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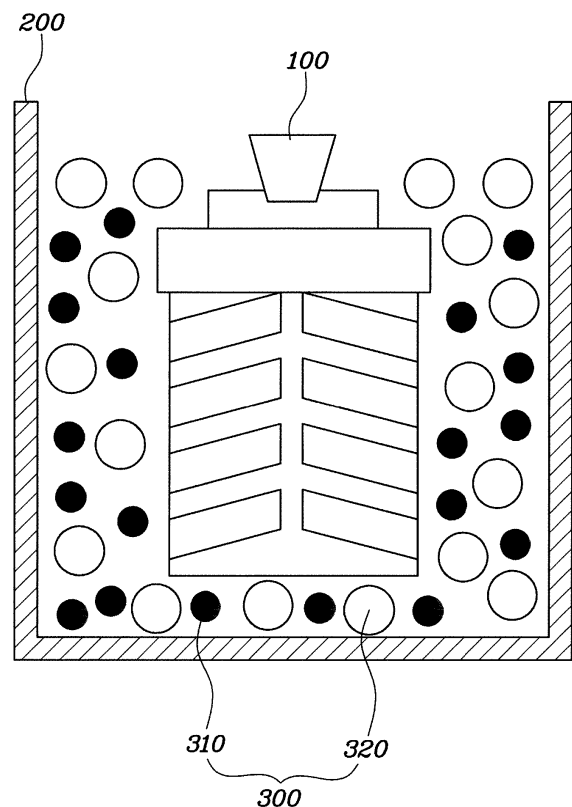
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(54) **METHOD OF MANUFACTURING PRECISION CAST PARTS FOR VEHICLE EXHAUST SYSTEMS**

(57) A method of manufacturing precision cast parts for vehicle exhaust systems includes fabricating a model of a product to be manufactured using a substance selected from the group consisting of a wax and a plastic, forming a first coating layer on a surface of the model using a first slurry, forming a second coating layer on the surface of the model coated with the first coating layer using a second slurry, drying the first and second coating layers to form a mold and heating the mold to remove the model, pre-heating the mold, placing the mold in a ceramic box with a top portion open, and filling an inner part of the ceramic box with ceramic balls, and producing a product by injecting a molten metal into the mold to cast the product.

FIG. 2



Description**TECHNICAL FIELD**

[0001] The present disclosure relates to a precision casting method, and more particularly to a method of manufacturing precision cast parts for vehicle exhaust systems capable of saving manufacturing costs and reducing manufacturing time while providing excellent heat resistance and precision.

BACKGROUND

[0002] Generally, parts used in automobile exhaust systems have to endure exhaust gases having a high temperature of 800 to 950°C. Particularly, drive parts are manufactured using materials containing a large amount of expensive nickel (Ni) having high heat resistance, such as stainless steel, and Inconel alloys, since such parts have a complicated shape.

[0003] Elements such as aluminum (Al), titanium (Ti), and the like are added to such heat-resistant alloys to enhance high-temperature strength. In this case, since the added elements such as Al, Ti, and the like are highly reactive with air, it is difficult to control the alloy elements. Therefore, the alloy elements are dissolved in a vacuum state, and subjected to a precision casting process to manufacture the parts.

[0004] A precision casting process includes fabricating a model having the same shape as a product to be cast using wax or plastics, dipping the model in the slurry to coat a surface of the model several times with slurry, in which a filler is mixed with a binder, together with powdery sand, drying the model, and heating a mold to a temperature of 100 to 200°C to remove the wax and plastics remaining in the mold.

[0005] The mold thus manufactured is heated to a temperature of 1,000 to 1,200°C to secure fluidity of a molten metal, the molten metal is injected into the mold, and the mold is cooled, and then removed. Then, the molten metal is subjected to subsequent processes to prepare a product.

[0006] However, the above-described method has a drawback in that, when the product is prepared by such a method, labor and manufacturing costs may be high since the method includes performing a coating process several times. Additionally, the method has a problem in that the mold may be damaged during pre-heating of the mold or injection of the molten metal when the coating number decreases. A conventional mold capable of easily shaking out casts, and a method of manufacturing the same suffer from an unsolved problem in that labor and manufacturing costs may be high since the method includes performing a coating process several times. Further, the mold may be damaged when the coating number is optionally decreased.

