IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HENGDIAN GROUP DMEGC MAGNETICS CO., LTD.,
ZHEJIANG INNUOVO MAGNETICS CO., LTD.,
ZHEJIANG DONGYANG EAST MAGNETIC RARE EARTH CO., LTD.,
Petitioners

v.

HITACHI METALS, LTD.
Patent Owner.

U.S. Patent No. 6,527,874 to Gang Li
Issue Date: March 04, 2003
Title: Rare Earth Magnet and Method for Making Same

Inter Partes Review No.: IPR2017-01313

Petition for *Inter Partes* Review of U.S. Patent No. 6,527,874 Under 35 U.S.C. §§ 311-319 and 37 C.F.R. §§ 42.1-.80, 42.100-.123

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EXHIBIT LIST

Exhibit #	*Description*
1001	U.S. Patent No. 6,527,874 to Li, entitled "Rare Earth Magnet and Method for Making Same"
1002	Amendment dated October 30, 2002 during prosecution of U.S. Patent No. 6,527,874
1003	European Patent 0 753 867 A1 to Uchida, entitled "Rare earth permanent magnet and method for producing the same"
1004	U.S. Patent No. 5,690,752 to Yamamoto, entitled "Permanent Magnet Containing Rare Earth Metal, Boron and Iron"
1005	U.S. Patent No. 5,788,782 to Kaneko, entitled "R-Fe-B Permanent Magnet Materials and Process of Producing the Same"
1006	Reserved
1007	Japanese Published Application H05-192886 to Kaneko, entitled "Method for Manufacturing R-Fe-B-Based Permanent Magnet Material," and Certified Translation
1008	Declaration John Ormerod, Ph.D.
1009	HHE Report No. HETA-88-166-1944, Hoeganaes Magnetic Materials, Rancocas, New Jersey (January 1989)
1010	P. N. Peapell et al., Basic Material Studies by, Butterworth & Co. (Publishers) Ltd. (1985)
1011	J.E. Flinn, Rapid Solidification Technology For Reduced Consumption of Strategic Materials, Noyes Publications (1985)
1012	T.B. Coplen, Atomic Weight of the Elements 1999, J. Phys. Chem. Ref. Data, Vol. 30, No. 3, 2001
1013	U.S. Patent No. 5,595,608 to Takebuchi, entitled "Preparation of Permanent Magnet"

1014	Reserved
1015	J. Bernadi et al., Microstructural analysis of strip cast Nd-Fe-B alloy for high $(BH)_{max}$ magnets, Journal of Applied Physics, Volume 83, Number 11, June 1, 1998, pp. 6396-6398
1016	Masato Sagawa et al., *New Material for Permanent Magnets on a Base of Nd and Fe*, Journal of Applied Physics, Volume 55, Number 6, March 15, 1984
1017	S. Szymura et al., *Structure and magnetic properties of (Nd, Dy)-(Fe,Co)-B magnets with Al, Cr and Nb additions*, Journal de Physique III, EDP Sciences, 1991, 1 (10), pp. 1657-1662.
1018	U.S. Patent No. 3,032,399 to Hoke, "Preparation of Metal Borides"
1019	P. J. McGuiness et al., *A study of Nd-Fe-B magnets produced using a combination of hydrogen decrepitation and jet milling*, J. of Material Science 24 (1989) 2541-2548
1020	Reserved
1021	U.S. Patent No. 4,990,306 to Ohashi, entitled "Method of Producing Polar Anisotropic Rare Earth Magnet"
1022	J. Ormerod, *The Physical Metallurgy and Processing of Sintered Rare Earth Permanent Magnets*, Journal of the Less-Common Metals, 111 (1985) 49-69
1023	CV of John Ormerod, Ph.D.

I. INTRODUCTION

Hengdian Group DMEGC Magnetics Co., Ltd., Zhejiang Innuovo Magnetics Co., Ltd., and Zhejiang Dongyang East Magnetic Rare Earth Co., Ltd. (collectively, "Petitioner") petition for *Inter Partes* Review, seeking cancellation of claims 1-8 ("challenged claims") of U.S. Patent No. 6,527,874 ("the '874 patent") (EX1001), which is assigned to Hitachi Metals, Ltd. ("Patent Owner").

II. OVERVIEW

Patent Owner admits that R-Fe-B rare earth sintered magnets containing the claimed amount of Niobium (Nb) were well-known before the filing date of the '874 patent. EX1001, 1:11-28; EX1008, ¶90. The Board need look no further than the Discussion of Related Art section to understand the well-known nature of the claimed subject matter. EX1001, 1:11-45. Other prior art corroborates this and shows that the rare earth sintered magnets with the claimed compositions and manufacturing methods were known. EX1003, Abstract, 2:55-3:5; EX1007, ¶¶ 0001, 0010, 0021-0022. There is nothing new.

III. STANDING (37 C.F.R. § 42.10(a); PROCEDURAL STATEMENTS)

Petitioner certifies: that (1) the ’874 patent is available for IPR; and (2) Petitioner is not barred or estopped from requesting IPR of any claim of the ’874 patent on the grounds identified herein. This Petition is filed in accordance with 37 C.F.R. § 42.106(a). Filed herewith are a Power of Attorney and an Exhibit List pursuant to § 42.10(b) and § 42.63(e). The required fee is paid through online credit card, and the Office is authorized to charge any fee deficiencies and credit overpayments to Deposit Acct. No. 160605 (Customer ID No. 00826).

IV. MANDATORY NOTICES (37 C.F.R. § 42.8(a)(1))

A. Real Party-In-Interest (37 C.F.R. § 42.8(b)(1))

The real party in interest is Hengdian Group DMEGC Magnetics Co., Ltd., Zhejiang Innuovo Magnetics Co., Ltd., and Zhejiang Dongyang East Magnetic Rare Earth Co., Ltd.

B. Notice of Related Matters (37 C.F.R. § 42.8(b)(2))

The ’874 patent was previously asserted in the International Trade Commission Investigation No. 337-TA-855 (“the 855 Investigation”). The Administrative Law Judge (“ALJ”) in the 855 Investigation issued a claim construction order involving the challenged claims of the ’874 patent. The ALJ, however, did not adjudicate validity issues raised by the respondents in the 855 Investigation because the patent owner withdrew the complaint on the remaining respondents, terminating the investigation.

C. Designation of Lead and Back-Up Counsel and Service (37 C.F.R. § 42.8(b)(3), 42.8(b)(4) and 42.10(a)-(b))

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Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney accompanies this petition. Petitioner consents to service by email.

V. STATEMENT OF THE PRECISE RELIEF REQUESTED AND THE REASONS THEREFORE (37 C.F.R. § 42.22(a))

Petitioner requests IPR and cancellation of claims 1-8. Petitioner's full statement of the reasons for the relief requested is set forth in detail below.

VI. The ’874 Patent

The ’874 patent was filed July 10, 2001 and allege priority to JP2000-207675, filed on July 10, 2000. EX1001.

The magnets of the ’874 patent are purportedly created using well-known elements in known ranges and using a well-known method. *See* EX1008, ¶19. The ’874 patent purports to have discovered that “with addition of only such a small amount of Nb and/or Mo, it is possible to increase the coercive force and improve the squareness of a demagnetization curve, while suppressing the conventional problems of a reduction in remanence and a deterioration in the processability of the sintered magnet due to production of borides.” *Id.* at 2:67-3:6. Accordingly, the ’874 patent purports to have solved a known problem of the prior art by reducing the amount of Nb and/or Mo in strip casted alloys. *Id.*, 1:11-45, 3:7-24; EX1008, ¶20.

A. Claim Construction Under 37 C.F.R. § 42.104(b)(3)

Claims 1-8 should be accorded their “broadest reasonable construction” (“BRI”) in light of the ’874 patent’s specification. 37 C.F.R. § 42.100(b); *see also In Re Cuozzo Speed Technologies, LLC*, No. 2014-1301, slip. op. at 16, 19 (Fed. Cir. Feb. 4, 2014). In accordance with this standard of claim construction, Petitioner asserts that all terms should be given their ordinary and customary meaning.

Certain terms of the ’874 patent were construed in the 855 Investigation, however, the PTAB is not bound by the ALJ’s claim construction and can apply a broader standard. *In re Trans Texas Holding Corp.*, 498 F.3d 1290, 1297-98, 1301 (Fed. Cir. 2007); *Texas Instruments, Inc. v. Cypress Semiconductor Corp.*, 90 F.3d 1558, 1569 (Fed. Cir. 1996). Further, the ALJ's construction is pursuant to a different standard under *Philips*. *PPC Broadband, Inc. v. Corning Optical Commc'ns RF, LLC*, 815 F.3d 734, 742 (Fed. Cir. 2016) ("Under *Cuozzo*, claims are given their [BRI] consistent with the specification, not necessarily the correct construction under the framework laid out in *Phillips*.").

In particular, Petitioner submits that under the BRI, "rapidly solidified alloy" includes an alloy that is strip cast. EX1008, ¶43. For example, the '874 patent itself admits that strip casting provides a "rapidly solidified" alloy. *See, e.g.,* EX1001, 3:11 (teaching "a rapidly solidified rare earth alloy by strip casting"), *see also id.,* 3:44-49 (stating that a "known strip casting apparatus" can be used for quenching and rapidly solidifying the melted alloy). Claim 6 of the '874 patent itself admits that quenching by strip casting results in "a rapidly solidified alloy."

Similarly, Petitioner submits that the construction of "having a general formula represented by $(Fe_{1-m}T_m)_{100-x-y-z}Q_xR_yM_z$" includes compositions comprising the claimed elements. EX1008, ¶45, n.11. For example, the '874 patent itself admits that the sintered magnet may have impurities and additives. *See, e.g.,* EX1001, 4:2-3 (stating the alloy contains "inevitable impurities"), 4:3-6 (teaching elemental substitutes), 7:11-14 (teaching additional substitutes). During prosecution, Applicant argued that the cited prior art (EP 0633581) "do not even discuss or teach a single example of using the coercivity improving components (from among Nb, Mo, AI, Ti, V Cr, Mn, Bi, Ta, W, Sb, Ge, Sn, or Zr)," thus not allegedly rendering the rejected claims obvious. EX1002, 9. Accordingly, Applicant's argument show that elements in addition to, for example Nb, is contemplated.

Petitioner reserves the right to assert different constructions of "rapidly solidified all" and "having a general formula represented by $(Fe_{1-m}T_m)_{100-x-y-z}Q_xR_yM_z$" under the *Philips* standard, including the constructions adopted by the ALJ, in any subsequent district court litigation or ITC investigation.

VII. PERSON OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art ("POSA") is a hypothetical person who is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity. *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 420 (2007). A POSA would have (i) a bachelor's degree in materials science, metallurgical engineering, or physics and two to four years of work or research experience in the field of rare-earth magnets, or (ii) a master's degree in materials science, metallurgical engineering, or physics and one to two years of work or research experience in the field of rare-earth magnets. EX1008, ¶16.

VIII. IDENTIFICATION OF CHALLENGE (37 C.F.R. § 42.104(B))

Petitioners request IPR of Claims 1-8 of the '874 patent on the grounds of unpatentability listed below. Per 37 C.F.R. § 42.6(d), copies of the references are filed herewith. In support of the proposed grounds, this Petition includes the declaration of a technical expert, Dr. John Ormerod (EX1008), explaining what the art would have conveyed to a POSA as of the priority date. Dr. Ormerod is an expert in the field of rare earth magnets and has offered a declaration from the perspective of a POSA.

