UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VALEO NORTH AMERICA, INC. AND VALEO EMBRAYAGES, Petitioner,

v.

SCHAEFFLER TECHNOLOGIES AG & CO. KG, Patent Owner.

> Case IPR2016-00502 Patent 8,161,740 B2

Before JOSIAH C. COCKS, MICHAEL W. KIM, and JAMES J. MAYBERRY, *Administrative Patent Judges*.

MAYBERRY, Administrative Patent Judge.

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

I. INTRODUCTION

Petitioners, Valeo North America, Inc. and Valeo Embrayages (collectively, "Valeo"), filed a Petition (Paper 1, "Pet.") requesting *inter partes* review of claims 1–13 of U.S. Patent No. 8,161,740 B2 (Ex. 1001, the "740 patent"). Patent Owner, Schaeffler Technologies AG & Co. KG ("Schaeffler"), filed a Preliminary Response (Paper 6, "Prelim. Resp.") to the Petition. We instituted trial on all challenged claims. Paper 7, 28 ("Dec. on Inst.").

After we instituted trial, Schaeffler filed a Patent Owner Response (Paper 13, "PO Resp."). Schaeffler also filed a contingent Motion to Amend claims 1–13 (Paper 14, "Motion to Amend"). Valeo filed a Reply to Schaeffler's Patent Owner Response and an Opposition to the Motion to Amend. Papers 17, 18. Schaeffler filed a Reply to Valeo's Opposition to the Motion to Amend. Paper 22.

Valeo relies on the Declaration testimony of Dr. Steven Shaw ("Dr. Shaw") in support of its Petition, Reply, and Opposition to Schaeffler's Motion to Amend (Exs. 1002, 1060). Schaeffler relies on the Declaration testimony of Dr. Robert Parker ("Dr. Parker") in support of its Patent Owner Response, Motion to Amend, and Reply to Valeo's Opposition to the Motion to Amend (Exs. 2006, 2014).

Oral hearing was conducted on March 9, 2017. The record contains a transcript of the hearing. Paper 35 ("Tr.").

The Board has jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. Valeo has shown, by a preponderance of the evidence, that claims 1–13 of the '740 patent are unpatentable under 35 U.S.C. § 103(a) over U.S. Patent

No. 6,450,065 B1 (Ex. 1003, "Eckel"), U.S. Patent No. 6,026,940 (Ex. 1005, "Sudau"), and U.S. Patent No. 5,295,411 (Ex. 1008, "Speckhart"). Further, we grant-in-part Schaeffler's Motion to Amend, with respect to substitute claims 19 and 25 only.

A. Related Matters

The parties represent that the '740 patent is not involved in any litigation or administrative proceeding. Pet. 1; Paper 5, 1. Schaeffler filed a reissue application (application no. 15/495,094) for the '740 patent on April 24, 2017.

B. The '740 Patent

The '740 patent, titled "Force Transmission Device with a Rotational Speed Adaptive Damper and Method for Improving the Damping Properties," issued April 24, 2012. Ex. 1001 (54) (45). The claims of the '740 patent are directed to a force transmission device that includes a rotational speed adaptive absorber. *Id.* at 1:16–20. The rotational speed adaptive absorber purportedly improves the damping properties of the force transmission device. *Id.* at 1:20–22.

Figure 1a, reproduced below, depicts an embodiment of the apparatus of the '740 patent.



Figure 1a depicts a schematic of a force transmission device, such as that found in a vehicle drive train. Ex. 1001, 5:18–21. The force transmission device transmits power from engine 100 (depicted at the left of Figure 1a and incorrectly labeled "101") to output 101 and includes input E and output A. *Id.* at 5:21–28.

Damper assembly 2 includes dampers 3, 4 and rotational speed adaptive absorber 5. Ex. 1001, 5:36–38. Rotational speed adaptive absorber 5, which is discussed in greater detail below, is configured as a centrifugal force pendulum device that absorbs rotational vibration over a large range of rotational speeds. *Id.* at 5:38–46.

The force transmission device transmits power through either hydrodynamic component 6 or device 7. Ex. 1001, 6:2–7. Hydrodynamic component 6 includes pump shell P and turbine shell T, which form operating cavity AR. *Id.* at 6:8–15. Hydrodynamic component 6 can be configured as a hydrodynamic clutch or a hydrodynamic speed/torque

converter. *Id.* at 6:16–22. When configured as a hydrodynamic speed/torque converter, hydrodynamic component 6 includes stator shell L, and defines first power path I between input E and output A. *Id.* at 6:22–31. Device 7 is configured as a lock-up clutch that circumvents hydrodynamic component 6 and defines second power path II, which mechanically transmits power. *Id.* at 6:31–38.

Figure 2 of the '740 patent, reproduced below, depicts an embodiment of rotational speed adaptive absorber 5.



Figure 2 depicts rotational speed adaptive absorber 5 as a centrifugal force pendulum. Ex. 1001, 5:45–46. Rotational speed adaptive absorber 5

includes inertial mass support device 10 and pendulum masses 9.11–9.14, each of pendulum masses 9.11–9.14 being movably supported by support device 10 through shoulder bolts 26 and through support rollers 27. *Id.* at 9:39–47. Rotation about axis R causes inertial masses 9.11–9.14 to swing back and forth in a pendulum motion. *See id.* at 5:49–51.

Rotating components vibrate corresponding to a certain order of excitation, "q," which, for example, equals 2 for a four-cylinder internal combustion engine. Ex. 1001, 9:59–62. Rotational speed adaptive absorber 5 is tuned, not to the order "q," but to a higher order—that is, the tuning is shifted to a higher order by a value q_F , such that the effective order of the absorber (" q_{eff} ") is equal to the sum of "q" and " q_F ." *Id.* at 9:48–58, 11:8–10. The inventors of the '740 patent purportedly discovered that in force transmission devices with hydrodynamic components with an operating fluid such as oil, the oil affects the movement of the pendulum weights of a rotational speed adaptive absorber and, by tuning the absorber to a higher order, the absorber counteracts the effects of the oil. *Id.* at 10:13–27. Specifically, the '740 patent discloses that a q_F ranging between 0.05 and 0.5 counteracts the adverse effects of the oil on the pendulum weights. *Id.* at 11:2–11.

C. Illustrative Claims

Claims 1 and 11 of the '740 patent are independent. Claim 1 is representative of the claimed subject matter and is reproduced below.

1. A force transmission device for power transmission between an input and an output, comprising: at least an input (E) and an output (A); and

a vibration damping device disposed in a cavity that can be filled at least partially with an operating medium, the vibration damping device coupled with a rotational speed adaptive absorber,

wherein the rotational speed adaptive absorber is tuned as a function of an oil influence to an effective order q_{eff} , which is greater by an order shift value q_F than an order q of an exciting vibration of a drive system.

Ex. 1001, 12:66–13:9.

D. The Prior Art

We instituted *inter partes* review of the '740 patent on three asserted grounds of unpatentability, which rely on the following references:

Reference	Reference No.	Date	Exhibit
Eckel	US 6,450,065 B1	Sept. 17, 2002	Ex. 1003
Nester	Tyler M. Nester, et al., "Vibration Reduction in a Variable Displacement Engine Using Pendulum Absorbers," Paper No. 2003- 01-1484, SAE International	2003	Ex. 1004
Sudau	US 6,026,940	Feb. 22, 2000	Ex. 1005
Speckhart	US 5,295,411	Mar. 22, 1994	Ex. 1008

E. Asserted Grounds of Unpatentability

We instituted *inter partes* review of claims 1–13 of the '740 patent on the following grounds of unpatentability.

References	Basis	Claims Challenged
Eckel, Sudau, and	§ 103(a)	1–13
Speckhart		
Nester, Sudau, and	§ 103(a)	1–4, 6–13
Speckhart		
Nester, Sudau, Speckhart,	§ 103(a)	5
and Eckel		

II. ANALYSIS

A. Level of Ordinary Skill in the Art

Schaeffler contends that the level of ordinary skill in the art of the '740 patent is a person having a "Bachelor's degree in Mechanical Engineering (or similar field), along with two years of drivetrain design experience in the automotive industry." PO Resp. 38.

In the Petition, Valeo contends that "[t]he level of ordinary skill in the art is evidenced by the prior art." Pet. 17. Valeo asserts that encompassed in this level of ordinary skill is (1) the knowledge "that pendulums are typically slowed down by the medium in which they operate;" and (2) the practice of "routinely test[ing] and optimiz[ing] the [centrifugal force pendulum] absorber to determine the optimal amount of overtuning." *Id.* at 17–18.

Valeo also contends that Schaeffler's characterization of the level of ordinary skill ignores certain skills reflected in the record evidence. Reply 2. Specifically, Valeo contends that a person having ordinary skill in the art would have had (1) "a solid understanding of physics and fluid mechanics of the oil within a torque converter;" (2) the capability to "test the response of a [centrifugal pendulum vibration absorber (CPVA)] at different orders of excitation to create an 'order sweep;" (3) "skill[s] in noise, vibration, and

harshness ('NVH');" and (4) an understanding "that tuning a CPVA involves trial and error." *Id.* at 2–3; *see also id.* at 3–5 (providing support for the four asserted skills).

The level of ordinary skill in the art is a factual issue underlying a determination of whether a claim is obvious and how a claim term is construed. See, e.g., Graham v. John Deere Co., 383 U.S. 1, 17 (1966) (identifying "the level of ordinary skill in the pertinent art" as one of "several basic factual inquires" in an obviousness analysis); Trivascular, Inc. v. Samuels, 812 F.3d 1056, 1061–62 (Fed. Cir. 2016) ("In construing claim" terms, the Board must determine the scope of the claims by giving them their broadest reasonable construction in light of the specification as they would be interpreted by one of ordinary skill in the art." (emphasis added)). Factual indicators of the level of ordinary skill in the art include "the various prior art approaches employed, the types of problems encountered in the art, the rapidity with which innovations are made, the sophistication of the technology involved, and the educational background of those actively working in the field." Jacobson Bros. v. United States, 512 F.2d 1065, 1071 (Ct. Cl. 1975); see also Orthopedic Equip. Co. v. United States, 702 F.2d 1005, 1011 (Fed. Cir. 1983) (quoting with approval Jacobson Bros.).

We find that the prior art of record is primarily directed to vibration absorbers for periodically operating machines, such as an internal combustion engine for an automobile. *See, e.g.*, Ex. 1003 (directed to a speed-adaptive dynamic-vibration absorber for a shaft of a periodically operating machine); Ex. 1004 (directed to a pendulum vibration absorber for a crank shaft of an automobile); Ex. 1005 (directed to a torque converter with a vibration damper); Ex. 1008 (directed to a vibration absorber for a

rotating shaft, such as an engine crankshaft, flywheel, clutch, or torque converter).

The types of problems encountered in the prior art include addressing vibrations in a rotating shaft from an engine, including, but not limited to, non-linear effects and hydrostatic and hydrodynamic effects of a lubricant. See, e.g., Ex. 1003, 2:66–3:2 ("[I]n addition to the non-linearity of the swinging inertial masses, hydrostatic and hydrodynamic effects resulting from a lubricant can also be largely compensated."); Ex. 1004, Abstract ("The absorbers are tuned to address the dominant second order vibrations, and are slightly overtuned to account for nonlinear effects."); Ex. 1005, 1:61–65 ("It is the object of the invention to construct the torsional vibration damper at the lockup clutch of a hydrodynamic torque converter in such a way that torsional vibrations delivered by a drive, for example, by an internal combustion engine, can be filtered out to the greatest possible extent."); Ex. 1008, 2:9-15 ("This invention resides in a system for absorbing torsional vibration in a shaft . . . wherein the shaft is exposed to torsional disturbances which tend to alternately increase and decrease the rotational speed of the shaft and wherein the disturbances are regularly spaced throughout each revolution of the shaft.").

We additionally find that innovation is not rapid in this area. For example, the record includes evidence concerning vibration absorbers of the general type disclosed in the '740 patent from most of the twentieth century. *See* Ex. 1010 (providing a patent filed in 1969); Ex. 1011 (technical article from 1964); Ex. 1012, 1 ("CPVAs were used in [internal combustion] engines as early as 1929."); Ex. 1013 (reference book dated 1941). Also, the technology encompasses a basic mechanical structure. *See* Exs. 1003, 1004,

1005, 1008, 1010, 1011, 1015. Finally, record evidence demonstrates that individuals in this field have engineering degrees. *See, e.g.*, Ex. 1002 (presenting the expert declaration of Dr. Shaw, a professor of Mechanical Engineering); Ex. 2006 (presenting the expert declaration of Dr. Parker, a professor of Mechanical Engineering).

We discern from the '740 patent that its disclosure and claims are broader than the automotive industry. The disclosure discusses the application of the invention of the '740 patent to a force transmission device between a drive engine and an output. *See, e.g.*, Ex. 1001, 1:16–20 ("The invention relates to a force transmission device, in particular for power transmission between a drive engine and an output, the device including a hydrodynamic component and a vibration damping device with a rotational speed adaptive absorber."), 12:66–14:42 (claiming a force transmission device generally). Although we recognize that the automotive industry may represent the most prevalent use of the invention of the '740 patent, we discern nothing in the disclosure, nor have we been directed to any other evidence, to support a more narrow interpretation of the disclosure.

Based on our evidentiary findings, we determine that a person having ordinary skill in the art would have at least a Bachelor's degree in Mechanical Engineering or a similar engineering field, and at least two years of experience mitigating vibrations in rotating shafts associated with periodically operating machines, such as an internal combustion engine. We agree with Valeo, to some extent, that our hypothetical artisan of ordinary skill would have an understanding of the workings of a torque converter, and a general understanding of influences on a centrifugal pendulum vibration absorber in different operating environments.

B. Claim Construction

In an *inter partes* review, claim terms in an unexpired patent are given their broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b). Under the broadest reasonable construction standard, claim terms are generally given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. In re Translogic Tech., Inc., 504 F.3d 1249, 1257 (Fed. Cir. 2007). Although our claim interpretation cannot be divorced from the specification and the record evidence, see Microsoft Corp. v. Proxyconn, Inc., 789 F.3d 1292, 1298 (Fed. Cir. 2015) (quoting In re NTP, Inc., 654 F.3d 1279, 1288 (Fed. Cir. 2011)), we must be careful not to import limitations from the specification that are not part of the claim language. See SuperGuide Corp. v. DirecTV Enters., Inc., 358 F.3d 870, 875 (Fed. Cir. 2004). Any special definition for a claim term must be set forth in the specification with reasonable clarity, deliberateness, and precision. See In re Paulsen, 30 F.3d 1475, 1480 (Fed. Cir. 1994); see also Luminara Worldwide, LLC v. Liown Elecs. Co., 814 F.3d 1343, 1353 (Fed. Cir. 2016) ("The standards for finding lexicography and disavowal are 'exacting.'").

