(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 036 634 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
18.03.2009 Bulletin 2009/12

(51) Int Cl.:
B22D 13/10 *(2006.01)*

(21) Application number: **08252676.5**

(22) Date of filing: **12.08.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: **14.09.2007 GB 0717925**

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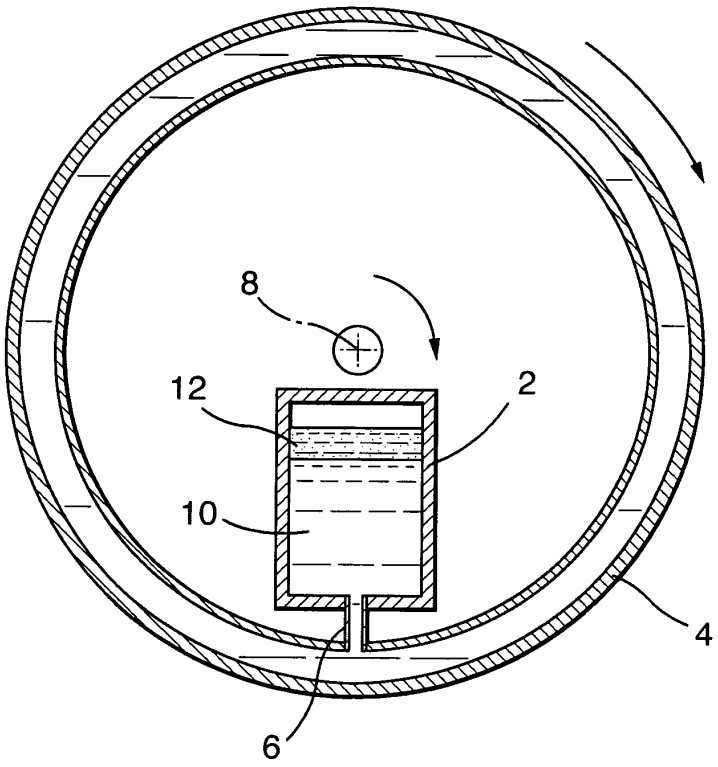
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(54) **Centrifugal casting method and apparatus**

(57) Apparatus for forming a cast component has a chamber for holding an alloy and which is rotated about an axis to separate an impurity from the alloy by centrifugal force. The chamber feeds a mould that is also rotating and into which the alloy is supplied to form a component by centrifugal casting.

Fig.1.



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Description

[0001] This invention relates to methods and apparatus for centrifugal casting of components.

[0002] According to a first aspect of the invention there is provided a method of forming a cast component comprising the steps of: providing a chamber containing a molten alloy and an impurity; rotating the chamber about an axis to separate the alloy and the impurity by centrifuging; and supplying the alloy from the chamber to a mould rotating about the axis to centrifugally cast the alloy in the mould.

[0003] Preferably the molten alloy comprises titanium, vanadium, chromium and aluminium. The molten alloy may be formed from the oxides of at least some of its constituent elements which react exothermically in the chamber. The impurity may be aluminium oxide.

[0004] A conduit between the chamber and the mould may have a supply valve which is opened to allow molten alloy to be supplied to the mould.

[0005] According to a second aspect of the invention there is provided apparatus for forming a cast component, the apparatus comprising a chamber for holding an alloy and being rotatable about an axis, a rotatable mould rotatable about the axis, a conduit connecting the chamber with the mould, rotating means for rotating the chamber with a velocity sufficient to separate molten alloy from an impurity by centrifuging and for rotating the mould with sufficient velocity to centrifugally cast a component.

[0006] The conduit may have a supply valve for allowing the supply of alloy from the chamber to the mould.

[0007] Preferably the mould is annular.

[0008] Embodiments of the invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 depicts a schematic diagram of a casting apparatus according to a first embodiment of the invention.

[0009] Figure 1 depicts a centrifugal casting apparatus in accordance with a first embodiment of the invention.

[0010] The apparatus comprises a chamber 2 and a mould 4 connected by a conduit 6. The chamber and mould are mounted together on a frame (not shown) which enables the two components to rotate about an axis 8.

[0011] An alloy is added to the chamber which must be capable of withstanding the melting point of the alloy.

[0012] The alloy may be provided as an ingot having the desired composition which is melted within the chamber. Alternatively the ingot is melted away from the chamber in a crucible or such like and added to the chamber 2 in its molten form. Additional heating elements (not shown) may be provide in or around the chamber 2 to maintain the alloy in its molten state. In the preferred embodiment, described in greater detail below, the alloy is formed during an exothermic reaction within the chamber between molten aluminium and oxides selected from titanium, vanadium and / chromium.

