

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GENERAL ELECTRIC COMPANY,
Petitioner,

v.

UNITED TECHNOLOGIES CORPORATION,
Patent Owner.

Case IPR2016-00534
Patent 8,365,513 B2

Before HYUN J. JUNG, SCOTT A. DANIELS, 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.”) pursuant to 35 U.S.C. §§ 311–319 to institute an *inter partes* review of claims 1–8 of U.S. Patent No. 8,365,513 B2 (“the ’513 patent”). United Technologies Corporation (“Patent Owner”) filed a Preliminary Response (Paper 6, “Prelim. Resp.”). On August 12, 2016, we instituted review of claims 1 and 3–8, but not of claim 2 (Paper 9, “Inst. Dec.”).

During the trial, Patent Owner timely filed a Response (Paper 18, “PO Resp.”). Petitioner timely filed a Reply (Paper 27, “Pet. Reply”). An oral hearing was held on May 19, 2017, and a copy of the transcript has been entered into the record (Paper 38, “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 the claims for which trial proceeded. Based on the record before us, Petitioner has shown, by a preponderance of the evidence, that claims 1 and 3–8 of the ’513 patent are unpatentable.

II. BACKGROUND

A. *Related Proceedings*

Neither party is aware of any other judicial or administrative matter that would affect, or be affected by, a decision in this proceeding. Pet. 1; Paper 5, 1.

B. *The ’513 Patent*

The ’513 patent is directed to a turbofan engine control system in which a change in the effective nozzle exit area achieves a target operability line. Ex. 1001, Title, Abstract. A target operability line — a key term in

this proceeding, the meaning of which is disputed as discussed further below — provides a desired fuel consumption, engine performance, and/or fan operability margin in response to an engine operating condition that is a function of airspeed and throttle position. *Id.* at Abstract, 1:44–56. Figure 1 of the '513 patent is reproduced below:

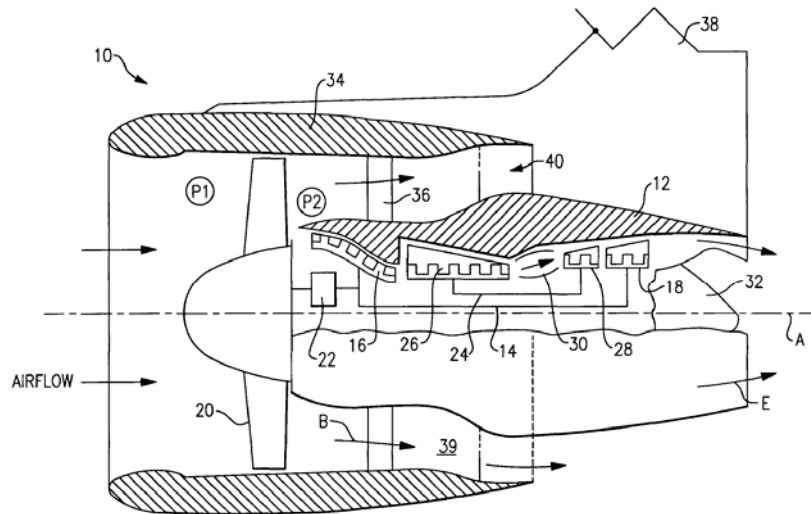


FIG. 1

Figure 1 is a cross-sectional view of turbofan engine 10. *Id.* at 2:6–7, 2:14. Engine 10 includes core nacelle 12 housing low spool 14, high spool 24, and combustor 30. *Id.* at 2:14–25. Low spool 14 supports low pressure compressor 16 and low pressure turbine 18, and drives turbofan 20 through gear train 22. *Id.* at 2:17–20. High spool 24 supports high pressure compressor 26 and high pressure turbine 28. *Id.* at 2:20–21. Airflow enters fan nacelle 34, which surrounds core nacelle 12 and turbofan 20. *Id.* at 2:35–36. Bypass airflow B within bypass flow path 39 exits fan nacelle 34 through nozzle exit area 40. *Id.* at 2:48–49.

In one example, engine 10 includes a structure associated with nozzle exit area 40 to change the physical area and geometry of area 40, thereby manipulating the thrust provided by bypass flow B. *Id.* at 2:54–57. This

may be accomplished by using air flow control device 41, illustrated in Figure 2 of the '513 patent, reproduced below:

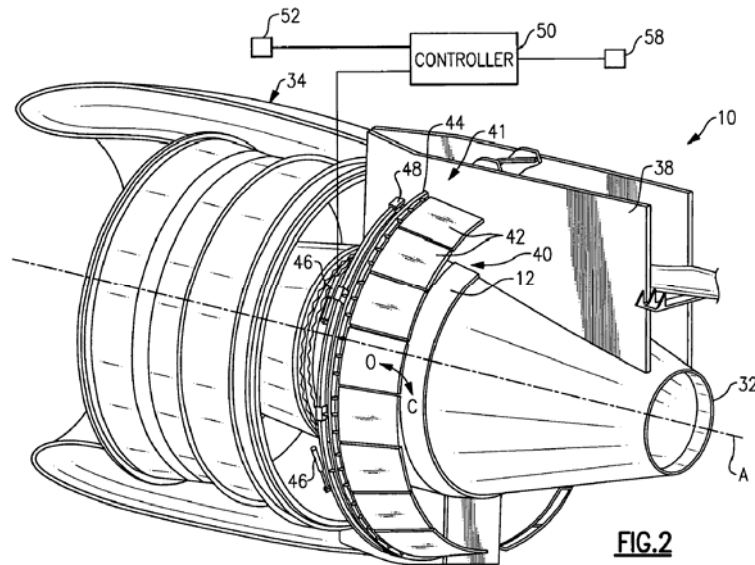


Figure 2 is a partially broken perspective view of turbofan engine 10. *Id.* at 2:8–9. It illustrates controller 50 to command actuators 46 of device 41, moving flaps 42 between open and closed conditions. *Id.* at 3:38–42.

C. Illustrative Claim

Trial was instituted as to independent claim 1 and its dependent claims 3–8. Claim 1 is illustrative of those claims:

1. A turbofan engine comprising:
 - a spool supporting a turbine and housed within a core nacelle;
 - a turbofan coupled to the spool, the turbofan including a *target operability line*;
 - a fan nacelle surrounding the turbofan and core nacelle to provide a bypass flow path having a nozzle exit area;
 - a controller programmed to command a flow control device for effectively *changing the nozzle exit area to achieve the target operability line* in response to an engine operating condition including at least one of airspeed and throttle position; and

wherein the flow control device includes effectively open and closed conditions, the command effectively changing the nozzle exit area between the effectively open and closed conditions; and

wherein the effectively open condition corresponds to an engine idle condition.

Ex. 1001, 4:7–23 (emphases added).

D. Asserted Grounds of Unpatentability

We instituted a trial to determine whether claims 1 and 3–8 of the ’513 patent are unpatentable under 35 U.S.C. § 102(b) or § 103(a) on the following grounds. *See* Inst. Dec. 25.

Reference(s)	Statutory Basis	Claim(s) Tried
William S. Willis, <i>Quiet Clean Short-Haul Experimental Engine (QCSEE) Final Report</i> (Aug. 1979) (Ex. 1011, “Willis”)	§ 102(b)	1 and 4–8
Willis	§ 103(a)	7
Willis and U.S. Patent No. 3,892,358 (July 1, 1975) (Ex. 1005, “Gisslen”)	§ 103(a)	6
Willis and U.S. Patent No. 3,932,058 (Jan. 13, 1976) (Ex. 1013, “Harner”)	§ 103(a)	3

III. ANALYSIS

A. 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); Office Patent Trial Practice Guide, 77 Fed. Reg. 48,756, 48,764 (Aug. 14, 2012).

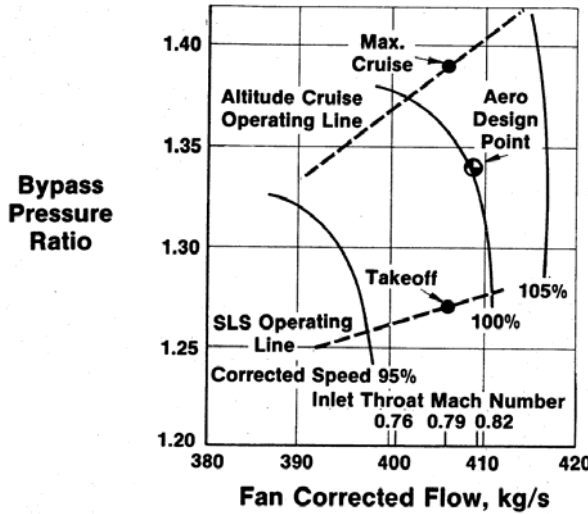
1. “*target operability line*”

Claim 1 recites “the turbofan including *a target operability line*,” wherein a flow control device “chang[es] the nozzle exit area *to achieve the target operability line*.” Ex. 1001, 4:10–16 (emphases added).

