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Paper No. 38
Entered: June 22, 2018

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GENERAL ELECTRIC COMPANY,
Petitioner,

v.

UNITED TECHNOLOGIES CORPORATION,
Patent Owner.

Case IPR2017-00428
Patent 8,695,920 B2

Before HYUN J. JUNG, MITCHELL G. WEATHERLY, and GEORGE R. HOSKINS, *Administrative Patent Judges*.

HOSKINS, *Administrative Patent Judge*.

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

I. INTRODUCTION

General Electric Company ("Petitioner") filed a Petition (Paper 1, "Pet.") to institute an *inter partes* review of claims 1–4, 7–14, 17, and 19 of U.S. Patent No. 8,695,920 B2 ("the '920 patent"). Subsequently, United Technologies Corporation ("Patent Owner") filed with the Office a disclaimer of claims 1–4, 7, 8, 17, and 19 of the '920 patent, as well as a Preliminary Response (Paper 6, "Prelim. Resp."). *See* Ex. 2016; Prelim. Resp. 8.

We then instituted a trial as to the remaining challenged claims 9–14.[1] Paper 8 ("Inst. Dec."). During the trial, Patent Owner filed with the Office a disclaimer of claim 9 of the '920 patent, as well as a Response (Paper 16, "PO Resp."). *See* Ex. 2028; PO Resp. 1 n.1. Petitioner filed a Reply (Paper 22, "Pet. Reply"). An oral hearing was held on March 1, 2018, and a copy of the transcript has been entered into the record (Paper 37, "Tr.").

We have jurisdiction under 35 U.S.C. § 6. This Decision is a Final Written Decision under 35 U.S.C. § 318(a) as to the patentability of claims 10–14 of the '920 patent. Based on the record before us, Petitioner has not shown, by a preponderance of the evidence, that claims 10–14 are unpatentable.

[1] The present proceeding was not affected by the later decision in *SAS Institute, Inc. v. Iancu*, 138 S. Ct. 1348 (2018). We instituted review of all challenged claims which had not been disclaimed (claims 9–14), on the sole ground of unpatentability presented in the Petition for those claims. *See also* 37 C.F.R. § 42.107(e) ("No *inter partes* review will be instituted based on disclaimed claims.").

II. BACKGROUND

A. Related Proceedings

The parties have identified other IPR proceedings as related matters to the present proceeding. Pet. 1–2; Paper 4, 2. The other proceedings include IPR2017-00431, filed on the same day as the present proceeding, to challenge the same '920 patent. In the '431 IPR, we instituted a trial only as to claim 9 of the '920 patent on the same day the present trial was instituted, but as indicated above Patent Owner subsequently disclaimed claim 9. *See* '431 IPR, Papers 8, 16. Accordingly, on December 19, 2017, we entered a Judgment and Final Written Decision against Patent Owner in the '431 IPR. *See* '431 IPR, Paper 21.

B. The '920 Patent

The '920 patent concerns a gas turbine engine incorporating a "low stage count" low pressure turbine, for example, three to six stages. Ex. 1001, Title, 1:40–52. Figure 1B of the '920 patent is reproduced below:

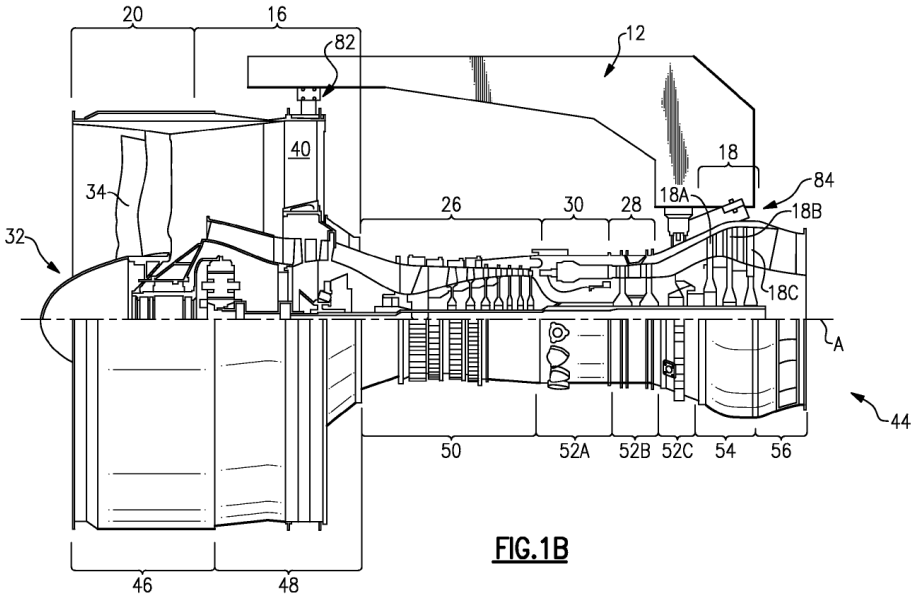

FIG.1B

Figure 1B is a general sectional view through a gas turbine engine, including fan section 20 for directing an air stream through the engine. *Id.* at 3:1–2, 5:14–16. A core portion of the airstream powers the engine by passing through, in sequence, low pressure compressor 16, high pressure compressor 26, combustor 30, high pressure turbine 28, and low pressure turbine 18. *Id.* at 3:36–46, 3:66–4:12. A bypass portion of the airstream provides thrust by flowing around the engine core to exit at fan nozzle exit area 44. *Id.* at 4:28–43.

Figure 1A of the '920 patent is reproduced below:

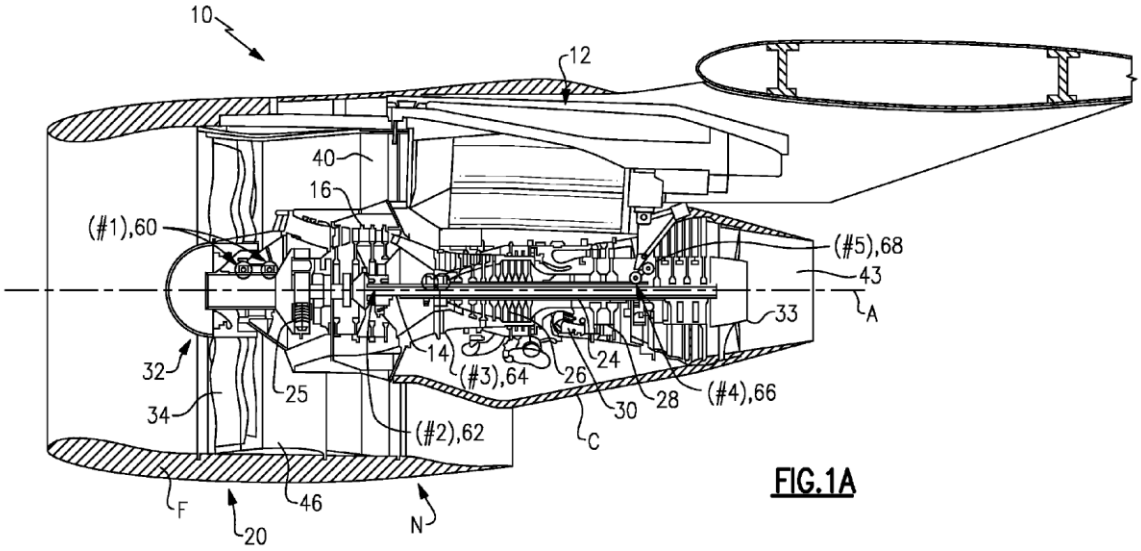

FIG.1A

Figure 1A is a general schematic sectional view of the engine, illustrating low spool 14 including low pressure compressor 16 and low pressure turbine 18,[2] and high spool 24 including high pressure compressor 26 and high pressure turbine 28. *Id.* at 3:36–46. Low spool 14 drives fan section 20 through gear train 25. *Id.* at 3:39–41.