SUMMARY OF THE DISCLOSURE

[0007] Therefore, the present disclosure has been made in view of the above problems, and it is an object of the present disclosure to provide a method of manufacturing precision cast parts for vehicle exhaust systems capable of manufacturing precision cast parts for vehicle exhaust systems having excellent precision while decreasing the coating number during manufacture of a mold.

[0008] It is another object of the present disclosure to provide a method of manufacturing precision cast parts for vehicle exhaust systems capable of reducing labor and manufacturing time to improve productivity and reduce manufacturing costs.

[0009] The technical objects of the present disclosure are not limited to the aforesaid, and other technical objects not described herein will be clearly understood by those skilled in the art from the detailed description below.

[0010] According to an aspect of the present disclosure, the above and other objects can be accomplished by the provision of a method of manufacturing precision cast parts for vehicle exhaust systems, which includes fabricating a model of a product to be manufactured using wax or plastics, forming a first coating layer on a surface of the model using first slurry, forming a second coating layer on the surface of the model coated with the first coating layer using second slurry, drying the first and second coating layers to form a mold and heating the mold to remove the model, pre-heating the mold, placing the mold in a ceramic box with a top portion open, and filling an inner part of the ceramic box with ceramic balls, and producing a product by injecting a molten metal into the mold to cast the product.

[0011] In this case, the method of manufacturing precision cast parts for vehicle exhaust systems may further include heating the ceramic balls to a temperature of 500 to 700°C to remove foreign substances remaining on surfaces of the ceramic balls prior to cast preparation.

[0012] The cast preparation may include pre-heating the mold to a temperature of 500 to 1,200°C.

[0013] The product production may include casting the product in a vacuum state to prevent oxidation of the molten metal.

[0014] The ceramic ball may be formed of alumina (Al₂O₃), and may include first and second ceramic balls having different diameters. In this case, the first ceramic balls may have a higher diameter than the second ceramic balls.

[0015] The ceramic box may be formed of Inconel materials.

[0016] The first slurry may be formed by mixing zircon powder and colloidal silica, and the second slurry may be formed by mixing aluminosilicate, colloidal silica, and sand.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The above and other objects, features and other advantages of the present disclosure will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a flowchart showing a method of manufacturing precision cast parts for vehicle exhaust systems according to one preferred embodiment of the present disclosure; and

FIG. 2 is a schematic diagram for explaining a preparation of a cast according to one preferred embodiment of the present disclosure.

DETAILED DESCRIPTION

[0018] Hereinafter, preferred embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. Prior to the description, it should be understood that the terms used in the specification and appended claims should not be construed as limited to general and dictionary meanings, but interpreted based on the meanings and concepts corresponding to technical aspects of the present disclosure on the basis of the principle that the inventor is allowed to define terms appropriately for best explanation. Therefore, the description given herein is merely a preferable example for the purpose of illustration only and is not intended to limit the scope of the disclosure, so it should be understood that various other equivalents and modifications that can replace those at the time of filing this application could be made thereto without departing from the spirit and scope of the disclosure.

[0019] Reference will now be made in detail to the preferred embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0020] The present disclosure is characterized in that, when precision cast parts for vehicle exhaust systems having excellent heat resistance and a complicated shape are manufactured using a precision casting technique, parts having excellent precision, by reinforcing a strength of a mold using ceramic balls while simplifying processes due to a decrease in coating number, may be produced.

[0021] FIG. 1 is a flowchart showing a method of manufacturing precision cast parts for vehicle exhaust systems according to one preferred embodiment of the present disclosure, and FIG. 2 is a schematic diagram for explaining preparation of a cast according to one preferred embodiment of the present disclosure.

[0022] As shown in FIGS. 1 and 2, the method of manufacturing precision cast parts for vehicle exhaust systems according to one preferred embodiment of the present disclosure includes model fabrication, first and second coatings, mold preparation, cast preparation, and product production.

[0023] The model fabrication may include fabricating a model of a product to be manufactured using wax or plastics, such as precision cast parts for vehicle exhaust systems, etc.