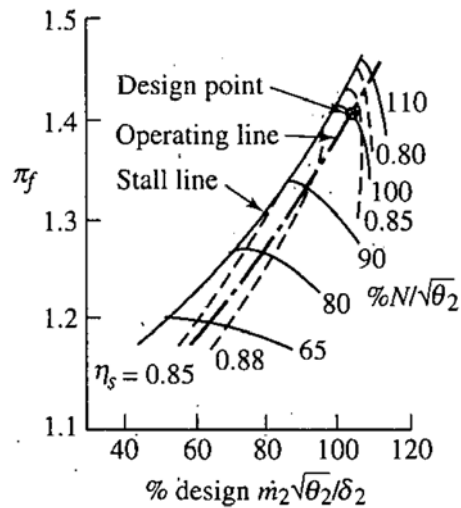
The parties disagree as to the meaning of “target operability line.” See Pet. 22–24; PO Resp. 23–35. There is, however, a substantial amount of agreement between the parties concerning the background knowledge a person of ordinary skill in the art would bring to bear when considering this term. The parties agree the term would be understood to refer to a line on a “fan map,” even though the ’513 patent does not directly discuss, much less illustrate, a fan map. See Pet. 8–9, 22–24 & Ex. 1003 ¶ 30; PO Resp. 14–15, 23–29 & Ex. 2009 ¶¶ 21–22. The parties’ disagreement concerns exactly what kinds of line(s) on the fan map would be considered a target operability line.

More specifically concerning the common ground, the parties agree a person of ordinary skill in the art at the time of the ’513 patent’s invention would have been aware of “fan maps” which plot fan “operating lines.” See Pet. 8–9, 23–24 & Ex. 1003 ¶¶ 30–32; PO Resp. 1, 5–6, 14–15, 23–25 & Ex. 2009 ¶¶ 21–23. Importantly, as discussed further below, Patent Owner argues the claimed fan “target operability line” is a term coined by the ’513 patent to represent a specific type of fan “operating line” that was not previously recognized in the art. See Tr. 20:11–14, 23:3–25:4, 28:22–29:14.

Two illustrative fan maps found in the prior art of record are reproduced below:



Willis Figure 11



Mattingly Figure 9-39

The Willis fan map on the left is reproduced from Figure 11 of Willis (Ex. 1011.039¹), and the Mattingly fan map on the right is reproduced from Figure 9-39 of the book “Elements of Gas Turbine Propulsion” authored by Jack Mattingly (Ex. 1014.001, .088). Both fan maps plot a fan’s pressure ratio along the vertical axis, and the fan’s corrected air mass flow rate along the horizontal axis. Ex. 1011.038–.039; Ex. 1014.087–.088; *see also* PO Resp. 5–7 (discussing Mattingly’s fan map). Both fan maps illustrate fan operating lines: the “Altitude Cruise Operating Line” and the “SLS Operating Line” in Willis, and the “Operating line” in Mattingly.

¹ As both parties have done, we cite to the Willis disclosure by referring to the “GE-1011” page numbering in the lower right hand corner of each page. We do likewise for the other prior art references cited herein.

The parties agree that a given fan operating line identifies how the plotted performance characteristics of a fan *having a constant nozzle exit area* will change with changing throttle inputs. See Pet. 8–9; Tr. 14:13–15:10, 23:19–24:6; PO Resp. 2 (“changes in the nozzle exit area cause the fan to ‘jump’ from one operating line to another”), 8, 14, 23–24 & Ex. 2009 ¶¶ 24–25, 40–41. In other words, each fan *operating line* illustrated in the Willis and Mattingly fan maps corresponds to *one* nozzle exit area configuration. Ex. 2009 ¶¶ 26–28. The Willis fan map specifies three “Corrected Speed” curves based on throttle input (95%, 100%, and 105%). The Mattingly fan map specifies five speed curves based on throttle input (65%, 80%, 90%, 100%, and 110%). The intersection of a given throttle input (i.e. fan speed) curve with a fan operating line identifies the pressure ratio and corrected air mass flow rate of the fan which result from the specified throttle input, using the nozzle exit area configuration corresponding to the fan operating line. Thus, for a constant nozzle exit area, the fan’s operating point moves along the corresponding operating line to the right as the throttle input is increased, and moves along the corresponding operating line to the left as the throttle input is decreased. See PO Resp. 7–8 (“The fan will operate at different points up and down its operating line based on the throttle input.”), 14–16, 24–25; Ex. 2009 ¶¶ 24–25, 40–41.

A further point of common ground between the parties is identified in the Mattingly fan map as a fan “Stall line,” also called the stall or flutter boundary. The parties agree that fan operating points *above* the stall or flutter boundary on a fan map would (or at least, could) create fan instability

and, therefore, represent an unsafe operation condition.² See Pet. 8–11 & Ex. 1003 ¶¶ 27, 32–34; PO Resp. 9 & Ex. 2009 ¶¶ 25–28. Thus, engines are typically designed to maintain a “stall margin” distance below the stall line, to ensure safe operation. See Pet. 9–10 & Ex. 1003 ¶¶ 27, 32–34; PO Resp. 9–10. For example, the parties agree that if an engine lacks the capability to adjust its nozzle exit area (and, therefore, is limited to a single operating line), the engine’s operating line is set relatively low on the fan map to provide an appropriately safe stall margin during takeoff and landing. Pet. 6–7 & Ex. 1003 ¶ 27; PO Resp. 10–12 & Ex. 2009 ¶¶ 25–28, 34, 46. Such a low operating line, however, results in a performance penalty when cruising between takeoff and landing, reducing the fuel efficiency of the engine during that phase of flight. Pet. 6–7 & Ex. 1003 ¶¶ 27, 34, 46; PO Resp. 12 & Ex. 2009 ¶¶ 25–28, 46; Ex. 1001, 1:34–36, 1:58–61, 3:24–37.

With the foregoing areas of agreement in mind, we turn to the point of contention between Petitioner and Patent Owner. According to Petitioner, the “target operability line” in claim 1 refers “to the series of points within a fan map that the fan section is designed to operate (*i.e.*, an operating line).” Pet. 22–23 (citing Ex. 1001, 1:47–49); Ex. 1003 ¶¶ 53–55. Petitioner looks to the prosecution history of the ’513 patent for support. Pet. 23–24; Pet. Reply 1–2, 5–6; Tr. 8:10–11:16. Specifically, during prosecution, the Examiner rejected claims as indefinite, because “the limitation ‘a target operability line’ is not clear.” Ex. 1002.124. The Examiner continued: “[a]s best can be determined, the limitation appears to mean the operation of the

² The technical difference(s) between fan “stall,” “flutter,” and “surge” are not material in the context of the present decision. See Ex. 1001, 1:16–17, 3:30–33; Prelim. Resp. 10–11; Ex. 1003 ¶¶ 33–34.

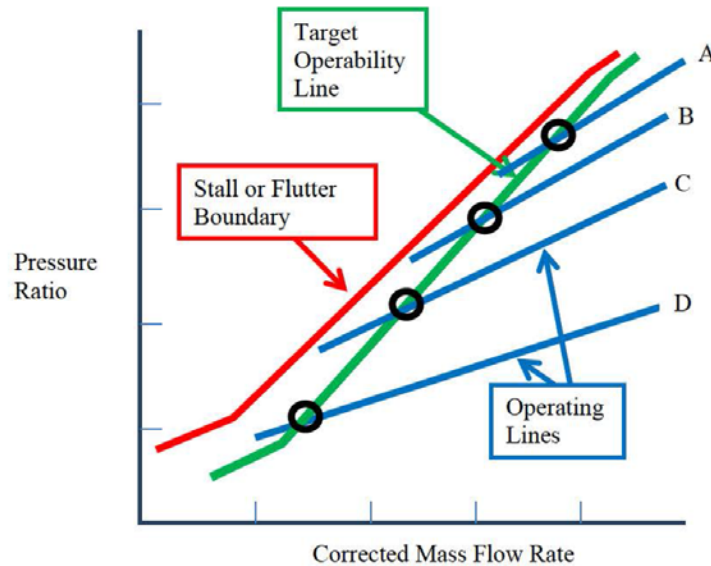
low pressure spool during operation of the engine *is defined a fan operating line.*” *Id.* (emphasis added). The applicant responded as follows:

[T]he term “target operability line” is clearly understood in the art. *The meaning of this term is set forth in many industry documents, for example, SAE Document AIR1419 (attached). An “operating line” or “operational line” may be expressed by multiple operating points. The operating line represents the location on [a] map where the engine may operate without encountering instability. The target operability line relates to the turbofan, or fan*

Id. at .133 (emphases added). The succeeding Office Action was a Notice of Allowance, which stated: “The SAE document in the [applicant’s] remarks [reproduced directed above] overcomes the 112 second paragraph rejection.” *Id.* at .141–.146.

