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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte PETER G. SMITH, STUART S. OCHS, and
FREDERICK M. SCHWARZ

Appeal 2017-010042
Application 13/346,100
Technology Center 3700

Before JEREMY M. PLENZLER, GEORGE R. HOSKINS, and
PAUL J. KORNICZKY, *Administrative Patent Judges*.

HOSKINS, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

Appellant[1] appeals under 35 U.S.C. § 134 from the Examiner's decision rejecting claims 1, 3–10, 14, 15, and 17 in this application. The Board has jurisdiction over the appeal under 35 U.S.C. § 6(b).

We AFFIRM.

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[1] We use the word "Appellant" to refer to "applicant" as defined in 37 C.F.R. § 1.42. Appellant identifies the real party in interest as United Technologies Corporation. Appeal Br. 1 (dated Dec. 5, 2016).

CLAIMED SUBJECT MATTER

Claim 1 is the sole independent claim on appeal. Claims 1, 14, 15, and 17 are reproduced below. *See* Claims App. 2–4 (dated Jan. 4, 2017).

1. A gas turbine engine comprising:

a core engine disposed about an engine centerline axis, the core engine including a first spool and a second spool, the first spool including a first compressor and a first turbine and the second spool including a second compressor and a second turbine;

a core nacelle defined about the core engine;

a fan section disposed forward of the core engine;

a fan nacelle mounted at least partially around said core nacelle to define a fan bypass flow path for a fan bypass airflow;

a fan variable area nozzle movable relative said fan nacelle to vary a fan nozzle exit area and adjust a pressure ratio of the fan bypass airflow during engine operation;

a multiple of fan exit guide vanes in communication with said fan bypass flow path, said multiple of fan exit guide vanes rotatable about an axis of rotation to vary said fan bypass flow path, wherein the axis of rotation for each of the multiple fan exit guide vanes is located about a geometric center of gravity of a cross-section of the fan exit guide vane taken parallel to the engine centerline axis; and

a gear system driven by the core engine to drive a fan within said fan nacelle at a speed different than both the first compressor and the second compressor, said gear system defines a gear reduction ratio of greater than or equal to 2.5.

14. The engine as recited in claim 1, wherein said core engine includes a low pressure turbine which defines a pressure ratio that is greater than five (5).

15. The engine as recited in claim 1, wherein said bypass flow defines a bypass ratio greater than six (6).

17. The engine as recited in claim 1, wherein said bypass flow defines a bypass ratio greater than ten (10).

REJECTIONS ON APPEAL

Claims 1, 3–10, 14, 15, and 17 stand rejected under 35 U.S.C. § 112, first paragraph,[2] for lack of written description.[3]

Claims 1, 3–10, 14, 15, and 17 stand rejected under 35 U.S.C. § 112, first paragraph, for lack of enablement.

Claims 1, 3–10, 14, 15, and 17 stand rejected under 35 U.S.C. § 112, second paragraph, as indefinite.

Claims 5 and 6 stand rejected under 35 U.S.C. § 112, fourth paragraph, as being of improper dependent form.

Claims 1, 3, 4, 7, and 10 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Coplin (US 4,827,712, iss. May 9, 1989), Gisslen (US 3,892,358, iss. July 1, 1975), Neitzel (US 4,791,783, iss. Dec. 20, 1988), Suljak (US 2009/0067978 A1, pub. Mar. 12, 2009), and Dunbar ’187 (US 5,259,187, iss. Nov. 9, 1993).

Claims 5 and 6 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, Dunbar ’763 (US 6,292,763 B1, iss. Sept. 18, 2001), and Ferri (US 2,805,818, iss. Sept. 10, 1957).

Claims 8 and 9 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, and Rauch (D. Rauch, *Design Study of an Air Pump and Integral Lift Engine ALF-504*

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[2] The application on appeal was filed on January 9, 2012, before the AIA amendments to § 112 took effect on September 16, 2012. *See* Leahy-Smith America Invents Act (“the AIA”), Pub. L. No. 112–29, § 4(e), 125 Stat. 284, 297 (2011); MPEP § 2161(I).

[3] The Examiner has withdrawn some aspects of the written description rejection. *See* Ans. 2 (withdrawing Final Act. ¶¶ 4, 5).

Using the Lycoming 502 Core, NASA Report CR-120,992, NASA Lewis Research Center, Cleveland, Ohio, July 1972).

Claim 14 stands rejected under 35 U.S.C. § 103(a) as unpatentable over Coplin, Gisslen, Neitzel, Suljak, Dunbar '187, and Boggia (S. Boggia & K. Rüd, *lntercooled Recuperated Gas Turbine Engine Concept*, AIAA 2005–4192, 41st AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit, Tucson, Arizona, July 10–13, 2005).

Claims 15 and 17 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Coplin, Gisslen, Neitzel, Suljak, Dunbar '187, and Jane's Aero-Engines (Jane's Aero-Engines, Issue Seven, ed. Bill Gunston, Jane's Information Group Inc., Alexandria, Virginia, 2000).

OPINION

A. Written Description (Claims 1, 3–10, 14, 15, and 17)

The test for sufficiency of a written description under 35 U.S.C. § 112 ¶ 1 is whether an application's disclosure "reasonably conveys to those skilled in the art that the inventor had possession of the claimed subject matter as of the filing date." *Ariad Pharms., Inc. v. Eli Lilly & Co.*, 598 F.3d 1336, 1351 (Fed. Cir. 2010) (en banc). This "requires an objective inquiry into the four corners of the specification from the perspective of a person of ordinary skill in the art." *Id.* Written description and enablement are separate requirements of 35 U.S.C. § 112 ¶ 1, requiring different analyses. *Ariad*, 598 F.3d at 1342–54.

Claim 1

The Examiner determines Appellant's Specification fails to demonstrate possession of a "gear system defin[ing] a gear reduction ratio of greater than or equal to 2.5," as recited in claim 1. Final Act. 4–7 (emphasis by Examiner), 44–45. The Examiner acknowledges the Specification's disclosure that "the gear system may define a gear reduction ratio of greater than or equal to 2.5" (Spec. ¶¶ 10, 29), but dismisses the disclosure as "merely repeat[ing]" the claim language. Final Act. 5.

The Examiner relies on MPEP § 2163.03(V), which provides that "[a]n original claim may lack written description support when . . . the claim defines the invention in functional language specifying a desired result but the disclosure fails to sufficiently identify how the function is performed or the result is achieved." Final Act. 5 (emphases by Examiner). The Examiner determines the challenged subject matter in claim 1 correspondingly recites "functional language specifying a desired result, i.e., gear reduction ratio of greater than 2.5," and Appellant's Specification does not sufficiently specify structure(s) for achieving that result. *Id.* at 5, 44–45; Ans. 4–5.