1. "tuned as a function of an oil influence"

Valeo offers an express construction for the phrase "tuned as a function of an oil influence," which appears in independent claims 1 and 11. Pet. 15; *see* Ex. 1001, 13:6–7, 14:28–29. Valeo contends that we should construe this phrase to mean "overtuned by an order shift value within the range that compensates for the influence of oil on the absorber." Pet. 15. Valeo argues that "the only explanation in the '740 patent of how to tune an

absorber as a function of the influence of oil is the '740 patent's bald identification of a shift order range between 0.05 and 0.5." *Id.* Valeo further argues that the Specification provides "a clear disclaimer that the invention requires q_F to fall in a range between 0.05 and 0.5." *Id.* at 16.

Schaeffler does not offer an express construction of this phrase. *See* PO Resp. 36 (offering an express construction of the phrase "tuned . . . to an effective order q_{eff}, which is greater by an order shift value q_F than an order q of an exciting vibration of a drive system" and omitting the "as a function of an oil influence" language from the phrase). However, Schaeffler's arguments implicitly incorporate a construction of this phrase to limit the recited "oil influence" to oil flowing, or rotating, through the cavity of a torque converter. *See, e.g.*, PO Resp. 64 ("[T]he inventors of the '740 Patent surprisingly found that, due to the influence of the torque converter environment where oil is flowed through, such a design would not have provided the expected level of increase in operating range, and would have unexpectedly improved the CPA performance relative to even-tuning."); Tr. 30:5–7 ("[W]ith respect to oil influence, we have to look at what the patent defines as its oil. The patent defines oil influence as that of rotating oil.").

We determine that neither party's construction is proper. Instead, for the reasons provided below, we construe the term "tuned as a function of an oil influence" to mean "tuned by an order shift value that compensates for the influence of oil on the absorber," and we further determine that such influence is not limited to that of rotating oil.

With respect to Valeo's proffered construction, we disagree on two points. First, the word "overtuned" is not necessary for the construction, as it would render other words in the claim directed to tuning superfluous. *See*

Bicon, Inc. v. Straumann Co., 441 F.3d 945, 950 (Fed. Cir. 2006) (stating that "claims are interpreted with an eye toward giving effect to all terms in the claim," so that physical structures and characteristics specifically described in a claim are not rendered "merely superfluous"). Independent claims 1 and 11 each recite that the rotational speed adaptive absorber is tuned to an effective order q_{eff} , which is greater by an order shift value q_F . As q_{eff} is greater by a value q_F , the resulting tuning is an over-tuning.

Second, we do not agree with Valeo that the recited tuning is limited to an order shift value within the range that compensates for the influence of oil on the absorber, to the extent that the range is a value of q_{eff} between 0.05 and 0.5. *See* Pet. 16. More particularly, we do not agree with Valeo that the '740 patent disclaims values of q_{eff} outside the range of 0.05 and 0.5. "The standard[] for finding . . . disavowal [is] '*exacting*.'" *Luminara Worldwide*, *LLC*, 814 F.3d at 1353 (emphasis added). "Disavowal (or disclaimer) requires that the patentee make it clear, either in the Specification or in the prosecution history, "that the invention does not include a particular feature." *Id.* "While such disavowal can occur either explicitly or implicitly, *it must be clear and unmistakable*." *Id.* (emphasis added). "Absent a clear disavowal . . . in the [S]pecification or the prosecution history, the [claim] is entitled to the full scope of its claim language." *Home Diagnostics, Inc. v. LifeScan, Inc.*, 381 F.3d 1352, 1358 (Fed. Cir. 2004).

Valeo relies on the disclosure in the Specification that q_F "is adjusted in a range between 0.05 and 0.5." Pet. 16 (citing Ex. 1001, 11:10–11). We find that this disclosure is not a clear and unmistakable disavowal of values of q_F outside the range of 0.05 and 0.5. This disclosure addresses the sole described embodiment in the Specification, but Valeo has not identified, nor

are we able to ascertain independently, any disclosure that limits the claimed invention to the sole disclosed embodiment.

Further, Valeo's reliance on Alloc Inc. v. Int'l Trade Comm'n, 342 F.3d 1361 (Fed. Cir. 2003), is unavailing. Pet. 16. As the Federal Circuit explained in Alloc, "it is impermissible to read the one and only disclosed embodiment into a claim without other indicia that the patentee so intended to limit the invention." Alloc, 342 F.3d at 1370. Valeo points to no other language in the Specification or prosecution history to support a more narrow reading of the claim limitation "tuned as a function of an oil influence." Further, the Federal Circuit stated that "where the specification makes clear at various points that the claimed invention is narrower than the claim language might imply, it is entirely permissible and proper to limit the claims." Id. In Alloc, the Federal Circuit found that the specification at issue, at different points, "indicate[d] that the claimed invention use[d] coaxial, rather than side-by-side lumens" such "that the asserted claims read only on catheters having coaxial lumens." Id. Again, Valeo points to no language in the Specification, other than the single quotation noted above, limiting the meaning of the phrase "tuned as a function of an oil influence" to the range for q_F of between 0.05 and 0.5.

We are also not persuaded that the recited "oil influence" should be limited to the effects on a rotational speed adaptive absorber by rotating oil. Schaeffler asserts that the Specification defines "oil influence" as the influence of rotating oil. *See* Tr. 30:6–7 ("The patent defines oil influence as that of rotating oil."). We disagree. At oral hearing, Schaeffler argued that two statements—one from the originally-filed specification and one from the '740 patent Specification—define "oil influence" as the influence of rotating

oil. *See* Tr. 31:20–32:7. The first cited disclosure provides that "the influence of the rotating oil upon the particular inertial mass . . . leads to a shifting of the order of the absorber to a lower order." Ex. 1006, 7. The second cited disclosure provides:

The Inventors have found that in force transmission devices with hydrodynamic components which are flowed through by an operating medium during operation, in particular oil, . . . the oil of the rotating oil masses has a significant effect upon the function of the absorber 5, in particular of the centrifugal force pendulum. Thus, in particular a relative movement occurs between the inertial mass and the rotating oil.

Ex. 1001, 10:13–22.

As with disavowal, the Federal Circuit has instructed us that the standard for finding that a patentee has been its own lexicographer is exacting. See Luminara Worldwide, 814 F.3d at 1353. "To act as a lexicographer, a patentee must 'clearly set forth a definition of the disputed claim term' and 'clearly express an intent to redefine the term." Id. Contrary to Schaeffler's position, the cited disclosures do not clearly set forth a definition of "oil influence" limiting the term to the influence of rotating oil. For example, the cited disclosure from the '740 patent expressly limits that disclosure to "force transmission devices with hydrodynamic components." See Ex. 1001, 10:13–22 (emphasis added). Independent claim 1, however, is not limited to force transmission devices with hydrodynamic components. As seen in the claims, claim 6, which depends from claim 1, further recites a force transmission device comprising a hydrodynamic component, suggesting that a hydrodynamic component is not a limitation of claim 1. See id. at 13:6–14:3; see e.g., Comark Commc'ns, Inc. v. Harris Corp., 156 F.3d 1182, 1186 (Fed. Cir. 1998) ("The

doctrine of claim differentiation create[s] a presumption that each claim in a patent has a different scope."). Schaeffler fails to direct us to anything in the Specification or prosecution history that would persuasively overcome the presumption that claim 6 is narrower than claim 1, in that claim 1, by its own terms, does not require a force transmission device comprising a hydrodynamic component. Accordingly, we are unpersuaded that the patentee acted as its own lexicographer such that the '740 patent Specification provides a definition for the term "oil influence."

For the reasons above, we determine that the phrase "tuned as a function of an oil influence" should be afforded its broadest reasonable interpretation, which is "tuned by an order shift value that compensates for the influence of oil on the absorber." We further determine that "oil influence" is not limited to that of rotating oil.¹

2. "tuned . . . to an effective order q_{eff} "

Schaeffler offers an express construction for the phrase "tuned . . . to an effective order q_{eff} , which is greater by an order shift value q_F than an order q of an exciting vibration of a drive system." Schaeffler asserts that this claim term means that the square root of the ratio of length "L" and

¹ Although our construction of the phrase "tuned as a function of an oil influence" is not one that was advocated by either party, we conclude that due process has been served as the parties had ample opportunity during the course of this proceeding to be heard and make their case as to the meaning of that phrase. *See, e.g.*, Pet. 15–16 (providing a construction of "tuned as a function of oil influence"); Prelim. Resp. 20 (providing no express constructions); PO Resp. 36–37 (providing an express construction of "tuned . . . to an effective order q_{eff} , which is greater by an order shift value q_F than an order q of an exciting vibration of a drive system" but not what is meant by "oil influence"); Mot. to Amend 14 (providing claim construction, but not for the phrase "tuned as a function of an oil influence").

length "l," for the claimed rotational speed adaptive absorber, is set equal to q_{eff} , rather than q. PO Resp. 36–37; *see also* PO Resp. 21 (describing tuning a centrifugal pendulum absorber in terms of "L" and "l"). Valeo does not address this proposed construction. *See generally* Reply.

As will be evident from our analysis below, we determine that we do not need to expressly construe this claim term to resolve a dispute between the parties. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (construing *explicitly* only those claim terms in controversy and only to the extent necessary to resolve the controversy).

B. Overview of the Prior Art

We instituted trial on grounds of unpatentability that rely on combinations of Eckel, Nester, Sudau, and Speckhart. *See* Dec. on Inst. 28. We summarize these four references below.

1. Overview of Eckel

Eckel, titled "Speed-Adaptive Dynamic-Vibration Absorber," issued September 17, 2002, and is directed to "a speed-adaptive dynamic-vibration absorber for a shaft rotatable about an axis, including a hub part on which at least one inertial mass." Ex. 1003, 1:5–7.

Eckel's Figure 1 is reproduced below.



F I G. 1

Figure 1 depicts "a front view of a speed-adaptive dynamic-vibration absorber" disclosed in Eckel. Ex. 1003, 3:65–67. The absorber absorbs vibrations in a shaft (not shown) that rotates about axis 1, and includes hub part 2 and inertial masses 3. *Id.* at 4:12–16. Two supports 4 mounted on hub part 2 support each inertial mass 3. *Id.* at 4:16–18. Hub part 2 includes rolling path 8, and inertial mass 3 has rolling path 9. *Id.* at 4:24–25. Bolt 6 extends into opening 7 formed in inertial mass 3. *Id.* at 4:20–23. Rolling paths 8, 9 and bolt 6 are configured such that inertial masses 3 move back and forth relative to hub part 2 along path of motion B. *Id.* at 4:26–31. As

inertial masses 3 move between the deflection positions, bolts 6 hob on rolling paths 8, 9. *Id.* at 4:34–35. Inertial masses 3 move in this pendulum-like motion along path of motion B in response to a torsional vibration superimposed on a rotational motion about axis 1. *Id.* at 4:42–45.

Eckel discloses purported advantages in vibration absorption when the radius of curvature ("R") of path of motion B lies within a field defined by the equation:

$$R = k \frac{L}{x^2},$$

where k is a constant in the range of 0.8 to 1.2; L is the distance of curvature midpoint ("M"—*see* Ex. 1003, Fig. 3) from axis 1; and x is the order of exciting vibration ("q" in the '740 patent). Ex. 1003, 5:7–21. Preferably, k does not equal the value 1. *Id.* at 5:20–21.

In a preferred configuration that purportedly further improves the vibration damping action of the absorber, Eckel discloses that in a first region adjacent to the middle position of the inertial mass, R of path of motion B lies in a sub-field bounded by a circle whose radius is defined by the above formula, with k equaling 1.2 and a circle whose radius is defined by the above formula, with k equaling 1.0. Ex. 1003, 5:56–6:5. In a contiguous sub-field, R of path of motion B lies in a sub-field bounded by the above formula, with k equaling 1.0. Ex. 1003, 5:56–6:5. In a contiguous sub-field, R of path of motion B lies in a sub-field bounded by a circle whose radius is defined by the above formula, with k equaling 1.0 and a cycloid whose radius is defined by the above formula, with k equaling 0.8. *Id.* at 6:5–22. Eckel does not disclose any specific path of travel for path of motion B but, instead, describes the spatial boundaries for the path of motion B.

Eckel discloses that its designated field of the path of motion addresses non-linear effects of the inertial masses, and further discloses that "hydrostatic and hydrodynamic effects resulting from a lubricant can also be largely compensated." Ex. 1003, 2:66–3:2.

2. Overview of Nester

Nester, is a technical paper titled "Vibration Reduction in a Variable Displacement Engine Using Pendulum Absorbers," with a copyright notice of 2003. Ex. 1004, 1. Nester discloses experimental results of employing pendulum absorbers on a crankshaft to reduce vibrations in internal combustion engines operating in four-cylinder or eight-cylinder mode. *Id.*, Abstract. Nester discusses that the vibration levels are unacceptably high when a V8 engine was run in V4 mode, with the vibration more of a concern when the engine is idling. *Id.* at 1.

Nester also discloses that when an engine causes a vibration absorber to undergo large motions, non-linearity effects adversely affect the performance of the absorber. Ex. 1004, 2. Nester discloses that these nonlinearity effects can be overcome by over-tuning the absorber to a value of 2.15 for a four-cylinder engine. *Id.* That is, instead of tuning the absorber to an order of excitation of 2 to correspond to the four-cylinder engine, Nester's absorber is over-tuned by an order shift value of 0.15 to an order of 2.15. Nester's testing purportedly demonstrates that this over-tuning is effective in attenuating the vibration. *Id.* at 6.

3. Overview of Sudau

Sudau, titled "Lockup Clutch with a Compensation Flywheel Mass at the Torsional Vibration Damper," issued February 22, 2000 and "is directed

to a lockup clutch for a hydrodynamic torque converter with a torsional vibration damper." Ex. 1005, 1:7–9.

Sudau's Figure 1 is reproduced below.



Figure 1 depicts "the upper half of a longitudinal section through a hydrodynamic torque converter with a lockup clutch and a torsional vibration damper with a compensation flywheel according to an embodiment of" Sudau. Ex. 1005, 3:18–22. Torque converter 100 includes primary flange 3 and impeller shell 5, which forms converter housing 9. *Id.* at 3:29–35. Impeller shell 5 has vanes that form impeller wheel 11, which cooperates with vanes of turbine wheel 13. *Id.* at 3:36–39. Turbine wheel 13 is coupled to a driven shaft through turbine hub 15. *Id.* at 3:39–42. Turbine hub 15 is positioned between axial bearing 17 and axial bearing 19,

with axial bearing 17 separating turbine hub 15 from primary flange 3. *Id.* at 3:46–48. "[A]xial bearing 19, together with another axial bearing 21 fixes stator wheel 23 which, together with [] impeller wheel 11 and [] turbine wheel 13, forms [] hydrodynamic converter circuit 24." *Id.* at 3:48–53. Torque converter 100 also includes lockup clutch 25 with piston 27, of which piston 27 is mounted on turbine hub 15. *Id.* at 3:54–57. Piston 27 transfers engine force to the driven shaft. *Id.* at 3:57–63.