Patent Owner asserts Petitioner, and the Board in its Institution Decision, “conflate[] ‘target operability line’ with ‘operating line,’ arguing that these terms mean the same thing.” PO Resp. 1, 32–34. According to Patent Owner, while a fan “‘operating line’ [was] a well-known term of art” prior to the ’513 patent, a fan “‘target operability line’ [was] *not* a well-known term.” PO Resp. 25–26 (citing Ex. 2008, 34:12–35:2, 36:6–9, 39:14–16), 28 (citing Ex. 2008, 41:1–7); Ex. 2009 ¶¶ 40, 44. Therefore, Patent Owner contends this term was “coined” by the ’513 patent such that “one must turn to the patent specification to ascertain its meaning.” PO Resp. 25–26; Ex. 2009 ¶ 44. Patent Owner asserts the ’513 patent specification “repeatedly and consistently distinguishes between” operating lines and target operability lines. *Id.* at 1, 26–28 (citing Ex. 1001, Abstract, 1:5–7, 1:17–24, 1:37–40, 1:54–62, 3:30–33); Ex. 2009 ¶¶ 43–45; Tr. 26:3–27:3, 30:22–34:4.

According to Patent Owner, the difference between the two lines is that a “target operability line” is “a line connecting points *across different fan operating lines that optimizes fan operability margin.*” PO Resp. 1, 14–16, 29–35; Ex. 2009 ¶¶ 32–56. Patent Owner provides the following illustration of its claim construction position:



PO Resp. 15; Ex. 2009 ¶¶ 31–36. This illustration is a schematic fan map, including a green line illustrating Patent Owner’s proposed claim construction of target operability line, in that the green line connects points (black circles) across different fan operating lines (blue lines) to optimize fan operability margin from the stall or flutter boundary (distance between green line and red line). PO Resp. 14–16; Ex. 2009 ¶¶ 31–36.

Patent Owner contends “[f]an ‘operability’ is a well-known concept, meaning the fan is in a safe and reliable functioning condition.” PO Resp. 29 (citing Ex. 1001, 1:16–40; Ex. 2008, 49:7–8; Ex. 2011.004); Ex. 2009 ¶ 45. Based on that understanding of “operability,” Patent Owner contends the “key concept” of the ’513 patent’s invention is “that an *optimized fan operability margin may be achieved by changing the fan*

operating line” along a target operability line. PO Resp. 30–31 (emphasis added) (citing Ex. 1001, 1:27–36, 1:58–61, 3:28–30); Ex. 2009 ¶¶ 46, 49. In this way, the claimed target operability line “seek[s] to avoid ‘unnecessarily large operating margins’” away from the stall or flutter boundary, while minimizing performance penalties such as by increasing the fuel efficiency. PO Resp. 31–32 (citing Ex. 1001, 1:58–61, 3:28–30), 34; Ex. 2009 ¶ 44. Patent Owner maintains the prosecution history relied upon by Petitioner is ambiguous, and fails to overcome clear statements in the Specification concerning the meaning of target operability line. PO Resp. 35 n.35; Tr. 20:19–22, 22:15–23:2, 34:5–35:5.

We previously considered the meaning of “target operability line” in our institution decision. See Inst. Dec. 7–8. Now, having the benefit of a fully developed record before us, we review anew the evidence regarding this issue.

We begin our claim construction analysis with the language of the claim, “target operability line,” read in light of the ’513 patent Specification. The Specification repeatedly uses the terms “operability” and “operating.” Ex. 1001, Abstract, 1:5–7, 1:16–40, 1:46–49, 1:54–58, 3:24–37. These discussions suggest a difference in meaning between a fan’s target operability line and a fan’s operating line. In particular, the Specification uses the term “operability” in the context of optimizing “fuel consumption, engine performance, and/or fan operability margin.” *Id.* at Abstract, 1:16–19, 1:24–36, 1:37–40, 1:47–49, 3:24–30. The Specification uses the term “operating line” in the context of “mov[ing],” “control[ing],” or “manipulat[ing]” the fan operating line, by changing the nozzle exit area, in order to achieve operability optimization. *Id.* at Abstract, 1:19–24, 1:31–32,

1:54–58, 3:30–33. Thus, the specific term “target operability line” is described as “provid[ing] desired fuel consumption, engine performance, and/or fan operability margin,” by “mov[ing] the operating line.” *Id.* at Abstract, 1:46–49, 1:54–58, 3:30–33. As one example, the Specification indicates one may “*move the operating line toward the stall or flutter boundary of the turbofan 20 to a target operability line,*” to achieve “[b]etter fuel consumption.” *Id.* at 3:24–37 (emphasis added).

Based on these disclosures in the Specification, we maintain our construction from the Institution Decision that the broadest reasonable interpretation of a “target operability line” corresponds to a specific operating line that is defined by the series of points on a fan map at which the fan section of a turbofan engine, or turbofan, is designed to operate. The term “target” reflects that the target operability line is a fan operating line selected to optimize fuel consumption, engine performance, and/or fan operability margin. Ex. 1001, Abstract, 1:37–40, 1:47–49. The target operability line may, therefore, be the current fan operating line, or some other fan operating line achievable by changing the current nozzle exit area, thereby improving upon the fuel consumption, engine performance, and/or fan operability margin in comparison to the current fan operating line. The term “operability” reflects that the target operability line is a fan operating line selected to ensure a sufficiently safe operability margin away from the fan stall or flutter boundary. *Id.* at 1:16–19, 1:58–61 (referring to avoiding “unnecessarily large” fan operability margins), 3:24–30 (same).

Patent Owner’s claim construction position takes the concept of optimization — which we agree is present in the Specification — on a course that is untethered to the Specification. Patent Owner’s claim

construction illustration (PO Resp. 15) is neither contained in nor described by the '513 patent Specification. The green line of Patent Owner's illustration may indeed represent one example of how a person of ordinary skill in the art would design an engine fan to maximize fuel efficiency while maintaining a sufficient operability margin below the stall or flutter boundary. However, there is nothing in the Specification that informs a person of ordinary skill in that art that this example defines the broadest reasonable construction of claim 1.

Instead, the Specification indicates the target operability line “provides desired fuel consumption, engine performance, *and/or* fan operability margin.” Ex. 1001, Abstract, 1:47–49 (emphasis added). The Specification therefore fails to support Patent Owner's contention that fan operability margin is the essential and defining characteristic of the target operability line. Fan operability margin is one factor, not the only factor, to consider when determining the target operability line; other factors, such as fuel consumption and engine performance, also are taken into account. This understanding is confirmed by claim 2, which depends from claim 1 to add that “the target operability line is *near* a stall/flutter boundary of the turbofan,” thus suggesting that factors other than a minimum fan operability margin are at play in claim 1 as a matter of claim differentiation. Ex. 1001, 4:24–26 (emphasis added). For these reasons, the Specification does not support the suggestion in Patent Owner's green line illustration that the target operability line must *always* maintain a *minimized* yet safe operability margin away from the stall or flutter boundary.

Moreover, during prosecution of the '513 patent, Patent Owner overcame an indefiniteness rejection by arguing to the Examiner that “the

term ‘target operability line’ is clearly understood in the art” because its “meaning . . . is set forth in many industry documents,” such as SAE Document AIR1419. Ex. 1002.124, .133 (emphasis added), .146. The referenced SAE Document uses the term “operating line.” *Id.* at .136 (“FAN ON OPERATING LINE . . .”), .137 (“compression component operating lines,” “compressor operating lines,” and “operating line assessment factors”). Patent Owner does not cite, and we cannot find, any instance in the SAE Document referring to “operability line” — much less in such a way as to suggest the green line of Patent Owner’s claim construction illustration. The SAE Document, rather, suggests that the claimed “target operability line” corresponds to one of the traditionally known operating lines, each of which corresponds to one nozzle exit area, and is targeted to maintain engine stability margins in light of pressure distortions. *Id.* at .136 (“compressor variable geometry is scheduled” in accordance with a “stability margin” in which “[t]he assessment of the influence of total-pressure distortion on engine stability forms part of a total procedure necessary to determine installed engine stability and stability margins”). This conclusion is consistent with Patent Owner’s statement that “[a]n ‘operating line’ or ‘operational line’ may be expressed by multiple operating points” (*id.* at .133), which equates operating line and operational line.³

Patent Owner’s claim construction is not persuasive, further, because it lacks clarity. Patent Owner proposes that we construe target operability

³ It is consistent, further, with the prosecution of the European counterpart of the ’513 patent, in which the Patent Owner submitted a “Fan Map” figure which referred to two lines as each being a “Target Operability Line, Or Operating Line.” *See* Ex. 1020.098; Pet. Reply 1–2, 6–8.

line to be a line “that optimizes fan operability margin.” PO Resp. 13–16, 29–32. However, Patent Owner does not explain how a person of ordinary skill in the art is to know when the line is sufficiently optimized so as to fall inside the scope of claim 1, or is not sufficiently optimized so as to fall outside the scope of claim 1. *See id.*; Tr. 27:8–28:20; *id.* at 39:6–43:17 & 47:16–48:9 (discussing optimization in the context of Willis Figure 11). We decline to adopt a claim construction that replaces the present dispute over the meaning of “target operability line” with a future dispute over the meaning of “optimization.”

