

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte JIANXIN LIU and MICHAEL L. RYNERSON

Appeal 2008-1733
Application 10/416,148
Technology Center 1700

Decided: April 7, 2008

Before EDWARD C. KIMLIN, CATHERINE Q. TIMM, and ROMULO H. DELMENDO, *Administrative Patent Judges*.

DELMENDO, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF CASE

Appellants appeal under 35 U.S.C. § 134 (2002) from a final rejection of claims 1-26 and 39-44. We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM-IN-PART.

Appellants state they invented a method of casting metal and composite articles utilizing a mold, which comprises a porous powder article as a sacrificial pattern. (Spec. 1, ll. 10-13).

Claims 1, 4-11, 17, 20, 21, 24, 39, 41, and 42 on appeal read as follows:

1. A method for producing a cast article from a casting mold, the casting mold having an article-forming cavity defined by mold walls, the mold walls having an inlet for introducing molten metal into the article-forming cavity, the method comprising the steps of:

a) making a porous powder article;

b) forming the casting mold around the porous powder article so that the porous powder article is retained within and is substantially coextensive with the article-forming cavity of the casting mold; and

c) pouring molten metal into the casting mold so that it flows through the inlet into the article-forming cavity;

wherein the powder of the porous powder article becomes integral to the cast article and the step of pouring the molten metal into the casting mold substantially destroys the structure of the porous powder article.

4. The method of claim 1, further comprising the step of providing the porous powder article with a ceramic coating.

5. The method of claim 4, wherein the porous powder article comprises a polymer binder, the method further comprising the step of debinding the porous powder article of the polymer binder after the step of providing the porous powder article with a ceramic coating.

6. The method of claim 5, further comprising the step of storing the porous powder article after the step of debinding the porous powder article.

7. The method of claim 1, further comprising the step of heating the casting mold.

8. The method of claim 7, further comprising the step of storing the casting mold after the step of heating the casting mold.

9. The method of claim 1, further comprising the step of heating the casting mold immediately prior to the step of pouring.

10. The method of claim 7, wherein at least one of the steps of heating the casting mold and pouring are done under a protective atmosphere.

11. The method of claim 10, wherein the protective atmosphere includes at least one of the groups consisting of hydrogen, nitrogen, and argon.

17. A method of producing a casting mold, the casting mold having an article-forming cavity defined by mold walls, the mold walls having an inlet for introducing molten metal into the article-forming cavity, the method comprising the steps of:

- a) making a porous powder article; and
- b) forming a casting mold around the porous powder article so that the porous powder article is retained within and is substantially coextensive with the article-forming cavity of the casting mold such that when molten metal is poured into the casting mold and enters the article-forming cavity through the inlet the molten metal will cause the structure of the porous powder article to be substantially destroyed and the powder of the porous powder article to become integral to the cast article that will be formed by solidification of the molten metal.

20. The method of claim 17, further comprising the step of providing the porous powder article with a ceramic coating.

21. The method of claim 20, wherein the porous powder article comprises a polymer binder, the method further comprising the step of debinding the porous powder article of the polymer binder after the step of providing the porous powder article with a ceramic coating.

24. The method of claim 21, further comprising the step of storing the porous powder article after the step of debinding the porous powder article.

39. A casting mold comprising:

a) mold walls;

b) an article-forming cavity defined by the mold walls, the mold walls having an inlet for introducing molten metal into the article-forming cavity; and

c) a porous powder article, the porous powder article being substantially coextensive with the article-forming cavity, wherein the structure of the porous powder article is such that it will be substantially destroyed when molten metal enters the article-forming cavity through the inlet and wherein the powder of the porous powder article is such that it will become integral to the cast article that is to be formed by the solidification of the molten metal entering into the article-forming cavity through the inlet.

41. The casting mold of claim 39, further comprising a ceramic coating on the porous powder article.

42. The casting mold of claim 39, wherein the porous powder article has a relative density in the range of 30% to 40%.

The prior art relied upon by the Examiner in rejecting the claims on appeal is:

Hathaway	US 5,765,624	Jun. 16, 1998
Smith	US 5,839,329	Nov. 24, 1998

The Examiner rejected the appealed claims as follows:

- I. claims 39-44 under 35 U.S.C. § 102(b) as anticipated by Smith (Ans. 3-5);
- II. claims 39 and 41-44 under 35 U.S.C. § 102(b) as anticipated by Hathaway (Ans. 5-6); and
- III. claims 1-26 under 35 U.S.C. § 103(a) as unpatentable over the combined teachings of Smith and Hathaway (Ans. 6-9).

