



(43) International Publication Date
30 January 2014 (30.01.2014)

- (51) International Patent Classification:
B22D 19/16 (2006.01) B22D 25/06 (2006.01)
- (21) International Application Number:
PCT/US2013/031820
- (22) International Filing Date:
15 March 2013 (15.03.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
13/559,829 27 July 2012 (27.07.2012) US
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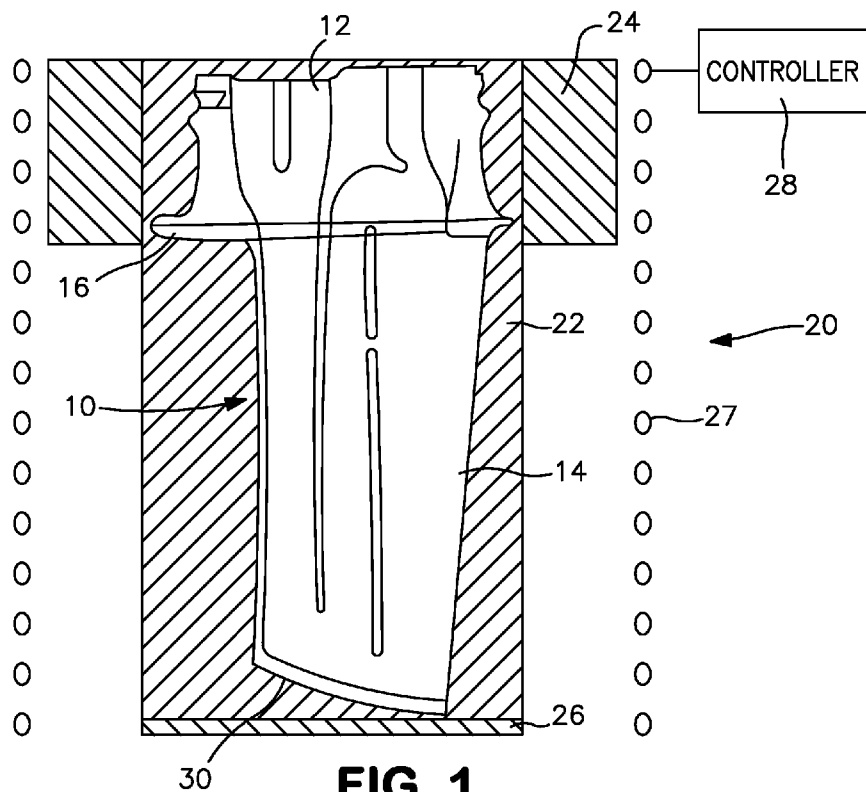
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

[Continued on next page]

(54) Title: ARTICLE WITH GROUPED GRAIN PATTERNS



(57) Abstract: An article includes a first portion having a first grain pattern and a second portion having a second grain pattern different from the first grain pattern. The article is a cast article such as a turbine engine blade.

WO 2014/018112 A1

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

— before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

Published:

— with international search report (Art. 21(3))

ARTICLE WITH GROUPED GRAIN PATTERNS

[0001] The present disclosure relates to an article having a grouped grain structure and to a method for forming such an article.

[0002] It is known that cast articles can be formed with different grain patterns. For example, it is known how to form an equiaxed structure where there are randomly solidified and distributed grains with a significant number of low-angle grain boundaries. It is also known how to form a directionally solidified structure where fewer grains with high angle boundaries are solidified radially. Further, it is known how to form a single crystal grain structure in which one high angle grain is in the radial direction. The limitation of only one grain pattern in a single cast structure has limited the properties that are made use of when designing a structure.

SUMMARY

[0003] In accordance with the present disclosure, there is provided an article which broadly comprises a first portion having a first grain pattern and a second portion having a second grain pattern different from the first grain pattern.

[0004] In another and alternative embodiment, the first grain pattern is an equiaxed grain pattern.

[0005] In another and alternative embodiment, the first portion is a root attachment section.

[0006] In another and alternative embodiment, the second grain pattern is a directionally solidified pattern.

[0007] In another and alternative embodiment, the second portion is an airfoil portion.

[0008] In another and alternative embodiment, the article is a turbine engine blade.

[0009] In another and alternative embodiment, the article is a cast article.