Ground	Reference(s)	Basis	Claims Challenged
1	Uchida	35 U.S.C. § 102	1, 4, 7
2	Uchida	35 U.S.C. § 103	1, 4, 7, 8
3	Uchida and Yamamoto	35 U.S.C. § 103	2, 5, 6
4	Uchida and Kaneko I	35 U.S.C. § 103	3
5	Kaneko II and Uchida	35 U.S.C. § 103	1-8

Prior art references in addition to the primary references listed above provide further background, further motivation to combine the teachings of these references and/or further support for why a POSA would have a reasonable expectation of success to arrive at the invention recited in the challenged claims.

As the Board knows, the fact that a reference was disclosed to the Examiner is not a bar to institute an IPR. For example, the Board instituted IPR in *Sharp Corp. v. Surpass Tech Innovation LLC*, IPR2015-00021, Paper 10 (P.T.A.B. Mar. 18,

2015) even though the Petitioner relied on previous considered references, because the petitioner presented different arguments that "shed[] a different light on the [repeated] reference." *Id.* at 14. The Board also instituted IPR in *Owens Corning v. Fast Felt Corp*., IPR2015-00650, Paper 9 (P.T.A.B. Aug. 13, 2015) even though the Examiner considered Petitioner's primary reference, because secondary references were added by the Petitioner. *Id.* at 25–26. Here, several prior art references were not disclosed to the Examiner (*e.g.,* EX1003, EX1004, EX1007) and new evidence is submitted to shed a different light on the prior art (*e.g*., EX1008).

IX. INVALIDITY ANALYSIS

A. Ground 1: Uchida Anticipates Claims 1, 4, and 7

1. Disclosure of Uchida

European Patent 0753867 ("Uchida," EX1003) was published on January 15, 1997 and qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA). Uchida was not disclosed during prosecution of the '874 patent.

Uchida discloses a rare earth permanent magnet consisting essentially, by weight, of 27.0-31.0% of at least one rare earth element, 0.5-2.0% of B, 0.02-0.15% of N, 0.25% or less of O, 0.15% or less of C, at least one optional element selected from the group consisting of 0.1-2.0% of Nb, 0.02-2.0% of Al, 0.3-5.0% of Co, 0.01-0.5% of Ga and 0.01-1.0% of Cu, and a balance of Fe. EX1003, Abstract; EX1008, ¶39. Uchida taught including Nb to prevent the anomalous growth of grains. EX1003, 4:12 EX1008, ¶39. Uchida explicitly stated that "[a] content less than 0.1

weight % is insufficient for effectively preventing the anomalous growth grains, and a content exceeding 2.0 weight % is undesirable because the residual magnetic flux density (Br) decreases due to increased amount of Nb borides." EX1003, 4:14-15.

Uchida also taught the conventional steps to manufacturing the permanent rare earth magnet. EX1008, ¶40. The steps included "(a) strip-casting a melt of said R-Fe-B based alloy . . . (c) pulverizing the heat-treated alloy strip into a coarse powder; (d) pulverizing the coarse powder into a fine powder . . . (h) sintering the heat-treated green body in the vacuum furnace." EX1003, 2:56-3:4.

2. Claim 1

Uchida teaches every element of Claim 1 as shown in the following claim chart. EX1008, ¶41-42.

Claim 1	Uchida
A rapidly solidified alloy sintered magnet having a general formula represented by $(Fe_{1-m}T_m)_{100-x-y-z}Q_xR_yM_z$	Uchida discloses "[a] rare earth permanent magnet" that falls within the claimed general formula. EX1003, Claim 1, Abstract. *See also id.*, 10:41-11:13. Uchida discloses "[a]n alloy strip produced by rapidly quenching an alloy melt on a cooling surface in accordance with the strip-casting . . . ." *Id.*, 5:42; *see also id.*, 2:57 and 5:31-34 (disclosing strip-casting). *See also id.*, 2:38-39.
where T denotes at least one element selected from the group consisting of Co and Ni,	Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of . . . at least one optional element selected from the group consisting of . . . . . . 0.3-5.0% of Co . . . ." *Id.*, Claim 1, Abstract; *see also id.,* 10:42-46, Table 2.

Claim 1	Uchida
Q denotes at least one element selected from the group consisting of B and C,	Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of . . . 0.5-2.0% of B . . . ." *Id.*, Claim 1, Abstract; *see also id.,* 10:42-46, Table 2.
R denotes at least one rare earth element	Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of 27.0-31.0 % of at least one rare earth element including Y . . . ." *Id.,* Claim 1, Abstract; *see also id.,* 10:42-46, Table 2.
and M denotes Nb, and	Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of . . . at least one optional element selected from the group consisting of . . . 0.1-2.0% Nb . . . ." *Id.,* Claim 1, Abstract. *See also id.,* 4:12-14, 10:42-46, Table 2.
the mole fractions x, y, z, and m respectively satisfy 2≦x≦28 (atom %), 8≦y≦30 (atom %), 0.1≦z<1.0 (atom %), and 0≦m≦0.5 (atom %).	Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of 27.0-31.0% of at least one rare earth element including Y, 0.5-2.0% of B . . . at least one optional element selected from the group consisting of 0.1-2.0% of Nb . . . 0.3-5.0% of Co . . . and a balance of Fe." *Id.*, Claim 1, Abstract. *See also id.,* 10:42-46, Table 2. Uchida discloses "[t]he content of Nb is 0.1-2.0 weight %, preferably 0.2-1.5 weight % based on the total weight of the R-Fe-B based, sintered permanent magnet." *Id.*, 4:13-14. *See also* EX1008, ¶¶47-58 (converting weight % to atom %).

Uchida teaches a sintered magnet with the claimed composition. *See, e.g.,* EX1003, Claim 1, Abstract; EX1008, ¶42. Uchida provides several examples of sintered magnets, e.g., Example 5, that have the claimed composition. *Id.* "[W]hen, as by a recitation of ranges or otherwise, a claim covers several compositions, the claim is 'anticipated' if one of them is in the prior art." *In re Taylor*, 621 Fed. Appx. 667, 669 (Fed. Cir. 2015); *see also Ineos USA LLC v. Berry Plastics Corp.*, 783 F.3d 865, 869 (Fed. Cir. 2015) (holding that a claim is anticipated if the prior art describes the claimed range with sufficient specificity such that a reasonable fact finder could conclude that there is no reasonable difference in how the invention operates over the ranges).

a) Uchida discloses "[a] rapidly solidified alloy"

Uchida discloses "a rapidly solidified alloy" as recited by Claim 1. EX1008, ¶43. Uchida is directed towards manufacturing an R-Fe-B based sintered rare earth magnet by strip casting a melt of an R-Fe-B based alloy (EX1003, 2:57), which provides a "rapidly solidified alloy." EX1008, ¶43. Strip casting rapidly solidifies an alloy by injecting the alloy strip onto the surface of a cooling roll. EX1003, 5:32-34 ("The 'strip-casting method' referred to in the present invention is a production method of alloy strip by injecting an alloy melt onto the surface of a cooling roll, etc. to quench the melt alloy, thereby forming alloy strip on the surface."), 5:42-45 ("An alloy strip produced by rapidly quenching an alloy melt on a cooling surface in accordance with the strip-casting method . . . alloy strip which is formed during the strip-casting by rapid quenching of molten metal on a cooling roll."); EX1011 at 4-6; EX1008, ¶44.[1]

b) Uchida discloses a "sintered magnet having a general formula represented by $(Fe_{1-m}T_m)_{100-x-y-z}Q_xR_yM_z$" where (1) "T denotes . . . Co," (2) "Q denotes . . . B," (3) "R denotes at least one rare earth element," and (4) "M denotes Nb"

Uchida discloses a permanent magnet with the claimed elements. Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of 27.0-31.0% of at least one rare earth element [i.e., element R] . . . 0.5-2.0% of B [i.e., element Q] . . . at least one optional element selected from the group consisting of 0.1-2.0% of Nb [i.e., element M]. . . 0.3-5.0% of Co [i.e., element T] . . . and a balance of Fe." Ex. 1003, Claim 1; *see also id.*, Abstract. Thus, Uchida discloses all of the required elements of Claim 1. EX1008, ¶45. As discussed above, this limitation should be construed to include compositions comprising the claimed elements (*see supra* Section VI.A), thus Uchida meets this limitation.

Furthermore, Uchida teaches the exact composition consisting of the claimed elements. Uchida teaches "0.02-0.15% N, 0.25% *or less* of O, 0.15% *or less* of C, at least one *optional* element selected from the group consisting of . . . 0.02-2.0% of

[1] Uchida's strip casting causes solidification from a melted alloy in a short time interval between initiation and completion of solidification. EX1008, ¶44.

Al . . . 0.01-0.5% of Ga and 0.01-1.0% of Cu," but those elements are not required according to Uchida. EX1003, Claim 1 (emphasis added); *see also id.*, Abstract. Specifically, Uchida does not require O nor C, which are commonly considered as impurities (*see* EX1008, ¶46; EX1003, 18:58-19:3; EX1007, 0022; EX1005, 9:61-67; EX1001, 4:62-65), because Claim 1 of Uchida includes zero O and zero C. *In re Mochel*, 470 F.2d 638, 640 (C.C.P.A. 1974) (holding that the term "up to" includes zero as a lower limit).

Uchida also does not require Al, Ga, and Cu, because those are "optional" and furthermore only requires choosing "at least one" of the listed elements (which includes Nb and Co) even if included. *See Upsher-Smith Labs. v. Pamlab, LLC,* 412 F.3d 1319, 1322 (Fed. Cir. 2005) (stating that a reference disclosing an optional component teaches compositions that both do and do not contain that component). As to N, as Claim 4 and column 2 lines 49-52 of Uchida shows, the inclusion of N (and O and C) is a result of pulverizing under nitrogen atmosphere, which is encompassed by Claim 1 of the '874 patent. *See* EX1008, ¶46; *see also* EX1001, 3:66-4:6 (discussing "inevitable impurities"), 4:58-59 (disclosing pulverization in nitrogen atmosphere). Thus, Uchida teaches the exact composition as required by Claim 1. EX1008, ¶46.

The fact that a POSA had "various ways of formulating a [magnet]" based on Uchida does not change the fact that Uchida is anticipatory, "since many of these are within the scope of its claim." *Kennametal Inc. v. Ingersoll Cutting Tool Co*., 780 F.3d 1376, 1382-83 (Fed. Cir. 2015); *see also id.* at 1381 ("[A] reference can anticipate a claim even if it '[d]oes not expressly spell out' all the limitations arranged or combined as in the claim."). Claims are anticipated where, as here, the prior art lists several "components that can be included in the compositions" even though it may disclose "a number of different combinations." *Wm. Wrigley Jr. Co. v. Cadbury Adams USA LLC,* 683 F. 3d 1356, 1360-61 (Fed. Cir. 2012).

c) Uchida discloses "mole fractions x, y, z, and m respectively satisfy $2 \leq x \leq 28$ (atom %), $8 \leq y \leq 30$ (atom %), $0.1 \leq z < 1.0$ (atom %), $0 \leq m \leq 0.5$ (atom %)"

Uchida discloses mole fractions x, y, z and m, which correspond to the amount of the elements Fe, T, Q, R, and M. As Dr. Ormerod explains, Uchida's disclosure of the amount of each element by weight % can be converted to atom % by dividing the disclosed weight % by the molecular weight (or atomic weight) of each element. EX1008, ¶¶28-31, 47-48, nn.1-3. The resulting number of molecules for each element (i.e., the moles of each element) is then used to calculate the % atom in view of the total number of molecules of all elements. *Id.*; EX1010, 18; EX1012, 703-04, 706-07, 709.

