

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GENERAL ELECTRIC COMPANY,
Petitioner,

v.

UNITED TECHNOLOGIES CORPORATION,
Patent Owner.

Case IPR2017-00427
Patent 8,313,280 B2

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

WEATHERLY, *Administrative Patent Judge*.

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

I. INTRODUCTION

A. BACKGROUND

General Electric Company (“GE”) filed a petition (Paper 1, “Pet.”) to institute an *inter partes* review of claims 1–4, 7–13, 15, and 16 (the “challenged claims”) of U.S. Patent No. 8,313,280 B2 (Ex. 1001, “the ’280 patent”). 35 U.S.C. § 311. Petitioner supported the Petition with a Declaration from Magdy Attia, Ph.D. (Ex. 1003). United Technologies

Corporation (“UTC”) timely filed a Preliminary Response. Paper 6. On July 5, 2017, based on the record before us at the time, we instituted an *inter partes* review of all challenged claims as listed in the table below. Paper 7 (“Institution Decision” or “Dec.”).

References	Basis	Claims
U.S. Patent No. 3,932,058 (Ex. 1013, “Harner”)	§ 103	1, 8–10, 12, 13, 15, and 16
Harner in view of U.S. Patent No. 6,318,070 B1 (Ex. 1008, “Rey”)	§ 103	11
U.S. Patent No. 3,892,358 (Ex. 1005, “Gisslen”) in view of U.S. Patent No. 4,130,872 (Ex. 1006, “Harloff”)	§ 103	1–4 and 7

Dec. 2, 21.

After we instituted this review, Patent Owner filed a Patent Owner Response in opposition to the Petition (Paper 16, “PO Resp.”) that was supported by a Declaration from Ernesto Benini, Ph.D. (Ex. 2002). Petitioner filed a Reply in support of the Petition (Paper 21, “Reply”) along with a second declaration from Dr. Attia (Ex. 1023). Patent Owner did not move to amend any claim of the ’280 patent.

We heard oral argument on March 15, 2018. A transcript of the argument has been entered in the record (Paper 28, “Tr.”).

We have jurisdiction under 35 U.S.C. § 6. Petitioner must prove propositions of unpatentability by a preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73.

For the reasons expressed below, we conclude that Petitioner has demonstrated by a preponderance of evidence that claims 1–4, 7–13, 15, and 16 are unpatentable.

B. RELATED PROCEEDINGS

The parties identified no other proceedings as being related to this proceeding. Pet. 1; Paper 4, 1.

C. THE '280 PATENT

The '280 patent is related to managing a turbofan's operating line to maintain a sufficient fan stability margin without compromising overall engine performance. Ex. 1001, 1:39–41. To accomplish this goal, controller 50 configures flow control device 41, which effectively alters fan nozzle exit area 40 of turbofan 20, to move the operating line of turbofan 20. *Id.* at 2:53–3:1, 3:13–18, 4:8–19. Controller 50 is programmed to detect when the stability margin for turbofan 20 is inadequate and respond to such a condition by increasing nozzle exit area 40. *Id.* at 4:4–10. Control of this type enables engine 10 to operate at peak efficiency but also to alter its operating characteristics to avoid potential instability or to manage noise levels from engine 10. *Id.* at 3:1–13.

Claims 1 and 15, which are the independent claims among the challenged claims, recite:

1. A turbofan engine control system for managing a turbofan operating line comprising:
 - a spool including a turbine housed in a core nacelle;
 - a turbofan coupled to the spool;
 - a fan nacelle surrounding the turbofan and core nacelle and providing a bypass flow path having a nozzle exit area; and

a controller programmed to effectively change the nozzle exit area in response to an undesired stability margin for the turbofan by lowering the turbofan operating line and increasing the turbofan stability margin, wherein the controller detects the undesired stability margin.

Id. at 4:27–38.

15. A method of managing a turbofan engine turbofan operating line, the method comprising the steps of:

detecting at least one of a turbofan pressure ratio, low spool speed, airflow direction and throttle position;

determining the undesired turbofan stability margin from the detecting step;

effectively increasing a nozzle exit area of a bypass flow path in response to an undesired turbofan stability margin; and

lowering the turbofan operating line and increasing the turbofan stability margin as a result of the nozzle exit area increasing.

Id. at 6:6–17.

II. ANALYSIS

A. CLAIM INTERPRETATION

“A claim in an unexpired patent shall be given its broadest reasonable construction in light of the specification of the patent in which it appears.” 37 C.F.R. § 42.100(b); *see also* *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2142 (2016) (affirming that USPTO has statutory authority to construe claims according to Rule 42.100(b)). When applying that standard, we interpret the claim language as it would be understood by one of ordinary skill in the art in light of the specification, and absent any special definition, we give claim terms their ordinary and customary meaning. *See In re Suitco Surface, Inc.*, 603 F.3d 1255, 1260 (Fed. Cir. 2010); *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007) (“The ordinary and customary

meaning is the meaning that the term would have to a person of ordinary skill in the art in question.” (internal quotation marks omitted)). Only terms which are in controversy need to be construed, and then only to the extent necessary to resolve the controversy. *See Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

Claim 1 requires that “the controller detects the undesired stability margin.” Ex. 1001, 4:37–38. Claim 15 recites a step of: “determining the undesired turbofan stability margin from the detecting step.” *Id.* at 6:10–11. The parties agree that claims 1 and 15 use “detect” and “determine” interchangeably to mean “to find out, through investigation or calculation.” PO Resp. 23–24; Reply 3. However, the parties disagree on the meaning of “undesired stability margin.” Interpreting this phrase is critical to deciding whether any of the challenged claims is unpatentable.

GE contends that “undesired stability margin” means “the fan section has insufficient stability margin to avoid experiencing an instability (e.g., a stall, surge, or flutter).” Pet. 22; Reply 3. UTC contends that the term means “a stability margin (i.e., the difference between the pressure ratio at the fan stability limit line and the pressure ratio at the fan operating point) at which instability may result due to a sudden change in airflow.” PO Resp. 29–30. Thus, we must decide whether detecting an “undesired stability margin” necessarily requires calculating a stability margin by calculating “the difference between the pressure ratio at the fan stability limit line and the pressure ratio at the fan operating point.” We conclude that it does not and that the evidence of record supports GE’s proposed interpretation of this phrase.

