

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

FIKE CORPORATION,
Petitioner,

v.

DONADON SAFETY DISCS AND DEVICES S.R.L.,
Patent Owner.

Case IPR2015-00341
Patent 8,674,260 B2

Before WILLIAM V. SAINDON, JAMES P. CALVE, and
TIMOTHY J. GOODSON, *Administrative Patent Judges*.

CALVE, *Administrative Patent Judge*.

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

I. BACKGROUND

Petitioner Fike Corporation (“Fike”) filed a Petition (Paper 5, “Pet.”) seeking *inter partes* review of claims 1–9 of U.S. Patent No. 8,674,260 B2 (Ex. 1001, “the ’260 patent”). Patent Owner Donadon Safety Discs and Devices S.R.L. (“Donadon”) did not file a Preliminary Response to the Petition. See 37 C.F.R. § 42.107. We instituted trial as to claims 1–9 (all claims) of the ’260 patent. Paper 8. Donadon did not file a Response to the Petition. 37 C.F.R. § 42.120. Fike has filed a Reply. Paper 13 (“Reply”), 1 (acknowledging lack of Response and relying on reasons stated in Petition).

Neither party requested oral argument by the December 7, 2015 due date for requesting a hearing set forth in the Scheduling Order (Paper 11). We issued an order (Paper 16) that there would be no oral argument.

We have jurisdiction under 35 U.S.C. § 6(c). This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a).

A. *Related Proceedings*

The parties inform us that they are not aware of any pending related matters. Pet. 1; Paper 6, 1.

B. *The ’260 Patent (Ex. 1001)*

The ’260 patent relates to a method of producing safety/rupture discs, having a pre-calculated breaking threshold. Ex. 1001, 1:6–8. The method laser machines non-through cuts in very thin discs without resolidifying a layer in proximity of the non-through cut. *Id.* at 2:36–3:28, 3:32–46. The devices rupture to allow pressurized fluid pressure to flow out of a plant to prevent damage to other parts of the plant. *Id.* at 1:24–30, 3:36–38. Figures 1 and 2, reproduced below, illustrate safety disc 1 with at least one score or non-through cut 2 formed in surface 1a along a working line. *Id.* at 4:33–34.

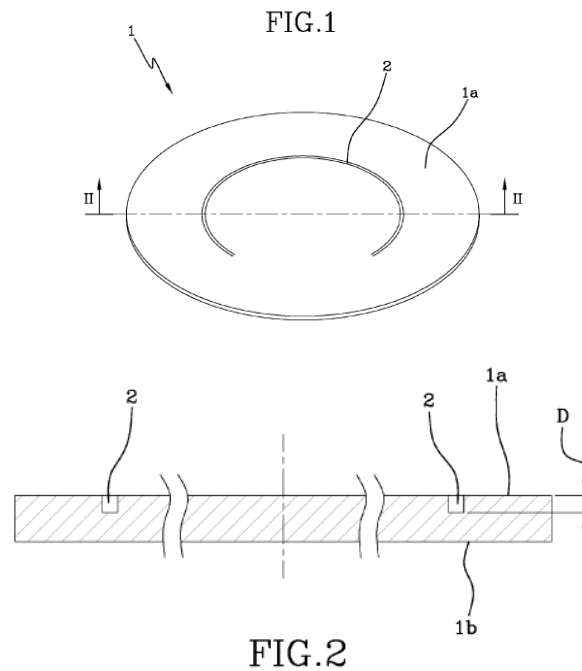


Figure 1 is a perspective view of a safety disc 1. Figure 2 is a section view of disc 1 seen in Figure 1.

Safety disc 1 is a foil element that has a very thin thickness compared with its other two dimensions. *Id.* at 4:12–15. The foil element is shown as a planar disc 1 in Figure 1, but it can have different shapes depending on the shape of the duct in which it is applied. *Id.* at 4:16–18. Disc 1 can be made of metal materials like stainless steel, nickel, aluminum, or metal alloys, and can be graphite, plastic materials, or glass-ceramic materials. *Id.* at 4:40–44.

The scores or non-through cuts 2 are obtained with a pulse laser acting directly on the surface of the foil element. *Id.* at 4:45–47. Scores are made by material removal through ablation, i.e., by raising the temperature of the material above its boiling point at a very fast rate to directly vaporize and remove the material without melting or oxidizing the surrounding regions. *Id.* at 4:48–53. Score depths for each laser pass can range between 0.005 μm and 5 μm . *Id.* at 6:1–2.

The '260 patent discloses laser wavelengths of 800–1800 nm (*id.* at 5:10–11) and 1030–1552 nm (*id.* at 5:22–23). The '260 patent discloses laser pulse durations of 10–900 femtoseconds, and preferably 500–800 femtoseconds (*id.* at 5:35–39), 0.9–500 picoseconds, and preferably 1–50 picoseconds (*id.* at 5:28–31), and less than 10 nanoseconds, preferably less than 1 nanosecond (*id.* at 5:11–13). The '260 patent discloses various pulse repetition rates, speeds of motion between the laser beam and foil element, pulse energy values, wavelengths, and pulse durations. *Id.* at 5:44–8:67.

During prosecution, one of the inventors identified the critical feature of the invention as pulse duration of 10–900 femtoseconds, and stated that other laser parameters can be selected for acceptable results. Ex. 1002, 115–16, ¶¶ 12–17; Pet. 11, 21–22. Parent application 12/663,622, from which the '260 patent claims priority as a continuation-in-part, discloses pulse durations of 10–80 ns. Ex. 1003, 18 (specification), 23 (claim 8); Pet. 13.

C. Illustrative Claim

Claim 1, the sole independent claim, is reproduced below.

1. A method for production of a safety/rupture disc, comprising the steps of:

providing a foil element of metal material having a thickness within the range of between 15 μm and 800 μm ;

selecting a wavelength for a laser beam of a pulse laser within a range of between 800 nanometers and 1800 nanometers;

selecting a pulse repetition rate for the laser beam within a range of between 15 KHz and 800 KHz;

selecting a pulse duration for the laser beam within a range of between 10 femtoseconds and 900 femtoseconds and ablating at least one non-through cut in the metal material of the foil element by directly applying said laser beam to the foil element to remove part of the metal material from the foil element thereby obtaining the safety/rupture disc.

D. Prior Art

Fike relies on the following references:

Reference	Patent/Printed Publication	Date	Exhibit
Modena	WO 2008/155,783 A1	Dec. 24, 2008	1004
Perry	US 6,621,040 B1	Sept. 16, 2003	1005
Gillespie	<i>Femtosecond Laser Manufacturing Experiments</i> , Honeywell Federal Manufacturing and Technologies	Jan. 2000	1006
Pham	<i>Laser Milling</i> , Proc. Inst. Mech. Engrs, Vol. 216, Part B: Journal of Engineering Manufacture, © IMechE 2002	Mar. 1, 2002	1007
Mozley	US 2010/0140238 A1	June 10, 2010	1008
Muddiman	CA 1,304,650	July 7, 1992	1009

E. Asserted Grounds of Unpatentability

Fike challenges the patentability of claims 1–9 of the '260 patent on the following grounds:

References	Basis	Claim(s) Challenged
Modena, Perry	§ 103	1–8
Modena, Perry, and either Mozley or Muddiman	§ 103	9
Gillespie, Perry	§ 103	1–7
Gillespie, Perry, and either Mozley or Muddiman	§ 103	8, 9
Mozley, Perry	§ 103	1–9
Gillespie, Pham	§ 103	1–7
Gillespie, Pham, and either Mozley or Muddiman	§ 103	8, 9

II. ANALYSIS

A. Claim Interpretation

In an *inter partes* review, claims of 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); *In re Cuozzo Speed Techs., LLC*, 793 F.3d 1268, 1279 (Fed. Cir. 2015), *cert. granted sub nom. Cuozzo Speed Techs. LLC v. Lee*, 84 U.S.L.W. 3218 (Jan. 15, 2016) (No. 15-446). Claim terms are given an ordinary and customary meaning as 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). “[C]laim terms need only be construed ‘to the extent necessary to resolve the controversy.’” *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011); *see also EMI Grp. N. Am., Inc. v. Intel Corp.*, 157 F.3d 887, 895 (Fed. Cir. 1998) (the construction of a claim term was “irrelevant” because it did not affect the underlying controversy between the parties).

