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(54) Method for manufacturing a pattern and core assembly for a cast hollow component

(57) A pattern (20) with internal cores for creating a hollow component is composed of a first pattern half (10) having one or more first self-locating features (12); a second pattern half (16) having one or more second self-locating features (18); and one or more cores (14) disposed in contact with the one or more first self-locating features (12) and the one or more second self-locating features (18). The method for its manufacture includes the steps of creating a first pattern half (10) having one or more first self-locating features (12); creating a second pattern half (16) having one or more second self-locating features (18); providing one or more cores (14); and assembling the pattern (20) by engaging the one or more first self-locating features (12) and the one or more second self-locating features (18) about the one or more cores (14).

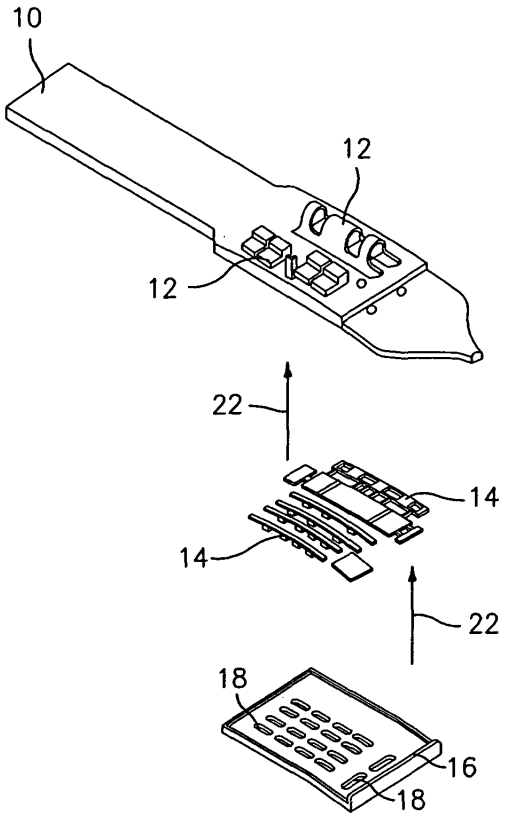

FIG. 1

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Description

FIELD OF USE

[0001] This disclosure relates to manufacturing hollow components and, more particularly, to manufacturing a pattern for hollow components.

BACKGROUND OF THE INVENTION

[0002] In the lost wax casting process a wax pattern of a component is produced. The wax pattern is a replica of the component to the produced. Usually a number of wax patterns are assembled together on a wax gating tree to form a cluster or wax mold assembly. The wax mold assembly is immersed in a liquid ceramic slurry which quickly gels after draining, strengthening refractory granules are sprinkled over the ceramic slurry covered wax mold assembly and the refractory granules bond to the slurry coating to produce a ceramic layer on the wax mold assembly. This process is repeated several times to produce many ceramic layers on the wax mold assembly. The wax is then melted out leaving a ceramic shell mold having an internal cavity identical in shape to that of the original wax cluster. This ceramic shell mold is called an investment casting mold. The mold is fired at a high temperature to purify it by removing all traces of residual wax, while at the same time curing the ceramic shell mold. The ceramic shell mold is then transferred to a casting furnace, which may be operated at either vacuum conditions or at atmospheric conditions. A charge of molten metal is then poured into the ceramic shell mold and the mold is allowed to cool to room temperature, after which the ceramic shell mold is removed leaving the cast component or components.

[0003] In the lost wax casting of hollow components, the wax patterns of the hollow components are produced by injecting wax into a pattern die which has one or more preformed ceramic cores located therein. The pattern die has shaped surfaces and the ceramic core is spaced from these shaped surfaces of the pattern die by supports, such as spacer supports, chaplets and the like, to ensure the correct thickness gap exists between the surfaces of the die and the ceramic core surfaces. Typically, the ceramic core has shaped projections which locate in correspondingly shaped apertures in the pattern die. The combination of the projections and the supports prevent the ceramic cores from moving longitudinally in the pattern die by a precisely positioned pin and slot arrangement.