[0013] The alloy may contain impurities which will affect the final characteristics of the cast component. To remove these impurities the chamber 2 is rotated about the axis 8 to separate the alloy 10 from the impurity 12 centrifugally.

[0014] Once the alloy is sufficiently separated from the impurity, preferably determined empirically through trial and error, a supply valve in the conduit is opened to supply the alloy to the mould 4 for the centrifugal casting process.

[0015] In the preferred embodiment the mould 4 lies further away from the axis than the chamber 2 which allows the alloy to be supplied using the generated centrifugal force. In alternative arrangements the alloy may be pumped from the chamber to the mould.

[0016] The mould 4, like the chamber 2, rotates about the axis 8 and produces a sound, porous free casting with a fine grain size due to the relatively rapid solidification of the alloy and the centrifugal force exerted which breaks up dendrite formation whilst forming an accurate cast shape.

[0017] The mould is preferably ceramic formed using a lost wax process. In the preferred use, where the cast component is an engine casing, the mould is annular. For other, more complex shapes it will be appreciated that an appropriate mould shape is required. It may be necessary to provide a counter-balance to ensure smooth rotation of the mould about the axis.

[0018] In the preferred method the alloy comprises titanium, vanadium, chromium and aluminium. The preferred alloy has 25wt%V, 15%Cr, 2%Al with the balance being Ti plus any impurities. The preferred method of forming the alloy is to load the chamber 2 with titanium, vanadium and chromium oxides in powder, flake or particle form. Aluminium is added to the chamber in flake form and mixed with the other elements.

[0019] When the oxides of the elements combine with molten aluminium they react exothermically to give aluminium oxide Al_2O_3 and liquid alloy. The aluminium oxide is an impurity and must be removed else the final characteristic of the alloy will be affected.

[0020] The constituent oxides and aluminium flakes are placed in the chamber 2 as a charge. A mass, preferably disk shaped, and formed of the desired alloy is placed at the base of the chamber 2 to prevent the charge from entering the cast. Once the chamber is loaded with the charge rotation of the chamber and the cast about the axis 8 is started.

[0021] When the preferred rotation speed of the order 200rpm is achieved the aluminium in the chamber is heated till it is melted. This begins a self-sustaining exothermal reaction within the charge reducing the oxides to their base metals and melting further aluminium in the chamber. In an alternative technique the exothermic reaction can be started by means of an electrical resistance heating wire at the point furthest from the disk. Benefi-

cially this technique means that the charge need not be heated en masse. The reaction propagates through the charge till all the powder or flakes have been converted to their base metals and alloyed. Sufficient aluminium flakes are provided so that once all the oxides have been reduced to their base metals a small proportion of the aluminium remains to be alloyed with the other components.

[0022] Al_2O_3 is less dense than the alloy and is squeezed to the inside of the chamber by the alloy moving outwards under the influence of the centrifugal force. The alloy may then be supplied to the mould. It typically takes less than 5 minutes for the reaction to propagate through the charge depending on the charge constituents, size of the charge and rotational speed.

[0023] When the melted alloy reaches the disk blocking the conduit 6 the heat of the alloy causes the disk to melt which allows the flow of molten alloy into the rotating cast component. The alloy continues to flow till the cast is full and it is therefore important that the volume of the cast is equal to or less than the volume of alloy formed in the chamber to stop impurities from entering the cast.

[0024] The rotational speed and density difference between the alloy and the aluminium oxide should be sufficient to allow adequate separation before the disk melts. Routine trial and error experiments may be used to determine an acceptable rotational velocity for any given alloy and charge size to ensure adequate separation of the alloy from the impurity. By changing the properties of the disk, either physically or compositionally it is possible to change the time taken for it to melt and thereby control the supply of alloy to the cast in that way.

[0025] For the alloy described above the density difference between the aluminium oxide impurity at 2.5 g/cm^3 and the alloy at around 5g/cm^3 a revolution velocity of 200 rpm is sufficient to separate the alloy and impurity.

[0026] It will be appreciated that the present invention offers significant advantages. Offering the ability to separate impurities from the alloy during the casting process enables high quality control and the use of alloy stock having higher levels of impurity. The technique enables the desired quantity of alloy to be manufactured at its point of use which overcomes the need to melt the alloy first during manufacture and again as it is used in the casting process with significant energy savings. As a further advantage the reliance on the alloy supply chain is reduced as the alloy can be made at its point of use using its constituent elements.

