

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CANON U.S.A., INC. and CANON INC.,
Petitioner,

v.

SLINGSHOT PRINTING LLC,
Patent Owner.

IPR2022-01541
Patent 7,152,951 B2

Before JO-ANNE M. KOKOSKI, JON B. TORNQUIST, and
JOHN D. HAMANN, *Administrative Patent Judges*.

TORNQUIST, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Canon U.S.A., Inc. and Canon Inc. (collectively “Petitioner”) filed a Petition (Paper 2, “Pet.”) requesting an *inter partes* review of claims 1–7, 9, 10, 20–22, and 24 of U.S. Patent No. 7,152,951 B2 (Ex. 1001, “the ’951 patent”). Slingshot Printing LLC (“Patent Owner”) filed a Preliminary Response to the Petition. Paper 5. Upon review of the parties’ arguments and supporting evidence, we instituted review with respect to all grounds asserted in the Petition. Paper 7 (“Institution Decision” or “Dec.”). After institution, Patent Owner filed a Response (Paper 10, “PO Resp.”), to which Petitioner filed a Reply (Paper 13, “Pet. Reply”), and Patent Owner filed a Sur-reply (Paper 16, “Sur-reply”).

Petitioner relies, *inter alia*, upon a declaration from Charles M. Curley (Ex. 1002), and Patent Owner relies upon a declaration from Steven J. Dietl (Ex. 2003).

An oral hearing was held on March 4, 2024, and a transcript of the hearing is included in the record (Paper 22, “Tr.”).

For the reasons that follow, we conclude that Petitioner has proven by a preponderance of the evidence that claims 1–7, 9, 10, 20–22, and 24 of the ’951 patent are unpatentable.

II. BACKGROUND

A. Related Matters

The parties identify the following district court proceeding as a related matter: *Slingshot Printing LLC v. Canon U.S.A., Inc. and Canon Solutions America, Inc.*, No. 2:21-cv-00123 (E.D.N.Y.). Pet. 1; Paper 6, 2.

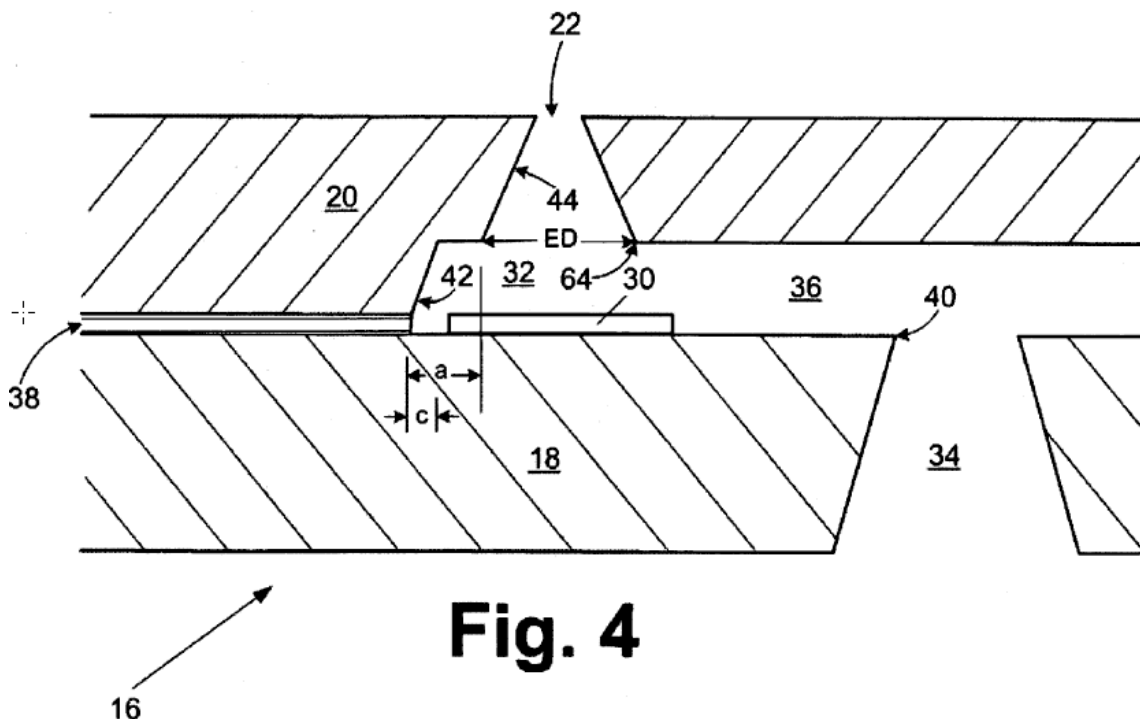
B. Real Parties in Interest

Petitioner identifies itself as the real party in interest. Pet. 1. Patent Owner identifies itself as the real party in interest. Paper 6, 1.

C. The '951 patent

The '951 patent is titled “High Resolution Ink Jet Printhead” and issued December 26, 2006, from an application filed February 10, 2004. Ex. 1001, codes (22), (45), (54). The '951 patent explains that “[a]s the capabilities of ink jet printers are increased to provide higher quality images at increased printing rates, printheads, which are the primary printing components of ink jet printers, continue to evolve and become more complex.” *Id.* at 1:14–18.

Figure 4 of the '951 patent is reproduced below.



formed in nozzle plate 20 between substrate 18 and nozzle hole 22. *Id.* at 3:15–19. Nozzle plate 20 is preferably adhesively attached to substrate 18 by adhesive layer 38. *Id.* at 3:28–29. Fluid for ejection is provided through opening or slot 34 in substrate 18. *Id.* at 3:24–28, 3:35–36.

