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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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*Ex parte* DANIEL BERNARD KUPRATIS and
FREDERICK M. SCHWARZ

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Appeal 2019-000663
Application 15/420,221
Technology Center 3700

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Before JENNIFER D. BAHR, LINDA E. HORNER, and
BRANDON J. WARNER, *Administrative Patent Judges.*

BAHR, *Administrative Patent Judge.*

DECISION ON APPEAL

STATEMENT OF THE CASE

Pursuant to 35 U.S.C. § 134(a), Appellant[1] appeals from the Examiner's decision to reject claims 1–14 and 19–21.[2] We have jurisdiction under 35 U.S.C. § 6(b).

We REVERSE.

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

[2] Appellant cancelled claims 15–18 and 22–30 in an Amendment filed July 9, 2018, with the Appeal Brief. *See* Adv. Act. 1–2 (mailed Aug. 1, 2018).

## CLAIMED SUBJECT MATTER

The claims are directed to a geared turbofan gas turbine engine having a turbine section including a fan turbine and a second turbine. Spec. ¶ 6. Claim 1, reproduced below, is the only independent claim and is illustrative of the claimed subject matter.

> 1. A gas turbine engine comprising:
>
> a fan including a plurality of fan blades rotatable about an axis;
>
> a compressor section;
>
> a combustor in fluid communication with the compressor section;
>
> a turbine section in fluid communication with the combustor, the turbine section including a fan drive turbine and a second turbine, wherein the second turbine is disposed forward of the fan drive turbine and the fan drive turbine includes a plurality of turbine rotors with a ratio between the number of fan blades and the number of fan drive turbine rotors is between 2.5 and 8.5; and
>
> a speed change system configured to be driven by the fan drive turbine to rotate the fan about the axis at a different speed than the fan drive turbine;
>
> wherein the fan drive turbine has a first exit area and rotates at a first speed, the second turbine section has a second exit area and rotates at a second speed, which is faster than the first speed, said first and second speeds being redline speeds, a first performance quantity is defined as the product of the first speed squared and the first area, a second performance quantity is defined as the product of the second speed squared and the second area, and a performance ratio of the first performance quantity to the second performance quantity is greater than 0.5.

REJECTIONS[3]

I. Claims 1–14 and 19–21 stand rejected under 35 U.S.C. § 112(a) as failing to comply with the enablement requirement.

II. Claims 1–14 and 19–21 stand rejected under 35 U.S.C. § 103 as unpatentable over Suciu,[4] Rosen[5] or Merchant,[6] and further in view of Kurzke[7] and Mattingly.[8]

OPINION

*Rejection I—Enablement*

In rejecting the claims for lack of enablement, the Examiner states that because the ranges recited for the "performance ratio," "gear ratio," "bypass ratio," and "pressure ratio" in claims 1, 2, 6, 8, 12, 13, 19, and 20 "are not bounded by an upper limit, each of the unbounded limitations therefore includes numerical values . . . which range to infinity." Final Act. 2–3. The Examiner determines that Appellant's "disclosure does not enable such large values of performance ratio, gear ratio, bypass ratio, [and] pressure ratio." *Id.* at 3.

Citing *Scripps Clinic & Research Foundation v. Genentech, Inc.*, 927 F.2d 1565 (Fed. Circ. 1991), Appellant argues that "[o]pen-ended [ranges in]

[3] The Examiner withdrew a rejection of claim 11 under 35 U.S.C. § 112(b). Ans. 2.
[4] US 2006/0130456 A1, published June 22, 2006.
[5] US 3,747,343, issued July 24, 1973.
[6] US 2006/0179818 A1, published Aug. 17, 2006.
[7] Joachim Kurzke, *Fundamental Differences Between Conventional and Geared Turbofans*, Proceedings of ASME Turbo Expo 2009: Power for Land, Sea and Air, 145–153 (2009).
[8] Jack D. Mattingly, *Elements of Gas Turbine Propulsion* (McGraw-Hill, Inc. 1996).

claims are not inherently improper" and that, in assessing whether such limitations in claims are in compliance with the enablement requirement, "the Examiner must first determine whether 'there is an inherent, albeit not precisely known, upper [or lower] limit' and the[n] secondly determine whether 'the specification enables one of skill in the art to approach that limit.'" Appeal Br. 3–4. Appellant contends that "the Examiner's enablement analysis focuses on an irrelevant range: between the claimed lower limit and infinity." *Id.* at 4.

