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(54) ALUMINUM ALLOY SEMI-SOLID FORMING METHOD AND DEVICE

(57) The semi-solid molding method of the present invention comprises six parts as the traditional method: a mold, a main machine, an injection system, a pulping machine, a quantitative feeding system, and a holding furnace; the injection system, the pulping machine, and the quantitative feeding system are combined and called integrated pulping injection system, and the system is placed in the holding furnace. In order to adapt to the difficulty of molding the semi-solid slurry to carry less heat into the mold with large wall thickness, the semi-solid mold is divided into three layers according to the function, which greatly reduces the heat absorption capacity of the mold, due to the characteristics of the constant flow pump, the holding pressure after filling can reach 0.01MPa-30MPa, so low pressure casting, high pressure casting, differential pressure casting, liquid die forging and semi-solid extrusion forging can be unified in one kind of main machine.

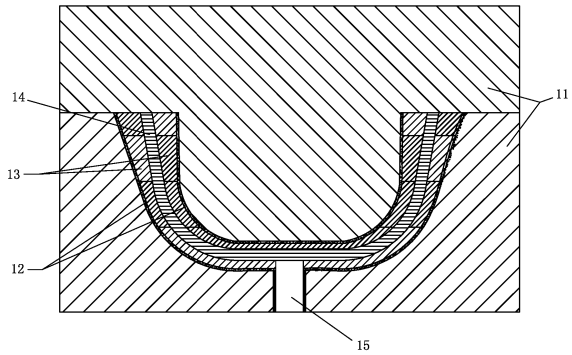

Fig. 1

EP 3 527 303 A1

Description

Technical field

[0001] The present invention relates to a light alloy molding method, in particular a semi-solid molding method.

Background of the present invention

[0002] The semi-solid slurry is strongly stirred during the solidification of the metal to break the dendrites, and a solid-liquid mixed slurry with spherical solid phase particles of uniformly suspended is obtained. It has good fluidity and can be used for semi-solid die casting, semi-solid extrusion casting, and semi-solid die forging.

[0003] The gas is not easily entangled during filling, its molding temperature is low, the mold life is long, the deformation resistance is small, and the production efficiency is high; the high pressure is applied during the molding to cause the solidified metal to plastic deformation, and the unsolidified solidification continues under high pressure. The shrinkage hole has small shrinkage, the structure is compact, the mechanical performance is higher than that of ordinary castings, and the heat treatment, no riser feeding, and high metal utilization rate can be obtained. It is suitable for the production of thin, thick-walled parts and for the formation of any alloy material with a wide range of crystallization temperature intervals.

[0004] Although the castings produced by the semi-solid molding technology have many advantages and the preparation methods of the slurry are many, the continuous preparation, storage, transportation and molding of the low-cost high-quality slurry have always been problems, which seriously restrict the promotion and application of the technology. The present invention solves the above problems in an all-round ways for the system.

Summary of the present invention

[0005] The semi-solid molding method of the present invention comprises semi-solid die casting, semi-solid extrusion casting, semi-solid die forging, and comprises the following six parts: a mold, a main machine (supporting and fixing the anti-lifting mold), an injection system (a pressure chamber, an injection rod, a power system, etc.), a pulping machine, a quantitative feeding system, and a holding furnace; the injection system (pressure chamber, pressure rod, power system, etc.), the pulping machine, and the quantitative feeding system are combined and called integrated pulping injection system, and the system is placed in the holding furnace, and the mold is provided with a heat insulating structure.

[0006] The three major problems of such semi-solid molding are solved (the large size of the mold can not adapt to the heat demand of the semi-solid slurry flow, the rapidity of the large-tonnage squeeze casting machine is difficult to match the rapid solidification of the semi-solid slurry, continuous pulping, quantitative delivery, and rapid injection are inherently complex and making them more difficult to reconcile). To illustrate the present invention more clearly, there are five aspects.

1) Mold

[0007] In order to solve the above technical problems, the present invention provides a novel mold for semi-solid slurry molding, the mold is provided with a cavity and a gate for casting, and the mold is provided with at least an outer layer, an intermediate layer and an inner layer from the outside to the inside. The wall thickness of the inner layer is proportional to the slurry flow. The inner layer is divided into at least two sections on each module along the flow direction, and the division of each section is calculated by a computer according to different casting requirements.

2) Main machine

[0008] The novel main machine for the semi-solid slurry molding of the present invention is disposed with an attachment means for changing the mold increasing force into the internal force of the mold. The attachment means comprises two clamping molds on both sides of the split upper mold and the lower mold, and the clamping device comprises two U-shaped clamping jaws symmetrically placed, and the clamping clamps are driven by an oil cylinder for relative movement, the direction of movement is perpendicular to the mold opening and closing direction. After the upper mold and the lower mold are clamped, the two clamping jaws are respectively driven by the cylinders to lock on both sides of the mold, and the clamping force counteracts the mold increasing force generated when the liquid metal fills the mold. For the mold of the four-opening mold, the opposite two cylinders can be used to drive the square type and the annular clamping cylinder to lock the mold on the side of the mold.

[0009] For a six-opening mold, the attachment means is capable of inserting a convex or concave portion of the front and rear or left and right side molds into a concave or convex portion of the top or bottom molds so as to lock the top and bottom molds, or the bottom and the top molds are locked by the inwardly extending steps of the front and rear, left and right side molds, and the side molds are locked by a ring or a square frame driven by an oil cylinder on the moving template.

[0010] The attachment means converts a three-opening mold into a four-opening mold by using a dummy mold which does not participate in the molding and only plays the locking function, and converts a five-opening mold to a six-opening mold by using a dummy mold.

3) Continuous pulping machine

[0011] The present invention provides a circulation refining device for continuously preparing aluminum alloy

semi-solid slurry for refining slurry, the refining device comprises a driving mechanism and a refining mechanism, a refining portion of the refining mechanism inserts to the slurry to refine the slurry, the refining mechanism comprises a rotor and a stator, the stator is hollow inside, the rotor is placed inside the stator, and the driving mechanism drives the rotor to rotate inside the stator; the refining portion immersing in the slurry to perform the refining function is provided with a refining cavity, the rotor in the refining cavity is provided with a blade, and the bottom of the stator is provided with a suction port connected to the refining cavity, and a jet hole is defined in the sidewall of the stator in the refining cavity; the driving mechanism drives the rotor to rotate, and the blade rotates to form a negative pressure to make the slurry enter the refining cavity from the suction port to be refined and eject to the outside of the stator from the jet hole.