Figure 7 of the '951 patent is reproduced below.

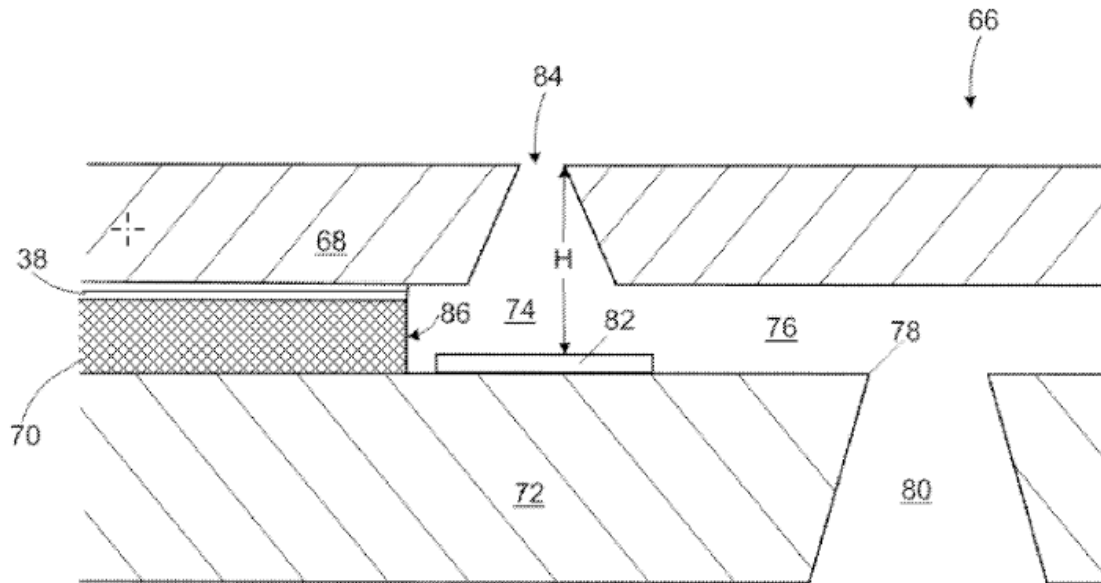


Fig. 7

Figure 7 depicts an embodiment in which nozzle plate 68 is formed separate from thick film layer 70. Ex. 1001, 5:35–39. The '951 patent explains that

the thick film layer 70 is preferably provided by a photoresist material that is spin coated or laminated to substrate 72. The thick film layer 70 has a thickness ranging from about 6 to about 30 microns and is preferably photodeveloped to provide ink chambers 74 and ink channels 76 therein. . . . [T]he substrate 72 includes an ink feed edge 78 that may be provided by an ink feed slot 80 provided in the substrate 72. Ink ejection devices 82 are formed on the substrate 72 and are aligned with a nozzle 84 provided in the nozzle plate 68. The nozzles 84 are preferably laser ablated in the nozzle plate 68.

Id. at 5:37–49. The '951 patent explains that in this embodiment “side

Figure 5 of the '951 patent is reproduced below.



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center of nozzle 46 being a distance T_1 from the ink feed edge that is less than nozzle 48 (distance T_2). *Id.* at 3:55–60. The '951 patent explains that the difference in nozzle distances leads to nozzle 46 having different fluidic characteristics than nozzle 48. *Id.* at 4:6–9. The '951 patent further explains that in order to provide a fluidic seal between adjacent ink chambers (such as chambers 50 and 52), a distance F_1 ranging from about 7.5 to about 30 microns is required, and the distance G_1 ranges from 0 to about 10 microns. *Id.* at 3:63–4:3.

Figure 6 of the '951 patent is reproduced below.

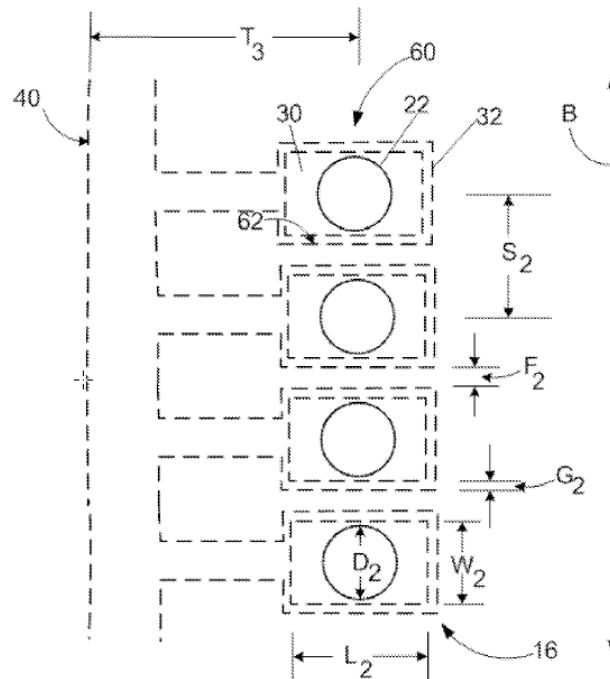


Fig. 6

Figure 6 is a plan view of a portion of a printhead. Ex. 1001, 2:53–54. As shown in Figure 6, ink chambers 32 are spaced substantially the same distance T_3 from ink feed edge 40 “so that the fluidic characteristics of each nozzle 22 are substantially the same.” *Id.* at 4:21–26. “[U]nlike the prior art

design, the center to center spacing S_2 between adjacent nozzles 22 is preferably less than 42 microns providing a pitch of greater than about 600 dpi up to about 1200 dpi for ablated ink chambers.” *Id.* at 4:32–35.

