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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ALLIANCE OF RARE-EARTH PERMANENT MAGNET INDUSTRY,
Petitioner,

v.

HITACHI METALS, LTD.,
Patent Owner.

Case IPR2014-01265
Patent 6,537,385 B2

Before MICHAEL P. TIERNEY, MICHELLE R. OSINSKI, and JO-ANNE M. KOKOSKI, *Administrative Patent Judges.*

OSINSKI, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

A. Background

Alliance of Rare-Earth Permanent Magnet Industry ("Petitioner") filed a Corrected Petition (Paper 13, "Pet.") requesting an *inter partes* review of claims 1, 5, and 6 of U.S. Patent No. 6,537,385 B2 (Ex. 1001, "the '385 patent"). On February 13, 2015, pursuant to 35 U.S.C. § 314, we instituted an *inter partes* review of claims 1, 5, and 6 on the following grounds of unpatentability asserted by Petitioner:

Reference	Basis	Claims
Hasegawa[1] and Yamamoto[2]	§ 103(a)	1, 5, and 6
Ohashi[3] and Yamamoto	§ 103(a)	1, 5, and 6
He[4]	§ 102(b)	1
He and Yamamoto	§ 103(a)	5 and 6

Decision to Institute (Paper 17, "Dec. Inst."), 6, 19–20.

[1] Hasegawa, JP 1993-283217 (published Oct. 29, 1993) ("Hasegawa," Ex. 1008 and Ex. 1004 (English translation)). Hasegawa is a Japanese language document. Unless indicated otherwise, all citations to Hasegawa in this decision will refer to its certified English language translation.

[2] Yamamoto et al., US 5,383,978 (issued Jan. 24, 1995) ("Yamamoto," Ex. 1007).

[3] Ohashi et al., US 4,992,234 (issued Feb. 12, 1991) ("Ohashi," Ex. 1005).

[4] Shuixiao He, *Rare Earth Permanent Magnet Milling Equipment - Jet Mill Closed Loop System*, 21 MAGNETIC MATERIALS AND PARTS, 48–51 (Oct. 1990) ("He," Ex. 1009 and Ex. 1006 (English translation)). He is a Chinese language document. Unless indicated otherwise, all citations to He in this decision will refer to its certified English language translation.

Hitachi Metals, Ltd. ("Patent Owner") filed a Patent Owner Response (Paper 26, "PO Resp."), and Petitioner filed a Reply (Paper 31, "Pet. Reply").

Petitioner relies on the Declaration of John Ormerod Ph.D. in support of its Petition (Ex. 1002). Patent Owner relies on the Declaration of Laura H. Lewis (Ex. 2002) in support of its Response. Petitioner refers to the deposition testimony of Dr. Lewis (Ex. 1010). Patent Owner refers to the deposition testimony of Dr. Ormerod (Ex. 2003).

We heard oral argument on November 6, 2015. A transcript is entered in the record as Paper 38 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6(c). This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73.

We determine Petitioner has shown by a preponderance of the evidence that claims 1, 5, and 6 of the '385 patent are unpatentable under 35 U.S.C. § 103(a).

B. Related Proceedings

Petitioner represents that the '385 patent was asserted in International Trade Commission Investigation No. 337-TA-855, which was terminated before adjudication of any validity issues. Pet. 5.

Patent Owner represents that *Inter Partes* Review No. IPR2014-01266 of U.S. Patent No. 6,491,765 B2 ("the '765 patent")[5] also is related to this proceeding. Paper 12, 2.

[5] The '385 patent is a divisional of the '765 patent. Ex. 1001.

C. The ’385 Patent

The ’385 patent relates to methods for manufacturing neodymium-iron-boron magnets, referred to as R—Fe—B type rare earth magnets. Ex. 1001, Abstr., 1:6–8, 1:15–18. The method includes a first step of coarsely pulverizing a material alloy to a size on the order of several hundred micrometers or less using a hydrogen embrittlement apparatus, and a second step of finely pulverizing the material alloy to an average particle size on the order of several micrometers with, for example, a jet mill. *Id*. at 1:24–34.

During the second pulverization step, super-fine powder that is rich in the rare earth element (R) (i.e., powder having a particle size of 1 μm or less) is produced. *Id*. at 2:18–22. These R-rich super-fine powder particles oxidize easily as compared to other particles such that “oxidation of the rare earth element vigorously proceeds during the manufacturing process steps.” *Id*. at 2:28–30. The rare earth element, thus, is consumed by reacting with oxygen, and “the production amount of the $R_2T_{14}B$ crystal phase as the major phase decreases.” *Id*. at 2:31–32. The result is a reduction in the coercive force and remanent flux density of the resultant magnet, and deterioration of the squareness of the demagnetization curve. *Id*. at 2:33–36.

In an effort to improve and stabilize the magnet properties even when a material alloy including an R-rich phase is used, the ’385 patent describes the additional step of “removing at least part of [the] powder in which the concentration of the rare earth element is greater than the average concentration of the rare earth element contained in the entire powder, to reduce the average concentration of oxygen bound with the rare earth element contained in the powder.” *Id*. at 3:20–26.

Table I of the ’385 patent is reproduced below.