The Examiner also finds Pratt & Whitney (a division of the real party in interest, United Technologies Corporation (*see* Coy[4], 3)) took seven years and spent several hundreds of millions of dollars to increase the 2.8125 gear reduction ratio in the PW8000 engine to 3.0 in the GTF engine, despite that other engines were already known to have gear reduction ratios of between 2.3 and 3.73. Final Act. 6–7 (citing Rauch, 1, 6, 36; Jane's Aero-Engines, 510–512; Warwick[5], 1–2). Based on that finding, the Examiner concludes a

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[4] P. Coy, *The Little Gear That Could Reshape the Jet Engine*, Bloomberg Business, Oct. 15, 2015.

[5] G. Warwick, *Civil Engines: Pratt & Whitney gears up for the future with GTF*, Flight, Nov. 2007.

person of ordinary skill in the art "would not have recognized that [Appellant was] in possession of the invention as claimed, i.e., gear reduction ratios ranging from 4.0 to 25, 50, 100, . . . , 2000 and greater." *Id.*

Appellant relies on paragraph 29 of the Specification as demonstrating possession of a gear system defining a gear reduction ratio of greater than or equal to 2.5. Appeal Br. 3. Appellant asserts the Examiner errs in requiring the Specification to demonstrate possession of gear reduction ratios "reach[ing] to infinity," because the law does not require Appellant to "demonstrate possession of theoretical and unachievable numerical values," even though claim 1 does not specify an upper limit for the gear reduction ratio. *Id.* at 4. Appellant contends a person of ordinary skill in the art would have known "inherent limitations exist" in achievable gear reduction ratios. *Id.*

The Examiner answers that Appellant's arguments are "just attorney argument," "without factual support in" the evidence of record including Appellant's Specification. Ans. 5–7. According to the Examiner, Appellant's claimed gear reduction ratio does "<u>not have an **inherent** upper limit because [ratio] values changed over time</u> as technology advanced." *Id.* at 5–6 (emphases by Examiner).

The issue here is written description, not enablement. The enablement requirement is discussed below. Written description requires only that the Specification demonstrates Appellant had possession of the claimed invention at the time the application was filed. *See Ariad*, 598 F.3d at 1351. That requirement is met here. Appellant's Specification demonstrates the invention encompasses a gas turbine engine having a gear reduction ratio of greater than or equal to 2.5. Spec. ¶¶ 10, 29. Nothing more is required. The

MPEP section cited by the Examiner concerns the discussion in *Ariad* relating to "a generic claim [that defines] the boundaries of a vast genus of chemical compounds," and whether "the applicant has invented species sufficient to support a claim to a genus." *Ariad*, 598 F.3d at 1349; MPEP § 2163.03(V). Such concerns do not apply here, where the challenged subject matter is a reduction ratio achieved by, for example, an epicycle gear train such as a planetary gear system. Spec. ¶ 29. The Examiner does not explain why such a gear system could not achieve a reduction ratio that greatly exceeds 2.5. *See* Final Act. 5, 44–45; Ans. 4–5. Therefore, we do not sustain the written description rejection of claim 1.

Claims 3–10

Claims 3–10 are rejected for lack of written description based solely on the challenged subject matter of their common parent claim 1. *See* Final Act. 4–11. For the reasons provided above in connection with claim 1, we do not sustain the written description rejection of claims 3–10.

Claim 14

The Examiner determines Appellant's Specification fails to demonstrate possession of "a low pressure turbine which defines a pressure ratio that is greater than five (5)," as recited in claim 14. Final Act. 7–9 (emphasis by Examiner), 44–45. The Examiner's reasoning in support of this rejection is substantially the same as the rejection of claim 1, re-cast to the low pressure turbine pressure ratio subject matter at issue here. *See id.*; Ans. 3–7. Appellant's response is likewise substantially the same. *See* Appeal Br. 4–5.

The issue here is written description, not enablement. The enablement requirement is discussed below. Appellant's Specification demonstrates the invention encompasses a low pressure turbine pressure ratio of greater than five (5). Spec. ¶¶ 11, 12, 29. Nothing more is required. The challenged subject matter is a pressure ratio achieved by a low pressure turbine. Spec. ¶¶ 28–30, Fig. 1A. The Examiner does not explain why a low pressure turbine could not achieve a pressure ratio that greatly exceeds five (5). *See* Final Act. 7–8, 44–45; Ans. 4–5. Therefore, we do not sustain the written description rejection of claim 14.

Claims 15 and 17

The Examiner determines Appellant's Specification fails to demonstrate possession of "a bypass ratio greater than six (6)" as recited in claim 15 or "greater than ten (10)" as recited in claim 17. Final Act. 9–11 (emphases by Examiner), 44–45. The Examiner's reasoning in support of this rejection is substantially the same as the rejection of claim 1, re-cast to the bypass ratio subject matter at issue here. *See id.*; Ans. 3–7. Appellant's response is likewise substantially the same. *See* Appeal Br. 4–5.

The issue here is written description, not enablement. The enablement requirement is discussed below. Appellant's Specification demonstrates the invention encompasses a bypass ratio of greater than "about six (6)," or more narrowly of greater than 10. Spec. ¶¶ 13, 29. Nothing more is required, at least regarding the upper end of the claimed range, which is the basis for the Examiner's rejection.[6] The challenged subject matter is a bypass ratio achieved by the geometrical configuration of a gas turbine engine splitting an incoming airflow into a bypass flow path and a core flow path. Spec. ¶¶ 5, 13, 29, 31, 34, 37, Fig. 1A. The Examiner does not explain why such an engine geometry could not achieve a bypass ratio that greatly exceeds six (6) or ten (10). *See* Final Act. 9–11, 44–45; Ans. 4–5. Therefore, we do not sustain the written description rejection of claims 15 and 17.

B. Enablement (Claims 1, 3–10, 14, 15, and 17)

A specification is not enabling if a person of ordinary skill in the art would require "undue experimentation" to practice the claimed invention. *In re Wands*, 858 F.2d 731, 736–37 (Fed. Cir. 1988). "Enablement is not precluded by the necessity for *some* experimentation." *Id.* (emphasis added); *see also Enzo Biochem, Inc. v. Calgene Inc.*, 188 F.3d 1362, 1371 (Fed. Cir. 1999) (enablement is not negated if a reasonable amount of experimentation is required to practice the claimed invention). Whether undue experimentation would be necessary is not a single, simple factual determination, but rather is a conclusion reached by weighing many factual considerations, such as: (1) the quantity of experimentation necessary, (2) the amount of direction or guidance presented, (3) the presence or absence of working examples, (4) the nature of the invention, (5) the state of the prior art, (6) the relative skill of those in the art, (7) the predictability or unpredictability of the art, and (8) the breadth of the claims. *Wands*,

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[6] The difference between "greater than *about* six (6)" in Appellant's Specification (emphasis added), and "greater than six (6)" in claim 15, is not at issue in the rejection on appeal.