ISSUES

- I. Have Appellants shown error in the Examiner's determination that claims 39-44 are anticipated by Smith?
- II. Have Appellants shown error in the Examiner's determination that claims 39 and 41-44 are anticipated by Hathaway?
- III. Have Appellants shown error in the Examiner's determination that claims 1-26 would have been obvious over the combined teachings of Smith and Hathaway?

FINDINGS OF FACT

I.

1. Smith describes bonded-particulate components for a wide variety of utilities, such as rotary bits for subterranean drilling manufactured by techniques such as layered-manufacturing or those employed in rapid prototyping technology, wherein a support structure is provided for the preformed component to physically support the preformed component during various manufacturing processes such as sintering and infiltration. (Abstract; Col. 9, ll. 17-39).
2. Smith's Figure 1 is reproduced below:

During infiltration, the infiltrant 18 melts and is capillary fed past the blank 14 and through the crown 12. The infiltrant 18 effectively binds the particles comprising the crown 12 together, as well as the crown 12 to the blank 14, resulting in a single structure. In addition, the infiltrant 18 fills voids or vugs present between the particles of the crown 12.

7. Smith teaches that crown 12 may be a two-part matrix comprised of metal particulates bonded together with a laser-reactive bonding agent, such as a polymer, resin, Wood's metal, lead alloy and/or other suitable material known in the art. (Col. 6, ll. 1-4).
8. The Examiner found that Smith describes a casting mold for infiltrating preformed components and component assemblies. (Ans. 3-4).
9. Specifically, the Examiner found that Smith's Figure 1 describes every limitation of appealed claim 39, as follows (Ans. 10-11):

[T]he casting mold includes mold walls that define an article-forming cavity and an inlet, while using the porous powder article (crown 12 of Figure 1) as a pattern, such that the porous powder article pattern 12 is retained within and is substantially coextensive with an article-forming cavity of the casting mold 24 and includes a two-part matrix comprised of metal particulates bonded together with a laser-reactive bonding agent, such as a polymer, resin, Wood's metal, lead alloy etc., such that the pattern (crown 12) is relatively fragile prior to casting; and casting molten metal in the form of a metal infiltrant 18 into mold inlets adjacent the exposed portion 20 of crown 12 of the heated casting mold to substantially destroy the structure of the porous powder article (due to melting, or debinding, of the polymer

binder, resulting in distribution of powder since the porous powder article is no longer intact due to structural collapse – see column 6, lines 38-49), such that the powder of the porous powder article becomes integral to the cast article upon solidification of the molten metal, resulting in a cast composite material product.

10. Thus, the Examiner found that the term “casting mold” recited in the appealed claims reads on Smith’s castable material 24, which in turn was found to be “defined by mold walls that define an article-forming cavity.” (Ans. 4).
11. The Examiner also found that Smith’s crown 12 is a “porous powder article” as recited in the appealed claims and that “casting molten metal in the form of metal infiltrant 18 into mold inlets adjacent the exposed portion 20 of crown 12 of the heated casting mold” substantially destroys the structure of the porous powder article such that the powder of the porous powder article becomes integral to the cast article. (Ans. 10-11).
12. Appellants do not contest the Examiner’s finding that Smith’s Figure 1 describes “mold walls having an inlet for introducing molten metal into the article-forming cavity” as recited in appealed claim 39.
13. Appellants’ Specification broadly defines “casting” as “simply an article that is produced by allowing a molten metal to solidify in a mold.” (Spec. 1, ll. 16-17).
14. Furthermore, Appellants’ Specification informs one skilled in the relevant art that the use of known rapid prototyping processes, which are described as involving infiltration, is a

preferred embodiment of Appellants' invention. (Spec. 2, ll. 16-32; Spec. 5, ll. 7-33).

II.