[0010] Further in accordance with the present disclosure, there is provided a method for forming an article which broadly comprises providing a mold and casting a metal material within the mold so that a first portion has a first grain pattern and a second portion has a second grain pattern different from the first grain pattern.

[0011] In another and alternative embodiment, the method may further comprise forming the mold using a wax pattern and dipping the wax pattern into a ceramic material.

[0012] In another and alternative embodiment, the method may further comprise applying a cobalt containing material to a surface of said wax pattern prior to said dipping step.

[0013] In another and alternative embodiment, the cobalt containing material applying step comprises applying a material selected from the group consisting of 7% cobalt aluminate and cobalt oxide.

[0014] In another and alternative embodiment, the method may further comprise placing a shield around the mold.

[0015] In another and alternative embodiment, the shield placing step may comprise placing a shield which extends from a first region of the mold where a root attachment section will be formed to a second region of the mold where a platform will be formed.

[0016] In another and alternative embodiment, the method may further comprise providing a scepter and a controller for the scepter; programming the controller to

have a grouped grain program profile; and powering the sceptor after the metal material in molten form has been placed into the mold to form the part having the first grain pattern and the second grain pattern.

[0017] In another and alternative embodiment, the casting step may comprise forming said first grain pattern as an equiaxed grain pattern.

[0018] In another and alternative embodiment, the casting step may further comprise forming the equiaxed grain pattern in a root attachment section.

[0019] In another and alternative embodiment, the casting step may comprise forming the second grain pattern as a directionally solidified pattern.

[0020] In another and alternative embodiment, the casting step may further comprise forming the second pattern in an airfoil portion.

[0021] In another and alternative embodiment, a casting system for forming a part having a first portion with a first grain pattern and a second portion with a second grain pattern different from the first grain pattern, the casting system broadly comprises a mold having a length and a shield having a length less than the length of the mold.

[0022] In another and alternative embodiment, the casting system further comprises a sceptor surrounding the mold and a controller for the sceptor.

[0023] In another and alternative embodiment, the controller is programmed to have a grouped grain program profile.

[0024] Other details of the article with the grouped grain patterns and a method and a casting system for forming same are set forth in the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Fig. 1 is a schematic representation of a casting system for forming a turbine engine component;

[0026] Fig. 2 is a flow chart of a method for forming a turbine engine component; and

[0027] Fig. 3 is a schematic representation of a baffle or shielding arrangement used in the casting system of Fig. 1.

DETAILED DESCRIPTION

[0028] In accordance with the present disclosure, there is provided a method for forming an article or a part, such as a turbine engine component, in which a first portion has a first grain pattern and a second portion has a second grain pattern different from the first grain pattern. The turbine engine component may be a turbine blade or a vane.

[0029] In one exemplary embodiment, as shown in Fig. 1, a turbine engine blade 10 may be formed in a single casting technique. The turbine engine blade 10 may have an equiaxed grain pattern in a root attachment section 12 and a directionally solidified grain pattern in the airfoil portion 14. The turbine engine blade 10 may be provided with a platform 16. Such a cast structure can provide excellent transverse properties in the root attachment section 12 and excellent radial properties in the airfoil portion 14. Such a cast structure may fulfill more of the needed design characteristics for a turbine engine blade 10 which rotates.

[0030] Referring now to Fig. 1, there is shown a casting system 20 for forming a turbine engine blade 10 having an equiaxed grain pattern in the root attachment section 12 and a directionally solidified grain pattern in the airfoil portion 14. The casting system 20

includes a mold 22 having a length. Referring now to Fig. 2, the mold 22 may be formed by forming a wax pattern. The mold 22 may be formed by dipping the wax pattern into a ceramic material. The mold 22 has the shape of the external portions of the turbine engine blade 10. Once the mold 22 has been formed, the wax pattern may be removed and the mold may be fired.

Thereafter, the mold 22 may be placed within a furnace.

[0031] To form the component having an equiaxed grain pattern in the first section 12 of the component and a different grain pattern in a second section 14 of the component, a shield or baffling arrangement 24 may be used. The shield or baffling arrangement 24 may be used to confine the gradient or the different grain pattern to the area between a chill plate 26 and a platform 16 of the turbine engine component 10. The shield or baffling arrangement 24 has a length which is less than the length of the mold 22.