[0024] When fabrication of the model is completed, in the first coating, a surface of the model is coated with a first slurry including colloidal silica and zircon powder by dipping the model in such a dipping solution. In this case, the first coating is repeatedly performed once or twice to form a first coating layer.

[0025] When formation of the first coating layer is completed, in the second coating, powdery sand is mixed with backup slurry including colloidal silica and aluminosilicate to prepare second slurry, and a second coating layer is formed on a surface of the model coated with the first coating layer using the second slurry.

[0026] In this case, the second coating layer may be formed by performing a precision casting process 3 to 5 times, a coating number of which is 1 to 5 times lower than a conventional precision casting process which has been performed 6 to 8 times to form a conventional backup coating layer. In this case, when the coating number is less than 3 times, a mold 100 may be damaged during subsequent pre-heating and casting of the mold 100, resulting in poor casting. On the other hand, when the coating number is greater than 5 times, productivity may not be improved and manufacturing costs may not be saved due to increases in labor and time for the manufacturing. As a result, the coating may be performed 3 to 5 times.

[0027] When formation of the second coating layer is completed, in the mold preparation, the first and second coating layers are dried and heated to remove the model formed of the wax or plastics.

[0028] In this case, removal of the model may include heating the mold 100 to a temperature of 100 to 200°C to remove the model. In this case, when the heating temperature is less than 100°C, a long period of time may be required to remove the model, resulting in lowered productivity. On the other hand, when the heating temperature is greater than 200°C, foreign substances may be formed inside the mold 100 as the wax or plastics combust.

[0029] The wax or plastics thus removed may be recycled during subsequent fabrication of the model.

[0030] When the mold 100 is prepared, in the cast preparation, the mold 100 is pre-heated, and then placed in a ceramic box 200 with a top portion open and an inner part filled with ceramic balls 300.

[0031] In this case, the mold 100 may be pre-heated to a temperature of 500 to 1,200°C, depending on types of materials of the molten metal. Therefore, precision of a product may be improved to secure fluidity of the molten metal during casting.

[0032] Meanwhile, the ceramic box 200 may be formed of Inconel. In this case, when the mold 100 is manufactured using stainless steel, etc., the mold 100 may be damaged, for example, deformed due to insufficient heat resistance as the mold 100 may be heated to 1,200°C.

[0033] In addition, the ceramic balls 300 filled in the ceramic box 200 may be formed of alumina (Al_2O_3), and may include first and second ceramic balls 310 and 320 having different diameters. Here, the first ceramic balls 310 are preferably formed so that the first ceramic balls 310 have a greater diameter than the second ceramic balls 320. More preferably, the first ceramic balls 310 may be formed so that the diameter of the first ceramic balls 310 is twice as great as that of the second ceramic balls 320.

[0034] The ceramic balls 300 may be filled in the ceramic box 200 to reinforce the mold 100 manufactured according to one preferred embodiment of the present disclosure by lowering the coating number. In this case, the mold 100 may endure a load applied against a pressure of the molten metal, compared to when ceramic balls having a single size are used when pores of the first ceramic balls 310 are filled with the second ceramic balls 320 having a relatively low diameter.

[0035] More preferably, the first ceramic balls 310 may be formed so that the diameter of the first ceramic balls 310 is twice that of the second ceramic balls 320.

[0036] The method of manufacturing precision cast parts for vehicle exhaust systems according to one preferred embodiment of the present disclosure may further include heating the ceramic balls 300 to remove foreign substances from surfaces of the ceramic balls 300 prior to cast preparation.

[0037] This is because poor casting may be caused in the ceramic balls 300 formed of inexpensive alumina since gases are generated and incorporated into products during casting due to a layer of fine foreign substances formed on surfaces of the ceramic balls 300.

[0038] Therefore, the ceramic balls 300 may be heated to a temperature of 500 to 700°C to remove foreign substances remaining on the surfaces of the ceramic balls 300. In this case, when the ceramic balls 300 are heated to a temperature of less than 500°C, a long period of time may be required to remove the foreign substances or the foreign substances may not be completely burn. When the ceramic balls 300 are heated to a temperature of greater than 700°C, an increase in expense required to remove the foreign substance may be encountered. As a result, the ceramic balls 300 may be heated to a temperature of 500 to 700°C.