Uchida teaches the mole fraction "$2 \leq x \leq 28$ (atom %)," which pertains to element Q (e.g., B), because Uchida discloses 0.5-2.0 weight percent of B. EX1003, Claim 1, Abstract, 2:44-46. When converted to atomic percent, the range of B taught by Uchida is 3.02-11.46 atomic percent. EX1008, ¶ 49. This range of B entirely falls within the claimed range of element Q.

Uchida teaches the mole fraction "$8 \leq y \leq 30$ (atom %)," which pertains to element R (i.e., rare earth element), because Uchida discloses 27.0–31.0 weight percent of Nd, which is a rare earth element. EX1003, Claim 1, Abstract, 3:33-34 ("The rare earth element to in the present invention is at least one element selected from the group consisting of lanthanides and yttrium."); EX1008, n.4. When converted to atomic percent, the range of Y by Uchida is 12.22-13.31 atomic percent. *Id.*, ¶50. This range of the rare earth element entirely falls within the claimed range of element R. *Id.*

Uchida teaches the mole fraction "$0.1 \leq z < 1.0$ (atom %)," which pertains to element M (i.e., Nb), because Uchida discloses 0.1-2.0 weight percent of Nb. EX1003, Claim 1, Abstract, 2:44-46, 4:13-14. When converted to atomic percent, the range of Nb taught by Uchida is 0.07-1.33 atomic percent. EX1008, ¶51. This range of Nb is sufficiently specific and substantially overlaps with the claimed range of element M such that a POSA would understand to be reasonably the same. EX1008, ¶51. Uchida further discloses a preferred amount of Nb, 0.2-1.5 weight % (EX1003 at 4:13-14), which if converted corresponds to 0.14-1.00 atomic % of Nb. EX1008, ¶51. This range of Nb entirely falls within the claimed range of element R.

Uchida teaches the mole fraction "$0 \leq m \leq 0.5$ (atom %)," where the relative atomic fractions of Fe and T are represented by (1-m) and m, respectively, and the balance of the alloy is (100-x-y-z). EX1008, ¶52. This expression means that the balance of the alloy is (1-m) of Fe and m of T. Uchida discloses that the remaining balance of the alloy comprises of Fe and optionally Co. EX1003, 2:44-48; EX1008, ¶52. Accordingly, because Co is an optional element that can be omitted (i.e., 0 atom percent) (EX1003, Claim 1, Abstract, 2:44-48, 4:10-11), the amount of Co disclosed in Uchida falls within the claimed range of T, which encompasses zero. *Upsher,* 412 F.3d at 1322.

With respect to the requirement that the amount of Fe be "1-m," if Co is omitted because it is optional, the amount of M becomes [0*(100-x-y-z)], i.e., zero, and the amount of Fe becomes [1*(100-x-y-z)]; EX1008, ¶53. This expression of the amount of Fe essentially represents that the remainder of the alloy is made up of Fe. *See, e.g.,* EX1001, 4:2 ("Fe as the remainder"); EX1008, ¶53. Uchida teaches the "balance" of the alloy is Fe. EX1003, Claim 1, Abstract, 2:47; EX1008, ¶53.

Accordingly, Uchida explicitly discloses the claimed amount of the elements. EX1008, ¶54. Moreover, the ranges disclosed in Uchida overlap the claimed range and any alleged difference in Uchida's range and the claimed range is not reasonable different and there is no critical difference. EX1008, ¶54. As such, Claim 1 is anticipated by Uchida.

d) Uchida Example 5 Discloses the Claimed Ranges

To the extent there is any doubt Claim 1 is anticipated, Uchida discloses exemplary alloys comprising the claimed ranges for elements Fe, T, Q, R, and M. The elemental composition of Example 5 is shown in Table 2:

Table 2 (to be contd.)

	Chemical Composition of Magnet (weight %)												
No.	Nd	Pr	Dy	B	Fe	Nb	Al	Co	Ga	Cu	N	O	C
Examples													
4	27.0	0.5	1.5	1.05	bal.	0.35	0.08	2.5	0.09	0.08	0.05	0.16	0.07
5	22.3	2.0	5.5	1.00	bal.	0.50	0.20	2.0	0.09	0.10	0.04	0.14	0.06
6	20.7	8.6	1.2	1.05	bal.	-	0.08	2.0	0.09	0.10	0.07	0.18	0.07
7	22.0	5.0	1.5	1.10	bal.	-	1.00	2.5	-	-	0.06	0.17	0.07
8	27.0	0.5	1.5	1.05	bal.	0.35	0.08	2.5	0.09	0.08	0.04	0.14	0.06
9	22.3	2.0	5.5	1.0	bal.	0.50	0.20	2.0	0.09	0.10	0.03	0.12	0.06
Comparative Examples													
7	20.7	8.6	1.2	1.05	bal.	-	0.08	2.0	0.09	0.10	0.01	0.18	0.07
8	30.0	0.5	1.5	1.50	bal.	-	0.20	3.0	0.08	0.10	0.06	0.15	0.07

See EX1003, Table 2, 14:1-20.

The following table compares Uchida's Example 5, when converted to atomic percent with the claimed ranges. EX1008 at ¶56.

Element	Uchida (atomic %)	'874 patent claim 1 (atomic %)
Rare Earth Elements	13.12	8 – 30
B	5.99	2 – 28
Nb	0.35	0.1 – 1.0
Co	2.20	0 – 44.95
Fe	76.60	41 - 89.9
N	0.18	N/A
C	0.32	N/A

O	0.57	N/A
Al	0.48	N/A
Ga	0.08	N/A
Cu	0.10	N/A

As can be seen, each claimed amount of the claimed element is disclosed in Uchida Example 5. EX1008, ¶¶57-58, n.11. It has been established that when prior art discloses a particular example that is within a claimed range, the claimed range is anticipated. *Titanium Metals Corp v. Banner,* 778 F.2d 775, 782 (Fed. Cir. 1985)).

3. Claim 4

The composition based limitations of Claim 4 are the same as those set forth in Claim 1. EX1008, ¶59. Claim 4, which is directed to a method of manufacturing a rare earth sintered magnet and claims certain steps, is anticipated for the reasons explained below. The prior art teaches every element of the claim as shown in the following claim chart. EX1008, ¶60.

Claim 4	Uchida
A method for manufacturing a rare earth sintered magnet, comprising the steps of: producing a rapidly solidified alloy by quenching and solidifying a melt of an alloy having a general formula represented by $(Fe_{1-m}T_m)_{100-x-y-z}Q_xR_yM_z$	Uchida discloses "a method for producing such rare earth permanent magnet, comprising the steps of (a) strip-casting a melt of said R-Fe-B-based alloy, except for the N, O and C contents into an alloy strip…" EX1003, 2:56-58; *see also id.*, Claim 1, Abstract, 5:31-34, 5:42-45.
where T denotes at least one element selected from the group consisting of Co and Ni,	Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of . . . at least one optional element selected from the group consisting of . . . . . . 0.3-5.0% of Co . . . ." *Id.*, Claim 1, Abstract.

Claim 4	Uchida
Q denotes at least one element selected from the group consisting of B and C,	Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of . . . 0.5-2.0% of B . . . ." *Id.*, Claim 1, Abstract.
R denotes at least one rare earth element	Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of 27.0-31.0 % of at least one rare earth element . . . ." *Id.,* Claim 1, Abstract.
and M denotes Nb,	Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of . . . at least one optional element selected from the group consisting of . . . 0.1-2.0 % Nb . . . ." *Id.,* Claim 1, Abstract. Uchida discloses "[t]he content of Nb is 0.1-2.0 weight %, preferably 0.2-1.5 weight % based on the total weight of the R-Fe-B based, sintered permanent magnet." *Id.*, 4:12-14.
and the mole fractions x, y, z, and m respectively satisfy $2 \leqq x \leqq 28$ (atom %), $8 \leqq y \leqq 30$ (atom %), $0.1 \leqq z < 1.0$ (atom %), and $0 \leqq m \leqq 0.5$ (atom %);	Uchida discloses "[a] rare earth permanent magnet consisting essentially, by weight, of 27.0-31.0 % of at least one rare earth element . . . 0.5-2.0 % of B . . . at least one optional element selected from the group consisting of 0.1-2.0 % of Nb . . . 0.3-5.0 % of Co . . . and a balance of Fe." *Id.*, Claim 1, Abstract; *see also id.,* 4:12-14; EX1008, ¶¶47-58.
producing a powder of the rapidly solidified alloy, and	Uchida discloses "a method for producing such rare earth permanent magnets comprising the steps of (a) strip-casting a melt of said R-Fe-B based alloy, except for the N, O, and C contents into an alloy strip having 1 mm thickness or less; (b) heat-treating the alloy strip at 800-1100 °C in an inert gas

Claim 4	Uchida
	atmosphere or in vacuum; (c) pulverizing the heat-treated alloy strip into a coarse powder; (d) pulverizing the coarse powder into a fine powder . . . ." EX1003, 2:56–3:4.
manufacturing a permanent magnet by sintering the powder of the rapidly solidified alloy.	Uchida discloses "a method for producing such rare earth permanent magnets comprising the steps of . . . (c) pulverizing the heat-treated alloy strip into a coarse powder; (d) pulverizing the coarse powder into a fine powder in a nitrogen containing atmosphere; (e) recovering the fine powder . . . in the form of a slurry; (f) wet-compacting the slurry to form a green body . . . (h) sintering the heat-treated green body in the vacuum furnace." *Id.,* 2:56–3:4.

The same anticipation analysis for Claim 1 applies to the corresponding limitations of Claim 4. EX1001, 8:15-24. For the reasons provided in the analysis of Claim 1, Uchida discloses these limitations. EX1008, ¶¶41-58, 61. Moreover, Uchida teaches the claimed step of "producing a rapidly solidified alloy by quenching and solidifying a melt of an alloy," because it discloses strip-casting a melt of an alloy (EX1003, 2:57, 5:42-45), which is nothing more than a standard process for preparing permanent magnets. EX1008, ¶43-44, 62; EX1001, 3:44-49.

Uchida also teaches the claimed steps of "producing a powder of the rapidly solidified alloy, and manufacturing a permanent magnet by sintering the powder of the rapidly solidified alloy," which are also standard. EX1001, 8:13-26; EX1008, ¶63. Uchida discloses producing a powder of the strip cast alloy and then sintering the powder to produce a permanent magnet. EX1003, 2:56-3:4. These steps are the same as those recited in Claim 4, thus, Claim 4 is anticipated by Uchida. EX1008, ¶63.

4. Claim 7

Claim 7 is anticipated by Uchida. Claim 7 depends from any one of Claims 4 to 6. As discussed above, Uchida discloses all the limitations of Claim 4. Claim 7 requires "embrittling the rapidly solidified alloy by allowing the rapidly solidified alloy to occlude hydrogen and then release the hydrogen." Uchida discloses occluding hydrogen and then dehydrogenating the rare earth alloy (EX1003, 5:49-50), which causes the rare earth alloy to become embrittled (*id.*, 5:52) and thus making the rare earth alloy easier to pulverize. EX1008, ¶66; *see also* EX1003, 9:59-10:2, 10:44, 13:17 and claim 10. Thus, Uchida discloses the additional limitation. EX1008, ¶¶65-66. As such, Claim 7 is anticipated.