[0012] The driving mechanism comprises a motor, a rotating wheel, a driving belt and a rotating shaft, the output end of the motor is connected to the rotating wheel, the driving belt is respectively connected to the rotating wheel and the rotating shaft, the rotating shaft is fixedly connected with the top of the rotor; the motor working drives the rotating wheel to rotate, Thereby, the power is transmitted to the rotating shaft through the transmission belt, and the rotating shaft is rotated, thereby driving the rotor to rotate relative to the stator.

4) Injection system, slurry delivery

[0013] The present invention provides a constant current pump for continuously transporting an aluminum alloy semi-solid slurry for transporting aluminum liquid, the pump comprises a driving mechanism and an aluminum liquid transport mechanism, the aluminum liquid transport mechanism comprising a rotor and a stator, the stator is hollow inside, the rotor is disposed inside the stator, the driving mechanism drives the rotor to rotate inside the stator; the stator is placed inside the slurry, and the liquid transportation portion that performs the aluminum liquid transporting function is provided with a pump chamber, and the rotor in the pump chamber is provided with a curved or rectangular rotating piece, and the side wall of the stator is provided with a liquid suction port and a liquid discharge port which are connected to the aluminum liquid container and the guide cylinder, and the liquid discharge port is connected with a guide cylinder.

[0014] The driving mechanism comprises a motor, a rotating wheel, a driving belt and a rotating shaft, the output end of the motor is connected to the rotating wheel, the driving belt is respectively connected to the rotating wheel and the rotating shaft, the rotating shaft is fixedly connected with the top of the rotor; the motor working drives the rotating wheel to rotate, Thereby, the power is transmitted to the rotating shaft through the transmission belt, and the rotating shaft is rotated, thereby driving the rotor to rotate relative to the stator.

5) Holding furnace

[0015] The present invention provides a holding furnace for continuously preparing an aluminum alloy semi-solid slurry, comprising a furnace body, a crucible and a heater, the crucible and the heater are both disposed in the furnace body, and the heater arranges at least two independent heating elements in a vertical direction; these heating elements are powered by separate external power sources, the crucible is heated by the heater, and the operating temperature of each heating element is set to rise from bottom to top, thereby the liquid in the crucible forms a temperature gradient which gradually rises from the bottom to the top. For the knotting furnace, it is also possible to use a silicon carbon rod or the like to reflect from the upper portion to heat the aluminum water to cause a high top and low bottom temperature field to meet the needs of the pulping.

Brief description of the drawings

[0016] The present invention will be further described below in conjunction with the embodiments and the accompanying drawings.

FIG. 1 is a schematic view showing the structure of a novel mold for semi-solid slurry molding of the present invention.

FIG. 2 is a schematic view showing the structure of the semi-solid molding machine of a two-opening mold of the present invention.

FIG. 2-1 is a schematic view showing the structure of a semi-solid molding machine for a four-opening mold of the present invention.

FIG. 3 is a schematic view of a circulation refining device for continuously preparing aluminum alloy semi-solid slurry according to the present invention;

FIG. 4 is a schematic view showing the structure of the constant current pump for continuously preparing aluminum alloy semi-solid slurry according to the present invention;

FIG. 5 is a schematic view showing the structure of a holding furnace for continuously preparing aluminum alloy semi-solid slurry according to the present invention;

Detailed description of the embodiment

1) Mold

[0017] Please refer to FIG. 1, a novel mold for semi-solid slurry molding as a preferred embodiment of the present invention is provided. The mold 1 is provided with a cavity and a gate 15 for casting molding, and the mold has an outer layer 11, an intermediate layer 12 and an inner layer 13 sequentially from the outside to the inside. The outer layer 11 is used for load bearing and is made of ordinary cast iron or steel, the intermediate layer 12 is

used for controlling the heat flux and is made of heat resistant material, and the inner layer 13 is used for restraining the size of the casting 14 and is made of heat resistant steel. Graphite paper, stainless steel sheets, aluminum silicate fibers or asbestos paper are attached to the intermediate layer 12, or the intermediate layer 12 is a shelter layer. The wall thickness of the inner layer 13 is proportional to the slurry flow. The inner layer 13 is divided into at least two sections on each module along the flow direction, and the division of each section is calculated by the computer according to different casting requirements.

[0018] In summary, the mold 1 of the present invention is provided with three layers of outer, intermediate and inner layers, and with the layered and variable wall thickness in the flow direction, the new mold has small heat capacity, large temperature gradient and high pressure bearing capacity for semi-solid extrusion molding, when the product has a small modification, the inner layer can just be replaced, which is beneficial to reduce the replacement cost, the outer layer made of ordinary steel is beneficial to reduce the mold cost, the mold has small thermal stress, small deformation and long service life.

2) The main machine

[0019] The novel main machine for the semi-solid slurry molding of the present invention is an attachment means 2 for changing the mold increasing force into the internal force of the mold. Referring to FIG. 2, the attachment device 2 for a two-opening mold 7 of an upper mold 71 and a lower mold 72 is provided with a clamping device at two sides, the clamping device comprises two U-shaped clamping jaws 21 symmetrically placed. The clamping jaws 21 are each driven by an oil cylinder 22 for relative movement, and the direction of movement is perpendicular to the opening and closing direction of the mold 7. After the upper mold 71 and the lower mold 72 are clamped, the two clamping jaws 21 are respectively driven by the oil cylinder 22 to be engaged on both sides of the mold 7, and the clamping force counteracts the mold increasing force generated when the liquid metal is filled into the mold. The same is true for four-opening mold and six-opening molds.

[0020] Referring to FIG. 2-1, the attachment device 3 comprises a clamping device disposed on the four sides of a four-opening mold 8 comprising a upper mold 81, a lower mold 84, a left mold 82 and a right mold 83, and the clamping device comprises symmetrically placed The two locking frames 31 are respectively driven by a cylinder 32 for relative movement, and the moving direction is perpendicular to the opening and closing direction of the mold 8. After the mold 8 is closed, the two locking frames 31 are respectively driven by the oil cylinder 32 to be attached to the front and rear sides of the mold 8, and the clamping force counteracts the mold-increasing force generated when the liquid metal is filled into the mold.

[0021] By setting a suitable clamping mechanism, the huge mold-increasing force generated during liquid forging and semi-solid extrusion molding is changed to the internal force of the mold system, which greatly reduces the tonnage of the molding main machine and improves the rapidity. The cost of liquid casting forging and semi-solid extrusion molding will be greatly reduced, paving the way for the promotion of liquid forging and semi-solid extrusion molding.