[2] Reference numeral 18 does not appear in Figure 1A. Nonetheless, in comparison with Figure 1B, it is apparent that low pressure turbine 18 is illustrated in Figure 1A between, roughly, #5 bearing 68 and tail cone 33.

C. '920 Patent Claims on Trial

The '920 patent issued with twenty claims. Ex. 1001, 7:42–8:62. As discussed above, the claims remaining in the present trial are claims 10–14. Each of those claims depends, directly or indirectly, from independent claim 9, which has been disclaimed by Patent Owner. Claims 9–14 are each reproduced here:

> 9. A method of designing a gas turbine engine comprising:
>
> providing a core nacelle defined about an engine centerline axis;
>
> providing a fan nacelle mounted at least partially around said core nacelle to define a fan bypass flow path for a fan bypass airflow;
>
> providing a gear train within said core nacelle;
>
> providing a first spool along said engine centerline axis within said core nacelle to drive said gear train, said first spool includes a first turbine section including between three–six (3–6) stages, and a first compressor section;
>
> providing a second spool along said engine centerline axis within said core nacelle, said second spool includes a second turbine section including at least two (2) stages and a second compressor section;
>
> providing a fan including a plurality of fan blades to be driven through the gear train by the first spool, wherein the bypass flow path is configured to provide a bypass ratio of airflow through the bypass flow path divided by airflow through the core nacelle that is greater than about six (6) during engine operation.
>
> 10. The method as recited in claim 9, wherein said first turbine section defines a pressure ratio that is greater than about five (5.0).
>
> 11. The method as recited in claim 10, wherein a fan pressure ratio across the plurality of fan blades is less than about 1.45.
>
> 12. The method as recited in claim 11, wherein the gear train is configured to provide a speed reduction ratio greater than about 2.5:1.

13. The method as recited in claim 12, wherein the plurality of fan blades are configured to rotate at a fan tip speed of less than about 1150 feet/second during engine operation.

14. The method as recited in claim 13, wherein the second turbine section includes two (2) stages.

Ex. 1001, 8:14–48.

D. Tried Ground of Unpatentability

Petitioner challenges claims 10–14 of the '920 patent under 35 U.S.C. § 103(a) as having been obvious over Bruce E. Wendus et al., *Follow-On Technology Requirement Study for Advanced Subsonic Transport* (Aug. 2003) (Ex. 1005, "Wendus") and Julian Moxon, *How to save fuel in tomorrow's engines*, FLIGHT International (July 1983), 272–273 (Ex. 1006, "Moxon"). *See* Pet. 12–13.

The other grounds of unpatentability set forth in the Petition relate only to claims which Patent Owner disclaimed after the filing of the Petition. *See id.*; Exs. 2016, 2028.

III. ESTOPPEL

Petitioner contends Patent Owner's actions in this proceeding violate the estoppel provision of 37 C.F.R. § 42.73(d)(3). *See* Paper 30. Patent Owner disagrees. *See* Paper 32. The cited rule pertinently provides a patent owner "is precluded from taking action inconsistent with [an] adverse judgment, including obtaining in any patent: (i) A claim that is not patentably distinct from a finally refused or canceled claim . . . ." 37 C.F.R. § 42.73(d)(3)(i).

In the '431 IPR, we instituted review of one claim on one ground: whether claim 9 of the '920 patent was unpatentable as anticipated by

Joachim Kurzke, *Preliminary Design* (Mar. 2008) ("Kurzke 2008"). *See* '431 IPR, Paper 8, at 6, 19. Patent Owner subsequently disclaimed claim 9, leading to entry of adverse judgment against Patent Owner in the '431 IPR, pursuant to 37 C.F.R. § 42.73(b)(2). *See* '431 IPR, Paper 21.

Petitioner contends Patent Owner, in the present proceeding, "relies solely on a limitation in disclaimed claim 9 as the *patentable distinction* with respect to the challenged claims" 10–14 versus Wendus and Moxon, which "cannot be reconciled" with the disclaimer of claim 9. Paper 30, at 1 (emphasis added). That is, in Petitioner's view: "To the extent [Patent Owner] believes dependent claims 10–14 are patentable, it must rely on the limitations in those claims — not the limitations found in disclaimed claim 9," because "[o]therwise . . . [Patent Owner] has not shown that those claims are *patentably distinct* from claim 9." *Id.* at 3–4 (emphasis added). According to Petitioner, "in an IPR the patentee effectively 'obtains' claims [under § 42.73(d)(3)(i)] because the Board either rejects challenges to or cancels the claims at issue." Paper 30, at 2; Tr. 6:24–8:14. Petitioner further cites the decision in *MaxLinear, Inc. v. CF CRESPE LLC*, 880 F.3d 1373 (Fed. Cir. 2018), as addressing the estoppel impact of invalidated claims. Paper 30, at 5.

Patent Owner contends the patentability of claims 10–14 over Wendus and Moxon must be evaluated based on all limitations in those claims, including limitations of the now-disclaimed parent claim 9, considering the claims as a whole. Paper 32, at 1–3; *see also id.* at 4–5 (arguing claims 10–14 are patentably distinct from claim 9). Patent Owner asserts the patentability of claims 10–14 over the prior art (such as Wendus and Moxon) is a different legal concept from whether claims 10–14 are

patentably distinct from claim 9 under 37 C.F.R. § 42.73(d)(3)(i). *Id.* at 1, 4. Patent Owner further contends the decision in *MaxLinear*, *supra*, supports Patent Owner's position. *Id.* at 2–3.

We determine § 42.73(d)(3)(i) does not apply here, because Patent Owner is not "obtaining" claims 10–14 in this proceeding, as set forth in the rule. Instead, Patent Owner is merely defending against a charge of unpatentability of claims 10–14 over prior art. Claims 10–14 have already been obtained by Patent Owner during the original prosecution of the '920 patent. Moreover, the rule forbids obtaining a "*claim* [here, claims 10–14] that is *not patentably distinct* from a finally refused or canceled *claim* [here, claim 9]." 37 C.F.R. § 41.37(d)(3)(i) (emphases added). Petitioner provides arguments regarding limitations in claim 9 (*see* Paper 30; Tr. 4:7–7:4), and Patent Owner provides arguments concerning claims 10–14 as a whole (*see* Paper 32). However, these arguments insufficiently compare the respective subject matters of claim 9 and the challenged claims 10–14 in relationship to whether there is a patentable distinction between them.

Finally, Petitioner does not establish that the *MaxLinear* decision aids Petitioner's cause. That decision concerned common law collateral estoppel arising from a prior court judgment of unpatentability, not the regulatory estoppel of 37 C.F.R. § 42.73(d)(3). *MaxLinear*, 880 F.3d at 1376–77. Further, Petitioner asserts the *MaxLinear* decision supports its position here merely because "[Patent Owner has] failed to demonstrate that . . . the claims [10–14] are 'patentably distinct' from claim 9." Paper 30, 5. However, as already indicated above, the record presently before us does not provide any basis for us to conclude that claim 10 is not patentably distinct from claim 9.

On the record before us, we conclude 37 C.F.R. § 42.73(d)(3) does not apply here because Patent Owner is not obtaining claims 10–14 in this proceeding.

IV. OBVIOUSNESS ANALYSIS

To prevail on its challenge under 35 U.S.C. § 103(a), Petitioner must prove unpatentability by a preponderance of the evidence. 35 U.S.C. § 316(e).

A claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness, if in the record.[3] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1996).

A. Level of Ordinary Skill in the Art

Petitioner contends a person of ordinary skill in the art pertaining to the '920 patent, at the time of invention, "would include someone who has a[n] M.S. degree in Mechanical Engineering or Aerospace Engineering as well as at least 3–5 years of experience in the field of gas turbine engine design and analysis." Pet. 16; Ex. 1003 ¶ 4. The Patent Owner Response

[3] Patent Owner does not rely on objective evidence of nonobviousness in this proceeding. *See* Tr. 32:8–20.

does not address the level of ordinary skill in the art. While Patent Owner's witness Dr. Jack D. Mattingly believes Petitioner understates the level of ordinary skill, he nonetheless expresses opinions "from the perspective of one with the skill level [Petitioner] identified." Ex. 2019 ¶¶ 35–39. In considering the issues presently before us, we have adopted and applied Petitioner's proposed identification of the level of ordinary skill in the art, which is consistent with the '920 patent and the asserted prior art.