TABLE 1

Sample No.	Percentage of super-fine powder (%)	IHc (kA/m)	Br (T)	Sinter density (g/cm^3)	Oxygen amount (ppm)
1	0.5	1,009	1.42	7.65	2,900
2	1.0	1,003	1.42	7.60	3,050
3	3.0	1,003	1.41	7.65	3,200
4	5.0	995	1.40	7.60	3,500
5	7.0	987	1.38	7.52	4,000
6	10.0	963	1.36	7.45	5,300
7	13.0	812	1.32	7.30	7,400
8	15.0	692	1.29	7.00	8,500

As reported in Table I above, oxygen increases, and coercive force iHc and residual magnetic flux density Br deteriorate, as the percentage of super-fine powder in the entire powder increases. *Id*. at 11:29–38. When the percentage of super-fine powder is 10.0% or less, excellent magnetic properties, including a coercive force iHc of 900 kA/m or more and a residual magnetic flux density Br of 1.35 T or more, are obtained. *Id*. at 11:39–44.

In a preferred embodiment, the molten material alloy is cooled by a strip casting method, which is a rapid cooling method. *Id*. at 1:38–39, 3:55–56. In a preferred embodiment, the material alloy is obtained by cooling a molten material alloy at a cooling rate in a range between $10^{2\circ}$ C/sec and $10^{4\circ}$ C/sec. *Id*. at 1:45–47, 3:51–54. Alloys prepared by rapid cooling methods, as compared to ingot casting methods (in which a molten alloy is poured into a mold and cooled comparatively slowly), have a fine structure, are small in grain size, have a wide area of grain boundaries, and have a good dispersion of the R-rich phase. *Id*. at 1:37–39, 1:64–2:4. Although the preferred embodiment is applied to a rapidly solidified alloy produced by a strip casting method, it also is applicable to an alloy produced by an ingot method. *Id*. at 12:24–29.

D. Illustrative Claim

Claim 1 is illustrative of the claimed subject matter, and is reproduced below.

> 1. A method for manufacturing alloy powder for R—Fe—B rare earth magnets, comprising a first pulverization step of coarsely pulverizing an R—Fe—B alloy for rare earth magnets produced by a rapid cooling method and a second pulverization step of finely pulverizing the material alloy,
>
> wherein said second pulverization step comprises a step of removing at least part of the powder in which the concentration of rare earth element is greater than the average concentration of rare earth element contained in the entire powder.

Ex. 1001, 13:19–30.

II. DISCUSSION

A. Claim Construction

In an *inter partes* review, claim terms in an unexpired patent are interpreted according to their broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 100(b); *see In re Cuozzo Speed Techs., LLC*, 793 F.3d 1268, 1278 (Fed. Cir. 2015) ("We conclude that Congress implicitly approved the broadest reasonable interpretation standard in enacting the AIA."), *cert. granted sub nom. Cuozzo Speed Techs. LLC v. Lee*, 84 U.S.L.W. 3218 (Jan. 15, 2016) (No. 15-446). Claim terms are given their ordinary and customary meaning as understood by one of ordinary skill in the art in the context of the entire disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007).

In the Decision to Institute, we interpreted "concentration of rare earth element" as "the amount of rare earth element in a powder in comparison to the amount of all the elements in the powder." Dec. Inst. 7. The parties do not dispute this interpretation in the Patent Owner Response or in the Petitioner Reply. We adopt the above claim construction based on our previous analysis, and see no reason to deviate from that construction for purposes of this Decision.

The interpretation of the claim term "rapid cooling method" is relevant to our analysis for the Final Written Decision. Patent Owner urges that "one of ordinary skill in the art would understand the ordinary and customary meaning of 'rapid cooling method' to refer to a cooling mechanism different and faster than ingot casting, but not cooled so fast that it exceeds rapid cooling and enters the domain of super-rapid cooling." PO Resp. 8 (citing Ex. 2002 ¶¶ 81–82). Patent Owner contends that this proposed interpretation is consistent with the Specification of the '385 patent, including dependent claims 5 and 6, as well as the ordinary and customary usage of the term. *Id.* Patent Owner's expert points to the language of the Specification stating that "a rapidly cooled method" is "typified by a strip casting method and a centrifugal casting method." Ex. 2002 ¶ 81 (quoting Ex. 1001, 1:35–40). We conclude that such language indicates only that strip casting and centrifugal casting are typical *examples* of rapid cooling methods or *exemplify* rapid cooling methods, not that rapid cooling methods necessarily exclude super-rapid cooling methods.

Petitioner contends that the term "rapid cooling method" should be construed as a cooling method in which "a molten material alloy is put into contact with a single chill roll, twin chill rolls, a rotary chill disk, a rotary cylindrical chill mold, or the like, to be rapidly cooled thereby producing a solidified alloy thinner than an ingot cast alloy.'" Pet. Reply 6 (quoting Ex. 1001, 1:41–45). Petitioner contends that such a construction comports with the clear definition set forth in the Specification. *Id.* at 3. Petitioner further argues that the doctrine of claim differentiation supports Petitioner's proposed construction in that dependent claim 5 "specifically recites cooling the alloy material at a rate 'in the range between 10^{2}°C/sec and 10^{4}°C/sec'" such that the rapid cooling method of claim 1 must include cooling rates outside of this range. *Id.* at 4 (citing Ex. 1001, 14:1–5). We agree with Petitioner. The additional language of the Specification stating that "[i]n a preferred embodiment, the material alloy for rare earth magnets is obtained by cooling a molten material alloy at a cooling rate in a range between 10^{2}°C./sec and 10^{4}°C./sec" (Ex. 1001, 3:51–54), along with the same language appearing in dependent claim 5, supports that rapid cooling methods can encompass a broader range of cooling rates such that the reference to the particular range was necessary to ensure specific protection directed to a narrower and preferred range of cooling rates.[6]

We adopt Petitioner's proposed construction for a "rapid cooling method" as "a cooling method in which a molten material alloy is put into contact with a single chill roll, twin chill rolls, a rotary chill disk, a rotary cylindrical chill mold, or the like, to be rapidly cooled thereby producing a solidified alloy thinner than an ingot cast alloy."