1. Plain Language of the Claims

The plain language of claim 15 expressly covers detecting an undesired fan stability margin from “detecting at least one of a turbofan pressure ratio, low spool speed, *airflow direction* and throttle position.” *Id.* at 6:8–11 (emphasis added). We interpret the plain language of this step to encompass detecting any one or more of these four parameters. As explained below, the Specification supports our interpretation by indicating, for example, that controller 50 may rely solely upon data provided by sensing device 60, which measures only “direction of the airflow into the engine 10,” to detect “undesired stability margin” stemming from non-axial inlet flow.

Claim 1 broadly recites that the “controller detects the undesired stability margin” without restrictions on the information used to do so. *Id.* at 4:27–38. Claim 7, which depends directly from claim 1, further requires “first and second pressure sensors in communication with the controller, the controller programmed to determine the undesired stability margin from the first and second pressure sensors.” *Id.* at 4:58–61. As explained below, the Specification indicates that controller 50 may use data provided by a pair of pressure sensors 52a and 52b, which measure a pressure gradient stemming from non-axial flow across the inlet of turbofan 20, to detect an undesired fan stability margin.

2. The Specification

The Specification explains one potential source of an “undesired stability margin” as follows:

Reaching an *undesired stability margin* can result in a stall or flutter condition. *Undesired stability margins* for the turbofan 20 can occur during conditions in which the airflow does not enter

the fan nacelle in a direction parallel with the inlet axis, which also corresponds to the rotational axis A.

Referring to Figure 1, air flowing into the fan nacelle 34 in a direction D [red] causes a pressure gradient across the inlet side of the turbofan 20 having low and high pressure regions L, H, [dark blue] which can result in the *undesired reduction of fan stability margin* as shown in FIG. 3. This reduction in stability margin may cause the differential pressure across the turbofan 20 to become unstable.

Id. at 3:37–49 (emphasis added).

The Specification describes, among others, sensors for detecting direction of airflow and pressure gradients across the inlet of turbofan 20 and illustrates the arrangement of those sensors in the colorized version of Figure 1 shown below.

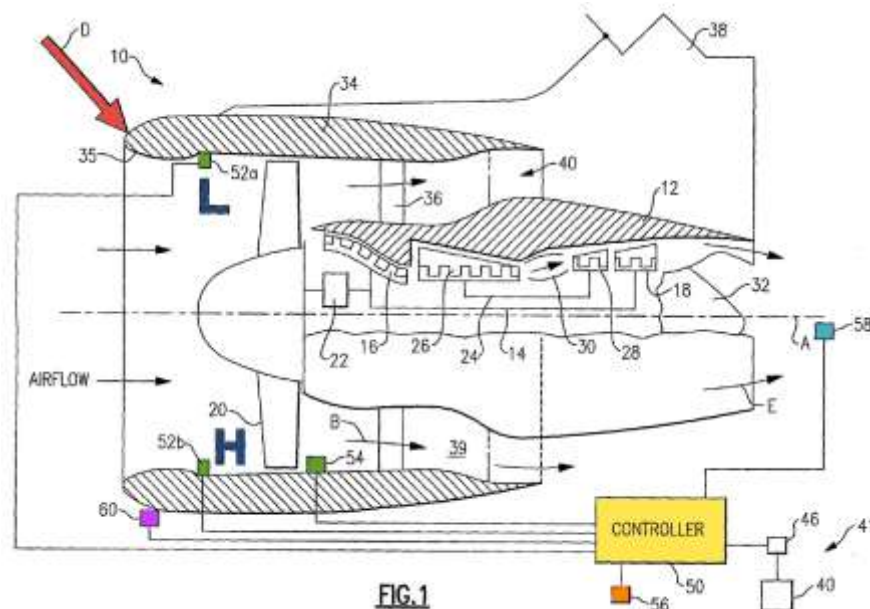


Figure 1 is a cross-sectional view of a turbofan engine with elements of interest colorized to aid our analysis.

Engine 10 includes controller 50 (yellow) which communicates with pressure sensors 52a, 52b, 54 (green), airflow direction sensor 60 (magenta), throttle position sensor 56 (orange) and low spool speed sensor 58 (light

blue). *Id.* at 3:50–67. These sensors provide the information used in the detecting step of claim 15. Controller 50 can detect the undesired stability margin caused by air flowing into the fan inlet in direction D (“non-axial flow”) in two ways. First, controller 50 may use data from “inlet pressure sensors 52a, 52b [green] that are used to determine the pressure gradient *across the turbofan inlet*,” *id.* at 3:50–52 (emphasis added), which is then used to determine the presence of “low and high pressure regions L, H, [dark blue] which can result in the *undesired reduction of fan stability margin* as shown in FIG. 3,” *id.* at 3:43–47 (emphasis added). Second, controller 50 can use sensing device 60 [magenta] which directly “determine[s] the direction of the airflow into the engine 10 relative to the inlet axis” by determining the “angle of attack, slide slip and/or direction of flight.” *Id.* at 3:66–4:3. Neither type of detecting “undesired stability margin” stemming from non-axial flow into the fan inlet involves calculating any pressure ratio, much less calculating a difference in a pressure ratio at the fan stability limit line and the pressure ratio at the fan operating point. Calculating the pressure ratio across the fan requires using pressure sensor 54. *Id.* at 3:57–59. As discussed above, only sensors 52a, 52b, and 60 are involved in controller 50 detecting that non-axial flow is entering the fan inlet. This non-axial flow detection as described in the Specification is one example of detecting as recited in claim 15 (i.e., “detecting . . . airflow direction”).

In our Institution Decision, we raised concern that the Specification does not appear to identify a quantitative standard for discerning a desired stability margin from an undesired one. Dec. 9. The failure to do so indicates that “undesired stability margin” is used in a qualitative rather than

quantitative sense, and detecting the presence of “undesired stability margin” does not require calculating a specific stability margin as UTC proposes. On this issue, UTC argues that Figure 3 graphically illustrates how the controller discerns whether a stability margin is “undesired” by illustrating how changes in flight conditions or the nozzle exit area can affect the stability margin. Rather than reflecting the calculation of specific values of “stability margin,” we determine that Figure 3 merely qualitatively illustrates well known consequences of changes in flight conditions or nozzle exit area.

For example, an “undesired reduction of fan stability margin,” *id.* at 3:44–46, caused by inlet flow in direction D (Figure 1) is shown by the red arrow in the colorized and annotated version of Figure 3 below.