[0039] When cast preparation is completed as described above, in product production, a molten metal is injected into the mold 100 to cast a product.

[0040] In this case, product production may include casting the product in a vacuum state. This is because parts used in a vehicle exhaust system are generally manufactured using materials having excellent heat resistance, such as Inconel. In this case, Inconel has a problem in that the molten metal may be excessively oxidized at high temperature, which leads to a degradation of product quality.

Table 1

Items	Product material	Casting atmosphere	2 nd coating No.	Mold preheating temp.	Case material	Ceramic balls	Pretreatment	Target parts	Results
Process condition range	SUS 300 series	Air	3-5 times	500-700°C	SUS 304	Diameters of 1/2 mm mixed	Foreign substances removed from ceramic balls	Waste gate valve for turbochargers (minimum thickness portion with thickness of 2-5 mm)	-
	Incone 1 series	Vacuum	3-5 times	1,000-1,200°C	Incone 1718C	Diameters of 1/2 mm mixed	Foreign substances removed from ceramic balls	Turbogenerator turbine wheel (minimum thickness portion with thickness of 2-5 mm)	-
Example 1	SCH22	Air	3 times	650°C	SUS 304	Diameters of 1/2 mm mixed	○	Waste gate valve	Good
Example 2	SCH22	Air	4 times	650°C	SUS 304	Diameters of 1/2 mm mixed	○	Waste gate valve	Good
Example 3	SCH22	Air	5 times	650°C	SUS 304	Diameters of 1/2 mm mixed	○	Waste gate valve	Good
Example 4	SCH22	Air	4 times	500°C	SUS 304	Diameters of 1/2 mm mixed	○	Waste gate valve	Good
Example 5	SCH22	Air	4 times	700°C	SUS 304	Diameters of 1/2 mm mixed	○	Waste gate valve	Good
Example 6	Incone 1718C	Vacuum	3 times	1,100°C	Incone 1718C	Diameters of 1/2 mm mixed	○	Turbine wheel	Good
Example 7	Incone 1718C	Vacuum	4 times	1,100°C	Incone 1718C	Diameters of 1/2 mm mixed	○	Turbine wheel	Good

(continued)

Items	Product material	Casting atmosphere	2 nd coating No.	Mold preheating temp.	Case material	Ceramic balls	Pretreatment	Target parts	Results
Example 8	Incone 1 718C	Vacuum	5 times	1,100°C	Incone 1 718C	Diameters of 1/2 mm mixed	○	Turbine wheel	Good
Example 9	Incone 1 718C	Vacuum	4 times	1,000°C	Incone 1 718C	Diameters of 1/2 mm mixed	○	Turbine wheel	Good
Example 10	Incone 1 718C	Vacuum	4 times	1,200°C	Incone 1 718C	Diameters of 1/2 mm mixed	○	Turbine wheel	Good
Comp. Example 1	SCH22	Air	Twice	650°C	SUS 304	Diameters of 1/2 mm mixed	○	Waste gate valve	Mold damaged
Comp. Example 2	SCH22	Air	4 times	450°C	SUS 304	Diameters of 1/2 mm mixed	○	waste gate valve	Insufficiently filled
Comp. Example 3	SCH22	Air	4 times	650°C	SUS 304	Diameter of 1 mm only	○	Waste gate valve	Mold damaged
Comp. Example 4	SCH22	Air	4 times	650°C	SUS 304	Diameter of 2 mm only	○	Waste gate valve	Mold damaged
Comp. Example 5	SCH22	Air	4 times	650°C	SUS 304	Diameters of 1/2 mm mixed	×	Waste gate valve	Defects in systemic structure
Comp. Example 6	SCH22	Air	4 times	650°C	SUS 304	Not used	×	Waste gate valve	Mold damaged
Comp. Example 7	Incone 1 718C	Air	4 times	1,100°C	Incone 1 718C	Diameters of 1/2 mm mixed	○	Turbine wheel	Molten metal oxidized

(continued)