[0004] However, it is difficult to optimize the position of the ceramic cores relative to the pattern die surfaces due to the manufacturing tolerances of size and shape of the ceramic core and also because of distortions within the ceramic core making process. It is particularly difficult to optimize the certain surface features of the ceramic core relative to the pattern die surfaces due to the distortions of the ceramic core, because the relationship between these core surface features and the shaped projections of the ceramic core suffers the greatest dimensional variations. The larger the ceramic core the more pronounced is the distortion.

[0005] The supports fitted to the core are positioned to ensure that the correct thickness of wax is achieved. However, where distortion is excessive the point load exerted onto the ceramic core by the supports actually strain the ceramic core while trying to correct the distorted shape against the restraint imposed by the shaped projections of the ceramic core locating in the corresponding shaped apertures in the pattern die. In the extreme case the strain is enough to fracture the brittle ceramic core thus scrapping the wax pattern. If the strain is insufficient to break the ceramic core, there is a residual strain imposed in the ceramic core which, when the wax is removed from the ceramic shell mold, causes the ceramic core to spring back to its free state and subsequently produces a cast turbine blade or turbine vane which has a thin wall section. With the complexity and level of detail in new components increasing, such methods are becoming less and less robust.

[0006] Consequently, there is room for improvement in the field of manufacturing hollow components having thin walled, complex structures.

SUMMARY OF THE INVENTION

[0007] In accordance with the present disclosure, a method for manufacturing a hollow component using a wax pattern with internal cores broadly comprises creating a first pattern half having one or more first self-locating features; creating a second pattern half having one or more second self-locating features; providing one or more cores; and assembling the pattern by engaging the one or more first self-locating features and the one or more second self-locating features about the one or more cores.

[0008] In accordance with the present disclosure, a pattern for a hollow component broadly comprises a first pattern half having one or more first self-locating features; a second pattern half having one or more second self-locating features; and one or more cores disposed in contact with the one or more first self-locating features and the one or more second self-locating features.

[0009] The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1 is a representation of the assembly of a pattern with internal cores for creating a hollow component of the present invention having a first pattern half, a

second pattern half and one or more cores disposed between and in contact with the patterns; and

FIG. 2 is a representation of the assembled pattern of FIG. 1.

[0011] Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0012] The wax pattern for a hollow component and its method of manufacture described herein facilitates the consistent placement and location of cores within the wax pattern. In addition, since the cores are not being subjected to wax injection pressures, the dimensions of the resultant hollow component are also ensured.

[0013] Referring now to FIGS. 1 and 2, a wax pattern for a hollow component described herein is shown being assembled and in a final form. Generally, a first pattern half 10 comprises one or more first self-locating features 12 that may align with one or more cores 14. The first self-locating features 12 may possess physical features that complement at least a portion, if not all of, the physical features of the cores 14. Preferably, the first self-locating features 12 complement the cores 14 such that the cores 14 are disposed within the self-locating features 12. A second pattern half 16 may also comprise one or more second self-locating features 18 that may align with the cores 14. The second self-locating features 18 may also possess physical features that complement at least a portion, if not all of, the physical features of the cores 14. Preferably, the second self-locating features 18 complement the cores 14 such that the cores 14 are disposed within the self-locating features 18. The self-locating features 12, 18 may be either positive features, negative features or a combination of both positive and negative features.

[0014] Once the first pattern half 10, one or more cores 14 and second pattern half 16 are aligned, the two pattern halves 10, 16 are combined together to form a wax pattern 20 of a component having a hollow interior as represented in FIG. 2. For example, as represented in FIG. 1, second pattern half 16 may be may have positive self-locating features which facilitates combining second pattern half 16 with one or more cores 14 and engage in a direction indicated by an arrow 22 the first pattern half 10 having complementary, negative self-locating features. The cores 14 are disposed between pattern halves 10, 16 and rest within the first self-locating features 12 and second self-locating features 18. The wax pattern 20 may then be sealed at a parting surface between pattern halves 10, 16 and core exits using any number of methods known to one of ordinary skill in the art. For example, the wax pattern 20 may be sealed using a welding method known to one of ordinary skill in the art. In such an application, the weld seam would then be blended as known to one of ordinary skill in the art.