Sudau's torque converter 100 further includes a torsional vibration damper having carrier 51 and compensation flywheel mass 54. Ex. 1005, 4:11–16. Torsional vibrations from piston 27 cause the compensation flywheel mass 54 to deflect, which compensates for the vibrations. *Id.* at 4:16–21.

4. Overview of Speckhart

Speckhart, titled "Torsional Vibration Absorber System," issued March 22, 1994 is directed to "absorbing torsional vibrations and for reducing speed variations in a rotating shaft." Ex. 1008, 1:5–8. Speckhart describes a vibration absorption system mounted to a rotatable shaft associated with an internal combustion engine, with the rotatable shaft exposed to torsional vibrations from the engine. *Id.* at 3:4–13. The rotatable shaft "may take the form of an engine crankshaft, a flywheel, a clutch, a torque converter, or some other part." *Id.* at 3:13–16. Speckhart also discloses that, if the absorber cannot be even-tuned, then it should be slightly over-tuned. *See id.* at 6:21–34.

C. Analyzed Grounds of Unpatentability

We instituted trial on three grounds of unpatentability for claims 1–13 of the '740 patent: 1) claims 1–13 are unpatentable under 35 U.S.C.

§ 103(a) over Eckel, Sudau, and Speckhart; 2) claims 1–4 and 6–13 are unpatentable under 35 U.S.C. § 103(a) over Nester, Sudau, and Speckhart; and 3) claim 5 is unpatentable under 35 U.S.C. § 103(a) over Nester, Sudau, Speckhart, and Eckel. *See* Dec. on Inst. 28.

Section 103(a) [of 35 U.S.C.] forbids issuance of a patent when "the differences between the subject matter sought to be patented 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) when available, secondary considerations, such as commercial success, long felt but unsolved needs, and failure of others. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). We analyze these factual determinations, along with the reasons for combining the references for each ground, below.² In making our factual findings underlying our obviousness conclusions, we consider the entire trial record.

1. Claims 1–13 and Eckel, Sudau, and Speckhart

a. Independent claims 1 and 11

(i) The subject matter of independent claims 1 and 11

Claim 1 recites "[a] force transmission device for power transmission between an input and an output, comprising: at least an input (E) and an

² We analyze the level of ordinary skill in the art in Section II.A.1, *supra*.

output (A)." Ex. 1001, 12:66–13:1. Valeo contends that Sudau's torque converter is the recited force transmission device and includes an input and output. Pet. 20. Schaeffler does not dispute this contention. See PO Resp. 53–70 (addressing Ground 1, but not contesting Valeo's characterization of Sudau's disclosure). We agree with Valeo and find that Sudau discloses a force transmission device for power transmission-a torque converterwhich includes an input and output to that torque converter. See, e.g., Ex. 1005, 3:29 ("[Figure] 1 shows a hydrodynamic torque converter 100."); id. at 3:41–42 ("The turbine hub 15 is connectable with a conventionally constructed driven shaft via the inner toothing 16."); id., Fig. 1; Ex. 1002 ¶ 65 ("Virtually any element of a vehicle powertrain has an input and output because the powertrain delivers rotational power from the combustion in the cylinders of the engine to the wheels of a vehicle. An example of an input and an output of a component of the powertrain is the input to, and output of, Sudau's torque converter."). We additionally adopt as our own findings the assertions with respect to this claim element in the Petition and supporting Declaration. See Pet. 20; Ex. 1002 ¶¶ 64–65.

Claim 1 further recites "a vibration damping device disposed in a cavity that can be filled at least partially with an operating medium." Ex. 1001, 13:2–3. Valeo contends that Sudau's lock-up clutch with a vibration damper satisfies this claim element. Pet. 21. As Valeo explains, "[t]he vibration damper is inside the cavity formed by the torque converter housing and filled with the operating medium of torque converter fluid." *Id.* Schaeffler does not dispute this contention. *See* PO Resp. 53–70 (addressing Ground 1, but not contesting Valeo's characterization of Sudau's discloses a vibration

damper inside the cavity of its torque converter, which is filled with an operating medium. *See* Ex. 1005, 1:66–2:1, 3:17–20, 4:4–24; *see also* Ex. 1002 ¶ 67 (declaring how Sudau discloses the recited vibration damping device).

Claim 1 further requires "the vibration damping device [be] coupled with a rotational speed adaptive absorber." Ex. 1001, 13:3–5. Valeo contends that "Eckel teaches a speed-adaptive dynamic-vibration absorber that is an example of a rotational speed adaptive absorber." Pet. 21. Schaeffler does not dispute that Eckel discloses the recited rotational speed adaptive absorber. *See* PO Resp. 53–70 (addressing Ground 1, but not contesting Valeo's characterization of Sudau's disclosure). We agree with Valeo and find that Eckel teaches a rotational speed adaptive absorber. *See*, *e.g.*, Ex. 1003, Abstract, 1:19–27, 1:50–57; *see also* Ex. 1002 ¶¶ 50, 68–69 (discussing how Eckel discloses a rotational speed adaptive absorber).

Claim 1 further requires "the rotational speed adaptive absorber [be] tuned as a function of an oil influence to an effective order q_{eff} , which is greater by an order shift value q_F than an order q of an exciting vibration of a drive system." Ex. 1001, 13:6–9; *see also* PO Resp. 23–25 (describing mistuning of rotational speed adaptive absorbers and explain that an effective order greater than the order shift value is an "overtuning"). Valeo contends that Eckel's rotational speed adaptive absorber has an effective order that is greater by an order shift value than the excitation order of its drive system—that is, that the rotational speed adaptive absorber is overtuned. Pet. 22–25. Valeo further contends that "rotational speed adaptive absorbers that rely on centrifugally driven pendulum masses to absorb vibrations inherently possess an effective absorption order q_{eff} that can be

expressed geometrically based on the ratio of the length of the pendulum and the distance of the pendulum mass from the rotation axis." *Id.* at 22 (referencing Ex. 1002 ¶ 71). As Valeo explains, the mathematical relationships that express the tuning of a centrifugally driven pendulum mass are governed by the physics of these masses, and that the mathematical relationships expressed in Eckel are the same as those expressed in the '740 patent, albeit using different variable symbols. *See* Pet. 8–12. Specifically, Valeo presents a table, reproduced below, illustrating the equivalence between the terminology used in the '740 patent and the terminology used in Eckel, including the relationship between Eckel's variable "k" (which Valeo refers to as a "detuning factor") and the variables q_{eff} , q_F , and q, which appear in claim 1:

Feature	'740 Patent	Eckel
Order of excitation vibration	q	X
Distance from the center of rotation to the center of curvature of the path of the pendulum center of mass at its midpoint	L _{eff}	L
Radius of curvature of the path of the center of mass of the pendulum mass	l _{eff}	R
Detuning amount (order shift)	q_F	$x\left(\frac{1-\sqrt{k}}{\sqrt{k}}\right)$
Detuning factor	$\left(\frac{q}{q+q_F}\right)^2$	k
Effective order	$q_{eff} = q + q_F$	$x + x \left(\frac{1 - \sqrt{k}}{\sqrt{k}}\right)$
Effective center of gravity distance	$S_{eff} = L_{eff} + l_{eff}$	L + R

The above table presents mathematical relationships between certain features of a rotational speed adaptive absorber, expressed in the nomenclature of the '740 patent and Eckel, respectively. *See* Pet. 8–10.

Valeo further contends that Eckel expressly teaches that its disclosed tuning of its rotational speed adaptive absorber addresses the influence of oil on the pendulum mass. Pet. 23; *see also* Ex. 1003, 2:66–3:2 ("Thus, for example, in addition to the non-linearity of the swinging inertial masses hydrostatic and hydrodynamic effects resulting from a lubricant can also be largely compensated."); Ex. 1002 ¶ 75 (indicating that a pendulum tuned to a certain value of "k" results in a pendulum that would inherently address the influences of oil).

As to the requirement in claim 1 that the effective order q_{eff} be greater by an order shift value q_F than an order q of an exciting vibration of a drive system, Valeo contends that, for "k" values less than 1, the resulting q_{eff} of Eckel's rotational speed adaptive absorber would be greater than q, with the difference between q_{eff} and q being the order shift value q_F .³ See Pet. 25 ("[*A*]*ny* value of k < 1 in Eckel provides a positive order shift value q_F .").

Schaeffler does not dispute that Eckel discloses a tuning range, and that a portion of that range overlaps the claimed tuning range of claim 1 (that is, a range of values for "k" resulting in over-tuning). Schaeffler does dispute, however, that a person having ordinary skill in the art would have had reason to apply Eckel's teaching of the portion of its range that

³ Valeo's analysis assumes a four-cylinder internal combustion engine as the power source, consistent with the example in the '740 patent, which results in an excitation order (q) of 2. *Compare* Pet. 22–24 *with* Ex. 1001, 10:28–11:14.

represents over-tuning to Sudau. *See* PO Resp. 53–62. We address Schaeffler's arguments in the subsequent section, which concerns the reasons to combine Sudau, Eckel, and Speckhart.

Schaeffler also disputes Eckel's teachings with respect to the claim language requiring the rotational speed adaptive absorber be tuned *as a function of an oil influence*—arguing that the oil influence experienced in Eckel's system is different from that experienced in Sudau's system. PO Resp. 62–63. To the extent that this argument is based on Schaeffler's proposed construction requiring the "oil influence" to be that of rotating oil, as we determined in our claim construction analysis, above, claim 1 is not so limited. Otherwise, we treat this argument as being one directed to why a person of ordinary skill in the art would not have had reason to modify Sudau based on Eckel's teachings, and we address it in the subsequent section as well.

We find that Eckel discloses tuning its rotational speed adaptive absorber, as a function of an oil influence, to an effective order q_{eff} , which is greater by an order shift value q_F than an order q of an exciting vibration of a drive system. Eckel expressly discloses that its contemplated tuning range covers values for "k" of less than 1, which results in a q_{eff} value that is greater by an order shift value q_F than an order q of an exciting vibration of a drive system. *See, e.g.*, Ex. 1002 ¶¶ 42, 51, 53, 67–78 (describing the relationship of "k" to the effective tuning order). Further, Eckel expressly discloses that its disclosed tuning range compensates for hydrostatic and hydrodynamic influences resulting from a lubricant (that is, oil). *See* Ex. 1003, 2:66–3:2; Ex. 1002 ¶ 52.

Independent claim 11 is a method claim that corresponds to the subject matter of claim 1. *Compare* Ex. 1001, 12:66–13:9 *with id.* at 14:20–31. *See also* Pet. 35–38 (providing a comparable analysis for claim 11 as provided for claim 1). Schaeffler does not provide any separate arguments directed to claim 11.

Accordingly, on the complete record before us, we find that Valeo has shown, by a preponderance of the evidence, that combination of Eckel, Sudau, and Speckhart discloses the subject matter of independent claims 1 and 11.

(ii) The reasons to combine Eckel, Sudau, and Speckhart

Valeo asserts that "[i]t would have been obvious to a [person having ordinary skill in the art] to apply Eckel's rotational speed adaptive absorber to a vehicle with Sudau's torque converter because the benefits of Eckel's rotational speed adaptive absorber could be predictably applied to any rotating machine with order excitation." Pet. 18. Valeo continues that incorporating "Eckel's rotational speed adaptive absorber into a powertrain that includes a torque converter [such as disclosed in Sudau] would yield the predictable and explicitly taught result of damping rotational vibrations." *Id.* at 19 (citing Ex. 1002 ¶¶ 59–61).

Valeo contends that "it would have been obvious to a [person having ordinary skill in the art] to couple Eckel's absorber directly to Sudau's lock-up clutch." Pet. 21. Valeo first reasons that an artisan of ordinary skill would have understood that Eckel's absorber could have been used to address any rotational vibration from an engine. *Id.* at 21–22 (referencing Ex. 1002 ¶ 69). Valeo further reasons that Sudau teaches "that a torque converter can have a vibration damper and rotational speed adaptive

absorber directly coupled to each other within the torque converter housing." *Id.* at 22 (referencing Ex. 1005, 1:61–65, 2:20–24; Ex. 1002 ¶ 69). Valeo also reasons that "Speckhart expressly confirms that a rotational speed adaptive absorber can be implemented on the crankshaft (as in the example taught by Eckel) or alternatively within a torque converter (as in the example taught by Sudau)." *Id.* (referencing Ex. 1008, 3:13–19). That is, Speckhart provides an overarching teaching that rotational speed adaptive absorbers can be implemented on the converters.

For reasons set forth below, Schaeffler contends that a person having ordinary skill in the art would not have had reason to modify Sudau with Eckel's centrifugal pendulum absorber that was over-tuned, as required by claim 1, and, instead, that such a combination would have resulted in undertuning the absorber. PO Resp. 54.

First, Schaeffler contends that an artisan of ordinary skill would have turned to over-tuning a centrifugal pendulum absorber to compensate for problems concerning non-linearity of the absorber performance due to high amplitude vibrations. PO Resp. 55. Schaeffler argues, however, that Sudau's torque converter's lock-up clutch would not experience high amplitude vibrations, so there would have been no reason to over-tune the absorber. *Id.* at 55–57. Additionally, Schaeffler argues that the presence of elastic elements 41 in Sudau's torque converter would dampen vibrations, further reducing the amplitude of vibrations experienced by the added centrifugal pendulum absorber of Eckel. PO Resp. 56, 57.

Valeo responds that a torque converter could experience high amplitude vibrations. Reply 8 (citing Ex. 1060 (2d. Dec. of Dr. Steven Shaw) ¶ 35). Valeo further contends that Schaeffler's own documents depict

systems with a centrifugal pendulum absorber just downstream from other vibration dampeners. Reply 12–14.

We are persuaded that Valeo's reasons to combine the teachings of Eckel and Speckhart with Sudau are sufficient. As Valeo indicates, Speckhart provides a teaching that rotational speed adaptive absorbers can be implemented in torque converters. *See* Pet. 22. Speckhart also discloses that even-tuning or over-tuning is preferred. *See* Ex. 1008, 6:21–34. Also, we credit Dr. Shaw's testimony that Schaeffler's documents depict a system with an over-tuned centrifugal pendulum absorber downstream from a vibration dampener. Ex, 1060 ¶ 51; *see also* Ex. 1039 (discussing adding a centrifugal pendulum-type absorber downstream of a dual-mass flywheel); Ex. 2006 ¶¶ 42–44 (describing a dual-mass flywheel). Finally, Eckel makes clear that non-linearity is not the only effect compensated by its disclosed range of tuning. Significantly, Eckel expressly discloses that hydrodynamic and hydrostatic effects of lubricants are compensated. *See* Ex. 1003, 2:66– 3:2.