B. Claim Construction

The Board interprets claims of an unexpired patent using the broadest reasonable construction in light of the specification of the patent in which they appear. *See* 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2144–46 (2016) (upholding the use of the broadest reasonable construction standard).

In this proceeding, no explicit construction of any claim term is needed to resolve the issues presented. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co. Ltd.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (per curiam) (claim terms need to be construed "only to the extent necessary to resolve the controversy") (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). This includes the terms "core nacelle" and "fan nacelle" in claim 9 (*see* Pet. 16–19), "spool" in claim 9 (*see id.* at 19–20), "bypass ratio of airflow" in claim 9 (*see id.* at 20–22), "first turbine section . . . pressure ratio" in claim 10 (*see id.* at 27–28), "fan pressure ratio" in claim 11 (*see id.* at 22–24), and "fan tip speed" in claim 13 (*see id.* at 24–27).

However, we note the parties' agreement that, at least insofar as the issues presented by this proceeding are concerned, the "first" spool of claim 10 refers to a low pressure spool such as low spool 14 of the '920 patent specification, and the "second" spool of claim 10 refers to a high pressure spool such as high spool 24 of the '920 patent specification. *See* Pet. 19–20, 71–74; PO Resp. 4–7. Accordingly, we hereafter refer to the first and second spools of claim 10 as, respectively, low pressure or high pressure spools.

C. Obviousness over Wendus and Moxon

Petitioner asserts claims 10–14 of the '920 patent are unpatentable under 35 U.S.C. § 103(a) as having been obvious over Wendus and Moxon. *See* Pet. 58–76. Petitioner provides the testimony of Dr. Reza S. Abhari in support. Exs. 1003, 1040. Patent Owner opposes Petitioner's assertions. *See generally* PO Resp. Patent Owner provides the testimony of Dr. Jack D. Mattingly in support. Ex. 2019.

We have reviewed the arguments and evidence of record. Based on our review, and for the following reasons, we determine a preponderance of the evidence fails to demonstrate claims 10–14 of the '920 patent are unpatentable as having been obvious over Wendus and Moxon. We begin our analysis with brief summaries of the Wendus and Moxon disclosures, including a consideration of the status of Moxon as prior art, and we then address Petitioner's and Patent Owner's contentions as to obviousness.

1. Wendus

Wendus is a NASA publication studying an "Advanced Ducted Propulsor (ADP) engine" proposed for entry into service, and comparing the

Wendus ADP engine to "a baseline current technology engine" based on technology already entered into service. Ex. 1005.011.[4] Petitioner relies on the Wendus ADP engine in its proposed ground of unpatentability. *See* Pet. 59–60.[5]

Patent Owner does not challenge the status of Wendus as prior art to the '920 patent. Thus, Petitioner's argument and evidence in that specific regard (*see* Pet. 15) stands unrebutted in the record presently before us.

2. Moxon

Moxon appears to be a periodical article publication concerning fuel economy in turbofan engines. Ex. 1006. Moxon addresses the "leading role" of an engine's high pressure turbine "in setting the overall efficiency level of the engine," with the aim being "to wring the maximum work out of each blade [of the turbine] without compromising life and reliability." *Id.* at .003. According to Moxon: "Because of the [life and reliability] requirements, a move to one instead of two HP turbine stages is thought unlikely," although attempts had been made in that regard. *Id.* at .003–.004.

[4] As both parties have done, we cite to the Wendus and Moxon disclosures by referring to the "GE-1005" (Wendus) or "GE-1006" (Moxon) page numbering in the lower right hand corner of each page.

[5] During his deposition, Dr. Abhari indicated his opinions were based not on any specific engine in Wendus, but rather on how a person of ordinary skill in the art would evaluate Wendus as a whole. Ex. 2020, 59:14–63:17. Nonetheless, the Petition's case for obviousness repeatedly relies on modifying "the ADP engine" in Wendus. Pet. 59–60, 65, 66–75. Petitioner's Reply Brief confirms this is Petitioner's position in the present proceeding. Pet. Reply 23–24 (citing Ex. 1003 ¶¶ 126–135, as indicating "Dr. Abhari . . . analyzed the engine configuration illustrated in Figures 4 and 5 of Wendus," which show the Wendus ADP Engine).

Patent Owner challenges the status of Moxon as prior art to the '920 patent. *See* PO Resp. 44–47.

Petitioner contends Moxon is prior art to the '920 patent. Pet. 15. Petitioner asserts Moxon was published in July 1983 which, if true, would pre-date by more than one year the '920 patent's potential priority filing date in June 2008. *See id.*; Ex. 1001 (63), 1:7–9 (priority date). Petitioner relies on the date stamp on the cover page of Exhibit 1006, as indicating the copy of Moxon reproduced in the exhibit was received by the University of Michigan Engineering Library on or before August 4, 1983. Pet. 15; Ex. 1006.001. According to Petitioner, "a periodical such as Moxon qualifies as prior art once a person receives it," because such receipt shows "Moxon was disseminated and thus publicly available by that [receipt] date." Pet. Reply 25 (citing MPEP § 2128.02 and *SRI Int'l, Inc. v. Internet Sec. Sys., Inc.*, 511 F.3d 1186, 1194 (Fed. Cir. 2008)).

Patent Owner responds that Petitioner has not met its burden to show Moxon "was 'sufficiently accessible to the public interested in the art' before the critical date." PO Resp. 44–47. In Patent Owner's view, Petitioner has not established Moxon was disseminated or otherwise made locatable by interested persons of ordinary skill in the art exercising reasonable diligence. *Id.* at 45–47 (citing Federal Circuit case law). According to Patent Owner, the date stamp on the cover page of Exhibit 1006 evidences only when the copy of Moxon reproduced in the exhibit was archived by a library, not when Moxon became publicly available. *Id.* at 44–46 (citing *Apple Inc. v. DSS Tech. Mgmt., Inc.*, IPR2015-00369, Paper 14 at 6 (PTAB Aug. 12, 2015) and *Dish Network*

LLC v. Dragon Intellectual Prop., LLC, IPR2015-00499, Paper 14 at 6–7 (PTAB Oct. 20, 2015)).

Petitioner replies that the prior Board decisions cited by Patent Owner are distinguishable from the facts presented here. Pet. Reply 25–26. In particular, the references at issue in those other decisions were theses, and "[t]here are significant differences between a single copy of a thesis in a library and a publication disseminated via mail for establishing that a reference is prior art." *Id.* at 26.

Patent Owner has not filed a motion to exclude Exhibit 1006, or any portion thereof, from the evidence presented in this proceeding. We, therefore, review Exhibit 1006 for everything it discloses. *See* 37 C.F.R. § 42.64(c) ("A motion to exclude evidence must be filed to preserve any objection.")