D. Illustrative Claim

Petitioner challenges claims 1–7, 9, 10, 20–22, and 24 of the ’951 patent. Pet. 1, 3. Claim 1, reproduced below, is illustrative of the challenged claims:

1. 1[pre] A printhead for an ink jet printer, the printhead comprising:
 - 1[a] a semiconductor substrate containing at least one ink feed edge and a plurality of ink ejection actuators spaced a distance from the ink feed edge,
 - 1[b] each of the ink ejection actuators having an aspect ratio ranging from about 1.5:1 to about 6:1;
 - 1[c] a thick film layer attached to the semiconductor substrate,
 - 1[d] the thick film layer having formed therein a plurality of ink feed chambers and ink feed channels corresponding to the plurality of ink ejection actuators;
 - 1[e] a nozzle plate attached to the thick film layer,
 - 1[f] the nozzle plate containing a plurality of nozzle holes in the nozzle plate corresponding to the plurality of ink feed chambers,
 - 1[g] wherein adjacent ones of the nozzle holes are spaced apart with a pitch ranging from about 600 to about 2400 dpi and
 - 1[h] wherein the distance from the ink feed edge is substantially the same for each of the ink ejection actuators.

Ex. 1001, 6:51–7:3 (Petitioner’s claim designations in brackets have been added); Pet. Claim Listing.

E. Asserted Grounds of Unpatentability

Petitioner asserts that claims 1–7, 9, 10, 20–22, and 24 of the ’951 patent would have been unpatentable on the following grounds (Pet. 1, 3):

Claim(s) Challenged	35 U.S.C. § ¹	Reference(s)/Basis
1–3, 6, 9, 10	103	Powers ² , Whitman ³
4, 5, 7, 20–22, 24	103	Powers, Whitman, Cleland ⁴
1–4, 6, 7, 9, 10, 20–22, 24	103	Hamafuku ⁵ , Imanaka ⁶ , Whitman
5	103	Hamafuku, Imanaka, Whitman, Cleland

III. ANALYSIS

A. Legal Standard

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and “the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art;

¹ The Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. § 103 effective March 16, 2013. The ’951 patent issued from an application filed February 10, 2004. Ex. 1001, code (22). Accordingly, we apply the pre-AIA version of § 103. Pet. 2.

² US 6,719,405 B1, issued April 13, 2004. Ex. 1004 (“Powers”).

³ US 6,213,587 B1, issued April 10, 2001. Ex. 1005 (“Whitman”).

⁴ US 6,491,377 B1, issued December 10, 2002. Ex. 1006 (“Cleland”).

⁵ JP Application No. H09-131869, published May 20, 1997. Ex. 1007 (“Hamafuku”).

⁶ US 6,299,293 B1, issued October 9, 2001. Ex. 1008 (“Imanaka”).

(3) the level of ordinary skill in the art; and (4) when in evidence, objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. Level of Ordinary Skill in the Art

In order to determine whether an invention would have been obvious at the time it was made, we consider the level of ordinary skill in the pertinent art. *Graham*, 383 U.S. at 17. The resolution of this question is important because it allows us to “maintain[] objectivity in the obviousness inquiry.” *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718 (Fed. Cir. 1991).

In assessing the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *In re GPAC, Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (quotation omitted).

Petitioner contends that a person of ordinary skill in the relevant time period “would have been a person holding at least a Bachelor’s level college degree in Mechanical Engineering, Materials Science, Physics, Electrical Engineering, or a related field, and at least two years of training or experience in the design of inkjet cartridges and printheads.” Pet. 6 (citing Ex. 1002 ¶ 40).

Patent Owner “does not believe that Materials Science alone is a sufficiently related discipline to the technology of the ’951 patent, but does not otherwise dispute” Petitioner’s definition of the ordinarily skilled artisan. PO Resp. 30–31.

Upon review of the prior art of record, we adopt Petitioner’s definition of a person of ordinary skill in the art as it is consistent with the prior art of record, but note that neither party contends the outcome of this case depends on whether a person of ordinary skill could include an individual with a degree in Materials Science.

C. Claim Construction

In an *inter partes* review proceeding, a patent claim is construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b) (as amended Oct. 11, 2018). This rule adopts the same claim construction standard used by Article III federal courts, which follow *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc), and its progeny. Under this standard, the words of a claim are generally given their “ordinary and customary meaning,” which is the meaning the term would have to a person of ordinary skill at the time of the invention, in the context of the entire patent including the specification. *See Phillips*, 415 F.3d at 1312–13.

Petitioner contends that all claim terms should be afforded their plain and ordinary meaning. Pet. 7.

Patent Owner agrees that all claim terms should be given their plain and ordinary meaning, but contends Petitioner does not apply the plain and ordinary meaning of the term “thick film layer.” PO Resp. 31–32. In particular, Patent Owner contends that the ordinary meaning of “thick film layer” in the art is “a polymer layer, usually a photoresist material, applied on top of the thin film layers of metal and other components on a semiconductor chip.” *Id.* at 32 (citing Ex. 2003 ¶ 59).

Petitioner argues in response that Patent Owner is attempting to import limitations from a preferred embodiment of the '951 patent, and nothing in the written description or claims requires that the “thick film layer” be made of any particular material, much less a polymeric material. Pet. Reply 10–11.