3) Continuous pulping

[0022] Referring to FIG. 3, a cycle refining device 4 for continuously preparing aluminum alloy semi-solid slurry is provided for refining the slurry, the device 4 comprising a driving mechanism and a refining mechanism. The refining portion of the refining mechanism is inserted to the crucible where the slurry is placed to refine the slurry. The refining mechanism comprises a rotor 41 and a stator 42. The stator 42 is hollow inside, the rotor 41 is disposed inside the stator 42, and the driving mechanism drives the rotor 41 to rotates inside the stator 42. The refining portion of the stator 42 immersing in the slurry to perform the refining function is provided with a refining cavity, the rotor 41 in the refining cavity is provided with a blade 411, and the bottom of the stator 42 is provided with a suction port connected to the refining cavity, and a jet hole 421 is defined in the sidewall of the stator 42 in the refining cavity; the driving mechanism drives the rotor 41 to rotate, and the blade 411 rotates to form a negative pressure to make the slurry enter the refining cavity from the suction port to be refined and eject to the outside of the stator 42 from the jet hole 421. The minimum gap between the rotor 41 and the stator 42 is 1-2000 micrometers, and a large number of fine streams (aluminum liquid in which solid phase particles are suspended) sprayed by the scattering pump are cut by a small gap, thereby The refinement efficiency of suspended grains is high by continuously preparing an aluminum alloy semi-solid slurry device. The number of the jet holes 421 can be set as needed, and it is preferable to provide two or more, and the two or more jet holes 421 are symmetrical with each other with the rotation axis of the rotor 41 as a central axis to uniformly and sufficiently eject the slurry. The jet hole 421 has an aperture of 0.1-20 mm, and the aperture axis forms an angle of 20-90° downward with the axis of rotation of the rotor 41. The specific aperture and angle can be set according to the size of the crucible to adjust the slurry to be ejected from the jet hole and to ensure that the slurry in the crucible is sufficiently refined.

[0023] The driving mechanism comprises a motor 43, a driving wheel 44, a driven wheel 46, a driving belt 45 and a rotating shaft 47. The output end of the motor 43 is connected to the driving wheel 44. The driven wheel 46 is disposed on the rotating shaft 47, and the driving belt 45 is tensioned on the driving wheel 44 and the driven wheel 46, the shaft 47 is fixedly coupled to the top of the rotor 41. The motor 43 drives the driving wheel 44 to

rotate, thereby transmitting power to the rotating shaft 47 through the driving belt 45 so as to drive the rotating shaft 47 to rotate, thereby driving the blades 411 of the rotor 41 to rotate relative to the stator 42. The blade 411 can be provided as needed, preferably 2-16 pieces. The driving mechanism drives the blade 411 to rotate a large amount of fine flow from the jet hole 421, and tilts downward to impact the bottom of the crucible at the upper portion of the heat exchanger, and is sucked back by the hole at the bottom of the scattering pump to be re-cut and then injected, that is, the heat exchange intensity is increased (benefit to control the solid phase comparison) and further the refining effect on suspended grains is strengthened.

[0024] In summary, the present invention utilizes the rotation of the blade 411 to form a negative pressure to draw the slurry into the refining cavity of the stator 42 for refinement, and the refined slurry is ejected from the jet hole 421 to return the crucible, it is continuously sucked from the suction port, repeated circulation, and refinement; thus, the refining efficiency of the suspended crystal grains is higher, and the difference in specific gravity due to the temperature causes the prepared slurry to accumulate in the bottom of the crucible for continuous collection and delivery.

4) Injection system and slurry delivery

[0025] Please refer to FIG. 4, a constant current pump 5 for continuously preparing an aluminum alloy semi-solid slurry is used for transporting aluminum liquid, the pump 5 comprising a driving mechanism and an aluminum liquid transport mechanism. The aluminum liquid transport mechanism comprises a rotor 51 and a stator 52. The stator 52 is hollow inside, and the rotor 51 is disposed inside the stator 52. The driving mechanism drives the rotor 51 to rotate inside the stator 52. The liquid transportation portion of the stator 52 disposed inside the slurry for performing the aluminum liquid transporting function is provided with a pump chamber, and the rotor 51 in the pump chamber is provided with a curved or rectangular rotating piece 511, the side wall of the stator 52 is provided with a liquid suction and a liquid discharge port connected to an aluminum liquid container and a guide cylinder 53, the liquid discharge port is connected with the guide cylinder 53. The liquid suction port and the liquid discharge port are placed at an angle of 45 degrees from the point where the rotor 51 and the stator 52 are tangent. A high temperature resistant sealing ring 541 and a gasket 542 are disposed between the rotor 51 and the stator 52 at the upper portion of the pump chamber. The high temperature resistant sealing ring 541 is a U-shaped, V-shaped or square high temperature sealing ring, and the gasket 542 is a square gasket in cross section. The driving mechanism comprises a motor 55, a driving wheel 56, a driven wheel 58, a driving belt 57 and a rotating shaft 59. The output end of the motor 55 is connected to the driving wheel 56. The driven wheel 58 is disposed on the rotating shaft 59. The driving belt 57 is tensioned on the driving wheel 56 and the driven wheel 58, the rotating shaft 59 is fixedly coupled to the top of the rotor 51. The motor 55 drives the driving wheel 56 to rotate, thereby transmitting power to the rotating shaft 59 through the driving belt 57, thereby rotating the rotating shaft 59 and thereby driving the rotor 51 to rotate relative to the stator. The pump is sealed by the high temperature resistant sealing rings and gaskets, which are made of graphite, carbon fiber and high temperature resistant composite materials.

[0026] The rectangular rotary vane in the pump can be replaced by an arc-shaped rotary vane, the number of which is 2-15, the thickness is 2-15 mm, the length is 5-100 mm, and the inner bearing of the original rotary vane pump is cancelled. The closing angle between the suction port of the rotary vane pump and the liquid discharge port is larger than the split angle of the rotor. The root of the blade is provided with a pressure equalization groove. The low pressure side and the low pressure port of the pressure equalization groove are connected, and the high pressure side and the high pressure port are connected.

[0027] The rotor 51, the stator 52 and the rotary vane 511 of the pump are made of graphite, CC fiber, ceramic material, metal molybdenum, tungsten or composite material of metal alloy with surface coating or plating with molybdenum, tungsten or other aluminum corrosion resistant.

[0028] In summary, the present invention adopts a volumetric pump, which has a constant flow characteristic, and thus the filling speed of the liquid metal is substantially reduced when the horizontal section of the liquid metal is suddenly expanded, thereby overcoming the shortcomings of the uncontrollable level flow rate of the liquid pressure control system of the conventional pressure control and improving the intrinsic quality of the casting, and the operation of placing the filter in each casting can be eliminated. The new aluminum alloy semi-solid molding process is capable of timely and automatically completing a large pressure rise when the cavity is full, which is of great significance for improving the intrinsic quality of aluminum alloy semi-solid molded parts.