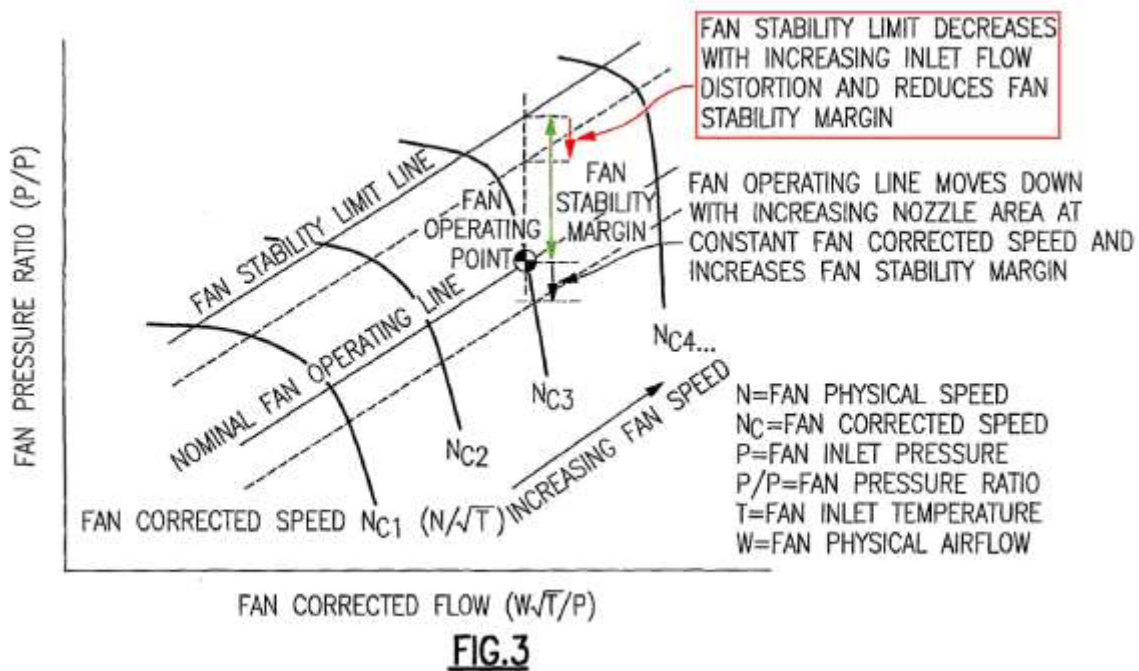


Figure 3 is an exemplary fan performance map. *Id.* at 2:3.

The red box in the annotated Figure highlights text that identifies the cause of the downward shift in the stability limit line as “inlet flow distortion.”

The Specification indicates that flow in direction D of Figure 1 causes “inlet flow distortion” in the form of “local pressure gradients” in the inlet, *id.* at 1:27–31, that are also described as “low and high pressure regions L, H” across the inlet side of turbofan 20, *id.* at 3:43–45. *See also* Ex. 1002, 229 (SAE ARP1420 Revision B stating that “[i]nlet flow distortion refers to spatial variations in the total pressure at the inlet/engine interface plane”). Thus, the Specification indicates that changes in flight conditions, such as the direction of inlet flow, shifts the stability limit line downward and “reduces fan stability margin,” *id.* at Figure 3 (red arrow above), and “can result in the undesired reduction of fan stability margin,” *id.* at 3:43–47. The Figure also indicates that the fan operating line moves down as nozzle exit area increases. *Id.* at Figure 3. However, the X- and Y-axes of the Figure are labeled only with the variable names and known formulas defining those variables without indicating any numeric scale.

We determine that Figure 3 merely illustrates general concepts of how changes in flight conditions or nozzle exit area affect the stability margin without illustrating specific stability margins or providing any quantitative standard for discerning an acceptable stability margin from an undesired one. The claims are similarly devoid of any express language requiring that a stability margin be numerically calculated. Rather, they simply require detecting whether conditions that may lead to instability are present (i.e., the presence of an “undesired stability margin”) and, if so, adjusting fan nozzle exit area by “lowering the turbofan operating line.” *Id.* at 4:34–36 (claim 1), 6:15–17 (claim 15). The plain language of the claims and the Specification does not require “calculating a stability margin” as UTC contends.

3. *The Prosecution History*

UTC also argues that the prosecution history supports its contention that the claims require calculating a stability margin. PO Resp. 35–36 (citing Ex. 1002, 187–88, 216, 225–34, 240). We disagree based on our analysis of the prosecution history described below.

The portion of the prosecution history upon which UTC relies reflects that the Examiner rejected then-pending claims 20 and 34 (issued claims 1 and 15) as indefinite under 35 U.S.C. § 112, ¶ 2 because “[t]he disclosure fails to clearly define what exactly the ‘stability margin’ and ‘operational line’ are.” Ex. 1002, 198. The Applicants argued that “‘stability margin’ was a well understood term in the art and supported their argument with an affidavit under 37 C.F.R. § 1.132 to which they attached an SAE standard having the formula below for calculating “‘stability margin.’” *Id.* at 216, 222 (¶ 4), 230.

$$SM = \left(\frac{PR1 - PRO}{PRO} \right) \times 100$$

The Examiner accepted this formulaic definition of “stability margin” as sufficient to overcome the rejection of the claims as being indefinite. Ex. 1002, 240 (“regarding the definition of ‘stability margin,’ the applicant has demonstrated that the term is well known and clearly defined in the art.”) However, the Examiner did not comment on whether the claims required determining the relationship between the operating point and the stability limit line or calculating a stability margin using the formula.

UTC argues that the applicants emphasized that the claims “required detecting or determining stability margin (i.e., the relationship between the operating point and the stability limit line)” by distinguishing a prior art reference. PO Resp. 35–36 (citing Ex. 1002, 187–88, and quoting Ex. 1002,

216 (“[The reference] does not relate to detecting the stability margin across the fan . . .”). However, the cited evidence does not support the proposition that the claims required determining the relationship between the operating point and the stability limit line.

The beginning of page 187 of Exhibit 1002 reflects the Applicants’ attempt (unsuccessful at the time) to overcome the Examiner’s rejection of claims based upon alleged indefiniteness of “stability margin” by citing information in the Specification. Ex. 1002, 187, *see also* 198 (maintaining rejection of claims as indefinite for reciting “stability margin”). Accordingly, this portion of the prosecution history fails to address whether the claims require calculating “stability margin.” Rather, it merely defines “stability margin” to overcome a rejection of the claims as being indefinite.