858 F.2d at 736–37. "A patent need not disclose what is well known in the art." *Id.* at 735.

The Examiner and Appellant agree that the decision in *Scripps Clinic & Research Found. v. Genetech, Inc.*, 927 F.2d 1565 (Fed. Cir. 1991), *overruled on other grounds*, *Abbott Labs. v. Sandoz, Inc.*, 566 F.3d 1282, 1291–92 (Fed. Cir. 2009) (en banc), pertains to the enablement of an open-ended range of values, such as recited in the claims at issue here. *See* Final Act. 22–24, 46 (also citing *Andersen Corp. v. Fiber Composites, LLC*, 474 F.3d 1361, 1376–77 (Fed. Cir. 2007)); Appeal Br. 5–6. In *Scripps*, the court stated "[o]pen-ended claims are not inherently improper; as for all claims their appropriateness depends on the particular facts of the invention, the disclosure, and the prior art." *Scripps*, 927 F.2d at 1572. Further, such claims "may be supported if there is an inherent, albeit not precisely known, upper limit and the specification enables one of skill in the art to approach that limit." *Id.* (citing *In re Fisher*, 427 F.2d 833, 839 (CCPA 1970)).

Claim 1

The Examiner determines Appellant's Specification does not enable a gas turbine engine comprising a gear reduction ratio of greater than or equal to 2.5, as recited in claim 1, because the recited range "is not bounded at its upper limit and therefore includes gear reduction ratios ranging from 2.5 to 25, 50, 100, . . . , 2000 and greater." Final Act. 12. The Examiner notes "the scope of the claims must bear a reasonable correlation to the scope of enablement provided by the specification to persons of ordinary skill in the art." *Id.* at 13–14, 21–22 (emphasis omitted) (quoting *Fisher*, 427 F.2d at 839). The Examiner also determines Appellant "cannot rely on the knowledge of one skilled in the art to supply information that is required to enable the novel aspect of the claimed invention when the enabling knowledge is in fact not known in the art." *Id.* at 16–17 (citing *ALZA Corp. v. Andrx Pharms., LLC,* 603 F.3d 935, 941 (Fed. Cir. 2010); MPEP § 2161.0(III)). The Examiner, further, provides an analysis of the *Wands* factors. *Id.* at 17–18.

The Examiner finds Pratt & Whitney took 20–30 years and spent several hundreds of millions of dollars to increase the 2.8125 gear reduction ratio in the PW8000 engine to 3.0 in the GTF engine, despite that other engines were already known to have gear reduction ratios of between 2.3 and 3.73. Final Act. 14–16, 18 (citing Rauch, 1, 6, 36; Jane's Aero-Engines, 510–512; Warwick; Coy).

Applying the *Scripps* decision, *supra*, the Examiner finds the gear reduction ratio at issue here does "not have an inherent upper limit," because it is an engineering design variable, unlike the blood protein purity percentage at issue in *Scripps* which had an inherent upper limit of 100%. Final Act. 23–24 (emphasis by Examiner), 49–50. The Examiner takes official notice that, as technology has advanced and will continue to advance over time, stronger and lighter materials will be created, thus increasing achievable gear reduction ratios. *Id.* at 50–51; Ans. 16–17. The Examiner further determines Appellant's Specification fails to enable a person of ordinary skill in the art to approach any sort of limit, because it does not describe any details of a gear reduction structure to achieve an unbounded limit. Final Act. 24, 46–49.

Appellant argues a person of ordinary skill in the art would know that a gear reduction ratio has "a practical upper limit that is far short from infinity," based on constraints imposed for a feasibly working gas turbine engine. Appeal Br. 5–8. For example, according to Appellant, the fan must turn with enough speed to deliver air to the engine core to power the engine, and to deliver air to the bypass flow path to provide thrust, yet at the same time "the fan must turn at a speed within practical, physical limits, making an infinite gear ratio impractical." *Id.* at 8. Appellant additionally asserts the "Examiner's own research" demonstrates that gas turbine engine advances "occur in small predictable increments over a long period of time," and "that the gas turbine engine art is mature." *Id.* at 7.

The Examiner replies that Appellant's Specification "failed to disclose any space limitations, material limitations, weight limitations, operational limitations, etcetera," and Appellant has "failed to explain how one of ordinary skill in the art could determine the alleged practical upper limits of the gear reduction ratio." Final Act. 49–50, 57; Ans. 8–11, 15–16, 28–32.

Upon consideration of the foregoing, we note first that the subject matter at issue (*Wands* factor (4)) is a gear system having "a gear reduction ratio of greater than or equal to 2.5." Claims App. 2. The gear system is placed between a turbine-compressor spool and a fan, so that energy extracted from an airflow by the turbine can power the fan, at a lesser rotational speed than the turbine-compressor spool. *Id.*; Spec. ¶¶ 5, 28–30, Fig. 1A. Appellant's Specification indicates an epicycle gear train such as a planetary gear system may be suitable here. Spec. ¶ 29.

We appreciate that Appellant's Specification in the foregoing regards is sparse, and Appellant's figures are highly schematic (*Wands* factors (1)–(3)), thus requiring some amount of experimentation to implement the claimed invention. Nonetheless, "a patent need not teach, and preferably omits, what is well known in the art" (*Wands* factors (5)–(7)). *Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1384 (Fed. Cir. 1986) (citing *Lindemann Maschinenfabrik v. American Hoist & Derrick*, 730 F.2d 1452, 1463 (Fed. Cir. 1984)). We determine the state of the art of gear systems was advanced, and gear systems were highly predictable, at the time of Appellant's invention (*Wands* factors (5) and (7)). A person of ordinary skill in the art would have known how to change the size and configuration of various gears, such as in a planetary gear system, to achieve a desired gear reduction ratio (*Wands* factors (6) and (7)).

As to the breadth of the claims (*Wands* factor (8)), we determine a person of ordinary skill in the art would have appreciated that the claimed gear reduction ratio has an inherent, albeit not precisely known, upper limit. *Scripps*, 566 F.3d at 1572. The gear reduction ratio equals the rotational speed of the turbine-compressor spool, divided by the rotational speed of the fan. It is therefore mathematically limited by an inherent *maximum* rotational speed achievable by the turbine-compressor spool. This inherent maximal limitation arises from the finitely available airflow to drive spool rotation, the weight of the spool, the energy extraction work performed by the turbine, and the air compression work performed by the compressor. The ratio is, further, limited by an inherent *minimum* rotational speed of the fan, which is required to power the engine and fly the aircraft.

The Examiner cites two cases holding that claims were not enabled due to open-ended upper ranges of certain performance characteristics. However, these cases concerned arts that are far less predictable than the gear systems at issue here. *See MagSil Corp. v. Hitachi Global Storage Techs., Inc.*, 687 F.3d 1377, 1378–79, 1381 (Fed. Cir. 2012) (applying electromagnetic energy to a quantum mechanical effect tunnel junction "causes a change in resistance by at least 10% at room temperature," where "the inventors' best efforts [had] achieved a maximum change in resistance of only 11.8% at room temperature"); *Fisher*, 427 F.2d at 839 (drug potency of "at least 1 International Unit of ACTH per milligram," which unlike "mechanical" cases involving "predictable factors," concerns "unpredictable factors" such as "chemical reactions and physiological activity"). Thus, the results reached in those cases are distinguished from the facts presented here.

