4

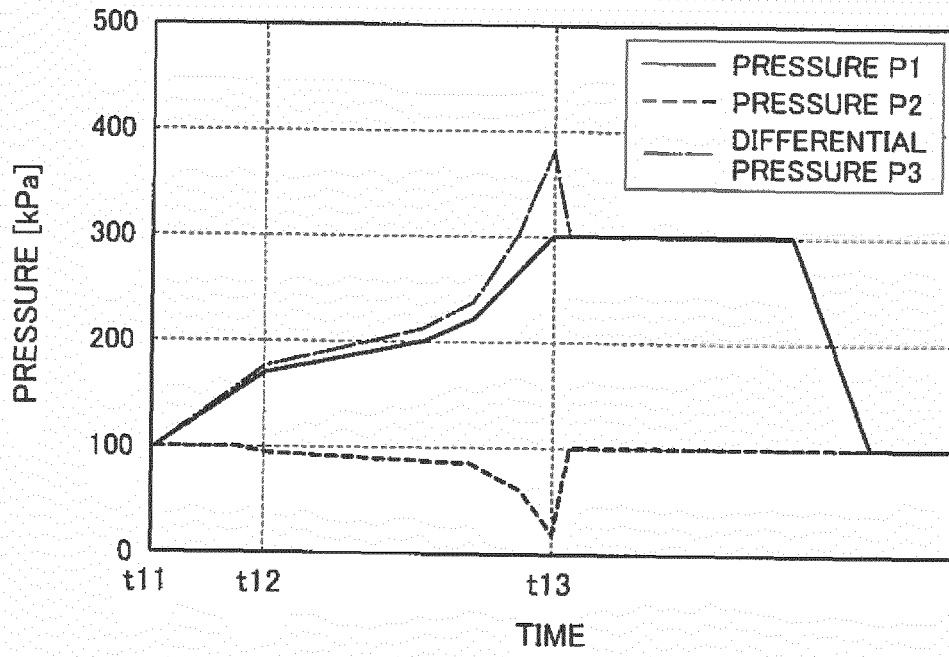
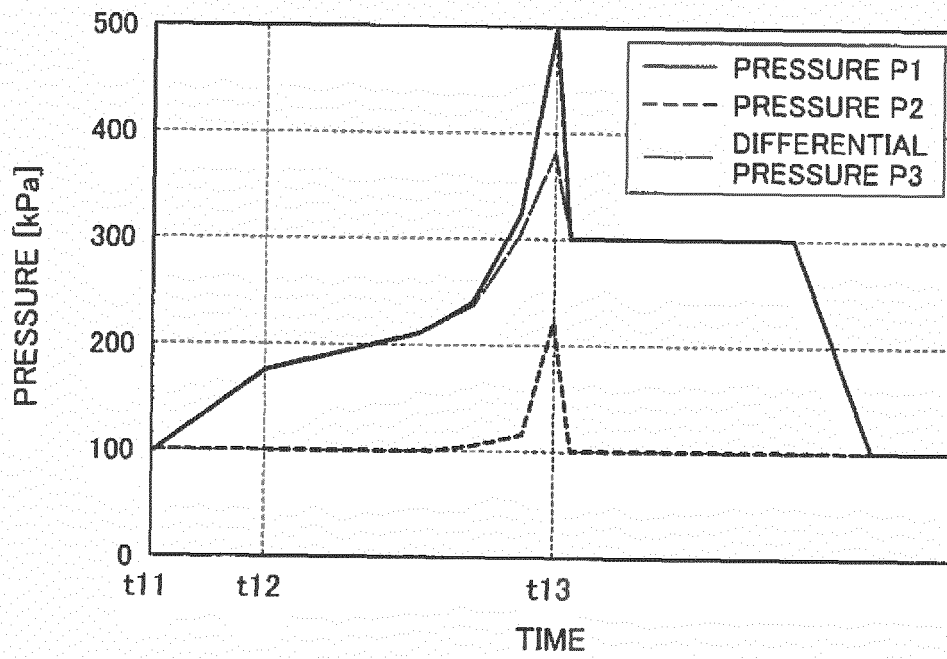


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER

B22D18/04(2006.01) i, B22D18/08(2006.01) i

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)

B22D18/04, B22D18/08

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013

Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2007-253168 A (Kosei Aluminum Co., Ltd.), 04 October 2007 (04.10.2007), entire text (Family: none)	1-3
A	JP 6-264157 A (Hitachi Metals, Ltd.), 20 September 1994 (20.09.1994), entire text (Family: none)	1-3
A	JP 4897734 B2 (Tanida Ltd.), 14 March 2012 (14.03.2012), entire text (Family: none)	1-3

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Date of the actual completion of the international search
26 December, 2013 (26.12.13)Date of mailing of the international search report
14 January, 2014 (14.01.14)Name and mailing address of the ISA/
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