We determine a preponderance of the evidence establishes Moxon was accessible to the public interested in the art in or before August 1983. First, the attributes of Exhibit 1006 itself suggest Moxon was part of an issue of a regularly distributed periodical, and the issue was distributed to subscribers in or before August 1983. The name of the periodical, "FLIGHT INTERNATIONAL," appears in large and stylized lettering at the top of the cover page, above a glossy photograph of an airplane. Ex. 1006.001. The cover page also lists thirteen different countries, with corresponding monetary amounts next to each country, which appear to reflect the cover price of the periodical in each respective country, including "U.S.A. $2.75." *Id.*

The next page includes masthead information typically found in regularly distributed periodicals. *Id.* at .002. This information includes the

date of the issue ("Week ending 30 July, 1983"); the number of the issue ("Number 3873, Volume 124"); an ISSN number ("0015-3710"); publisher information ("Published in association with *Aeroplane Monthly* and *Airports International* by Transport Press . . . "); a copyright date of 1983; and a listing of editors, advertising contacts, and a subscriptions manager. *Id.* The masthead information further describes FLIGHT International as the "World's first and only complete aeronautical weekly," "Founded 1909." *Id.*

The foregoing evidence of publication and mailing to subscribers of Exhibit 1006, in or before August 1983, and the concomitant accessibility to interested persons of ordinary skill in the art exercising reasonable diligence, is corroborated by the date stamp on the cover page of the Exhibit. *Id.* at .001. That is, the date stamp reflects that the University of Michigan received a copy of the issue on or before August 4, 1983, which is consistent with the date information provided in the issue itself, described above. *Id.*

The two prior Board decisions cited by Patent Owner both considered the public accessibility of a "thesis" archived by the Massachusetts Institute of Technology Libraries. *See* IPR2015-00369, Paper 14, at 5–7; IPR2015-00499, Paper 14, at 2, 4. Such theses are unlike the periodical issue of FLIGHT International here, in that such theses are not normally mailed to persons included in the periodical's list of subscribers. Thus, the two prior Board decisions are not particularly pertinent to the facts presented here.

We conclude a preponderance of the evidence establishes Moxon is prior art in the present proceeding.

3. Claim 10

Petitioner contends, and Patent Owner does not dispute, that the Wendus ADP engine includes every limitation of claim 10 except that its high pressure turbine has one stage rather than at least two stages as claimed.[6] Pet. 58. Petitioner also contends, and Patent Owner also does not dispute, that two-stage high pressure turbines were known in the art prior to the '920 patent's priority date, as evidenced for example by Moxon. *Id.* at 4, 5, 60–62. We have considered the evidence cited by Petitioner in these regards, and we are persuaded that Wendus and Moxon disclose all limitations recited in claim 10 as Petitioner contends.

Thus, the issue to be decided here is: has Petitioner shown by a preponderance of the evidence that it would have been obvious to modify the Wendus ADP engine, by replacing its one-stage high pressure turbine with a two-stage high pressure turbine, thereby resulting in the invention of claim 10? For the following reasons, we find Petitioner has not met this burden.

a) Petitioner's Argument and Evidence

Petitioner's case relies on the supporting testimony of Dr. Abhari. *See* Pet. 62–66; Pet. Reply 6–7. Dr. Abhari testifies "there is a finite number of choices for stage count of the high pressure turbine," and "two-spool gas turbine engines used in commercial aviation generally include either one or two stages in the high pressure turbine." Ex. 1003 ¶ 140 (citing Ex. 1029, a

[6] A turbine "stage" consists of a matched set of rotating blades and stationary airfoils, which extract energy from the expansion of a compressed and combusted airflow to power the turbine. *See* Ex. 1003 ¶¶ 19–21, 24–28; Ex. 2019 ¶¶ 30, 33–34, 48.

Turbofan and Turbojet Engines Database Handbook dated in 2007, identifying several commercial engines having a two-stage high pressure turbine). In Dr. Abhari's opinion, "it's always a question of one-stage HPT or two-stage HPT," which is "to a large extent a binary choice; so you have to pick one," and "[i]t is one or the other typically." Ex. 2020, 40:3–42:1.[7] According to Dr. Abhari, "[g]iven primarily two choices, it would have been obvious for a person of ordinary skill in the art to consider both." Ex. 1003 ¶ 140.

Dr. Abhari acknowledges a person of ordinary skill in the art would have known of various tradeoffs — that is, competing advantages and disadvantages — involved in choosing between one or two stages for a high pressure turbine. Ex. 1003 ¶¶ 137–142; Ex. 1040 ¶¶ 6–8, 18. The advantages of a one-stage high pressure turbine are an axially shorter engine, with fewer parts, than a two-stage turbine. Ex. 1003 ¶ 140. Having fewer parts is advantageous because it reduces the weight of the engine, and reduces the cost of obtaining parts. *Id.* The advantages of a two-stage high pressure turbine are less mechanical stress on the turbine, and a higher efficiency, than a one-stage turbine. *Id.* ¶¶ 140–141. Reducing the stress on

[7] In the Reply Brief, Petitioner additionally relies on Dr. Mattingly's textbook *Elements of Propulsion: Gas Turbines and Rockets*. *See* Pet. Reply 1 (citing Ex. 1033.008). We have accorded little weight to that evidence, however, because the textbook is dated in 2016, at least five years after the '920 patent's priority date. *See* Ex. 1033.002; Pet. 11–12 (asserting '920 patent is not entitled to priority preceding Dec. 30, 2011). Further, the relied-upon disclosure is not materially different from other evidence which pre-dates the '920 patent's priority date. *See* Ex. 1033.008 ("Modern aircraft gas turbine engines typically have a single-stage or two-stage core or high-pressure turbine (HPT).").

the turbine is advantageous because it improves the life and reliability of the turbine. *Id.* ¶ 140. In support of this testimony, Dr. Abhari cites Dr. Mattingly's 1996 textbook *Elements of Gas Turbine Engine Propulsion*, which states:

> In aircraft gas turbine engines, engine weight and performance must be balanced. Weight can be reduced by increasing stage loading (reduces the number of stages), but this normally leads to a loss in stage efficiency . . . .

Ex. 1014.138; Ex. 1003 ¶ 140.

Dr. Abhari cites disclosures of Wendus and Moxon as being consistent with the foregoing opinions. Dr. Abhari relies on the Wendus disclosure that the one-stage high pressure turbine of its ADP engine "result[s] in substantial mechanical and structural challenges." Ex. 1003 ¶ 141 (quoting Ex. 1005.021). Dr. Abhari also relies on the Wendus disclosure that the two-stage high pressure turbine of the baseline engine was more efficient than the one-stage high pressure turbine of the Wendus ADP engine, advantageously providing reduced fuel burn. Ex. 1040 ¶ 18 (citing Ex. 1005.013, .021). Dr. Abhari further relies on the Moxon disclosure that, due to life and reliability requirements, "a move to one instead of two HP turbine stages is thought unlikely." Ex. 1003 ¶¶ 138, 141 (quoting Ex. 1006.003–.004). Moxon, further, discusses how a two-stage high pressure turbine has less diameter than a one-stage turbine, advantageously helping to keep the engine core slim. *Id.* ¶ 138 (citing Ex. 1006.004).

Thus, according to Dr. Abhari, one solution to the mechanical and structural challenges posed by a one-stage high pressure turbine is to utilize two stages instead, thus motivating a person of ordinary skill in the art to use

a two-stage high pressure turbine in the Wendus ADP engine. *Id.* ¶ 141. Dr. Abhari testifies such a change would have predictably yielded lower mechanical stresses and thereby lowered the risk of component failure in the high pressure turbine, and would also increase efficiency. *Id.* ¶ 142. In Dr. Abhari's view, obtaining such advantages compensates for the increased weight, size, and cost that result from the increased number of parts in a two-stage turbine versus a one-stage turbine. *Id.*

b) Patent Owner's Responsive Argument and Evidence

Patent Owner contends Petitioner's case for the obviousness of replacing the Wendus ADP engine's one-stage high pressure turbine with a two-stage high pressure turbine is tainted by a hindsight desire to reach the invention recited in claim 10, and runs contrary to express disclosures in Wendus. PO Resp. 1–2, 21–37. According to Patent Owner, Petitioner overlooks that "Wendus specifically assessed and rejected a known two-stage HPT engine," the PW4084, in favor of a one-stage high pressure turbine engine. *Id.* at 1–2, 21–22, 24, 27–28, 32–36 (citing Ex. 1005.011–.016, .021, .050, .054); Ex. 2019 ¶¶ 50–54, 57–58, 60–63, 66; Ex. 2021.001; Ex. 1029.376). Patent Owner further contends nothing in Moxon overrides the teachings in Wendus directed to choosing a one-stage high pressure turbine. PO Resp. 36–37; Ex. 2019 ¶¶ 64–66. Thus, in Patent Owner's view, a person of ordinary skill in the art would not have attempted to add a second stage to the Wendus ADP engine's high pressure turbine, because that would be contrary to Wendus's express teachings and intended purpose. PO Resp. 32–37.