The Examiner cites various items of evidence reflecting the time and money spent to develop commercial gas turbine engines. This evidence does not persuade us of lack of enablement. The enablement inquiry concerns whether a person of ordinary skill in the art is able to make and use the full scope of the claimed invention. That is, *can* it be done? Developing a commercially acceptable engine, by contrast, encompasses many additional considerations. For example, Jane's Aero-Engines identifies the "prime requirements driving current civil aircraft engine developments" as including: (1) "reduced costs, throughout the whole life cycle of the engine" by achieving "reduced purchase costs," "reduced fuel consumption," and "increased component life"; (2) "reduced environmental impact"; (3) "improved reliability"; and (4) "levels of safety as good as or better than those being achieved today." Jane's Aero-Engines, 21. Many of these considerations have little or nothing to do with whether a person of ordinary skill in the art could make or use a gear system with a gear reduction ratio that greatly exceeds 2.5.

The strongest evidence against enablement in this regard is provided by Warwick and Coy, which focus on the gear system(s) being developed by Pratt & Whitney. Warwick indicates "P&W believes its GTF geared turbofan is a 'game changer,'" and "P&W has already spent $1 billion over the past 20 years on geared turbofan research and development, and its spending is running at $100 million a year." Warwick, 1. Coy concludes "Pratt & Whitney's new PurePower Geared Turbofan aircraft engines are impressive beasts." Coy, 1. However, these articles demonstrate, when read as a whole, that large portions of Pratt & Whitney's research and development were directed to *optimization* of a geared turbofan engine for *commercial* use, not simply making a geared turbofan engine that will work. There is little evidence of record directed to the latter issue, which is the critical issue here.

For the foregoing reasons, we do not sustain the rejection of claim 1 as lacking enablement.

Claims 3–10

Claims 3–10 are rejected for lack of enablement based solely on the challenged subject matter of their common parent claim 1. *See* Final Act. 12–24, 46–59. For the reasons provided above in connection with claim 1, we do not sustain the enablement rejection of claims 3–10.

Claim 14

The Examiner determines Appellant's Specification does not enable a gas turbine engine comprising a low pressure turbine pressure ratio of greater than five (5), as recited in claim 14, because the recited range "is not bounded at its upper limit and therefore includes pressure ratios ranging from 5 to 10, 50, 100, 500, . . . , 5000 and greater." Final Act. 12. The Examiner notes "the scope of the claims must bear a reasonable correlation to the scope of enablement provided by the specification to persons of ordinary skill in the art." *Id.* at 13–14, 21–22 (emphasis omitted) (quoting *Fisher*, 427 F.2d at 839). The Examiner also determines Appellant "cannot rely on the knowledge of one skilled in the art to supply information that is required to enable the novel aspect of the claimed invention when the enabling knowledge is in fact not known in the art." *Id.* at 16–17 (citing *ALZA*, 603 F.3d at 941; and MPEP § 2161.0(III)). The Examiner, further, provides an analysis of the *Wands* factors. *Id.* at 18–19.

The Examiner finds Pratt & Whitney took 20–30 years and spent several hundreds of millions of dollars to develop the GTF engine, despite that other turbines were already known to have pressure ratios of between about 4 to 9.5. Final Act. 16 (citing Boggia, Fig. 5; Warwick; Coy).

Applying the *Scripps* decision, *supra*, the Examiner finds the turbine pressure ratio at issue here does "not have an inherent upper limit," because it is an engineering design variable. Final Act. 23–24 (emphasis by Examiner), 49–50. The Examiner takes official notice that, as technology has advanced and will continue to advance over time, stronger and lighter materials will be created, thus increasing achievable turbine pressure ratios. *Id.* at 50–51; Ans. 16–17. The Examiner further determines Appellant's Specification fails to enable a person of ordinary skill in the art to approach any sort of limit, because it does not describe any details of a turbine structure to achieve an unbounded limit. Final Act. 24, 46–49.

Appellant argues a person of ordinary skill in the art would know that a turbine pressure ratio has "a practical upper limit that is far short from infinity," based on constraints imposed for a feasibly working gas turbine engine. Appeal Br. 5–8. Appellant contends "an infinitely high [turbine] pressure ratio would neither be desirable nor achievable," because this "would cause a complete obstruction of the flow of combustion products through the gas path, rendering the engine inoperable." *Id.* at 8. Appellant additionally asserts the "Examiner's own research" demonstrates that gas turbine engine advances "occur in small predictable increments over a long period of time," and "that the gas turbine engine art is mature." *Id.* at 7.

The Examiner replies that Appellant's Specification "failed to disclose any space limitations, material limitations, weight limitations, operational limitations, etcetera," and Appellant has "failed to explain how one of ordinary skill in the art could determine the alleged practical upper limits of . . . the [turbine] pressure ratio." Final Act. 49–50, 57; Ans. 8–11, 15–16, 28–32.

Upon consideration of the foregoing, we note first that the subject matter at issue (*Wands* factor (4)) is a low pressure turbine having "a pressure ratio that is greater than about five (5)." Claims App. 3. The low pressure turbine converts the energy of an expanding airflow to a rotational energy, to drive the low pressure compressor and the fan. Spec. ¶ 30. The amount of converted energy is reflected by the turbine's pressure ratio value. *Id.* ¶ 29.

We appreciate that Appellant's Specification in the foregoing regards is sparse, and Appellant's figures are highly schematic (*Wands* factors (1)–(3)), thus requiring some amount of experimentation to implement the claimed invention. A person of ordinary skill in the art would have known that a low pressure turbine has an alternating series of stationary and rotating blades to convert the energy of an expanding airflow to a rotational energy. *See* Jane's Aero-Engines, 14 (Figure), 16 (low pressure turbine "uses several alternating sets of nozzle guide vanes and rotor blades to extract enough power to drive the fan"). We determine the state of the art of low pressure turbines was advanced, and low pressure turbines were highly predictable, at the time of Appellant's invention (*Wands* factors (5) and (7)). A person of ordinary skill in the art would have known how to change the size and configuration of the turbine blades to achieve a desired pressure ratio (*Wands* factors (6) and (7)).