Upon review of the prior art of record, we determine that no claim terms require construction for purposes of this Final Written Decision. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’”) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

D. Obviousness in View of Powers and Whitman

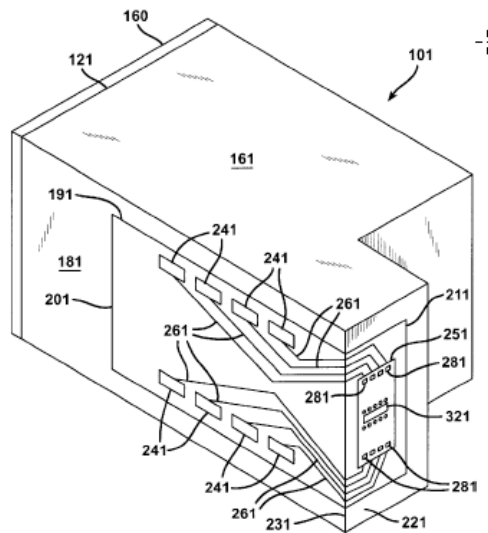
Petitioner asserts that claims 1–3, 6, 9, and 10 would have been obvious in view of the combined disclosures of Powers and Whitman. Pet. 7–40.

1. Powers

Powers “relates to inkjet printheads” and, in particular, to an inkjet printhead with “a bubble chamber having a curved or convex wall portion partially surrounding a rectangular heater element.” Ex. 1004, 1:6–9.

Opening 30 resides directly above surface 38 of heater element 10 and may have an opening on the order of about 11 to 14 microns. Ex. 1001, 4:33–37. Powers reports that “[i]n the future, it is expected that this dimension will gradually shrink as printing resolutions increase from 600 DPI^[7] (dots-per-inch) to 900 or 1200 DPI or more.” *Id.* at 4:37–40.

FIG. 4



⁷ The '951 patent uses the term “dpi,” whereas Powers uses the term “DPI.” *See* Ex. 1001, 1:62–63; Ex. 1004, 4:37–40. We understand these terms to be identical and use them interchangeably.

Figure 4, printhead 101 has housing 121 that is formed of body 161 and lid 160. *Id.* at 6:46–48. Heater chip 251 contains at least one ink via 321 that fluidly connects the heater chip to a supply of ink internal to the housing. *Id.* at 7:16–18. Powers explains that, “[f]or simplicity in this crowded figure, dots or small circles depict the heater elements in the columns. In an actual printhead, hundreds or thousands of heater elements may be found on the printhead and may have various vertical and horizontal alignments, offsets or other.” *Id.* at 7:23–27. A nozzle plate with a plurality of orifices adheres over heater chip 251 such that the nozzle holes align with the heaters. *Id.* at 7:27–30.

2. Whitman

Whitman discloses an inkjet printhead with improved reliability.

Ex. 1005, code (57). Figure 5 of Whitman is reproduced below:

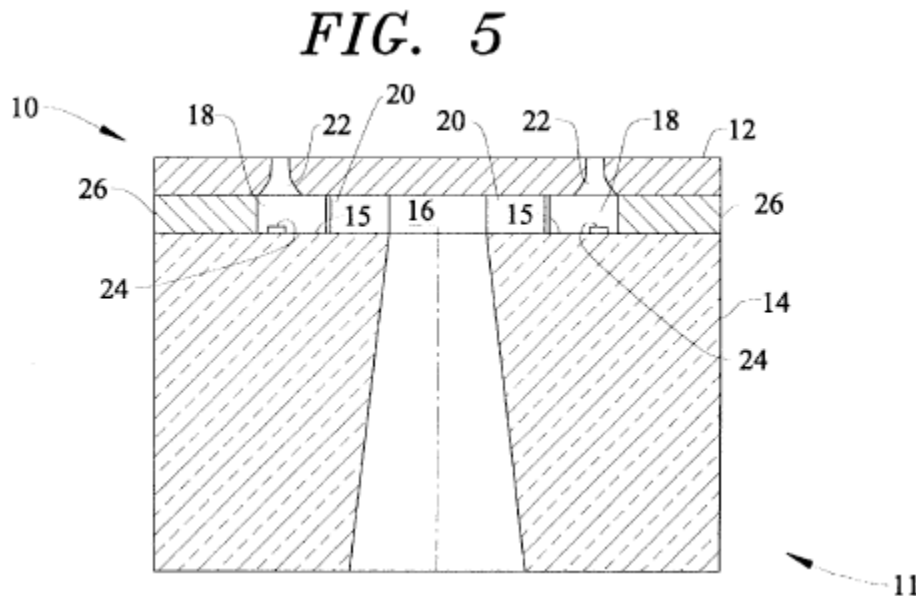


Figure 5 is an enlarged cross-sectional detail of inkjet printhead 10 comprising at least one energy-generating element or transducer, such as heater 24. *Id.* at 5:17–19. Whitman explains that heater 24 may be formed

of a resistance layer that is deposited on surface 15 of substrate base 14. *Id.* at 5:25–28.