5) Holding furnace

[0029] Please refer to FIG. 5, a holding furnace 6 for continuously preparing an aluminum alloy semi-solid slurry is provided, the holding furnace 6 comprises a furnace body, a crucible and a heater, and the crucible 61 and the heater 62 are placed in the furnace body, the heater 62 arranges at least two independent heating elements in a vertical direction; these heating elements are powered by external independent power sources, so that the heater 62 heats the crucible 61, and the operating temperature of each heating element is set to gradually rise from the bottom to the top, thereby forming a temperature gradient for the crucible 61 which gradually rises

from the bottom to the top. There is a cooling device at the bottom of the crucible 61. The cooling device comprises a heat conductive graphite paper 631, a heat conducting ring 632 and a water cooling ring 633. The heat conductive graphite paper 631 is adhered to the bottom of the crucible 61. The heat conducting ring 632 is disposed in the furnace body, and the top thereof is closely attached to the bottom of the heat conductive graphite paper 631, and the bottom portion thereof and the bottom of the furnace body are connected, the cooling ring 633 is disposed on the bottom of the furnace 64. A heat shield 65 is disposed on the outside of the furnace body, and the heat shield 65 covers the top and the periphery of the furnace body. The heating element comprises a resistance wire, a resistance band, a silicon carbon rod and an induction coil. The heating element arranges2-5 segments in the vertical direction. For the knotting furnace, a silicon carbon rod or the like can be used to reflect from the upper part the aluminum carbon water can be reflected from the upper part by a silicon carbon rod or the like to cause high top and low bottom temperature field to meet the needs of pulping. The cooling ring 633 conducts heat in the form of water cooling, air cooling or oil cooling. The heat conducting ring 632 is made of heat resistant steel or graphite. The ratio of the height to diameter of the crucible 61 is 1.0-2.5.

[0030] In summary, the present invention continuously prepares a semi-solid slurry under the protection of an inert gas, and has less oxidized slag in the slurry, which can further improve the intrinsic quality of the casting; the furnace body of the new semi-solid molding process of the aluminum alloy uses large depth of use, silicon carbide or graphite crucible, which has less pollution to aluminum liquid than knotting furnace, is easy to clean, has small heat capacity of liquid carrier (silicon carbide or graphite crucible), and has flexible and convenient temperature control; the furnace body and the furnace cover 66 adopt shielded and insulated technique, whose energy-saving effect is good; the aluminum leakage has an automatic processing and alarm device 67.

[0031] Although the present invention has been described with reference to the preferred embodiments thereof for carrying out the patent for invention, it is apparent to those skilled in the art that a variety of modifications and changes may be made without departing from the scope of the patent for invention which is intended to be defined by the appended claims.

Industrial applicability

[0032] The semi-solid molding method of the present invention can provide a systemic slurry having continuous preparation, storage, transportation and molding, and has low cost, excellent quality and less pollution.

Claims

1. An aluminum alloy semi-solid molding device, wherein comprising a mold, a main machine, an injection system, a pulping machine, a quantitative feeding system and a holding furnace, the injection system, the pulping machine and the quantitative feeding system are placed in the holding furnace, and the mold is provided with a heat insulation and cooling structure.

2. The aluminum alloy semi-solid molding device according to claim 1, wherein the device is suitable for semi-solid high pressure casting, semi-solid extrusion casting, semi-solid vacuum and low pressure casting, semi-solid pressure regulating casting, semi-solid differential pressure casting and semi-solid low pressure casting.

3. The aluminum alloy semi-solid molding device according to claim 1, wherein the mold is provided with at least an outer layer, an intermediate layer and an inner layer, and the outer layer is rigid for bearing; the inner layer is thin for constraining the casting size; the intermediate layer is used to control the heat flux.

4. The aluminum alloy semi-solid molding device according to claim 3, wherein the wall thickness of the inner layer is proportional to the slurry flow.

5. The aluminum alloy semi-solid molding device according to claim 3, wherein the inner layer is divided into at least two sections on each module along the flow direction.

6. The aluminum alloy semi-solid molding device according to claim 1, wherein the main machine is provided with an attachment means for changing the mold increasing force into the internal force of the mold.

7. The aluminum alloy semi-solid molding device according to claim 6, wherein the attachment means is U-shaped caliper for a two-opening mold.

8. The aluminum alloy semi-solid molding device according to claim 6, wherein the attachment means is locked by a frame for a four-opening mold.

9. The aluminum alloy semi-solid molding device according to claim 6, wherein for a six-opening mold, the attachment means is capable of inserting a convex or concave portion of the front and rear or left and right side molds into a concave or convex portion of the top or bottom molds so as to lock the top and bottom molds, or the bottom and the top molds are locked by the inwardly extending steps of the front

and rear, left and right side molds, and the side molds are locked by a ring or a square frame driven by an oil cylinder on the moving template.

10. The aluminum alloy semi-solid molding device according to claim 6, wherein the attachment means converts a three-opening mold into a four-opening mold by using a dummy mold which does not participate in the molding and only plays the locking function, and converts a five-opening mold to a six-opening mold by using a dummy mold.

11. The aluminum alloy semi-solid molding device according to claim 1, wherein the pulping machine is used for refining the slurry, the pulping machine comprises a driving mechanism and a refining mechanism, a refining portion of the refining mechanism inserts to the slurry to refine the slurry, the refining mechanism comprises a rotor and a stator, the stator is hollow inside, the rotor is placed inside the stator, and the driving mechanism drives the rotor to rotate inside the stator;
the refining portion immersing in the slurry to perform the refining function is provided with a refining cavity, the rotor in the refining cavity is provided with a blade, and the bottom of the stator is provided with a suction port connected to the refining cavity, and a jet hole is defined in the sidewall of the stator in the refining cavity; the driving mechanism drives the rotor to rotate, and the blade rotates to form a negative pressure to make the slurry enter the refining cavity from the suction port to be refined and eject to the outside of the stator from the jet hole.

12. The aluminum alloy semi-solid molding device according to claim 11, wherein the pulping machine is used for refining the slurry, the minimum gap between the rotor and the stator is 1-2000 μm, the diameter of the rotor is 3 cm - 50 cm, the number of the blades of the rotor are 2-17, and the shape of the blade can be straight, forward bend or back bend.

13. The aluminum alloy semi-solid molding device according to claim 11, wherein the pulping machine is used for refining the slurry, the hole diameter of the jet hole is 0.1-20 mm, the space height of the hole of the jet hole occupies from 2 cm to d (the diameter of the rotor).