15. Hathaway describes a mold for casting light-weight cast iron, wherein one or more pieces comprising ceramic particulates held together by a binder are disposed in spaced positions in the mold prior to pouring molten base metal. (Col. 2, ll. 22-59).
16. According to Hathaway, the pieces comprising ceramic particulates “may be disposed at the bottom of the mold downsprue, runner, riser base, riser neck, or the equivalent, e.g., an area in the mold that feeds the molten metal to the casting mold” and that “[p]ieces disposed in the mold are preferably secured to the mold wall prior to pouring molten base metal therein.” (Col. 2, ll. 44-49).
17. Hathaway states that the “ceramic particulates are gradually released into the stream of molten base metal as it flows into the mold and become distributed in the molten base metal, and cooling the base metal” forms “a composite having the ceramic particles distributed therein.” (Col. 2, ll. 37-41).
18. Hathaway further teaches that a “portion of the mixture containing ceramic particulate and binder material may be placed within the mold cavities and/or mold runner to provide more even distribution throughout the structure.” (Col. 4, l. 64 to col. 5, l. 10).

19. Hathaway teaches: “The amount of filler, excluding the binder, may range from 10 to 40 volume percent of the casting, depending on the intended use of the casting involved, and preferably 30 to 40 volume percent for those castings requiring weight reductions on the order of 20%.” (Col. 3, ll. 46-50.)

III.

20. The Examiner found that Smith differs from the subject matter of appealed claim 1 only in that molten metal is not poured into the casting mold.
21. Hathaway states that “[a]s the molten base metal is poured into the downsprue and spreads throughout the mold, the binder steadily dissolves, providing a substantially even, gradual release of the ceramic particles.” (Col. 5, ll. 11-16).
22. Smith teaches: “[B]ecause the particles forming the crown 12 may be held together by a polymer or epoxy resin, the structural integrity that such a component may have at room temperature may not be maintained during the infiltration process.” (Col. 6, ll. 38-42).
23. Smith teaches that “the component or assembly may be dipped *one or more times* into a castable material, such as a ceramic, plaster, or a graphite slurry to form a relatively rigid material around the component” (emphasis added) and further states that the component may be coated with a materials such as boron nitride. (Col. 3, ll. 54-57; col. 4, ll. 62-66).

24. Smith also teaches, in an alternative embodiment, that heating during infiltration may be accompanied by assisting the dissipation and/or vaporization of the polymer binder with a flow of a gas such as hydrogen. (Col. 7, ll. 36-47).

PRINCIPLES OF LAW

“To anticipate a claim, a prior art reference must disclose every limitation of the claimed invention, either explicitly or inherently.” *In re Schreiber*, 128 F.3d 1473, 1477 (Fed. Cir. 1997).

“Section 103 forbids issuance of a patent when the ‘differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains.’” *KSR Int’l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1734 (2007).

ANALYSIS

I.

With respect to the §102 rejection of claims 39-44 over Smith, claim 42 is the only claim argued separately pursuant to 37 C.F.R. § 41.37(c)(vii). (Amended Appeal Brief filed May 11, 2007, hereinafter “App. Br.,” 28-31). Accordingly, we confine our discussion of this rejection to claims 39 and 42, with claims 40, 41, 43, and 44 standing or falling together with claim 39.

The Examiner explained that Smith’s castable material 24 as described in Figure 1 is a casting mold defined by mold walls, which define an article-forming cavity as well as an inlet, and that crown 12 is a “porous

powder article” having the characteristics recited in appealed claim 39. (Facts 1-12).

Appellants, on the other hand, urge that Smith teaches “infiltration, rather than casting,” and thus cannot anticipate claim 39. (App. Br. 28). Additionally, Appellants argue that “any attempt to cast molten metal at element 20 [of Smith’s Figure 1] would result in unconfined molten metal escaping willy-nilly from all around the periphery of the device shown in FIG. 1 such that no person of ordinary skill in the art would even consider that device to be a casting mold or usable as one.” (App. Br. 29).

We cannot agree with Appellants. Appellants’ own Specification broadly defines “casting” as “simply an article that is produced by allowing a molten metal to solidify in a mold.” (Fact 13). Smith describes exactly that. (Fact 6). More significantly, the Specification explicitly informs one skilled in the relevant art that the use of known rapid prototyping processes, which are described as involving infiltration, is a preferred embodiment of Appellants’ invention. (Fact 14). Thus, rather than distinguish, appealed claim 39 embraces the type of rapid prototyping technology involving infiltration as described in Smith.