The material beginning at the bottom of page 187 and carrying over to page 188 and the quoted material at page 216 reflect the Applicants’ argument that U.S. Patent 5,305,599 (“Marvin”) did not render the claims unpatentable because Marvin’s control system related to detecting instability of its high pressure compressor rather its fan as the claims require. *Id.* at 187–88, 216. The Applicants later convinced the Examiner that Marvin completely lacked a fan and that element 30 that the Examiner had identified as the claimed “fan” was actually a low pressure compressor. *See id.* at 216 (arguing that Marvin’s element 30 is low pressure compressor), 240 (Examiner agreeing that Marvin fails to describe detecting stability margin across the fan). The Examiner’s agreement that Marvin failed to render pending claims 20 and 34 (claims 1 and 15 in the ’280 patent) obvious thus merely demonstrates that Marvin failed to disclose a fan or a control system relating to detecting and avoiding instability of such a fan. We determine

that this portion of the prosecution history is not probative of whether the claims require determining the relationship between the operating point and the stability limit line as UTC contends or calculating a stability margin.

4. Conclusion

For all the reasons expressed above, we reject UTC's argument and agree with GE that "undesired stability margin" means "the fan section has insufficient stability margin to avoid experiencing an instability (e.g., a stall, surge, or flutter)." The claims do not require calculating a stability margin or determining the relationship between the operating point and the stability limit line.

B. THE PARTIES' POST-INSTITUTION ARGUMENTS

In our Institution Decision, we concluded that the argument and evidence adduced by GE demonstrated a reasonable likelihood that claims 1–4, 7–13, 15, and 16 were unpatentable as obvious based on the challenges identified in the table in Part I.A above. Dec. 2, 21. We must now determine whether GE has established by a preponderance of the evidence that the specified claims are unpatentable over the cited prior art. 35 U.S.C. § 316(e). We previously instructed UTC that "any arguments for patentability not raised in the [Patent Owner Response] will be deemed waived." Paper 8, 6; *see also In re Nuvasive, Inc.*, 842 F.3d 1376, 1381 (Fed. Cir. 2016) (holding that patent owner's failure to proffer argument at trial as instructed in scheduling order constitutes waiver). Additionally, the Board's Trial Practice Guide states that the Patent Owner Response "should identify all the involved claims that are believed to be patentable and state the basis for that belief." Office Patent Trial Practice Guide, 77 Fed. Reg.

48,756, 48,766 (Aug. 14, 2012). Accordingly, we primarily address and resolve the issues placed in dispute by the parties.

C. LEGAL STANDARDS

For GE to prevail in its challenges to the patentability of the claims, GE must establish facts supporting its challenges by a preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). “In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden never shifts to UTC. *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (citing *Tech. Licensing Corp. v. Videotek, Inc.*, 545 F.3d 1316, 1326–27 (Fed. Cir. 2008)) (discussing the burden of proof in *inter partes* review).

The Supreme Court in *KSR International Co. v. Teleflex Inc.*, 550 U.S. 398 (2007), reaffirmed the framework for determining obviousness as set forth in *Graham v. John Deere Co.*, 383 U.S. 1 (1966). The *KSR* Court summarized the four factual inquiries set forth in *Graham* that we apply in determining whether a claim is unpatentable as obvious under 35 U.S.C. § 103(a) as follows: (1) determining the scope and content of the prior art, (2) ascertaining the differences between the prior art and the claims at issue, (3) resolving the level of ordinary skill in the pertinent art, and (4) considering objective evidence indicating obviousness or

nonobviousness.¹ *KSR*, 550 U.S. at 406 (citing *Graham*, 383 U.S. at 17–18). In this *inter partes* review, GE cannot satisfy its burden of proving obviousness by employing “mere conclusory statements.” *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016). Thus, to prevail GE must explain how the proposed combinations of prior art would have rendered the challenged claims unpatentable. With these standards in mind, we address each challenge below.

D. LEVEL OF ORDINARY SKILL

GE contends a person of ordinary skill in the art pertaining to the ’280 patent, at the time of invention, “includes someone with an M.S. degree in Mechanical Engineering or Aerospace Engineering as well as at least 3–5 years of experience in the field of gas turbine engine design and analysis.” Pet. 24, n.5; Ex. 1003 ¶ 4. UTC does not address expressly the level of ordinary skill in the art in the Patent Owner Response. However, UTC’s witness, Dr. Benini, expresses opinions based on the same level of skill identified by GE. Ex. 2002 ¶ 22. In considering the issues presently before us, we have adopted and applied GE’s proposed identification of the level of ordinary skill in the art, which is consistent with the ’280 patent and the asserted prior art.