As to the breadth of the claims (*Wands* factor (8)), we determine a person of ordinary skill in the art would have appreciated that the claimed pressure ratio has an inherent, albeit not precisely known, upper limit. *Scripps*, 566 F.3d at 1572. The ratio equals the "pressure measured prior to inlet of low pressure turbine 18 as related to the pressure at the outlet of the low pressure turbine 18 prior to exhaust nozzle." Spec. ¶ 29. It is therefore mathematically limited by an inherent *maximum* pressure achievable at the turbine inlet. This inherent maximum limitation arises from the finitely available airflow to drive the low pressure turbine, and the fact that the high pressure turbine will dissipate some of the airflow's energy before it reaches the low pressure turbine. *See* Spec. ¶ 30, Fig. 1A. The inherent maximum limitation arises further from the finite capabilities of the fan, the high and low pressure compressors, and the combustor disposed upstream of the low pressure turbine. *See id.*

The Examiner cites two cases holding that claims were not enabled due to open-ended upper ranges of certain performance characteristics. As explained above with respect to claim 1, the results reached in those cases are distinguished from the facts presented here.

The Examiner cites various items of evidence reflecting the time and money spent to develop commercial gas turbine engines. This evidence does not persuade us of lack of enablement, for substantially the same reasons discussed above in connection with the gear system of claim 1.

For the foregoing reasons, we do not sustain the rejection of claim 14 as lacking enablement.

Claims 15 and 17

The Examiner determines Appellant's Specification does not enable a gas turbine engine comprising a bypass ratio greater than six (6) as recited in claim 15, or greater than ten (10) as recited in claim 17, because the recited ranges are "not bounded at [their] upper limit and therefore include[] bypass ratios ranging from 6 to 15, 25, 50, 100, . . . , 250 and greater." Final Act. 12–13. The Examiner notes "the scope of the claims must bear a reasonable correlation to the scope of enablement provided by the specification to persons of ordinary skill in the art." *Id.* at 13–14, 21–22 (emphasis omitted) (quoting *Fisher*, 427 F.2d at 839). The Examiner also determines Appellant "cannot rely on the knowledge of one skilled in the art to supply information that is required to enable the novel aspect of the claimed invention when the enabling knowledge is in fact not known in the art." *Id.* at 16–17 (citing *ALZA*, 603 F.3d at 941; and MPEP § 2161.0(III)). The Examiner, further, provides an analysis of the *Wands* factors. *Id.* at 18–19.

The Examiner finds Pratt & Whitney took 20–30 years and spent several hundreds of millions of dollars to increase the bypass ratio of 10 in the PW8000 engine to 10–12 in the GTF engine, despite that other engines were already known to have bypass ratios of 12.5. Final Act. 14–16, 19 (citing Rauch, 1, 6; Jane's Aero-Engines, 510–512; Warwick; Coy). The Examiner also finds Rolls Royce, a competitor of Pratt & Whitney in the gas turbine engine market, similarly took 18 years of research and development to achieve a bypass ratio of 11 or 15. *Id.* at 20–21 (citing Read[7]).

Applying the *Scripps* decision, *supra*, the Examiner finds the bypass ratio at issue here does "not have an inherent upper limit," because it is an engineering design variable. Final Act. 23–24 (emphasis by Examiner), 49–50. The Examiner takes official notice that, as technology has advanced and will continue to advance over time, stronger and lighter materials will be created, thus increasing achievable bypass ratios. *Id.* at 50–51; *see also id.* at 51–56 (extended discussion of engine bypass ratios over time); Ans. 23–27 (additional discussion). The Examiner further determines Appellant's Specification fails to enable a person of ordinary skill in the art to approach any sort of limit, because it does not describe any details of an engine structure to achieve an unbounded limit. Final Act. 24, 46–49.

Appellant argues a person of ordinary skill in the art would know that a bypass ratio has "a practical upper limit that is far short from infinity," based on constraints imposed for a feasibly working gas turbine engine. Appeal Br. 5–8. For example, according to Appellant, "[t]he minimum amount of airflow required to operate the engine," and practical limitations

[7] B. Read, *Powerplant Revolution*, AeroSpace (May 2014), at 28–31.

on the overall size of an aircraft engine, "provide[] an inherent practical upper limitation to the claimed bypass ratio." *Id.* at 8. Appellant additionally asserts the "Examiner's own research" demonstrates that gas turbine engine advances "occur in small predictable increments over a long period of time," and "that the gas turbine engine art is mature." *Id.* at 7.

The Examiner replies that Appellant's Specification "failed to disclose any space limitations, material limitations, weight limitations, operational limitations, etcetera," and Appellant has "failed to explain how one of ordinary skill in the art could determine the alleged practical upper limits of . . . the bypass ratio." Final Act. 49–50, 57; Ans. 8–11, 15–16, 28–32. The Examiner, further, cites additional evidence concerning advances in materials required to make longer fan blades to accommodate an increase in engine size for a higher bypass ratio. Ans. 12–15 (citing "Eric Adams, 'The World's Hugest Jet Engine is Wider than a 737's Fuselage', April 28, 2016, Pgs. 2 and 3").

Upon consideration of the foregoing, we note first that the subject matter at issue (*Wands* factor (4)) is a gas turbine engine having a bypass flow that "defines a bypass ratio greater than six (6)" or "greater than ten (10)." Claims App. 3–4. The bypass flow area is "disposed radially outward of the primary core exhaust path," defining an "annular" space around the engine core. *Id.*; Spec. ¶¶ 3, 31, Fig. 1A (bypass flow path 40 lies between core nacelle 12 and fan nacelle 34). Thus, the airflow delivered by the engine's fan is split into two paths, a first path through the engine core to power the engine, and a second "bypass" path surrounding the engine core to provide thrust for the aircraft. Spec. ¶¶ 3, 28–31, Fig. 1A (arrows showing core engine airflow path to exhaust E, and bypass flow path B).

We appreciate that Appellant's Specification in the foregoing regards is sparse, and Appellant's figures are highly schematic (*Wands* factors (1)–(3)), thus requiring some amount of experimentation to implement the claimed invention. We determine the state of the art of high bypass flow engines was advanced and predictable at the time of Appellant's invention (*Wands* factors (5) and (7)). A person of ordinary skill in the art would have known how to change the relative sizes of the engine core nacelle (such as nacelle 12 in Appellant's Figure 1) and the fan nacelle (nacelle 34), as well as the geometry of the engine downstream of the fan (fan 20) where the airflow paths diverge, to achieve a desired bypass ratio (*Wands* factors (6) and (7)).

As to the breadth of the claims (*Wands* factor (8)), we determine a person of ordinary skill in the art would have appreciated that the claimed bypass ratio has an inherent, albeit not precisely known, upper limit. *Scripps*, 566 F.3d at 1572. The ratio reflects how much larger the bypass airflow path is, versus the core engine airflow path. This inherent upper limit arises from the fact that the fan nacelle (such as nacelle 34 in Appellant's Figure 1) cannot be infinitely large, and the engine core nacelle (nacelle 12) cannot be infinitely small, while still forming a working gas turbine engine.

The Examiner cites two cases holding that claims were not enabled due to open-ended upper ranges of certain performance characteristics. As explained above with respect to claim 1, the results reached in those cases are distinguished from the facts presented here.