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[6] If the upper limit of rapid cooling methods were understood by those of ordinary skill in the art to be limited to "something close to 10,000 degrees Celsius per second" as argued by Patent Owner, reference to such an upper limit as a preferred embodiment and in dependent claim 5 would appear to be superfluous. *See* Tr. 70:8–11. We have also considered the statement in the Specification that "[i]n the rapid cooling method, the molten alloy is cooled at a rate in the range between 10[]^{2}°C./sec and 10^{4}°C./sec" (Ex. 1001, 1:45–47), but, in the context of the entire Specification, we consider this to be a statement of a particular cooling rate in accordance with the invention, rather than an express definition clearly and deliberately limiting the term "rapid cooling" to a particular cooling rate.

B. Obviousness of Claims 1, 5, and 6 over Hasegawa and Yamamoto

1. Overview of Hasegawa

Hasegawa discloses that an alloy used to make rare-earth magnets is generally obtained by conventional powder metallurgy. Ex. 1004 ¶ 2. Hasegawa further discloses that melted cast ingots of rare-earth magnets have a multi-phase crystal structure including a main phase $R_2Fe_{14}B$, and an Nd-rich (i.e., rare earth-rich) phase. *Id.* ¶ 3. In Hasegawa, melted cast ingot is pulverized using mechanical pulverization techniques or a method that "involves causing hydrogen to be absorbed into the melted cast ingot of a rare-earth-iron-boron based magnet and allowing disintegration to occur to produce a coarse powder." *Id.* Hydrogen pulverization can produce pulverized powder in about one-fourth of the time of mechanical pulverization and can also cause the rare-earth rich phase to be more easily pulverized. *Id.* After coarse pulverization by mechanical or hydrogen pulverization, the powder is then finely pulverized using a jet mill. *Id.*

Hasegawa further discloses that the rare earth-rich phase oxidizes more readily than the main phase, and that if the rare earth-rich phase is excessively pulverized, a magnet obtained from such a fine powder may include excessive oxide phase and lack good magnetic properties. *Id.* To combat this known problem, Hasegawa discloses that wind power is used to remove R-rich phase fine powder during a particle classification step following pulverization. *Id.* ¶ 4; Ex. 1002 ¶ 66. The remaining powder having lower concentrations of rare earth is compacted compressively, sintered, and heat-treated. Ex. 1004 ¶ 4. The method allows rare earth-iron-boron magnets of high coercivity and high energy product to be obtained by using "classifiers that employ wind power to remove Nd-rich phase [(i.e., rare earth rich phase)] that includes large quantities of oxygen due to excessive pulverization and thus improve sinterability and reduce the oxide phase that is present at the grain boundaries." *Id*. ¶ 5.

2. Overview of Yamamoto

Yamamoto discloses that "[p]ermanent magnet alloy ingots are generally produced by a metal mold casting method consisting in casting molten alloy in a metal mold." Ex. 1007, 1:15–17. Yamamoto also discloses a method for producing a rare earth metal magnet alloy by "a strip casting system combined with a twin roll, a single roll, a twin belt or the like." *Id*. at 1:59–61. Yamamoto states that "an ingot produced by this method has a composition more uniform than that obtained with the metal mold casting method," but that sufficient improvement has not yet been seen. *Id*. at 1:62–2:3. Yamamoto further discloses "melting a rare earth metal-iron alloy to obtain a molten alloy and solidifying the molten alloy uniformly at a cooling rate of 10 to 1000° C./sec." *Id*. at 2:34–36.

3. Obviousness of Claims 1, 5, and 6

a. Claim 1

Petitioner alleges that independent claim 1 would have been obvious over the combination of Hasegawa and Yamamoto. Pet. 17–20. Petitioner relies on Hasegawa for every element of independent claim 1, except for the recitation of "an R—Fe—B alloy for rare earth magnets produced by a *rapid cooling method*." *Id*. at 18 (emphasis added). Petitioner argues that Yamamoto teaches "a rapid cooling (strip cast) method in making a strip cast R—Fe—B material alloy more uniformly that is pulverized into magnet powder." *Id*. at 17 (citing Ex. 1007, Abstr., 1:8–14, 2:32–37). Patent Owner does not dispute that Hasegawa teaches every element of independent claim 1 except for the alloy being produced by a rapid cooling method, nor that Yamamoto teaches a rapid cooling method. *See* PO Resp. 9–20.