Items	Product material	Casting atmosphere	2 nd coating No.	Mold preheating temp.	Case material	Ceramic balls	Pretreatment	Target parts	Results
Comp. Example 8	Incone 1 718C	Vacuum	Twice	1,100°C	Incone 1 718C	Diameters of 1/2 mm mixed	○	Turbine wheel	Mold damaged
Comp. Example 9	Incone 1 718C	Vacuum	4 times	650°C	Incone 1 718C	Diameters of 1/2 mm mixed	○	Turbine wheel	Insufficiently filled
Comp. Example 10	Incone 1 718C	Vacuum	4 times	1,100°C	SUS 304	Diameters of 1/2 mm mixed	○	Turbine wheel	Cased damaged
Comp. Example 11	Incone 1 718C	Vacuum	4 times	1,100°C	Incone 1 718C	Diameter of 1 mm only	○	Turbine wheel	Mold damaged
Comp. Example 12	Incone 1 718C	Vacuum	4 times	1,100°C	Incone 1 718C	Diameter of 2 mm only	○	Turbine wheel	Mold damaged
Comp. Example 13	Incone 1 718C	Vacuum	4 times	1,100°C	Incone 1 718C	Diameters of 1/2 mm mixed	×	Turbine wheel	Defects in systemic structure
Comp. Example 14	Incone 1 718C	Vacuum	4 times	1,100°C	Incone 1 718C	Not used	×	Turbine wheel	Mold damaged

[0041] Table 1 lists results obtained by comparing the precision cast parts for vehicle exhaust systems prepared in Examples according to one preferred embodiment of the present disclosure and Comparative Examples.

[0042] As listed in Table 1, it could be seen that factors having great effects on cast quality include a casting atmosphere depending on materials and parts, a second coating number of the mold 100, a pre-heating temperature of the mold 100, materials of the ceramic box 200, mixing of the ceramic balls 300 with different sizes, and pretreatment of the ceramic ball 300.

[0043] First, since the waste gate valves, each of which includes a minimum thickness portion having a thickness of approximately 2 to 5 mm, are formed of a stainless steel material as shown in Examples 1 to 5, the waste gate valves have high oxidation resistance to the molten metal at a high temperature, and thus may also be prepared by air casting.

[0044] However, it could be seen that, when the second coating number is reduced to less than 3 times, the mold 100 is damaged as described in Comparative Example 1, which makes it impossible to cast a product. On the other hand, it could be seen that, when the second coating number is increased to at least 6 times, productivity may be degraded due to an increase in manufacturing costs and time required for the second coating. As a result, the second coating number may be limited to 3 to 5 times.

[0045] In addition, when the mold 100 is pre-heated at a temperature of less than 500°C as described in Comparative Example 2, the mold 100 is not sufficiently heated, and thus the molten metal may be solidified before the mold 100 is filled with the molten metal, resulting in an insufficient filling of the molten metal. The mold 100 may be heated to a temperature of 700°C or higher, but an increase in manufacturing costs may be encountered due to an increase in temperature. As a result, the heating temperature is limited to a range of 500 to 700°C.

[0046] In this case, the material of the ceramic box 200 may be used as long as it is SUS 300-series stainless steel capable of enduring a temperature of 500 to 700°C when the mold 100 is heated to that temperature.

[0047] Meanwhile, the ceramic balls 300 serve to reinforce the mold 100 when the mold 100 is heated to a high temperature. In the present disclosure, first ceramic balls 310 having a diameter of 2 mm, and second ceramic balls 320 having a diameter of 1 mm were used together. Such ceramic balls 300 endure a load applied against a pressure of the molten metal in a state in which the mold 100 is heated to a high temperature.

[0048] However, the mold 100 may be damaged when the ceramic balls 300 having a single diameter are used as described in Comparative Examples 3 and 4, whereas the mold 100 may also be damaged even when the ceramic balls 300 are not used as described in Comparative Example 6, unlike when ceramic balls 300 having a single diameter are used.

[0049] Additionally, when the ceramic balls 300 are not pre-heated to a temperature of 500 to 700°C for 1 to 2 hours to remove foreign substances, toxic gases are generated by the foreign substances remaining on surfaces of the ceramic balls 300 when the mold 100 is heated to a high temperature (heated or cast) as described in Comparative Example 5. Then, the toxic gases flow backward through fine cracks of the ceramic-coated mold 100 so that the toxic gases are incorporated into a molten metal, leading to casting defects.