For the foregoing reasons, we determine the broadest reasonable interpretation of a “target operability line” is a specific operating line that is defined by the series of points on a fan map at which the fan section of a turbofan engine, or turbofan, is designed to operate.

2. “*effectively open and closed conditions*”

Claim 1 recites “the flow control device includes *effectively open and closed conditions*.” Ex. 1001, 4:18–19 (emphasis added). In our Institution Decision, we adopted Patent Owner’s proffered construction of these terms over Petitioner’s proffered construction, and:

determine[d] that the broadest reasonable interpretation consistent with the [’513 patent] Specification of “effectively,” as used in the claim term “effectively open and closed conditions,” is structurally or non-structurally.⁴ We further determine[d] under the broadest-reasonable-interpretation

⁴ The distinction between structural and non-structural “effectively” open and closed conditions described in the ’513 patent at column 2, lines 49–63, is not material in the context of the present decision. All prior art references cited by Petitioner incorporate structural changes to the nozzle exit area.

standard that “open and closed conditions” mean[] discrete endpoint conditions that are respectively open and closed.

Inst. Dec. 8–10. Patent Owner’s post-institution Response provides several arguments why that construction is correct. PO Resp. 36–41. Petitioner’s post-institution Reply similarly does not take issue with the Board’s construction. Pet. Reply 17–18. Based on our review of the complete record, we do not perceive any reason or evidence that compels any deviation from the interpretation set forth in our Institution Decision, and we apply that interpretation in the present decision.

3. *Remaining Claim Terms*

No further explicit constructions of any claim terms are needed to resolve the issues presented by the arguments and evidence of record. *See Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011) (“claim terms need only be construed ‘to the extent necessary to resolve the controversy’”) (citing *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” (see Pet. 18–20), “turbofan” (see *id.* at 20–21), “spool” (see *id.* at 21–22), “flow control device” (see *id.* at 24–25), “idle condition” (see *id.* at 26–27), and “throttle” (see *id.* at 27). *See also* PO Resp. 41 (“[i]t is unnecessary to construe these terms for purposes of this proceeding” and “each of these terms is clear in the context of the ’513 patent and should receive its plain meaning”).

B. *Anticipation by Willis*

Petitioner asserts claims 1 and 4–8 of the ’513 patent are unpatentable under 35 U.S.C. § 102(b) as anticipated by Willis. Pet. 27–38 (claim 1), 41–

46 (claims 4–8). Petitioner cites the Declaration of Dr. Magdy Attia in support. Ex. 1003. Patent Owner opposes Petitioner’s assertions.

PO Resp. 42–62. Patent Owner cites the Declaration of Dr. Ernesto Benini in support. Ex. 2010.

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 demonstrates claims 1 and 4–8 of the ’513 patent are unpatentable as anticipated by Willis. We begin our analysis with a brief statement of the law of anticipation, then provide a brief summary of Willis, and finally address Petitioner’s and Patent Owner’s contentions.

1. Law of Anticipation

“A patent [claim] is invalid for anticipation under 35 U.S.C. § 102 if a single prior art reference discloses each and every limitation of the claimed invention.” *Purdue Pharma L.P. v. Epic Pharma, LLC*, 811 F.3d 1345, 1351 (Fed. Cir. 2016) (citing *Schering Corp. v. Geneva Pharm., Inc.*, 339 F.3d 1373, 1377 (Fed. Cir. 2003)).

2. Willis

Willis is a NASA “Final Report” concerning the “Quiet Clean Short-Haul Experimental Engine (QCSEE).” Ex. 1011.001. In the Preliminary Response, Patent Owner asserted Petitioner failed to establish Willis is a prior art printed publication. Prelim Resp. 46–53; Inst. Dec. 12–13. During the oral hearing, however, Patent Owner’s counsel indicated Patent Owner no longer disputes the public availability of Willis. Tr. 50:2–7.

Petitioner relies on the under-the-wing (UTW) version of the QCSEE illustrated in Figure 8 (hereafter “Willis UTW Engine”). See Pet. 27–29.

Figure 8 is reproduced below:

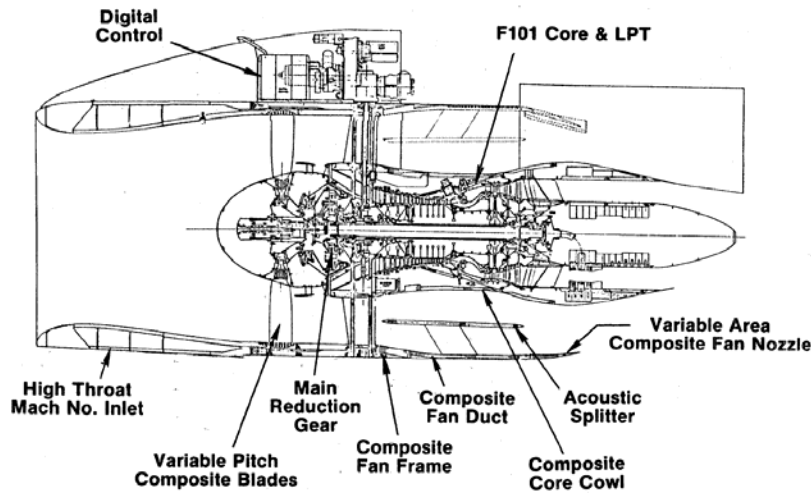


Figure 8 is a cross-sectional view of the Willis UTW Engine, most pertinently identifying a “Variable Area Composite Fan Nozzle” at the downstream end of a bypass flow duct, defined between a “Composite Core Cowl” and a “Composite Fan Duct.” Ex. 1011.032–.034.

3. Independent Claim 1

- a. “a spool supporting a turbine and housed within a core nacelle” and
“a turbofan coupled to the spool”

Petitioner contends the Willis UTW Engine includes a spool supporting a turbine and housed within a core nacelle, with a turbofan coupled to the spool. Pet. 29–31. This contention, which Patent Owner does not dispute, is supported by a preponderance of the evidence. Specifically, we find the claimed spool, turbine, and turbofan are disclosed in that the Willis UTW Engine is a “*turbofan* propulsion system[]” that “is based on a lightweight, high-speed, power *turbine* driving a slower speed, quiet *fan*” via

an “input gear supported by the *power turbine shaft*.” Ex. 1011.024, .088, .094 (emphases added); Ex. 1003 ¶¶ 66–68. Further, we find the claimed core nacelle is disclosed in that the Willis UTW Engine’s spool and turbine are housed within a “Composite Core Cowl.” Ex. 1011.033 (Fig. 8); Ex. 1003 ¶ 67 (annotating Fig. 8 to identify where the turbine (“LPT”) and its associated shaft are illustrated as disposed within the composite core cowl).

b. “a fan nacelle surrounding the turbofan and core nacelle to provide a bypass flow path having a nozzle exit area”

Petitioner contends the Willis UTW Engine includes a fan nacelle surrounding the turbofan and core nacelle to provide a bypass flow path having a nozzle exit area. Pet. 32–33. This contention, which Patent Owner does not dispute, is supported by a preponderance of the evidence. We find the fan nacelle is disclosed as the “Composite Fan Duct” in Figure 8 of Willis, surrounding the “Variable Pitch Composite Blades” of the turbofan and the composite core cowl to provide a bypass flow path. Ex. 1011.033 (Fig. 8); Ex. 1003 ¶ 69 (annotating Fig. 8 to identify the bypass flow path). We further find the Willis UTW Engine bypass flow path has a nozzle exit area, identified in Figure 8 of Willis as being defined by the “Variable Area Composite Fan Nozzle.” Ex. 1011.033 (Fig. 8); Ex. 1003 ¶ 69 (annotating Fig. 8 to identify the nozzle exit area).

c. “a controller programmed to command a flow control device for effectively changing the nozzle exit area . . . in response to an engine operating condition including at least one of airspeed and throttle position”