Patent Owner relies on Wendus's description of its ADP engine's one-stage high pressure turbine as one of the "CRITICAL TECHNOLOGIES" of the engine, providing "significant reductions in weight, price, and maintenance cost in the" high pressure turbine. Ex. 1005.050; PO Resp. 24, 32 (further citing Ex. 1005.011–.013, 052, .054); Ex. 2019 ¶¶ 50–54, 57, 58, 61. Wendus, further, touts its ADP engine's "high specific work and high efficiency" and "lower acquisition and maintenance costs." Ex. 1005.021; PO Resp. 24, 32. Patent Owner also points out that Wendus pursued its ADP engine's one-stage high pressure turbine to achieve these benefits, despite recognizing that the turbine presented "substantial mechanical and structural challenges." Ex. 1005.021; PO Resp. 24–25; Ex. 2019 ¶ 55.

Patent Owner, moreover, asserts Petitioner's case for obviousness is inconsistent with a typical engine design procedure, in which one selects a high pressure turbine design at the *beginning* of the process, and *then* designs the remainder of the engine around the selected high pressure turbine. PO Resp. 1, 15–18, 26, 28–29; Ex. 2019 ¶¶ 42–45, 57–59. Indeed, according to Patent Owner, that is how Wendus designed its ADP Engine. PO Resp. 21–24, 26, 27, 31–33 (citing Ex. 1005.013–.016, .019); Ex. 2019 ¶¶ 50–54, 57–58. In light of this allegedly typical engine design procedure, Patent Owner contends "one of ordinary skill in the art would have no reason to substitute the one-stage HPT in [the Wendus ADP Engine] with a two-stage design." PO Resp. 26, 28; Ex. 2019 ¶¶ 42, 57, 60.

Patent Owner further asserts Petitioner has failed to establish a reasonable expectation of success in the proposed modification of the Wendus ADP engine to include a two-stage high pressure turbine to reach

the invention of claim 10. PO Resp. 2, 4–7, 15–21, 29–32, 40–43. Patent Owner faults Petitioner for ignoring the complexity of gas turbine engine design, and for not addressing how the proposed change would affect other features of the engine, including the features recited in claim 10. *Id.*; Ex. 2019 ¶¶ 30–34, 41–49, 56–58.

c) Petitioner's Reply Argument and Evidence

In reply, Petitioner asserts Wendus does not teach away from using a two-stage high pressure turbine, because Wendus does not criticize, discredit, or otherwise discourage such use. Pet. 65–66; Pet. Reply 2, 8–12. According to Dr. Abhari, Wendus "never explicitly refers to a two-stage high pressure turbine, or describes a two-stage HPT as inferior to a one-stage HPT in any way." Ex. 1040 ¶ 25. Indeed, Dr. Abhari discusses Wendus's disclosure that a two-stage turbine would be 3.1% more efficient that the Wendus ADP engine's one-stage turbine. Ex. 1040 ¶¶ 18, 25–26 (citing Ex. 1005.013, Table 1).

Dr. Abhari concludes the one-stage high pressure turbine is not central or critical to the design of the Wendus ADP engine. Ex. 1040 ¶¶ 19–20. In support, Dr. Abhari cites Wendus's identification of other, "[c]urrent ADPs us[ing] an existing core (V2500, PW2040, PW4000)," each of which has a two-stage high pressure turbine. *Id.* ¶ 19 (quoting Ex. 1005.044, and citing Ex. 1038.001 and Ex. 1029.044, .374, .494); Pet. Reply 12 (also citing Ex. 1029.368). Dr. Abhari further cites another ADP engine, not mentioned in Wendus, which incorporated the two-stage high pressure turbine of the PW2000 engine. Ex. 1040 ¶ 20 (citing Ex. 1034.002).

According to Petitioner, there would have been a reasonable expectation of success in the proposed modification, given that the prior art includes numerous examples of two-stage high pressure turbines in high bypass ratio geared engines such as the Wendus ADP engine. Pet. Reply 2–3, 15–17. Petitioner contends Patent Owner's assertions concerning how engine design typically begins by selecting a high pressure turbine are not persuasive of non-obviousness, because those arguments require Petitioner to demonstrate the physical insertion of Moxon's actual turbine into the completed Wendus ADP engine, which is inconsistent with the law of obviousness. Pet. Reply 4–6.

Petitioner also contends the engine design element changes required in modifying the Wendus ADP engine to include a two-stage high pressure turbine "have no relevance to the issue of reasonable expectation of success," because such design elements are not recited in claim 10. Pet. Reply 18. Further according to Petitioner, even if such required design element changes were relevant, the evidence of record establishes they would have been within the capabilities of a person of ordinary skill in the art. Pet. Reply 19 (citing Ex. 1003 ¶ 140 and Ex. 1039, 44:5–20, as well as several examples of prior art recognition of engines having a two-stage high pressure turbine).

Petitioner further asserts the evidence of record does not support Dr. Mattingly's testimony that the proposed inclusion of a two-stage high pressure turbine in the Wendus ADP engine could result in other claimed parameters falling outside the ranges specified in claim 10. Pet. Reply 20–23. Petitioner contends Dr. Mattingly "conducted no analysis and cited no evidence to support his conclusory statement[s]." *Id.* at 20. Petitioner relies

on Dr. Abhari's testimony as establishing that the low spool parameters recited in claim 10 "*could and would* remain the same despite modifications to the high spool components (*e.g.*, the HPT stage count)" in the Wendus ADP engine. *Id.* at 21 (emphases added) (citing Ex. 1040 ¶ 10 and Ex. 1005.019–020). Petitioner, further, cites several prior art engine designs having a two-stage high pressure turbine, and other design parameters within claim 10, as establishing a reasonable expectation of success in implementing a two-stage high pressure turbine in the Wendus ADP engine while maintaining the other claimed parameters within the scope of claim 10. *Id.* at 21–22 (citing Ex. 1040 ¶ 23 and Exs. 1008, 1009, 1013, 1019, and 1024).

d) Findings and Conclusions

For the following two reasons, we conclude a preponderance of the evidence does not support Petitioner's contention that claim 10 would have been obvious over Wendus and Moxon.

(1) Motivation for Using Two-Stage High Pressure Turbine in the Wendus ADP Engine

We, first, determine Petitioner has not established that a person of ordinary skill in the art would have been motivated to modify the Wendus ADP engine by replacing its one-stage high pressure turbine with a two-stage high pressure turbine.

Dr. Abhari's testimony, and supporting documentary evidence, does establish a few points of fact that tend to support Petitioner's case. First, high pressure turbines used in two-spool gas turbine engines prior to the '920 patent generally had either one stage or two stages. Ex. 1003 ¶ 140.

That is, the high pressure turbine stage count generally was a binary choice, such that there were usually only two options. *Id.*; Ex. 2020, 40:3–42:1. Neither Patent Owner nor Dr. Mattingly persuasively disputes this fact. *See, e.g.*, Ex. 2019 ¶ 42 (Dr. Mattingly does "not agree" with Dr. Abhari on this point, but Dr. Mattingly does not provide any basis or documentary evidence for his disagreement).

Second, a person of ordinary skill in the art at the time of the '920 patent's invention would have known of various tradeoffs involved in choosing between one or two stages for the high pressure turbine of a two-spool gas turbine engine. Ex. 1003 ¶¶ 137–142; Ex. 1040 ¶¶ 6–8, 18. A one-stage turbine advantageously is axially shorter, and has fewer parts, versus a two-stage turbine, thereby reducing the weight of the engine and the cost of obtaining parts. Ex. 1003 ¶ 140. A two-stage turbine reduces the stress placed on the turbine, and provides a higher efficiency, versus a one-stage turbine, thereby improving the life, reliability, and fuel consumption of the turbine. *Id.* ¶¶ 140–141; Ex. 1014.138. Neither Patent Owner nor Dr. Mattingly materially disputes these facts.