As to the argument that “unconfined molten metal escaping willy-nilly from all around the periphery of the device shown in FIG. 1” of Smith, it is unsupported by any factual evidence (e.g., experimental evidence) and is actually contrary to Smith’s teaching that infiltrant 18 is melted and capillary fed to effectively bind the particles comprising crown 12 together, as well as the crown 12 to the blank 14, resulting in a single structure. (Fact 6.) Even if Appellants were correct, appealed claim 39 does not preclude “unconfined molten metal escaping willy-nilly...”

For these reasons, Appellants have not demonstrated any reversible error in the Examiner's anticipation determination as to claim 39.

Claim 42 recites: "wherein the porous powder article has a relative density in the range of 30% to 40%." Appellants contend that the Examiner did not account for this limitation. (App. Br. 30-31.) The Examiner did not explain how Smith's disclosure *anticipates* this claim. Accordingly, we reverse the *anticipation rejection* of claim 42. We make no ruling on obviousness since it is not before us.

II.

With respect to the § 102 rejection over Hathaway, Appellants argue each of claims 41 and 42 separately from claims 39, 43, and 44. Accordingly, we address claims 39, 41, and 42 only, with claims 43 and 44 standing or falling together with claim 39.

Hathaway describes a mold for casting light-weight cast iron, wherein one or more pieces comprising ceramic particulates held together by a binder are disposed in spaced positions in the mold prior to pouring molten base metal. (Fact 15). According to Hathaway, the pieces comprising ceramic particulates "may be disposed at the bottom of the mold downsprue, runner, riser base, riser neck, or the equivalent, e.g., an area in the mold that feeds the molten metal to the casting mold" and that "[p]ieces disposed in the mold are preferably secured to the mold wall prior to pouring molten base metal therein." (Fact 16). Hathaway states that the "ceramic particulates are gradually released into the stream of molten base metal as it flows into the mold and become distributed in the molten base metal, and cooling the base metal" forms "a composite having the ceramic particles distributed therein."

(Fact 17). Based on these facts, we agree with the Examiner that Hathaway describes, either explicitly or inherently, every limitation of appealed claim 39.

Appellants' only argument against the Examiner's rejection of claim 39 is that "Hathaway...contains no teaching that any [ceramic particulate] piece is substantially coextensive with the article-forming cavity" as required by the appealed claim 39. (App. Br. 31). We disagree.

During examination, claims terms must be given their broadest reasonable construction consistent with the specification. *In re Icon Health and Fitness, Inc.*, 496 F.3d 1374, 1379 (Fed. Cir. 2007)("[T]he PTO must give claims their broadest reasonable construction consistent with the specification...Therefore, we look to the specification to see if it provides a definition for claim terms but otherwise apply a broad interpretation.>").

Here, Hathaway teaches that a "portion of the mixture containing ceramic particulate and binder material may be placed within the mold cavities and/or mold runner to provide more even distribution throughout the structure..." (Fact 18). When secured to the mold walls as explicitly taught in the preferred embodiment at column 5, lines 6-8, the ceramic particulate and binder material would necessarily be "substantially coextensive with the article-forming cavity," as required by appealed claim 39, in order to facilitate even distribution throughout the structure. We find it particularly significant that Appellants have failed to direct us to any special definition for the phrase "substantially coextensive." And, they have failed to direct us to any persuasive evidence that a person having ordinary skill in the art would not have considered the preferred embodiment of Hathaway to secure

the particulates and binder pieces in a manner “substantially coextensive with the article-forming cavity.”

As to claim 41, the Examiner refers to “section 3. in the (9) Grounds of Rejection section [of the Answer] for details.” (Ans. 15). But that section does not address how Hathaway *describes* the limitations of claim 41. Accordingly, we reverse the Examiner’s rejection of claim 41.

As to claim 42, the Examiner refers to Hathaway’s disclosure at column 3, lines 46-50. But this disclosure relates to the volume percent of the amount of filler relative to the casting. (Fact 19). Accordingly, we also reverse the rejection of claim 42.

III.

With respect to the § 103 rejection over the combined teachings of Smith and Hathaway, Appellants have presented arguments under separate headings for certain sets of claims as follows: (i) claims 1-16; (ii) claim 4; (iii) claim 5; (iv) claim 6; (v) claim 7; (vi) claim 8; (vii) claim 9; (viii) claims 10 and 11; (ix) claims 17-26; (x) claim 20; (xi) claim 21; and (xii) claim 24. We address these arguments accordingly. To the extent that common arguments are made, we address the sets of claims together.