No terms require express construction to reach our final decision.

B. Asserted Grounds of Unpatentability

1. Claims 1–8 – Obviousness Over Modena and Perry

a. Overview of Modena (*Ex. 1004*)

Modena discloses a method of producing safety/rupture discs with a pre-calculated breaking threshold. *Ex. 1004*, 1:6–8. Cuts 5 are formed on metallic surface 2a of plate 2 by applying laser beam 8 directly onto metallic surface 2a to remove portions by ablation, or by melting and sublimation. *Id.* at 12:3–8, Fig. 1. Laser beam 8 has a wavelength between 1000 nm and 1100 nm and preferably 1064 nm. *Id.* at 13:1–3. Modena discloses a laser pulse duration between 10 ns and 80 ns. *Id.* at 13:7–8.

Fike asserts that Modena is prior art under 35 U.S.C. § 102(b) because it was published on December 24, 2008, over two years before the July 21, 2011, filing date of the application that issued as the '260 patent. Pet. 14. Fike asserts that the challenged claims recite “a pulse duration for the laser beam within a range of between 10 femtoseconds and 900 femtoseconds.” *Id.* Fike also asserts that PCT/IT2007/000433, which was filed on June 18, 2007, and from which the '260 patent claims priority as a continuation-in-part, discloses a pulse duration of 10–80 nanoseconds. *Id.* (citing Ex. 1003, 11, 18, 19). Donadon has not disputed these facts, which are considered to be admitted. See 37 C.F.R. §§ 42.23(a), 42.120(a). Thus, Fike contends that none of the challenged claims is entitled to a priority date before Modena’s publication. Pet. 14. Donadon has not carried its burden of production to show entitlement to an earlier priority date. See *Research Corp. Techs., Inc. v. Microsoft Corp.*, 627 F.3d 859, 870–71 (Fed. Cir. 2010) (patentee has the burden to show entitlement to a priority date when relying on a priority date to antedate a reference). Thus, we conclude Modena is § 102(b) prior art.

b. Overview of Perry (Ex. 1005)

Perry discloses high precision laser cutting or machining of metals and alloys using ultrashort laser pulses that leave negligible heat affected zones, and no modification of material surrounding the area of the cut (kerf). Ex. 1005, 1:18–20, 2:39–43. The method uses laser pulses of a wavelength of 780–1000 nm and pulse durations of 10 femtosecond to 100 picoseconds delivered at a repetition rate of 0.1 kHz to over 100 kHz. *Id.* at 2:44–46. The short laser pulses (< 100 picoseconds) remove very small amounts of material (0.01–1 micron) per laser pulse with very small transport of energy by shock or thermal conduction away from the area of interest; material to a

depth beyond 1 micron (less than 0.1 microns in some metals) from the interaction point is unaffected by removal of the material. *Id.* at 2:54–59, 4:39–47. Perry also discloses use of the method for disk patterning and non-through cuts in metal material. *See id.* at 4:9–11, 7:34–38, Pet. 15–16.

Cut quality and cut efficiency are significantly higher with ultrashort pulses than with conventional longer pulse lasers. Ex. 1005, 3:8–10. Laser pulses will encounter solid surface for the duration of the pulse and deposit energy into solid density material to raise a depth to a temperature far above the boiling point (typically above the ionization point), so the depth that is raised above its boiling point vaporizes and is removed completely from the kerf without redeposition on the walls. *Id.* at 3:15–29.

c. Analysis

Fike asserts that claims 1–8 are unpatentable under 35 U.S.C. § 103 over Modena and Perry. Pet 25–33. Regarding claim 1, Fike asserts that Modena discloses a method of producing safety/rupture discs (Ex. 1004, 1:6–7) by providing metal foil 2 with an average thickness of 400 μm (*id.* at 15:29–31 (0.4 mm)), laser beam wavelength of 1000–1100 nm (*id.* at 13:1–3), pulse repetition rate of 40 kHz (*id.* at 15:31–33), and pulse duration of 10–80 nanoseconds (*id.* at 13:7–8) to ablate a non-through cut, but not the claimed pulse duration of 10–900 femtoseconds. Pet. 13–14, 25–29.

Fike contends that Perry discloses a high precision machining method for disk patterning and non-through cuts in metals such as 140 μm stainless steel (Ex. 1005, Abstract, 4:5–11, 7:15–18) using laser wavelengths of 780 nm to over 1000 nm delivered at a high repetition rate of 0.1 kHz to over 100 kHz (*id.* at 2:44–46, 7:57–63), and a pulse duration of 10 femtoseconds to 100 picoseconds (*id.* at 2:44–46) to ablate material without affecting other

material beyond 1 micron from the cut (*id.* at 4:39–50, 7:34–38). Pet. 15–16, 25–29. Fike contends that Perry is from the same field as the '260 patent and solves the same problem of reducing heat affected zones. *Id.* at 23, 24; see *In re Bigio*, 381 F.3d 1320, 1325 (Fed. Cir. 2004).

Fike asserts that it would have been obvious to use femtosecond pulse duration lasers, as taught by Perry, in the method of Modena because Perry teaches laser pulse durations between 10 femtoseconds and 100 picoseconds produce high machining speed, precision cuts, and negligible heat affected zones that do not alter characteristics of material surrounding the kerf. *Id.* at 15, 22. Fike asserts that Perry teaches femtosecond laser pulse durations to control the depth, length, and width of laser milled features for cold laser cuts without heat transfer to material adjacent the ablation site. *Id.* at 22–24. Fike's rationale is supported by rational underpinnings and is persuasive.

Fike contends that Modena discloses speed of relative motion between the laser beam and foil (claim 2) in a range of 0.07 m/s and 50 m/s (claim 3), selecting an energy value for each pulse (claim 4), score depth between 0.005 μm and 5 μm (claim 6), planar disc (claim 7), and dome-shaped foil (claim 8). *Id.* at 13–14, 29–33.

Fike contends that Perry discloses energy values for each laser pulse of 1 microjoule to over 5 millijoules (claims 4 and 5), score depth of 0.01–1 micron (claim 6), and planar disk patterning (claim 7). *Id.* at 15–16, 30–32.

Fike also cites the Declaration of Dr. Michael Bass, Ph.D (Ex. 1010, “the Bass Declaration”) to support its contentions. *Id.* at 25–33. Dr. Bass testifies that Modena and Perry teach or suggest the limitations of claims 1–8. Ex. 1010 ¶¶ 32–41, 60–65. For claim 1, Dr. Bass testifies that Modena describes a method for producing disc-shaped safety/rupture discs from

metal plates of 0.4 mm thickness using a laser beam wavelength between 1000 nm and 1100 nm for pulse durations of 10–80 ns at a frequency of 40 kHz to form non-through cuts or score lines and remove between 1 and 50 μm of disc material by ablation. *Id.* ¶¶ 34, 61.

Dr. Bass testifies that Perry teaches high precision machining of metals and alloys for disk patterning using laser pulses of 10 femtoseconds to 100 picoseconds to convert a workpiece region from solid state to plasma state so quickly there is insufficient time for significant heat transfer to occur beyond the material removed, thereby eliminating heat affected zones and maintaining the metal's grain structure, alloy composition, material strength, and hardness. *Id.* ¶¶ 37–40. Dr. Bass testifies that Perry teaches the use of femtosecond laser pulses for *cold* ablation with no melt zone, microcracks, surface debris, or shock zone, and with minimal heat transfer to surrounding material, so there are no unexpected results from using femtosecond pulse durations to ablate non-through cuts in metal foil burst discs, particularly where Mr. Modena states that other parameters can be selected and balanced as desired. *Id.* ¶¶ 67–69. The Bass Declaration further states that a skilled artisan could combine the teachings of Modena and Perry to arrive at claims 1–8. *Id.* ¶¶ 70–74, 77.