[0050] Therefore, it could be seen that SUS 300-series stainless steel parts having a thickness of 2 to 5 mm are prepared under the optimum conditions such as a casting atmosphere of air, a second coating number of 3 to 5 times, a temperature of 500 to 700°C used to heat the mold 100, use of SUS 300-series stainless steel as a material of the ceramic box 200, mixed use of ceramic balls 300 having different thicknesses of 1 mm and 2 mm, and removal of foreign substances on the ceramic balls 300, as described in Examples 1 to 5.

[0051] Meanwhile, it could be seen that the conditions used for turbocharger turbine wheels including a minimum thickness portion having a thickness of 2 mm or less are the optimum conditions. In this case, since the turbine wheels have parts directly exposed to exhaust gases having a high temperature of 800 to 950°C, Inconel-series materials having good heat resistance may be used.

[0052] Inconel-series materials have good heat resistance when the Inconel-series materials are prepared into parts, but are very sensitive to oxidation when the Inconel-series materials are in a molten metal state. Therefore, the Inconel-series materials should be necessarily cast in a vacuum atmosphere. Accordingly, it could be seen that the molten metal is easily oxidized when the Inconel-series materials are melted and cast in the air, which makes it impossible to cast the Inconel-series materials, as described in Comparative Example 7.

[0053] In addition, when the second coating number is less than 3 times (Comparative Example 8), casting is impossible due to damage of the mold 100. On the other hand, when the second coating number is greater than or equal to 6 times, it may cause an increase in manufacturing costs. As a result, the second coating number may be limited to 3 to 5 times.

[0054] Additionally, the temperature used to heat the mold 100 should be 1,000°C or higher since the minimum thickness portion is very thin. Here, when the heating temperature is less than 1,000°C, the mold 100 is not sufficiently heated, and thus the molten metal may be solidified before the mold 100 is filled with the molten metal, resulting in insufficient filling of the molten metal (Comparative Example 9). On the other hand, although the mold 100 may be heated to 1,200°C or higher, an increase in manufacturing costs may be encountered accordingly. As a result, the heating temperature may be limited to a range of 1,000 to 1,200°C.

[0055] The material of the ceramic box 200 may not be used as an SUS 300-series stainless steel material such as

a waste gate valve since the material of the ceramic box 200 does not endure a temperature of 1,000 to 1,200°C used to heat the mold 100 (Comparative Example 9). High-heat-resistance materials of Inconel series should be used as the material of the ceramic box 200.

[0056] As described above for the ceramic balls 300, it could be seen that the mold 100 may be damaged when the ceramic balls 300 having a single size are used (Comparative Examples 11 and 12) or the ceramic balls 300 are not used (Comparative Example 14), and that casting defects in products occur when foreign substances are not removed from the surfaces of the ceramic balls 300 (Comparative Example 13).

[0057] Therefore, it could be seen that Inconel-based parts having a thickness of 2 mm or less are prepared under the optimum conditions such as a casting atmosphere of a vacuum, a second coating number of 3 to 5 times, a temperature of 1,000 to 1,200°C used to heat the mold 100, use of an Inconel-based material as a material of the ceramic box 200, mixed use of ceramic balls 300 having different thicknesses of 1 mm and 2 mm, and previous removal of foreign substances on the ceramic balls 300, as described in Examples 6 to 10.

[0058] According to the above preferred embodiments of the present disclosure, an effect of reducing the manufacturing costs by approximately 30% may be achieved upon manufacture of the precision cast parts for vehicle exhaust systems since the coating cost may be curtailed and a cycle time may be reduced due to a decrease in a second coating number, compared to the conventional precision casting process.

[0059] According to preferred embodiments of the present disclosure, since the method of manufacturing precision cast parts for vehicle exhaust systems can be useful in manufacturing the precision cast parts for vehicle exhaust systems having excellent precision with a decrease in a coating number, the method has effects of reducing labor and manufacturing time to improve productivity and save manufacturing costs.

[0060] Although the preferred embodiments of the present disclosure have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the disclosure as disclosed in the accompanying claims.

