UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/943,069	11/17/2015	Georgy Samsonidze	1576-1826	9125

10800 7590 12/20/2019

Maginot, Moore & Beck LLP
One Indiana Square, Suite 2200
Indianapolis, IN 46204

EXAMINER
CHERN, CHRISTINA

ART UNIT	PAPER NUMBER
1721	

MAIL DATE	DELIVERY MODE
12/20/2019	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte GEORGY SAMSONIDZE and BORIS KOZINSKY

Appeal 2019-001943
Application 14/943,069
Technology Center 1700

Before ROMULO H. DELMENDO, CHRISTOPHER L. OGDEN, and MERRELL C. CASHION, JR., *Administrative Patent Judges*.

DELMENDO, *Administrative Patent Judge*.

DECISION ON APPEAL

The Appellant[1] appeals under 35 U.S.C. § 134(a) from the Primary Examiner's final decision to reject claims 1, 2, 6, 7, 10–13, and 19–21.[2] Claim 22 was also finally rejected (Final Act. 3), but was subsequently

---

[1] We use the word "Appellant" to refer to "applicant" as defined in 37 C.F.R. § 1.42—namely, Robert Bosch GmbH, which is also identified as the real party in interest (Appeal Brief filed October 29, 2018 ("Appeal Br.") at 2). Also, according to the Specification (Specification filed November 17, 2015 ("Spec."), ¶ 1), the "invention was made with government support under DE-EE0004840 awarded by the Department of Energy - Office of Energy Efficiency and Renewable Energy" and "[t]he government has certain rights in the invention."

[2] *See* Appeal Br. 5–19; Reply Brief filed January 2, 2019 ("Reply Br.") at 2–10; Final Office Action entered June 13, 2018 ("Final Act.") at 3–15; Examiner's Answer entered November 23, 2018 ("Ans.") at 3–14.

canceled (Supplemental Advisory Action entered November 1, 2018 (entering an Amendment filed October 18, 2018)). We have jurisdiction under 35 U.S.C. § 6(b).

We reverse.

I. BACKGROUND

The subject matter on appeal relates to a thermoelectric generator including semiconductor legs formed of a specified alloy having a stable half-Heusler structure and to a vehicle containing such a generator (Specification filed ("Spec.") ¶¶ 9, 14). According to the Inventors, a vehicle exhaust having a thermoelectric generator operates under the Seebeck principle to convert heat energy represented by a temperature difference between exhaust gas on a hot side and coolant on a cold side into electrical energy, which may then be used to power electrical components in the vehicle, charge the vehicle's battery, or power the vehicle's drivetrain (*id.* ¶ 6).

Representative claim 1 is reproduced from the Claims Appendix to the Appeal Brief, as follows:

> 1. A thermoelectric generator comprising:
> a hot side heat exchanger;
> a cold side heat exchanger;
> a plurality of n-type semiconductor legs arranged between the hot side heat exchanger and the cold side heat exchanger; and
> a plurality of p-type semiconductor legs arranged between the hot side heat exchanger and the cold side heat exchanger and alternating electrically in series with the plurality of n-type semiconductor legs,
> wherein at least one of the plurality of n-type semiconductor legs and the plurality of p-type semiconductor legs is formed of an alloy having a stable half-Heusler structure

> and ***comprising Si and Sn with molar fractions of x Sn and 1-x Si, and x is less than 0.5***.

(Appeal Br. 20 (emphasis added)). Claim 6, the only other independent claim, is directed to a vehicle with an exhaust system including the same thermoelectric generator specified in claim 1 (*id.* at 21).

II. REJECTIONS ON APPEAL

The claims on appeal stand rejected under 35 U.S.C. § 103, as follows:

A. Claims 1, 2, 10–13, and 19 as unpatentable over Ono et al.[3] ("Ono") in view of Liu et al.[4] ("Liu");

B. Claims 6, 7, and 21 as unpatentable over Ono in view of Liu, and further in view of Winckler;[5] and

C. Claims 1, 10, 11, 19, and 20 as unpatentable over Liu in view of Ono.

III. DISCUSSION

1. The Examiner's Position

The Examiner finds that Ono describes a thermoelectric generator having most of the limitations recited in claim 1, including an alloy having a stable half-Heusler structure such as NbCoSn, wherein the Sn may be partially replaced with Sb such that the molar fractions are *x* Sn and 1-*x* Sb, wherein *x* is less than 0.5 (Final Act. 3). The Examiner acknowledges, however, that Ono does not disclose the presence of Si in the structure such

[3] US 2004/0261833 A1, published December 30, 2004.