Appellant submits that "one of ordinary skill in the art would recognize that performance ratios, gear ratios, bypass ratios, and pressure ratios have inherent upper limits based on the practical physical limitations and basic architecture of a bypass turbine engine" and that "Appellant's disclosure is record evidence and fully supports that inherent, practical limitations exist for each of the claimed quantities." *Id.*

With respect to bypass ratio, Appellant contends that one would understand from at least the disclosure in paragraphs 43, 46, and 60 of Appellant's Specification "that the basic architecture of a bypass turbine engine requires sufficient airflow to be delivered by the fan 42 to the core flow path C for combustion to occur and the engine to function" and that "[t]he minimum amount of airflow required to operate the engine provides an inherent practical upper limitation to the claimed bypass ratio." *Id.* at 4–5. Appellant adds that one would understand from Figure 1 "that the blades 42 and the flow paths B, C must fit within the surrounding structure, again, making an infinite bypass area ratio unachievable." *Id.* at 5.

With respect to gear ratio, Appellant contends that one would understand from paragraphs 46 and 51 of Appellant's Specification "that the

fan must have some speed to deliver sufficient airflow to the core engine so that the engine may operate and for the fan to produce thrust, making an infinitely high gear ratio impractical." *Id.* Appellant points out that "[a]n infinitely high gear ratio would also require an infinitely high speed of the turbine driving the geared architecture," but "[t]he limited combustion products for extraction of energy[, described in paragraph 43 of Appellant's Specification,] makes an infinitely high turbine speed impractical." *Id.*

With respect to performance ratio, Appellant contends that "a worker would understand that an infinitely large ratio would require the fan drive turbine to rotate infinitely faster, or have an infinitely larger turbine exit area compared to the second turbine"[9] and that "one would recognize that an infinite turbine exit area is unachievable." *Id.* at 6 (citing Spec. ¶¶ 80, 84, 86). Thus, according to Appellant, "since both the exit area 110 and rotational speed of the fan drive turbine 46 have practical limitations, an infinite performance ratio is impossible." *Id.*

With respect to fan drive turbine pressure ratio, Appellant contends that one would understand from paragraphs 43 and 48 of Appellant's Specification "that the limited combustion products delivered to the low pressure turbine 46 makes an infinitely high turbine pressure ratio impractical." *Id.* at 5–6.

[9] Claim 1 recites that "the second turbine section has a second exit area and rotates at a second speed." Appeal Br. 14 (Claims App.). Therefore, although, mathematically, either a second exit area of zero or a second speed of zero would yield a second performance quantity of zero, and, thus, a performance ratio of infinity, we agree with Appellant's position that one of skill in the art would understand that claim 1 does not cover such a theoretical possibility.

For the above reasons, Appellant submits that "a worker would understand at least in view of Appellant's disclosure that there are practical limits to each of the claimed quantities" referenced by the Examiner in the enablement rejection. *Id.* at 6.

In response, the Examiner states that "[n]othing in the cited passages allows one of ordinary skill in the art to determine the limits for any of the claim elements (gear ratio, turbine speed, turbine pressure ratio, turbine exit area) and as a result the claims are not enabled." Ans. 4. According to the Examiner, "while an infinite value of any variable is of course unachievable, the larger matter is that an artisan is not enabled to determine what any of the limits of any of the claim variables may be, as the disclosure provides insufficient guidance." *Id.*

Insofar as the enablement requirement is concerned, the dispositive issue is whether an applicant's disclosure, considering the level of ordinary skill in the art as of the date of the appellant's application, would have enabled a person of such skill to make and use the appellant's invention without undue experimentation. *In re Strahilevitz*, 668 F.2d 1229, 1232 (CCPA 1982). Factors to be considered in determining whether a disclosure would require undue experimentation include: (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. *In re Wands*, 858 F.2d 731, 737 (Fed. Cir. 1988).