Regarding claims 2–8, Dr. Bass testifies that Modena discloses speeds between the laser beam and disc surface of 100 and 300 mm/s (claims 2 and 3), score depths between 0.005 μm and 5 μm (claim 6), a planar disc-shaped configuration (claim 7), and a dome-shaped element (claim 8). *Id.* ¶¶ 33–34, 62–65. Dr. Bass testifies that Perry discloses energy pulses of 1 microjoule to over 5 millijoules (claims 4 and 5), score depths of 0.01–1 micron per pulse (claim 6), and planar disc patterning (claim 7). *Id.* ¶¶ 37–39, 63–65.

Fike asserts that the claims are obvious because they combine prior art elements according to known methods to yield predictable results and use known techniques to improve similar devices and methods in the same way, and the prior art provides teachings, suggestions, and motivation to combine the prior art teachings to arrive at the claimed invention. Pet. 21. Fike cites the Declaration of Mario Modena, one of the inventors who submitted a declaration during prosecution of the application that issued as the '260 patent. *Id.* at 11–12. Mr. Modena testified that the principal feature of the invention is a pulse duration of 10–900 femtoseconds, and other parameters, such as wavelength, power, frequency, scanning speed, number of passes, type of material, and desired burst pressure, can be selected and balanced to achieve acceptable results. *Id.* (citing Ex. 1002, 115–17 (¶¶ 12–15)). Fike's rationale is persuasive and supported by rational underpinning.

Dr. Bass also testifies that in view of the prior art's disclosure of the claimed parameters in Modena and Perry as set forth in his Declaration (e.g., Ex. 1010 ¶¶ 32–41, 60–65), a skilled artisan would have been able to make the claimed methods by manipulating these parameters as disclosed in the prior art (*id.* ¶ 68). Dr. Bass testifies that Mr. Modena acknowledges that the claimed parameters (with the exception of the claimed femtosecond pulse duration) were not critical features of the claimed methods and “could be selected and balanced to achieve acceptable results.” *Id.* ¶ 68. Dr. Bass testifies that the prior art taught the advantages of femtosecond laser pulses to score thin foils with non-through cuts to make thin foil safety discs so this claimed feature is not new and does not produce unexpected results, contrary to the statement of Mr. Modena. *Id.* ¶¶ 68–69.

Regarding claim 1, Dr. Bass testifies that the prior art teaches ranges within or overlapping the claimed ranges for material thickness, wavelength, pulse repetition rate, and pulse duration, and a skilled artisan could have combined teachings of Modena and Perry to achieve that invention. *Id.* ¶ 70.

Regarding claims 2 and 3, Dr. Bass testifies that skilled artisans would understand that relative motion must be imparted between a laser beam and foil work piece to produce lines of weakness based on teachings in Modena of such claimed speed ranges. *Id.* ¶¶ 34, 62, 71. Dr. Bass also testifies that the prior art such as Modena and Perry teach energy values per pulse in the claimed range of 1–250 microjoules, so a skilled artisan would know how to select a pulse energy value within the claimed range, as recited in claims 4 and 5. *Id.* ¶¶ 63, 72. Dr. Bass further testifies that the Modena and Perry teach score depths in the claimed range and skilled artisans would know how to adjust laser parameters to achieve the score depth with the range recited in claim 6. *Id.* ¶¶ 64, 73. Finally, Dr. Bass testifies that skilled artisans would know that foil safety elements come in the shapes recited in claims 7 and 8 based on teachings of Modena and Perry. *Id.* ¶¶ 65, 74.

Whether an invention would have been obvious is a legal question based on underlying findings of fact, including (1) the scope and content of the prior art; (2) the level of ordinary skill in the prior art; (3) the differences between the claimed invention and the prior art; and (4) objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966); *In re Gartside*, 203 F.3d 1305, 1319 (Fed. Cir. 2000). Relevant secondary considerations include commercial success, long-felt but unsolved needs, failure of others, and unexpected results. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007); *In re Soni*, 54 F.3d 746, 750 (Fed. Cir. 1995).

Fike and Dr. Bass have set forth where Modena and Perry disclose each claimed feature including laser parameters that fall within or overlap the claimed ranges and render those ranges obvious. Fike asserts Modena and Perry disclose respective foil thicknesses of 400 μm and 140 microns (μm) that fall in the claimed range of 15 μm to 800 μm . Pet. 26. Fike also asserts that Modena and Perry disclose laser wavelengths of 1000–1100 nm and 780–1000 nm, respectively, that overlap the claimed range of 800–1800 nm. *Id.* at 27. Fike also asserts that Modena and Perry disclose pulse rates of 40 kHz and 0.1 to over 100 kHz, respectively, that fall within or overlap the claimed range of 15–800 kHz. *Id.* Fike further asserts that Perry discloses laser pulse durations of 10 femtoseconds to 100 picoseconds (i.e., 10–100,000 femtoseconds) that encompass the claimed range of 10–900 femtoseconds. *Id.* at 28. For claim 3, Fike contends that Modena discloses relative motion speed of 100–300 mm/s (i.e., 0.1–0.3 m/s) that falls within the claimed range of 0.07–50 m/s. *Id.* at 28–29. For claim 5, Fike contends that Perry discloses an energy value per laser beam pulse of 1 microjoule to over 5 millijoules (i.e., 1–5,000 microjoules) that encompasses the claimed range of 1–250 microjoules. *Id.* at 30–31. For claim 6, Fike contends that Modena and Perry disclose respective score depths of 1–50 μm and 0.01–1 μm , that encompass or fall in the claimed range of 0.005–5 μm . *Id.* at 31.

“Where a claimed range overlaps a range disclosed in the prior art, there is a presumption of obviousness.”¹ *Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1311 (Fed. Cir. 2006); *see also In re Peterson*, 315 F.3d

¹ This presumption does not alter the fact that in an *inter partes* review, the ultimate burden of persuasion of unpatentability remains on the Petitioner.

1325, 1329 (Fed. Cir. 2003). Even a slight overlap in range can establish obviousness. *E.g.*, *In re Woodruff*, 919 F.2d 1575, 1578 (CCPA 1990) (a claimed invention was rendered obvious by a prior art reference whose disclosed range (“about 1-5%” carbon monoxide) abutted the claimed range (“more than 5% to about 25%” carbon monoxide)); *In re Malagari*, 499 F.2d 1297, 1303 (CCPA 1974) (a claimed invention was rendered *prima facie* obvious by a prior art reference whose disclosed range (0.020–0.035% carbon) overlapped the claimed range (0.030–0.070% carbon)); *see also In re Geisler*, 116 F.3d 1465, 1469 (Fed. Cir. 1997) (a claimed invention was rendered *prima facie* obvious by a prior art reference whose disclosed range (50–100 Angstroms) overlapped the claimed range (100–600 Angstroms)). A *prima facie* case of obviousness may exist when a claimed range and the prior art range do not overlap but are close enough to be recognized by a skilled artisan to have the same properties. *Titanium Metals Corp. v. Banner*, 778 F. 2d 775, 776, 783 (Fed. Cir. 1985) (a claim directed to an alloy containing “0.8% nickel, 0.3% molybdenum, up to 0.1% maximum iron, balance titanium” were obvious in view of prior art alloys containing 0.25% Mo and 0.75% Ni, and 0.31% Mo and 0.94% Ni absent evidence of different properties). Selecting a narrow range from within a slightly larger range in the prior art is no less obvious than identifying a range that simply overlaps a disclosed range. *Peterson*, 315 F.3d at 1329–30.

Donadon has not provided any evidence of criticality or unexpected results of the claimed ranges other than the femtosecond pulse duration. In fact, Mr. Modena stated during prosecution that the claimed ranges and laser parameters were not critical and could be selected and balanced to achieve acceptable results. Ex. 1002, 116 ¶ 14. 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 ranges is an optimum combination of percentages. *Peterson*, 315 F.3d at 1330; *In re Boesch*, 617 F.2d 272, 276 (CCPA 1980) (the “discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art.”). As discussed above, the prior art recognizes each of the claimed parameters as result effective variables for laser scoring. Mr. Modena’s Declaration confirms this fact. Therefore, Fike’s contentions are persuasive.