Nonetheless, the difficulty with Petitioner's case for motivation is that Dr. Abhari and Dr. Mattingly both testify, and the parties agree, that Wendus expressly considered at least some of the one-stage versus two-stage tradeoffs and specifically chose the one-stage option. *See* Ex. 1003 ¶¶ 141–142; Ex. 2019 ¶¶ 50–55; Pet. 63–66; PO Resp. 32–37. By expressly weighing the tradeoffs and choosing the one-stage option, Wendus teaches away from modifying the Wendus ADP engine to include the two-stage option. Further, even if it is determined that the Wendus disclosure does not reach the level of teaching away from the two-stage option under pertinent

case law, the evidence presented in this proceeding as a whole does not persuasively demonstrate a motivation to modify the Wendus ADP engine to include a two-stage high pressure turbine.

The decision in *Polaris Industries, Inc. v. Arctic Cat, Inc.*, 882 F.3d 1056 (Fed. Cir. 2018), recently set forth several legal principles relating to "teaching away" disclosures in the prior art, and whether a person of ordinary skill in the art would have been motivated to combine prior art references. Several of these principles apply to the facts presented in this case, as discussed below, so we quote the *Polaris* decision at length:

> "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant." *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1327 (Fed. Cir. 2009) (quoting *Ricoh Co., Ltd. v. Quanta Comput. Inc.*, 550 F.3d 1325, 1332 (Fed. Cir. 2008)). Moreover, a reference "must [be] considered for all it taught, disclosures that diverged and taught away from the invention at hand as well as disclosures that pointed towards and taught the invention at hand." *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 296 (Fed. Cir. 1985) (citation omitted). A reference does not teach away "if it merely expresses a general preference for an alternative invention but does not 'criticize, discredit, or otherwise discourage' investigation into the invention claimed." *DePuy*, 567 F.3d at 1327 (quoting *In re Fulton*, 391 F.3d at 1201). But even if a reference is not found to teach away, its statements regarding preferences are relevant to a finding regarding whether a skilled artisan would be motivated to combine that reference with another reference. *See Apple Inc. v. Samsung Elecs. Co.*, 839 F.3d 1034, 1051 n.15 (Fed. Cir. 2016) (en banc) (noting that, even if a reference "does not teach away, its statements regarding users preferring other forms of switches are relevant to a finding regarding whether a skilled

> artisan would be motivated to combine the slider toggle in" that reference with the invention of a second reference).

882 F.3d at 1069.

We apply those legal principles to the facts presented here. Wendus summarizes the study leading to the Wendus ADP engine as follows:

> **1. SUMMARY**
>
> A study was conducted to define and assess the *critical or enabling technologies* required for a year 2005 entry into service (EIS) engine for subsonic commercial aircraft . . . . *Two engines were selected* for this study — *a baseline current technology engine* and *an advanced technology engine*. The baseline engine is a turbofan based on 1995/96 EIS technology, e.g., PW4084. The year 2005 EIS advanced technology engine is an Advanced Ducted Propulsor (ADP) engine [i.e., the Wendus ADP engine].
>
> Performance analysis showed that *the ADP design offered many advantages* compared to the [baseline current technology PW4084] turbofan. . . .
>
> *Critical and enabling technologies for the year 2005 EIS ADP were identified and prioritized. Critical technology paths were defined.*

Ex. 1005.011 (emphases added). Wendus thereby indicates the goal of designing the Wendus ADP engine was to identify certain critical or enabling technologies that would improve upon the performance of the baseline current technology PW4084 engine. *See also id.* at .013 ("The turbofan engine used as a basis for comparison . . . represents a year 1995/96 entry into service (EIS) turbofan with PW4084 technology . . . .").

The PW4084 engine had a two-stage high pressure turbine. Ex. 2019 ¶¶ 53, 61; Ex. 2021.001 (PW4084 FAA Type Certificate, "2-stage high-pressure turbine"); Ex. 1029.044 ("Composition: Fan / LPC / HPC / *HPT* / IPT / LPT *Stages*"), .376 (PW4084 entry, "Composition: 1 / 6B / 11 / *2* / - / 7") (emphases added). Petitioner does not offer evidence to dispute

that fact. *See, e.g.*, Pet. Reply 6 n.6 (referring to "the two-stage HPT of the baseline engine" in Wendus); Tr. 11:13–15.

Petitioner and Dr. Abhari correctly point out that Wendus does not expressly describe the PW4084 engine as having a two-stage high pressure turbine. *See* Pet. Reply 9; Ex. 1040 ¶ 25. However, that does not alter the fact that Wendus compared the Wendus ADP engine's one-stage high pressure turbine with the PW4084 engine's two-stage high pressure turbine, having both advantageous and disadvantageous results. On the advantageous side, Wendus determined its ADP engine's one-stage turbine provided "high specific work" and "high efficiency (low fuel burn) at a minimum number of parts (lower acquisition and maintenance costs)," albeit with a lesser efficiency than the PW4084 engine's two-stage turbine. Ex. 1005.013, .021. Also advantageously, the Wendus ADP engine's one-stage turbine was a "significant technology advance[] compared to present day engines" in that it provided "significant reductions in weight, price, and maintenance cost in the . . . HPT." *Id.* at .050. On the disadvantageous side, the Wendus ADP engine's one-stage turbine was 3.1% less efficient than the PW4084 engine's two-stage turbine. *Id.* at .013 (Table 1). Also disadvantageously, the Wendus ADP engine's one-stage turbine posed "substantial mechanical and structural challenges." *Id.* at .021.

After studying those advantages and disadvantages of the Wendus ADP engine's one-stage turbine versus the PW4084 engine's two-stage turbine, Wendus described the one-stage turbine as one of the "critical or enabling technologies" to achieve "advantages" over the PW4084 engine. *Id.* at .011–.013, .021, .050, .052–.054; Ex. 2019 ¶¶ 50–55. These

engine-to-engine advantages included "a 6.6 percent reduction in [Direct Operating Cost Plus Interest] compared to" the PW4084 engine, which was "very significant." Ex. 1005.048, .008. Wendus discloses that the one-stage high pressure turbine helped to achieve this relative engine cost reduction. *Id.* at .050.

Moreover, Wendus recognized the very benefits cited by Dr. Abhari as the reasons for modifying the Wendus ADP engine to include a two-stage high pressure turbine. *See id.* at .021 (two-stage turbine provides less mechanical stress than one-stage turbine, in that the latter presents "substantial mechanical and structural challenges"), .013 (two-stage turbine is more efficient than one-stage turbine). Wendus, nonetheless, identified the one-stage high pressure turbine of the Wendus ADP engine as a critical or enabling technology to achieve advantages over a prior art engine having a two-stage high pressure turbine. "An inference of nonobviousness is especially strong where the prior art's teachings undermine the very reason being proffered as to why a person of ordinary skill would have combined the known elements." *DePuy Spine v. Medtronic Sofamor Danek*, 567 F.3d at 1326; *see also Fluor Tec, Corp. v. Kappos*, 499 F. Appx. 35, 41–42 (Fed. Cir. 2012) (unpublished) (it would not have been obvious to modify Mak's gas processing methods to add an expander, because "Mak specifically discusses the advantages of the 'no turboexpander design' for low-pressure feed gas" such that the proposed addition "is not simply a design choice that one would employ").