B. Ground 2: Claims 1, 4, 7, and 8 Would Have Been Obvious by Uchida Alone

To the extent Uchida does not anticipate Claims 1, 4, and 7 of the '874 patent, Uchida would have rendered these claims obvious. Claim 8 would also have been obvious over Uchida. EX1008, ¶77.

1. Claim 1

As discussed above in Ground 1, Uchida discloses a rapidly solidified alloy sintered magnet having the claimed formula and ranges of Claim 1. *See supra* Section

IX.A.2. Claim 1 is also rendered obvious by Uchida. Anticipation is the epitome of obviousness. *See In re Kalm*, 378 F.2d 959, 962 (C.C.P.A. 1967).

a) "A rapidly solidified alloy"

Uchida teaches a "rapidly solidified alloy" as discussed above. *See supra* Section IX.A.2.a). Additionally, a POSA would have been motivated to use strip casting, because Uchida teaches that strip-casting is preferred (EX1003, 5:31-32), and rapidly solidifies the alloy (*id.*, 5:42-43). See EX1008, ¶79. Thus, Uchida provides a POSA with explicit motivation to produce a "rapidly solidified alloy." *Id.* Indeed, strip-casting and the advantages it offered to make rare earth sintered magnets was well-known. EX1008, ¶79-80; EX1003, 2:56-58; EX1007, Abstract; EX1015, 6398, EX1005, 3:34-40; EX1015, 6398. Accordingly, it would have been obvious to a POSA to have a rapidly solidified alloy using strip casting. EX1008, ¶80.

b) A "sintered magnet having a general formula represented by $(Fe_{1-m}T_m)_{100-x-y-z}Q_xR_yM_z$" where (1) "T denotes . . . Co," (2) "Q denotes . . . B," (3) "R denotes at least one rare earth element," and (4) "M denotes Nb"

Uchida teaches the claimed composition as discussed above. *See supra* Section IX.A.2.b). Additionally, a POSA would have been motivated to use a sintered magnet having a general formula of $(Fe_{1-m}T_m)_{100-x-y-z}Q_xR_yM_z$, with T=Co, Q=B, R=rare earth element, and M=Nb. *See* EX1003, 2:57, 4:13-14, 5:31-34; *see also* EX1008, ¶81-82. Moreover, a POSA would have been motivated to use the elemental composition disclosed in Uchida to create a "sintered permanent magnet having a remarkably improved corrosion resistance and excellent magnetic properties." EX1003, 2:38-39; EX1008, ¶81.

With respect to each element, it would have been obvious to a POSA to omit the optional Co (EX1003, Claim 1, Abstract), and to include Co, because Uchida teaches increasing the corrosion resistance and heat stability of the magnet by including an optimal amount of Co. EX1003, 4:25-26; EX1008, ¶82. A POSA would have included B and a rare earth element, because Uchida is directed to a R-Fe-B based permanent magnet. EX1003, 2:1-2; EX1008, ¶82. A POSA would have been motivated to include Nb, because Uchida teaches preventing the anomalous growth of grains by adding Nb. EX1003, 4:12-16; EX1008, ¶82.

Additionally, it would have been obvious to a POSA to omit certain elements that are taught by Uchida as being optional. Uchida teaches including "at least one optional element selected from the group consisting of" Nb, Al, Co, Ga, and Cu. EX1003, Claim 1, Abstract. This list of optional elements is small. EX1008, ¶83. Thus, choosing Nb out of the five elements and omitting other optional elements would have been obvious and a matter of routine experimentation. EX1008, ¶83. Moreover, Uchida's teaching of alternatives does not mean that choosing Nb "is inapt for obviousness purposes." *In re Mouttet,* 686 F.3d 1322, 1334 (Fed. Cir. 2012); *Gnosis S.P.A. v. S. Ala. Med. Sci. Found.,* IPR2013-00116, Paper 68 (Final

Written Decision) at 15 (P.T.A.B. June 20, 2014) ("Mere inferiority of a modification does not make that modification unobvious."). Given that there were only five options, at the very least, it would have been obvious to choose Nb and Co. *In re Kubin*, 561 F.3d 1351, 1359 (Fed. Cir. 2009). EX1008, ¶83.

c) "Mole fractions x, y, z, and m respectively satisfy $2 \leq x \leq 28$ (atom %), $8 \leq y \leq 30$ (atom %), $0.1 \leq z < 1.0$ (atom %), $0 \leq m \leq 0.5$ (atom %)"

Uchida teaches the claimed amounts as discussed in Ground 1. *See supra* Section IX.A.2.c). *See also In re Haase*, 542 Fed. Appx. 962 (Fed. Cir. 2013) (finding that a "relevant comparison between disputed claim limitations and the prior art [that] pertains to a range of overlapping values" establishes a *prima facie* case of obviousness); *In re Kenneth*, 409 F.3d 1339, 1341 (Fed. Cir. 2005) (finding *prima facie* case of obviousness where the prior art disclosed ranges that overlapped all of the claimed ranges). Additionally, it would have been obvious to use the amounts of the elements as disclosed in Uchida, which fall within the claimed range, and is expected to work. *See* EX1003, 2:38-39; EX1008, ¶84.

With respect to the amount of element Q (e.g., B) being "$2 \leq x \leq 28$ (atom %)," Uchida teaches a range of B (i.e., 0.5-2.0 weight percent, which corresponds to 3.02-11.46 atomic percent) that falls within the claimed range. *See supra* IX.A.2.c); EX1008, ¶¶49, 85. Uchida teaches narrower ranges of B, which also fall within the claimed range. *See, e.g.,* EX1003, 3:8 (disclosing 0.9-2.0 % weight of B), 4:52

(disclosing 1.1 weight % of B), Example 5 (disclosing 1.0 % weight of B); EX1008, ¶85. Accordingly, it would have been obvious to have the claimed amount of B, which is taught by Uchida and also in the common range for rare earth sintered magnets. EX1008, ¶85; EX1016, 2 (disclosing a B amount of 4-17 % atom).

With respect to the amount of element R (i.e., rare earth element) being "$8 \leq y \leq 30$ (atom %)," Uchida teaches a range of Nd (i.e., 27.0–31.0 weight percent, which corresponds to 12.22-13.31 atomic percent) that falls within the claimed range. *See supra* IX.A.2.c); EX1008, ¶¶50, 86. Uchida teaches "regulating the content of rare earth element within 27.0-31.0 weight % to improve the corrosion resistance." EX1003, 3:56; EX1008, ¶86. Accordingly, it would have been obvious to have the claimed amount of a rare earth element, which is taught by Uchida and also in the common range for rare earth sintered magnets. EX1008, ¶86.

With respect to the amount of element M (i.e., Nb) being "$0.1 \leq z < 1.0$ (atom %)," Uchida teaches a range of Nb (i.e., 0.1-2.0 weight percent, which corresponds to 0.07-1.33 atomic percent) that falls within the claimed range. *See supra* IX.A.2.c); EX1008, ¶¶51, 87. Uchida further explains:

> A content less than 0.1 weight % is insufficient for effectively preventing the anomalous growth of grains, and a content exceeding 2.0 weight % is undesirable because the residual magnetic flux density (Br) decreases due to increased amount of Nb borides.

EX1003, 4:14-16. Uchida further teaches a preferred Nb amount of 0.2-1.5 weight %. *Id.*, 4:12-14. As discussed above for Ground 1, 0.1-2.0 weight % of Nb substantially overlaps with the range claimed by Claim 1 of the '874 patent. Moreover, a POSA would have been motivated to include the preferred amount of Nb, which falls within the range claimed by Claim 1 of the '874 patent. EX1008, ¶87. Accordingly, it would have been obvious to have the claimed amount of Nb, which is taught by Uchida and also in the common range for rare earth sintered magnets. *Id.*

With respect to the amount of element T (e.g., Co) being "$0 \leq m \leq 0.5$ (atom %)," and the amount of element Fe being "1-m," Uchita teaches a range of Co and Fe that fall within the claimed ranges. *See supra* IX.A.2.c); EX1008, ¶88. Uchida further teaches less than 0.3 weight % of Co is insufficient and more than 5.0 weight % is excessive, and also teaches a preferred range of 0.4-4.5 weight %, which also falls within the claimed range. EX1003, 4:21-25; EX1008, ¶88. Accordingly, it would have been obvious to have the claimed amount of Co, which is taught by Uchida and also known to be in the common range for rare earth sintered magnets. *Id.*. Uchida also teaches that the balance of the alloy is Fe. *See, e.g.,* EX1003, 2:47. Accordingly, it would have been obvious to have the claimed amount of Fe, which is taught by Uchida and also known to be in the common range for rare earth sintered magnets. EX1008, ¶88.

Courts have long held that claims are made obvious when the prior art discloses overlapping ranges. *See Ex Parte Jani*, Appeal 2013-001176 (P.T.A.B. Dec. 23, 2014) (citing *In re Harris,* 409 F.3d 1339, 1341 (Fed. Cir. 2005) and *In re Peterson*, 315 F.3d 1325, 1329-30 (Fed. Cir. 2003)). In *Ex Parte Jani*, the Board held that the prior art teaching of a range of 28-58% of an element made obvious the claimed range of 40-60% of that same element in part because it is well settled that it is obvious to one of ordinary skill in the art to develop optimum ranges for result-effective parameters. *Id.* at 3, 5-6.

d) Reasonable Expectation of Success

A POSA would have had a reasonable expectation of success considering that a POSA would only have to look to the teachings of Uchida alone to render Claim 1 obvious. EX1008, ¶89. A POSA would have been able to combine these well-known classes of elements in known amounts to create a sintered magnet according to known principles and techniques, and would have had a reasonable expectation of success in doing so. *Id.* Such a result would have been predictable because of the conventional use of the claimed elements and amounts and processes. EX1008,

¶89. The ’874 patent itself admits that these elements and ranges were known. *See, e.g.,* EX1001, 1:11-28; EX1008, ¶89.[2]

As such, Claim 1 of the ’874 patent would have been obvious. EX1008, ¶90.

2. Claim 4

Uchida teaches a method for manufacturing the claimed rare earth sintered magnet with the claimed composition, made according to the claimed steps. *See supra* Section IX.A.3. As stated above, the composition limitations of Claim 4 are similar to those of Claim 1. As such, the obviousness analysis of Claim 1 over Uchida applies to Claim 4’s composition limitations.

The claimed steps of Claim 4 are also obvious over Uchida. As explained above for Ground 1, the claimed step of “producing a rapidly solidified alloy by quenching and solidifying a let of an alloy” is taught by Uchida and is nothing more than a standard process of strip casting an alloy for preparing rare earth sintered magnets. EX1003, 5:42-45; EX1008, ¶¶62, 92; EX1001, 3:44-49. Uchida teaches strip casting an alloy melt onto a cooling roll to produce a “fine and uniform metal

[2] Moreover, at the initial stage Patent Owner must show “that a [POSA] would have had no reasonable expectation of success.” *Par Pharm. Inc. v. Novartis AG*, IPR2016-01479, Paper 8 (Institution Decision) at 11 (P.T.A.B. Feb. 15, 2017).

structure to sinter a fine powder." EX1003 at 5:34-36; EX1008 ¶93. The claimed steps of "producing a powder of the rapidly solidified alloy, and manufacturing a permanent magnet by sintering the powder of the rapidly solidified alloy" are also standard steps. EX1001, 8:13-26; EX1011, 4-5; EX1008, ¶93. As discussed in Ground 1, Uchida discloses producing a coarse powder of the strip casted R-Fe-B based alloy and then sintering the powder to produce a rare earth permanent magnet. EX1003, 2:55-3:5, 5:31-6:9; EX1008, ¶93.