Regarding the claimed pulse duration of 10–900 femtoseconds that Mr. Modena stated was critical to the invention, Perry discloses a range of 10–100,000 femtoseconds, which completely overlaps the claimed range. Perry teaches that this range produces cold laser ablation, the same results Mr. Modena describes as unexpected. Ex. 1005, 2:39–67; Ex. 1002 115–17 ¶¶ 12–17. *E.g.*, *Geisler*, 116 F.3d at 1469–70; *Peterson*, 315 F.3d at 1330 (the “same standard applies when, as here, the applicant seeks to optimize certain variables by selecting narrow ranges from broader ranges disclosed in the prior art”); *In re Wertheim*, 541 F.2d 257, 267 (CCPA 1976) (noting that “ranges which overlap or lie inside ranges disclosed by the prior art may be patentable if the applicant can show criticality in the claimed range by evidence of unexpected results”); *see also ClearValue, Inc. v. Pearl River Polymers, Inc.*, 668 F.3d 1340, 1345 (Fed. Cir. 2012) (prior art range of 150 ppm or less was genus disclosure that anticipated claimed range of less than or equal to 50 ppm where there was no considerable difference in properties between the claimed range and prior art range). The overlap itself provides sufficient motivation to optimize the ranges. *See In re Applied Materials, Inc.*, 692 F.3d 1289, 1295 (Fed. Cir. 2012).

In addition, Perry describes the application of 120 femtosecond laser pulses to a 140 μm thick stainless steel foil element at a high repetition rate and laser wavelengths that overlap the claimed ranges of those elements in claim 1. Ex. 1005, 7:11–33, 7:57–8:5. Perry discloses that “*central to the present invention* is that the focusing conditions must achieve the threshold irradiance to initiate plasma formation. Typical values are approximately 10^{14} W/cm^2 for 100 fsec pulses.” *Id.* at 7:11–14 (emphasis added). Thus, Perry recognizes that very short duration laser pulse durations, e.g., 100 and 120 femtosecond pulses, are critical to initiating plasma formation at the kerf to remove material through cold laser ablation, as Dr. Bass explains. *See* Ex. 1010 ¶ 39. Perry teaches the results that Mr. Modena asserts are unexpected for the claimed method, i.e., “cold” laser ablation. Perry’s disclosure of pulse durations of 100 and 120 femtoseconds, which fall within the claimed range of 10–900 femtoseconds, would anticipate the claimed range and thus this disclosure also renders the claimed range obvious. *See Titanium Metals*, 778 F. 2d at 781, 782 (a titanium base alloy containing 0.25% by weight Mo and 0.75% Ni fell squarely within the ranges of 0.2–0.4% Mo and 0.6–0.9% Ni of claims 1 and 2 and anticipated those claims; “It is also an elementary principle of patent law that when, as by a recitation of ranges or otherwise, a claim covers several compositions, the claim is “anticipated” if *one* of them is in the prior art.”); *ClearValue*, 668 F.3d at 1345 (noting that if the prior art example had been at 50 ppm (rather than a range of 150 ppm or less), there would be no dispute Hassick anticipates a claimed range of 50 ppm or less).

Nor has Donadon provided any evidence or contentions of teaching away from the proposed combination of Modena or Perry.

In view of Donadon's failure to oppose the contentions and evidence presented in Fike's Petition and related papers (37 C.F.R. § 42.120(a)), we consider all of the foregoing allegations of material fact in the Petition and related papers to be admitted. *See* 37 C.F.R. § 42.23(a). We determine that Fike has established by a preponderance of evidence that claims 1–8 are unpatentable under 35 U.S.C. § 103(a) over Modena and Perry.

2. Claim 9 – Obviousness Over Modena, Perry, and Mozley/Muddiman
a. Overview of Mozley (Ex. 1008)

Like the '260 patent, Mozley discloses laser scoring of rupture discs to remove material from the disc. Ex. 1008 ¶¶ 2, 12. Mozley discloses rupture discs as dome-shaped and substantially flat discs. *Id.* ¶ 3. Mozley discloses laser scoring sheet material of less than 2 mm thickness. *Id.* ¶ 60.

b. Overview of Muddiman (Ex. 1009)

Like the '260 patent, Muddiman discloses laser scoring of rupture discs. Ex. 1009, 3:1–4. Muddiman exposes preselected areas of a disc to a laser beam to remove a given depth of metal and create a line of weakness. *Id.* at 3:29–36. Muddiman uses this method for conventional or reverse buckling compression loaded discs. *Id.* at 4:1–6. Muddiman also discloses sheet metal discs of 1/10,000th of an inch thickness. *Id.* at 5:1–4.

c. Analysis

Fike asserts that claim 9, which recites a foil thickness of 20–100 µm, would have been obvious over Modena and Perry in view of either Mozley or Muddiman. Pet. 33–34. Fike asserts that Mozley discloses laser scoring of rupture discs of less than 2 mm thickness, which overlaps the claimed range. *Id.* at 18–19, 33–34. Fike asserts that Muddiman scores rupture discs in material of 1/10,000th of an inch thickness (2.54 µm). *Id.* at 19–20, 34.

Fike also asserts that Mozley is prior art under 35 U.S.C. § 102(b) because it was published on June 10, 2010, more than one year prior to the July 21, 2011, filing date of the '260 patent. Pet. 18–19. Fike asserts that Muddiman is prior art under 35 U.S.C. § 102(b) because it was issued on July 7, 1992, more than one year before the July 21, 2011. Both references are from the same field of laser scoring of rupture discs.

Dr. Bass testifies that the claimed foil thickness would have been obvious over Mozley's foil thickness of less than 2 mm, and Muddiman's ultra-thin thickness of 2.54 μm . Ex. 1010 ¶¶ 53–59, 66. Dr. Bass testifies that Mozley discloses pulsed YAG lasers with wavelengths of 355 nm–1064 nm to ablate score lines in rupture discs by removing material as vapor without melting or oxidizing material adjacent to material being removed. *Id.* ¶ 54. Dr. Bass testifies that Mozley teaches laser scoring to remove material in very small amounts and the depth of scoring can be controlled in an order of magnitude of microns, thereby enabling the micro-machining of ultra-thin burst discs. *Id.* ¶¶ 54–55. Dr. Bass also testifies that the claimed thickness of 20–100 μm would have been obvious to a skilled artisan who knows that score depths of 0.005 μm to 5 μm are achievable, as taught by Modena, because laser beams can make non-through cuts to any foil with a thickness exceeding the score depth, and Mozley's foil thicknesses overlap the claimed range. *See id.* ¶¶ 64, 66, 75. Fike's contention that claim 9 is an obvious combination of known elements to yield known results (Pet. 21) is supported by rational underpinnings and is persuasive.

Mozley's thickness of less than 2 mm encompasses claim 9's range of 20 μm – 100 μm , especially in view of Muddiman's ultra-thin thickness of 2.54 μm . *Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317,

1322 (Fed. Cir. 2004) (claim was obvious when multiple prior art references disclosed a range of values that encompassed the claimed value). We have no evidence of the criticality of the claimed range, unexpected results from the claimed range, or properties of the claimed range that differ from the prior art range. In view of Donadon's failure to oppose these contentions and evidence and (37 C.F.R. § 42.120(a)), the foregoing allegations of material fact are considered to be admitted. See 37 C.F.R. § 42.23(a).

In *In re Huang*, 100 F.3d 135 (Fed. Cir. 1996), the prior art taught a shock-absorbing grip with a polyurethane layer and a textile layer, and the Huang grip increased the thickness of the polyurethane layer relative to the textile layer to increase the shock-absorbing qualities, as recognized by the prior art. *Huang*, 100 F.3d at 139. The court held that Huang's contribution was specific claimed thickness ratios and these ratios were obvious unless they produced a new and unexpected result different in kind and not merely in degree from the prior art. *Id.* ("even though [a] modification results in great improvement and utility over the prior art, it may still not be patentable if the modification was within the capabilities of one skilled in the art, unless the claimed ranges 'produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art.'"). Here, the prior art teaches laser scoring of ultra-thin discs, and there is no evidence of unexpected results from scoring discs in the claimed thickness range as compared to ultra-thin discs of Muddiman or discs in Mozley's disclosed range, which encompasses the claimed thickness range.