The basis of the Examiner's enablement rejection is that the ranges for the cited limitations are not bounded by an upper limit and, therefore,

include numerical values that range to infinity. Final Act. 2–3. To the extent that this determination appears to relate to the breadth of the claims, we recognize that the limitations in claims 1, 2, 6, 8, 12, 13, 19, and 20 are broad in that they do not expressly recite an upper boundary for the recited performance ratio, gear ratio, bypass ratio, and pressure ratio. However, the Examiner does not adequately explain how the breadth of these limitations would relate to undue experimentation.

The amount of disclosure necessary to provide enablement for a range with no upper limit depends on the particular facts of the invention, the disclosure, and the prior art; the relevant question is whether one of ordinary skill in the art would be able to make and/or use the claimed invention from the disclosure in the specification without undue experimentation. *In re Fisher*, 427 F.2d 833, 836 (CCPA 1970). For example, the disclosure of a single value within an open-ended range may be sufficient when persons skilled in the art are able to make and/or use the invention with values other than the particular disclosed value, but is insufficient when "they are not able to do so." *Id.* The Examiner has not identified any other value less than infinity for the recited ranges as being not enabled, and Appellant persuasively explains why, given the context of the claimed structures, there is an inherent upper limit that a skilled artisan would recognize as being less than infinity.

For the above reasons, we do not sustain the rejection of claims 1–14 and 19–21 under 35 U.S.C. § 112(a).

*Rejection II—Obviousness*

The Examiner finds that Suciu discloses a gas turbine engine comprising a fan, a compressor section, a combustor, a turbine section including a fan drive turbine (low speed/pressure turbine (LPT) 26) and a second turbine (high speed/pressure turbine (HPT) 25). Final Act. 4; *see* Suciu, Fig. 1; ¶ 14. The Examiner also finds that Suciu's fan drive turbine (LPT 26) includes three turbine rotors. *Id.* The Examiner finds that Suciu is silent as to the ratio of the number of fan blades to the number of fan drive turbine rotors, but determines it would have been obvious to provide Suciu with between 6 and 13 fan blades, as taught by Rosen, to provide a desired noise level. *Id.* (citing Rosen 4:35–45). The Examiner notes that the ratio of 13 fan blades to 3 fan drive turbine rotors is 4.3, which falls within the claimed range of between 2.5 and 8.5. *Id.* at 4–5. As an alternative position, the Examiner finds that Merchant teaches that the blade count in the fan is a result-effective variable and determines that, thus, discovering the optimum number of fan blades in Suciu involves only routine skill in the art. *Id.* at 5. Thus, the Examiner determines it would have been obvious to provide Suciu with less than 18 fan blades and a ratio of fan blades to fan drive turbine rotors between 2.5 and 8.5. *Id.* Appellant does not contest the Examiner's findings or reasoning regarding the combination of Suciu and either Rosen or Merchant. *See* Appeal Br. 7–13.

The Examiner finds that Suciu is silent as to the claimed performance ratio of the first performance quantity to the second performance quantity and the claimed gear reduction ratio. Final Act. 5. However, the Examiner finds that Kurzke teaches a first performance quantity (LPT $AN^2$) of 36.4 x $10^6$ $m^2RPM^2$, which is 5.64 x $10^{10}$ $in^2RPM^2$, for a geared bypass engine. *Id.*

(citing Kurzke 152, Table 2, col. 4). The Examiner finds that Mattingly teaches making the second performance quantity (HPT $AN^2$) 5 x $10^{10}$ $in^2RPM^2$. *Id.* (citing Mattingly 727, Table 9-16a). Using the first performance quantity taught by Kurzke and the second performance quantity taught by Mattingly, the Examiner finds that the performance ratio is 1.13, which is greater than 0.5, as recited in claim 1. The Examiner also finds that Kurzke teaches that geared turbofans may comprise gear ratios of greater than about 2.3, namely gear ratio 3. *Id.* (citing Kurzke 152, Table 2). Based on the teachings of Kurzke and Mattingly, the Examiner determines it would have been obvious to make the performance ratio greater than 0.5 and the gear reduction ratio greater than about 2.3 because "it has been held that combining or simple substitution of prior art elements according to known methods to yield predictable results renders the limitation obvious." *Id.* at 5–6.

Furthermore, the Examiner finds that "Kurzke and Mattingly teach the general conditions of the claim – that the first and second performance quantities ($AN^2$) were well-known results-effective variables, affecting [fuel consumption] and that optimization of the first and second performance quantities was known." *Id.* at 6 (citing Kurzke 150–151, Figure 17; Mattingly 726–727). Thus, the Examiner determines that "[d]iscovering the optimum or workable ranges of the first and second performance quantities, and thus the performance ratio, was well known in the art and would have been obvious." *Id.* at 6.