Claims

1. A method of manufacturing precision cast parts for vehicle exhaust systems, comprising:

fabricating a model of a product to be manufactured using a substance selected from the group consisting of a wax and a plastic;
forming a first coating layer on a surface of the model using a first slurry;
forming a second coating layer on the surface of the model coated with the first coating layer using a second slurry;
drying the first and second coating layers to form a mold and heating the mold to remove the model;
pre-heating the mold, placing the mold in a ceramic box with a top portion open, and filling an inner part of the ceramic box with ceramic balls; and
producing a product by injecting a molten metal into the mold to cast the product.

2. The method of claim 1, further comprising heating the ceramic balls to a temperature of 500 to 700°C to remove foreign substances from surfaces of the ceramic balls prior to the cast preparation.

3. The method of claim 1 or 2, wherein the cast preparation comprises pre-heating the mold to 500 to 1,200°C.

4. The method of any one of the preceding claims, wherein the step of producing a product comprises casting the product in a vacuum state to prevent oxidation of the molten metal.

5. The method of any one of the preceding claims, wherein the ceramic balls are formed of alumina (Al₂O₃) and comprise first and second ceramic balls having different diameters, wherein the first ceramic balls have a greater diameter than the second ceramic balls.

6. The method of any one of the preceding claims, wherein the ceramic box is formed of Inconel.

7. The method of any one of the preceding claims, wherein the first slurry is formed by mixing zircon powder and colloidal silica.

8. The method of any one of the preceding claims, wherein the second slurry is formed by mixing aluminosilicate, colloidal silica, and sand.