For the foregoing reasons, Fike has established by a preponderance of evidence that claim 9 is unpatentable under 35 U.S.C. § 103(a) over Modena and Perry, further in view of Mozley or Muddiman.

3. *Claims 1–7 – Obviousness Over Gillespie and Perry*
a. *Overview of Gillespie (Ex. 1006)*

Like the '260 patent, Gillespie discloses the use of femtosecond lasers to score burst discs. Ex. 1006, 5. Gillespie discloses that energy absorption of ultrashort laser pulses occurs so quickly that the material is ablated with almost no heat transfer to the surrounding material, resulting in a cold laser cut, whereas pulses longer than 10 picoseconds first melt, then vaporize, the material with significant heat transfer to material outside the cutting region. *Id.* at 6. Gillespie discloses a pulse length of 125 femtoseconds, wavelength of 0.825 μm , pulse rate of 1 kHz, and energy of 5 mJ/pulse. *Id.*

b. *Analysis*

Fike asserts that claims 1–7 are unpatentable under 35 U.S.C. § 103(a) over Gillespie and Perry. Pet. 34–41. Regarding claim 1, Fike asserts that Gillespie uses a femtosecond laser that produces exceptionally high quality metallography for scoring stainless steel burst discs of 0.007 inch thickness (177.8 μm), laser wavelengths of 0.825 μm (825 nm) and 800 nm, pulse length of 125 fs, and pulse width of 150 fs to cut a channel in a disc of about 0.003 inches without breaking through, and ablate the material with virtually no heat transfer to surrounding material. *Id.* at 34–38. Fike relies on Perry to teach the same features of claim 1 as in the first ground of unpatentability discussed above including disk patterning of 140 micron stainless steel using laser wavelengths of 780 to over 1000 nm at repetition rates of 0.1 kHz to over 100 kHz and pulse durations of 10 femtoseconds to 100 picoseconds for non-through cuts of 50 microns in 1 mm thick steel. *Id.* at 25–29, 34–38. Fike asserts Gillespie is prior art under 35 U.S.C. § 102(b) because it was published in 2000 for public release with unlimited distribution. *Id.* at 16.

Regarding claims 2 and 3, Fike asserts that Gillespie discloses moving the laser lens at 1 mm/sec (0.001 m/s). *Id.* at 38. Regarding claims 4 and 5, Fike asserts Gillespie discloses an energy value per pulse of 5 millijoules/pulse (5000 microjoules). *Id.* at 38–39. Regarding claim 6, Fike asserts that Gillespie discloses average score depths per pass of 1.697 μm on flat burst discs. *Id.* at 39–40. Fike asserts that Perry discloses energy values per pulse of 1 microjoule to over 5 millijoules (claims 4 and 5), score depth of 0.01–1 micron per pulse (claim 6), and disk patterning (claim 7). *Id.* at 38–41.

Fike cites the Bass Declaration in support of its contentions. *Id.* at 34–41. Dr. Bass testifies that Gillespie describes the results of femtosecond laser manufacturing experiments for making flat burst discs by pulsing a laser with wavelengths of .825 μm (825 nm) or 800 nm at frequencies of 1 kHz for 125 and 150 femtoseconds to deliver up to 5 millijoules per pulse to form score lines and non-through cuts and ablate channels of 0.003 inches in a 0.007 inch disc. Ex. 1010 ¶¶ 42–44, 61. Dr. Bass testifies that Gillespie also teaches relative movement between the burst disk and laser of 1 mm/sec (claims 2 and 3) at 5 millijoules per pulse (claims 4 and 5) for score depths per pass of 0.005–5 μm (average score depth of 1.697 μm in a test involving 36 laser passes) on flat discs (claims 6 and 7). *Id.* ¶¶ 44–45, 62–65.

Dr. Bass testifies Perry teaches high precision machining of metals and alloys for disk patterning using laser pulses of 10 femtoseconds to 100 picoseconds to convert a workpiece region from solid state to plasma state so quickly there is insufficient time for significant heat transfer to occur beyond the material removed, thereby eliminating heat affected zones and maintaining the metal's grain structure, alloy composition, material strength, and hardness. *Id.* ¶¶ 37–40. Dr. Bass testifies that Perry teaches the use of

femtosecond laser pulses for cold ablation with no melt zone, microcracks, surface debris, or shock zone, and with minimal heat transfer to surrounding material, so there are no unexpected results from using femtosecond pulse durations to ablate non-through cuts in foil burst discs, particularly where Mr. Modena states that other parameters can be selected and balanced as desired. *Id.* ¶¶ 67–69. Dr. Bass testifies that a skilled artisan could combine teachings of Gillespie and Perry to arrive at claim 1. *Id.* ¶¶ 70–74, 77.

Fike asserts that the features of claims 1–7 were well known in the art and merely combine prior art elements according to known methods to yield predictable results, use known techniques to improve similar devices and methods in the same way, and the prior art would teach, suggest, or motivate a skilled artisan to modify or combine the references to arrive at the claimed subject matter. Pet. 21. Fike’s contentions are supported by rational underpinnings in view of the above and are persuasive.

Fike argues that Mr. Modena, one of the inventors, declared during prosecution of the application that issued as the ’260 patent that the critical parameter for the invention to work was a laser pulse duration of 10–900 femtoseconds and other parameters such as wavelength, power, frequency, scanning speed, number of passes, type of material, and burst pressure can be selected and balanced to achieve acceptable results. *Id.* at 21–22. Fike contends that Mr. Modena’s statement is a binding admission that laser parameters can be changed without any undue experimentation by a skilled artisan and should be given strong consideration in the obviousness analysis. *Id.* at 22 (citing *Constant v. Advanced Micro-Devices, Inc.*, 848 F.2d 1560, 1569 (Fed. Cir. 1988)). Fike further asserts that the prior art like Gillespie discloses femtosecond laser pulses for durations of 125 femtoseconds, which

falls in the claimed range to score burst discs by making “cold” laser cuts with virtually no heat transfer to the surrounding material. *Id.* at 22–23.

Fike also asserts that the prior art solves the problem to be solved by the '260 patent of reducing heat affected zones and Gillespie does so in the field of laser milling of rupture discs with femtosecond laser pulses within the claimed pulse duration range, so it would have been obvious to combine Gillespie and Perry as they come from the same field of art and focus on the same problem. *Id.* at 23–24. Fike contends that where, as here, there is a design need to solve a problem and a finite number of identified, predictable solutions, a skilled artisan would have good reason to pursue known options and if this leads to the anticipated success, the result is likely the product of ordinary skill and common sense rather than innovation. *Id.* at 24. Fike's contentions are supported by rational underpinnings and persuasive.

Regarding claim 3's recital of a scanning speed of between 0.07 m/s and 50 m/s, Fike argues that it would have been a matter of common sense under *KSR* to select and balance such a laser parameter as scanning speed in view of Mr. Modena's Declaration that such parameter can be selected and balanced for acceptable results. *Id.* at 24–25, 38; Ex. 1002, 116, ¶ 14.

Dr. Bass testifies that Gillespie's teachings are relevant to determining the obviousness of the challenged claims because Gillespie discloses pulsing a laser for 125 femtoseconds to score non-through cuts on stainless steel to form burst discs and discloses that a train of femtosecond laser pulses results in ablation with virtually no heat affected zones surrounding the ablation site to make a “cold” cut, whereas pulse durations of 10 picoseconds and longer result in melting, vaporization, and significant heat transfer and significant heat affected zones in the work piece. Ex. 1010 ¶¶ 46–47, 67.