Next, Schaeffler contends that Eckel's teachings would have directed a person having ordinary skill in the art to under-tune the absorber. PO Resp. 58. Schaeffler argues that Eckel's recommended path of motion for its centrifugal pendulum absorber was under-tuned or even-tuned. *Id.* Schaeffler continues that the entire range disclosed in Eckel represents "an innumerable quantity of potential paths," such that an artisan of ordinary skill would have followed Eckel's recommended paths, rather than explore other (that is, over-tuned) paths. *Id.* Schaeffler further argues that, instead of over-tuning, Eckel's teachings would have led an artisan of ordinary skill to employ non-circular travel paths to address non-linear effects on the

absorber at large swing angles. *Id.* at 60. Schaeffler asserts that Dr. Shaw's work demonstrates that Valeo's proposed modification, using a "k" value of 0.8, would have decreased performance. *Id.* at 61.

Valeo responds that Eckel teaches over-tuning, and that a person having ordinary skill in the art would have had reason to rely on this teaching, even if Eckel's preferred approach is under- or even-tuning (which Valeo disputes). Reply 28–29; *see also* Ex. 1060 ¶ 103 ("But, read fairly, Eckel discloses all three possibilities: over-tuning, under-tuning, and eventuning. In my opinion, a PHOSITA could have easily selected and tested any one of those options with a reasonable expectation of success based on the teachings of Eckel and knowledge in the art."). Valeo argues that, given that over-tuning was known to overcome non-linear effects, an artisan of ordinary skill would have considered Eckel's teaching of over-tuning. Reply 28.

We are persuaded that Valeo's reasons to combine the teachings of Eckel and Speckhart with Sudau are sufficient. Eckel is available for all it teaches and, even if Eckel's preferred approach is under- or even-tuning a centrifugal pendulum absorber, the reference does not in any way teach against over-tuning. *See Merck & Co. v. Biocraft Labs., Inc.*, 874 F.2d 804, 807 (Fed. Cir. 1989) ("[I]n a section 103 inquiry, 'the fact that a specific [embodiment] is taught to be preferred is not controlling, since all disclosures of the prior art, including unpreferred embodiments, must be considered."") (citing *In re Lamberti*, 545 F.2d 747, 750 (CCPA 1976)).

In summary, we agree with Valeo that a person having ordinary skill in the art would have considered all three possibilities outlined in Eckel: over-tuning, under-tuning, and even-tuning. *See* Ex. 1060 ¶ 103; *see, e.g.*,

In re Peterson, 315 F.3d 1325, 1330 (Fed. Cir. 2003) ("The normal desire of scientists or artisans to improve upon what is already generally known provides the motivation to determine where in a disclosed set of percentage ranges is the optimum combination of percentages."). With respect to Schaeffler's argument directed to employing non-circular paths, rather than tuning, we find this argument contrary to Eckel's express teachings. Eckel teaches that an absorber may be both over-tuned and travel a non-circular path. *See* Ex. 1003, 29–37 (defining one boundary of its disclosed range of travel paths as a cycloid path with an absorber with k=0.8 (over-tuned)). Further, Schaeffler's arguments are focused on non-linear effects. Eckel expressly teaches, however, that its tuning range addresses hydrostatic and hydrodynamic effects as well. *See id.* at 2:66–3:2.

In our Decision instituting trial, we stated that "Eckel expressly teaches paths of travel for an absorber within a field that results in positive order shift values encompassed by claim 1." Dec. on Inst. 20. We indicated that "'[w]here a claimed range overlaps a range disclosed in the prior art, there is a presumption of obviousness." *Id.* (quoting *Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1311 (Fed. Cir. 2006) and also citing *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003)). Schaeffler argues that Valeo's Petition does not set forth sufficient evidence to support this presumption. PO Resp. 67.

Schaeffler argues that Valeo did not assert in the Petition an overlapping range but, instead, relied on a single point in Eckel's range (k=0.8). We are unpersuaded. Although Valeo refers to the 0.8 value for "k" as a "specific example," Valeo's analysis clearly relies on the range of "k" values from 0.8 to less than 1. *See* Pet. 25; *see also* Pet. 11 (comparing "k" values ranging from 0.8 to 0.999 with q_F values).

Schaeffler next argues that Eckel does not support a finding that the tuning order is a results-effective variable that a person having ordinary skill in the art would have optimized. PO Resp. 67. Schaeffler contends that the path's curvature is the only result-effective variable. *Id.* at 68. We disagree. "A recognition in the prior art that a property is affected by the variable is sufficient to find the variable result-effective." *In re Applied Materials, Inc.*, 692 F.3d 1289, 1297 (Fed. Cir. 2012). Eckel recognizes that the value of "k" affects the performance of its centrifugal pendulum absorber and, as we have found above, "k" is a measure of the tuning of the absorber. *See* Ex. 1003, 5:7–6:27.

Schaeffler also argues that Eckel already discloses an optimal range, which is under-tuned. PO Resp. 69. This argument fails to consider that different applications may have different optimal values.

Further, Schaeffler's reliance on *Minnesota Min. & Mfg. Co. v. Johnson & Johnson Orthopaedics, Inc.*, 976 F.2d 1559 (Fed. Cir. 1992), is inapposite. *See* PO Resp. 69–70. In *Minnesota Mining*, the Court, in considering whether a claim was anticipated by a prior art reference, stated that "[t]he "Master recognized that although Garwood's specific claims are subsumed in Straube's generalized disclosure of knit fiberglass as a substrate, this is not literal identity." *Minnesota Min.*, 976 F.2d at 1572. Here, Eckel does not provide a generalized disclosure of a genus but, instead, discloses a discrete, bounded range of tuning/path combinations.

Next, Schaeffler contends that Eckel is directed to a centrifugal pendulum absorber on a crankshaft, and that the resulting operating

environment is "vastly different" from Sudau's torque converter, with flowing oil. PO Resp. 62. Schaeffler argues that Eckel's reference to "hydrostatic and hydrodynamic effects resulting from a lubricant," are limited to oil "splashing around" on a crankshaft. *Id.* (referencing Dr. Shaw's testimony on the different operating environments of a torque converter and crankshaft). Schaeffler further argues that Dr. Shaw admits that his modeling of crankshafts did not account for the effects of lubricants. *Id.* at 63.

Valeo responds that, as Schaeffler's expert admits, Eckel is not limited to crankshafts. Reply 29. Valeo further responds that the use of the words "hydrostatic" and "hydrodynamic" in Eckel is telling, as those terms could not be limited to thin-film lubricants. *Id.* Valeo explains that "hydrodynamics deals 'with the motion of fluids and the forces acting on solid bodies immersed in fluids,' while hydrostatic means 'of or relating to fluids at rest or to the pressures they exert or transmit.'" *Id.* (referencing Ex. 1052 (MERRIAM WEBSTER'S COLLEGIATE DICT., 10th. ed., 1996)). Valeo emphasizes that Eckel's reference to hydrodynamic and hydrostatic effects deals precisely with the types of oil effects in Sudau's torque converter. *Id.* at 30; *see* Ex. 1060 ¶ 105.

We are persuaded that Valeo's reasons to combine the teachings of Eckel and Speckhart with Sudau are sufficient. We agree with Valeo and find that, by using the terms "hydrodynamic" and "hydrostatic," Eckel teaches that its disclosed tuning range compensates for the effects of oil other than merely thin-film lubricants on a crankshaft. For example, the term "hydrodynamics" relates to the effects by a fluid on bodies immersed in the fluid, which would make no sense in the context of a thin-film lubricant.
In making our finding, we credit Dr. Shaw's testimony, which is corroborated by dictionary definitions. *See* Ex. 1060 ¶ 105. We do not credit Dr. Parker, who declares "while Eckel mentions hydrostatic and hydrodynamic effects associated with a lubricant, that is for thin-film lubrication between two sliding surfaces. The terms hydrostatic and hydrodynamic are commonly used to refer to such lubrication conditions." Ex. 2006 ¶ 205. Dr. Parker offers no supporting evidence for his statement that "hydrostatic" and "hydrodynamic" are terms commonly used to describe thin-film lubrication effects.

In conclusion, we find that Valeo has demonstrated, by a preponderance of the evidence, that a person having ordinary skill in the art would have been motivated to modify Sudau's torque converter with Eckel's centrifugal pendulum absorber, based on the teachings of Eckel and Speckhart, and would have also been motivated to consider the full range of teachings in Eckel, including over-tuning the absorber. Valeo provides the requisite reasoning, supported by rational underpinnings, for its proposed combination. *See KSR Int'l Co.*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)) ("[O]bviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness."). We note, however, that the totality of Schaeffler's arguments and supporting evidence indicates that Valeo's obviousness position, as we have addressed so far, while adequate, is not a strong one.

"The obviousness inquiry entails [not only] consideration of whether a person of ordinary skill in the art 'would have been motivated to combine

the teachings of the prior art references to achieve the claimed invention, [but also] . . . would have had a reasonable expectation of success in doing so."" *Insite Vision Inc. v. Sandoz, Inc.*, 783 F.3d 853, 859 (Fed. Cir. 2015) (text omitted in the original). Except with respect to unexpected results, Schaeffler does not contest whether a person having ordinary skill would have had a reasonable expectation of success in modifying Sadau by adding a vibration absorber. We find that a person having ordinary skill in the art would have had a reasonable expectation of success in modifying Sudau with Eckel's centrifugal pendulum absorber, as Speckhart expressly teaches that vibration absorbers may be used for a variety or components, including crank shafts, flywheels, clutches, and torque converters. *See* Ex. 1008, 3: 12–16. We address unexpected results, below, in connection with secondary considerations.

(iii) Secondary considerations

Schaeffler contends that unexpected results establish that the invention of claim 1 is non-obvious. PO Resp. 63. Schaeffler appears to assert these unexpected results to support two separate positions: (1) that a person having ordinary skill in the art would not have combined the references as proposed by Valero because the invention is the product of an unexpected result, and (2) that these unexpected results provide an indicium of non-obviousness. *See, e.g.*, Tr. 61 ("MR. OLIVER: Now, I understand that you are asking about the reason to combine rather than the unexpected results, but when that -- when I see that question, or hear that question rather, I see a somewhat overlap of that."). We conclude that these two arguments collapse into the second argument—whether the alleged unexpected results provide an indicium of non-obviousness.

"A determination of whether the subject matter of claims in issue would have been obvious under 35 U.S.C. § 103 involves factual findings with respect to . . . objective evidence of nonobviousness, e.g., long-felt need, commercial success, failure of others, copying, *unexpected results*, i.e., the secondary considerations." *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 291 (Fed. Cir. 1985) (emphasis added). "For [secondary considerations] to be accorded substantial weight, its proponent must establish a nexus between the evidence and the merits of the claimed invention." *In re GPAC Inc.*, 57 F.3d 1573, 1580 (Fed. Cir. 1995).

Schaeffler contends that there is a nexus between the unexpected results and claims 1 and 11. PO Resp. 65. Specifically, Schaeffler argues that claims 1 and 11 recite tuning a rotational speed adaptive absorber as a function of oil influence and "[t]he unexpected results of the present invention stem from the result of over-tuning as a function of oil influence, which is much different than the effect in air (where over-tuning avoids nonlinear effects, but harms performance)." Id. As Dr. Parker summarized, the alleged unexpected results are "that over-tuning in the claimed range improved performance of a [centrifugal force pendulum] (and that eventuning made the vibrations worse than using no [pendulum] at all)." Ex. 2014 ¶ 15; see also PO Resp. 29–33 (discussing the alleged unexpected results and how the inventors arrived at the results). The inventors employed a custom-designed test stand to determine the effects of centrifugal pendulum absorber tuning in an air and an oil environment, such as would be experienced by an absorber integrated into a torque converter. Ex. 2006 ¶¶ 88–90; see also id. at ¶¶ 92–93 (describing the experimental test

stand, including how the test stand could sweep through excitation orders, eliminating the need to test absorbers with different geometries).

Valeo responds that no nexus between any alleged unexpected results and the claims of the '740 patent exists. Reply 23. Valeo argues that the claims do not require the rotational speed adaptive absorber to be within the chamber of a torque converter, subjected to rotating oil, and downstream of the vibration damping device—conditions for which the alleged unexpected results were seen. *Id.* at 24.

"[T]here is a presumption of nexus for objective considerations when the patentee shows that the asserted objective evidence is tied to a specific product and that product 'is the invention disclosed and claimed in the patent."" *WBIP, LLC v. Kohler Co.*, 829 F.3d 1317, 1329 (Fed. Cir. 2016) (internal citation omitted).⁴ "The presumption of nexus is rebuttable." *Id.* (internal citation omitted). We find that Schaeffler is entitled to a presumption of nexus. Schaeffler has adequately demonstrated that the system configuration it tested falls within the scope of the original claims.⁵ We further find, however, that Schaeffler has failed to set forth an adequate basis to support the conclusion that other embodiments falling within the scope of the claims will experience the unexpected results. Accordingly, as we explain in greater detail below, Schaeffler fails to demonstrate that the evidence of unexpected results is commensurate in scope with the claims. *See In re Huai-Hung Kao*, 639 F.3d 1057, 1068 (Fed. Cir. 2011) ("If [a

⁴ In this proceeding, the "specific product" is the system configuration tested and simulated by Schaeffler.

⁵ Although our analysis is directed to claim 1, we address the issue of nexus for all of the original claims.

patentee] demonstrates that an embodiment has an unexpected result and provides an adequate basis to support the conclusion that other embodiments falling within the claim will behave in the same manner, this will generally establish that the evidence is commensurate with scope of the claims."). This failure rebuts the presumption of a nexus.

We agree with Valeo that the claims fail to recite that the force transmission device includes a torque converter, that the rotational speed adaptive absorber is a centrifugal force pendulum, and that the oil influence is that of rotating oil flowing through the cavity of the torque converter. *See* Reply 24–25. That is, the claims fail to recite the configuration of the testing environment that demonstrated the alleged unexpected results. *See*, *e.g.*, Ex. 2006 ¶¶ 88–93 (describing the inventor's objectives in testing an absorber for a torque converter and the experimental test stand used to generate the alleged unexpected results). Schaeffler offers no persuasive evidence that other system configurations that fall within the scope of the claims (that is, configurations without a torque converter, centrifugal force pendulum, or rotating oil) would experience the unexpected results.

