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(72) Inventor: **SAHA, Deepak**

Guilderland, NY 12084 (US)

(74) Representative: **Szary, Anne Catherine**

GE International Inc.

Global Patent Operation - Europe

15 John Adam Street

London

WC2N 6LU (GB)

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(71) Applicant: **General Electric Company**

Schenectady, NY 12345 (US)

(54) **Casting Method for super-Alloy and stainless Steel**

(57) Embodiments of the present invention include a method for producing a component that includes melting a super-alloy or stainless steel alloy (10) and transferring

the melted alloy to a mold (11). The mold is mechanically vibrated while the melted alloy solidifies (12). The component then is removed from the mold (13).

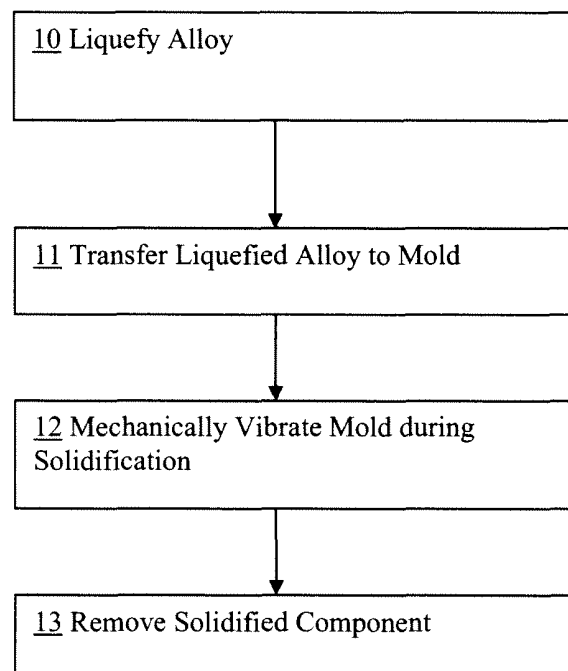


Figure 1

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Description

BACKGROUND OF THE INVENTION

[0001] The invention relates to methods for preparing super-alloy and stainless steel components that have improved mechanical and corrosive properties.

[0002] Metals can oxidize, corrode, and become brittle if they are exposed to relatively high temperatures (i.e., greater than or equal to about 700°C) and especially if they are present in oxidative environments. Environments, such as those with high temperatures and corrosive atmospheres, can be produced in gas turbines, such as gas turbines used for power generation applications. It would be beneficial to be able to manufacture metal components that last longer in high-temperature, oxidative environments.

SUMMARY OF THE INVENTION

[0003] Embodiments of the invention include a method for producing a component that includes melting a stainless steel alloy and transferring the melted stainless steel alloy to a mold. The mold is mechanically vibrated while the melted stainless steel solidifies. The component is then removed from the mold.

[0004] Embodiments of the present invention also include a method for producing a component that includes melting a super-alloy and transferring the melted super-alloy to a mold. The mold is mechanically vibrated while the melted super-alloy solidifies. The component is then removed from the mold.

[0005] The above described and other features are exemplified by the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] These and other features of this invention will be more readily understood from the following detailed description of the various aspects of the invention taken in conjunction with the accompanying drawings that depict various embodiments of the invention, in which:

FIG. 1 shows a block diagram of an illustrative method infrastructure for implementing one embodiment of the invention.

DETAILED DESCRIPTION

[0007] In embodiments of the present invention, a casting of molten material in a mold is performed while mechanical vibration of the mold occurs. The mold is mechanically vibrated and the vibration continues until the molten material solidifies. The resulting component has improved mechanical properties and is more resistant to corrosion. The mechanical vibration has a frequency range of from 8 to 60 Hz.

[0008] The metal component can be any one of, for

example, combustion liners or transition pieces, buckets, nozzles, blades, vanes, shrouds, as well as other components, for example, components that will be disposed in a hot gas stream in a turbine engine. The metal component can include stainless steel and super-alloys.

[0009] A super-alloy, or high-performance alloy, is an alloy that exhibits excellent mechanical strength and creep resistance at high temperatures, good surface stability, and corrosion and oxidation resistance. A super-alloy's base alloying element is usually nickel or nickel-iron. Included in super-alloys are nickel-chromium-iron alloys such as INCONEL® (Special Metals Corporation) alloys; nickel-iron-chromium alloys such as INCOLOY® (Special Metals Corporation) alloys; nickel-iron alloys; and nickel-chromium molybdenum alloys such as HASTELLOY® (Haynes International) alloys.

[0010] A wide variety of iron-based stainless steel alloys are useful in embodiments of the present invention. Martensitic stainless steel alloy whose chemistry and processing achieve an excellent combination of strength and toughness is suitable for use in embodiments of the present invention and is described in US Patent 6,743,305. Such a steel alloy is characterized by a hardening phase of copper-rich precipitates, which in combination with certain chemistry and processing requirements yields the desired strength and toughness properties for the alloy. Duplex stainless steels are characterized by high strength and resistance to stress cracking and generally have less nickel than martensitic stainless steel. Another useful stainless steel in an embodiment of the invention is austenitic stainless steel.

[0011] Possible constituents of the stainless steel alloys used in embodiments of this invention include chromium, nickel, copper, molybdenum, manganese, silicon, copper, carbon and niobium.

[0012] As known in the art, chromium provides the stainless properties for the alloy, and for this reason a minimum chromium content of 14 weight percent is required for the alloy.