[0032] Referring now to Fig. 3, it can be seen that the shield or baffling arrangement 24 surrounds the mold 22. This shield or baffling arrangement 24 may be a round ceramic or graphite washer that is placed over the region of the mold 22 where the root attachment section 12 of the turbine engine component 10 is to be formed. The shield or baffling arrangement 24 may stop or be terminated in line with the region of the mold where a platform 16 of the turbine engine component 10 may be formed. The shield or baffling arrangement 24 may be something which is purchased or produced on site. The shield or baffling arrangement 24 may be placed on the mold 22, in the foundry, or at preparation of the mold 22. The shield or baffling arrangement 24 may be as simple as using a graphite washer at mold preparation or when the mold is placed into the scepter for pouring.

One reason for using the shield or baffle arrangement 24 is that it should enhance proper grain structure in the final turbine engine component.

[0033] The molding system 20 further includes a scepter 27 for heating the molten metal in the mold 22 to a desired temperature regime. When the scepter power is turned off there will be no heat source, radiant or otherwise, in the area of the root attachment section 12, thereby leaving that area of the casting to freeze off quickly as an equiaxed structure requires.

[0034] A controller 28 may be provided to control the power to the scepter 27. The controller 28 is known as a scepter power supply controller. The controller 28 is programmable and may have programmed into it a "grouped grain" program profile which is just like programming in any other standard DS or SX profile that is called up when it is time to run that specific job.

[0035] If desired, a cobalt containing material, such as 7% cobalt aluminate or cobalt oxide, may be added to the wax pattern on a surface in a region below where the platform 16 of the turbine engine component is to be formed. The cobalt containing material may help to provide equiaxed grain growth in that specific area. The cobalt containing material may be in a slurry form and may be a sample taken from the first prime of the equiaxed shell line. The cobalt containing material may be applied by hand painting, spraying or dipping prior to first prime.

[0036] After the controller 28 has been programmed and power to the scepter 27 has been turned on, molten metal may be poured into the mold 22. The mold metal may be one of many different metal alloys, preferably a nickel based or cobalt based metal alloy. Examples of metal alloys which may be used to form the turbine engine

component 10 include IN 792 and all derivatives and similar alloy compositions including IN 792 Mod 5, IN 792 MOD, GTD-111. Alternatively, alloys that have similar constituents as IN 792 relative to grain boundary strengtheners may be used. Other alloys which are used as DS alloys may be used.

[0037] As can be seen from Fig. 1, the turbine engine component 10 may be formed with the tip 30 down.

[0038] Following the program used by the controller 28, the power to the scepter 27 is turned off at a programmed time. The metal in the mold 22 is then allowed to solidify. When solidified, the turbine engine component 10 may be removed from the mold 22.

[0039] While the present disclosure has shown how to form a turbine blade, it should be apparent that the system and method disclosed herein may be used to form a wide variety of turbine engine components, including vanes and blade outer air seals.

[0040] It should also be apparent that the system and method of the present disclosure may be used to form parts other than turbine engine components for which grouped grain patterns may be useful.

[0041] There has been provided in accordance with the present disclosure an article with grouped grain patterns. While the article has been described in the context of specific embodiments thereof, other unforeseen alternatives, modifications, and variations may become apparent to those skilled in the art having read the foregoing disclosure. Accordingly, it is intended to embrace those alternatives, modifications, and variations as fall within the broad scope of the appended claims.

WHAT IS CLAIMED IS:

1. An article comprising:
 - a first portion having a first grain pattern; and
 - a second portion having a second grain pattern different from said first grain pattern.
2. The article of claim 1 wherein said first grain pattern is an equiaxed grain pattern.
3. The article of claim 2, wherein said first portion is a root attachment section.
4. The article of claim 1, wherein said second grain pattern is a directionally solidified pattern.
5. The article of claim 4, wherein said second portion is an airfoil portion.
6. The article of claim 1, wherein said article is a turbine engine blade.
7. The article of claim 1, wherein said article is a cast article.
8. A method for forming an article comprising:
 - providing a mold; and
 - casting a metal material within said mold so that a part is produced which has a first portion having a first grain pattern and a second portion having a second grain pattern different from said first grain pattern.
9. The method according to claim 8, further comprising:

forming said mold using a wax pattern and dipping the wax pattern into a ceramic material.