E. CLAIMS 1, 8–10, 12, 13, 15, AND 16: OBVIOUSNESS IN VIEW OF HARNER

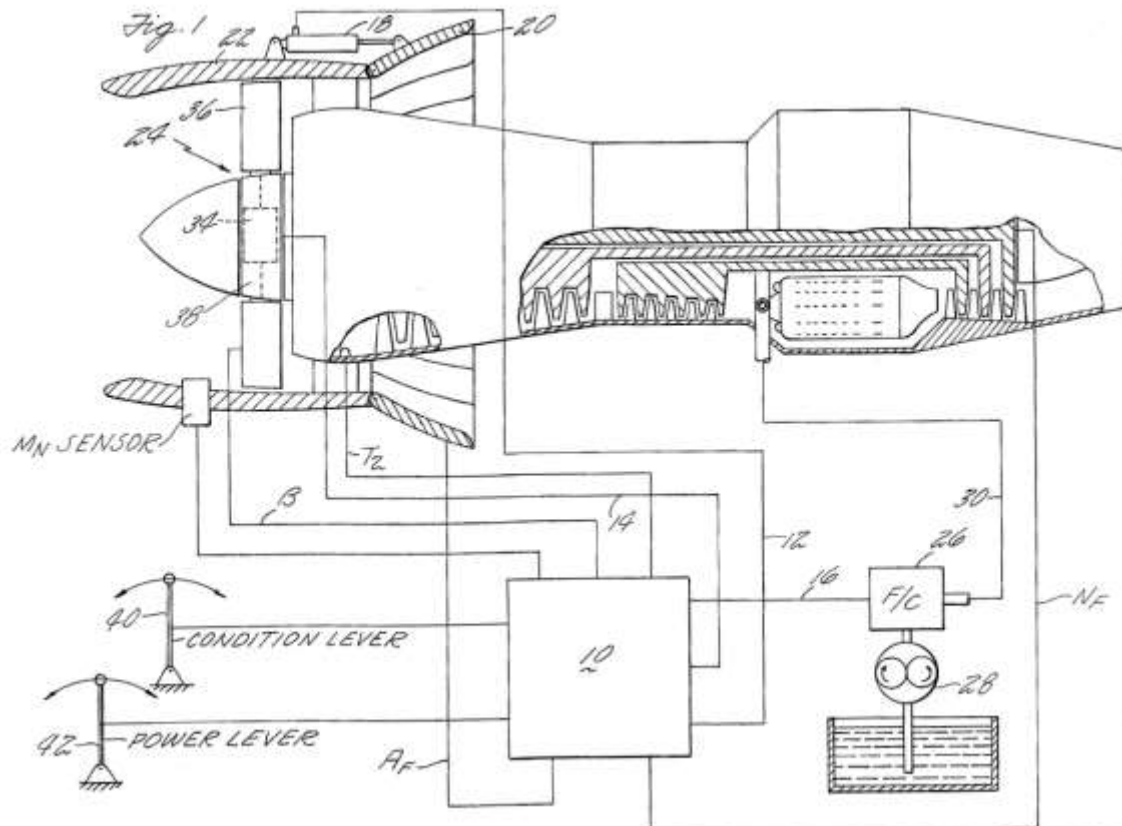
GE argues that Harner in view of the knowledge of an ordinarily skilled artisan renders claims 1, 8–10, 12, 13, 15, and 16 unpatentable as obvious. Pet. 24–50. For the reasons explained below, we determine that

¹ Neither party has addressed the effect of any objective indicia of nonobviousness.

GE has proven the obviousness of these claims by a preponderance of evidence.

1. Overview of Harner

Harner describes a turbofan engine having a control system for preventing fan instability in the form of surge and stall by managing the nozzle exit area of the fan. Ex. 1013, 1:6–46, 3:28–36, 5:24–25, Figure 1. Harner’s Figure 1, reproduced below, schematically illustrates some of the components of its turbofan and control system.



Bypass duct 22 includes actuator 18 for variable nozzle 20 that permits Harner's control system to alter the exit area of nozzle 20. Figure 2 illustrates function generator 72, which calculates an "optimum fan exhaust nozzle area signal" based on power lever angle (i.e., throttle position) and Mach number of the aircraft "to optimize performance in the normal operating regime." *Id.* at 5:49–54. Harner's engine also includes function generator 74 "to assure that the fan operates without excursions into the surge range," which calculates another nozzle exit area as a function of corrected fan speed and aircraft Mach number. *Id.* at 5:55–63. Selector switch 76 permits only the larger of the two calculated nozzle exit areas to pass through. *Id.* at 5:64–68. In this manner, Harner "selects the larger of the normal scheduled area and the minimum fan exit area which is required to avoid fan surge." *Id.* at 1:44–46.

2. GE's Argument Regarding Independent Claims 1 and 15

GE contends that Harner describes every element of claims 1 and 15, Pet. 25–34 (claim 1), 43–48 (claim 15), except that Harner does not explicitly describe lowering the operating line and increasing stability margin, *id.* at 32 (claim 1), 46 (claim 15). GE contends, however, that an ordinarily skilled artisan would have understood that selecting the larger of the "normal" nozzle area and the "minimum" nozzle area that is required to avoid surge constitutes lowering the fan operating line and increasing the stability margin in response to the presence of an undesired stability margin. *Id.* at 31–33 (citing Ex. 1003 ¶¶ 68–70). Dr. Attia testifies that it was well known by an ordinarily skilled artisan that increasing nozzle exit area lowers the turbofan operating line and increases stability margin. Ex. 1003 ¶ 70. In support of his testimony, he cites a 1996 textbook on gas turbine engines that

explains that the “operating line can be moved away from the stall or surge line by increasing the exhaust nozzle throat area.” *Id.* (quoting Ex. 1014, 151).

3. Analysis of UTC’s Counterarguments

UTC contends that Harner fails to describe the controller of claim 1 or the “determining” step of claim 15 because Harner’s turbofan controller “cannot determine the fan’s operating point and is therefore incapable of detecting or determining an undesired stability margin.” PO Resp. 52. UTC rests its argument upon our adoption of UTC’s interpretation of detecting/determining the “undesired stability margin” as calculating “the difference between the fan pressure ratio and fan corrected flow at the stability limit line, and the fan pressure ratio at the same corrected flow at the fan’s actual operating point.” *Id.* at 49.

As explained in Part II.A above, we disagree with UTC’s proposed interpretation of “undesired stability margin.” Instead, we interpret “undesired stability margin” to mean “the fan section has insufficient stability margin to avoid experiencing an instability (e.g., a stall, surge, or flutter).” We determine that Harner describes a controller programmed to act in response to such a margin (claim 1) and determining such a margin (claim 15).

Throughout operation of its engine, Harner continually compares the minimum nozzle area to avoid fan surge (output of function generator 74) with the nozzle area for generating optimum fan exhaust nozzle area (output of function generator 72). Ex. 1013, 5:49–68. When the former nozzle area is larger than the latter, then operating the engine with an exit area calculated for optimum thrust could result in operating the fan with excursions into the

surge range (i.e., with an “undesired stability margin”). *Id.* To avoid the undesired stability margin, Harner always selects the largest of the two nozzle exit areas (i.e., the lowest operating line). *Id.* at 5:55–68. An ordinarily skilled artisan understands that changing the nozzle exit area by selecting the greater of two calculated nozzle exit areas results in selecting a lower operating line and increasing the stability margin. Ex. 1002 ¶¶ 68–70, 94–95 (citing Ex. 1014, 151, Figure 10-53; Ex. 1010, 1:62–65). For these reasons, we conclude that GE has demonstrated by a preponderance of evidence that Harner in view of the knowledge of an ordinarily skilled artisan describes the controller of claim 1 and the determining step of claim 15.