Petitioner argues that "[o]ne of ordinary skill would have been motivated to use the R—Fe—B material alloy formed by the rapid cooling method taught by Yamamoto with the pulverization techniques taught by Hasegawa in order to pulverize a more uniform R—Fe—B material alloy." *Id*. (citing Ex. 1002 ¶ 59) (emphasis omitted). Petitioner further argues that "one of o[r]dinary skill knows that material alloys produced by either the ingot or strip cast methods produce R-rich superfine powder (particles 1µm or less), which are removed and taught in Hasegawa." *Id*. (citing Ex. 1001, 12:24–29; Ex. 1002 ¶¶ 34–35, 51–52, 59, Illustration 8) (emphasis omitted). *Id*. Petitioner also provides expert testimony that "one of ordinary skill would have been motivated to combine these prior art teachings of *Hasegawa* and *Yamamoto* according to known methods to yield predictable results. Such a modification would have been obvious because it would have involved the use of known techniques to improve a similar method." Ex. 1002 ¶ 64 (*cited at* Pet. 18).

Patent Owner counters that one of ordinary skill in the art would not have been motivated to combine the teachings of Hasegawa and Yamamoto to arrive at the claimed invention. PO Resp. 10–20. Patent Owner does not appear to dispute Petitioner's contention that strip casting would result in a more uniform alloy. In particular, Patent Owner acknowledges that utilizing a rapid cooling method generates an alloy with the R-rich phase distributed *uniformly* along the boundaries of columnar $R_2Fe_{14}B$ grains having a mean width of about 5–25 µm, as compared to an alloy generated by ingot casting which results in *randomly* dispersed regions of R-rich phase and α-Fe dendrites with columnar $R_2Fe_{14}B$ grains having a mean width of about 50–150 µm. *Id.* at 11 (citing Ex. 2005, 476).

Patent Owner, however, does dispute that generating a more uniform alloy would motivate a person of ordinary skill in the art to utilize a rapid cooling method in connection with the pulverization process of Hasegawa. PO Resp. 10–20. Patent Owner elaborates that the more uniform composition of a strip cast alloy, as compared to an ingot cast alloy, would result in a smaller average particle size and a powder distribution that is relatively uniform in particle size and shape during hydrogen pulverization. *Id.* at 12–13 (citing Ex. 2002 ¶ 41; Ex. 2006, 4). Patent Owner recognizes that "finely milled $R_2Fe_{14}B$ phase particles [on the order of 1–5 μm] improve the density of the magnet, thereby positively impacting the magnetic resonance and coercivity as well as the mechanical integrity of the final magnet," but explains that more finely milled particles would then have to be removed as part of Hasegawa's particle classification step, thereby resulting in a significantly diminished yield. *Id.* at 16–17 (citing Ex. 2002 ¶ 93). Patent Owner argues that Petitioner "fail[ed] to consider the[] consequences of changing *Hasegawa's* starting alloy." *Id.* at 18.

Petitioner has shown, and Patent Owner has not disputed, that the claimed elements (i.e., steps) are known in the art, albeit not combined in a single reference, and are used for their known purpose. Pet. 18–20; *see* Tr. 77:8–19. We are persuaded that Petitioner has shown that a person of ordinary skill in the art would have known how to combine Yamamoto's rapid cooling method (in place of Hasegawa's ingot casting method) with Hasegawa's pulverization and particle classification technique using known methods. *See* Ex. 1002 ¶ 35 ("Rare earth elements . . . are collected and are melted together to form a cast alloy using known techniques to one of ordinary skill such as the ingot cast method or a strip cast method."); *see also* Ex. 1001, 1:36–45, 12: 24–29 (referring to material alloy being produced by two types of methods—ingot casting and rapid cooling—and stating that the present invention was applicable to both an ingot method and a rapid cooling method); Ex. 1002 ¶ 51 ("The ingot or strip cast methods are interchangeable to those skilled in the art."). Petitioner has also shown sufficiently that a person of ordinary skill in the art would have recognized the results of the combination to be predictable. Ex. 1002 ¶ 64; *see also* Pet. Reply 13 (citing Ex. 2011, 2) ("[Petitioner] agrees with [Patent Owner] that a person of ordinary skill would have known that a hydrogen pulverized strip cast alloy has a narrower particle size and shape distribution in comparison to a typical ingot cast alloy. . . . [A] person of ordinary skill would have known to adjust basic, fundamental jet milling settings to accommodate the uniform particle size and shape distribution of the strip cast alloy.")).

Patent Owner argues that "the problem with the combination is that the predictable result says that, for example, in the case of the Hasegawa/Yamamoto combination, you are going to throw out 50 percent of your powder." Tr. 77:23–78:2. Patent Owner argues that one with ordinary skill in the art, for various considerations, such as diminished yield, would not have implemented a rapid cooling method in connection with Hasegawa's pulverization and particle classification techniques. PO Resp. 10–20. Whether implementation of Yamamoto's rapid cooling method makes commercial sense does not control the obviousness determination. The challenged claims are not limited to an industrial scale economically viable process. Specifically, the claims do not recite a minimum required yield that would distinguish the prior art teachings. Patent Owner has not provided persuasive reasoning or evidence to support its contention that one of skill believed there to be some technological incompatibility that prevented the combination of Yamamoto's rapid cooling method with Hasegawa's pulverization and particle classification techniques; that the combination was unpredictable in some way; or that one with ordinary skill in the art would not have known how to use Yamamoto's rapid cooling method with Hasegawa's pulverization and particle classification techniques. *See Orthopedic Equip. Co. v. United States*, 702 F.2d 1005, 1013 (Fed. Cir. 1983) ("[T]he fact that the two [prior art disclosures] would not be combined by businessmen for economic reasons is not the same as saying that it could not be done because skilled persons in the art felt that there was some technological incompatibility that prevented their combination. Only the latter fact is telling on the issue of nonobviousness.").