10. The method according to claim 9, further comprising:
applying a cobalt containing material to a surface of said wax pattern prior to said dipping step.

11. The method according to claim 10, wherein said cobalt containing material applying step comprises applying a material selected from the group consisting of 7% cobalt aluminate and cobalt oxide.

12. The method according to claim 8, further comprising placing a shield around said mold.

13. The method according to claim 12, wherein said placing step comprises placing a shield which extends from a first region of the mold where a root attachment section will be formed to a second region of the mold where a platform will be formed.

14. The method according to claim 12, further comprising:

providing a sceptor and a controller for said sceptor;

programming said controller to have a grouped grain program profile; and

powering said sceptor after said metal material in molten form has been placed into said mold to form said part having said first grain pattern and said second grain pattern.

15. The method of claim 8 wherein casting step comprises forming said first grain pattern as an equiaxed grain pattern.

16. The method of claim 15, wherein said casting step further comprises forming said equiaxed grain pattern in a root attachment section.

17. The method of claim 15, wherein said casting step comprises forming said second grain pattern as a directionally solidified pattern.

18. The method of claim 17, wherein said casting step further comprises forming said second pattern in an airfoil portion.

19. A casting system for forming a part having a first portion with a first grain pattern and a second portion with a second grain pattern different from the first grain pattern, said casting system comprising:

a mold having a length; and

a shield having a length less than the length of the mold.

20. The casting system of claim 19, further comprising a scepter surrounding said mold and a controller for said scepter.