[0015] For purposes of illustration, and not to be taken in a limiting sense, the cores 14 are shown disposed within the self-locating features 12, 18 and between the two halves 10, 16. It is contemplated that the self-locating features 12, 18 may be formed at various angles through each pattern half 10, 16 such that one or more cores 14 may be disposed at an angle to each pattern half 10, 16 within their self-locating features 12, 18, respectively. It is also contemplated that one or more additional pieces may be added, e.g., a layered pattern may be manufactured having several pieces stacked one on top the other rather than only two halves being employed. Also, as more pieces are used to form the pattern or large pieces are used to form the pattern, additional self-locating features may be incorporated to facilitate the connection between the parts as well as the cores rather than the cores alone.

[0016] As described, the wax pattern 20 of a component having a hollow interior may comprise a first pattern half 10, a second pattern half 16 and one or more cores 14 disposed therein. Each pattern half 10, 16 defines the external shape of the wax pattern of the hollow component and may comprise any material suitable for withstanding the operating conditions of a typical casting process as known to one of ordinary skill in the art. The cores 14 may comprise any ceramic material or refractory metal suitable for use in typical casting processes as known to one of ordinary skill in the art. Suitable ceramic materials may include, but are not limited to, silica, alumina, zirconia, combinations comprising at least one of the foregoing, and the like. Suitable refractory metals may include, but are not limited to, molybdenum, tungsten, combinations comprising at least one of the foregoing, and the like.

[0017] For purposes of illustration, and not to be taken in a limiting sense, the hollow component formed by wax pattern 20 may be a turbine engine component such as a turbine engine blade or vane. One pattern half may define the convex airfoil shaped surface of a pattern of a hollow turbine engine blade or vane. The other pattern half may similarly define the concave airfoil shaped surface of a pattern of the hollow turbine engine blade or vane. The cores may define the internal shape of the pattern of the hollow turbine engine component. For example, the core may possess a convex airfoil shaped surface and a concave airfoil shaped surface. It is contemplated though that the method(s) and resulting pattern described herein may be utilized in practically any industry that casts to hollow, thin walled components.

[0018] It is to be understood that the invention is not limited to the embodiments described and shown herein, which are deemed to be merely illustrative of the best modes of carrying out the invention, and which are susceptible to modification of form, size, arrangement of parts, and details of operation. The invention rather is intended to encompass all such modifications which fall within the scope of the accompanying claims.

Claims

1. A method for manufacturing a hollow component using a wax pattern with internal cores, comprising:

   creating a first pattern half (10) having one or more first self-locating features (12);
   creating a second pattern half (16) having one or more second self-locating features (18);
   providing one or more cores (14); and
   assembling the pattern by engaging said one or more first self-locating features (12) and said one or more second self-locating features (18) about said one or more cores (14).

2. The method of claim 1, wherein said step of providing one or more cores comprises providing one or more refractory metal cores.

3. The method of claim 1 or 2, wherein said step of providing one or more cores comprises providing one or more ceramic cores.

4. The method of claim 1, 2 or 3, wherein said step of assembling the pattern comprises engaging complementarily said one or more first self-locating features (12) with each of said one or more second self-locating features (18).

5. The method of any preceding claim, wherein said step of assembling the pattern comprises:

   aligning said one or more first self-locating features (12) with said one or more cores (14);
   aligning said one or more second self-locating features (18) with said one or more cores (14) ;
   aligning said first pattern half (10) and said second pattern half (16); and
   disposing said first pattern half (10) in contact with said one or more cores (14) and said second pattern half (16).

6. The method of any preceding claim, further comprising the steps of:

   welding said first pattern half (10) and said second pattern half (16) about said one or more cores (14); and
   blending a weld seam formed by welding.

7. The method of claim 6, wherein said welding step comprises wax welding.

8. The method of claim 6 or 7, wherein said blending step comprises blending said weld seam to seal one or more core exits and a parting surface formed between said first pattern half (10) and said second pattern half (16).

9. The method of any preceding claim, wherein said step of assembling the pattern comprises disposing said one or more cores (14) at an angle within said one or more first self-locating features (12) and said one or more second self-locating features (18).

10. The method of any preceding claim, wherein said step of assembling the pattern comprises disposing said one or more cores (14) within said one or more first self-locating features (12) and said one or more second self-locating features (18) through a side portion of said first pattern half (10) and said second pattern half (16).