14. The aluminum alloy semi-solid molding device according to claim 11, wherein the aperture axis of the jet hole forms an angle of 90-45° with the axis of rotation of the rotor.

15. The aluminum alloy semi-solid molding device according to claim 11, wherein the suction port of the pulping machine is single-sided or double-sided, and may be fully open or half open.

16. The aluminum alloy semi-solid molding device according to claim 1, wherein the injection system and the slurry transporting are using a positive displacement pump, a rotary vane pump, a gear pump, a screw pump or a Rogowski pump.

17. The aluminum alloy semi-solid molding device according to claim 16, wherein the rotary vane pump comprises a driving mechanism and an aluminum liquid transport mechanism, and the aluminum liquid transport mechanism comprises a rotor and a stator, the stator is hollow inside and the rotor is disposed inside the stator, the driving mechanism drives the rotor to rotate inside the stator; the transport portion of the stator disposed inside the slurry to perform the aluminum liquid transport function is provided with an aluminum liquid receiving chamber, and the rotor in the aluminum liquid receiving chamber is provided with a curved rotating piece or a rectangular rotating piece, the number of which is 2-15, the thickness is 2-15 mm, the length is 5-100 mm, and the side wall of the stator is provided with a liquid suction port and a liquid discharge port connected to the aluminum liquid receiving cavity, and the liquid discharge port is connected with a guide cylinder.

18. The aluminum alloy semi-solid molding device according to claim 17, wherein a closing angle between the liquid suction port and the liquid discharge port is larger than a bisector angle of the rotor, and the root of the blade is disposed with a pressure equalization groove, the low pressure side and the low pressure port of the pressure equalization groove are connected, and the high pressure side and the high pressure port are connected.

19. The aluminum alloy semi-solid molding device according to claim 17, wherein a high temperature resistant sealing ring and gasket are arranged between the rotor and the stator in the upper portion of the aluminum liquid receiving chamber, and the material thereof is graphite, carbon fiber or high temperature resistant composite material.

20. The aluminum alloy semi-solid molding device according to claim 1, wherein the material of the injection system and the pulping machine is made of graphite, CC fiber, ceramic material, metal molybdenum, tungsten or composite material of metal alloy with surface coating or plating with molybdenum, tungsten or other aluminum corrosion resistant.

21. The aluminum alloy semi-solid molding device according to claim 1, wherein the heating belt of the holding furnace is independently controlled by 2-5 layers to ensure that the furnace temperature is high at the top and low at the bottom, and the knotting furnace can use a silicon carbon rod or the like for

reflection from the upper portion to heat the aluminum water to cause the furnace temperature of high at the top and low at the bottom so as to meet the needs of the pulping, the bottom of the crucible is provided with a cooling device, and the height to diameter ratio of the crucible is 1.2-3.