Petitioner contends the Willis UTW Engine includes a controller to command a flow control device to change the nozzle exit area in response to

a throttle position engine operating condition. Pet. 34–35; Pet. Reply 12–13. This contention, which Patent Owner does not dispute, is supported by a preponderance of the evidence. We find the controller is shown as the “Digital Control” in Figure 79 of Willis, which receives a throttle position input as the “Electro / Mechanical Power Lever Signal.” Ex. 1011.142–.143 (Fig. 79); Ex. 1003 ¶ 70. We further find, in response to that input, the Willis UTW Engine’s controller commands a flow control device — that is, the “Variable Area Composite Fan Nozzle” illustrated in Figure 8 — to change the nozzle exit area. Ex. 1011.033 (Fig. 8), .142–.143 (Fig. 79), .148; Ex. 1003 ¶ 70.

d. “the turbofan including a target operability line” and the “controller programmed . . . to achieve the target operability line”

Petitioner contends the Willis UTW Engine’s turbofan has a target operability line, which the controller achieves in response to the throttle position input. Pet. 30–32, 35; Pet. Reply 11–14. Patent Owner disputes this contention. PO Resp. 42–56. The parties’ disagreement concerns Willis’s description of Figure 11 (Ex. 1011.039), reproduced below:

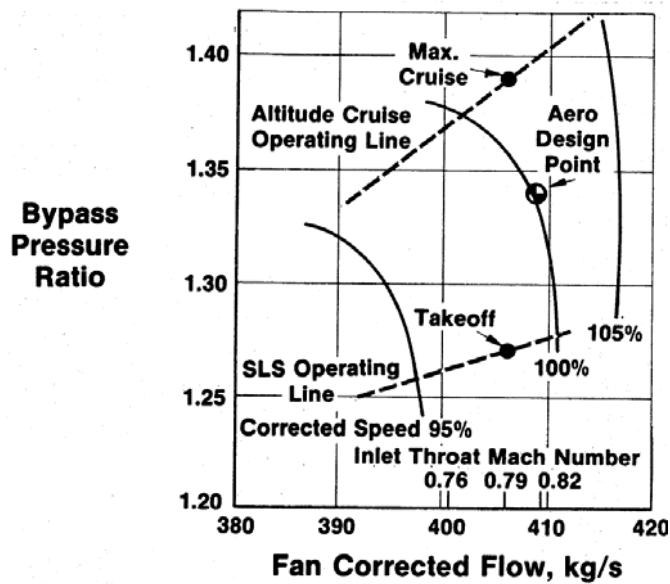


Figure 11. UTW Variable-Pitch Fan Design Map.

Figure 11 is a fan design map for the Willis UTW Engine, indicating “[k]ey operating points.” Ex. 1011.038. One key operating point is “[t]he takeoff point” which “was selected to be on a low operating line . . . for reduced noise.” *Id.* Another key operating point is “[t]he maximum cruise point” which “is on a higher operating line [than the takeoff point], *reached by closing the variable exhaust nozzle*” relative to the takeoff point configuration “to increase thrust at altitude.” *Id.* (emphasis added).

Petitioner contends Figure 11 of Willis discloses a “target operability line” as recited in claim 1, because Willis switches between two different operating lines: the SLS Operating Line for takeoff, and the Altitude Cruise Operating Line at the maximum cruise altitude. Pet. 31–32, 35; Ex. 1003 ¶¶ 68, 70; Pet. Reply 11–14.

Patent Owner argues Willis lacks the claimed “target operability line” because Willis fails to disclose a line connecting points across different fan operating lines that optimizes fan operability margin. PO Resp. 1, 16–17,

42–47; Ex. 2009 ¶¶ 69–76. According to Patent Owner, the SLS and Altitude Cruise Operating Lines are “traditional ‘operating lines’” which are different from the claimed target operability line, which in Patent Owner’s view connects points across different traditional operating lines.

PO Resp. 43–44; Ex. 2009 ¶¶ 70–71, 75. Patent Owner further asserts neither of the Willis UTW Engine’s disclosed fan operating lines optimizes fan operability margin. PO Resp. 44–47; Ex. 2009 ¶¶ 72–74.

A preponderance of the evidence supports Petitioner’s contention that Willis discloses achieving a target operability line, as we have construed that term *supra*. That is, we find the Willis UTW Engine achieves a specific operating line — either the SLS Operating Line, or the Altitude Cruise Operating Line — both of which are defined by a series of points on a fan map at which the fan section is designed to operate. We further find the Willis UTW Engine achieves the SLS Operating Line to “keep jet velocity low for reduced noise” (Ex. 1011.038), thereby providing a desired “engine performance” as described in the ’513 patent (Ex. 1001, Abstract, 1:47–49). Similarly, the Willis UTW Engine achieves the Altitude Cruise Operating Line to “increase thrust at altitude” (Ex. 1011.038), thereby providing a desired “engine performance” as described in the ’513 patent (Ex. 1001, Abstract, 1:47–49). Patent Owner’s rebuttal relies on a claim construction that we have rejected for reasons provided above.

Patent Owner further argues Willis fails to disclose the claimed “controller . . . for effectively changing the nozzle exit area to achieve the target operability line.” PO Resp. 2, 17–20, 48–56; Ex. 2009 ¶¶ 77–90. According to Patent Owner, the Willis UTW Engine instead varies the nozzle exit area “to maintain a maximum inlet Mach number,” which is

different from achieving a target operability line. PO Resp. 48–49; Ex. 2009 ¶¶ 59–63, 68, 81–83. Patent Owner contends the Willis UTW Engine controls three variables (fuel flow, fan pitch, and fan nozzle area), and explicitly pairs each of those controlled variables with a correspondingly determined cycle parameter (fuel flow determines engine pressure ratio, fan pitch determines fan speed, and fan nozzle area determines inlet Mach number). PO Resp. 49–51 (citing Ex. 1011.038, .148, .243, .246); Ex. 2009 ¶¶ 80–83, 88–89. In Patent Owner’s view, Willis “never discloses pairing the fan nozzle area with a target operability line or anything similar,” as target operability is instead paired with fan pitch which affects the fan stall margin. PO Resp. 49–51, 54–55; Ex. 2009 ¶¶ 80–83, 86–89.

Petitioner replies that page .038 of Willis discloses effectively changing the nozzle exit area to achieve the target operability line. Pet. Reply 2, 15–16.

A preponderance of the evidence supports Petitioner’s contention. Willis states that the Altitude Cruise Operating Line is “reached by closing the variable exhaust nozzle.” Ex. 1011.038. We find Willis thereby discloses, as claimed, “effectively changing the nozzle exit area to achieve the target operability line” (i.e. the Altitude Cruise Operating Line). This is true regardless of whether Willis additionally changes the nozzle exit area to achieve other performance objectives, such as “to hold a scheduled inlet Mach number.” Ex. 1011.148–.149; *see, e.g.*, Pet. Reply 15. Patent Owner’s rebuttal that the Altitude Cruise Operating Line is not a target operability line is not persuasive, as discussed above. Further, claim 1 of the ’513 patent fails to exclude variables other than the nozzle exit area (for

example, fan pitch) being used in addition to the nozzle exit area to achieve the target operability line. Cf. Tr. 44:5–45:1.

e. “wherein the flow control device includes effectively open and closed conditions, the command effectively changing the nozzle exit area between the effectively open and closed conditions”

Petitioner contends the Willis UTW Engine’s nozzle exit area flow control device has effectively open and closed conditions, such that controller commands effectively change the nozzle exit area between those positions. Pet. 35–37. Patent Owner disputes this contention. PO Resp. 57–62.

Petitioner argues Willis discloses “an effectively open condition with a larger nozzle exit area (2900 in²), and an effectively closed condition with a smaller nozzle exit area (2500 in²).” Pet. 35–36 (citing Ex. 1011.149, Fig. 82); Ex. 1003 ¶ 71. Petitioner’s annotated version of Figure 82 from Willis is reproduced below:

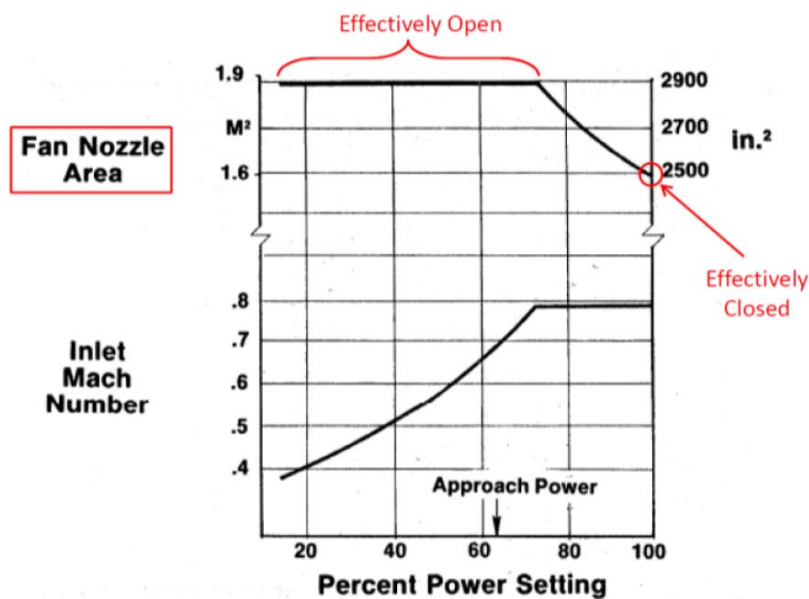


Figure 82. UTW Fan Nozzle Control Characteristics.