The Examiner cites various items of evidence reflecting the time and money spent to develop commercial gas turbine engines. This evidence does not persuade us of lack of enablement, for substantially the same reasons discussed above in connection with the gear system of claim 1.

For the foregoing reasons, we do not sustain the rejection of claims 15 and 17 as lacking enablement.

C. Definiteness (Claims 1, 3–10, 14, 15, and 17)

"[T]he statutory language of 'particular[ity]' and 'distinct[ness]'" in 35 U.S.C. § 112, second paragraph, requires claims "to be cast in clear—as opposed to ambiguous, vague, indefinite—terms." *In re Packard*, 751 F.3d 1307, 1313 (Fed. Cir. 2014). A claim is indefinite when it contains words or phrases whose meaning is unclear to a person of ordinary skill in the art. *Ex parte McAward*, Appeal No. 2015–006416, 2017 WL 3669566, at *2–6 (PTAB Aug. 25, 2017) (precedential); *Ex parte Miyazaki*, Appeal No. 2007–3300, 2008 WL 5105055, at *4 (BPAI Nov. 19, 2008) (precedential) ("[t]he test for definiteness under 35 U.S.C. § 112, second paragraph, is whether 'those skilled in the art would understand what is claimed when the claim is read in light of the specification'") (quoting *Orthokinetics, Inc. v. Safety Travel Chairs, Inc.*, 806 F.2d 1565, 1576 (Fed. Cir. 1986)).

The Examiner determines the claim term "greater than" in claims 1, 14, 15, and 17 "is indefinite as it is <u>not bounded at its upper limit</u>; therefore, applicant has failed to define the metes and bounds of applicant's claimed invention." Final Act. 25 (emphasis by Examiner); Ans. 40.

Appellant responds that the claims are not unclear, and "[t]he Examiner's requirement that both upper and lower limits be explicitly recited is legally unfounded." Appeal Br. 9–10. Further according to Appellant, "even if an upper limit were required," "there are practical and inherent physical upper limits to the claimed gear ratio, pressure ratio, and bypass ratios [based on] the basic architecture of a bypass turbine engine." *Id*. at 10; Reply Br. 6–7. Appellant cites *Fisher*, 427 F.2d at 838, as holding that "the recitation of an open-ended ratio of 'at least 1 International Unit of ACTH per milligram' was definite." Appeal Br. 10.

The Examiner replies that the *Fisher* decision is distinguishable here, because it addressed definiteness of the term "International Unit," not the definiteness of an open-ended range. Ans. 40–42. The Examiner also concludes Appellant has "failed to explain how one of ordinary skill in the art could determine the alleged inherent limitations of the gear reduction ratio, the pressure ratio, and the (BPR) bypass ratio," and Appellant's Specification "failed to disclose any constraints that would have placed the alleged physical and structural limitation on the claimed open-ended figures of merit." *Id.* at 42–43.

We conclude the claims at issue here are not unclear, simply because they fail to place an express upper boundary on the claimed ranges of values for a gear reduction ratio, a low pressure turbine pressure ratio, and a bypass ratio. The claims may be broad in these respects, but they are not unclear. As in *Fisher*, this breadth of the claims may raise the issue of whether Appellant's disclosure enables the claimed invention, but the claims are not thereby indefinite. *See Fisher*, 427 F.2d at 838 (claims are not indefinite for failing to identify the amino acid structure beyond the 24th position in the claimed compound).

Thus, we do not sustain the rejection of claims 1, 3–10, 14, 15, and 17 as indefinite.

D. Dependent Form (Claims 5 and 6)

The Examiner determines claim 5 fails to "specify a further limitation" of claim 1 as required by 35 U.S.C. § 112, ¶ 4. Final Act. 25–27. The Examiner's position is that claim 5 is inconsistent with subject matter recited in claim 1. *Id.* In particular, claim 1 recites fan exit guide vanes which are "rotatable about an axis of rotation [that] is located about a geometric center of gravity of a cross-section of the fan exit guide vane taken parallel to the engine centerline axis." Claims App. 2; Final Act. 26. Claim 5 depends from claim 1, and recites that each fan exit guide vane includes "a pivotable portion rotatable about said axis of rotation relative a fixed portion," and claim 6 depends from claim 5. Claims App. 3; Final Act. 26–27.

Appellant argues the rejection is improper, because claim 5 "recite[s] features disclosed in Figures 3A–C" of Appellant's Specification. Appeal Br. 11 (citing Spec. ¶ 39).

The Examiner replies that claims 1 and 5, when read together, improperly "combin[e] two different embodiments that are not disclosed as being combinable." Ans. 44–50 (emphasis by Examiner). The Examiner interprets claim 1 as encompassing the embodiment of Figures 2A–2C but not the embodiment of Figures 3A–3C, and interprets claim 5 as encompassing the embodiment of Figures 3A–3C but not the embodiment of Figures 2A–2C. *Id.* Appellant, in response, cites the arguments presented in the Appeal Brief. Reply Br. 7.

Claim 1 requires a guide vane having an axis of rotation that "is located about a geometric center of gravity of a cross-section of the" guide vane. Claims App. 2. That limitation encompasses the embodiment of

Appellant's Figures 2A–2C, wherein guide vane 50 has axis of rotation 60, which is located about the geometric center of gravity of the cross-section of vane 50 shown in the Figures. *See* Spec. ¶¶ 18–20, 35–36. The limitation does not encompass the embodiment of Appellant's Figures 3A–3C, wherein guide vane 50′ has pivoting portion 66P which pivots around axis of rotation 60 relative to fixed portion 66F. *Id.* ¶¶ 21–23, 39. As the Examiner explains, the pivoting movement of portion 66P relative to portion 66F *changes* the geometric center of gravity of guide vane 50′, such that the center does not coincide with the axis of rotation, as is required by claim 1. *See* Ans. 44–50.

Although the Examiner sets forth reasons why claims 5 and 6 may be indefinite or lack written description support, the Examiner has failed to establish sufficiently that claim 5 is an improper dependent claim. We see no persuasive reason why claim 5 does not further limit claim 1, even if those further limitations may mix various embodiments from Appellant's Specification, or result in an indefinite claim. Accordingly, we do not sustain the Examiner's decision to reject claims 5 and 6 as improper under 35 U.S.C. § 112, ¶ 4.