Dr. Bass testifies that Perry and Gillespie thus disclose the benefits of femtosecond duration laser pulses to obtain cold laser ablation and control the depth, length, and width of laser milled features, and a skilled artisan could select and balance other parameters, as acknowledged by Mr. Modena. *Id.* ¶¶ 67–69; *see* Pet. 21–24. The Bass Declaration also states that a skilled artisan could combine the teachings of Gillespie and Perry to arrive at the invention of claims 1–7. Ex. 1010 ¶¶ 70–74, 76, 77.

Fike and Dr. Bass have set forth where Gillespie and Perry disclose values and ranges of parameters that are within or overlap claimed ranges. Fike asserts Gillespie and Perry disclose a foil thickness of 177.8 μm and 140 microns (μm), respectively, that fall in the claimed range of 15 μm to 800 μm . Pet. 35. Fike asserts that Gillespie and Perry also disclose laser wavelengths of 800 nm/825 nm and 780–1000 nm, respectively, that are within or overlap the claimed range of 800–1800 nm. *Id.* at 35–36. Fike asserts that Perry disclose pulse rates of 0.1 to over 100 kHz that overlaps the claimed range of 15–800 kHz. *Id.* at 36. Fike asserts that Gillespie and Perry disclose respective laser pulse durations of 125 femtoseconds/150 femtoseconds and 10 femtoseconds to 100 picoseconds (i.e., 10–100,000 femtoseconds) that are within or encompass the claimed range of 10–900 femtoseconds. *Id.* at 36–38.

Regarding claims 2 and 3, Fike contends Gillespie discloses relative motion between the laser beam and foil of 1 mm/s (i.e., 0.001 m/s) that is near an endpoint of the claimed range of 0.07–50 m/s and renders that range obvious in view of Mr. Modena’s Declaration that parameters such as scanning speed can be selected and balanced to achieve acceptable results. *Id.* at 38. For claim 4, Fike asserts that Perry and Gillespie select an energy

value for each laser beam pulse, as claimed. *Id.* at 38–39. For claim 5, Fike asserts that Perry teaches an energy value per pulse of 1 microjoule to over 5000 microjoules, and this range overlaps the claimed range of 1–250 microjoules. *Id.* at 39. For claim 6, Fike contends Gillespie and Perry disclose score depths of 1.697 μm (average scope depth from Table 6) and 0.01–1 μm , respectively, that fall within or overlap the claimed range of 0.005–5 μm . *Id.* at 39–40. Regarding claim 7, Fike asserts that Gillespie discloses laser machining on flat burst discs and Perry discloses use of its method for disk patterning. *Id.* at 40–41.

Donadon has not provided any evidence of criticality or unexpected results of the claimed ranges other than the femtosecond pulse duration. In fact, Mr. Modena stated during prosecution that the claimed ranges and laser parameters were not critical and could be selected and balanced to achieve acceptable results. Ex. 1002, 116 ¶ 14. Thus, the normal desire of scientists or artisans to improve upon what is already known provides the motivation to determine where in a disclosed set of ranges is an optimum combination of percentages. *Peterson*, 315 F.3d at 1330; *Boesch*, 617 F.2d at 276 (the “discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art.”). The prior art discloses that each claimed parameter as result effective variables that can be adjusted for laser scoring. Mr. Modena’s Declaration confirms this fact.

Regarding a pulse duration of 10–900 femtoseconds that Mr. Modena stated was critical to the invention, Perry discloses a range of 10–100,000 femtoseconds that completely overlaps the claimed range. Perry teaches that this range provides cold laser ablation – the same results that Mr. Modena describes as unexpected. Ex. 1005, 2:39–67; Ex. 1002 115–17 ¶¶ 12–17.

Selecting a narrow range from within a somewhat broader range disclosed in the prior art is no less obvious than identifying a range that simply overlaps a disclosed range. *Peterson*, 315 F.3d at 1329–30. Nor has Donadon provided any evidence or contentions of teaching away from the proposed combination of Gillespie or Perry.

In addition, Gillespie teaches pulse durations of 125 femtoseconds and 150 femtoseconds that are within the claimed range of 10–900 femtoseconds and provide “cold” ablation cuts, whereas longer pulse durations create heat affected zones. Ex. 1006, 6, 11; Pet. 16–17; Ex. 1010 ¶¶ 47, 67. Perry also teaches the use of 120 femtosecond laser pulses to a 140 μm thick stainless steel foil at a high repetition rate and laser wavelengths that overlap the ranges of those elements in claim 1. Ex. 1005, 7:11–33, 7:57–8:5. Perry discloses that “*central to the present invention* is that the focusing conditions must achieve the threshold irradiance to initiate plasma formation. Typical values are approximately 10^{14} W/cm² for 100 fsec pulses.” *Id.* at 7:11–14 (emphasis added). Perry thus recognizes that very short duration laser pulse durations, e.g., 100 and 120 femtosecond pulses, initiate plasma formation at the kerf to remove material through cold laser ablation, as Dr. Bass explains. Ex. 1010 ¶ 39. Thus, Perry teaches the unexpected results of the claimed method, i.e., “cold” laser ablation, with pulse durations in the claimed range.

Gillespie’s disclosure of pulse durations of 125 and 150 femtoseconds and Perry’s disclosure of pulse durations of 100 and 120 femtoseconds that fall within the claimed range of 10–900 femtoseconds would anticipate the claimed range, and also would render that range obvious. *Titanium Metals*, 778 F. 2d at 781, 782; *ClearValue*, 668 F.3d at 1345.

Although Gillespie discloses a relative motion of 0.001 m/s that does not fall within or overlap the range of 0.07 m/s and 50 m/s recited in claim 3, nonetheless this disclosure renders obvious the claimed range where there is no evidence that the difference would result in different properties, in view of Mr. Modena's testimony that such scanning speed values can be selected and balanced to achieve acceptable results. Ex. 1002, 116 ¶ 14; see Pet. 38; *Titanium Metals*, 778 F. 2d at 783 (a *prima facie* case of obviousness may exist when a claimed range and prior art range do not overlap but are close enough to be recognized by a skilled artisan to have the same properties).

In view of Donadon's failure to oppose the contentions and evidence presented in Fike's Petition and related papers (37 C.F.R. § 42.120(a)), we consider all of Fike's foregoing allegations of material fact in the Petition and related papers to be admitted. See 37 C.F.R. § 42.23(a). Based on all of the foregoing, we determine that Fike has established by a preponderance of evidence that claims 1–7 are unpatentable under 35 U.S.C. § 103(a) over Gillespie and Perry.

4. *Claims 8 and 9 – Obviousness Over Gillespie,
Perry, and Mozley/Muddiman*

Fike asserts claims 8 and 9 are unpatentable under 35 U.S.C. § 103(a) over Gillespie, Perry, and Mozley or Muddiman. Pet. 41–42. Fike asserts that Mozley and Muddiman disclose a dome-shaped foil element, as recited in claim 8. *Id.* Fike asserts that claim 9's foil thickness of 20 µm – 100 µm is obvious because Mozley discloses laser scoring of sheet material with a thickness less than 2 mm, and Muddiman forms flat rupture discs from material that is 1/10,000th of an inch thick (2.54 µm). *Id.* at 42.

Dr. Bass testifies that Mozley and Muddiman disclose dome-shaped elements as in claim 8, and a skilled artisan would know that safety elements come in planar and dome shapes. Ex. 1010 ¶¶ 53–59, 65, 74. Dr. Bass also testifies that the claimed foil thickness would have been obvious in view of Mozley’s disclosed thickness of less than 2 mm, which covers the claimed range of 20 μm – 100 μm , and Muddiman’s disclosed ultra-thin thickness of 2.54 μm . *Id.* ¶¶ 53–59, 66. Dr. Bass testifies that a skilled artisan knowing that score depths of 0.005 μm to 5 μm are achievable, as taught by Modena, would understand that a laser beam could be applied to a foil thickness exceeding such a score depth to make a non-through cut. *Id.* ¶¶ 64, 66, 75.