UTC raises no other argument in response to GE’s argument and evidence that Harner renders independent claims 1 and 15 unpatentable as obvious. *See* PO Resp. 46–57 (contending only that Harner fails to describe the claimed controller of claim 1 and the determining step of claim 15). Based on our review of GE’s argument and evidence relating to all other aspects of claims 1 and 15, which we adopt as our own, we conclude that GE has demonstrated by a preponderance of evidence that Harner combined with the knowledge of an ordinarily skilled artisan renders claims 1 and 15 unpatentable as obvious.

4. Dependent Claims 8–10, 12, 13, and 16

GE sets forth its argument and evidence demonstrating that claims 8–10, 12, and 13, which depend directly or indirectly from claim 1, and claim 16, which depends from claim 15, are unpatentable as obvious in view of Harner and the knowledge of an ordinarily skilled artisan. Pet. 34–42, 48–50 (citing Ex. 1013, 1:25–35, 1:40–46, 3:1–4, 3:64–67, 4:22, 5:24–28,

5:49–55, 5:68–6:1, 6:14–22, Figure 1; Ex. 1003 ¶¶ 73–88, 96–98). UTC does not separately identify any reasons why Harner fails to render claims 8–10, 12, 13, and 16 obvious. *See* PO Resp. 46–57 (arguing in support of claims 1 and 15 without addressing distinct reasons that GE’s evidence fails to establish unpatentability of claims 8–10, 12, 13, and 16). We adopt as our own the reasoning and evidence proffered by GE relating to the obviousness of claims 8–10, 12, 13, and 16 in view of Harner and the knowledge of an ordinarily skilled artisan. On that basis, we conclude that GE has demonstrated by a preponderance of evidence that Harner and the knowledge of an ordinarily skilled artisan renders dependent claims 8–10, 12, 13, and 16 unpatentable as obvious.

5. Conclusion

Based on the record developed at trial, we conclude that GE has demonstrated by a preponderance of evidence that Harner and the knowledge of an ordinarily skilled artisan renders claims 1, 8–10, 12, 13, 15, and 16 unpatentable as obvious.

F. CLAIM 11: OBVIOUSNESS IN VIEW OF HARNER AND REY

Claim 11 depends from claim 10, which depends from claim 9, which depends from claim 1. Ex. 1001, 4:66–5:11. As explained above, we conclude that GE has proven that claims 1, 9, and 10 are obvious in view of Harner and the knowledge of an ordinarily skilled artisan. Claim 9 introduces a “flow control device” as the element that the controller commands “to effectively increase the nozzle exit area.” *Id.* at 4:66–5:3. Claim 10 requires that the flow control device “increases the physical nozzle exit area in response to the undesired stability margin.” *Id.* at 5:5–7. Claim 11 recites the additional requirement that the “flow control device is

adapted to open flaps arranged around a perimeter of the bypass flow path to increase the physical nozzle exit area.” *Id.* at 5:8–11.

GE argues that claim 11 is unpatentable because an ordinarily skilled artisan would have found it obvious to incorporate the variable area fan nozzle of Rey into Harner’s turbofan engine. Pet. 50–54. Rey describes a turbofan engine in which “the variable area nozzle 30 includes a plurality of flaps 38, circumscribing the core engine 14.” Ex. 1008, 3:33–35. GE contends that each of Harner and Rey expressly would have motivated an ordinarily skilled artisan to include a circumscribing-flap arrangement like Rey’s into Harner’s turbofan nozzle largely because Harner and Rey both focus on altering the nozzle exit area to prevent fan surge. Pet. 51–52 (citing Ex. 1013, 1:40–46; Ex. 1008, 1:44–53; Ex. 1003 ¶ 104). Dr. Attia testifies that the “disclosures in Harner and Rey *would have suggested* to one of ordinary skill in the art that the two could be combined.” Ex. 1003 ¶ 104 (emphasis added). GE also contends that an ordinarily skilled artisan would have considered Rey’s flap-based variable area fan nozzle to have been a well-known structure for implementing the variable area fan nozzle as suggested by Harner. Pet. 51 (citing Ex. 1003 ¶ 103; Ex. 1005, 1:6–11 (1975 Patent explaining that in “aircraft gas turbine engines it is often necessary or desirable to provide a variable area exhaust nozzle.... Such variable area nozzles generally comprise an annular array of flaps.”)).

UTC argues that GE has failed to identify adequately a reason why an ordinarily skilled artisan would have modified Harner by incorporating Rey’s variable area fan nozzle. PO Resp. 57–61. UTC criticizes GE’s argument as merely reflecting what an ordinarily skilled artisan “could” have done rather than what an ordinarily skilled artisan “would” have been

motivated to do. *Id.* at 59–61. However, UTC proffers no evidence including testimony from any person representative of ordinary skill to support its argument or respond to GE’s contention that Harner and Rey suggest their combination. *See generally* Ex. 2002 (offering no testimony regarding whether Harner and Rey suggest their combination to an ordinarily skilled artisan). Instead, they argue that GE’s argument and evidence must fail as a matter of law. *Id.*

We credit Dr. Attia’s unrebutted testimony and GE’s identification of express motivation within Harner and Rey to combine their respective teachings to arrive at the turbofan engine control system of claim 11. We have reviewed the cases cited by UTC for the proposition that GE’s evidence fails as a matter of law and find them to be unpersuasively applied to the facts of this case. Accordingly, we conclude that GE has demonstrated by a preponderance of evidence that the combined teachings of Harner and Rey render claim 11 unpatentable as obvious.

G. CLAIMS 1–4 AND 7:

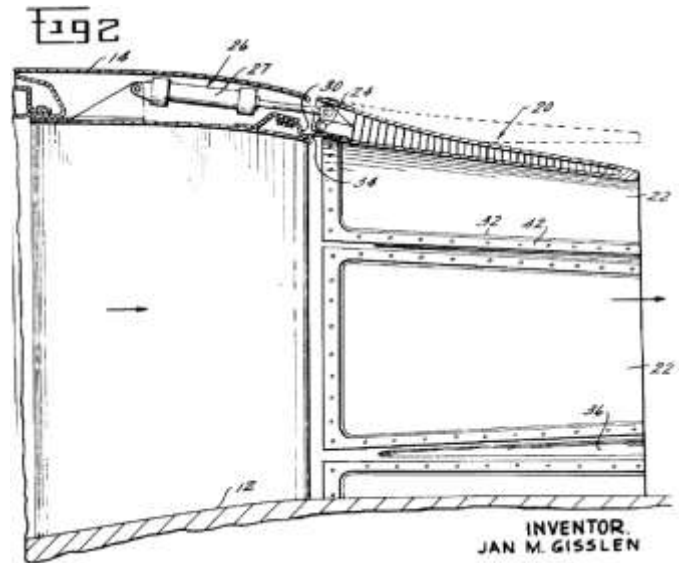
OBVIOUSNESS IN VIEW OF GISSLEN AND HARLOFF

GE contends that the combination of Gisslen and Harloff renders claims 1–4 and 7 unpatentable as obvious. Pet. 54–72. For the reasons explained below, we determine that GE has proven the obviousness of these claims by a preponderance of evidence.