[4] US 2010/0163091 A1, published July 1, 2010.

[5] US 3,020,325, issued February 6, 1962.

that the molar fractions of Sn and Si are *x* Sn and 1-*x* Si, wherein *x* is less than 0.5 (*id.* at 4). To resolve this difference, the Examiner relies on Liu (*id.*). Specifically, the Examiner finds that Liu, which the Examiner considers as analogous art to Ono, teaches a half-Heusler structure such as TiNiSn in which Sn can be partially replaced with Si or Sb (*id.*). Based on these findings, the Examiner concludes:

> Since the prior art of Liu recognizes the equivalency of substituting tin with either silicon or antimony in the field of half-Heusler thermoelectric alloys, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to replace the antimony of Ono with the silicon of Liu as it is merely the selection of a functionally equivalent Group IV element recognized in the art and one of ordinary skill in the art would have a reasonable expectation of success in doing so.

(*Id.*).

2. The Appellant's Contentions

The Appellant contends that the Examiner "has failed to clearly articulate the reasons for obviousness, and has therefore not established a *prima facie* case of obviousness" (Appeal Br. 5). Pointing out that, in claim 1, the molar fraction of Sn, relative to the molar fraction of Si, must be less than 0.5—i.e., "*x* is less than 0.5"—the Appellant argues that "[n]one of the prior art references teach or suggest a half-Heusler silicon-tin alloy that has more silicon [Si] than tin [Sn]" (*id.* at 6). Specifically, the Appellant urges that "Ono recognizes that doping the tin alloy with a *small percentage* of antimony can improve the electrical conductivity of the resulting alloy," as disclosed in Ono's working examples in which the Sb doping levels were 0%, 1%, or 2%, but Ono teaches away from replacing more than 50% of Sn

with Sb by disclosing that replacing large quantities of Sn with Sb adversely affects the alloy's properties (*id.* at 8–10 (citing, e.g., Ono ¶¶ 34, 54–70)).

The Appellant further argues that the Examiner's obviousness rationale based on substituting a portion of Sn with either Si or Sb as equivalent elements is flawed because Liu "merely indicating that silicon and antimony are two elements that may be substituted for tin in Liu does not establish that the properties of such a modification would be the same in any alloy" such as that disclosed in Ono (Appeal Br. 11). The Appellant points out that Sb (Group V) has one more valence electron than Sn (Group IV), whereas Si (Group IV) has the same number of valence electrons as Sn (*id.*). According to the Appellant, an obviousness rationale based on substitution of one element for another is permissible only when the substitution would be expected to provide a predictable result but "since the results of modifying Ono to replace the antimony doping agent with silicon would not have been predictable, Ono and Liu cannot be combined so as to establish a *prima facie* case of obviousness with respect to claim 1" (*id.* at 12).

3. Opinion

We agree with the Appellant that the Examiner's rejection fails to articulate a sufficient reason to support a conclusion that a person having ordinary skill in the art would have combined Ono and Liu in the manner as recited in claim 1. *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006) (cited in *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007)).

Ono describes a thermoelectric conversion material that includes a half-Heusler alloy represented by the formula QRL, wherein Q is at least one element selected from group 5 elements V, Nb, and Ta, R is at least one

element selected from Co, Rh, and Ir, and L is at least one element selected from Sn and Ge (Ono ¶¶ 2, 32). Ono teaches that the alloy's physical properties may be controlled by substituting the atoms and slightly changing the state in the vicinity of the Fermi level in order to increase the Seebeck coefficient and reduce the electric resistivity (*id.* ¶ 33). Specifically, Ono teaches that "when part of the element L is substituted by an element Z (Z=Sb, In) and doped with a carrier, that is, when the foregoing formula is $QR(L_{1-p}Z_p)$, where $0<p<0.5$, its electricity transport phenomenon can be controlled" (*id.*). According to Ono, an appropriate amount of L to be substituted with Z is ***less than*** 50 atomic% and "[w]hen the amount of the dope exceeds 50 at %, the material becomes like a metal rather than like a semiconductor, ***and good thermoelectric performance cannot be obtained***" (*id.* ¶ 34 (emphasis added)).