21. The casting system of claim 20, wherein said controller is programmed to have a grouped grain program profile.

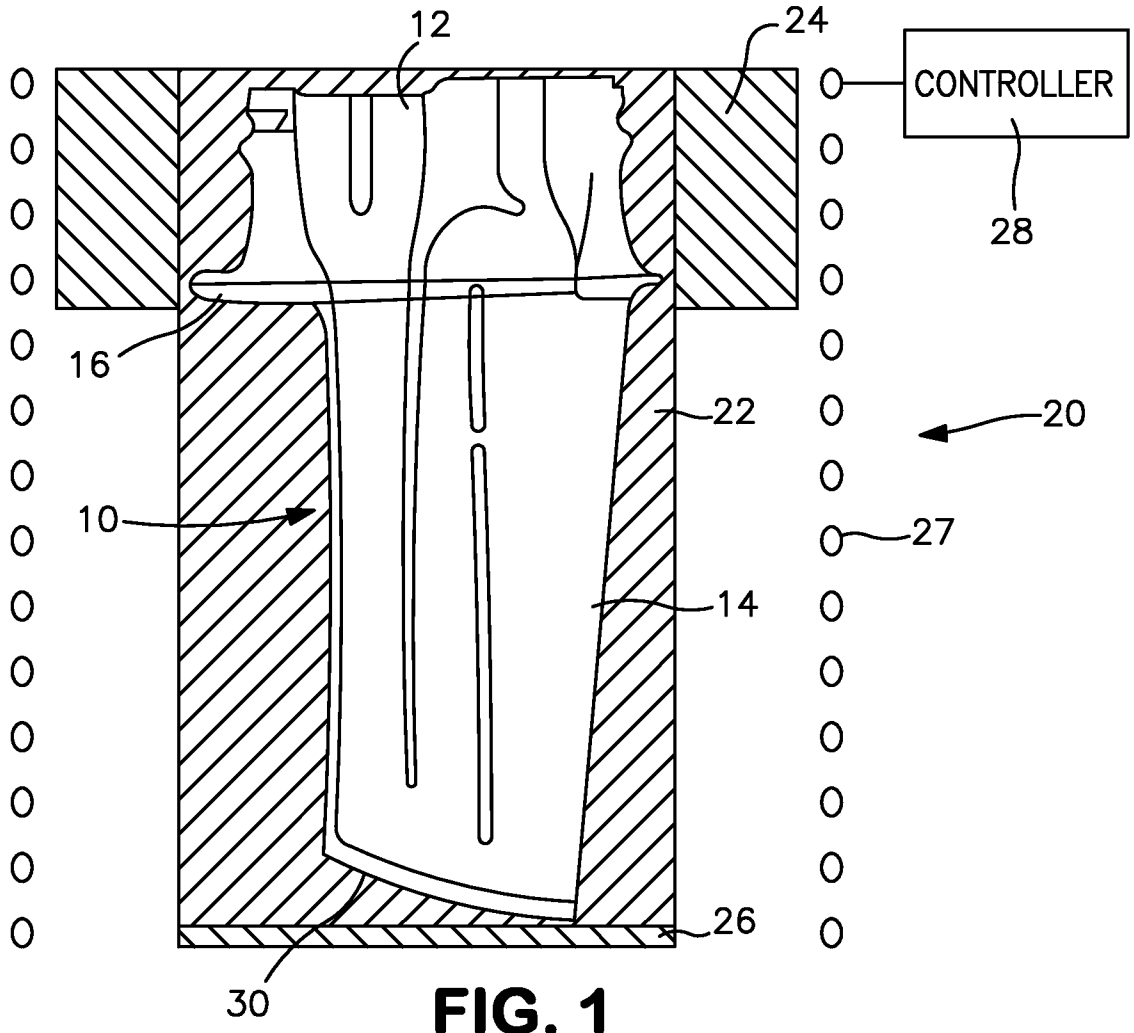


FIG. 1

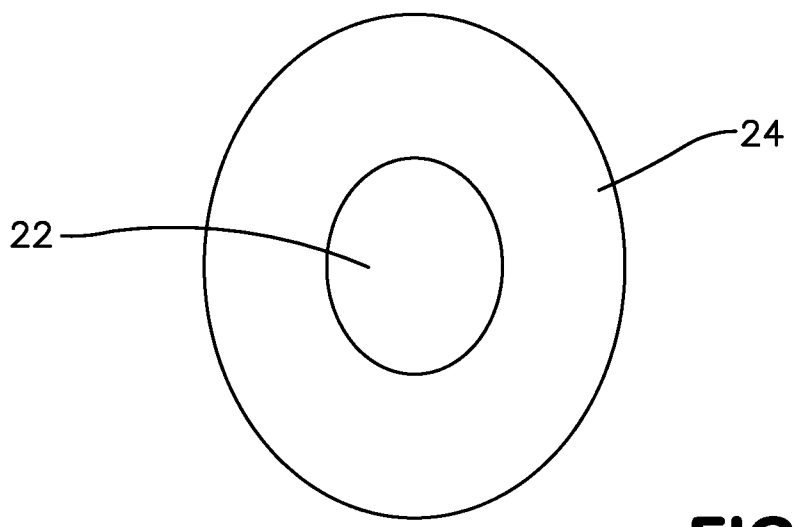


FIG. 3

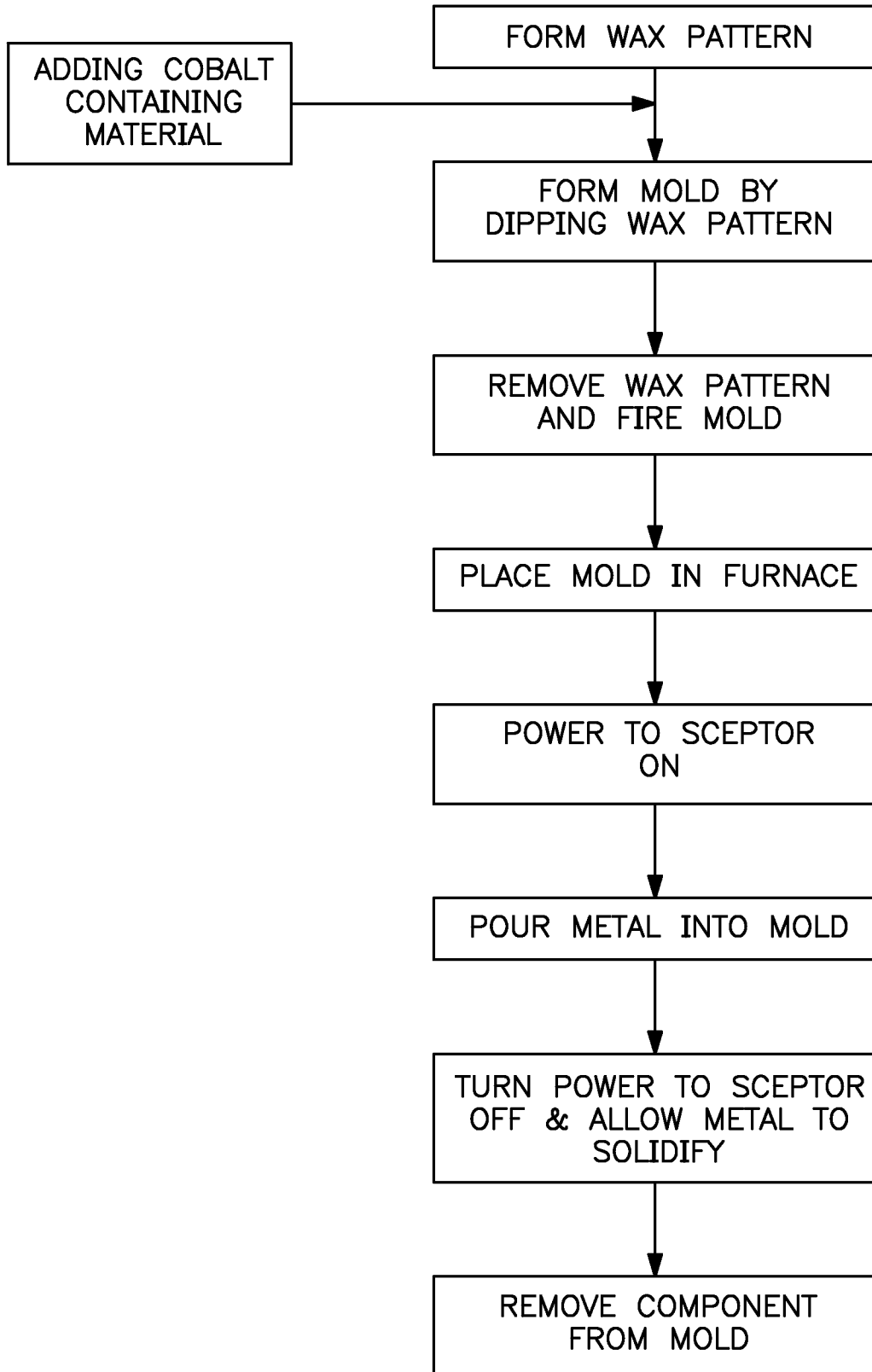




FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/031820

A. CLASSIFICATION OF SUBJECT MATTER B22D 19/16(2006.01)i, B22D 25/06(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 19/16; B22D 27/04; C22C 19/05; B23P 15/04; F01D 5/28; B23P 6/00; F01D 5/14; B22D 25/06		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models Japanese utility models and applications for utility models		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS(KIPO internal) & Keywords: turbine, blade, vane, airfoil, root, equiaxed, directionally, grain, and shield		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0484025 A1 (GENERAL ELECTRIC COMPANY) 06 May 1992 See abstract; column 2, lines 25-49; claims 1,2; and figure 1.	1-6
Y		7-21
Y	US 4813470 A (CHIANG, FENG) 21 March 1989 See abstract; column 3, line 49 - column 5, line 34; claims 1,7,22-24,29; and figures 1A,2A.	7-21
A	US 6632299 B1 (HARRIS, KENNETH) 14 October 2003 See abstract; column 1, lines 35-48, column 4, lines 49-60; and claims 8,14,17.	1-21
A	US 4436485 A (VONNEGUT, GEORGE L.) 13 March 1984 See abstract; column 2, line 45 - column 3, line 33; and figures 1-3.	1-21
A	EP 1312436 A1 (HICKHAM INDUSTRIES, INC.) 21 May 2003 See abstract; paragraphs [0015]-[0018]; claims 1-5; and figures 1-3.	1-21
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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 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 24 December 2013 (24.12.2013)		Date of mailing of the international search report 24 December 2013 (24.12.2013)
Name and mailing address of the ISA/KR  Korean Intellectual Property Office 189 Cheongsu-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140		Authorized officer SONG, Ho Keun Telephone No. +82-42-481-5580 

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/031820

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