Given the claimed steps disclosed in Uchida are well-known and standard techniques, a POSA would have had reasonable expectation of success. EX1008, ¶94. As such, Claim 4 would have been obvious.

3. Claim 7

Claim 7 depends from any one of Claims 4 to 6. As recited above in Ground 1, Uchida anticipates Claim 7. Claim 7 is also rendered obvious by Uchida's teaching, because a POSA would have also been motivated to utilize the embrittling step taught in Uchida by occluding hydrogen and then releasing the hydrogen. EX1003, 5:48-50; 9:59-10:2, 10:44-11:20, 13:17 and Claim 10; EX1008 ¶¶96, 97. Uchida teaches that hydrogen occlusion and dehydrogenation are the preferred methods of coarse pulverization. EX1003, 5:48-50. Uchida also teaches hydrogen occlusion makes the "alloy strip easily degraded to a coarse powder of a narrow particle size distribution." EX1003, 5:52-53.

Given the claimed step is well-known and a standard technique used for creating a rare earth sintered magnet, a POSA would have had reasonable expectation of success. EX1008, ¶97; EX1013, 3:50-60; EX1019, 2548. As such, Claim 7 would have been obvious.

4. Claim 8

Claim 8 depends from Claim 4 and requires the additional step of "grinding the permanent magnet." As discussed above, Uchida anticipates and/or renders Claim 4 obvious. The additional step of "grinding the permanent magnet" would have been obvious. EX1008, ¶98-99.

Uchida teaches machining the sintered rare earth permanent magnet to an appropriate shape and structure. EX1003, 6:45-46, 7:21-22. The step of "grinding the permanent magnet," a type of machining process, was a common final step of manufacturing a rare earth sintered magnet to obtain a suitable shape. EX1008, ¶99; *see also* EX1021, 4:3-8 ("In the present invention, such deformation is remedied by *machining* the sintered magnet body with a suitable abrading machine such as a centerless *grinder* to remove the projections . . . until the magnet body has an accurately cylindrical surface.") (emphasis added); EX1022, 65. A POSA would have found it obvious to use the commonly used machining technique of grinding, for example to remove abrasions or otherwise shape the magnet to the appropriate dimensions. EX1008, ¶99. Uchida also found that the disclosed rare earth permanent magnets had good magnetic properties after machining, thus providing a POSA with a reasonable expectation of success when combined with the well-known nature of grinding permanent magnets. *Id.*; EX1003, 7:18-20. Thus, Uchida renders Claim 8 obvious. EX1008, ¶99.

C. Ground 3: Claims 2, 5, and 6 Would Have Been Obvious Over Uchida in Light of Yamamoto

Claims 2, 5, and 6 are obvious over Uchida in light of Yamamoto (EX1004). The skill level of a POSA, and the disclosure of Uchida are discussed above. *See supra* Sections VII (describing a POSA), IX.A.1 (describing Uchida).

1. Disclosure of Yamamoto

U.S. Patent No. 5,690,752 ("Yamamoto," EX1004) was issued on November 25, 1997, and therefore qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA). Yamamoto was not disclosed during prosecution of the '874 patent.

Yamamoto discloses manufacturing a permanent rare earth magnet by pulverizing, molding, and sintering an alloy material. EX1004, Abstract. The alloy of Yamamoto contained "25 to 31% by weight of a rare earth material, 0.5 to 1.5% by weight of boron and iron under cooling conditions of a cooling rate of higher than 500° C./sec. and not higher than 10,000° C./sec. and a supercooling degree of 50° to 500° C." *Id.*, Abstract. Yamamoto taught strip casting the alloy through a single roll with a cooling rate between 500° C/sec and 10,000° C/sec, and preferably between 1000-5000° C/sec. *See id.*, 2:65-67, 3:66-4:4. The associated benefits include satisfactory sintering of the alloy which will exhibit excellent residual flux, superior magnetic properties and coercive force. *Id.*, 2:40-44, 2:46-49, 3:9-20; *see also* EX1008, ¶102.

2. Claims 2 and 5

Claim 2 depends from Claim 1 and requires "the cooling rate at which a melt of a material rare earth alloy is quenched to produce the rapidly solidified alloy is in a range of 10^2 K/sec to 10^4 K/sec." Claim 5 depends from Claim 4 and requires that "the cooling rate is from 10^2 K/sec to 10^4 K/sec." Claims 1 and 4 are anticipated and/or rendered obvious by Uchida as discussed above. *See supra* Sections IX.A.2, IX.A.3, IX.B.1, IX.B.2. Claims 2 and 5 would have been obvious over Uchida in view of Yamamoto because the limitations of Claims 2 and 5 are well-known. EX1008, ¶103.

Uchida teaches strip casting. EX1003, 5:31-32. Uchida explains that the strip casting in Uchida is "a production method of alloy strip by injecting an alloy melt onto the surface of a cooling roll, etc. to quench the melt alloy, thereby forming alloy strip on the surface." EX1003, 5:32-34. Uchida further explains that the alloy strip is produced by "rapidly quenching". *Id.*, 5:42-45.

Yamamoto, like Uchida, is directed to R-Fe-B-based permanent magnets. EX1004, 3:2-5. Yamamoto teaches the production of a permanent magnet by strip casting using "a single roll." *Id.*, 2:61, 3:5-6, 4:1, 6:54-55. Yamamoto states that the alloy "is obtained by uniformly solidifying by a single roll method a molten alloy . . . under cooling conditions of a cooling rate of higher than 500° C./sec., and not higher than 10,000° C./sec." *Id.*, 2:60-67. When converted to Kelvin,[3] Yamamoto discloses a cooling rate between 500 K/sec and 10,000 K/sec, which overlaps the range of 100 K/sec to 10,000 K/sec as claimed in Claim 2 of the '874 patent. EX1008, ¶105. That the range disclosed in Yamamoto overlaps the range in Claim 2 is not surprising, given that both are directed to known strip casting methods. *See* EX1001, 13:45-50 ("A melt of the alloy . . . is quenched and solidified using a melt quenching apparatus such as a known strip casting apparatus. . . . [T]he cooling rate at this quenching is controlled to be in the range of 1.0×10^2 K/sec to 1.0×10^4 K/sec.").

It would have been obvious to configure Uchida's single roll strip casting to cool the rare earth alloy at the rates as disclosed in Yamamoto, also teaching a single roll strip casting method, in order to produce a uniform alloy, thereby obtaining good magnetic properties. EX1004, 2:39-49; EX1008, ¶106. Yamamoto provides motivation to control the cooling rate (EX1004, 3:56-4:4, 4:17-24), and teaches a range of cooling rate that entirely falls within the range of Claims 2 and 5 of the '874 patent. EX1008,

[3] A cooling rate of 500°C/sec and 10,000°C/sec correspond to 500 K/sec and 10,000 K/sec, respectively. EX1008, ¶106.

¶106. The benefits touted in Yamamoto would encourage a POSA to adjust the cooling range in Uchida to improve the magnetic properties as sought in the '874 patent. *Id.*

It would have been well within the capability of a POSA to implement Uchida's strip casting method with Yamamoto's cooling rates. EX1008, ¶107. It would have been obvious to combine Uchida with Yamamoto because both are directed to preparing rare earth permanent magnets by strip casting. EX1004, 6:53-55 (teaching "an alloy ingot for a permanent magnet being prepared by a strip casting method"); EX1003, 2:56 (teaching "a method for producing such rare earth permanent magnet, comprising the steps of (a) strip-casting"); EX1008, ¶107. The use of Yamamoto's cooling rate to obtain good magnetic properties would have been no more than a predictable use of known strip casting techniques, and thus obvious. *See KSR*, 550 U.S. at 417 (stating a claim is likely obvious if it is no "more than the predictable use of prior art elements according to their established functions").

Furthermore, a POSA would have reasonably expected the cooling rate of Yamamoto, which was a common cooling rate for strip casting, to successfully provide a rapidly solidified alloy sintered magnet when applied to the teachings of Uchida. EX1011, 6; EX1008, ¶108. Furthermore, Yamamoto teaches that the strip casting method using the cooling rate disclosed in Yamamoto produces "a permanent magnet which can be sintered satisfactorily during production and exhibit superior residual magnetic flux density and coercive force." EX1004, 2:46-49. Thus, Claims 2 and 5 are obvious over Uchida in light of Yamamoto. EX1008, ¶108.

Furthermore, at least Claim 2 is a product claim that is defined by the process of cooling the alloy at the claimed "cooling rate." "The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process." *In re Thorpe*, 777 F.2d 695, 698 (Fed. Cir. 1985) (citations omitted). Accordingly, Claim 2 would be obvious for the same reasons as Claim 1. EX1008, ¶108.

3. Claim 6

Claim 6 depends from Claim 5 and requires the additional limitation "wherein in the step of producing a rapidly solidified alloy the melt of the alloy is quenched by strip casting." The obviousness of Claim 5 is discussed above. *See supra* Section IX.C.2. The additional limitation is obvious because, as discussed above, both Uchida and Yamamoto teach quenching the alloy by strip casting. *See supra* Sections IX.A.2.a), IX.C.2. EX1008, ¶109.

Uchida states "[t]he 'strip-casting method' referred to in the present invention is a production method of alloy strip by injecting an alloy melt onto the surface of a cooling roll, etc. to quench the melt alloy, thereby forming alloy strip on the surface." EX1003, 5:32-34. Uchida also states that "[a]n alloy strip produced by rapidly quenching an alloy melt on a cooling surface in accordance with the strip-casting method has a fine metal structure." EX1003, 5:42-43. Thus, a POSA would have been motivated to use strip casting. EX1008, ¶110; *see supra* Section IX.B.1.a).

Yamamoto also teaches the production of a permanent magnet by strip casting. *See, e.g.,* EX1004, 2:55-67; *see also id.*, 3:65-4:2. A POSA would have been motivated to use strip casting as disclosed in Yamamoto to produce a uniform alloy, thereby obtaining good magnetic properties. EX1004, 2:39-49. EX1008, ¶111.

As such, Claim 6 would have been obvious. EX1008, ¶112.

D. Ground 4: Claim 3 Would Have Been Obvious Over Uchida in View of Kaneko I

Claim 3 is obvious over Uchida in light of Kaneko I (EX1005).

1. Disclosure of Kaneko I

U.S. Patent No. 5,788,782 ("Kaneko I," EX1005) was issued on August 4, 1998, and therefore qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA). Kaneko I was not disclosed during prosecution of the '874 patent.

Kaneko I teaches an R-Fe-B permanent magnet possessing good magnetic characteristics and using strip casting. EX1005, Abstract. Specifically, Kaneko I discloses the sectional structure of an R-Fe-B based alloy obtained by the strip casting process wherein the "main phase $R_2Fe_{14}B$ . . . crystal sizes are 0.1 micron to 50 micron in a short axial direction and 5 micron to 200 micron in a long axial direction, and the R-rich phase is finely dispersed as surrounding the main phase crystal grain, even in the locally omnipresent region." EX1005, 8:65-9:10; EX1008, ¶115.

2. Claim 3

Claim 3 depends from Claim 1. For the reasons discussed in Grounds 1 and 2, Claim 1 is anticipated and/or rendered obvious by Uchida. *See supra* Section IX.A.2 and IX.B.1. The additional limitations recited by Claim 3 are obvious in view of Kaneko I, which teaches each limitation of Claim 3 as shown in the table below. EX1008, ¶116.