Further, the proffered evidence demonstrates that the tested configuration did not experience unexpected results within the claimed range for order shift value (" q_F "). The test results demonstrate that the centrifugal force pendulum absorber performs better than no absorber at all in a narrow range of order shift values only, not for all values of " q_F " greater than zero, and the narrow range varied with the order of excitation ("q"). *See* Ex. 1001, Fig. 3 (showing that for values of q_F of 0.5 (x-axis value equal to 1.5) or greater, the system performs worse than a system with no absorber (value of "Dual Mass Flywheel without Centrifugal Force Pendulum" at x-axis

equal to 2.0)); see, e.g., Ex. 2006 ¶¶ 108 (showing that the optimum order shift value, q_F , for an excitation order of 3.0 is 0.24 and further showing that, for a range of order shift value of 0.05–0.08, the pendulum performs worse than a system with no pendulum), 109 (showing that the optimum order shift value, q_F , for an excitation order of 4.0 is 0.28 and further showing that, for a range of order shift value of 0.05–0.12, the pendulum performs worse than a system with no pendulum), 111 (showing that the optimum order shift value, q_F , for an excitation order of 1.0 is 0.07 and further showing that, for a range of order shift value of 0.05–0.08 and, by extrapolation, from 0.2–0.5, the pendulum performs worse than a system with no pendulum), 112 (showing that the optimum order shift value, q_F , for an excitation order of 6.0 is 0.43 and further showing that, for a range of order shift value of 0.05-0.16, the pendulum performs worse than a system with no pendulum). Although the optimal order shift values for the tested and simulated excitation orders fall within the claimed range of greater than zero, the claims do not provide any relationship between the order of excitation, "q," and the order shift value, " q_F ." Without this relationship, the unexpected results are not reasonably commensurate with the scope of these claims and no nexus exists.

We further recognize that claims 3 and 8–10 recite narrower ranges for the order shift value. As we indicated above (and discuss in greater detail *infra*, in connection with our analysis of Schaeffler's Motion to Amend), the test and simulation results demonstrate that the pendulum performs worse than a system with no absorber for certain parts of these narrower ranges for some orders of excitation. *See* Ex. 2006 ¶¶ 100, 105,

108, 109, 111, 112. Also, these claims do not have any relationship between the order of excitation, "q," and the order shift value, " q_F ."

Accordingly, we afford the evidence of alleged unexpected conditions very little weight.

(iv) Conclusion

We have weighed the underlying evidence in support of each of the *Graham* factors. Although we find this a close case, upon review of the complete record, including the Petition, Schaeffler's Patent Owner Response, and the testimonial evidence (including the cross-examination evidence and observations on cross-examination), we conclude that Valeo has shown, by a preponderance of the evidence, that independent claims 1 and 11 are unpatentable under 35 U.S.C. § 103(a) over Eckel, Sudau, and Speckhart.

b. Dependent claims 2-10, 12, and 13

(i) Claim 2

Claim 2 depends from claim 1 and further recites "wherein the order shift value q_F is selected, so that a resonance of the rotational speed adaptive absorber does not coincide with the order q of the exciting vibration." Ex. 1001, 13:10–13. Valeo contends that Eckel discloses the subject matter of claim 2. Pet. 26. As Valeo explains, when Eckel's "k" value is not 1, Eckel's absorber is tuned to an order different from the exciting vibration. *Id.* For example, with a value of q=2 (for a four cylinder engine) and a value of k=0.8, the order shift value is 0.236 and the resonance value of the rotational speed adaptive absorber is 2.236, which does not equal 2. *Id.* Schaeffler does not dispute these contentions. We agree with Valeo and find that for values of "k" less than 1, Eckel discloses that the rotational speed

adaptive absorber is over-tuned (as required by claim 1) and the resonance of the rotational speed adaptive absorber does not coincide with the order of excitation vibration. *See* Ex. 1003, 2:17–36; Ex. 1002 ¶¶37–42, 51, 72, 79.

(ii) Claims 3 and 8–10

Claim 3 depends from claim 1, and further recites "wherein the effective order q_{eff} of the rotational speed adaptive absorber exceeds the order q of the exciting vibration of the drive by the order shift value q_F in the range of >0.05 to 0.5." Ex. 1001, 13:14–18. Similarly, Claim 8 depends from claim 1, and further recites "wherein the effective order q_{eff} of the rotational speed adaptive absorber exceeds the order q of the exciting vibration of the drive by the order shift value q_F in the range of >0.05 to 0.4." *Id.* at 14:6–9. Claim 9 depends from claim 1, and further recites "wherein the rotational speed adaptive order q_{eff} of the rotational speed adaptive order q_{eff} of the rotational speed adaptive order q_{eff} of the rotational speed adaptive absorber exceeds the order q of the exciting "wherein the effective order q_{eff} of the rotational speed adaptive absorber exceeds the order q adaptive absorber exceeds the order q of the exciting vibration of the drive by the order q_{eff} of the rotational speed adaptive absorber exceeds the order q of the exciting vibration of the drive by the order shift value q_F in the range of >0.05 to 0.3." *Id.* at 14:10–14. Claim 10 depends from claim 1, and further recites "wherein the effective order q_{eff} of the rotational speed adaptive absorber exceeds the order q of the exciting vibration of the drive by the order shift value q_F in the range of >0.05 to 0.3." *Id.* at 14:10–14. Claim 10 depends from claim 1, and further recites "wherein the effective order q_{eff} of the rotational speed adaptive absorber exceeds the order q of the exciting vibration of the drive by the order shift value q_F in the range of >0.14 to 0.3." *Id.* at 14:15–19.

Valeo contends that Eckel teaches the recited ranges in claims 3, 8, 9, and 10. Pet. 26–27, 35. Valeo demonstrates that for a value of "k" equal to 0.8 (which lies in Eckel's disclosed range), order shift value q_F is 0.236, which overlaps the recited ranges for claims 3, 8, 9, and 10. *Id.*; *see also* Ex. 1002 ¶¶80, 101, 102, 103 (providing that Eckel's disclosed range includes a value for k of 0.8, which results in an order shift value q_F of 0.236, which overlaps each of the claimed ranges). Schaeffler does not dispute this

contention. We agree with Valeo. We find that for values of "k" in the range of 0.8 to 0.95 (a portion of Eckel's disclosed range), Eckel discloses that the value of order shift value q_F ranges from 0.236 to 0.05, which overlaps the recited ranges. We base this finding on Dr. Shaw's formula for q_F in terms of "k" and an order of excitation vibration of 2, which we credit here. *See* Ex. 1002 ¶ 40 (providing formula for q_F in terms of "k").

(iii) Claim 4

Claim 4 depends from claim 1 and further recites:

wherein the rotational speed adaptive absorber is configured as a centrifugal force pendulum device, comprising an inertial mass support device with inertial masses disposed thereon and movable relative thereto, configured and designed, so that a center of gravity distance S of a particular inertial mass is determined as a function of an order q of the exciting vibration of the drive and the order shift by q_F to an effective order q_{eff} defines a change of the center of gravity distance as a function of the order shift value q_F .

Ex. 1001, 13:19–28. Valeo contends that Eckel's rotational speed adaptive absorber is configured as a centrifugal force pendulum device. Pet. 27. Valeo further contends that Eckel's centrifugal force pendulum device includes an inertial mass support device with inertial masses disposed thereon and movable relative thereto. *Id.* at 28. Valeo explains that the embodiment depicted in Eckel's Figure 1 shows inertial masses 3 supported on mounting supports 4, and that Eckel expressly discloses that inertial masses 3 are moveable back and forth relative to hub 2. *Id.* Schaeffler does not dispute these contentions.

Valeo further contends that Eckel's masses are tuned such that a center of gravity distance S of a particular inertial mass is determined as a function of an order q of the exciting vibration of the drive, and the order

shift by q_F to an effective order q_{eff} defines a change of the center of gravity distance as a function of the order shift value q_F . Pet. 29. Schaeffler does not dispute this contention.

We agree with Valeo. Eckel's Figure 1 is reproduced below.





Figure 1 depicts "a front view of a speed-adaptive dynamic-vibration absorber" disclosed in Eckel. Ex. 1003, 3:65–67. Two supports 4 mounted on hub part 2 support each inertial mass 3. *Id.* at 4:16–18. Hub part 2 includes rolling path 8 and inertial mass 3 has rolling path 9. *Id.* at 4:24–25. Bolt 6 extends into opening 7 formed in inertial mass 3. *Id.* at 4:20–23. Rolling paths 8, 9 and bolt 6 are configured such that inertial masses 3 move back and forth relative to hub part 2 along path of motion B. *Id.* at 4:26–31. As inertial masses 3 move between the deflection positions, bolts 6 hob on rolling paths 8, 9. *Id.* at 4:34–35. Inertial masses 3 move in this pendulum-like motion along path of motion B in response to a torsional vibration superimposed on a rotational motion about axis 1. *Id.* at 4:42–45.

Further, we find that Eckel discloses that its value "R" is a function of the excitation order ("q" in the claim, or "x" in Eckel) and the order shift value q_F , which is a function of "k," as we credit Dr. Shaw's testimony in this regard. *See* Ex. 1002 ¶¶ 40, 41 (providing formulas for effective center of gravity distance in terms of "R" and " q_{eff} " in terms of " q_F " and "R").

(iv) Claim 5

Claim 5 depends from claim 1 and further recites "wherein a size of the order shift value q_F changes proportional to a change of the order q of the excitation of the drive." Ex. 1001, 13:29–31. Valeo contends that Eckel discloses the subject matter of claim 5. Valeo explains that order shift value q_F is proportional to order q by the ratio of 1 minus the square root of "k" to the square root of "k." Pet. 30. That is:

$$q_F = q\left(\frac{1-\sqrt{k}}{\sqrt{k}}\right)$$

Schaeffler does not dispute this contention. We agree with Valeo, crediting Dr. Shaw's testimony. See Ex. $1002 \ \mbox{\P} \ \mbox{87}$.

(v) Claim 6

Claim 6 depends from claim 1 and further recites:

comprising a hydrodynamic component with at least a primary shell functioning as a pump shell (P) and a secondary shell functioning as turbine shell (T) jointly forming an operating space (AR), wherein the turbine shell (T) is connected at least indirectly torque proof with the output (A) of the force transmission device and a device for bridging the hydrodynamic components, which are respectively disposed in a power path, and the device for damping vibrations is connected with the rotational speed adaptive absorber at least in series with one of the power paths, wherein a cavity which can be at least partially filled with an operating medium, is formed by an inner cavity of the force transmission device which inner cavity is flowed through by the operating medium of the hydrodynamic component.

Ex. 1001, 13:32–14:3. Valeo contends that Sudau, as modified by Eckel and Speckhart, discloses the subject matter of claim 6. Pet. 30–34. Specifically, Valeo contends that Sudau's torque converter 100 is the recited hydrodynamic component, configured, for the most part, as recited in the claim. *See id.* Valeo contends that, by modifying Sudau's torque converter 100 and adding Eckel's rotational speed adaptive absorber, "the vibration damping device of Sudau's torque converter and the rotational speed adaptive absorber are connected in series and located on power paths along the vehicle's power train." *Id.* at 33–34. Valeo also contends that "[a person having ordinary skill in the art] would understand that hydrodynamic converter circuit 24 is filled with torque converter fluid that flows through the impeller wheel 11, turbine wheel 13, and stator wheel 23." *Id.* at 34 (citing Ex. 1002 ¶ 99).

Schaeffler does not dispute this contention. We agree with Valeo. We find that Sudau's torque converter, as modified by Eckel's rotational speed adaptive absorber (based on the teachings of Eckel and Speckhart), discloses the subject matter of claim 6. We credit Dr. Shaw's testimony as to the workings and configuration of Sudau's torque converter 100, as modified by Eckel's rotational speed adaptive absorber. *See* Ex. 1002 ¶¶ 69, 88–99; *see also* Ex. 1005, Fig. 1, 3:29–4:24 (describing Figure 1).

(vi) Claims 7 and 13

Claim 7 depends from claim 1 and further recites "wherein the operating medium is oil." Ex. 1001, 14:4–5. Claim 13 depends from claim 11 and further recites "wherein the operating medium is oil." *Id.* at 14:41–

42. Valeo contends that "[a person having ordinary skill in the art] would understand that Sudau's hydrodynamic converter circuit 24 is filled with torque converter fluid such as oil." Pet. 34, 40 (citing Ex. 1002 ¶¶ 100, 118). Valeo further contends that, to the extent that it has not demonstrated that this claim element is present inherently in Sudau, "it would have been obvious . . . that Sudau's torque converter fluid could be oil because it was well-known to use oil as the operating medium of a torque converter." *Id.* (Ex. 1002 ¶¶ 100, 118).

Schaeffler does not dispute this contention. We agree with Valeo that this claim element is well within the knowledge of one of ordinary skill in the art. *See* Ex. 1002 ¶¶ 100, 118; *see also* PO Resp. 12 ("Oil is used in a torque converter . . . as the operating medium."); Ex. 2006 ¶ 45 ("[In a torque converter], all components of both paths are typically submerged in the chamber flowed through with oil.").

(vii) Claim 12

Claim 12 depends from claim 11, and further comprises the steps of: "determining the order of excitation q of a drive engine; defining a geometry of the rotational speed adaptive absorber for the order of excitation q; determining the required order shift value q_F ; and determining the geometry of the absorber as a function of the order shift value q_F ." Ex. 1001, 14:32– 40. Valeo contends that Eckel discloses the additional subject matter of claim 12. Pet. 37–40. Specifically, Valeo contends that Eckel discloses a mathematical relationship between the order of excitation (Eckel's "x"), order shift value q_F (in terms of "k"), and the geometry of a rotational speed adaptive absorber. *Id*.

Schaeffler does not dispute Valeo's contentions. We agree with Valeo and find that Eckel discloses the additional subject matter of claim 12. *See, e.g.*, Ex. 1003, 2:16–26 (disclosing a formula for the radius of curvature of the path of motion of a speed-adaptive dynamic-vibration absorber in the middle position as a function of "k" and "x"); Ex. 1002 ¶¶ 38–40 (mapping the '740 patent's mathematical expressions with those from Eckel). In support of our findings, we credit Dr. Shaw's testimony. Ex. 1002 ¶¶ 66–68 (describing how Eckel discloses the subject matter of claim 12).

(vii) Reasons to combine Eckel, Sudau, and Speckhart

We addressed the reasons to combine Eckel, Sudau, and Speckhart above in connection with our analysis of independent claims 1 and 11. As we discussed above, we are persuaded that Valeo has provided adequate reasoning, with rational underpinnings, for combining the teachings of Eckel, Sudau, and Speckhart.

(ix) Conclusion

Upon review of the complete record, including the Petition, Schaeffler's Patent Owner Response, and supporting evidence from both parties (including alleged evidence of secondary considerations, which we analyzed above in connection with our analysis of claim 1), we conclude that Valeo has shown, by a preponderance of the evidence, that claims 2–10, 12, and 13 are unpatentable under 35 U.S.C. § 103(a) over Eckel, Sudau, and Speckhart.