Appellant argues, persuasively, that "[t]he Examiner points to no evidence of an associated LPT $AN^2$ quantity in Mattingly or an associated HPT $AN^2$ quantity in Kurzke" and that, thus, "it is improper for the

Examiner to assume that the HPT $AN^2$ values allegedly disclosed by Mattingly would be appropriate for the particular LPT of Suciu in view of Kurzke." Appeal Br. 9. As Appellant points out, the Examiner does not point to any objective evidence that either Kurzke or Mattingly teaches or suggests performance quantities for both the LPT and the HPT, much less a *ratio between* such performance quantities. *Id.* Furthermore, "the Examiner has not pointed to any evidence of a ratio of performance quantities being recognized in any of the cited references." *Id.*

As is evident from both Mattingly and Kurzke, there are many design parameters (e.g., bypass ratio, pressure ratio, gear ratio) that contribute to the performance of a turbine engine. *See* Mattingly 726–731; Kurzke 146–152. Mattingly discloses a range (4–5 x $10^{10}$ $in^2RPM^2$) for what appears to be a "typical" design value for HPT $AN^2$. Mattingly 727. The Examiner does not direct our attention to any disclosure in Mattingly of any LPT $AN^2$ values associated with this range. Although Mattingly's Table 9-16*a* does not explicitly indicate engine bypass ratios associated with HPT $AN^2$ values in this range, Mattingly shows engine bypass ratios of 1.45 and 4.86 for Pratt & Whitney engines introduced in 1961 and 1970, respectively, perhaps suggesting that the HPT $AN^2$ values may be associated with such bypass ratios. *Id.*, Table 9-16*b*. The Examiner appears to arbitrarily select from Kurzke's Table 2 an LPT $AN^2$ value for an engine having a bypass ratio of 14, along with an HPT $AN^2$ of 5 x $10^{10}$ $in^2RPM^2$ from Mattingly's Table 9-16*a*, without offering sufficient technical explanation as to how or why one would design a turbine engine having this particular LPT $AN^2$ value with this particular HPT $AN^2$ value. Given the many engine design parameters that appear to be relevant to both the first performance quantity (LPT $AN^2$)

and the second performance quantity (HPT $AN^2$), the Examiner's explanation that "[t]hese are two different modifications applied to two different engine elements" and that "[t]hey are separately and explicitly taught by their respective secondary references, and would be obvious to apply to a gas turbine engine" is inadequate. *See* Ans. 4–5.

The Examiner states that "[t]he teachings of Kurzke and Mattingly are applied directly to each variable of the claimed ratio (first performance quantity, second performance quantity), and optimization of every variable in the ratio directly results in optimization of the ratio." *Id.* at 7. However, even assuming that both the first performance quantity (LPT $AN^2$) and the second performance quantity (HPT $AN^2$) were recognized as result-effective variables at the time of Appellant's invention, for the reasons discussed above, the Examiner does not provide sufficient evidence or technical explanation to indicate that optimizing each performance quantity individually in a single engine would yield a performance ratio greater than 0.5 as claimed.

For the above reasons, the rejection lacks the requisite evidentiary findings and reasoning to establish that the subject matter of claim 1 would have been obvious. Accordingly, we do not sustain the rejection of claim 1, or claims 2–14 and 19–21, which depend from claim 1, as unpatentable over Suciu, Rosen or Merchant, and Kurzke and Mattingly.

## DECISION

The Examiner's decision to reject claims 1–14 and 19–21 under 35 U.S.C. § 112(a) is REVERSED.

The Examiner's decision to reject claims 1–14 and 19–21 under 35 U.S.C. § 103 is REVERSED.

DECISION SUMMARY

| Claims Rejected | Basis | Affirmed | Reversed |
|---|---|---|---|
| 1–14, 19–21 | § 112(a) | | 1–14, 19–21 |
| 1–14, 19–21 | § 103 Suciu, Rosen or Merchant, and Kurzke and Mattingly | | 1–14, 19–21 |
| **Overall Outcome** | | | 1–14, 19–21 |

REVERSED