Figure 7 of Whitman is reproduced below:

FIG. 7

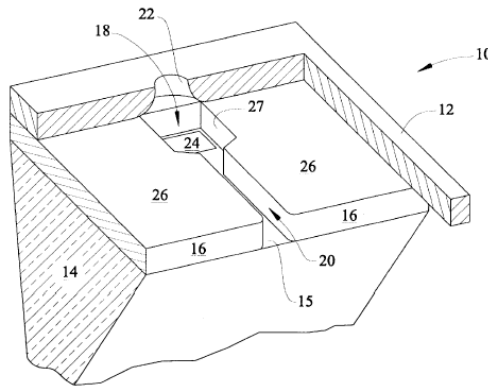


Figure 7 is a selectively sectioned perspective view of the inkjet printhead of Figure 5. Ex. 1001, 3:32–33. As shown in Figure 7, heater 24 is arranged within chamber 18, which has wall or barrier 27 that extends above heater 24. *Id.* at 5:57–66. Whitman explains that chamber 18 is preferably formed in a thick spacer or insulating film 26. *Id.* at 6:21–23. Plate 12 (or a “nozzle plate”) is provided with at least one aperture 22, and plate 12 cooperates with chamber 18 to allow heater 24 to eject ink from the chamber through aperture 22. *Id.* at 6:35–38, 6:57–61.

3. Analysis: Claim 1

a. Petitioner’s Arguments

Petitioner contends that Powers and Whitman teach or suggest every limitation of claim 1. Pet. 7–29. In particular, Petitioner contends Powers and Whitman disclose: (1) a printhead (the inkjet printhead of Powers) comprising a semiconductor substrate (heater chip 251) that contains at least one ink feed edge and a plurality of ink ejection actuators (heater elements

10) spaced a distance from the ink feed edge (*id.* at 7–15); (2) each ink ejection actuator having an aspect ratio ranging from 1.5:1 to about 6:1 (*id.* at 15 (citing Ex. 1004, 1:58–63) (Powers disclosing aspect ratios of “more than about 2.0,” and preferably “about 4.0 or 5.0 or greater than about 2.5”)); (3) a thick film layer attached to the semiconductor substrate (the “barrier layer” of Powers or “thick film layer 26” of Whitman) (*id.* at 16–20 (citing Ex. 1004, 7:26–30; Ex. 1005, 5:40–43, 6:21–23, 6:31–33; Ex. 1002 ¶¶ 136–142)); (4) a plurality of ink feed chambers and ink feed channels formed in the thick film layer and corresponding to the plurality of ink ejection actuators (*id.* at 20–22 (citing and discussing Fig. 2 of Powers and Figs. 5 and 7 of Whitman)); (5) a nozzle plate attached to the thick film layer (nozzle plate 18 of Powers) (*id.* at 23–24); (6) the nozzle plate containing a plurality of nozzle holes corresponding to the plurality of ink feed chambers (nozzle plate 18 of Powers) (*id.* at 24–25 (citing Ex. 1004, 4:23–26, 7:26–29)); and (7) an ink feed edge that is substantially the same for each of the ink ejection actuators (*id.* at 27–29).

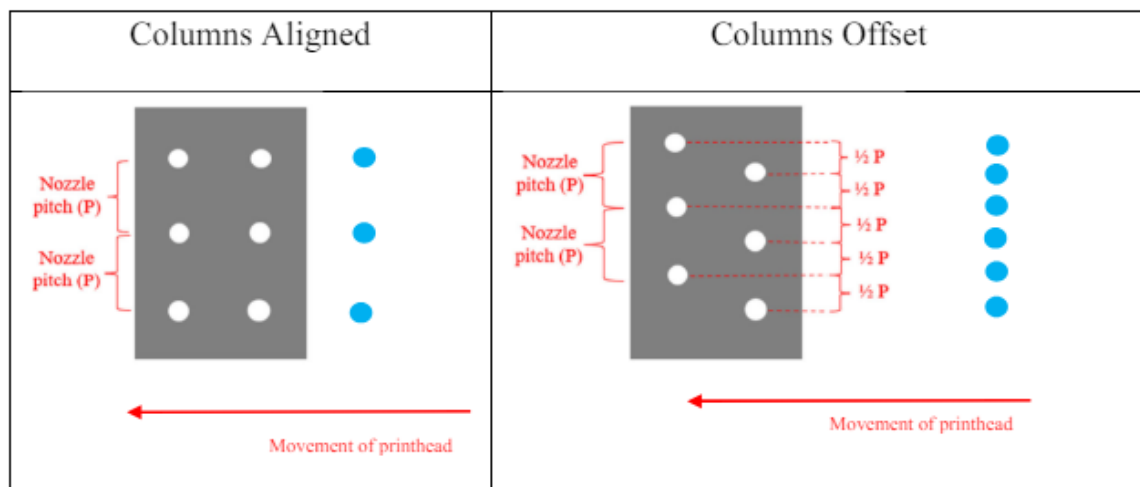
To the extent it is determined that Powers does not disclose “a thick film layer attached to the semiconductor substrate,” Petitioner contends that Whitman discloses this feature and that one of ordinary skill in the art would have sought to utilize such a thick film layer in Powers in order to improve the reliability of the printhead. Pet. 16–22, 38–39. Petitioner further contends that modifying the printhead of Powers to include Whitman’s structures and dimensions would constitute the use of known prior art elements, using known methods, to yield a predictable result. *Id.* at 39.

With respect to the limitation requiring that the adjacent nozzle holes are “spaced apart with a pitch ranging from about 600 to about 2400 dpi,”

Petitioner notes that Powers discloses that “present day printheads have small diameter openings on the order of about 11 or 14 microns” and, “[i]n the future, it is expected that this dimension [i.e., diameter opening] will gradually shrink as printing resolutions increase **from 600 DPI (dots-per-inch) to 900 or 1200 DPI or more.**” Pet. 26–27 (quoting Ex. 1004, 4:35–42) (emphasis and alterations by Petitioner). According to Petitioner, a person of ordinary skill in the art would understand from these disclosures that Powers teaches or suggests a nozzle pitch of 600 DPI, 900 DPI, or 1200 DPI. *Id.* at 27.

b. Patent Owner’s Arguments

Patent Owner contends that Petitioner’s arguments related to the combination of Powers and Whitman improperly conflate nozzle pitch and printing resolution. PO Resp. 2. According to Patent Owner, “the dpi nozzle pitch of a printhead is rarely the same as its dpi print resolution capability,” as dpi print resolution may be increased using various techniques, including the use of slightly offset columns of nozzles. *Id.* at 2–8. To explain its position, Patent Owner provides the following figure showing pairs of aligned and offset nozzles. *Id.* at 5.