1. Overview of Gisslen and Harloff

Gisslen relates to a particular design for a variable area exhaust nozzle for a turbofan gas turbine engine. Ex. 1005, 1:3–5, 1:66–68. Gisslen focuses its detailed disclosure almost exclusively on its particular design for the variable area fan nozzle because the “core engine” and fan turbine are “well-known.” *Id.* at 1:68–2:5.

Gisslen’s nozzle 20 is illustrated in Gisslen’s Figure 2, reproduced at right. That design includes an annular array of flaps 22 that can alter the exit area of fan duct 14 because flaps 22 are hinged at exit 24 to fan duct 14. *Id.* at 2:11–15. Gisslen’s nozzle 20 also includes band 30 around exit 24 and strips 32 between flaps 22 to prevent gases from leaking through the external surfaces of nozzle 20. *Id.* at 2:25–31.



Harloff relates to a control system for avoiding fan instability in the form of fan surges in a turbofan engine. Ex. 1006, 1:11–20. Harloff describes using a variable exit nozzle as one way to alter the operating point of the engine to avoid such instability. *Id.* at 1:39–40, 3:14–15. Harloff does not, however, describe details of a variable exit area nozzle except to assert that such nozzles are “well known in the art and are readily available usually as off-the-shelf items.” *Id.* at 3:19–37. Harloff describes that “time variant total pressure probes 33 and 35 are placed at entry plane 29 and discharge plane 31 of the fan 13.” *Id.* at 2:25–27. Harloff explains that the “use of

pressure ratios across the fan indicates incipient surge and by changing the operating point of the fan such a surge can be prevented.” *Id.* at 1:38–40.

2. *GE’s Argument*

GE argues that an ordinarily skilled artisan would have found claims 1–4 and 7 obvious in view of the combination of Gisslen and Harloff. Pet. 54–72. GE sets forth in detail the manner in which it contends that teachings from Gisslen and Harloff correspond to all limitations of claims 1–4 and 7. *Id.* at 58–72 (citing Ex. 1005, 1:66–2:13, Figure 1; Ex. 1006, 1:28–40, 2:9–11, 2:25–51, 2:63–64, 3:9–15, 3:25–34, 3:40–45, Figures 1, 2, 4). GE also relies upon testimony from Dr. Attia in support of its contentions relating to the manner in which Gisslen and Harloff describe the claimed invention. *Id.* (citing Ex. 1003 ¶¶ 111–30). GE relies upon Gisslen as describing details of a variable exit area nozzle for the fan of a turbofan engine and Harloff as describing both details of a turbofan engine and control of a variable nozzle exit area to avoid surge in the fan. *Id.* GE argues that an ordinarily skilled artisan would have been motivated to use Gisslen’s variable nozzle to provide adequate stall margin by controlling Gisslen’s nozzle with control mechanisms like Harloff’s. *Id.* at 56–57 (citing Ex. 1005, 1:5–10, 2:16–18; Ex. 1006, 1:39–40, 3:14–15; Ex. 1003 ¶¶ 108, 109).

3. *Analysis of UTC’s Counterarguments Relating to Claim 1*

UTC argues that GE fails to establish that the combination of Gisslen and Harloff renders claim 1 unpatentable as obvious for two reasons. PO Resp. 61–70. First, UTC contends that Harloff fails, as alleged by GE, to describe a controller that detects undesired stability margin. *Id.* at 61–68. Second, UTC argues that GE has failed to provide adequate motivation to

combine the teachings of Gisslen and Harloff. *Id.* at 68–70. For the reasons expressed below, we find GE’s argument and evidence to be persuasive on both points. We also conclude that GE has demonstrated by a preponderance of evidence that the combination of Gisslen and Harloff renders claim 1 unpatentable as obvious.

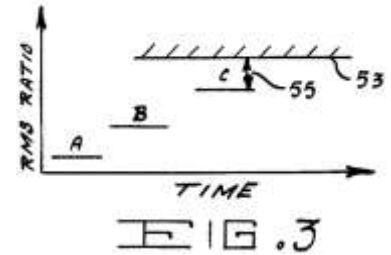
a) Whether Harloff Describes a Controller that Detects
Undesired Stability Margin

UTC recognizes that Harloff describes determining the pressure ratio across its fan (inlet pressure compared to outlet pressure). PO Resp. 62–64. UTC also recognizes that Harloff changes the operating point of its engine to prevent surge when the pressure ratio across the fan approaches a limit value 53 that indicates “incipient surge.” *Id.* (quoting Ex. 1006, 1:28–40). However, UTC contends that Harloff fails to describe the claimed controller that detects undesired fan stability margin because Harloff “never determines stability margin, . . . because fan pressure ratio alone is not sufficient for determining stability margin.” *Id.* at 64. UTC rests its argument upon our adoption of its proposed interpretation of detecting undesired stability margin. *Id.* at 64.

As explained in Part II.A above, we disagree with UTC’s proposed interpretation of “undesired stability margin.” Instead, we interpret “undesired stability margin” to mean “the fan section has insufficient stability margin to avoid experiencing an instability (e.g., a stall, surge, or flutter).” We determine that Harner describes a controller programmed to act in response to such a margin (claim 1) and determining such a margin (claim 15).