Claims

1. A method of forming a cast component comprising the steps of:

   providing a chamber (2) containing a molten alloy and an impurity;

   rotating the chamber about an axis (8) to separate the alloy (10) and the impurity (12) by centrifuging; and

   supplying the alloy (10) from the chamber to a mould (4) rotating about the axis to centrifugally cast the alloy in the mould.

2. A method according to claim 1, wherein the molten alloy comprises titanium.

3. A method according to claim 2, wherein the molten alloy comprises aluminium.

4. A method according to claim 2 or claim 3, wherein the molten alloy comprises titanium, aluminium, vanadium and chromium.

5. A method according to claim 4, wherein the alloy is formed from constituent elements of titanium oxide, vanadium oxide and chromium oxide which react exothermically with the aluminium in the chamber.

6. A method according to claim 4, wherein the impurity is aluminium oxide.

7. A method according to any preceding claim, wherein a conduit between the chamber and the mould has a supply valve which is opened after a predetermined period to allow molten alloy to be supplied to the mould.

8. A cast component produced by a method according to any one of claims 1 to 7.

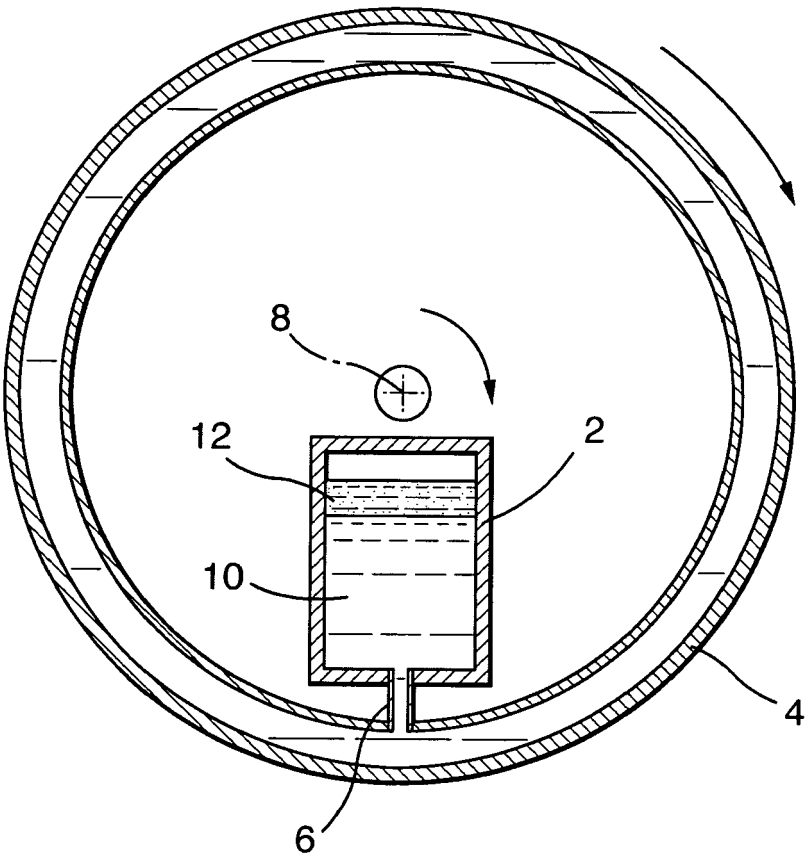
9. Apparatus for forming a cast component, the apparatus comprising a chamber for holding an alloy and being rotatable about an axis, a rotatable mould rotatable about the axis, a conduit connecting the chamber with the mould, rotating means for rotating the chamber with a velocity sufficient to separate molten alloy from an impurity by centrifuging and for rotating the mould with sufficient velocity to centrifugally cast a component

10. Apparatus according to claim 9, wherein the conduit has a supply valve for controlling the supply of alloy from the chamber to the mould following a predetermined period.

11. Apparatus according to any one of claims 9 and 10, wherein the mould is annular.

12. Apparatus according to any one of claims 9 to 11, wherein the chamber can withstand an exothermic reaction of constituent elements of titanium oxide, vanadium oxide and chromium oxide and molten aluminium.

Fig.1.



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EUROPEAN SEARCH REPORT

Application Number
EP 08 25 2676

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

B22D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 November 2008	Baumgartner, Robin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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