The figure above depicts two different printheads having two columns of nozzles. *Id.* In the printhead on the left, the nozzles of the first column are aligned with the nozzles of the second column. *Id.* In this configuration, Mr. Dietl testifies that if the printhead has nozzles spaced at 3 dpi, then the print resolution will also be 3 dpi. Ex. 2003 ¶ 39. In the printhead to the right, the nozzles of one column are vertically offset from those of an adjacent column by one half the pitch of the other column. PO Resp. 5. In such a configuration, Patent Owner contends “the number of dots applied to the paper per inch (i.e., the vertical dpi print resolution) is [the] pitch of a single column multiplied by the number of columns.” *Id.* According to Patent Owner, this technique of offsetting the nozzles of a printhead to double the print resolution is called “pitch doubling.” *Id.*; Ex. 2003 ¶ 39.

Patent Owner contends that increased vertical resolution can also be achieved by printing a first group of dots during one pass of the printhead and then advancing the paper a distance less than the vertical dimension of the printhead and printing a second group of dots during a second pass of the printhead. PO Resp. 6. Patent Owner further contends that higher resolution in the horizontal direction may be achieved by offsetting the timing at which nozzles fire from one row to the next, “effectively achieving [a] tighter dot spacing of 600 dpi print resolution when two or more rows of dots are considered.” *Id.* at 7.

Patent Owner contends Petitioner relies entirely upon Powers to disclose a printhead with “a pitch ranging from about 600 to about 2400 dpi,” but Powers only discloses that the diameters of nozzles in printheads “will gradually shrink as printing resolutions increase from 600 DPI (dots-per-inch) to 900 to 1200 DPI or more.” PO Resp. 41 (citing Ex. 1004, 4:35–42) (emphasis by Patent Owner). According to Patent Owner, Powers’s

discussion of print resolutions “says nothing” about the spacing of nozzles in any embodiment of Powers, as it was well recognized in the art that print resolution could be increased in various ways, including by offsetting the nozzles of each column. *Id.* at 42–43.

Patent Owner contends the disclosures of Powers, as well as Petitioner’s own declarant’s testimony, are consistent with this conclusion. First, although Powers uses aligned dots or small circles to depict the heater elements in the columns in Figure 4, Powers explains that this was “[f]or simplicity” in the crowded figure. Sur-reply 7–8 (citing Ex. 1004, 7:22–23). “[I]n an actual printhead, hundreds or thousands of heater elements may be found on the printhead and may have various vertical and horizontal alignments, offsets or other.” *Id.* (citing 7:23–26).

Second, Patent Owner contends Mr. Curley testified that almost all ink jet printers since the mid-1990s have utilized vertically offset columns to double the effective resolution of the printhead. PO Resp. 45 (citing Ex. 2003 ¶ 77). And, given that there are numerous ways to improve print resolution, including one method that has been nearly universally applied in the art, Patent Owner contends Petitioner has not demonstrated that Powers discloses a nozzle pitch of 600 DPI or greater.

c. Analysis

Referring to Figure 1a, Powers discloses that

For convenience, FIG. 1a shows the location of the small diameter opening 30 in phantom relative to the heater element and the bubble chamber. As seen, the small diameter opening of the orifice 24 resides directly above a surface 38 of the heater element, albeit offset from a center 36. As a representative example of size, present day printheads have small diameter openings on the order of about 11 or 14 microns. In the future, it is expected that this dimension will

gradually shrink as print resolutions increase from 600 DPI (dots-per-inch) to 900 or 1200 DPI or more.

Ex. 1004, 4:30–40.

With respect to Figure 4, Power discloses that

As shown, the heater chip contains two columns of heater elements on either side of via 321. For simplicity in this crowded figure, dots or small circles depict the heater elements in the columns. In an actual printhead, hundreds or thousands of heater elements may be found on the printhead and may have various vertical and horizontal alignments, offsets or other.

Ex. 1001, 7:21–27.

Petitioner contends that because the heaters of Figure 4 are not depicted as being offset, and because Powers suggests a present print resolution of 600 DPI, one of ordinary skill in the art would have understood that the nozzle pitch of Powers may be 600 DPI. Pet. Reply 2–3. We are not persuaded by this argument.

Assuming that Powers’s disclosure of print resolutions increasing from 600 DPI “to 900 or 1200 DPI or more” indicates that the print resolution of Powers printhead is 600 DPI (Ex. 1004, 4:39–40), we are not persuaded that this disclosure, accompanied by the disclosures of Powers as a whole, would indicate to one of ordinary skill in the art that the nozzle pitch of Powers’s printhead is also 600 DPI. Mr. Curley testifies that the practice of pitch doubling “has been pretty much followed in all” printheads “since the mid ’90s.” Ex. 1036, 8:2–9:3, 25:1–13 (explaining that “pitch doubling” “has been around pretty universally,” with “pretty much all printers hav[ing] been doing this since the mid ’90s”); *see also id.* at 8:2–6 (Mr. Curley testifying that “in the early days of inkjet printing, the printing resolution and the density of the printhead were the same. But that very

quickly changed”). The use of pitch doubling in Powers would indicate that the nozzle pitch of the printhead is roughly 300 DPI, not 600 DPI. *Id.* at 8:14–9:3.