2. Claims 1–4 and 6–13 and Nester, Sudau, and Speckhart

Under this proposed ground of unpatentability, Valeo relies on Nester's teaching of over-tuning a rotational speed adaptive absorber for the crankshaft of an engine. *See* Pet. 40. Specifically, claim 1 requires, in

relevant part, "the vibration damping device [be] coupled with a rotational speed adaptive absorber." Ex. 1001, 13:3–5. Valeo contends that Nester discloses the recited rotational speed adaptive absorber in the form of a crankshaft-mounted pendulum. Pet. 43. Valeo further contends that "it would have been obvious to a [person having ordinary skill in the art] to couple Nester's absorber directly to Sudau's lock-up clutch." Id. at 44. Valeo first reasons that an artisan of ordinary skill would have understood that Nester's absorber could have been used to address any rotational vibration from an engine. *Id.* (referencing Ex 1002 ¶ 129). Valeo further reasons that Sudau teaches "that a torque converter can have a vibration damper and rotational speed adaptive absorber directly coupled to each other within the torque converter housing." Id. (referencing Ex. 1005, 1:61-65, 2:20–24; Ex. 1002 ¶ 129). Valeo also reasons that "Speckhart expressly confirms that a rotational speed adaptive absorber can be implemented on the crankshaft (as in the example taught by Nester) or alternatively within a torque converter (as in the example taught by Sudau)." Id. (referencing Ex. 1008, 3:13–39).

Claim 1 further requires "the rotational speed adaptive absorber [be] tuned as a function of an oil influence to an effective order q_{eff} , which is greater by an order shift value q_F than an order q of an exciting vibration of a drive system." Ex. 1001, 13:6–9. Valeo contends that Nester's rotational speed adaptive absorber is in contact with oil. Pet. 45. Valeo further contends that, since Nester discloses an order shift value of 0.15 for an excitation order of 2 and the '740 patent discloses a preferred order shift value of 0.14, Nester's over-tuning accounts for the influence of oil. *Id*. Further, Valeo contends that Nester discloses an effective order q_{eff} value of

2.15 for a V4 (four cylinder) configuration (q=2), such that q_{eff} is greater than q by the order shift value of 0.15. *Id.* at 46.

In asserting that claims 1–4 and 6–13 of the '740 patent are obvious over Nester, Sudau, and Speckhart, Valeo concludes that:

It would have been obvious to a [person having ordinary skill in the art] to apply Nester's rotational speed adaptive absorber to a vehicle with Sudau's torque converter because the benefits of Nester's rotational speed adaptive absorber could be predictably applied to any motor vehicle, including one with a torque converter. In particular, the incorporation of Nester's rotational speed adaptive absorber into a powertrain that includes a torque converter would yield the predictable and explicitly taught result of damping rotational vibrations.

Pet. 41.

Schaeffler argues that Valeo fails to establish an adequate reason as to why an artisan of ordinary skill would modify Sudau with Nester's absorber. PO Resp. 70–71. We are persuaded this issue is dispositive as to this ground.

Schaeffler repeats an argument made with respect to the first ground—that a person having ordinary skill in the art would not have looked to Nester, which is directed to high amplitude vibrations, to modify an absorber on a lock-up clutch, which is subjected to low amplitude vibrations. PO Resp. 74–75. Schaeffler also repeats that positioning a rotational speed adaptive absorber downstream from a damper, as proposed in Valeo's modification, would subject the absorber to even smaller vibrations. *Id.* at 74–75.

Valeo responds that a torque converter could experience high amplitude vibrations. Reply 31 (citing Ex. 1060 \P 108). Valeo further contends that centrifugal pendulum absorbers positioned "behind elastic

elements does not necessarily reduce the vibration enough such that only small amplitude vibrations reach the" absorber. *Id.* at 31–32.

We are persuaded by Schaeffler's arguments of a deficiency in Valeo's reasons to combine the teachings of Nester and Speckhart with Sudau. As an initial matter, in favor of Valeo, we credit Dr. Shaw's testimony that Schaeffler's documents depict a system with an over-tuned centrifugal pendulum absorber downstream from a vibration dampener. Ex. 1060 ¶ 51; *see also* Ex. 1039 (discussing adding a centrifugal pendulum-type absorber downstream of a dual-mass flywheel); Ex. 2006 ¶¶ 42–44 (describing a dual-mass flywheel).

We are persuaded, however, that Valeo's reasoning lacks adequate rational underpinning. See KSR Int'l Co., 550 U.S. at 418 (citing In re Kahn, 441 F.3d 977, 988 (Fed. Cir. 2006)) ("[O]bviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness."). Valeo's reasoning fails to explain adequately why a person having ordinary skill in the art would have made the proposed modification. That is, Valeo's reasoning establishes that a person having ordinary skill in the art *could* have made the modification, but does not establish why the person would have made the modification. See Pet. 44 (stating that a person having ordinary skill in the art "would understand that Nester's rotational speed adaptive absorber *can* be applied to virtually any rotational vibration caused by the engine;" "a torque converter can have a vibration damper and rotational speed adaptive absorber directly coupled to each other within the torque converter housing;" and "Speckhart expressly confirms that a rotational speed adaptive absorber *can* be implemented on

the crankshaft . . . or alternatively within a torque converter") (emphasis added). Valeo's reasoning lacks any persuasive factual underpinning as to why a person having ordinary skill in the art would have taken Nester's teaching of a rotational speed adaptive absorber, tuned at 2.15 for a very specific operating environment (crankshaft with an eight-cylinder engine operating on four cylinders at idle speed⁶) and put a comparably-tuned absorber into Sudau's torque converter.

Unlike Eckel, which is not limited to compensating for non-linear effects, but expressly discloses compensating for hydrodynamic and hydrostatic effects, *see* Ex. 1003, 2:66–3:2, Nestor addresses non-linear effects only. *See* Ex. 1004, Abstract. Further, Eckel is directed to a broader operating environment than Nester. Accordingly, as we discussed above, we found that Valeo had provided the requisite reasoning, with rational underpinning, to combine Eckel, Sudau, and Speckhart. Nester's narrow teaching fails to provide the same factual support for a reason to combine references.

On the complete trial record before us, we conclude that Valeo has not shown, by a preponderance of the evidence, that independent claims 1 and 11 are unpatentable under 35 U.S.C. § 103(a) over Nester, Sudau, and Speckhart.

⁶ Valeo argues that Nester discloses that its absorber reduces vibrations "especially in V4 idle," which suggests that it works in a broader operating environment. Reply 32. Although we appreciate the word choice in Nester, a complete reading of Nester demonstrates that the only test environment discussed in Nester is one operating at idle speed. *See, e.g.*, Ex. 1004, 2 ("All tests were made with the trucks stationary and the engines running under nominal idle conditions at approximately 650 rpm.").

c. Dependent claims 2-4, 6-10, 12, and 13

With respect to dependent claims 2–4, 6–10, 12, and 13, Valeo relies on its same reasoning for modifying Sudau with the teachings of Nester and Speckhart asserted for claim 1. For the reasons discussed above in connection with our analysis of claim 1 over Nester, Sudau, and Speckhart, we find that Valeo fails to provide adequate reasoning, supported by rational underpinnings, to modify Sudau's torque converter with Nester's rotational speed adaptive absorber over-tuned to a value of 2.15 further in view of Speckhart's teaching.

3. Claim 5 over Nester, Sudau, Speckhart, and Eckel

Claim 5 recites "[t]he force transmission device according to claim 1, wherein a size of the order shift value q_F changes proportional to a change of the order q of the excitation of the drive." Ex. 1001, 13:29–31. Valeo contends that Eckel discloses the additional subject matter of claim 5 and further contends that an artisan of ordinary skill would have had reason to combine the teachings of Eckel with Nester, Sudau, and Speckhart. Pet. 58– 60.

Valeo relies on its same reasoning for modifying Sudau with the teachings of Nester and Speckhart asserted for claim 1. From our review of the record, we find it unclear as to how exactly Eckel's teaching is being employed, other than for its general disclosure that order shift value q_F changes proportional to a change of the order q. Valeo does not adequately explain how any teachings in Eckel bolster its reasoning for modifying Sudau's torque converter with Nester's rotational speed adaptive absorber.

For the reasons discussed above in connection with our analysis of claim 1 over Nester, Sudau, and Speckhart, we are persuaded that Valeo fails

to provide adequate reasoning, supported by rational underpinnings, to modify Sudau's torque converter with Nester's rotational speed adaptive absorber over-tuned to a value of 2.15, further in view of Speckhart's and Eckel's teachings.

D. Motion to Amend

Schaeffler filed a contingent Motion to Amend—contingent on us finding original claims 1–13 unpatentable. Mot. to Amend 1. As we have determined that claims 1–13 are unpatentable over Sudau, Eckel, and Speckhart, we now turn to the Motion to Amend.

Schaeffler has the burden of proving patentability of each proposed substitute claim. *See Nike, Inc. v. Adidas AG*, 812 F.3d 1326, 1334 (Fed. Cir. 2016) ("[T]he Board permissibly interpreted [37 C.F.R. § 42.20(c)] as imposing the burden of proving patentability of a proposed substitute claim on the movant: the patent owner."). Specifically, Schaeffler has the burden of proving that the substitute claims are patentably distinct over the prior art of record in the proceeding. *See Microsoft Corp. v. Proxyconn, Inc.*, 789 F.3d 1292, 1307–08 (Fed. Cir. 2015); *MasterImage 3D, Inc. v. RealD Inc.*, Case IPR2015–00040 (PTAB July 15, 2015) (Paper 42) (precedential); *Idle Free Systems, Inc. v. Bergstrom, Inc.*, Case IPR2012–00027 (PTAB June 11, 2013) (Paper 26) (informative); *but see In re Aqua Products*, No.2015–1177, 2016 WL 4375651, at *1 (Fed. Cir. Aug. 12, 2016) (granting rehearing *en banc* to address burdens of persuasion and production regarding motions to amend under 35 U.S.C. § 316(d) and vacating *In re Aqua Products*, 823 F.3d 1369 (Fed. Cir. 2016)).

a. New Independent Claims 14 and 23 and their Support in the

Specification

Schaeffler proposes to substitute new independent claim 14 for claim 1, and new independent claim 23 for claim 11. Mot. to Amend 1. New claim 14 recites:

14. A force transmission device, <u>comprised of a torque</u> <u>converter</u>, for power transmission between an input and an output, comprising:

at least an input (E) and an output (A);

a lock-up clutch; and

a vibration damping device disposed in a cavity that can be filled at least partially with an operating medium, the vibration damping device coupled with a rotational speed adaptive absorber <u>in the form of a centrifugal force pendulum,</u> <u>the rotational speed adaptive absorber being positioned after the</u> vibration damping device in the force flow direction,

wherein the rotational speed adaptive absorber is tuned as a function of an oil influence to an effective order q_{eff} , which is greater by an order shift value q_F than an order q of an exciting vibration of a drive system,

wherein the operating medium is oil and the oil influence is that of rotating oil in the cavity, which is flowed through with oil, on an inertial mass of the rotational speed adaptive absorber,

wherein the effective order q_{eff} of the rotational speed adaptive absorber exceeds the order q of the exciting vibration of the drive system by the order shift value q_F in the range of ≥ 0.05 to 0.5.

Mot. to Amend, Claims App. Substitute claim 23 recites similar subject matter, but in the form of a method claim. *See id*.

Schaeffler provides a mapping between each claim limitation of each substitute claim, and support for the claimed subject matter in the '740 patent. Mot. to Amend 5–14. Valeo does not dispute that the added subject matter has written description support in the '740 patent. We find that

Schaeffler has adequately demonstrated that the subject matter of the substitute claims has written description support.

Valeo does dispute a number of aspects of Schaeffler's Motion to Amend. We address each aspect in turn, below.

b. The Motion to Amend and Technical Requirements Established by the Board

Valeo contends that we should deny the Motion to Amend because Schaeffler failed to satisfy technical requirements established in certain decisions of the Board—decisions that we expressly directed Schaeffler to consider in drafting its Motion to Amend. Opp. Mot. to Amend 1. First, Valeo contends that Schaeffler's statement of contingency is unclear. Although Valeo is correct that Schaeffler did not adopt a claim-by-claim approach to specifying its contingency, we determine that Schaeffler's statement is sufficient. As we determined that all original claims are unpatentable, we see no reason why we should not understand Schaeffler's Motion to Amend as advocating for anything other than a consideration of all of the substitute claims. Also, from information provided in the Claims Appendix to the Motion to Amend, we determine that Schaeffler does not propose multiple substitute claims for a single original claim. Instead, original claims 1, 2, and 4–13 map 1-to-1 with substitute claims 14–25, with claim 3 not having a corresponding substitute claim. See Mot. to Amend, Claims App. (showing claim 3 with strikethrough language).

Next, Valeo contends that Schaeffler fails to provide a construction for all newly-added terms. Opp. Mot. to Amend 2. We determine that Schaeffler has sufficiently addressed the construction of added terms. Although best practices are for a patent owner to provide constructions for

each added claim term that may be the subject of a dispute between the parties, we do not find Schaeffler's failure to heed this guidance fatal.

Valeo calls out one term that it contends should have been construed—"the oil influence is that of rotating oil in the cavity." Opp. Mot. to Amend 3. We determine that this added language further defines the term "oil influence," a term that Valeo did not construe in its Petition, other than to state that it should be interpreted to mean "influence of oil on the absorber." Pet. 15. Valeo did not construe this term with respect to what the specific influences are. In substitute claims 14 and 23, the added language more specifically defines the nature of the oil. *See* Reply to Opp. Mot. to Amend 1.

Next, Valeo contends that Schaeffler fails to demonstrate that the claims are patentable over the prior art of record and art of which Schaeffler is aware. Opp. Mot. to Amend 4. Here, Schaeffler makes clear that it relies on secondary considerations to demonstrate the claims are patentable over the closest prior art, conceding that the claimed elements are found in the prior art. *See* Mot. to Amend 15. In analyzing the patentability of the substitute claims, Schaeffler identifies how the closest prior art references would not have suggested the unexpected results and does not contends that any of the limitations of the substitute claims are not present in these references. *See id.* at 15–23; *see also Kao Corp. v. Unilever U.S., Inc.*, 441 F.3d 963, 970 (Fed. Cir. 2006) ("[W]hen unexpected results are used as evidence of nonobviousness, the results must be shown to be unexpected compared with the closest prior art.") (internal citation and quotes omitted).

c. Patentability of the Substitute Claims over the Prior Art of Record

Schaeffler contends that "patentability [of the subject claims] is based, in part, on unexpected results, [and] the objective indicia overcome any suggestion of obviousness, particularly where the references do not suggest the unexpected result to a [person having ordinary skill in the art]." Mot. to Amend 16. We read Schaeffler's patentability position to be based solely on the objective indicium of unexpected results. *See id.* at 15 (indicating that the substitute claims are "distinguishable from the prior art" because of unexpected results that differ in kind from what would have been expected).

Valeo contends that each element of the substitute claims is present in the prior art. Opp. Mot. to Amend 7; *see also id.* at 8–10 (mapping the added claim elements to the prior art of record in this proceeding).