Mozley’s thickness of less than 2 mm encompasses claim 9’s range of 20 μm – 100 μm , in view of Muddiman’s ultra-thin thickness of 2.54 μm . *See Iron Grip Barbell*, 392 F.3d at 1322. There is no evidence of criticality, unexpected results, or properties of the claimed range that differ from the prior art range. The ’260 patent discloses a need for rupture discs with a thickness about 20 μm and score depth about 10 μm . Ex. 1001, 3:21–23, 3:36–38. The ’260 patent discloses exemplary foil thicknesses of 150 μm (Example 1), 20 μm (Examples 2, 3), 2000 μm (Example 4), and 40 μm (Example 5) without indicating that the different thicknesses have different properties. *Id.* at 6:5–8:67; *see In re Huang*, 100 F.3d at 139.

In view of Donadon’s failure to oppose the foregoing contentions and evidence (37 C.F.R. § 42.120(a)), Fike’s allegations of material fact are considered to be admitted. *See* 37 C.F.R. § 42.23(a). Based on all of the foregoing, we determine that Fike has established by a preponderance of evidence that claims 8 and 9 are unpatentable under 35 U.S.C. § 103(a) over Modena and Perry, further in view of Mozley or Muddiman.

5. *Claims 1–9 – Obviousness over Mozley and Perry*

Fike argues that claims 1–9 are unpatentable under 35 U.S.C. § 103 over Mozley and Perry. Pet. 42–48. Fike relies on Perry to disclose the same features of claims 1 and 4–7 as in the ground of Modena and Perry. *Id.* at 25–32, 43–48. For claim 1, Fike asserts that Mozley discloses forming score lines in a metal rupture discs with lasers wavelengths between 355 nm and 1064 nm, including a wavelength of 1064 nm, by removing material through vaporization or ablation without melting or oxidizing disc material adjacent to the material being removed. *Id.* at 42–46. Fike also asserts that Mozley discloses selecting a speed of relative motion between the laser and disc (claim 2), a substantially flat shaped disc (claim 7), a dome-shaped disc (claim 8), and a foil thickness of less than 2 mm. *Id.* at 46–48.

Fike cites the Bass Declaration in support of these contentions. *Id.* at 42–48. Dr. Bass explains how Mozley and Perry teach all the limitations of claims 1–9. See Ex. 1010 ¶¶ 36–41, 53–55, 60–66. Dr. Bass testifies that Perry discloses the benefits of femtosecond duration laser pulses with the claimed range to produce “cold” ablation with negligible heat affected zones and to control more accurately the depth, length, and width of laser milled features, and a skilled artisan could have selected and balanced the other claimed parameters, as acknowledged by Mr. Modena in the prosecution history of the ’260 patent. *Id.* ¶¶ 67–69; see Pet. 21–22. Finally, Dr. Bass testifies that a skilled artisan could combine the teachings of Mozley and Perry to arrive at the invention of claims 1–9. See Ex. 1010 ¶¶ 61, 70–77.

Fike has asserted that Mozley and Perry disclose methods of claims 1–9 including laser parameters that fall within or overlap the ranges recited in those claims such as Perry’s stainless steel foil thickness of 140 μm that

falls within the claimed range of 15–800 μm , Mozley’s and Perry’s laser wavelengths of 355–1064 nm and 780–1000 nm, respectively, that overlap the claimed range of 800–1800 nm, a pulse rate of 0.1 to over 100 kHz of Perry that overlaps the claimed range of 15–800 kHz, and laser pulses of 10 femtoseconds to 100 picoseconds of Perry that overlap the claimed range of 10–900 femtoseconds, where Mozley teaches laser ablation that removes material from a rupture disc without melting or oxidizing the material adjacent the kerf. As discussed above, Perry’s overlapping values render obvious the claimed ranges in the absence of evidence of unexpected results, criticality, or teaching away. Pet. 42–46.

Fike asserts that claim 3’s speed of motion of 0.07–50 m/s would have been obvious in view of Mozley’s teaching that speed of relative motion is a parameter to be selected and Mr. Modena’s admission that scanning speed is a non-critical parameter that can be selected and balanced for acceptable results. *Id.* at 46. Fike also asserts that Perry discloses ranges that overlap the ranges recited in claims 5 and 6, and Mozley discloses a thickness range that overlaps the range recited in claim 9. *Id.* at 46–48.

Fike has presented evidence and contentions as to how Mozley and Perry teach or suggest each feature of claims 1–9. Fike has asserted with citations to record evidence that Mozley and Perry disclose ranges that overlap or fall within the claimed ranges. Pet. 42–48; Ex. 1010 ¶¶ 36–41, 53–55, 61–76. In the case of the pulse duration of 10–900 femtoseconds, which Mr. Modena states is critical to the invention (Ex. 1002, 116 ¶ 14), Fike asserts that Perry discloses the advantages of femtosecond pulses for laser milling, and examples with 120 femtosecond laser pulses on a 140 μm thick foil element. Pet. 22–23; Ex. 1010 ¶ 38. Perry discloses that “*central*

to the present invention is that the focusing conditions must achieve the threshold irradiance to initiate plasma formation. Typical values are approximately 10^{14} W/cm² for 100 fsec pulses.” Ex. 1005, 7:11–14 (emphasis added). Perry recognizes very short pulse durations, e.g., 100 and 120 femtosecond pulses, as critical to plasma formation at the kerf to remove material through cold laser ablation, as Dr. Bass explains. Ex. 1010 ¶ 39.

Overlapping prior art ranges and prior art values within the claimed ranges render the claimed ranges obvious. *E.g.*, *Geisler*, 116 F.3d at 1469–70; *Peterson*, 315 F.3d at 1330; *In re Wertheim*; *ClearValue*, 668 F.3d at 1345; *In re Applied Materials, Inc.*, 692 F.3d at 1295. Perry’s disclosure of pulse durations of 100 and 120 femtoseconds that fall within the claimed range of 10–900 femtoseconds would anticipate that range. *See Titanium Metals*, 778 F. 2d at 781, 782; *ClearValue*, 668 F.3d at 1345.

Fike asserts claims 1–9 combine prior art elements by known methods to yield predictable results, and use known techniques to improve similar devices, methods, or products in the same way, where prior art such as Perry teaches that femtosecond pulse duration lasers solve the problem of reduced heat affected zones. Pet. 21–24 (citing Ex. 1010 ¶¶ 32–66 and 67–77). In view of all the foregoing, we determine Fike’s contentions of obviousness are supported by rational underpinning.

In view of Donadon’s failure to oppose the foregoing contentions and evidence (37 C.F.R. § 42.120(a)), Fike’s allegations of material fact are considered to be admitted. *See* 37 C.F.R. § 42.23(a). Based on all of the foregoing, we determine that Fike has established by a preponderance of evidence that claims 1–9 are unpatentable under 35 U.S.C. § 103(a) over Mozley and Perry.

6. Claims 1–7 – Obviousness Over Gillespie and Pham
a. Overview of Pham (Ex. 1007)

Pham discloses laser machining techniques for making complex parts and tools. Ex. 1007, 1. Pham discloses the process as laser ablation because it removes material directly in a layer-by-layer manner. *Id.* This process delivers laser radiation to a workpiece in an ordered sequence of pulses of predetermined length (duration) and repetition rate (frequency), as illustrated in Figures 1 and 2, reproduced below. *Id.*