In fact, a preponderance of the evidence supports Patent Owner's contention that Wendus designed other components of its ADP engine specifically to accommodate the chosen one-stage high pressure turbine. *See*

PO Resp. 22–23, 31–32; Ex. 2019 ¶¶ 52–53, 57–58. For example, Wendus determined early in the study "that a properly designed low shaft could not fit within the bore dimensions of the high-pressure turbine disk" of Wendus's "high work single stage high-pressure turbine." Ex. 1005.014. So that the low pressure shaft might transmit the required torque as well as "fit within the bore dimensional requirements of" the high pressure turbine disk, "a new shaft material with extremely high strength and high stiffness-to-weight capabilities was required." *Id.* However, the necessary material improvements could not be reasonably achieved in time for Wendus's target entry into service date, so "a low shaft study was conducted to guide the selection of a *revised* ADP cycle and component definition," leading to several design changes for "solving low shaft torque problems." *Id.* (emphasis added).

Based on the foregoing, we find Wendus teaches away from a two-stage high pressure turbine in its ADP engine. That is, upon reading Wendus, a person of ordinary skill in the art would be discouraged from the two-stage option, and would be led in the direction of the one-stage option, at least insofar as the Wendus ADP engine is concerned. *See DePuy,* 567 F.3d at 1327. Wendus does more than merely express a general preference for a one-stage high pressure turbine in the Wendus ADP engine. *See id.* Specifically, Wendus describes the one-stage turbine as a critical and enabling technology providing significant advantages over a prior art engine having a two-stage turbine, with such advantages representatively including reduced weight and cost. Ex. 1005.011–.013, .021, .050. A person of ordinary skill in the art would have known that modifying the Wendus ADP engine to include a two-stage turbine would have increased the weight and

cost of the engine, which Wendus criticizes, discredits, or otherwise discourages. *See Fulton*, 391 F.3d at 1201; *see also Black & Decker, Inc. v. Positec USA, Inc.*, 646 F. Appx. 1019, 1027 (Fed. Cir. 2016) (unpublished) (obviousness of modifying Mack's trimmer to use bolts or screws instead of spring grade wire was not supported by substantial evidence, because it ran counter to Mack's intended purpose of improving on prior art units which had relatively high costs and complex constructions, by having relatively fewer components, whereas proposed modification would increase the number of components and thereby increase assembly and repair costs).

We acknowledge Dr. Abhari's testimony that at least some ADP engines *other than* the Wendus ADP engine included a two-stage high pressure turbine, and Wendus even mentions one of those other ADP engines. *See* Ex. 1040 ¶¶ 19–20 (citing Ex. 1005.044). The cited discussion in Wendus, however, does not even address the stage count of the high pressure turbine in the other ADP engines, much less suggest that two stages might be an appropriate option for the Wendus ADP engine. Ex. 1005.044. Reading Wendus as a whole, we find that it teaches away from using a two-stage high pressure turbine in the Wendus ADP engine, as discussed above.

Moreover, even if the Wendus disclosure does not reach the level of teaching away from a two-stage high pressure turbine under pertinent case law, we nonetheless must consider the prior art for all that it teaches, including "disclosures that diverged and taught away from the invention at hand as well as disclosures that pointed towards and taught the invention at hand." *Ashland Oil*, 776 F.2d at 296. In weighing the evidence, "even if a reference is not found to teach away, its statements regarding preferences are

relevant to a finding regarding whether a skilled artisan would be motivated to combine that reference with another reference." *Polaris v. Arctic Cat*, 882 F.3d at 1069 (emphasis added) (citing *Apple v. Samsung*, 839 F.3d at 1051 n.15).

As discussed in detail above, the Wendus disclosure at the very least states a strong preference for using a one-stage high pressure turbine in the Wendus ADP engine, when describing the one-stage turbine as a critical and enabling technology providing significant advantages over a prior art engine having a two-stage turbine. The evidence as a whole establishes it was known that a two-stage high pressure turbine had certain advantages over a one-stage high pressure turbine. However, the evidence as a whole also establishes it was known that a one-stage high pressure turbine had certain advantages over a two-stage high pressure turbine. We agree with Patent Owner's position that it "makes little engineering sense" for a person of ordinary skill in the art, when seeking to improve upon or otherwise modify the Wendus ADP engine, to go against Wendus's strong preference for a one-stage high pressure turbine, despite the known advantages provided by a two-stage design. *See* PO Resp. 1–2. Indeed, as already discussed, the Wendus ADP engine was designed to use a one-stage high pressure turbine, in that other engine components were specifically designed to accommodate the turbine. *See* Ex. 1005.014.

Moxon, at best for Petitioner, supports Dr. Abhari's testimony regarding known tradeoffs when choosing between one and two stages for a high pressure turbine. Moxon does not discuss the specific design of the Wendus ADP engine (which did not exist at the time of Moxon), or contain

evidence weighing against Wendus's strong preference for a one-stage high pressure turbine over a two-stage high pressure turbine within that design.

For the foregoing reasons, we determine Petitioner has not established that a person of ordinary skill in the art would have been motivated to modify the Wendus ADP engine by replacing its one-stage high pressure turbine with a two-stage high pressure turbine.

(2) Motivation for Modifying the Wendus ADP Engine to Result in the Invention of Claim 10 as a Whole

We also determine Petitioner has not established the obviousness of claim 10, when considered as a whole. *See Gillette Co. v. S.C. Johnson & Son, Inc.*, 919 F.2d 720, 724 (Fed. Cir. 1990) ("What we stressed in *Kimberly-Clark* [*Corp. v. Johnson & Johnson*, 745 F.2d 1437, 1448 (Fed. Cir. 1984)], and have repeated many times since, was that 35 USC 103 requires analysis of a claimed invention *as a whole*[.]"). "Focusing on the obviousness of substitutions and differences, instead of on the invention as a whole, is a legally improper way to simplify the often difficult determination of obviousness." *Id.* (citing *Hybritech, Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1383 (Fed. Cir. 1986)); *see also* PO Resp. 29–31, 42–43 (arguing Petitioner's obviousness analysis ignores complexity of gas turbine design, and how proposed modification might impact multiple engine components).

Even if one were to proceed as proposed by Petitioner to modify the Wendus ADP engine by incorporating a two-stage high pressure turbine, there is little evidence to establish the obviousness of maintaining the rest of the Wendus ADP engine to remain within the scope of claim 10. In addition to a high pressure turbine having at least 2 stages, claim 10 requires a low

pressure turbine having between 3–6 stages and a pressure ratio of greater than about 5, and requires a bypass ratio of airflow greater than about 6. Ex. 1001, 8:14–37. It is undisputed that the Wendus ADP engine has a low pressure turbine with 6 stages and a pressure ratio of 12.72, and a bypass ratio of airflow of 16.7, falling within the scope of claim 10 in those respects. Ex. 1005.016, .021; Ex. 1003 ¶¶ 126, 136, 144, 148.

However, we credit the testimony of Dr. Mattingly that "[g]as turbofan engines are complex machines" which "contain thousands of interrelated parts." Ex. 2019 ¶¶ 30, 32. Thus, "[m]odifying a single component can change the operation of other components throughout the system," for example due to "undesirable impacts on the fluid dynamics and mechanics" of interrelated components. *Id.* ¶¶ 30, 32, 36, 41. In particular, Dr. Mattingly states "the choice of high pressure turbine affects the selection of myriad other engine components," such that "the selection of a two-stage high pressure turbine will cause a varying cascade of design changes." *Id.* ¶¶ 43–44, 56–57; *see also id.* at ¶¶ 46–49 (explaining that adding a second turbine stage without changing extracted power would require modifying the high spool shaft, cooling system, bearings, low spool shaft, and engine mounts).