Liu teaches that Si and Sb are interchangeable in the context of partially replacing Sn in a specific half-Heusler alloy having a composition defined by $A_{1-x}B_x$, where A is a half-Heusler thermoelectric material represented by the formula $(Ti_{a1}Zr_{b1}Hf_{c1})_{1-y-z}Ni_ySn_z$, wherein $0<a1<1$, $0<b1<1$, $0<c1<1$, $a1+b1+c1=1$, $0.25\leq y\leq 0.35$, and $0.25\leq z\leq 0.35$, and B represents at least one element selected from C, O, and N (Liu ¶¶ 28–31, 38). Liu does not disclose or suggest using other types of alloys, such as an alloy that is similar to that disclosed in Ono.

Because Liu's materials are not sufficiently similar to those disclosed in Ono, we agree with the Appellant (Appeal Br. 11) that the Examiner's proposed combination of Ono with Liu lacks the requisite showing of predictable results to support a conclusion that a person having ordinary skill in the art would have substituted Ono's Sb dopant with Liu's Si as a matter

of "mere substitution of one element for another known in the field." *KSR*, 550 U.S. at 416.

Moreover, consistent with the Appellant's position (Appeal Br. 6), the quantity of Z (e.g., Sb) relative to Sn in Ono is neither equal to nor greater than the quantity of Sn—i.e., Z must be less than 50% relative to Sn. Hence, even assuming that a person having ordinary skill in the art would have considered Si to be interchangeable with Sb as Ono's Z, the quantity of Si in Ono would never be greater than 50% relative to Sn, as required by claim 1. Contrary to the Examiner's position, Ono does not say "that the amount of tin to be substituted by antimony in the half-Heusler alloy NbCoSn can be equal to 0.5 (or 50 at %)" (Ans. 3). As we found above, Ono teaches that the amount of substitution must be less than 50 at % (Ono ¶ 34). Thus, the Examiner's reliance on *Titanium Metals Corp. of America v. Banner*, 778 F.2d 775, 783 (Fed. Cir. 1985), which held that a prima facie case of obviousness was established where a claimed alloy had constituent metal proportions sufficiently close to a specifically disclosed prior art alloy, is misplaced.

Indeed, Ono discloses using only small amounts of Sb dopant[6] (0%, 1%, or 2%) in the working examples (e.g., Ono ¶ 63 (Table 1)) and explicitly teaches away from using an amount of dopant (e.g., Z=Sb) exceeding 50 atomic % because "good thermoelectric performance cannot be obtained" (Ono ¶ 34). *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994)

[6] Although the Examiner alleges that Ono's Sb is not a dopant (Ans. 5), that allegation is directly contradicted by Ono's explicit teachings that Sb is in fact a dopant (e.g., Ono ¶ 63; *see also id.* ¶ 34 (disclosing the alloy's formula as $QR(L_{1-p}Z_p)$ after doping with a carrier).

("[I]n general, a reference will teach away if it suggests that the line of development flowing from the reference's disclosure is unlikely to be productive of the result sought by the applicant.").

For these reasons, we do not sustain the Examiner's rejection of claim 1. Because the contested limitations highlighted in reproduced claim 1 above are also recited in claim 6, the only other independent claim on appeal, we reverse the rejection of all other claims for the same reasons given for claim 1.

IV. CONCLUSION

In summary:

Claims Rejected	35 U.S.C. §	Reference(s)/ Basis	Affirmed	Reversed
1, 2, 10–13, 19	103	Ono, Liu		1, 2, 10–13, 19
6, 7, 21	103	Ono, Liu, Winckler		6, 7, 21
1, 10, 11, 19, 20	103	Liu, Ono		1, 10, 11, 19, 20
Overall Outcome				1, 2, 6, 7, 10–13, 19–21

REVERSED