E. Obviousness Over Coplin, Gisslen, Neitzel, Suljak, and Dunbar '187 (Claims 1, 3, 4, 7, and 10)

<u>*Claim 1*</u>

The Examiner finds Coplin discloses, in Figures 1–2, gas turbine engine 10 having each and every limitation of claim 1, except for (1) a fan variable area nozzle at the exit of the bypass flow path, and (2) rotatable fan exit guide vanes in the bypass flow path. Final Act. 28–29. In the latter regard, the Examiner finds Coplin's engine 10 has fan exit guide vanes 112, but vanes 112 are not rotatable. *Id.*; Coplin, Fig. 1, 2:43–45, 3:42–46, 5:31–34 (engine 10 has fan casing 108 secured to core casing 22 by a plurality of circumferentially arranged struts 112, located downstream of fan 76). Appellant does not dispute these findings, which we find are supported by a preponderance of the evidence. *See* Final Act. 28 (annotating Coplin, Fig. 1, to illustrate findings); Appeal Br. 11–13 (no disputes); 37 C.F.R. § 41.37(c)(1)(iv) (arguments not included in Appeal Brief are waived).

For the recited fan variable area nozzle at the exit of the bypass flow path, the Examiner finds Gisslen discloses a gas turbine engine having this feature. Final Act. 29–30. In particular, the Examiner finds Gisslen's engine 10 has fan variable area nozzle 20 that is moveable relative to fan nacelle 14 to vary the exit area and adjust a pressure ratio of the bypass airflow during engine operation. *Id.*; *see* Gisslen, Figs. 1–3, 1:55–61, 1:66–67, 2:5–15. The Examiner determines it would have been obvious to modify Coplin's engine 10 to incorporate this feature, based on the express teaching in Gisslen that "it is *often necessary or desirable* to provide a variable area exhaust nozzle *to enhance performance during various modes of engine operation* such as take-off, cruise or climb." Gisslen, 1:6–14 (emphasis added); Final Act. 30.

Appellant responds that Coplin teaches away from this proposed modification, because it is contrary to Coplin's intended purpose. Appeal Br. 13. Appellant asserts Coplin already has "flaps or petals 114 that provide a variable exhaust nozzle from the core engine [12]," for "controlling operation of the fan [72] by controlling the rotational speed of the turbine [20] driving the fan to control thrust during take-off conditions."

Id. (emphasis added). Further according to Appellant, Coplin's intended purpose is "to provide an engine of reduced size and weight," including "that a diameter and length of the fan casing is minimized." *Id.* (citing Coplin, 8:30–42, 6:39–48). Appellant contends adding a fan variable area nozzle at the exit of the bypass flow path in Coplin's engine 10, therefore, is contrary to the intended purpose of Coplin. *Id.*

We determine the Examiner has provided a rational underpinning, supported by a preponderance of the evidence, sufficient to support the legal conclusion of obviousness. *See 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 particular, Gisslen discloses that it may be necessary, or at least desirable, to provide a variable area exhaust nozzle to tailor the performance of a gas turbine engine to different phases of an airplane flight, such as take-off, cruise, and climb. Gisslen, 1:6–14. This teaching provides ample motivation for a person of ordinary skill in the art to add a variable area exhaust nozzle to Coplin's engine 10.

Coplin does not teach away from this modification, because Coplin does not criticize, discredit, or discourage using a variable area exhaust nozzle in Coplin's engine 10. *See In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004). Appellant argues Coplin's pivoting flaps 114 already perform the same function that would be provided by a variable area exhaust nozzle. Appeal Br. 13. However, this argument is unsupported by any citation to or discussion of Coplin's disclosure. *See id.* Based on our review of Coplin's disclosure, we find flaps 114, which are disposed directly downstream of low pressure turbine 20 at the exit of engine core 12, are used "to vary the expansion ratio of" low pressure turbine 20. *See* Coplin, Fig. 1, 3:15, 5:39–45. Thus, flaps 114 are not used to vary the pressure ratio across fan 72, which is the function performed by a variable area exhaust nozzle placed at the exit of Coplin's bypass flow path. We appreciate that low pressure turbine 20 powers fan 72. *See id.* at 3:20–22, 5:45–52. However, the principal purpose of flaps 114 is to maximize the fuel economy of the engine by changing fan speed during different phases of an airplane flight, *not* by varying the pressure ratio across fan 72. *See id.* at 5:45–63. Thus, we find Coplin's existing flaps 114 do not teach away from adding a variable area exhaust nozzle at the exit of Coplin's bypass flow path.

We also appreciate that Coplin, like most engine designers, would generally prefer a lighter and smaller gas turbine engine, all things being equal. *See, e.g.*, Coplin, Abstract, 1:9–18, 1:31–34, 1:57–62, 6:14–15, 6:39–48, 6:62–65, 8:30–42; *Polaris Indus., Inc. v. Arctic Cat, Inc.*, 882 F.3d 1056, 1067–70 (Fed. Cir. 2018) (even in the absence of a teaching away, general preferences as stated in the prior art are still relevant to determining whether a skilled artisan would be motivated to combine the prior art in the manner claimed). However, not all things are equal here. For example, Coplin discloses that reduction gear assembly 62 beneficially improves the efficiency of engine 10, despite the weight added to engine 10 by gear assembly 62. *See* Coplin, 1:38–46, 3:27–41, 3:52–61. Similarly, Gisslen discloses that a fan variable area nozzle enhances engine performance, despite the weight added by the variable nozzle. *See* Gisslen, 1:6–9, 2:5–23. Thus, weighing the evidence as a whole, we determine a person of ordinary skill in the art would have been motivated to pursue the desirable performance characteristics provided by adding a variable area exhaust nozzle to Coplin's engine 10, despite the resulting increase in engine weight.

See In re Urbanski, 809 F.3d 1237, 1243–44 (Fed. Cir. 2016) (person of ordinary skill in the art may be motivated to pursue desirable properties of one prior art reference, even at the expense of foregoing a benefit taught by another prior art reference).

Next, for the recited “rotatable” fan exit guide vanes, the Examiner relies upon the combined disclosures of Neitzel, Suljak, and Dunbar ’187. Final Act. 30–34. The Examiner finds Neitzel discloses, as shown in Figure 3, a gas turbine engine having fan exit guide vanes (i.e., outlet guide vanes 48) rotatable about an axis of rotation to vary a fan bypass flow path (i.e., bypass duct 58), wherein the axis of rotation is located about a geometric center of gravity of a cross-section of the fan exit guide vanes taken parallel to the engine centerline axis. Final Act. 30–31; *see* Neitzel, 4:6–8, 4:40–41. The Examiner finds Suljak discloses that guide vanes were conventionally rotated around a geometric center of gravity of the airfoil cross-section. Final Act. 31 (citing Suljak ¶ 21). The Examiner finds Dunbar ’187 discloses, as shown in Figure 1, rotatable fan exit guide vanes 52 disposed downstream of fan blades 30. *Id.* (citing Dunbar ’187, 1:42–51, 2:18–44, 3:65–4:20).