We appreciate Patent Owner's argument that "an invention 'composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art." PO Resp. 19 (citing *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007)). Petitioner, however, has set forth a sufficient rationale to arrive at what is claimed. Specifically, Petitioner has demonstrated that the claims represent the combination of prior art elements according to known methods to yield a predictable result. *See KSR*, 550 U.S. at 416 ("The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results."). This is itself a sufficient reason with rational underpinning to support a conclusion of obviousness. This is especially true where the evidence supports that consideration of design incentives, such as the provision of a "lower cost, more productive [process] better suited for higher volume manufacturing" would have led one of ordinary skill to pursue the predictable combination of elements. Pet. Reply 15 (citing Ex. 2003, 109:10–20).

After considering Petitioner's and Patent Owner's positions, as well as their supporting evidence, we conclude that Petitioner has demonstrated, by a preponderance of the evidence, that independent claim 1 of the '385 patent would have been obvious over the combination of Hasegawa and Yamamoto under 35 U.S.C. § 103(a).

b. Claims 5 and 6

Claim 5 depends from claim 1, and further includes "the step of producing the R—Fe—B alloy for rare earth magnets by cooling a molten material alloy at a cooling rate in a range between 10^{2}°C./sec and 10^{4}°C./sec." Ex. 1001, 14:1–4. Claim 6 depends from claim 5 and further recites that "the molten material alloy is cooled by a strip casting method." *Id.* at 14:5–6. With respect to claim 5, Petitioner argues that Yamamoto teaches solidifying a molten alloy uniformly at a cooling rate of 10 to 1000 °C/second. Pet. 20 (citing Ex. 1007, Abstr., 2: 32–37; Ex. 1002 ¶¶ 59, 71). With respect to claim 6, Petitioner argues that Yamamoto teaches " . . . a system for producing a permanent magnet alloy ingot by a strip casting method using a single roll." *Id.* at 21 (quoting Ex. 1007, 6: 16–29); *see also* Ex. 1007, Fig. 1; Ex. 1002 ¶¶ 72–73 (explaining that Yamamoto teaches that molten alloy is solidified under cooling conditions).

Petitioner provides expert testimony that "one of ordinary skill would have been motivated to combine these prior art teachings of *Hasegawa* and *Yamamoto* according to known methods to yield predictable results. Such a modification also would have been obvious because it would have involved the use of known techniques to improve a similar method." Ex. 1002 ¶ 71 (*cited at* Pet. 20).

Patent Owner does not dispute that Yamamoto teaches the claimed cooling rate range, nor cooling by a strip casting method. *See* PO Resp. 9–20. Patent Owner instead relies on the same argument that one of ordinary skill in the art would not be motivated to combine the rapid cooling method of Yamamoto with Hasegawa's pulverization and particle classification techniques as it did with respect to claim 1. *Id.* at 20. For the same reasons as described above in connection with independent claim 1, we determine that Petitioner has provided articulated reasoning with rational underpinning for combining the references based on the combination of prior art elements according to known methods to yield a predictable result.

After considering Petitioner's and Patent Owner's positions, as well as their supporting evidence, we conclude that Petitioner has demonstrated, by a preponderance of the evidence, that claims 5 and 6 of the '385 patent would have been obvious over the combination of Hasegawa and Yamamoto under 35 U.S.C. § 103(a).

C. Obviousness of Claims 1, 5, and 6 over Ohashi and Yamamoto

1. Overview of Ohashi

Ohashi discloses a method for the preparation of a permanent magnet composed of a rare earth element, iron, and boron. Ex. 1005, 1:6–16. Ohashi discloses rough pulverization of an alloy ingot via various types of pulverizing machines, such as stamp mills, jaw crushers, Braun mills, and the like, and fine pulverization via jet mills, ball mills, and the like. *Id*. at 4:38–46. Ohashi recognizes that "a magnetic alloy powder containing extremely fine particles are highly susceptible to the oxidation by the atmospheric oxygen," (*id*. at 3:41–43), and discloses that "the alloy under pulverization is strictly prevented against oxidation by the atmospheric oxygen by conducting the pulverization in an atmosphere of a non-oxidizing or inert gas such as nitrogen, argon and the like" (*id*. at 4:46–50).

Ohashi further discloses "particle size classification of the alloy powder for compression molding into a powder compact to be sintered, by which particles having a finer particle diameter . . . are removed so as to effectively prevent oxidation of the too fine particles." *Id*. at Abstr. Ohashi discloses that particle classification can be conducted using "screens of an appropriate mesh opening, rotative force, air stream and the like as well as a combination of these different principles." *Id*. at 5:1–4. Ohashi discloses removing particles having a diameter smaller than 2 μm from the alloy powder. *Id*. at 2:45–46, 4:19–22, 4:64–67. Ohashi also discloses that "[i]t is important that the volume fraction of the fine particles having a diameter smaller than 2 μm in the alloy powder after the particle size classification does not exceed 1% or, preferably, 0.5%." *Id*. at 5:50–53.