Pet. 36; Ex. 1003 ¶ 71. As shown in Petitioner's annotated version of Figure 82, the fan nozzle area varies from 2900 in² (marked "Effectively Open" by Petitioner) to 2500 in² (marked "Effectively Closed" by Petitioner) as a function of percent power setting. Petitioner additionally argues Willis discloses that a command from the controller effectively changes the nozzle exit area between the effectively open and closed conditions. Pet. 36 (citing Ex. 1011.038, .148); Ex. 1003 ¶ 71.

Patent Owner argues Willis fails to disclose that the 2500 in² fan nozzle exit area is an "effectively closed" position, because "Willis's nozzle can close much further than 2500 in²." PO Resp. 57; Ex. 2009 ¶¶ 91–100. Patent Owner relies on Figure 131 of Willis, which illustrates a nozzle exit area of 2100 in², less than Petitioner's alleged effectively closed position of 2500 in². PO Resp. 57–58 (citing Ex. 1001.212, .216); Ex. 2009 ¶¶ 92–93. Patent Owner additionally relies on Figure 150 of Willis, as showing test results of the same controller and nozzle used in Figure 82, and as disclosing a nozzle exit area "much less than 2500 in² and lower than 2200 in²." PO Resp. 60–61 (citing Ex. 1001.032–.049, .134, .148, .216, .243–.244); Ex. 2009 ¶¶ 97–98. Thus, Patent Owner's view is that the 2500 in² area "is at best an intermediate condition for Willis's nozzle, not the 'effectively closed condition' that Petitioner argues," and "Willis does not disclose what its 'effectively closed condition' is." PO Resp. 61.

Petitioner replies that Patent Owner's "position ignores that Willis discloses a control schedule with discrete open and closed endpoints of 2900 in² and 2500 in²" in Figure 82. Pet. Reply 3, 17 (citing Ex. 1011.148). Petitioner maintains Figure 82 of Willis discloses a discrete nozzle exit area closed endpoint of 2500 in² because that area "corresponds to a power

setting of 100 percent” and “a person of ordinary skill in the art would understand that the controller would prohibit the nozzle exit area from closing beyond that point.” Pet. Reply 17–18; Ex. 1022 ¶ 5. Petitioner dismisses Figures 131 and 150 of Willis as “represent[ing] experiments and tests conducted to define the final engine design” reflected in Figure 82. Pet. Reply 18–21 (citing Ex. 1011.019, .146–.148, .212, .243); Ex. 1022 ¶¶ 6–9. For example, Petitioner points out that the experiment of Figure 150 set the inlet Mach number at 0.75, whereas the final design of Figure 82 specifies an inlet Mach number of 0.79. Pet. Reply 21; Ex. 1022 ¶ 8. Petitioner adds that, regardless of Figure 82, Willis independently discloses an effectively closed condition in describing that the Altitude Cruise Operating Line is “reached by *closing* the variable exhaust nozzle” (Ex. 1011.038 (emphasis added)) to the configuration illustrated in Figure 8 (*id.* at .032–.033), versus other “part way” opened positions employed for example during takeoff (*id.* at .032). Pet. Reply 3, 21–22; Ex. 1022 ¶ 10.

A preponderance of the evidence supports Petitioner’s contention that the Willis UTW Engine includes an effectively closed condition, corresponding to a nozzle exit area of 2500 in² in Figure 82. First, we find the evidence establishes that the fan nozzle control characteristics of Figure 82 apply to the same Willis UTW Engine shown in Figure 8, which also has the fan map shown in Figure 11. *See* Ex. 1011.032–.033 (“Details of the UTW engine can be seen in Figure 8”), .038–.039 (“Key operating points for the UTW fan are indicated” in Figure 11), .148–.149 (“[t]he UTW QCSEE incorporated three prime manipulated variables: fuel flow, fan pitch, and fan nozzle area” and “Figure 82 shows the relationship between fan

nozzle area, inlet Mach number, and percent power demand at sea level conditions”).

We further find Figure 82 illustrates that the Willis UTW Engine’s fan nozzle has a discrete endpoint condition that is closed, having an area of 2500 in². This finding is based primarily on Figure 82 itself, because the 2500 in² point is self-evidently at one extreme end of the control configuration scheme illustrated in the figure, which Willis indicates reflects “the complete power setting range.” Ex. 1011.148–.149. This understanding of Figure 82 is supported by the testimony of Dr. Attia that the 2500 in² area in Figure 82 is a “closed nozzle area endpoint because it occurs at the terminal point of the power lever, *i.e.*, at 100 percent power setting.” Ex. 1022 ¶ 5. Dr. Attia further testifies a person of ordinary skill in the art would understand that the schedule illustrated in Figure 82 indicates the controller “would not allow the nozzle exit area to close beyond 2500 in²,” because that area corresponds to 100% power. *Id.*

We appreciate that Willis discloses, under some experimental conditions, a fan nozzle that achieves an area that is less than the 2500 in² effectively closed position of the Willis UTW Engine. Figure 131, for example, reflects a fan nozzle exit area of 2100 in². Ex. 1011.216. Figure 131, further, reports the results of a “UTW Performance Test” (*id.* at .212) including “UTW Measured Thrust” (*id.* at .216), suggesting the tests were conducted using the Willis UTW Engine. However, we find Willis indicates this test was performed on “the UTW engine as it was *initially tested* with a bell-mouth inlet for airflow calibration and to establish uninstalled performance levels with essentially 100% ram recovery.” *Id.* at .212 (emphasis added). These initial test results as reflected in Figure 131

identify “various combinations of blade angle and fan speed that can pump the indicated airflow,” demonstrating that “[t]he goal thrust level could be reached with a variety of settings of the controlled parameters.” *Id.* Thus, we find the test results of Figure 131 relate to an early version of the Willis UTW Engine, not the final version reflected in Figures 8, 11, and 82.

We find Figure 150 of Willis, similarly, is unrelated to the final version of the Willis UTW Engine reflected in Figures 8, 11, and 82. We find Willis indicates that the final version “is designed to hold the inlet throat Mach number constant at high power settings by variation of the fan nozzle area,” whereas “Figure 150 shows the results of an *inlet Mach number control experiment*.” Ex. 1011.243–.244 (emphasis added). In the experiment, the “control system inlet Mach number reference was set at 0.75.” *Id.* The final version of the Willis UTW Engine, by contrast, was designed to operate at a Mach number of 0.79. *Id.* at .038.

f. “the effectively open condition corresponds to an engine idle condition”

Petitioner contends Figure 82 of Willis discloses that the effectively open condition corresponds to an engine idle condition. Pet. 37–38. This contention, which Patent Owner does not dispute, is supported by a preponderance of the evidence. Specifically, we find Figure 82 illustrates the 2900 in² effectively open nozzle exit area is maintained “in the lower percent power setting region (<70%)”, with the “Approach Power” setting identified as being less than 70%. Ex. 1011.148–.149; Ex. 1003 ¶ 72. We find Willis further indicates the “approach” power setting is “higher” than “low-power ground idle conditions.” Ex. 1011.159; Ex. 1003 ¶ 72.

g. Conclusion

For the foregoing reasons, we conclude a preponderance of the evidence supports Petitioner's contention that Willis discloses each and every limitation of claim 1. We therefore determine claim 1 is anticipated by Willis, and is not patentable under 35 U.S.C. § 102(b).

4. Dependent Claims 4–8

Petitioner contends the Willis UTW Engine incorporates each and every limitation of claims 4–8 of the '513 patent. Petitioner contends the throttle position sensor of claim 4 is disclosed in Figure 79 of Willis as providing an “Electro/Mechanical Power Level Signal.” Pet. 41–42 (citing Ex. 1011.143, .148); Ex. 1003 ¶¶ 79–80. Petitioner contends the “physically open and closed nozzle exit areas” of claim 5 are disclosed in Figure 82 of Willis. Pet. 42 (annotating Figure 82); Ex. 1003 ¶ 81. Petitioner contends the actuator and flap of claim 6 are disclosed in Willis. Pet. 43–44 (citing Ex. 1011.128 (“nozzle flaps”), .142 (“fan nozzle . . . actuators”), .143 (“Fan Nozzle Actuation”)); Ex. 1003 ¶¶ 82–83. Petitioner contends the effectively closed condition of Willis is adapted to throttle a flow through the bypass flow path, when compared to the effectively open condition, as recited in claim 7. Pet. 44–46 (citing Ex. 1011.034, .216 (Fig. 131)); Ex. 1003 ¶¶ 84–89. Petitioner contends Willis discloses its effectively closed condition corresponds to a cruise condition, as recited in claim 8. Pet. 46 (citing Ex. 1011.038); Ex. 1003 ¶ 90.