We agree with Valeo that the prior art of record discloses each of the limitations recited in the substitute claims and Schaeffler does not dispute that the claim limitations are found in the prior art (Mot. to Amend 15).

Valeo further contends that the Petition demonstrates a "strong motivation" to combine the teachings of the prior art of record in this proceeding. Opp. Mot. to Amend 15. As we discussed above, in our analysis of the original claims, we find that Valeo has provided the requisite reasons to combine the teachings of Sudau, Eckel, and Speckhart. We found that Eckel disclosed a range of tuning of a centrifugal force pendulum that overlapped with the claimed ranges in the original claims. We further found that Eckel's express disclosure that its tuning range compensated for hydrodynamic and hydrostatic effects on the pendulum provided additional factual support to Valeo's reasoning. We further found that Speckhart disclosed that rotational speed adaptive absorbers could be applied to torque

converters, such as the torque converter of Sudau and that Speckhart further disclosed that its rotational speed adaptive absorber was preferably eventuned or slightly over-tuned. With respect to the newly-added claim limitations in the substitute claims, the recited subject matter (a torque converter, a lock-up clutch, and rotating oil in a cavity) is present in Sudau's torque converter. *See* Ex. 1005, 3:29 (disclosing torque converter 100), 3:54 (disclosing lock-up clutch 25); Ex. 2006 ¶¶ 46–47 (describing workings of the hydrodynamic component of a torque convertor, including its rotating oil). Accordingly, Valeo's reasons to combine provided with respect to the original claims are applicable to the substitute claims.

We cautioned, however, that the totality of Schaeffler's arguments and supporting evidence indicates that Valeo's position with respect to motivation to combine is not a strong one. For example, Eckel discloses a complex combination of tunings and swing paths for its absorber, making it difficult to limit those teachings directed to over-tuning the absorber. Also, Speckhart over-tunes its absorber to address non-linear effects, which Eckel appears to address by employing a cycloid swing path for its absorber. Finally, record evidence indicates that a torque converter, at the time of the invention of the '740 patent, may not experience high-amplitude vibrations that would cause non-linear effects on the absorber—effects each of Eckel and Speckhart discloses its invention addresses.⁷

Accordingly, we find that the subject matter of the substitute claims is disclosed by the combination of Sudau, Eckel, and Speckhart. We also find

⁷ We also found that Valeo failed to provide a persuasive reason, supported by rational underpinning, for combining the teachings of Nester with Sudau and Speckhart.

that a person having ordinary skill in the art would have been motivated to modify Sudau with the teachings of Eckel and Speckhart for the reasons provided by Valeo in the Petition with respect to the original claims. *See* Pet. 18–20; *see also* Sec. II.C.1.a.ii, *supra* (addressing Valeo's reasons to combine for original claims 1 and 11). We also find that a person having ordinary skill in the art would have had a reasonable expectation of success in modifying Sudau with Eckel's centrifugal pendulum absorber, as Speckhart expressly teaches that vibration absorbers may be used for a variety or components, including crank shafts, flywheels, clutches, and torque converters. *See* Ex. 1008, 3:12–16. We address our findings with respect to secondary considerations, below.

d. Secondary Considerations – Unexpected Results

Schaeffler asserts that unexpected results support a conclusion that the substitute claims are patentable. Mot. to Amend 15. "To be particularly probative, evidence of unexpected results must establish that there is a difference between the results obtained and those of the closest prior art, and that the difference would not have been expected by one of ordinary skill in the art at the time of the invention." *Bristol-Myers Squibb Co. v. Teva Pharm. USA, Inc.*, 752 F.3d 967, 977 (Fed. Cir. 2014). "'[D]ifferences in degree' of a known and expected property are not as persuasive in rebutting obviousness as differences in 'kind.'" *Id.* "When assessing unexpected properties, therefore, we must evaluate the significance and 'kind' of expected results along with the unexpected results." *Id.* "Whether an invention has produced unexpected results ... [is a] question[] of fact." *In re Peterson*, 315 F.3d 1325, 1328 (Fed. Cir. 2003).

(i) Nexus

As with our analysis of the original claims, we start our evaluation of secondary considerations with a determination of whether there is a nexus between the alleged unexpected results and the substitute claims. Schaeffler contends that the amendments embodied in the substitute claims provide a strong nexus between the unexpected results and the claims. Mot. to Amend 2. Schaeffler explains that the inventors of the '470 patent discovered "that the rotating oil in a torque converter had a significant and surprising influence on the inertial mass of a centrifugal force pendulum." *Id.* Schaeffler further explains that "the inventors found that, for an inertial mass affected by rotating oil in the cavity of a torque converter, over-tuning in the range of >0.05 to 0.5 improved performance." *Id.* at 3; *see* Ex. 2006 ¶¶ 201–202 (describing the elements of the substitute claims tied to the unexpected results).

Valeo contends that no nexus exists between the alleged unexpected results and the substitute claims. Opp. Mot. to Amend 23. Valeo argues that one aspect of the alleged unexpected results is that the centrifugal force pendulum of the system experiences small swing angles, and that the substitute claims are not limited to small swing angles. *Id.* at 24. Valeo argues that centrifugal force pendulums in a torque converter may experience large amplitude vibrations. *Id.* (citing Ex. 1060 ¶ 92). Similarly, Valeo argues that the claims do not specify parameters of the pendulum that limits them to linear operation. *Id.* at 25.

Schaeffler responds that Dr. Shaw testified that the results seen by Schaeffler would have existed for both large and small swing angles. Reply Opp. Mot. to Amend 11 (citing Ex. 2018, 209:23–211:10, 39:15–18,

252:22–253:11; Ex. 2014, ¶¶ 109–117). Schaeffler continues that Dr. Shaw's testimony "confirmed that the corrective tuning derives solely from the influence of rotating oil on the [centrifugal force pendulum], which is recited in the claims." *Id.* (citing Ex. 2018, 12:8–13:18, 261:5–8; 43:16–25; 67:11–68:9, 207:14–18, 90:14–16).

Valeo further contends that the substitute claims do not require the centrifugal force pendulum to be in a torque converter. Opp. Mot. to Amend 24. Valeo argues that the claims merely require the pendulum to be positioned after the vibration damping device, such that it could be outside the torque converter and subjected to large amplitude vibrations. *Id.*

"Evidence of secondary considerations must be *reasonably* commensurate with the scope of the claims." Kao, 639 F.3d at 1068 (emphasis added). With respect to the arguments directed to small and large swing angles, we find that the record evidence "provides an adequate basis to support" a conclusion of unexpected results, even for large swing angles. See id. ("If an applicant demonstrates that an embodiment has an unexpected result and provides an adequate basis to support the conclusion that other embodiments falling within the claim will behave in the same manner, this will generally establish that the evidence is commensurate with scope of the claims."). Further, we are unpersuaded that Valeo has demonstrated sufficiently that the centrifugal force pendulum would be subjected to large swing angles. Although Dr. Shaw testifies that the pendulum *may* encounter large swing angles (see Ex. 1060 ¶¶ 92, 100, 10), he fails to provide any persuasive factual support for this opinion. See In re Am. Acad. of Sci. Tech Ctr., 367 F.3d 1359, 1368 (Fed. Cir. 2004) ("[T]he Board is entitled to weigh the declarations and conclude that the lack of factual corroboration

warrants discounting the opinions expressed in the declarations."); *see also* 37 C.F.R. § 42.65(a) ("Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.").

With respect to Valeo's contention that the substitute claims do not require the centrifugal force pendulum to be located in the torque converter, we agree with Valeo that the language of these claims does not limit the pendulum to inside the torque converter. When read in light of the Specification, however, we determine that substitute claims 14 and 23 require the rotational speed adaptive absorber, in the form of a centrifugal force pendulum, to be within the same cavity of the force transmission device in which the vibration damping device is disposed, and that the pendulum is subjected to rotating oil in that cavity. Mot. to Amend, Claims App. Specifically, substitute claim 14 requires that the centrifugal force pendulum be tuned as a function of an oil influence, that the oil influence is that of rotating oil in the cavity on an inertial mass of the pendulum, and that the cavity is flowed through with oil. *Id*.

Further, the preamble of claim 14 recites that the force transmission device is "comprised of a torque converter." Mot. to Amend, Claims App. "[A] claim preamble has the import that the claim as a whole suggests for it." *Rowe v. Dror*, 112 F.3d 473, 478 (Fed. Cir. 1997) (quoting *Bell Commc 'ns Research, Inc. v. Vitalink Commc 'ns Corp.*, 55 F.3d 615, 620 (Fed. Cir. 1995)). "Where a patentee uses the claim preamble to recite structural limitations . . ., the PTO . . . give[s] effect to that usage." *Id.* "The determination of whether preamble recitations are structural limitations or mere statements of purpose or use 'can be resolved only on review of the

entirety of the patent to gain an understanding of what the inventors actually invented and intended to encompass by the claim."" *Id.* (quoting *Corning Glass Works, v. Sumitomo Elec. U.S.A., Inc.*, 868 F.2d 1251, 1257 (Fed. Cir. 1989). We determine, based on our review of the Specification and given that the language was added by amendment, that the recited torque converter is a structural limitation of claim 14. Accordingly, claim 14 requires the pendulum to be in a cavity of the force transmission device with rotating oil, and the required torque converter would be such a structure. Substitute claim 23 recites similar subject matter, such that it requires the pendulum to be in a cavity of the force transmission device subjected to rotating oil and the required torque converter would be such a structure. As such, the unexpected results are *reasonably* commensurate with the scope of the claims, at least with respect to the torque converter.

Although we are unpersuaded by Valeo's arguments with respect to a nexus between the alleged unexpected results and the above limitations of the substitute claims, when we consider the substitute claims as a whole, we are persuaded that Schaeffler has shown adequately that the structure that allegedly yielded the unexpected results are reasonably commensurate with the structure recited in *two* of the substitute claims only, thus, establishing a nexus to those two claims only and rebutting any presumed nexus for the other claims. We address the claims separately, below.

Substitute claims 14–16, 18, 23, and 24 each limits the value of the order shift value " q_F " to the range of >0.05 to 0.5. We find, however, that the purported unexpected results do not correspond to this recited range for all values of order of excitation "q." Based on our review of the record evidence, we find that the unexpected results are limited to a narrower range

of values for " q_F ," with that narrower range varying with the order of excitation, thus rebutting any presumed nexus for these claims.

As Dr. Parker summarized, the alleged unexpected results are "that over-tuning in the claimed range improved performance of a [centrifugal force pendulum] (and that even-tuning made the vibrations worse than using no [pendulum] at all)." Ex. 2014 ¶ 15. The record evidence shows, however, that for values of the order shift value " q_F " in the recited range of >0.05 to 0.5, the centrifugal force pendulum performed worse than using no pendulum at all. We reproduce Figure 3 from the '740 patent below.



Figure 3 presents the results of experiments determining the amplitude ratio for a system with a centrifugal force pendulum in air (solid line), a system with a centrifugal force pendulum in oil (dashed line), and a system without a centrifugal force pendulum (dashed-dotted line), subjected to an order of excitation equal to 2. *See* Ex. 2006 ¶¶ 90–100. Figure 3 illustrates that, under the influence of air, a centrifugal force pendulum tuned to the

excitation order performs best—that is, the solid line achieves its minimum value—at an order of excitation equal to the order of excitation of the experiment (q=2.0). *See id.* ¶ 95 ("We are interested in the minimum values of the solid (air) and dashed (oil) curves. These points identify at what excitation order the [pendulum] having a tuning order of 2.0 gives optimal vibration reduction."). The results indicate that for air, the pendulum should be even-tuned.

Dr. Parker explains that, because the system did not experience high swing angles, non-linear effects are not a concern, so a person having ordinary skill in the art would have expected the pendulum subjected to oil to perform best when even-tuned as well. *See* Ex. 2006 ¶ 98. As Dr. Parker explains, however, with even-tuning in oil, the pendulum performed *worse* than if there were no absorber at all—something unexpected. *Id.* Instead, the experiments demonstrate that over-tuning in the range of 6.4–8.7 percent would deliver optimum performance in oil. *Id.* at ¶ 100.

Accordingly, the tuning range for optimum performance of the pendulum in oil for an excitation order of 2 is 2.13–2.17, or a q_F ranging from 0.13–0.17. This range of q_F is much narrower than the recited range of >0.05 to 0.5 and the record evidence does not support a finding that the unexpected results would be present for other embodiments of the pendulum in the recited q_F range for an excitation order of 2. *See Kao*, 639 F.3d at 1068 (requiring applicant to "provide[] an adequate basis to support the conclusion that other embodiments falling within the claim will [exhibit the unexpected results], [which] will generally establish that the evidence is commensurate with scope of the claims"). More significantly, near the ends of the range, for an excitation order of 2, the pendulum performs the same or

worse than having no pendulum at all. As seen in Figure 3, above, a value of 1.5 on the x-axis (which corresponds to an over-tuning by a q_F of 0.5—the high end of the claimed range) results in an amplitude ratio of approximately 0.26 for a pendulum in oil, which is greater than the value for the amplitude ratio for the dual mass flywheel without a pendulum at x equal to 2, which is approximately 0.2. Similarly, at a q_F of 0.05 (x-axis value of 1.95), the amplitude ratio is approximately 0.2, the same as for the dual mass flywheel without a pendulum at x equal to 2.

Dr. Parker's simulation results for an order excitation of 2, and for other orders of excitation, show similar results. See Ex. 2006 ¶¶ 105 (showing the results for an excitation order of 2.0 comparable to those in Figure 3 of the '740 patent), 108 (showing that the optimum order shift value, q_F , for an excitation order of 3.0 is 0.24 and further showing that, for a range of order shift value of 0.05-0.08, the pendulum performs worse than a system with no pendulum), 109 (showing that the optimum order shift value, q_F , for an excitation order of 4.0 is 0.28 and further showing that, for a range of order shift value of 0.05-0.12, the pendulum performs worse than a system with no pendulum), 111 (showing that the optimum order shift value, q_F , for an excitation order of 1.0 is 0.07 and further showing that, for a range of order shift value of 0.05–0.08 and, by extrapolation, from 0.2–0.5, the pendulum performs worse than a system with no pendulum), 112 (showing that the optimum order shift value, q_F , for an excitation order of 6.0 is 0.43 and further showing that, for a range of order shift value of 0.05-0.16, the pendulum performs worse than a system with no pendulum). Although the optimal values for all of these excitation orders fall within the range of >0.05 to 0.5, claims 14–16, 18, 23, and 24 do not provide any

relationship between the order of excitation, "q," and the order shift value, " q_F ." Without this relationship, the unexpected results are not reasonably commensurate with the scope of these claims, and no nexus exists.