Most pertinently to our present decision, Dr. Mattingly testifies that replacing a one-stage high pressure turbine with a two-stage high pressure turbine would "necessar[ily]" involve "modifying the gas flow through the engine, affecting engine aerodynamics and thermodynamics." *Id.* ¶¶ 49, 56. These changes would "*likely*" lead to a redesign of low pressure spool components such that the "[l]ow pressure turbine and low pressure compressor stage counts, [and the] low pressure turbine pressure

ratio . . . *could* all change." *Id.* (emphases added). According to Dr. Mattingly, a person of ordinary skill in the art "would not expect all of these parameters to remain unchanged." *Id.*

Petitioner's case for obviousness does not establish that the other claimed parameters would likely remain within the scope of claim 10, if one were to modify the high pressure turbine to have two stages instead of one stage. Instead, Dr. Abhari simply points out that the Wendus ADP engine, with its one-stage high pressure turbine, meets all other claim limitations. Ex. 1003 ¶¶ 125, 132, 136, 143–144, 148. Dr. Abhari then opines that it would have been obvious to modify the Wendus ADP engine to have a two-stage high pressure turbine, without addressing whether or how this proposed modification might cause the other claimed parameters to remain within the scope of claim 10. *Id.* at ¶¶ 139–142. Dr. Abhari's silence on this point undermines the persuasiveness of Petitioner's case for obviousness.

For example, Dr. Abhari cites several specific commercial engines as having a two-stage high pressure turbine (Ex. 1003 ¶ 140 n.17), but overlooks the fact that some of the cited engines had other parameters falling outside the scope of claim 10. The Rolls Royce BR710 had a two-stage low pressure turbine, and a bypass ratio at static sea level of 4 to 4.2. Ex. 1029.044 (defining variables), .097–.099; *see also* Pet. 20–22 (asserting "the bypass ratio claim limitation is not limited to the cruise condition or any other particular condition because no condition is specified"). The CF34–8 had a bypass ratio at static sea level of 4.9. Ex. 1029.104. The CF6 had a bypass ratio at static sea level of 4.2 to 4.64 in some configurations. *Id.* at .106–.127. The PW4000 had a seven-stage low pressure turbine in some configurations. *Id.* at .374–.380. This evidence supports Dr. Mattingly's

stated opinion that modifying the Wendus ADP engine to include a two-stage high pressure turbine could likely result in the modified engine having other parameters falling outside the scope of the claim.

In reply to Dr. Mattingly's testimony, Dr. Abhari additionally opines that modifying the high spool shaft, cooling system, bearings, low spool shaft, and engine mounts as described by Dr. Mattingly "is within the level of ordinary skill in the art." Ex. 1040 ¶ 9. Further according to Dr. Abhari's reply, "a two-stage HPT *could* be utilized in an engine without changing the low spool design parameters (i.e., LPT stage count, LPT pressure ratio . . .)" versus a one-stage high pressure turbine. *Id.* ¶¶ 10, 22. Dr. Abhari cites Wendus in support, in that Wendus discloses one may add stages to the high pressure *compressor* while holding engine cycle parameters and low spool design constant. *Id.* ¶ 10 (citing Ex. 1005.018, .020).

However, Dr. Abhari's reply testimony does not provide a persuasive motivation or justification for why a person of ordinary skill in the art, when modifying the Wendus ADP engine to include a two-stage high pressure turbine, would maintain the other claimed parameters within the scope of claim 10. Petitioner's characterization of Dr. Abhari's testimony as indicating one "could and would" do so (Pet. Reply 21; Tr. 13:6–15:24) does not accurately reflect the cited testimony (Ex. 1040 ¶¶ 10, 21–23). Dr. Abhari's testimony, at best, establishes that this *could* have been done, not that this *would* have been done. The fact that the cited prior art would have allowed for the claimed invention, or possibly could be combined to reach the claimed invention, is not a sufficient reasoning to support obviousness. *Personal Web Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 991–92 & 993–94 (Fed. Cir. 2017) (obviousness requires "a motivation to pick

out those two references and combine them to arrive at the claimed invention," and "the amount of explanation needed will vary from case to case, depending on the complexity of the matter and the issues raised in the record"); *InTouch Techs., Inc. v. VGo Comms., Inc.*, 751 F.3d 1327, 1351–52 (Fed. Cir. 2014).

Dr. Abhari does not address, for example, the claimed requirements for the low pressure turbine, which is downstream of the high pressure turbine. Dr. Abhari does not inform us of how the use of a two-stage high pressure turbine would affect the airflow reaching the low pressure turbine. Dr. Abhari does not provide a reason why the Wendus ADP engine's low pressure turbine would continue to include 6 stages and a pressure ratio of 12.72, or otherwise would continue to fall within the scope of claim 10 (between 3–6 stages and a pressure ratio of greater than about 5), if the upstream high pressure turbine were modified as proposed.

Dr. Mattingly's testimony, as summarized above, is admittedly provided only at a high level of generality. For example, Dr. Mattingly states that incorporating a two-stage high pressure turbine within the Wendus ADP engine would *likely* lead to a redesign of the low spool components, not that it *would* do so. Ex. 2019 ¶¶ 49, 56. Dr. Mattingly states the redesign would likely change the low pressure turbine stage count and pressure ratio, but he does not address how those parameters might change. *Id.* For example, Dr. Mattingly does not opine on whether those low pressure turbine parameters might be expected to increase or decrease, if the Wendus ADP engine were modified to include a two-stage high pressure turbine. *Id.* Nor does Dr. Mattingly address the extent to which those low pressure turbine parameters might be expected to change, particularly

whether the extent would be likely to cause the modified Wendus ADP engine to fall outside the scope of claim 10. *Id.*

Nonetheless, Dr. Mattingly's testimony does persuade us that incorporating a two-stage high pressure turbine within the Wendus ADP engine would likely lead to changes to other components in the engine. Ex. 2019 ¶¶ 49, 56. These other components include, at the least, the low pressure turbine stage count and pressure ratio. *Id.* Dr. Abhari's testimony does not materially contradict Dr. Mattingly's testimony in that specific regard. Indeed, Dr. Mattingly's testimony makes sense, given that the low pressure turbine is downstream of the high pressure turbine, and both turbines are powered by the same airstream. It stands to reason that replacing a one-stage high pressure turbine with a two-stage high pressure turbine is likely to change the pressure of the airflow exiting the high pressure turbine, which is then available to power the downstream low pressure turbine. It is natural that such a change may require a corresponding redesign of the low pressure turbine, to account for the different incoming airflow pressure.

Given that relationship between the two turbines, it is incumbent upon Petitioner to provide a reason why a person of ordinary skill in the art would maintain the low pressure turbine stage count between 3 and 6, and the low pressure turbine pressure ratio greater than about 5, when incorporating a two-stage high pressure turbine in the Wendus ADP engine. *See* 35 U.S.C. § 316(e); *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006), *cited with approval in KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007). In not doing so, Petitioner has failed to address the claimed invention as a whole, and has improperly focused only on the obviousness of substitutions and

differences. *Gillette Co. v. S.C. Johnson & Son, Inc.*, 919 F.2d 720, 724 (Fed. Cir. 1990); *Hybritech, Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1383 (Fed. Cir. 1986).

To be clear, the problem we see in Petitioner's case is that it provides *insufficient reasoning*, such as an engineering motivation, for why it would have been obvious to modify the Wendus ADP engine to include a two-stage high pressure turbine, while also maintaining the other claimed parameters within the scope of claim 10. We do not base our decision on the lack of a reasonable expectation of success in reaching the invention of claim 10.

(3) Conclusion as to Claim 10

For the foregoing reasons, we determine a preponderance of the evidence does not support Petitioner's contention that it would have been obvious to modify the Wendus ADP engine, by replacing its one-stage high pressure turbine with a two-stage high pressure turbine, thereby resulting in the invention of claim 10. Therefore, Petitioner has not satisfied its burden to demonstrate that claim 10 is unpatentable as having been obvious over Wendus and Moxon.

4. Claims 11–14

The deficiencies in Petitioner's case for the obviousness of claim 10 also apply to claims 11–14, each of which depends from claim 10. Therefore, we determine Petitioner has not satisfied its burden to demonstrate that claims 11–14 are unpatentable as having been obvious over Wendus and Moxon.

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED, based on a preponderance of evidence, that claims 10–14 of the '920 patent have *not* been shown to be unpatentable; and

FURTHER ORDERED, because this is a final written decision, the parties to this proceeding seeking judicial review of our Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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