Patent Owner's Response relies solely on arguments as to claim 1, and does not address Petitioner's arguments and supporting evidence as to the subject matter added by claims 4–8.

We adopt Petitioner's above-identified contentions as our findings with regard to anticipation of the challenged dependent claims 4–8 because, upon review of the full record in this proceeding, the cited portions of Willis (as reflected in the summary above) reasonably support Petitioner's assertions that the elements of these claims are expressly disclosed by Willis. We, therefore, determine claims 4–8 are anticipated by Willis, and are not patentable under 35 U.S.C. § 102(b).

C. Obviousness over Willis

Petitioner asserts claim 7 of the '513 patent is unpatentable under 35 U.S.C. § 103(a) as having been obvious over Willis. *See* Pet. 46–47, 49–50. Petitioner cites the Declaration of Dr. Magdy Attia in support. Ex. 1003. Patent Owner opposes Petitioner's assertions. PO Resp. 62–64.

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 demonstrates claim 7 of the '513 patent is unpatentable as having been obvious over Willis. We begin our analysis with a brief summary of the law of obviousness, then consider the level of ordinary skill in the art, and finally address Petitioner's and Patent Owner's contentions.

1. Law of Obviousness

A patent claim is unpatentable under 35 U.S.C. § 103 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. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

2. *Level of Ordinary Skill in the Art*

In the Decision to Institute, we adopted Dr. Attia’s definition of a person of ordinary skill in the art. Inst. Dec. 6. That definition is “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.” *Id.* (quoting Ex. 1003 ¶ 4). Patent Owner has not provided a different definition. See PO Resp. 63–64. Indeed, Patent Owner’s declarant Dr. Benini substantially agrees with Dr. Attia’s definition. Ex. 2009 ¶ 18.

Patent Owner contends “the Petition fails to identify the level of ordinary skill in the art,” and “never adopts” or “cite[s] to” Dr. Attia’s definition. PO Resp. 63. This is problematic, in Patent Owner’s view, because it prevents the Board from analyzing whether a person of ordinary skill in the art would have the knowledge attributed to such a person in the Petition (discussed further below). *Id.* at 63–64.

Petitioner replies that the obviousness analysis in the Petition cites Dr. Attia’s Declaration at paragraphs 84–89, which Dr. Attia indicates is “given from the perspective of a POSITA” (Ex. 1003 ¶ 4). Pet. Reply 23–24; see also Inst. Dec. 6 (same conclusion).

After weighing the arguments presented, we do not perceive any persuasive reason why we should not adopt Dr. Attia’s definition of the level

of ordinary skill, with which Dr. Benini agrees. Patent Owner fails to provide a substantive rationale for why Dr. Attia's definition might be deficient. We appreciate that our rules proscribe incorporating arguments by reference. 37 C.F.R. § 42.6(a)(3). Nonetheless, under the circumstances of this case, in which the amount of incorporated material is very small (one short paragraph) and further is very clearly set forth in the evidence of record (Ex. 1003 ¶ 4), we decide to adopt Dr. Attia's definition of the level of ordinary skill, which seems reasonable. See 37 C.F.R. § 42.5(b).

3. *Dependent Claim 7*

Claim 7 depends directly from claim 1, and recites “the effectively closed condition is adapted to throttle a flow through the bypass flow path compared to the effectively open condition.” Ex. 1001, 4:39–42. Petitioner firstly contends Willis discloses this limitation, and therefore anticipates claim 7 along with its parent claim 1. Pet. 44–46, 49. As indicated above, we agree with that contention, based on the record of the present proceeding.

Petitioner secondly contends, in the event it is determined Willis fails to disclose the limitation of claim 7, the claimed subject matter would have been obvious based on Willis in view of the knowledge of a person of ordinary skill in the art. Pet. 49–50; Ex. 1003 ¶¶ 85–89. That knowledge includes, according to Dr. Attia's un rebutted testimony, the recognition “that the bypass duct's capacity to receive air flow is directly related to the size of the bypass nozzle exit area.” Ex. 1003 ¶ 88. This is so, according to Dr. Attia, because “[a] smaller nozzle exit area acts as a flow restrictor, thus reducing the flow capacity of the bypass duct.” *Id.* Dr. Attia further testifies that “the capacity of the fan to draw in air . . . is . . . largely dependent on the

capacity of the bypass duct to receive air,” so “decreasing the capacity of the bypass flow path by reducing the nozzle exit area would result in a corresponding reduction in the capacity of the fan to draw in airflow.” *Id.* Dr. Attia cites Figure 131 of Willis in support of that proposition, because it shows fan airflow being reduced when the bypass nozzle exit area is reduced. *Id.*

Patent Owner responds that Petitioner improperly relies on the knowledge of a person of ordinary skill in the art, because “when relying on a storehouse of information as broad as this, the Petition cannot merely cherry-pick helpful snippets of information” and must instead “address the ‘knowledge’ as a whole.” PO Resp. 63 (citing *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540 (Fed. Cir. 1983)). Patent Owner further asserts that “because Petitioner never addresses the scope and content of the ‘knowledge’ in the first *Graham* factor, it also fails to address the differences between the claimed invention and that ‘knowledge’ in the third *Graham* factor.” *Id.* at 64.

A preponderance of the evidence supports Petitioner’s contention, and we conclude, that claim 7 would have been obvious based on Willis. Dr. Attia’s testimony, summarized above, is persuasive. Dr. Attia’s basic point is that a smaller “effectively closed” nozzle exit area will “throttle” the air flow in the duct upstream of the exit area as compared to a larger “effectively open” condition. This testimony is unrebutted by contrary evidence. See PO Resp. 63–64 (no citation to contrary evidence in the record); Ex. 2009 ¶ 101. In particular, Patent Owner’s criticism that Dr. Attia cherry-picks helpful snippets of information, without addressing the knowledge of a person of ordinary skill in the art as a whole, is

unpersuasive because Figure 131 of Willis supports Petitioner's position, and the record before us does not indicate what knowledge might contradict Dr. Attia's testimony.

For the foregoing reasons, we conclude a preponderance of the evidence supports Petitioner's contention that claim 7 would have been obvious to a person of ordinary skill in the art from the Willis disclosure. We therefore determine claim 7 is not patentable under 35 U.S.C. § 103(a).

D. Obviousness over Willis and Gisslen

Petitioner asserts claim 6 of the '513 patent is unpatentable under 35 U.S.C. § 103(a) as having been obvious over Willis and Gisslen. *See* Pet. 11–13, 50–54. Petitioner cites the Declaration of Dr. Magdy Attia in support. Ex. 1003. Patent Owner opposes Petitioner's assertions. PO Resp. 64–65.

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 demonstrates claim 6 of the '513 patent is unpatentable as having been obvious over Willis and Gisslen. We begin our analysis with a brief summary of Gisslen, and then address Petitioner's and Patent Owner's contentions.

1. Gisslen

Gisslen discloses a variable area exhaust nozzle for an aircraft turbine engine. *See* Ex. 1005, 1:3–5. Figures 1 and 2 of Gisslen are reproduced below:

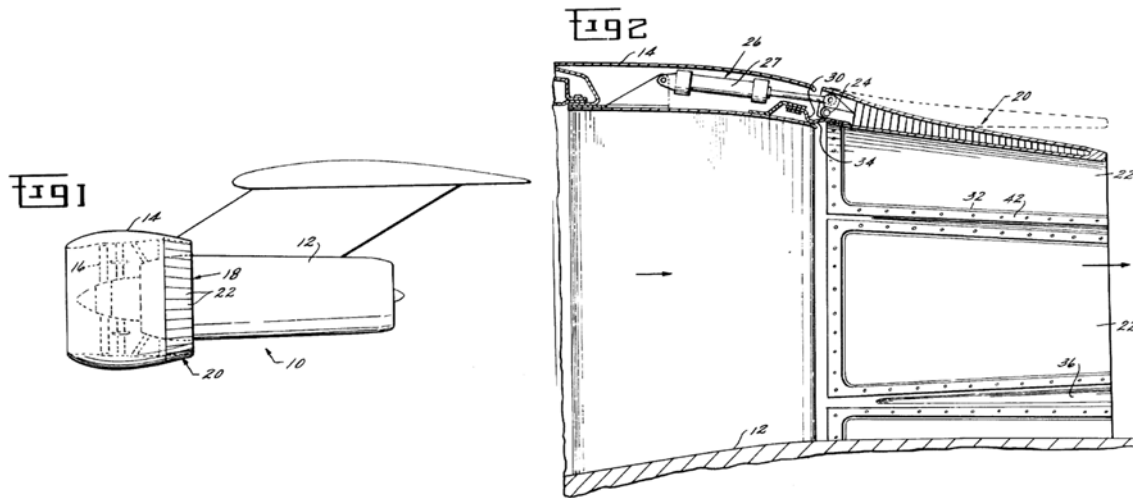


Figure 1 is a side view of engine 10 incorporating variable area nozzle 20, and Figure 2 is a partial cross-sectional view showing nozzle 20. *Id.* at 1:54–58, 1:66–67, 2:11. Nozzle 20 comprises an annular array of flaps 22 hingeably connected at 24 to air duct 14. *Id.* at 2:11–15. Actuator means 26 positions flaps 22 “to increase or decrease the cross-sectional flow area of [duct] outlet 18,” in order “to enhance performance during various modes of engine operation such as take-off, cruise or climb.” *Id.* at 1:6–14, 2:16–24.