Claim 3	Kaneko I
3. The rapidly solidified alloy sintered magnet of claim 1, wherein the alloy includes: $R_2F_{14}B$ compound crystal grains having a minor-axis size in a range between 0.1 μm and 10 μm and a major-axis size in a range between 5 μm and 500 μm;	Kaneko I discloses that "the main phase $R_2Fe_{14}B$ . . . crystal sizes are 0.1 μm to 50 μm in a short axial direction and 5 μm to 200 μm in a long axial direction." EX1005, 9:1-5.
and a R-rich phase exists uniformly at the grain boundaries of the crystal grains,	Kaneko I discloses that "the R-rich phase is finely dispersed as surrounding the main phase crystal grain, even in the locally omnipresent region." *Id.*, 9:6-8.
the alloy having a thickness in a range between 0.03 mm and 10 mm.	Kaneko I discloses that "[t]he resulting cast piece is a sheet whose thickness is 0.03 mm to 10 mm, through the single roll process and the double roll process are used properly depending on the desired thickness of the cast piece." *Id.*, 8:49-53.

a) "$R_2F_{14}B$ compound crystal grains having a minor-axis size in a range between 0.1 μm and 10 μm and a major-axis size in a range between 5 μm and 500 μm"

Like Uchida, Kaneko I is directed toward the manufacture of R-Fe-B-based sintered magnets by a strip casting process. EX1005, 5:10-25. Kaneko I teaches the sectional structure of an R-Fe-B based alloy obtained by the strip casting process wherein the "crystal sizes are 0.1 μm to 50 μm in a short axial direction and 5 μm to 200 μm in a long axial direction, and the R-rich phase is finely dispersed as surrounding the main phase crystal grain, even in the locally omnipresent region." *Id.*, 8:66-9:10. Thus, Kaneko I teaches the size in the long axial direction (i.e., major-axis size) that falls within the claimed "major-axis size in a range between 5 *μ*m and 500 *μ*m." EX1008, ¶117. Kaneko I further teaches the size in the short axial direction is 0.3 μm to 12 μm. EX1005, 14:59-60. Thus, the size in the short axial direction (i.e., minor-axis size) disclosed by Kaneko I overlaps with the claimed range and is not reasonably different from the claimed range. EX1008, ¶117. Furthermore, Kaneko I teaches the size in the short axial direction is 5 μm, which falls within the claimed range. EX1005, 17:46; EX1008, ¶117. As such, the claimed size in both directions are within the ranges described by Claim 3 of the '874 patent.

A POSA would have been motivated to have the crystal grain size taught by Kaneko I so that when the alloy is pulverized a fine powder is produced having a uniform grain distribution and for better magnetization and degree of orientation of the grains. EX1005, 5:47-51, 8:66-9:20; EX1008 ¶118. Kaneko I, like Uchida, covers strip casting. *See, e.g.,* EX1005, 4:20-21; EX1008 ¶118. Given Kaneko I's teachings, which are relevant to Uchida's teachings in that it covers strip casting, a POSA would be motivated to use the structure taught by Kaneko I with the alloy in Uchida for the advantages of a uniform and fine grain distribution, which is recognized by both Uchida and Kaneko I. *See, e.g.,* EX1003, 4:28-30 ("[T]he corrosion resistance is improved also by the uniform and fine grain structure."); EX1005, 4:26-27 ("[T]he powder having a uniform grain distribution can be produced, at this time, the R-rich phase is finely dispersed . . . ."); EX1008, ¶118. The grain size disclosed in Kaneko I allows "volume expansion [to] occur[] uniformly for fractionization, so that the main phase crystal grain is fractionalized by pulverization and the fine powder having a uniform grain distribution is obtained." EX1005, 9:11-15; EX1008, ¶118.

b) "a R-rich phase exists uniformly at the grain boundaries of the crystal grains"

Kaneko I teaches that "the R-rich phase is finely dispersed as surrounding the main phase crystal grain." EX1005, 9:1-7. The "finely dispersed" R-rich phase disclosed in Kaneko I "exists uniformly" as required by Claim 4, because a finely dispersed R-rich phase will be dispersed uniformly. EX1005, 8:10-11 (stating that the "Nd-rich phase are dispersed uniformly"); EX1008, ¶120. The R-rich phase that is "surrounding the main phase crystal grain" also means the R-rich phrase exists "at the grain boundaries of the crystal grains" as required by Claim 4, because "surrounding" the grain would result in being "at the grain boundaries." EX1005, 9:5-8; EX1008, ¶120.

A POSA would have been motivated to use Kaneko I's teaching of the claimed "R-rich phase [that] exists uniformly at the grain boundaries of the crystal grains" so that during hydrogenation processing, "volume expansion occurs uniformly for fractionization, so that . . . the fine powder having a uniform grain distribution is obtained." EX1005, 9:10-15; EX1008 ¶121. Given Uchida similarly teaches the benefits of a "uniform and fine grain" (EX1003, 4:28-30), a POSA would have been motivated to use Kaneko I's teachings to improve the resulting magnet's properties. EX1008, ¶121.

c) "the alloy having a thickness in a range between 0.03 mm and 10 mm"

Kaneko I describes a cast piece (i.e., an alloy strip) having a thickness of "0.03 mm to 10 mm," the exact range claimed in Claim 3 of the '874 patent. EX1005, 8:49-50. A POSA would have found it obvious to have a thickness of 0.03-10 mm as taught by Kaneko I, because Kaneko I explains the following reasons for having the disclosed thickness:

> *[W]hen the thickness is below 0.03 mm* a rapid cooling effect increases and the crystal grain size becomes smaller than 1 μm, thus easily oxidized when pulverized, which *results in deterioration of the magnetic characteristics*, and *when the thickness exceeds 10 mm*, a rapid cooling rate becomes slower, α-Fe is easily crystallized, the crystal grain size becomes larger and also the Nd-rich phase

> omnipresents, thus *the magnetic characteristics is deteriorated*.

Id., 8:56-65 (emphasis added); EX1008 ¶123. Unsurprisingly, Uchida also teaches thicknesses within the range disclosed by Kaneko I. *See, e.g.,* EX1003, 2:58 (disclosing a thickness of 1 mm or less), 9:56 (disclosing a thickness of 0.2-0.5 mm); EX1008, ¶123. A POSA would have known of the reasons for using a thickness between 0.03 and 10 mm in view of the teaching in Kaneko I. EX1008, ¶123.

Given that the claimed structure (i.e., the grain size and shape, R-rich phase structure, and alloy thickness) was known as shown by Kaneko I, and because a POSA would have been motivated to use those teachings of Kaneko I, the claimed structure would have been obvious. EX1008, ¶124. Also, given the claimed structure was known and understood, as evidenced by Kaneko I, a POSA would have had a reasonable expectation of success. EX1008, ¶124. Therefore, Claim 3 would have been obvious.

E. Ground 5: Claims 1-8 are Obvious Over Kaneko II in View of Uchida

Claims 1-8 are obvious over Kaneko II (EX1007) in view of Uchida. Ground 5 is different from the preceding grounds in that the primary reference is Kaneko II, which provides the amounts of the elements in atomic percent.

1. Disclosure of Kaneko II

Japanese Patent Application No. H07-18366 ("Kaneko II", EX1007) was published January 20, 1995, and therefore qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA). Kaneko II was disclosed during prosecution of the '874 patent, however, was not relied in any rejection or referenced in any office action.

Kaneko II teaches the manufacturing of R-Fe-B based permanent magnets that allows efficient pulverization and results in excellent oxidation resistance (corrosive resistance) and excellent magnetic properties. EX1007, Abstract. The metal alloy is a strip cast "comprising 10 atomic percent to 30 atomic percent of R (where R is at least one rare earth element including Y), 2 atomic percent to 28 atomic percent of B and the remainder of Fe (where a part of the Fe may be substituted by either or both of Co and Ni)." *Id.*, ¶0010. Kaneko II further discloses "[t]he slab of magnet material having a structure with finely separated R-rich phase of a specific composition . . . manufactured by strip casting." *Id.*, ¶ 0012; *see also* EX1008, ¶127.

2. Claim 1

Claim 1 is obvious over Kaneko II in light of Uchida. Kaneko II teaches every element of the claim as shown in the following claim chart, and Uchida further teaches using the claimed amount of Nb. EX1008, ¶128.

Claim 1	Kaneko II in view of Uchida
A rapidly solidified alloy sintered magnet having a general formula represented by $(Fe_{1-m}T_m)_{100-x-y-z}Q_xR_yM_z$	Kaneko II discloses "a method for manufacturing higher performance R-Fe-B based permanent magnet."

Claim 1	Kaneko II in view of Uchida
	EX1007, ¶0001; *see also* ¶¶ 0007, 0010, 0012, 0013, 0024, 0025, 0027, 0030, and 0033.
where T denotes at least one element selected from the group consisting of Co and Ni,	Kaneko II discloses "a molten metal alloy comprising . . . where a part of the Fe may be substituted by either or both of Co and Ni) . . . ." *Id.,* ¶0010.
Q denotes at least one element selected from the group consisting of B and C,	Kaneko II discloses "a molten metal alloy comprising . . . 2 atomic % to 28 atomic % of B . . . ." *Id.*
R denotes at least one rare earth element	Kaneko II discloses "a molten metal alloy comprising 10 atomic % to 30 atomic % of R (where R is at least one rare earth element including Y) . . . ." *Id.*
and M denotes Nb, and	Kaneko II discloses "the coercivity of the permanent magnet alloy can be increased by adding to the R-B-Fe alloy . . . 12.5 atomic % or less of Nb." *Id.*, ¶0022. Uchida discloses "[t]he content of Nb is 0.1-2.0 weight %, preferably 0.2-1.5 weight % based on the total weight of the R-Fe-B based, sintered permanent magnet." EX1003, 4:13-14.
the mole fractions x, y, z, and m respectively satisfy $2 \leqq x \leqq 28$ (atom %), $8 \leqq y \leqq 30$ (atom %), $0.1 \leqq z < 1.0$ (atom %), and $0 \leqq m \leqq 0.5$ (atom %).	Kaneko II discloses "a molten metal alloy comprising 10 atomic percent to 30 atomic percent of R (where R is at least one rare earth element including Y), 2 atomic percent to 28 atomic percent of B and the remainder of Fe (where a part of the Fe may be substituted by either or both of Co and Ni) . . . ." EX1007, ¶0010. Kaneko II discloses "[h]owever, if the amount of Co and Ni, either singly or together, exceeds 50% of Fe, a high

Claim 1	Kaneko II in view of Uchida
	coercively cannot be obtained, and a good permanent magnet cannot be obtained. Hence, the upper limit of Co is set to 50% of Fe." *Id.*, ¶0021. Kaneko II discloses that "the coercivity of the permanent magnet alloy can be increased by adding to the R-B-Fe alloy . . . . 12.5 atomic percent or less of Nb." *Id.,* ¶0022. Uchida discloses "[t]he content of Nb is 0.1-2.0 weight %, preferably 0.2-1.5 weight % based on the total weight of the R-Fe-B based, sintered permanent magnet." EX1003, 4:13-14. Uchida further teaches that "[a] content less than 0.1 weight % is insufficient for effectively preventing the anomalous growth of grains, and a content exceeding 2.0 weight % is undesirable because the residual magnetic flux density (Br) decreases due to increased amount of Nb borides." *Id.*, 4:14-16.

a) Kaneko II discloses "a rapidly solidified alloy"