2. Obviousness of Claims 1, 5, and 6

a. Claim 1

Petitioner alleges that independent claim 1 would have been obvious over the combined disclosures of Ohashi and Yamamoto. Pet. 21–25. Petitioner relies on Ohashi for every element of independent claim 1 except for the recitation of "an R—Fe—B alloy for rare earth magnets produced by a *rapid cooling method*." *Id*. at 21 (emphasis added). Petitioner relies on the same teachings in Yamamoto relating to a rapid cooling method and the same reasoning for combining Ohashi and Yamamoto as that for combining Hasegawa and Yamamoto as described above. *Id*. at 21–23 (citing Ex. 1001, 12:24–29, Ex. 1002 ¶¶ 34–35, 51–52, 74, 76–78, Illustration 8). Patent Owner does not dispute that Ohashi teaches every element of independent claim 1 except for the alloy being produced by a rapid cooling method, nor that Yamamoto teaches a rapid cooling method. PO Resp. 21–29.

Patent Owner again argues that Petitioner fails to weigh the advantages and disadvantages of using a rapid cooling method to produce a more uniform alloy and that one of ordinary skill in the art would not utilize Yamamoto's strip casting method with the pulverization and particle classification techniques of Ohashi. *Id.* at 28–29. For the same reasons as described above in connection with the challenge based on the combination of Hasegawa and Yamamoto, Patent Owner's arguments do not persuasively rebut Petitioner's rationale relating to the combination of prior art elements according to known methods to yield a predictable result in light of design incentives that would have prompted one of ordinary skill in the art to pursue the predictable combination. Pet. 23 (citing Ex. 1002 ¶ 78); Pet. Reply 15 (citing Ex. 2003, 109:10–20).

Petitioner has shown, and Patent Owner has not disputed, that the claimed elements (i.e., steps) are known in the art, albeit not combined in a single reference, and are used for their known purpose. *Id.* at 22–25; *see* Tr. 77:8–19. Petitioner has shown sufficiently that a person of ordinary skill in the art would have known how to combine Yamamoto's rapid cooling method with Ohashi's pulverization and particle classification technique using known methods. *See* Ex. 1002 ¶ 35 ("Rare earth elements . . . are collected and are melted together to form a cast alloy using known techniques to one of ordinary skill such as the ingot cast method or a strip cast method."); *see also* Ex. 1001, 1:36–45, 12: 24–29 (referring to material alloy being produced by two types of methods—ingot casting and rapid cooling—and stating that the present invention was applicable to both an ingot method and a rapid cooling method); *see also* Ex. 1002 ¶ 51 ("The ingot or strip cast methods are interchangeable to those skilled in the art.").

Petitioner has also shown sufficiently that a person of ordinary skill in the art would have recognized the results of the combination to be predictable. Ex. 1002 ¶ 78; *see also* Pet. Reply 13 (citing Ex. 2011, 2) ("[Petitioner] agrees with [Patent Owner] that a person of ordinary skill would have known that a hydrogen pulverized strip cast alloy has a narrower particle size and shape distribution in comparison to a typical ingot cast alloy. . . . [A] person of ordinary skill would have known to adjust basic, fundamental jet milling settings to accommodate the uniform particle size and shape distribution of the strip cast alloy.")). Petitioner also provides evidence of design incentives that would have prompted one of ordinary skill in the art to pursue the predictable combination. Pet. Reply 15 (citing Ex. 2003, 109:10–20).

After considering Petitioner's and Patent Owner's positions, as well as their supporting evidence, we conclude that Petitioner has demonstrated, by a preponderance of the evidence, that independent claim 1 of the '385 patent would have been obvious over the combination of Ohashi and Yamamoto under 35 U.S.C. § 103(a).

b. Claims 5 and 6

With respect to dependent claim 5, Petitioner argues that Yamamoto teaches solidifying a molten alloy uniformly at a cooling rate of 10 to 1000 °C/second. Pet. 24 (citing Ex. 1007, Abstr., 2: 32–37; Ex. 1002 ¶ 82). With respect to dependent claim 6, Petitioner argues that Yamamoto teaches " . . . a system for producing a permanent magnet alloy ingot by a strip casting method using a single roll." *Id.* at 24–25 (quoting Ex. 1007, 6: 16–29); *see also* Ex. 1007, Fig. 1; Ex. 1002 ¶ 83 (explaining that Yamamoto teaches that molten alloy is solidified under cooling conditions).

Petitioner provides expert testimony that "one of ordinary skill would have been motivated to combine these prior art teachings of *Ohashi* and *Yamamoto* according to known methods to yield predictable results. Such a modification also would have been obvious because it would have involved the use of known techniques to improve a similar method." Ex. 1002 ¶ 82 (*cited at* Pet. 24).

Patent Owner does not dispute that Yamamoto teaches the claimed cooling rate range, nor cooling by a strip casting method. *See* PO Resp. 21–29. Patent Owner, instead, relies on the argument that one of ordinary skill in the art would not be motivated to combine the rapid cooling method of Yamamoto with Ohashi's pulverization and particle classification techniques. *Id.* at 29. For the same reasons as described above in connection with independent claim 1, we determine that Petitioner has provided articulated reasoning with rational underpinning for combining the references based on the combination of prior art elements according to known methods to yield a predictable result.

After considering Petitioner's and Patent Owner's positions, as well as their supporting evidence, we conclude that Petitioner has demonstrated, by a preponderance of the evidence, that dependent claims 5 and 6 of the '385 patent would have been obvious over the combined teachings of Ohashi and Yamamoto under 35 U.S.C. § 103(a).