[0013] High alloy steels, such as but not limited to Fe-12Cr stainless steels (hereinafter Fe-12Cr steels), are known in the art. The high alloy steels possess desirable characteristics for use in various engineering articles. For example, these engineering articles may be employed in use at high temperatures, and may be subjected to thermal aging.

[0014] The process description herein is merely exemplary in purpose, and is not intended to limit the application in any manner. Such a process allows for the convenient preparation of articles having intricate and large geometries, such as turbine components.

[0015] It is possible in embodiments of the invention to dispose additional layers or coatings on the component parts. These coatings include thermal barrier coatings or erosion resistant coatings.

[0016] Fig. 1 shows a simplified flow diagram of an embodiment of the invention. Stainless steel alloy and super-alloys, discussed above, are melted at a temper-

ature above their melting point. This is shown as 10 in Fig. 1. The melted alloys are then transferred to a net shape or near net-shape mold as shown by 11. This step or any step described can be done in an inert atmosphere. The mold is mechanically vibrated. The mechanically vibration is preferably in a frequency range of from 8 to 60 Hz. The greater the mechanical vibration, the greater the solidification rate of the alloy in the mold. This is shown as 12 in Fig. 1. Greater mechanical vibration is believed to increase the forced convection rate in the melt. Greater mechanical vibration lowers the temperature differential between the center and edges of the melt in the mold allowing more uniform solidification. Finer grain structure occurs with increased mechanical vibration. Finer grain structure results in improved mechanical properties of the molded part as there is reduced strain at the grain boundaries. When the alloy has solidified it is removed from the mold, shown as 13 in Fig. 1.

[0017] The terms "first," "second," and the like, herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another, and the terms "a" and "an" herein do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item. The modifier "about" used in connection with a quantity is inclusive of the stated value and has the meaning dictated by the context, (e.g., includes the degree of error associated with measurement of the particular quantity). The suffix "(s)" as used herein is intended to include both the singular and the plural of the term that it modifies, thereby including one or more of that term (e.g., the metal(s) includes one or more metals). Ranges disclosed herein are inclusive and independently combinable (e.g., ranges of "up to about 25 wt%, or, more specifically, about 5 wt% to about 20 wt %", is inclusive of the endpoints and all intermediate values of the ranges of "about 5 wt% to about 25 wt%," etc).

[0018] While various embodiments are described herein, it will be appreciated from the specification that various combinations of elements, variations or improvements therein may be made by those skilled in the art, and are within the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

Claims

1. A method for producing a component comprising:

melting a stainless steel alloy or a super-alloy;
transferring the melted stainless steel alloy or super-alloy to a mold;

mechanically vibrating the mold while the melted stainless steel or super-alloy solidifies to form a component; and
removing the component from the mold.

2. The method of claim 1, wherein the stainless steel alloy is selected from the group consisting of martensitic stainless steel, duplex stainless steel, and austenitic stainless steel.
3. The method of claim 1, wherein the super-alloy is selected from the group consisting of nickel-chromium-iron alloys, nickel-iron-chromium alloys, nickel-iron alloys, and nickel-chromium molybdenum alloys.
4. The method according to any preceding claim, wherein the melting of the stainless steel alloy or super-alloy occurs in an inert atmosphere.
5. The method according to any preceding claim, wherein the transferring of the melted stainless steel or melted super-alloy occurs in an inert atmosphere.
6. The method according to any preceding claim, further comprising applying a coating to the component.
7. The method according to claim 6, wherein the coating comprises a thermal barrier coating or an erosion resistant coating.
8. The method according to any preceding claim, wherein the vibration comprises a frequency range of from 8 to 60 Hz.
9. The method according to any preceding claim, wherein the component is selected from the group consisting of a combustion liner, transition piece, buckets, nozzle, blade, vane, and shroud.

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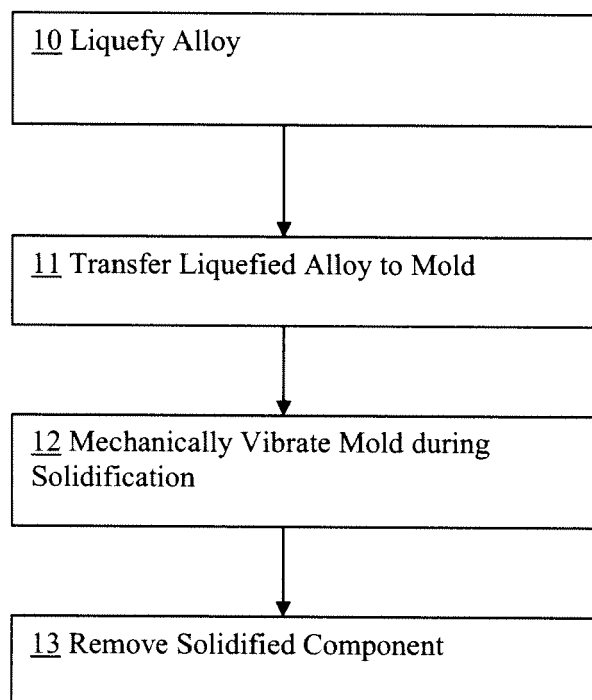


Figure 1



EUROPEAN SEARCH REPORT

Application Number
EP 10 15 8907

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 22 July 2010	Examiner Scheid, Michael
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.82 (P04C01)



EUROPEAN SEARCH REPORT

Application Number
EP 10 15 8907

DOCUMENTS CONSIDERED TO BE RELEVANT			
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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