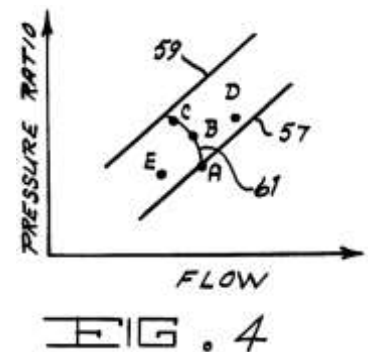
Harloff measures pressure entering and leaving fan 13 using pressure probe 33 at the entry to fan 13 and pressure probe 35 at the discharge of fan 13. Ex. 1006, 2:24–30. Harloff uses circuit 51 to compare the ratio of these two pressures to a predetermined threshold, limit 53 as shown in

Figure 3 reproduced at right. *Id.* at 2:63–67. Figure 3 plots changes in fan pressure ratio A, B, C, over time compared to limit value 53. Over time, Harloff monitors difference 55 between the pressure ratio and limit



value 53. When circuit 51 detects a pressure ratio approaching limit value 53, Harloff changes the operating point of the fan. *Id.* at 3:9–11, 3:31–34. Harloff changes the operating point to prevent surge. *Id.* at 1:38–40.

Figure 4, reproduced at right, is Harloff’s plot of pressure ratio versus flow, which is equivalent to a fan map. *Id.* at 2:4–5. Two operating lines, surge line 59 and clean operating line 57 are shown. *Id.* at 3:27–29. Line 61 is a line of constant speed. *Id.* As the fan pressure ratio moves along line 61 from point A to point B to point C, the fan pressure ratio increases to a point near surge line 59. *Id.*



at 3:30–31. Harloff indicates that it changes the operating point of the fan to point D, E, B, or A by altering “nozzle area, or the fan speed, or [Mach number], and [flight altitude].” *Id.* at 3:31–34; *see also id.* at 3:16–17 (defining h_{∞} as flight altitude and M_{∞} as Mach number). Increasing the nozzle exit area moves point C to points B and A along constant speed line 61, which constitutes moving the operating point away from surge line 59 and increasing stability margin. Ex. 1006, Figure 4; Ex. 1003 ¶ 117.

Figure 3 of the '280 patent illustrates moving the fan operating point to increase fan stability margin in the same way as Harloff. *See* Ex. 1001, Figure 3 (indicating “fan operating point moves down with increasing nozzle area at constant fan corrected speed [along line N_{C3}] and increases fan stability margin”). The claimed controller covers precisely this type of response to detecting undesired stability margin. *See* Part II.A.2 above (explaining how controller 50 alters fan operating point). Accordingly, we determine that Harloff describes the claimed controller that detects undesired fan stability margin.

b) Whether GE has Identified a Motivation to Combine Gisslen and Harloff

UTC argues that GE has not demonstrated a sufficient motive to combine teachings of Gisslen and Harloff to arrive at the claimed invention. PO Resp. 68–70. GE contends that an ordinarily skilled artisan “would have been motivated to use the variable nozzle disclosed by Gisslen to provide adequate stall margin at various flight conditions, and Harloff describes a known means of controlling the nozzle to do so.” Pet. 58 (citing Ex. 1003 ¶ 109). UTC cites no evidence relating to the presence or absence of such a motivation but argues that GE’s showing is insufficient as a matter of law. PO Resp. 68–70. The use of variable nozzle area fans to increase engine performance while maintaining adequate fan stability margin was well known before the critical date of the '280 patent. Ex. 1003 ¶ 109 (citing Ex. 1017, 11; Ex. 1008, 1:44–55; Ex. 1015, 4:34–43). Gisslen describes a fan with a variable nozzle area as a mechanism for improving performance in varying flight modes. Ex. 1005, 1:5–10, 2:16–18. Harloff describes enhancing performance by using a fan with a variable nozzle area to maintain stability margin. *See* Part II.G.3.a) above. We consider GE’s

unrebutted evidence of motivation to combine teachings of Gisslen and Harloff to demonstrate a motivation to combine teachings from Gisslen and Harloff to arrive at the claimed invention.

4. Conclusion

For the reasons expressed above, we determine that GE has established that Harloff describes the controller of claim 1 and that an ordinarily skilled artisan would have been motivated to combine teachings from Gisslen and Harloff to arrive at the claimed invention. UTC raises no other argument in response to GE's argument and evidence that the combination of Gisslen and Harloff renders independent claim 1 unpatentable as obvious. *See* PO Resp. 61–70. Based on our review of GE's argument and evidence relating to all other aspects of claim 1, which we adopt as our own, we conclude that GE has demonstrated by a preponderance of evidence that the combination of Gisslen and Harloff renders claim 1 unpatentable as obvious.

5. Dependent Claims 2–4 and 7

GE sets forth its argument and evidence demonstrating that claims 2–4 and 7, which depend directly or indirectly from claim 1, are unpatentable as obvious in view of the combination of Gisslen and Harloff. Pet. 65–72 (citing Ex. 1005, 1:66–2:5; Ex. 1006, 1:28–40, 2:25–27, Figures 1, 2; Ex. 1003 ¶¶ 119–30). UTC does not separately identify any reasons why the combination fails to render these dependent claims obvious. *See* PO Resp. 61–70 (arguing in support of claim 1 without addressing distinct reasons that GE's argument and evidence fails to establish unpatentability of dependent claims 2–4 and 7). We adopt as our own the reasoning and evidence proffered by GE relating to the obviousness of claims 2–4 and 7.

On that basis, we conclude that GE has demonstrated by a preponderance of evidence that the combination of Gisslen and Harloff renders dependent claims 2–4 and 7 unpatentable as obvious.

III. CONCLUSION

For all the reasons expressed above, we conclude that GE has demonstrated by a preponderance of the evidence that: (1) claims 1, 8–10, 12, 13, 15, and 16 are unpatentable as obvious over Harner and the background knowledge of an ordinarily skilled artisan, (2) claim 11 is unpatentable over the combination of Harner and Rey, and (3) claims 1–4 and 7 are unpatentable as obvious over the combination of Gisslen and Harloff.

IV. ORDER

For the reasons given, it is:

ORDERED, based on a preponderance of evidence, that claims 1–4, 7–13, 15, and 16 of U.S. Patent 8,313,280 B2 are *unpatentable*; and

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

IPR2017-00427
Patent 8,313,280 B2

PETITIONER:

Anish Desai
Brian Ferguson
Christopher Pepe
WEIL GOTSHAL & MANGES LLP
anish.desai@weil.com
brian.ferguson@weil.com
christopher.pepe@weil.com

PATENT OWNER:

M. Andrew Holtman
Cara R. Lasswell
C. Brandon Rash
FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER L.L.P.
andy.holtman@finnegan.com
cara.lasswell@finnegan.com
brandon.rash@finnegan.com