As noted by Petitioner, Figure 4 of Powers depicts the nozzles as being aligned, and not offset. Pet. 26 (citing Ex. 1004, Fig. 4); Pet. Reply 4 (asserting that “Powers makes **no** mention of offset nozzle columns to achieve its 600 DPI resolution”). But Powers explains that this was for the sake of “simplicity” in the crowded figure, and that “[i]n an actual printhead, hundreds or thousands of heater elements may be found on the printhead and may have various vertical and horizontal alignments, offsets or other.” Ex. 1004, 7:22–26. And, given that pitch doubling has essentially been universally applied in printheads since the 1990s, we are not persuaded that Powers’s simplified figure would indicate to one of ordinary skill in the art that the nozzle pitch of Powers’s printhead was at least 600 DPI.

Indeed, if Powers’s printhead had already achieved a nozzle pitch of 600 DPI using aligned columns of nozzles, increasing print resolution to 1200 DPI—a stated *future* goal in Powers—would be as simple as applying offset columns of nozzles in Powers, a practice Mr. Curley testifies was “pretty universally” followed in the art. Pet. Reply 4; Ex. 1036, 8:21–23 (Mr. Curley explaining that “a 600 DPI density in a printhead was usually manifested into a 1200 DPI printing resolution”). This strongly suggests that Powers’s 600 DPI print resolution was not achieved using aligned columns of nozzles, as depicted in Figure 4’s simplified illustration of the printhead.

As noted by Petitioner, in discussing example sizes for its nozzles, Powers explains that present-day printheads have small diameter openings on the order of about 11 to 14 microns, and these sizes will gradually shrink

as print resolutions increase from “600 DPI to 900 or 1200 DPI or more.” Ex. 1004, 4:33–42; Pet. 26–27; Pet. Reply 2–3. As to this disclosure, we agree with Petitioner that Powers’s prophetic discussion of achieving higher print resolutions through the use of smaller nozzles would suggest that the nozzle pitch of the printhead would also need to increase in the future. Pet. Reply 3–4. But Powers does not assert that its disclosed printhead could achieve a print resolution of greater than 600 DPI, or explain how its disclosed embodiments could be modified to achieve a resolution of “900 or 1200 DPI or more.” Nor does the Petition assert that Powers would be modified to achieve higher nozzle pitches, or explain how this would be done. Thus, Powers’s general statement regarding potential future improvements to print resolution does not demonstrate that Powers has already achieved a nozzle pitch of 600 DPI or greater.

Petitioner argues that “improvement disclosures,” such as Powers’s discussion of DPI values increasing “from 600 DPI (dots-per-inch) to 900 or 1200 DPI or more,” “are enabling.” Pet. 27 n.18 (citing *CFMT, Inc. v. Yieldup Int’l Corp.*, 349 F.3d 1333, 1340 (Fed. Cir. 2003)). We are not persuaded by this argument. The relevant question presented in *CFMT* was whether an improvement patent could be used as evidence that the original invention claimed in earlier patents was not enabled. *CFMT*, 349 F.3d at 1340. That proposition was rejected in that case. *Id.* (noting that “additional inventive work does not alone show nonenablement”). But the question in this proceeding is whether a patent that discloses that the claimed invention

has not yet achieved a particular print resolution goal can be said to disclose a printhead that achieved that same goal.⁸

Petitioner asserts in its Reply that Mr. Curley testified during his deposition “that the bubble chamber diameters disclosed in Powers allow for spacing between chambers to accommodate nozzles of 600 DPI.” Pet. Reply 8 (citing Ex. 1036, 48:8–18, 49:10–22). That Powers could potentially be configured to achieve a nozzle pitch of 600 DPI, however, is not persuasive evidence that Powers actually was configured to achieve this nozzle pitch. And, although Mr. Curley’s testimony provides some support for Petitioner’s arguments, it is not sufficient to overcome the evidence supporting Patent Owner’s position that Powers does not teach or suggest a printhead with a nozzle pitch of “about 600 dpi” or more.

In view of the foregoing, we are not persuaded that Powers teaches or suggests a printhead with a nozzle pitch “from about 600 to about 2400 dpi,” as recited in claim 1. Accordingly, Petitioner does not demonstrate by a preponderance of the evidence that claim 1 would have been obvious over the combined disclosures of Powers and Whitman.

⁸ A prior art patent need not be enabled to be used in an obviousness ground. *Symbol Techs., Inc. v. Opticon, Inc.*, 935 F.2d 1569, 1578 (Fed. Cir. 1991) (noting that “a non-enabling reference may qualify as prior art for the purpose of determining obviousness under § 103”). That does not mean, however, that a prior art reference that identifies a future goal of achieving higher print resolutions, without the reference or Petitioner explaining how to do so, can be said to teach or suggest how to achieve such a print resolution. *Id.* (explaining that although a non-enabling reference may be a prior art reference under § 103, it is only prior art “for what is disclosed in it”).

4. Analysis: Claims 2, 3, 6

Petitioner contends that Powers discloses the limitations of claims 2, 3, and 6. Pet. 29–32. In particular, Petitioner contends that Powers discloses ink ejection actuators in the form of heater resistors (*id.* at 29–30 (citing Ex. 1004, 1:31–34, Fig. 2)) (claim 2); heater resistors with a width of less than or equal to 15 microns (*id.* at 30 (citing Ex. 1004, 3:29–35 (“the width dimension is about 13.2 microns”))) (claim 3); and a plurality of ink ejection actuators that are disposed on both sides of an ink feed slot (*id.* at 31–32 (citing Ex. 1004, 7:15–17, 7:20–26; Ex. 1002 ¶¶ 185–189)) (claim 6).