D. Anticipation of Claim 1 by He

1. Overview of He

He discloses that "crude rare earth permanent magnet materials [can be] made from smelting method or quick quenching or reduction diffusion." Ex. 1006, 49. He further discloses that NdFeB material for rare earth permanent magnets can be made by crushing ingots into crude granules with hydrogen burst processing. *Id*. He discloses that the crude materials can be made finer in a milling compartment and then can be transferred to the separator. *Id*. He discloses that qualified fine powders can be separated and enter the cyclone separating device for settling, and ultra-fine powders that cannot be settled enter a filter with gas and are separated and collected. *Id*. at 49–50. He discloses that "[a]s far as rare earth permanent magnet powders are concerned, the normal ultra fine particles should have a granularity of less than 1μm and their weight should be about 0.1% of the qualified powders." *Id*.

2. Anticipation of Claim 1

Petitioner alleges that independent claim 1 is anticipated by He. Pet. 25–28. Patent Owner argues only that He fails to disclose a rapid cooling method. PO Resp. 29–33. Petitioner asserts that He's reference to quick quenching meets the claim limitation that the "R—Fe—B alloy for rare earth magnets [are] produced by a rapid cooling method." Pet. 26 (citing Ex. 1006, 49; Ex. 1002 ¶ 87). According to Petitioner "quick quenching is rapid cooling as understood by one of ordi[na]ry skill." Ex. 1002 ¶ 87.

Patent Owner argues that Petitioner's conclusory assertion regarding the equivalence of quick quenching and rapid cooling should be given little weight and that "the evidence suggests that 'quick quenching' does <u>not</u> encompass strip casting." PO Resp. 31. In particular, Patent Owner argues that strip casting was not commercially available as of He's publication date and that quick quenching most likely refers to "'melt spinning' which has '[c]ooling rates <u>in excess of 10^6 K s^{-1}</u>' according to Dr. Ormerod's 1989 publication." *Id.* at 31–32 (citing Ex. 2004, 245; Ex. 2013; Ex. 2014, 38).

We need not decide whether quick quenching refers specifically to strip casting. We need only decide whether quick quenching discloses a "rapid cooling method" as that claim term as been construed for purposes of this proceeding.[7] Patent Owner's first argument that *strip casting* in particular was not commercially available as of He's publication date is not persuasive evidence that He's quick quenching cannot be rapid cooling, because rapid cooling is not limited to strip casting in accordance with our construction of that term.

Patent Owner's second argument that He's quick quenching likely refers to melt spinning is also not persuasive evidence that He's quick quenching cannot be rapid cooling. In support of this argument, Patent Owner presented evidence that"[m]elt spinning consists of melting the alloy . . . . The melt . . . is sprayed . . . on to a rotating water cooled copper wheel or disc. Cooling rates in excess of 10^6 K s^{-1} are obtained." PO Resp. 8 (citing Ex. 2004, 245), 32; Ex. 2002 ¶ 85 ("[M]elt spinning . . . is a process in which the molten alloy is ejected onto a rapidly spinning wheel to cool at rates on the order of 10^5–10^7 degrees per second and form ribbons of nanocrystalline material."). According to Patent Owner, that rate of cooling is higher "than the maximum cooling rate" described in the '385 patent. *Id.* at 32. As set forth above, however, we do not agree with Patent Owner that "rapid cooling method" as used in claim 1 is limited to a particular cooling rate. Instead, we are persuaded that this evidence shows that melt spinning does meet the "rapid cooling method" limitation as we have construed it,

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[7] As discussed above, we have determined the broadest reasonable interpretation of the claim term "rapid cooling method" is "a cooling method in which a molten material alloy is put into contact with a single chill roll, twin chill rolls, a rotary chill disk, a rotary cylindrical chill mold, or the like, to be rapidly cooled thereby producing a solidified alloy thinner than an ingot cast alloy." Such a construction does not limit a "rapid cooling method" to a strip casting method.

because it describes a molten material being rapidly cooled to produce a solidified alloy thinner than an ingot cast alloy through contact with a rotary chill disk.

In addition to the evidence in the record supporting that quick quenching is melt spinning, and melt spinning is a process that comports with the construction of a "rapid cooling method" (Ex. 2002 ¶ 85; Ex. 2004, 245), Petitioner also presented expert testimony that He's reference to quick quenching would be understood by one of ordinary skill in the art to be rapid cooling. Pet. Reply 23 (citing Ex. 1002 ¶ 87; Ex. 2003, 114:16–18). Accordingly, we find sufficient evidence in the record to support that quick quenching discloses a rapid cooling method in accordance with the broadest reasonable interpretation of the term "rapid cooling method."

After considering Petitioner's and Patent Owner's positions, as well as their supporting evidence, we conclude that Petitioner has demonstrated, by a preponderance of the evidence, that independent claim 1 of the '385 patent is anticipated by He under 35 U.S.C. § 102(b).

E. Obviousness of Claims 5 and 6 over He and Yamamoto

With respect to dependent claim 5, Petitioner argues that Yamamoto teaches solidifying a molten alloy uniformly at a cooling rate of 10 to 1000 °C/second. Pet. 29 (citing Ex. 1007, Abstr., 2: 32–37; Ex. 1002 ¶ 93). With respect to dependent claim 6, Petitioner argues that Yamamoto teaches " . . . a system for producing a permanent magnet alloy ingot by a strip casting method using a single roll." *Id.* (quoting Ex. 1007, 6: 16–29); *see also* Ex. 1007, Fig. 1; Ex. 1002 ¶ 94 (explaining that Yamamoto teaches that molten alloy is solidified under cooling conditions).