Claim 17 recites "[t]he force transmission device according to claim 14, wherein a size of the order shift value q_F changes proportional to a change of the order q of the excitation of the drive." Mot. to Amend, Claims App. Although this claim recites a relationship between "q" and " q_F ," the relationship is still not tied to the unexpected results. For example, claim 17 would encompass an embodiment with "q" equal to 2 and a " q_F " equal to 0.5, which would not have seen any unexpected results (provided there was a proportional change in " q_F " with a change in "q").

Claims 20, 21, and 22 recite narrower ranges for " q_F ": >0.05–0.4, >0.05–0.3, and >0.14–0.3, respectively. These claims, however, do not recite a relationship between "q" and " q_F ," such that they encompass embodiments that the record evidence demonstrates would not realize any unexpected results. For example, for an excitation order of 6, values of " q_F " ranging from 0.05–0.16 show worse performance than for no pendulum at all. *See* Ex. 2006 ¶ 112. Similarly, for an excitation order of 1.0, values of " q_F " ranging from 0.2–0.5 show worse performance than for no pendulum at all. *Id.* at ¶ 111.

Claims 19 and 25 require an excitation order of 2.0 and an order shift value of approximately 0.14. We find that a nexus exists for these claims. The record evidence shows that, for an excitation order of 2, the pendulum in oil performed optimally for a " q_F " of approximately 0.14. *See* Ex. 2006 ¶ 100.

(ii) Unexpected Results

As we indicated above, the alleged unexpected results are "that overtuning in the claimed range improved performance of a [centrifugal force pendulum] (and that even-tuning made the vibrations worse than using no [pendulum] at all)." Ex. 2014 ¶ 15; *see* Ex. 2006 ¶¶ 90–114 (describing Schaeffler's results); *id.* at 115–123 (describing "conventional expectations"). Valeo contends that substitute claims 14–25, including claims 19 and 25, "do not attain unexpected results." Opp. Mot. to Amend 14.

First, Valeo contends that Schaeffler's documents demonstrate that a centrifugal force pendulum was slightly over-tuned (presumably optimally) for operations in air. Opp. Mot. to Amend 15. That is, Valeo argues that record evidence, in the form of Schaeffler's own documents, demonstrates that a person having ordinary skill in the art would not have been surprised at the pendulum's increased performance in oil after over-tuning, as over-tuning provides that enhanced performance even in air. *Id.* at 15–16. Schaeffler replies that the record evidence demonstrates that this slight over-tuning accounted for manufacturing tolerances, was outside the claimed range, and did not optimize performance. Reply Opp. Mot. to Amend 5–6.

We are persuaded by Schaeffler's explanations of Valeo's contention, and, thus, are persuaded that the subject matters of claims 19 and 25 were unexpected based on this record evidence.

Next, Valeo contends that a centrifugal force pendulum tuned to account for non-ideal conditions (such as non-linear effects) would inherently realize the results seen by Schaeffler. Opp. Mot. to Amend 16– 17. Valeo argues that "Schaeffler's patent simply recognizes latent
properties in the prior-art teaching to overtune relative to ideal conditions and this recognition does not render an otherwise-known invention nonobvious." *Id.* at 18.

Schaeffler contends that Valeo's "inherency" argument is irrelevant and "would vitiate unexpected results as a defense to obviousness." Reply Opp. Mot. to Amend 4-5 (citing In re Chapman, 357 F.2d 418, 422 (CCPA 1966)). We agree. The Federal Circuit "has held that 'when unexpected results are used as evidence of nonobviousness, the results must be shown to be unexpected compared with the closest prior art."" Kao Corp., 441 F.3d at 970. As Valeo recognizes, the closest prior art discloses a force transmission device with an even-tuned centrifugal force pendulum. See, *e.g.*, Opp. Mot. to Amend 6 ("The only newly-added claim element not explicitly taught by Haller⁸ is that the CPVA is over-tuned."), 7–10 (indicating that Sudau discloses all of the subject matter of claims 19 and 25 except for a centrifugal force pendulum as the rotational speed adaptive absorber, which is over-tuned as claimed). Schaeffler is comparing its test results with the closest prior art—the same system with a rotational speed adaptive absorber in the form of a pendulum that is even-tuned. Here, Valeo's arguments rely on the teachings of over-tuning of other systems. This over-tuning represents the novel aspect of Schaeffler's claims. In essence, Valeo argues that the outcome of the above combination of teachings is the above results, and is not unexpected—this is a *non sequitur*, as any results must obey the laws of nature. The pertinent question is

⁸ DE 102 36 752 A1, published Feb. 29, 2004.

whether those results were expected given the state of knowledge in the field. For the reasons set forth herein, we are persuaded that they were not.

Next, Valeo contends that Schaeffler's discovery was the product of the design process. Opp. Mot. to Amend 18. Valeo argues that, when a person having ordinary skill in the art experienced poor performance with an even-tuned centrifugal force pendulum in oil, the natural design process would have led that person to adjust the tuning. *Id.* Valeo further argues that a test stand could have been used to perform an order sweep, which would have yielded the optimal tuning. *Id.* at 19.

Schaeffler replies that Valeo's contention is contrary to the law of obviousness, where unexpected results demonstrate that the claimed range was not a product of ordinary skill. Reply Opp. Mot. to Amend 6; *see also In re Peterson*, 315 F.3d at 1330 ("In general, an applicant may overcome a prima facie case of obviousness by establishing 'that the [claimed] range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range."").

We agree with Schaeffler that a showing of unexpected results in a claimed range outweighs a general assertion that optimizing a resulteffective variable is within the routine skill in the art. We credit Dr. Parker's testimony that the performance of the pendulum would have been unexpected by the ordinary artisan. *See* Ex. 2006 ¶¶ 90–114 (describing Schaeffler's results); *id.* at 115–123 (describing "conventional expectations"). Significant to our findings is that the claimed system would experience small swing angles and, accordingly, linear effects. We find, based on the record evidence, that, under these conditions, the expectation of a person having ordinary skill in the art would have been to employ an even-

tuned pendulum, even in an oil medium, as over-tuning would degrade performance. *See* Ex. 2006 ¶¶ 121–122.

Next, Valeo contends that a person having ordinary skill in the art would have, through analysis and prior art teachings, expected the results achieved by the substitute claims (including claims 19 and 25). Opp. Mot. to Amend 20. Valeo argues that an artisan of ordinary skill would have known that, with an immersed pendulum, buoyancy and added mass affect the period of a pendulum, and that the more dense the fluid, the greater the effect. *Id.* at 21. Further, Valeo argues that the prior art teaches that the tuning of a pendulum in oil is a function of the viscosity of the oil, and that damping may detune the pendulum. *Id.* at 21–22.

Schaeffler replies that the prior art that predates the claimed invention identifies damping as a possible issue. Reply Opp. Mot. to Amend 8. Schaeffler explains, however, that Dr. Shaw's calculations show that damping results in a 0.02 percent detuning, which is outside the claimed range. *Id.* Schaeffler further explains that the prior art demonstrates that buoyancy and added mass have little effect on detuning. *Id.* Schaeffler also contends that the basic mathematical models governing simple pendulums affected by gravity do not account for the complex nature of rotating oil on a pendulum in a force transmission device. *Id.* at 9–10.

We are persuaded by Schaeffler's explanation. The evidence of record fails to demonstrate that the effects of rotating oil on a pendulum, embodied in claims 19 and 25, were within the knowledge of a person having ordinary skill in the art in the relevant time period.

Accordingly, for the reasons discussed above, we find that Schaeffler has adequately demonstrated that the inventions of claims 19 and 25 achieve

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unexpected results. The results represent a difference in kind, which is germane to a finding of unexpected results, and not merely in degree, which is not sufficient to show unexpected results. Given a linear system, employing a pendulum over-tuned more than slightly achieves an improvement that is not merely a matter of degree.

e. Determination of Obviousness of the Substitute Claims

We have weighed the underlying factual evidence, and determine that substitute claims 14–18 and 20–24 are obvious over Sudau, Eckel, and Speckhart. Underlining this determination is the finding that the prior art discloses each and every claim element and a finding of no nexus to the asserted secondary consideration of unexpected results.

With respect to claims 19 and 25, we are persuaded that Schaeffler has met its burden of showing that they are non-obvious over the prior art of record. In weighing the underlying factual evidence in this obviousness analysis, we find that the unexpected results evidence outweighs a relatively weak reason for combining Sudau, Eckel, and Speckhart.

<u>f. The Substitute Claims and the Definiteness Requirement of 35 U.S.C. § 112</u>

Valeo contends that certain terms in the substitute claims renderthese claims indefinite. Opp. Mot. to Amend 11–13.

We address each in turn below.

(*i*) "oil influence is that of rotating oil in the cavity"

Valeo contends that the term "oil influence is that of rotating oil in the cavity," which appears in both independent claims 14 and 23, is indefinite, rendering all of the substitute claims unpatentable. Opp. Mot. to Amend 11. Valeo argues that "the '740 patent does not identify what the influence or effect is." *Id.* at 11–12. Valeo argues that the parties' experts in this

proceeding disagree about what the influence is, which evidences that the term is indefinite. *Id.* at 12.

Schaeffler responds that Valeo "simply confuse[s] whether a [person having ordinary skill in the art] would have understood what is meant by the oil influence on a mass (as described in the patent) with whether [that person] could have identified the dominant underlying forces." Reply to Opp. Mot. to Amend 3. We agree.

In determining whether a claim is definite under 35 U.S.C. § 112, second paragraph, "[t]he USPTO . . . is obliged to test the claims for reasonable precision." *In re Packard*, 751 F.3d 1307, 1313 (Fed. Cir. 2014). The term "oil influence is that of rotating oil in the cavity" further limits the term "oil influence," which appears in original claims 1 and 11 and, no party, or the Office, indicated previously that "oil influence" was indefinite. We determine that an artisan of ordinary skill would have understood that the added phrase further defines the previously recited "oil influence" as being from rotating oil located in the recited cavity.

(ii) "flowed through with oil"

Valeo contends that the term "flowed through with oil" in claims 14 and 23⁹ is indefinite for lack of antecedent basis for the word "oil." Opp. Mot. to Amend 12. Valeo argues that the claim is unclear as to whether the recited "oil" is "the oil" that forms the operating medium or is "an oil," different from the oil forming the operating medium. *Id.* As we discussed

⁹ We note that claim 23 does not include the phrase "flowed through with oil." Instead, original claim 11 included the phrase "the cavity in particular flowed through by an operating medium of a hydrodynamic component," which now appears in substitute claim 23.

above, we "test the claims for reasonable precision." *In re Packard*, 751 F.3d at 1313.

We determine that a person having ordinary skill in the art, having read the Specification of the '740 patent, would have understood the term "flowed through with oil" to be limited to the recited operating medium. *See, e.g.*, Ex. 1001, 10:13–21 ("The Inventors have found that in force transmission devices with hydrodynamic components which are flowed through by an operating medium during operation, in particular oil, . . . the oil of the rotating oil masses has a significant effect upon the function of the absorber 5, in particular of the centrifugal force pendulum.").¹⁰ We credit Dr. Parker's testimony in this regard. Ex. 2014 ¶ 13 ("A [person having ordinary skill in the art] reading the amended claims would have understood that the operating medium oil is the oil rotating in the cavity.").

(iii) approximately 0.14

Valeo contends that "the '740 patent provides no information as to what 'approximately' means," rendering the term in claims 19 and 25 indefinite. Opp. Mot. to Amend 13. Valeo argues that Schaeffler must have intended to ensure that "approximately 0.14" did not encompass Nester's 0.15 value, yet "Dr. Parker testified that plus or minus two hundredths is how a [person having ordinary skill in the art] would implement an order shift value of 0.14." *Id.*

¹⁰ Schaeffler contends that Dr. Shaw testified that the "flowed through with oil" term would have been understood by a person having ordinary skill in the art as meaning the operating medium oil. Reply to Opp. to Mot. to Amend (citing Ex. 2018, 293:15–294:6). We do not read Dr. Shaw's testimony to support Schaeffler's position, as it was directed to claim 11, which includes different claim language.

The use of the word "approximately," like the word "about' avoids a strict numerical boundary to the specified parameter. Its range must be interpreted in its technologic and stylistic context." *Pall Corp. v. Micron Separations, Inc.*, 66 F.3d 1211, 1217 (Fed. Cir. 1995). We agree with Valeo that the Specification does not provide a standard for measuring the degree associated with the term "approximately." We find, however, that, in the stylistic context that the term is used (modifying a numerical value representing physical dimensions of a manufactured component—an absorber), an artisan of ordinary skill would have understood that the term "approximately" means within a small variation of the modified value, such as to allow for manufacturing tolerances. It is inapposite that such an interpretation could result in an overlap with Nester's teaching, as Schaeffler has made clear that the patentability of the claims does not rest on differences between the claimed invention and the prior art but, instead, on the secondary consideration of unexpected results.

g. The Substitute Claims and the Requirement of 35 U.S.C. § 101

Valeo argues that "the '740 patent asserts that its novel discovery is that the fluid surrounding a pendulum affects the pendulum, which is a fundamental law of nature." Opp. Mot. to Amend 14. Valeo continues that, "[b]ecause there is no inventive concept sufficient to transform this notion into patent-eligible subject matter, substitute claims 14–25 are unpatentable under 35 U.S.C. § 101." *Id*.

Valeo's argument is unpersuasive, as it misapplies the law of patentable subject matter under 35 U.S.C. § 101. We agree that "'laws of nature . . .' are not patentable subject matter under § 101 of the Patent Act." *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 566 U.S. 66 (2012).

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The Supreme Court tells us, however, that applying the law of nature to a structure or process may warrant patent protection. *Id.* Even if we assume, *arguendo*, that Schaeffler's inventive concept embodied in the substitute claims is a law of nature, we are persuaded that Schaeffler has applied that law to the structure and process for absorbing vibration in a torque converter. Valeo fails to persuasively explain why such an application runs afoul of § 101.

h. Conclusion

For the reasons provided above, Schaeffler has met its burden of showing patentability with respect to claims 19 and 25, and, thus, Schaeffler's Motion to Amend is granted-in-part with respect to claims 19 and 25 only. In all other respects, Schaeffler's Motion to Amend is denied.

III. CONCLUSION

For the foregoing reasons, Valeo has demonstrated, by a preponderance of the evidence, that claims 1–13 of the '740 patent are unpatentable. Additionally, we grant, in part, Schaeffler's contingent motion to amend, determining, based on the record before us, that substitute claims 19 and 25 are patentable.

IV. ORDERS

After due consideration of the complete trial record, it is:

ORDERED that claims 1–13 of the '740 patent are held *unpatentable* under 35 U.S.C. § 103(a) over Sudau, Eckel, and Speckhart;

FURTHER ORDERED that Schaeffler's contingent Motion to Amend is *granted-in-part* with respect to substitute claims 19 and 25 only; and

FURTHER ORDERED, that, because this is a Final Written Decision, 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.

For PETITIONER:

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