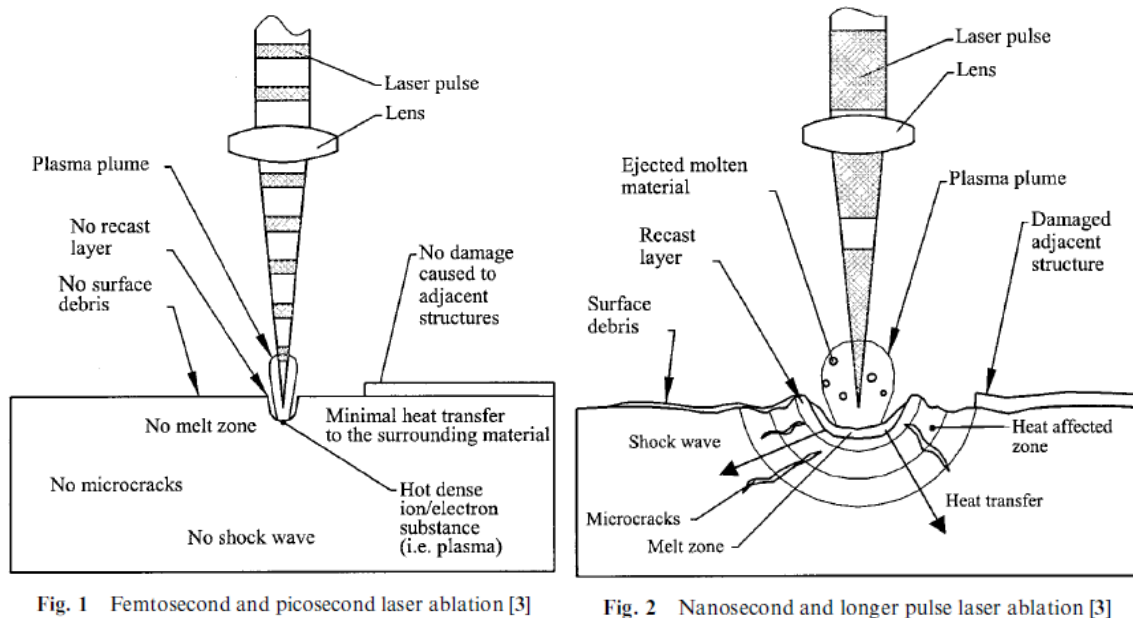


Figure 1 illustrates femtosecond and picosecond laser ablation while Figure 2 illustrates nanosecond or longer laser pulse ablation. *Id.* at 3.

Pham teaches that pulsed laser machining removes substrate within the laser pulse and the removal process varies depending on the laser pulse duration. *Id.* at 2–3. Pham discloses that laser ablation mechanisms for femtosecond and picosecond pulses are the same and involve direct solid-vapor transition (sublimation) with negligible thermal conduction into the substrate and almost no heat affected zone, as illustrated in Figure 1, because

the laser pulse duration is much shorter than the time needed for absorbed energy to be transferred into the substrate as heat. *Id.* at 3. The solid plasma leaves the material at the end of the pulse, expanding in an ionized state and taking most of the energy with it, so very little energy stays in the substrate. *Id.* Pham also discloses that picosecond pulse ablation forms a molten zone and involves some heat transfer, but the main removal mechanism is solid-vapor transition as in femtosecond pulse ablation. *Id.*

Pham illustrates nanosecond or longer laser pulse ablation in Figure 2. *Id.* Such longer pulse durations allow a thermal wave to propagate into the material, melt the material, and heat material to its vaporization temperature. *Id.* Some molten material is partially ejected from the cavity by vapor and plasma pressure, but part remains near the surface while heat dissipates into the material and forms a recast layer. *Id.* Thus, Pham teaches nanosecond pulse ablation forms a heat-affected zone, recast layer, microcracks, shock wave surface damage, and debris from ejected material. *Id.*

b. Analysis

Fike asserts that claims 1–7 are unpatentable under 35 U.S.C. § 103 over Gillespie and Pham. Pet. 48–54. Fike relies on Gillespie to teach the same features of claims 1, 2, 4, 6, and 7 as for the earlier ground based on Gillespie and Perry. *Id.* at 34–40, 48–54. Regarding claim 1, Fike asserts that Pham discloses laser milling of metals using a wavelength of 1064 nm in an ordered sequence of pulses at a rate of 0.1–50 kHz for femtosecond or picosecond pulses. *Id.* at 49–52. Fike asserts that Pham teaches scanning speeds of 5000 mm/s (5 m/s), as recited in claims 2 and 3. *Id.* at 52–53. Pham’s 0.1–50 kHz repetition rate overlaps claim 1’s rate of 15–800 kHz, and Pham’s 5 m/s scanning speed is in claim 3’s range of 0.07–50 m/s.

Fike asserts that Pham solves the problem disclosed in the '260 patent of reducing heat affected zones from laser milling, and Gillespie solves this problem in the field of laser milling of rupture discs. *Id.* at 23. Fike asserts that Pham also illustrates the benefits of femtosecond laser ablation to obtain higher accuracy milling with no melt zone, no microcracks, no shockwave, no recast layer, and minimal heat transfer. *Id.* Because the references focus on the same problem as the '260 patent, come from the same field of art, and describe similar solutions that combine well together and match the claimed solution, Fike asserts that motivation exists to combine their teachings to render the challenged claims obvious, particularly as Mr. Modena admits the critical feature of the invention for achieving reduced heat affected zones is 10–900 femtosecond pulse duration and other claimed parameters can be balanced to achieve acceptable results. *Id.* at 23–24. Fike further asserts that it would have been obvious as a matter of common sense to select and balance laser parameters such as power of each laser pulse (claim 5) based on Mr. Modena's admission. *Id.* at 21–22, 24–25.

Dr. Bass testifies that Gillespie and Pham teach or suggest the features of claims 1–7 and a skilled artisan could combine their teachings to arrive at the claimed inventions. Ex. 1010 ¶¶ 42–52, 60–65, 70–74, 77. Dr. Bass testifies that Gillespie and Pham disclose the benefits of femtosecond laser pulses for cold ablation with negligible heat affected zones and a skilled artisan could balance the other parameters, as Mr. Modena acknowledges. *Id.* ¶¶ 44–46, 51, 67–69. Dr. Bass also testifies that Pham is relevant to the obviousness of the challenged claims because Pham discloses a system for laser milling using pulsed lasers and identifies the benefits from using short femtosecond pulses as compared to nanosecond pulses. *Id.* ¶ 52.

In view of Donadon's failure to oppose the foregoing contentions and evidence (37 C.F.R. § 42.120(a)), Fike's allegations of material fact are considered to be admitted. *See* 37 C.F.R. § 42.23(a). Based on all of the foregoing, Fike has established by a preponderance of evidence that claims 1–7 are unpatentable under 35 U.S.C. § 103(a) over Gillespie and Pham.

7. Claims 8 and 9 – Obviousness Over Gillespie, Pham, and Mozley/Muddiman

Fike asserts claims 8 and 9 are unpatentable under 35 U.S.C. § 103(a) over Gillespie, Pham, and Mozley or Muddiman. Pet. 54–56. Fike asserts that Mozley and Muddiman disclose a dome-shaped foil element in claim 8. *Id.* at 55. Fike asserts Mozley and Muddiman render obvious claim 9's foil thickness of 20–100 μm , because Mozley discloses laser scoring of sheet material less than 2 mm in thickness, and Muddiman forms flat rupture discs from material of 1/10,000th of an inch thickness (2.54 μm). *Id.* at 55–56. Dr. Bass testifies that Mozley and Muddiman disclose a dome-shaped foil in claim 8. Ex. 1010 ¶¶ 53–59, 65–66, 74–75. Dr. Bass testifies that claim 9 is obvious in view of Mozley's foil thickness of less than 2 mm, which covers claim 9's range of 20 μm – 100 μm , and Muddiman's ultra-thin foil thickness of 2.54 μm . *Id.* We agree for the reasons discussed for Ground 2.

In view of Donadon's failure to oppose the foregoing contentions and evidence (37 C.F.R. § 42.120(a)), Fike's allegations of material fact are considered admitted. *See* 37 C.F.R. § 42.23(a). Based on the foregoing, Fike has established by a preponderance of evidence that claims 8 and 9 are unpatentable under 35 U.S.C. § 103(a) over Gillespie, Pham, and Mozley or Muddiman.

III. CONCLUSION

For the foregoing reasons, Fike has demonstrated by a preponderance of evidence that claims 1–9 of the '260 patent are unpatentable.

IV. ORDER

Accordingly, it is

ORDERED that Fike's request to cancel claims 1–9 of U.S. Patent No. 8,674,260 is granted; 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.

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Patent 8,674,260 B2

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