Petitioner argues that "[o]ne of ordinary skill would have been motivated to use a material alloy formed by the rapid cooling method taught by Yamamoto with the pulverization techniques taught by He that also teaches a material alloy formed by rapid cooling in order to pulverize a more uniform material alloy." *Id.* at 28 (emphasis omitted). Petitioner also provides expert testimony that "one of ordinary skill would have been motivated to combine these prior art teachings of [*He*] and *Yamamoto* according to known methods to yield predictable results. Such a modification also would have been obvious because it would have involved the use of known techniques to improve a similar method." Ex. 1002 ¶ 93 (*cited at* Pet. 29).[8]

Patent Owner does not dispute that Yamamoto teaches the claimed cooling rate range, nor cooling by a strip casting method. *See* PO Resp. 33–37. Patent Owner counters that one of ordinary skill in the art would not have been motivated to combine the teachings of He and Yamamoto to arrive at the claimed invention for the stated reason of pulverizing a more uniform alloy. PO Resp. 36–37. In particular, Patent Owner disputes that modifying He's quick quenching method to utilize the claimed cooling rate range of 10^{2}°C./sec and 10^{4}°C./sec would result in a more uniform alloy. Patent Owner argues that "replacing *He's* 'quick quenching' with the slower cooling methods disclosed in *Yamamoto* would actually result in a less homogeneous material alloy." *Id.* at 36 (citing Ex. 2015, Fig. 9).

[8] We consider Petitioner's reference to "Hasegawa" instead of "He" in the quoted portion of paragraph 93 of Exhibit 1002 to be an inadvertent typographical error. Taken in context, in which Heading "C" refers to "He" (Ex. 1002, 45), subheading "2" refers to "*He* in view of *Yamamoto*" (*id.* at 50), and the remainder of paragraph 93 refers to "He" (*id.* at 51), we consider Petitioner clearly to have intended to refer to "He," not "Hasegawa."

Petitioner responds that Patent Owner's argument "is based on the assumption that He's disclosure of 'quick quenching' refers to melt-spinning," but He does not refer to melt-spinning. Pet. Reply 24. Even if we were to agree with Petitioner that He does not necessarily refer to melt-spinning, we are not persuaded that Petitioner has explained sufficiently how utilizing Yamamoto's particular cooling rate would result in a more uniform alloy, considering the lack of explanation by Petitioner regarding how Yamamoto's cooling rate would differ from that already provided by He's quick quenching. Petitioner further responds that even if He were referring to melt-spinning, "[Patent Owner] disregards the fact that strip casting was a well-known, highly advantageous process at the time of the invention." *Id.* Even if we were to agree with Petitioner that strip casting provides certain advantages, this does not support provide evidentiary support for Petitioner's *articulated* rationale of pulverizing a more uniform alloy as set forth in its Petition. We are persuaded by Patent Owner's argument and determine that Petitioner's first articulated rationale, namely, producing a more uniform alloy for pulverization, lacks evidentiary rational underpinning.

Petitioner, however, has also supported its conclusion of obviousness based on the combination of prior art elements according to known methods to yield a predictable result. Pet. 29 (citing Ex. 1002 ¶ 93). Petitioner has shown, and Patent Owner has not disputed, that the claimed elements (i.e., steps) are known in the art, albeit not combined in a single reference, and are used for their known purpose. Pet. 25–29; *see* Tr. 77:8–19. We are persuaded that Petitioner has shown that a person of ordinary skill in the art would have known how to combine He's quick quenching with Yamamoto's particular cooling range of 10^2°C./sec to 10^4°C./sec and Yamamoto's strip casting method using known methods and would have recognized the results of the combination to be predictable. *See* Ex. 1002 ¶ 93; Pet. Reply 24 (citing Ex. 2005, 1) (describing strip casting as "similar to melt spinning"). Petitioner also provides evidence that one of ordinary skill in the art would have pursued the predictable combination. Pet. Reply 24 (citing Ex. 2003, 108:14–19) (explaining that even when melt-spinning and strip casting were both well-known, most high-volume manufacturers utilized strip casting). We determine that Petitioner has provided articulated reasoning with rational underpinning for combining the references based on the combination of prior art elements according to known methods to yield a predictable result.

After considering Petitioner's and Patent Owner's positions, as well as their supporting evidence, we conclude that Petitioner has demonstrated, by a preponderance of the evidence, that dependent claims 5 and 6 of the '385 patent would have been obvious over the combined teachings of He and Yamamoto under 35 U.S.C. § 103(a).

III. CONCLUSION

We determine Petitioner has established by a preponderance of the evidence that: claims 1, 5, and 6 are unpatentable under 35 U.S.C. § 103(a) as obvious over the combination of Hasegawa and Yamamoto; claims 1, 5, and 6 are unpatentable under 35 U.S.C. § 103(a) as obvious over the combination of Ohashi and Yamamoto; claim 1 is unpatentable under 35 U.S.C. § 102(b) as anticipated by He; and claims 5 and 6 are unpatentable under 35 U.S.C. § 103(a) as obvious over the combination of He and Yamamoto.

IV. ORDER

In consideration of the foregoing, it is:

ORDERED that claims 1, 5, and 6 of the '385 patent have been shown by a preponderance of the evidence to be unpatentable.

This is a Final Written Decision. Parties to this proceeding seeking judicial review of our decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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