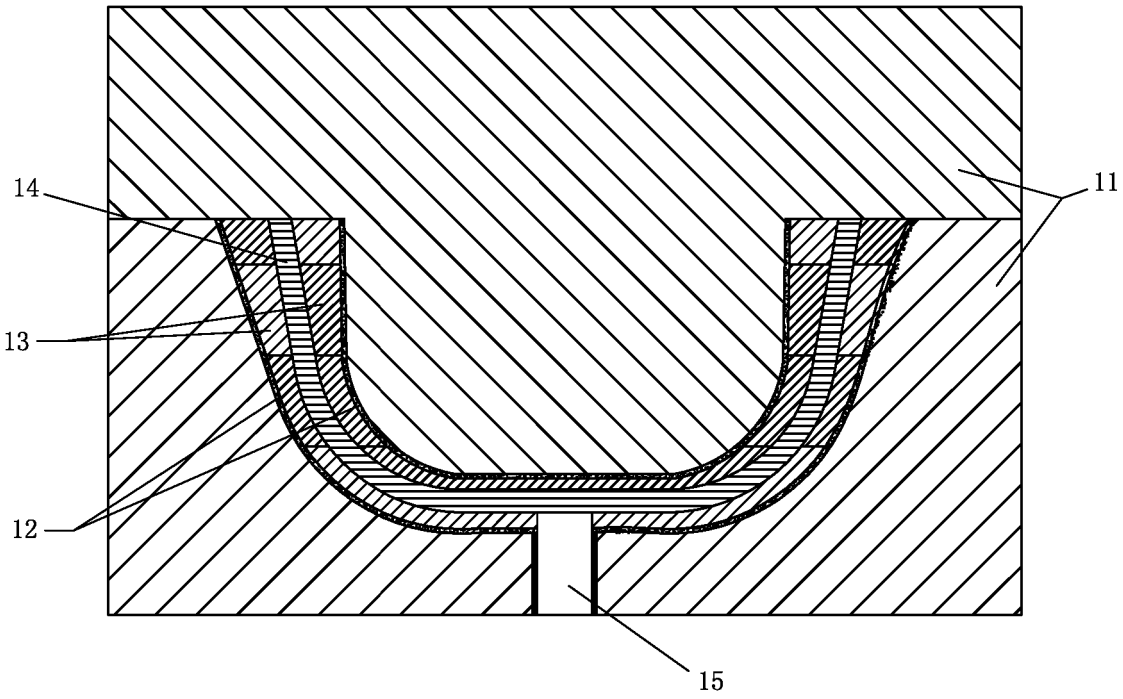

Fig. 1

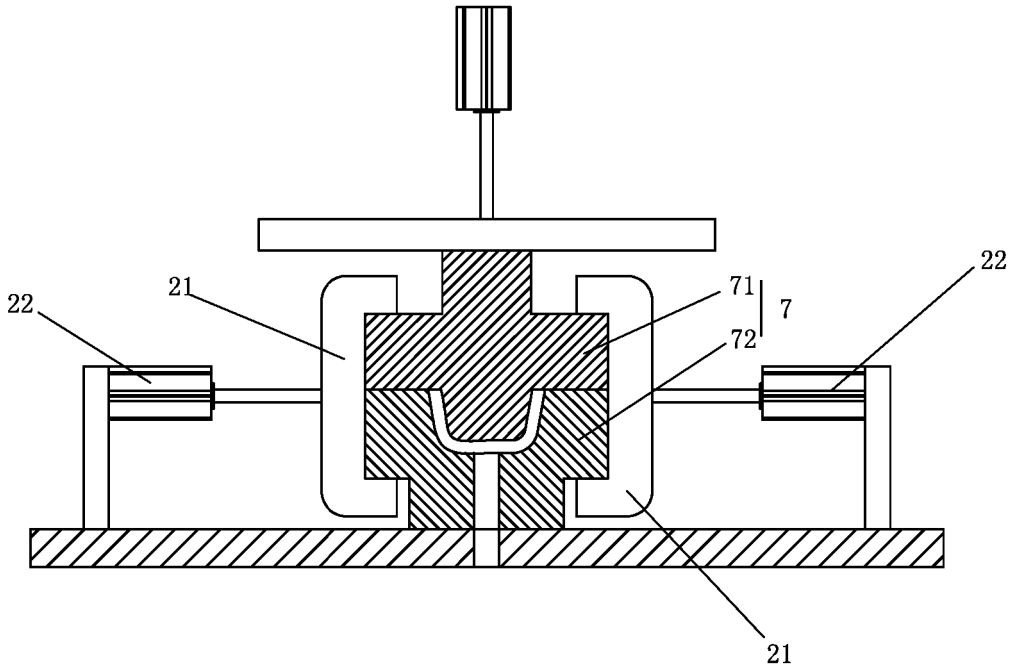

Fig. 2

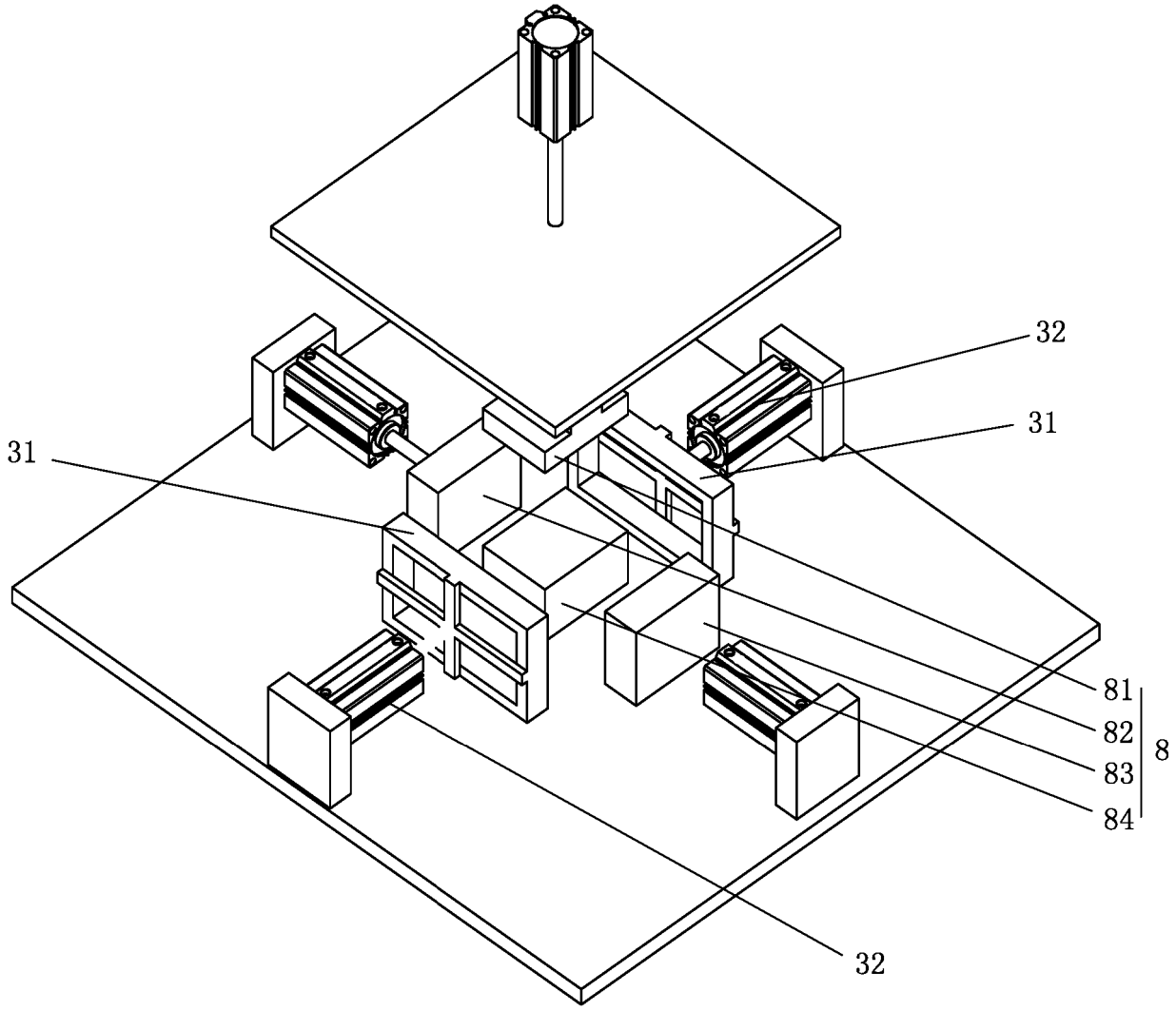

Fig. 2.1

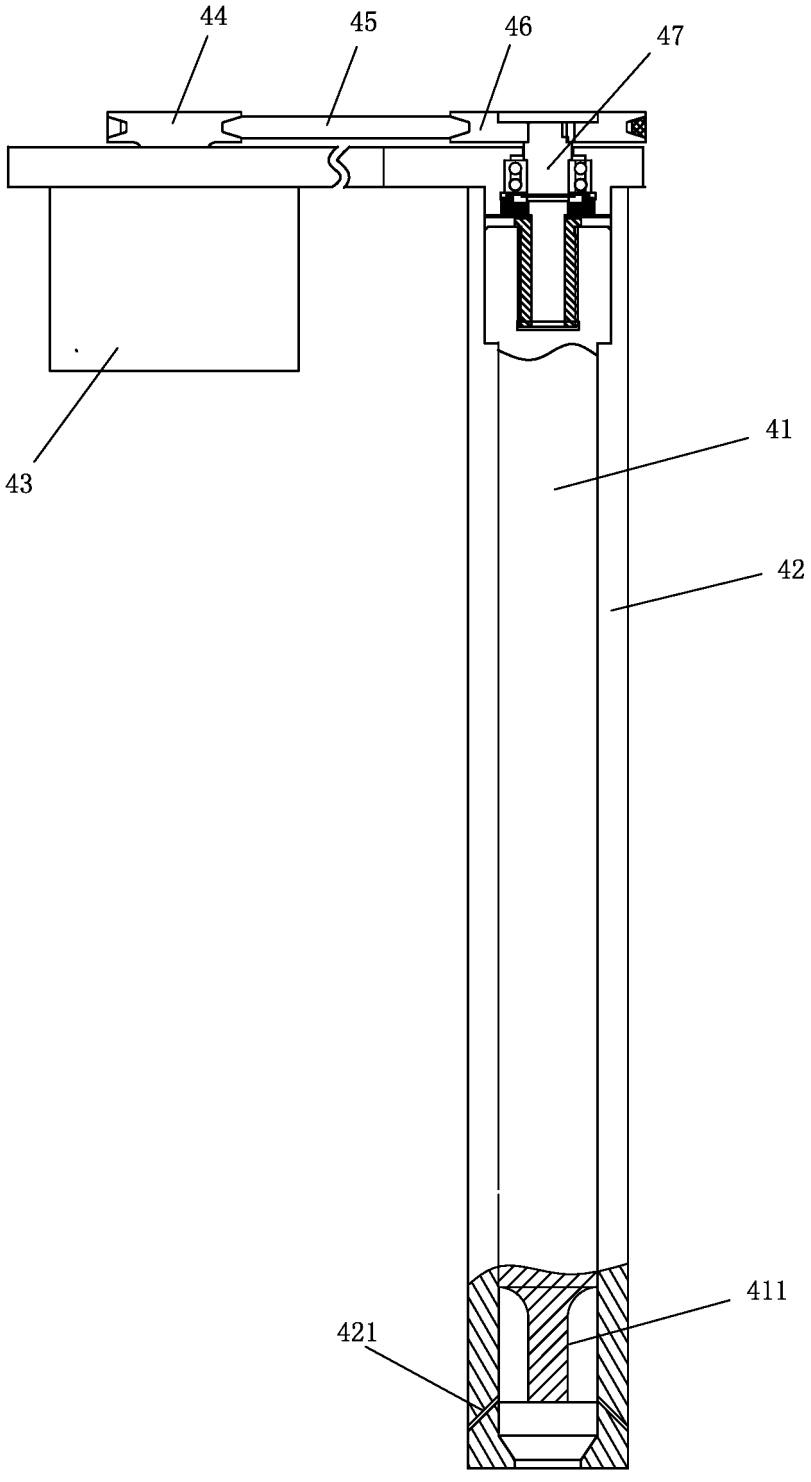

Fig. 3

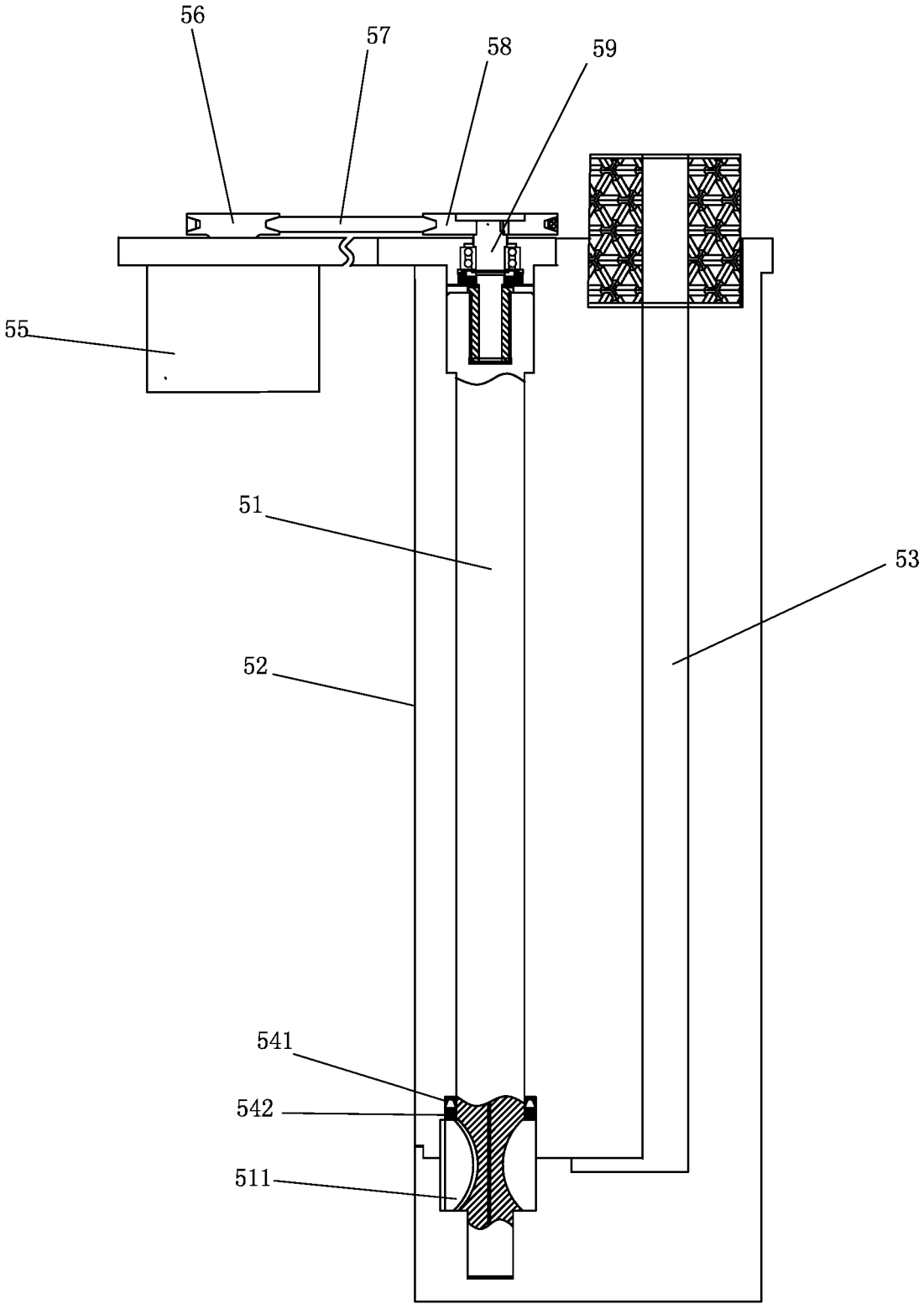

Fig. 4

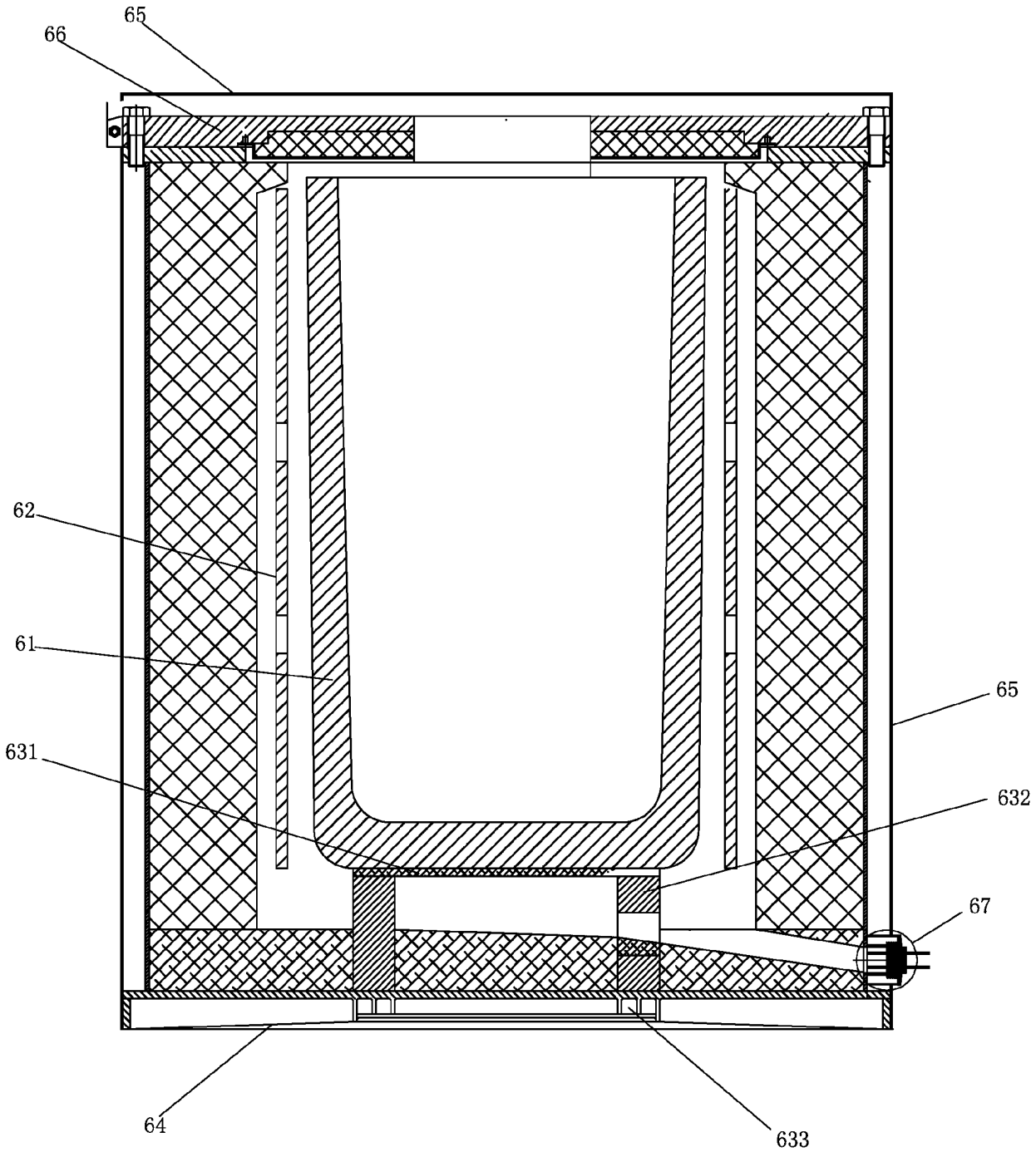

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/089596

A. CLASSIFICATION OF SUBJECT MATTER

B22D 17/00 (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)

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)

CNKI, CNABS, SIPOABS, DWPI: 铝合金, 镁合金, 轻合金, 金属, 半固态, 半液态, 压铸, 铸造, 成形, aluminium alloy, magnesium alloy, light alloy, metal, semi-solid, semi-liquid, die casting, cast, forming

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 206083784 U (FUJIAN RHEOMET LIGHT METAL CO., LTD.) 12 April 2017 (12.04.2017), description, pages 1 and 2	1, 2
PX	CN 206159007 U (FUJIAN RHEOMET LIGHT METAL CO., LTD.) 10 May 2017 (10.05.2017), description, pages 1 and 2	1, 2, 16-20
PX	CN 206083782 U (FUJIAN RHEOMET LIGHT METAL CO., LTD.) 12 April 2017 (12.04.2017), description, pages 1 and 2	1, 2, 11-15