Kaneko II discloses manufacturing a sintered rare earth magnet using strip casting. EX1007, ¶¶0001, 0008-0012. The strip casting method produces a rapidly solidified alloy. EX1008, ¶129. Therefore, this limitation is disclosed by Kaneko II. *See also supra* Section IX.A.2.a) (explaining that strip casting, which is disclosed by Uchida, rapidly solidifies an alloy).

b) Kaneko II discloses a "sintered magnet having a general formula represented by $(Fe_{1-m}T_m)_{100-x-y-z}Q_xR_yM_z$ where T denotes at least one element selected from the group consisting of Co and Ni, Q denotes at least one element selected from the group consisting of B and C, R denotes at least one rare earth element, and M denotes Nb"

Kaneko II teaches an R-Fe-B-based alloy comprising Fe, Co, B, Nb and a rare earth element. EX1007, at ¶0010 ("[A] molten metal alloy comprising 10 atomic % to 30 atomic % of R (where R is at least one rare earth element including Y), 2 atomic % to 28 atomic % of B and the remainder of Fe (where a part of the Fe may be substituted by either or both of Co and Ni) . . . ."). Kaneko II teaches T (i.e., Co), Q (i.e., B), R (i.e., a rare earth element), M (i.e, Nb), and Fe. *Id.*, ¶¶ 0010, 0022. Accordingly, Kaneko II discloses all claimed elements.

c) Kaneko II and Uchida disclose "mole fractions x, y, z, and m respectively satisfy $2 \leq x \leq 28$ (atom %), $8 \leq y \leq 30$ (atom %), $0.1 \leq z \leq 1.0$ (atom %), $0 \leq m \leq 0.5$ (atom %)"

Kaneko II discloses the range of atomic percent for the elements as disclosed in Claim 1. Mole fraction x requires element Q (i.e., B) to be in a quantity between 2 and 28 atomic percent. Kaneko II discloses 2-28 atomic percent of B, the exact same range as required for Q by Claim 1. *Id.*, ¶ 0010; EX1008, ¶132.

Mole fraction y requires element R (i.e., rare earth element) to be in a quantity between 8 and 30 atomic percent. Kaneko II discloses 10-30 atomic percent of at least one rare earth element, which is nearly identical and entirely falls within the claimed range for R. EX1007, ¶ 0010; EX1008, ¶133.

Mole fraction m requires the balance of the alloy is (1-m) of Fe and m of T, m is a quantity between 0 and 0.5. *See supra* Section IX.A.2.c); *see also* EX1008, ¶134. Kaneko II discloses that the remaining balance of the alloy comprises of Fe and optionally Co. EX1007, ¶0010; EX1008, ¶134. Kaneko II teaches that the amount of Co and/or Ni should not exceed 50% of Fe, and states that "the upper limit of Co is set to 50% of Fe." EX1007, ¶0021. Therefore, Kaneko II discloses the claimed range of elements Fe and T. EX1008, ¶134.

Mole fraction z requires element M (i.e., Nb) to be in a quantity between 0.1 and 1.0 atomic percent. Kaneko II discloses that "the coercivity of the permanent magnet alloy can be increased by adding . . . 12.5 atomic % or less of Nb." EX1007, ¶ 0022; EX1008, ¶135. Uchida teaches including 0.1-2.0 weight % and preferably 0.2-1.5 weight % of Nb in a similar R-Fe-B based permanent magnet. EX1003, 4:12-14; EX1008, ¶136. As discussed above in Ground 1, the range of Nb taught by Uchida corresponds to 0.07-1.33 and preferably 0.14-1.00 atomic percent, respectively. EX1008, ¶¶51, 136; *see supra* Section IX.A.2.c). Uchida explains why the amount of Nb should be controlled, stating that "[a Nb] content less than 0.1 weight % is insufficient for effectively preventing the anomalous growth of grains, and a content exceeding 2.0 weight % is undesirable because the residual magnetic flux density (Br) decreases due to increased amount of Nb borides." *Id.*, 4:14-16. In view of Uchida's teaching, a POSA would have been motivated to add

0.1-2.0 weight % and preferably 0.2-1.5 weight % of Nb in order to prevent the anomalous growth of grains while not substantially decreasing the residual magnetic flux density due to increase amount of Nb borides. EX1003, 4:14-16; EX1008, ¶137; EX1017, 1658. Moreover, a POSA would have looked to the teachings of Uchida in improving the permanent magnet of Kaneko II, because both provide applications for producing permanent rare earth magnets using the strip casting method, and have similar ranges for the elements used. *See, e.g.,* EX1003, Abstract; EX1007, ¶ 0022; EX1008, ¶137. Given the similarities of the subject matter of Kaneko II and Uchida, a POSA would have been encouraged by Uchida to adjust the Nb range to improve the magnet properties as explained in Uchida. *Id.*

d) Reasonable Expectation of Success

A POSA would have had a reasonable expectation of success in combining the teachings of Uchida with Kaneko II, given that Kaneko II and Uchida both provide applications for producing permanent rare earth magnets using the strip casting method, and have similar ranges for the elements used. EX1008, ¶138. A POSA would have been able to combine these well-known classes of elements in known amounts to create a sintered magnet according to known principles and techniques, and would have expected to obtain the claimed rapidly solidified alloy sintered magnet with a reasonable expectation of success. EX1008, ¶138.

As such, Claim 1 of the ’874 patent would have been obvious.

3. Claim 4

Claim 4 recites similar limitations as Claim 1. Thus the same rationale for the obviousness of Claim 1 over Kaneko II in view of Uchida applies to the similar composition limitations of Claim 4. *See supra* Section IX.E.2. The recited steps of Claim 4 are also disclosed in Kaneko II and Uchida. EX1008, ¶140.

Claim 4	Kaneko II in view of Uchida
A method for manufacturing a rare earth sintered magnet, comprising the steps of: producing a rapidly solidified alloy by quenching and solidifying a melt of an alloy having a general formula represented by $(Fe_{1-m}T_m)_{100-x-y-z}Q_xR_yM_z$	Kaneko II discloses "a method for manufacturing higher performance R-Fe-B based permanent magnet. A molten metal alloy whose main components are R, Fe and B is strip cast using a single-roller method . . . the powder is compacted and sintered to provide a high-performance R-Fe-B based permanent magnet." EX1007 ¶0001; *see also*, ¶¶0007, 0010, 0012, 0013, 0024, 0025, 0027, 0030, and 0033. *See also* EX1003, 2:56-58; *see also id.*, Claim 1, Abstract, 5:31-34, 5:42-45.
where T denotes at least one element selected from the group consisting of Co and Ni,	Kaneko II discloses "a molten metal alloy comprising . . . the remainder of Fe (where a part of the Fe may be substituted by either or both of Co and Ni)." *Id.*, ¶0010.
Q denotes at least one element selected from the group consisting of B and C,	Kaneko II discloses "a molten metal alloy comprising . . . 2 atomic percent to 28 atomic percent of B . . . ." *Id.*
R denotes at least one rare earth element	Kaneko II discloses "a molten metal alloy comprising 10 atomic percent to 30 atomic percent of R (where R is at least one rare earth element including Y) . . . ." *Id.*

Claim 4	Kaneko II in view of Uchida
and M denotes Nb,	Kaneko II discloses "the coercivity of the permanent magnet alloy can be increased by adding . . . 12.5 atomic percent or less of Nb." *Id.*, ¶0022.
and the mole fractions x, y, z, and m respectively satisfy 2≦x≦28 (atom %), 8≦y≦30 (atom %), 0.1≦z<1.0 (atom %), and 0≦m≦0.5 (atom %);	Kaneko II discloses "a molten metal alloy comprising 10 atomic percent to 30 atomic percent of R (where R is at least one rare earth element including Y), 2 atomic percent to 28 atomic percent of B and the remainder of Fe(where a part of the Fe may be substituted by either or both of Co and Ni)." *Id.*, ¶0010. Kaneko II discloses "[h]owever, if the amount of Co and Ni, either singly or together, exceeds 50% of Fe, a high coercively cannot be obtained, and a good permanent magnet cannot be obtained. Hence, the upper limit of Co is set to 50% of Fe." *Id.*, ¶0021. Kaneko II discloses "the coercivity of the permanent magnet alloy can be increased by adding . . . 12.5 atomic percent or less of Nb." *Id.*, ¶0022. Uchida discloses "[t]he content of Nb is 0.1-2.0 weight %, preferably 0.2-1.5 weight % based on the total weight of the R-Fe-B based, sintered permanent magnet." EX1003, 4:13-14. Uchida further teaches that "[a] content less than 0.1 weight % is insufficient for effectively preventing the anomalous growth of grains, and a content exceeding 2.0 weight % is undesirable because the residual magnetic flux

Claim 4	Kaneko II in view of Uchida
	density (Br) decreases due to increased amount of Nb borides." *Id.*, 4:14-16.
producing a powder of the rapidly solidified alloy, and	Kaneko II paragraph 0001 discloses "a method for manufacturing higher performance R-Fe-B based permanent magnet. A molten metal alloy whose main components are R, Fe and B is strip cast using a single-roller method . . . . The ability of Fe alloy containing R to absorb H_2 is used to spontaneously disintegrate the slab, and this is followed by dehydrogenation for stabilization to allow efficient fine pulverization . . . the powder is compacted and sintered to provide a high-performance R-Fe-B based permanent magnet." EX1007, ¶0001, *see also* ¶¶0007, 0010, 0012, 0013, 0024, 0025, 0027, 0030, and 0033). *See also* EX1003, 2:56-3:4.
manufacturing a permanent magnet by sintering the powder of the rapidly solidified alloy.	Kaneko II discloses "a method for manufacturing higher performance R-Fe-B based permanent magnet. A molten metal alloy whose main components are R, Fe and B is strip cast using a single-roller method . . . the powder is compacted and sintered to provide a high-performance R-Fe-B based permanent magnet." EX1007, ¶0001; *see also*, ¶¶0005, 0007, 0010, 0012, 0013, 0024, 0025, 0027, 0030, and 0033). *See also* EX1003, 2:56-3:4.

Kaneko II discloses producing a powder of the strip casted R-Fe-B based alloy and then sintering the powder to produce a rare earth permanent magnet. EX1007,

¶0001; EX1008, ¶141. Kaneko II recites "[t]he ability of Fe alloy containing R to absorb H_2 is used to spontaneously disintegrate the slab, and this is followed by dehydrogenation for stabilization to allow efficient fine pulverization . . . the powder is compacted and sintered to provide a high-performance R-Fe-B based permanent magnet." EX1007, ¶0001. In addition, Uchida also teaches the same limitations, showing the obviousness of the claimed steps. *See supra* Section IX.A.3. Thus, the combination of Kaneko II and Uchida discloses all of the elements of Claim 4. EX1008, ¶141.

Given the claimed steps are well-known and standard techniques used for creating a rare earth sintered magnet, including such magnets with the claimed elements, a POSA would have had reasonable expectation of success. EX1008, ¶142. As such, Claim 4 would have been obvious.

4. Claims 2 and 5

Claim 2 depends from Claim 1 and requires "the cooling rate at which a melt of the material rare earth alloy is quenched to produce the rapidly solidified alloy is in a range of 10^2 K/sec to 10^4 K/sec." *See supra* p. 35 (explaining that Claim 2 should not be given patentable weight). Claim 5 depends from Claim 4 and requires a similar limitation to Claim 2.

Kaneko II discloses strip casting an alloy using a single-roller or twin-roller method for rapid cooling.