The Examiner found that Smith differs from the subject matter of appealed claim 1 only in that molten metal is not poured into the mold. (Fact 20). To account for this difference, the Examiner relied on Hathaway, which discloses that it was known to pour molten metal into a mold containing particles held together with a binder. (Fact 21). Thus, one of ordinary skill in the art would have found it *prima facie* obvious to modify the method described in Smith by first melting the metal infiltrant and then

pouring it into the mold, as is notoriously well known in the art as shown in Hathaway, with a reasonable expectation of success.

Relying on extrinsic definitions and the Declaration of Howard A. Kuhn, Appellants argue that Smith's infiltration is not "casting." (App. Br. 12-18). As discussed in our discussion of Issue I above, Appellants' own Specification broadly defines "casting" as "simply an article that is produced by allowing a molten metal to solidify in a mold." (Fact 13). Smith describes exactly that. (Fact 6). Furthermore, the Specification explicitly informs one skilled in the relevant art that the use of known rapid prototyping processes, which are described as involving infiltration, is a preferred embodiment of Appellants' invention. (Fact 14). Neither the extrinsic definitions nor the Kuhn Declaration adequately explain away the explicit notice in the Specification that Appellants intend to cover infiltration within the scope of their claimed invention. Thus, Appellants' argument has no force.

Appellants contend that "it is the loss of the polymer binder during the heating of the porous powder article to the infiltration temperature that causes structural collapse" in Smith, not the pouring of the molten metal as required by appealed claim 1. (App. Br. 18, 26). Smith, however, teaches: "[B]ecause the particles forming the crown 12 may be held together by a polymer or epoxy resin, the structural integrity that such a component may have at room temperature may not be maintained during the infiltration process." (Fact 22). Thus, it would reasonably appear that the "structural integrity" of Smith's crown 12 would necessarily be compromised when molten metal infiltrates. Appellants have not directed us to any evidence to the contrary. That heat may also contribute to collapse as the binder melts

does not alter our determination, because appealed claim 1 or claim 17 reads on such an embodiment.

With respect to claims 4 and 20, Appellants argue that the prior art does not teach the limitation of providing the porous powder article with a ceramic coating. (App. Br. 22, 27.) Smith, however, teaches that “the component or assembly may be dipped *one or more times* into a castable material, such as a ceramic, plaster, or a graphite slurry to form a relatively rigid material around the component” (emphasis added) and further states that the component may be coated with a materials such as boron nitride. (Fact 23). This coated component is then said to be subject to infiltration conditions resulting in debinding, as required by appealed claim 5 or 21. (Fact 6).

With respect to claims 6, 8, and 24, Appellants argue that the prior art does not teach “storing.” (App. Br. 23-24, 27-28). Again, however, Appellants failed to direct us to any special definition in the Specification or other evidence indicating that “storing,” which is not limited to any particular time, distinguishes over the prior art.

As to claims 7 and 9, Appellants assert that Smith does not teach a casting mold. (App. Br. 23). As discussed above, however, Appellants’ position is contrary to the explicit description in their own Specification, which embraces the type of process described in Smith.

As to claim 10, Appellants contend that Smith does not teach a protective atmosphere, while the Examiner asserts that it does. (App. Br. 25; Ans. 19). A simple reading of the relied upon portions of Smith reveals that it also teaches, in an alternative embodiment, that heating during infiltration may be accompanied by assisting the dissipation and/or vaporization of the

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polymer binder with a flow of a gas such as hydrogen. (Fact 24). Thus, the Examiner is correct.

CONCLUSION

On this record, we determine that: (I) Appellants have not shown reversible error in the § 102 rejection over Smith as to claims 39-41, 43, and 44 but have successfully done so with respect to claim 42; (II) Appellants have not shown reversible error in the § 102 rejection over Hathaway as to claims 39, 43 and 44 but have successfully done so with respect to claims 41 and 42; and (III) Appellants have not shown reversible in the § 103 rejection over Smith in view of Hathaway as to claims 1-26.

DECISION

In view of the foregoing, the Examiner's decision to reject claims 1-26, 39-41, 43, and 44 is AFFIRMED, but the decision to reject claim 42 under 35 U.S.C. § 102 is REVERSED.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED-IN-PART

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