PX	CN 206153542 U (FUJIAN RHEOMET LIGHT METAL CO., LTD.) 10 May 2017 (10.05.2017), description, pages 1 and 2	1, 2, 6-10
PX	CN 206153543 U (FUJIAN RHEOMET LIGHT METAL CO., LTD.) 10 May 2017 (10.05.2017), description, pages 1 and 2	1, 2, 6-10

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 September 2017	10 October 2017
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officer LI, Shasha Telephone No. (86-10) 62085375

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/089596

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 206153544 U (FUJIAN RHEOMET LIGHT METAL CO., LTD.) 10 May 2017 (10.05.2017), description, page 2	1, 2, 6-10
PX	CN 206153547 U (FUJIAN RHEOMET LIGHT METAL CO., LTD.) 10 May 2017 (10.05.2017), description, pages 1 and 2	1, 2, 6-10
PX	CN 206153538 U (FUJIAN RHEOMET LIGHT METAL CO., LTD.) 10 May 2017 (10.05.2017), description, pages 1 and 2	1, 2, 6-10
PX	CN 206083826 U (FUJIAN RHEOMET LIGHT METAL CO., LTD.) 12 April 2017 (12.04.2017), description, pages 1 and 2	1-5
X	CN 2566961 Y (GENERAL RESEARCH INSTITUTE FOR NONFERROUS METALS) 20 August 2003 (20.08.2003), description, page 4, and figure 1	1, 2, 6-21
Y	CN 2566961 Y (GENERAL RESEARCH INSTITUTE FOR NONFERROUS METALS) 20 August 2003 (20.08.2003), description, page 4, and figure 1	3-5
Y	CN 1399585 A (BRUNEL UNIVERSITY) 26 March 2003 (26.03.2003), description, pages 1 and 9	3-5
A	JP 2014018823 A (YACHIYO IND CO., LTD. et al.) 03 February 2014 (03.02.2014), entire document	1-21
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/089596

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 206083784 U	12 April 2017	None	
CN 206159007 U	10 May 2017	None	
CN 206083782 U	12 April 2017	None	
CN 206153542 U	10 May 2017	None	
CN 206153543 U	10 May 2017	None	
CN 206153544 U	10 May 2017	None	
CN 206153547 U	10 May 2017	None	
CN 206153538 U	10 May 2017	None	
CN 206083826 U	12 April 2017	None	
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Information on patent family members

International application No.
PCT/CN2017/089596

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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CN 1112862 A	06 December 1995	None	
JP 2014213330 A	17 November 2014	JP 6132642 B2	24 May 2017
CN 105750521 A	13 July 2016	None	

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