FIG. 1

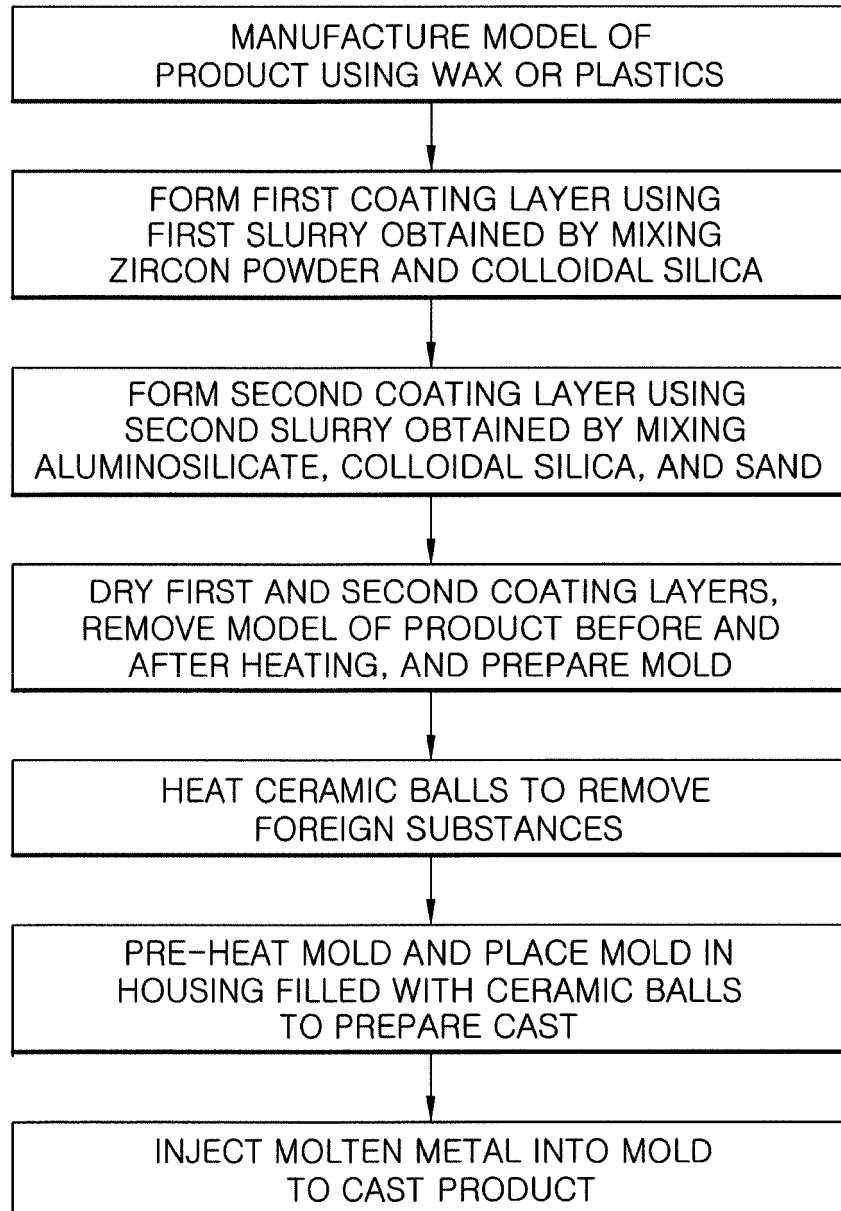
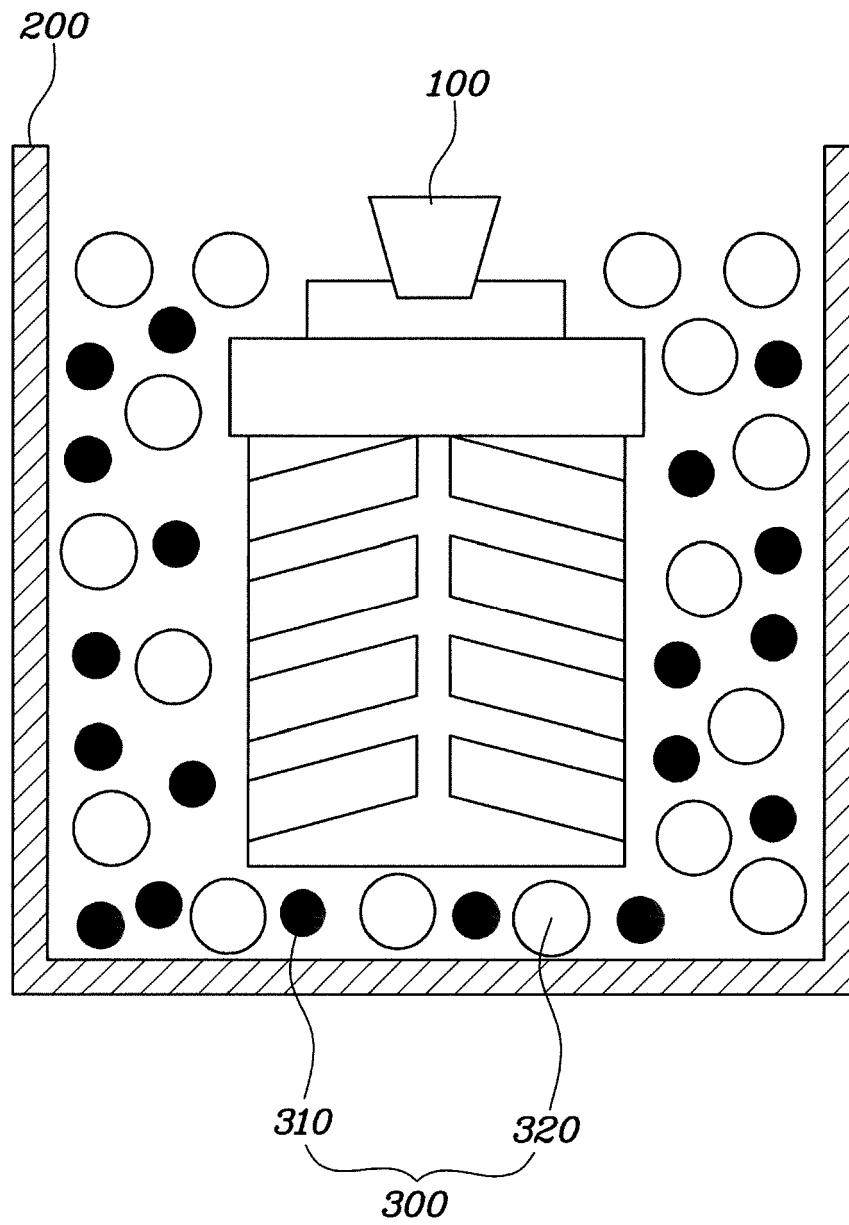


FIG. 2





EUROPEAN SEARCH REPORT

Application Number
EP 15 19 5578

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 15 19 5578

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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