11. A pattern with internal cores for creating a hollow component, comprising:

    a first pattern half (10) having one or more first self-locating features (12);
    a second pattern half (16) having one or more second self-locating features (18); and
    one or more cores (14) disposed in contact with said one or more first self-locating features (12) and said one or more second self-locating features (18).

12. The pattern of claim 11, wherein said one or more first self-locating features (12) are either negative or positive features and said one or more second self-locating features (18) complement said one or more first self-locating features (12).

13. The pattern of claim 11 or 12, further comprising one or more additional pattern pieces disposed in contact with said first pattern half (10) and/or said second pattern half (16).

14. The pattern of claim 11, 12 or 13, wherein said one or more cores (14) are disposed at an angle to said first pattern half (10) and said second pattern half (16).

15. The pattern of any of claims 11 to 14, wherein said one or more cores (14) are disposed through a side portion of said first pattern half (10) and said second pattern half (16).

16. The pattern of any of claims 11 to 15, wherein said first pattern half (10) and said second pattern half (16) comprise a wax material.

17. The pattern of any of claims 11 to 16, wherein said one or more cores (14) comprise a ceramic material.

18. The pattern of any of claims 11 to 17, wherein said one or more cores (14) comprise a refractory metal.

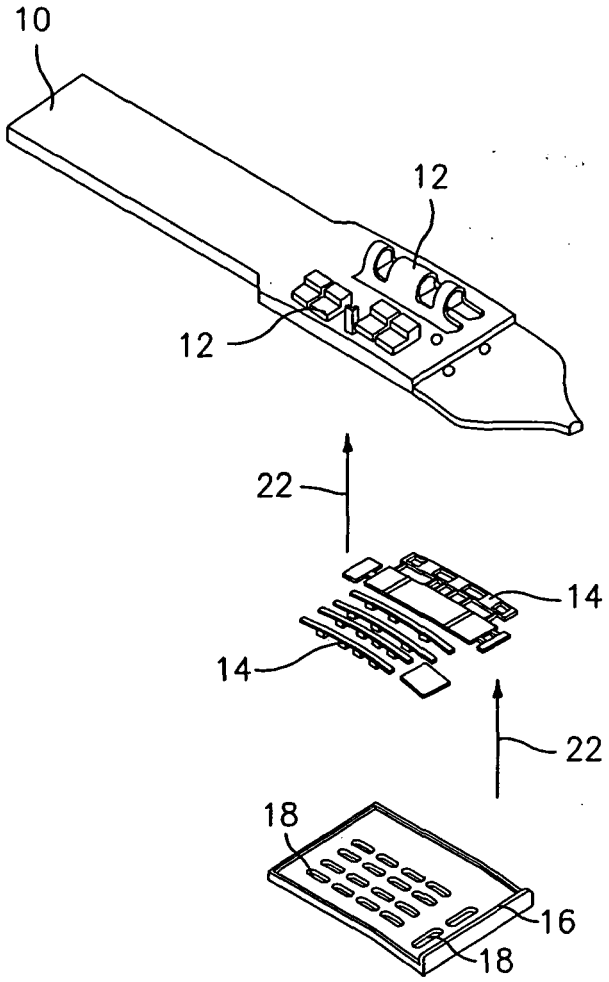

FIG. 1

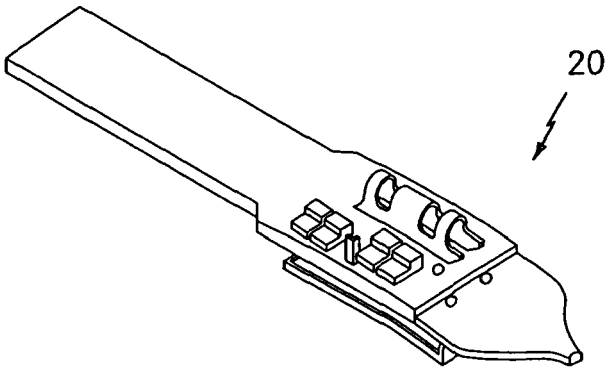

FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 06 25 5099

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 February 2007	Lombois, Thierry

CATEGORY OF CITED DOCUMENTS

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Application Number
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Place of search	Date of completion of the search	Examiner
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