> The slab of magnet material . . . is manufactured by strip casting a molten metal alloy of a specific composition using a single-roller or twin-roller method. . . . The slab thickness is limited to 0.03 to 10 mm because at less than 0.03 mm, the rapid cooling effect becomes strong . . . . If the thickness exceeds 10 mm, the cooling speed slows, inviting α-Fe to crystallize, crystal grain diameter to grow, and an Nd-rich phase to segregate, which is undesirable since magnetic properties degrade.

EX1007, ¶ 0012. It would have been obvious for a POSA to use a cooling rate that was known for the type of alloy that is disclosed by Kaneko II, which a POSA would have known overlaps with the claimed range of 10^2 K/sec to 10^4 K/sec. EX1008, ¶145; EX1004, 2:55-67; EX1011, 6. Further, a POSA would have been motivated to control the cooling rate to achieve a suitable permanent magnet. EX1008, ¶145; EX1004, 3:19-20, 4:17-24. Furthermore, the result of using the known cooling rate in Kaneko II's strip casting method would have been predictable and thus a POSA would have had a reasonable expectation of success. EX1008 at ¶145. Thus, Claims 2 and 5 would have been obvious. *Id.*

5. Claim 3

The additional limitation of Claim 3, which require certain crystal grain sizes, R-rich phase properties, and alloy thickness, are also obvious over the teachings of at least Kaneko II.

a) Kaneko II discloses "$R_2F_{14}B$ compound crystal grains having a minor-axis size in a range between 0.1 μm and 10 μm and a major-axis size in a range between 5 μm and 500 μm"

Kaneko II discloses a rare earth alloy comprising $R_2Fe_{14}B$ where the crystal grains are 0.1-50 μm in a minor-axis size and 5-200 μm in a major-axis size. EX1007, ¶0013; EX1008, ¶147. Specifically, Kaneko details a structure of an R-Fe-B alloy obtained by the strip casting process that has a "main phase of $R_2Fe_{14}B$ crystals . . . having, for example, a dimension in the minor-axis direction of 0.1 to 50 μm and a dimension in the major-axis direction of 5 to 200 μm." *Id.*, ¶0013. The ranges in Kaneko II overlap the ranges recited in Claim 3 of the '874 patent. EX1008, ¶147. Accordingly, this limitation would have been obvious.

b) Kaneko II discloses "a R-rich phase exists uniformly at the grain boundaries of the crystal grains"

Kaneko II teaches that an R-rich phase is finely dispersed at the crystal grains. EX1007, ¶¶0007, 0013; EX1008, ¶148. Specifically, Kaneko II discloses "[t]he R-rich phase is finely scattered and surrounds the crystal grains of the main phase crystal." EX1007, ¶0013. Therefore, Kaneko II discloses this limitation. EX1008, ¶148.

c) Kaneko II discloses "the alloy having a thickness in a range between 0.03 mm and 10 mm"

Kaneko II describes an alloy having a thickness in the exact range as claimed in Claim 3 of the '874 patent. EX1007, ¶0010; EX1008, ¶149. Kaneko II teaches that the "slab thickness is limited to 0.03 to 10 mm" to avoid oxidation and Nd-rich phase segregation. EX1007, ¶0012; EX1008, ¶149. Therefore, this limitation is disclosed by Kaneko II.

Given the claimed structure was commonly utilized, as evidenced by Kaneko II, a POSA would have had a reasonable expectation of success. EX1008, ¶150; *see also* EX1005, 8:49-53, 9:1-8. Accordingly, Claim 3 would have been obvious. EX1008, ¶150.

6. Claim 6

Claim 6 depends from Claim 5 and requires "the step of producing a rapidly solidified alloy the melt of the alloy is quenched by strip casting." Kaneko II discloses "[a] molten metal alloy whose main components are R, Fe and B is strip cast using a single-roller method." EX1007, ¶ 0001; *see also id.*, ¶¶ 0007, 0010, 0012, 0013, 0024, 0025, 0027, 0030, and 0033. In addition, Petitioner points to Section IX.C.3 for a showing of Uchida teaching the same limitation. Thus, the Claim 6 would have been obvious. EX1008, ¶152; *see also supra* Section IX.B.1.a) (discussing obviousness of strip casting to rapidly solidify an alloy).

7. Claim 7

Claim 7 depends from any one of Claims 4 to 6. As recited above, the combination of Kaneko II and Uchida disclose all the limitations of Claim 4. Kaneko II discloses the claimed step of "embrittling the rapidly solidified alloy by allowing the rapidly solidified alloy to occlude hydrogen and then release the hydrogen" by disclosing embrittling by occluding hydrogen and dehydrogenating the rare earth alloy. *See, e.g.,* EX1007, ¶0007; EX1008, ¶154. In addition, Petitioner points to Section IX.A.4 for a showing of Uchida teaching the same limitation. Thus, Claim 7 would have been obvious. EX1008, ¶154.

8. Claim 8

Claim 8 depends from Claim 4 and requires "the step of grinding the permanent magnet." Uchida describes machining the rare earth permanent magnet to an appropriate shape and structure. EX1003, 6:45-46, 7:18-22. As discussed for Ground 2, a POSA would have known that "grinding the permanent magnet" is a common machining process, thus, Claim 8 would have been obvious. EX1008, ¶156; *see supra* Section IX.B.4.

F. Objective Indicia of Non-Obviousness

Although objective indicia of non-obviousness must be taken into account in the obviousness calculus,[4] they do not necessarily control the obviousness conclusion. *Newell Cos., Inc. v. Kenney Mfg. Co.*, 864 F.2d 757, 768 (Fed. Cir.

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[4] Objective indicia have no relevance to the anticipation analysis of Ground 1, because they are only relevant to the obviousness inquiry. *Bristol-Myers Squibb Co. v. Ben Venue Labs.*, 246 F.3d 1368, 1380 (Fed. Cir. 2001).

1988). A strong case of obviousness, such as the instant one, cannot be overcome by objective evidence of non-obviousness. *See Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1372 (Fed. Cir. 2008); *Hoffmann-La Roche Inc. v. Apotex Inc.*, 748 F.3d 1326, 1334 (Fed. Cir. 2014). To the extent Hitachi asserts an objective indicia in this proceeding, detailed consideration of Hitachi's evidence should not be undertaken until Petitioner has had an opportunity to respond to Hitachi's position. *Amneal Pharms., LLC v. Supernus Pharms., Inc.*, IPR2013-00368, Paper 8, pp. 12-13 (P.T.A.B. Dec. 17, 2013).

1. No Unexpected Results Over the Closest Prior Art

Allegations of unexpected results are insufficient to rebut a strong *prima facie* case of obviousness. During prosecution, the Applicant made several statements regarding the alleged improvements of the invention. As explained below, none of them are unexpected in light of the prior art, because the alleged improvements were to be expected if anything.

During prosecution, Applicant alleged that it discovered that the conventional amount of Nb caused hardening of the permanent magnet, making machining the permanent magnet difficult. EX1002, 6; *see also* EX1001, 1:33-36 (the '874 patent stating that the alleged problem of having too much Nb is that "a nonmagnetic boride such as $NbFeB_2$ tends to be produced in a coarse grain state," which in turn causes the resultant rare earth magnet to be "hardened after sintering"). This exact effect—

the increased production of borides with an increasing amount of Nb—was taught by Uchida. EX1003, 4:15-16. Further, rare earth permanent magnets were known to be hard and the increased hardness as a result of increased amounts of metal borides was also known. EX1008, ¶157; EX1022, 65 (teaching that rare earth permanent magnets are hard and Nd-Fe-B magnets to be rather tougher); EX1018, 1:21-23 ("As a class, the metal borides are characterized in their physical properties by their high melting points, extreme hardness . . . ."). Accordingly, the alleged discovery was a known property of borides and cannot be the basis of any allegation of unexpected result. EX1008, ¶157.

The '874 patent also purports to have discovered that the use of strip casting results in a more uniform alloy structure. *Id.,* 2:61-67. This too was known property of strip casting, thus could not be the basis of any alleged discovery. EX1005, 3:34-40 (teaching that strip casting produces a homogenous composition); EX1008, ¶¶24, 161. Accordingly, this property cannot be the basis of any allegation of unexpected results either.

Applicant also asserted that the claimed range of Nb exhibited a "dramatic improvement in coercive force (FIG. 1) while exhibiting a hardness which result[ed] in a low grinding resistance." EX1002, 8; *see also id.*, EX1001, 7:1-5. To the extent this argument is alleging unexpected results, this argument also carries no weight in light of the prior art's teachings, which shows these effects of Nb were already known and to be expected. EX1008, ¶¶158-59. For example, Kaneko II discloses that by adding Nb "the coercivity of the permanent magnet alloy can be increased." EX1007, ¶0022; *see also* EX1017, 1658. A POSA would have known that if you have too little Nb, which increases coercivity, you will not have enough coercivity. EX1008, ¶159. Similarly, Uchida discloses that adding too much Nb is "undesirable because the residual magnetic flux density decreases due to increased amount of Nb borides." EX1003, 4:12-17. Again, a POSA would have known that too much Nb causes an increase in Nb borides, which in turn was known to cause a decrease in residual magnetic flux density and increase in hardness. EX1008, ¶159; *see also* EX1018, 1:21-23. Thus, a POSA would have expected the alleged effects. EX1008, ¶¶158-59. Furthermore, any alleged effect would have been nothing more than a latent property of an otherwise obvious composition, which cannot rebut obviousness. *In re Baxter Travenol Labs*., 952 F.2d 388, 392 (Fed. Cir. 1991) ("Mere recognition of latent properties in the prior art does not render nonobvious an otherwise known invention."); *Santarus, Inc. v. Par Pharm., Inc.*, 694 F.3d 1344, 1354 (Fed. Cir. 2012).

Additionally, although the Applicant asserted a "dramatic improvement in coercive force," the data presented in the '874 patent do not show a significant difference. EX1008, ¶160. For example, the change of coercive force observed in Table 1, which contains samples 2-5 that are allegedly covered by the purported invention (EX1001, 5:59-67, 6:30-43), is 534.8 A/m. EX1008, ¶160. This difference, is not a significant difference in coercive force when considered in light that the coercive force observed in the ’874 patent are very low and not practical for a permanent magnet. *See, e.g.,* EX1016, 1 (disclosing rare earth permanent magnets with a coercive force in the range of 1,000,000 A/m); EX1008, ¶160. The alleged “dramatic improvement” is based on a difference that is relatively small in magnitude, but have been exaggerated to be significant by showing it on a small scale. *Id.* At best, the alleged difference is one of degree and not of kind, which is insufficient to show unexpected results. *In re Harris*, 409 F.3d 1339, 1344 (Fed. Cir. 2005).

X. CONCLUSION

For the foregoing reasons, *inter partes* review of Claims 1-8 of the ’874 patent is requested.

Respectfully Submitted,

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CERTIFICATION OF WORD COUNT

Pursuant to 37 C.F.R. §§ 42.24, the undersigned certifies that the argument section of this Petition (Sections I–II, V–X) has 13,796 words, less than 14,000 words, according to the word count tool in Microsoft Word™.

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CERTIFICATION OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e), 42.8(b)(4) and 42.105, the undersigned certifies that on the 24th day of April 2017, a complete copy of the foregoing Petitioner's Petition for *Inter Partes* Review of U.S. Patent No. 6,527,874, Power of Attorney, Exhibit List, and all supporting exhibits were served via UPS® to the Patent Owner by serving the correspondence address of record for the '874 patent:

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