Based on those teachings of Neitzel, Suljak, and Dunbar ’187, the Examiner determines it would have been obvious to modify Coplin’s engine 10 so that fan exit guide vanes 112 are rotatable about their geometric centers of gravity. *Id.* at 31–34. As motivation, the Examiner finds Dunbar ’187 discloses “that pivoting/rotating a multiple of fan exit guide vanes facilitated improved engine efficiency by reducing the bypass air swirl angle which reduced drag and increased engine thrust.” *Id.* at 31 (citing Dunbar ’187, 1:42–51, 2:18–44, 3:65–4:20). The Examiner further determines that rotating Coplin's vanes 112 about their geometric centers of gravity would have advantageously reduced the amount of force required to rotate vanes 112, "because the moments generated by the upstream air pressure on opposite sides of [vanes 112] would have substantially canceled each other out," thereby reducing the size, weight, and cost of rotating vanes 112. *Id.* at 31–32.

Appellant argues the Examiner errs in relying on Neitzel in the foregoing regards. *See* Appeal Br. 11–13. We agree. Neitzel's gas turbofan aircraft engine 30, shown in Figures 2–3, is "convertible" between a turbofan mode and a turboshaft mode. Neitzel, 1:5–20, 3:36–40. In turbofan mode, engine 30 rotates fan 32 to provide forward thrust for the aircraft, in a similar fashion to Coplin's engine 10. *Id.* at 1:11–17, 3:40–50. In turboshaft mode, engine 30 rotates vertical shaft 42 to power a helicopter rotor to provide vertical thrust. *Id.* at 1:11–17, 3:40–60.

Neitzel's outlet guide vanes 48, cited by the Examiner, are rotated between an open position for turbofan mode, and a closed position for turboshaft mode to reduce the power absorbed by fan 32 as well as residual forward thrust in turboshaft mode. *Id.* at 3:61–4:8, 5:2–11. The Examiner does not cite, and we cannot find, any disclosure in Neitzel indicating outlet guide vanes 48 are rotated in a variable manner during turbofan mode to improve the performance of engine 30 in that mode. *See* Final Act. 30–34; Ans. 60–62. Thus, there is little or no relationship between Neitzel's rotating outlet guide vanes 48 and whether it would have been obvious to modify Coplin's stationary outlet guide vanes 112 to be rotatable to improve engine performance in Coplin's engine 10, which is not convertible.

Nonetheless, Suljak and Dunbar ’187 provide a rational underpinning sufficient to support the legal conclusion of obviousness here. Appellant does not address Suljak and Dunbar ’187. *See* Appeal Br. 11–14. Dunbar ’187 discloses fan exit guide vanes 52 disposed downstream of fan blades 30, wherein vanes 52 are rotated “to reduce losses, improve fan bypass efficiency and increase fan bypass stall margin.” Dunbar ’187, Fig. 1, 1:42–51, 3:65–4:19. “[S]ignificant increases in specific fuel consumption can be achieved” by such controlled rotation of vanes 52. *Id.* at 2:18–44. Thus, a preponderance of the evidence supports the Examiner’s determination that it would have been obvious to modify Coplin’s stationary vanes 112 to be rotatable, to achieve the advantages disclosed by Dunbar ’187.

Dunbar ’187 further discloses the pitch of vanes 52 “could be varied by having only the vane leading edge or vane trailing edge pivotable *or by otherwise varying the effective angle of incidence of the vanes, as is known to those skilled in the art*.” Dunbar ’187, 3:52–57 (emphasis added). Suljak correspondingly discloses “[a]irfoils are conventionally rotated around the geometric center of gravity (CG) of the airfoil cross section.” Suljak ¶ 21. Thus, the combination of Dunbar ’187 and Suljak establishes the obviousness of rotating Coplin’s vanes 112 about their respective geometric centers of gravity, as claimed.

For the foregoing reasons, we sustain the rejection of claim 1 as having been obvious over Coplin, Gisslen, Neitzel, Suljak, and Dunbar ’187.

Claims 3, 4, 7, and 10

Appellant does not present further argument against the rejections of claims 3, 4, 7, and 10 as having been obvious over Coplin, Gisslen, Neitzel, Suljak, and Dunbar ’187. Appeal Br. 11–13. For the reasons provided above, we sustain these rejections. *See* 37 C.F.R. § 41.37(c)(1)(iv).

F. Obviousness Over Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, and One or More of Dunbar ’763, Ferri, Rauch, Boggia, and Jane’s Aero-Engines (Claims 5, 6, 8, 9, 14, 15, and 17)

Appellant does not present further argument against the rejections of claims 5, 6, 8, 9, 14, 15, and 17 as having been obvious over Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, and one or more of Dunbar ’763, Ferri, Rauch, Boggia, and Jane’s Aero-Engines. Appeal Br. 13–14. For the reasons provided above, we sustain these rejections. *See* 37 C.F.R. § 41.37(c)(1)(iv).

DECISION

The rejection of claims 1, 3–10, 14, 15, and 17 under 35 U.S.C. § 112, first paragraph, for lack of written description, is reversed.

The rejection of claims 1, 3–10, 14, 15, and 17 under 35 U.S.C. § 112, first paragraph, for lack of enablement, is reversed.

The rejection of claims 1, 3–10, 14, 15, and 17 under 35 U.S.C. § 112, second paragraph, as indefinite, is reversed.

The rejection of claims 5 and 6 under 35 U.S.C. § 112, fourth paragraph, as being of improper dependent form, is reversed.

The rejection of claims 1, 3, 4, 7, and 10 under 35 U.S.C. § 103(a), as unpatentable over Coplin, Gisslen, Neitzel, Suljak, and Dunbar ’187, is affirmed.

The rejection of claims 5 and 6 under 35 U.S.C. § 103(a), as unpatentable over Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, Dunbar ’763, and Ferri, is affirmed.

The rejection of claims 8 and 9 under 35 U.S.C. § 103(a) as unpatentable over Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, and Rauch, is affirmed.

The rejection of claim 14 under 35 U.S.C. § 103(a) as unpatentable over Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, and Boggia, is affirmed.

The rejection of claims 15 and 17 under 35 U.S.C. § 103(a) as unpatentable over Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, and Jane’s Aero-Engines, is affirmed.

In summary:

Claim(s) Rejected	**Basis**	**Affirmed**	**Reversed**
1, 3–10, 14, 15, 17	§ 112, ¶ 1 (Written Description)		1, 3–10, 14, 15, 17
1, 3–10, 14, 15, 17	§ 112, ¶ 1 (Enablement)		1, 3–10, 14, 15, 17
1, 3–10, 14, 15, 17	§ 112, ¶ 2		1, 3–10, 14, 15, 17
5, 6	§ 112, ¶ 4		5, 6
1, 3, 4, 7, 10	§ 103 Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187	1, 3, 4, 7, 10	
5, 6	§ 103 Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, Dunbar ’763, Ferri	5, 6	
8, 9	§ 103 Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, Rauch	8, 9	
14	§ 103 Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, Boggia	14	
15, 17	§ 103 Coplin, Gisslen, Neitzel, Suljak, Dunbar ’187, Jane’s Aero-Engines	15, 17	
Overall Outcome		**1, 3–10, 14, 15, 17**	

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

AFFIRMED