2. *Dependent Claim 6*

Claim 6 depends from claim 5, which depends from claim 1, and recites “the flow control device includes an actuator adapted to move a flap” Ex. 1001, 4:35–38. Petitioner firstly contends Willis discloses this limitation, and therefore anticipates claim 6 along with its parent claims 1 and 5. Pet. 43–44, 50. As indicated above, we agree with that contention, based on the record of the present proceeding.

Petitioner secondly contends, in the event it is determined Willis fails to disclose the limitation of claim 6, the claimed subject matter would have been obvious based on Willis in view of Gisslen. Pet. 50–51; Ex. 1003

¶¶ 92–97. Petitioner asserts Willis and Gisslen both disclose turbofan engines including a variable area bypass nozzle comprising a plurality of flaps. Pet. 52; Ex. 1003 ¶ 95. According to Petitioner, a person of ordinary skill in the art would have known the Willis UTW Engine’s flaps are actuated between open and closed positions in order to achieve variable area configurations. Pet. 52–53 (citing Ex. 1008, 3:33–48 and Ex. 1011.128, 142–.143); Ex. 1003 ¶¶ 93, 97. Petitioner cites Gisslen as disclosing an actuator means for moving flaps between open and closed positions. Pet. 53–54 (citing Ex. 1005, 2:16–18); Ex. 1003 ¶ 94. Given this substantial overlap in disclosure between Willis and Gisslen, Petitioner contends it would have been obvious to use Gisslen’s actuator in the Willis UTW Engine to actuate the flaps of Willis’s variable area bypass nozzle. Pet. 52–53; Ex. 1003 ¶¶ 95–97.

Patent Owner argues “Gisslen . . . does not cure the deficiencies . . . for Willis regarding the features of claims 1 and 5,” because Gisslen has no “regard for achieving a target operability line” as recited in claim 1. PO Resp. 64; Ex. 2009 ¶ 101. During the oral hearing, Patent Owner additionally referred to the argument, already considered above, that Willis fails to disclose a controller for changing the nozzle exit area to achieve the target operability line. Tr. 43:18–45:3. Thus, in Patent Owner’s view, claim 6 is patentable over Willis and Gisslen “for at least the same reasons” that claim 1 is not anticipated by Willis. PO Resp. 64–65. Patent Owner’s objections to the Willis disclosure in connection with parent claim 1 are not persuasive for the reasons provided above.

The remainder of Petitioner’s obviousness contentions as to dependent claim 6 stand uncontested in the record before us. We conclude a

preponderance of the evidence supports Petitioner's above-identified contention that claim 6 would have been obvious to a person of ordinary skill in the art from Willis and Gisslen. We determine claim 6 is not patentable under 35 U.S.C. § 103(a).

E. Obviousness over Willis and Harner

Petitioner asserts claim 3 of the '513 patent is unpatentable under 35 U.S.C. § 103(a) as having been obvious over Willis and Harner. *See* Pet. 54–60. Petitioner cites the Declaration of Dr. Magdy Attia in support. Ex. 1003. Patent Owner opposes Petitioner's assertions. PO Resp. 65.

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 demonstrates claim 3 of the '513 patent is unpatentable as having been obvious over Willis and Harner. We begin our analysis with a brief summary of Harner, and then address Petitioner's and Patent Owner's contentions.

1. Harner

Harner discloses a control system for a fan propulsor, including “an engine bypass duct having a variable exit nozzle.” Ex. 1013, Abstract. As shown in Figure 1, control 10 is connected to actuator 18 to control the physical positioning of variable exhaust nozzle 20 of bypass duct 22. *Id.* at 2:67–3:4. Control 10 uses the power lever position (PLA) and the flight Mach number (M_N) “to create a commanded optimum fan exhaust nozzle exit area signal, A_{FSS} .” *Id.* at Fig. 2, 4:4, 4:12–19, 5:49–54. Control 10 also uses the temperature-corrected fan speed ($N_F / \sqrt{\Theta}$) and the flight Mach number (M_N) to calculate a minimum nozzle exit area signal, “to assure that

the fan operates without excursions into the surge range.” *Id.* at Fig. 2, 1:40–45, 5:55–6:2. Thus, maximum selector switch 76 “permit[s] solely the higher of the two values to pass through, A_{FFWD} ,” so that variable exhaust nozzle 20 is modified in accordance with that higher value. *Id.*

2. *Dependent Claim 3*

Claim 3 depends directly from claim 1 and recites “an airspeed sensor in communication with the controller for providing an aircraft airspeed.” Ex. 1001, 4:27–29.

Petitioner contends Willis discloses each and every limitation of parent claim 1. Pet. 54. Petitioner further contends that, while Willis does not disclose an airspeed sensor as recited in claim 3, the invention of claim 3 would have been obvious in view of Harner. *Id.* at 55; Ex. 1003 ¶¶ 98–106. Petitioner asserts Willis and Harner disclose similar gas turbine engines, both including variable pitch fans and variable area fan nozzles, and both utilizing fan pitch change, fuel flow, and fan exhaust nozzle exit area to control the engine. *Id.* at 56–57 (citing Ex. 1011.020, .148 and Ex. 1013, 1:28–33); Ex. 1003 ¶¶ 103–104. In particular, according to Petitioner, both use power lever position (the “throttle” of Willis and the “power lever” of Harner) to control the nozzle exit area, but Harner discloses additionally using corrected fan speed and the flight Mach number to control the nozzle exit area in order to “help[] prevent fan surge (*i.e.*, improve fan stability.” Pet. 57–59; Ex. 1003 ¶ 105; Ex. 1013, 1:40–42. Petitioner contends it would have been obvious to use corrected fan speed and flight Mach number to control Willis’s nozzle exit area to achieve that benefit. Pet. 57–58; Ex. 1003 ¶ 105. This would have been done, in Petitioner’s view, by

incorporating an airspeed sensor into the Willis UTW Engine, in order to provide the necessary flight Mach number information to Willis's engine controller. Pet. 58–60; Ex. 1003 ¶ 106.

Patent Owner argues “Harner does not cure the deficiencies . . . for Willis regarding the features of claim 1,” because Harner has no “regard for achieving a target operability line” as recited in claim 1. PO Resp. 65. During the oral hearing, Patent Owner additionally referred to the argument, already considered above, that Willis fails to disclose a controller for changing the nozzle exit area to achieve the target operability line. Tr. 43:18–45:3. Thus, in Patent Owner's view, claim 3 is patentable over Willis and Harner “for at least the same reasons” that claim 1 is not anticipated by Willis. PO Resp. 65. Patent Owner's objections to the Willis disclosure in connection with parent claim 1 are not persuasive, for the reasons provided above.

Patent Owner additionally asserts, in a footnote, that “Petitioner fails . . . to show why one of ordinary skill in the art at the time of the invention would have been motivated to combine a test engine [as in Willis], which does not fly, with an airspeed sensor [as in Harner].” *Id.* at 65 n.11. This contention is not persuasive, however, because the work reflected in the Willis report was directed to developing an engine that might be used in an actual aircraft. See Ex. 1011.003 (“The QCSEE Program included the design, fabrication, and testing of two experimental propulsion systems *for powered-lift transport aircraft.*”) (emphasis added), .024. In that context, we are persuaded by Dr. Attia's testimony that “an airspeed sensor in communication with the controller is a common element of a gas turbine

engine used in an aircraft application.” Ex. 1003 ¶ 106. That testimony is un rebutted. *See, e.g.*, Ex. 2009 ¶ 101.

For the foregoing reasons, we conclude a preponderance of the evidence supports Petitioner’s above-identified contention that claim 3 would have been obvious to a person of ordinary skill in the art from Willis and Harner. We therefore determine claim 3 is not patentable under 35 U.S.C. § 103(a).

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1 and 3–8 of U.S. Patent No. 8,365,513 B2 have been shown, by a preponderance of the evidence, to be unpatentable; and

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

IPR2016-00534
Patent 8,365,513 B2

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