Petitioner’s arguments with respect to claims 2, 3, and 6, however, do not resolve the issues noted above with respect independent claim 1, from which they depend. Accordingly, we are not persuaded that Petitioner demonstrates by a preponderance that claims 2, 3, and 6 would have been obvious in view of the combined disclosures of Powers and Whitman.

5. Analysis: Claims 9 and 10

Claim 9 depends from claim 1 and further requires that “a distance from the ink ejection actuators to an exit of the nozzle holes is greater than the pitch.” Ex. 1001, 7:23–25. Claim 10 depends from claim 1 and further requires “a ratio of the pitch to a distance from the ink ejection actuators to an exit of the nozzle holes is from about 0.5 to 1.5.” *Id.* at 7:26–28.

Petitioner contends that Powers discloses a 600 DPI printhead that would have a nozzle pitch of 42.33 microns and, although Powers does not disclose the precise distance from the ink ejection actuators to an exit of the nozzle holes, Whitman provides this information. Pet. 32–33. In particular, Petitioner contends that Whitman discloses a nozzle plate with a thickness of about 35 to 55 microns and a separation distance between the nozzle plate

and the transducer (ink ejection actuator) of about 8 to 27 microns. *Id.* at 34 (citing Ex. 1005, 6:34–37, 7:52–64, 8:9–15). Applying these dimensions, Petitioner calculates that the distance from the ink ejection actuators to the exit of the nozzle holes in Powers is at least 43 microns, which is greater than the 42.33 micron nozzle pitch recited in claim 9. *Id.* at 35. Petitioner also calculates that the ratio of the pitch (42.33 microns) to the distance from the actuators to the nozzle holes (43 microns) is 0.98, which falls within the claimed range of 0.5 to 1.5 recited in claim 10. *Id.* at 36.

Patent Owner contends that Powers does not disclose the nozzle pitch of its printhead and, therefore, Petitioner’s calculations are not supported in Powers and Whitman. PO Resp. 47–48.

Petitioner’s arguments with respect to claims 9 and 10 do not resolve the deficiencies noted above with respect to independent claim 1, from which they depend. Thus, Petitioner does not demonstrate by a preponderance of the evidence that claims 9 and 10 would have been obvious in view of the combined disclosures of Powers and Whitman.

E. Obviousness in View of Powers, Whitman, and Cleland

Petitioner contends that the subject matter of claims 4, 5, 7, 20–22, and 24 would have been obvious in view of the combined disclosures of Powers, Whitman, and Cleland. Pet. 40–49. In particular, Petitioner contends that (1) Cleland discloses a “heater resistor [that] has a resistance of about 140 Ω ” (Pet. 40–41 (citing Ex. 1006, 2:24–47, 8:21–32⁹; Ex. 1002

⁹ Petitioner’s citations to Ex. 1006, 8:21–32 do not contain the quote that is recited in the Petition. In column 7, however, Cleland reports that “[i]n a preferred embodiment, the heater resistor has a resistance of about 140 Ω .” Ex. 1006, 7:56–58.

¶¶ 222–232, 261)) (claim 4); (2) Cleland discloses nozzle holes that are in the form of an ellipse and have a ratio of major to minor axis in the range of 2:1 to 5:1 (*id.* at 41–42 (citing Ex. 1006, 10:55–62, Figs. 6A, 6B)) (claim 5); (3) Powers discloses a heater chip that contains “at least one ink via 321” and Cleland discloses the use of three ink vias to supply three different colors to the print head (*id.* at 42–44 (citing Ex. 1006, 18:57–59, 17:22–24, Fig. 13A)) (claim 7); and (4) Powers discloses an inkjet printer cartridge containing a printhead (*id.* at 45 (citing Ex. 1004, 6:46–62, Ex. 1002 ¶¶ 250–253)) (claim 24). With respect to independent claim 20, and its dependent claims 21 and 22, Petitioner contends each limitation is found in Powers, Whitman, and Cleland for the reasons set forth above with respect to claims 1, 2, 4, 6, and 7. *Id.* at 44 (incorporating arguments from sections X.A.1, X.A.2, X.A.4, X.B.1, X.B.3 of the Petition).

Again, Petitioner’s arguments with respect to the combination of Powers, Whitman, and Cleland do not resolve the issues noted above with respect to independent claim 1. Accordingly, Petitioner does not demonstrate by a preponderance of the evidence that claims 4, 5, 7, 20–22 and 24¹⁰ would have been obvious in view of the combined disclosures of Powers, Whitman, and Cleland.

F. Obviousness in View of Hamafuku, Imanaka, and Whitman

Petitioner contends that the subject matter of claims 1–4, 6, 7, 9, 10, 20–22, and 24 would have been obvious in view of the combined disclosures of Hamafuku, Whitman, and Imanaka. Pet. 50–90. Patent Owner disagrees.

¹⁰ Independent claim 20 contains the same disputed limitations as independent claim 1, and claims 4, 5, 7, 21, 22, and 24 all depend from either claim 1 or claim 20.

1. Hamafuku

Hamafuku discloses an inkjet head that can be miniaturized without reducing the number of inkjet parts. Ex. 1007, code (57). Figures 1–3 of Hamafuku are reproduced below.

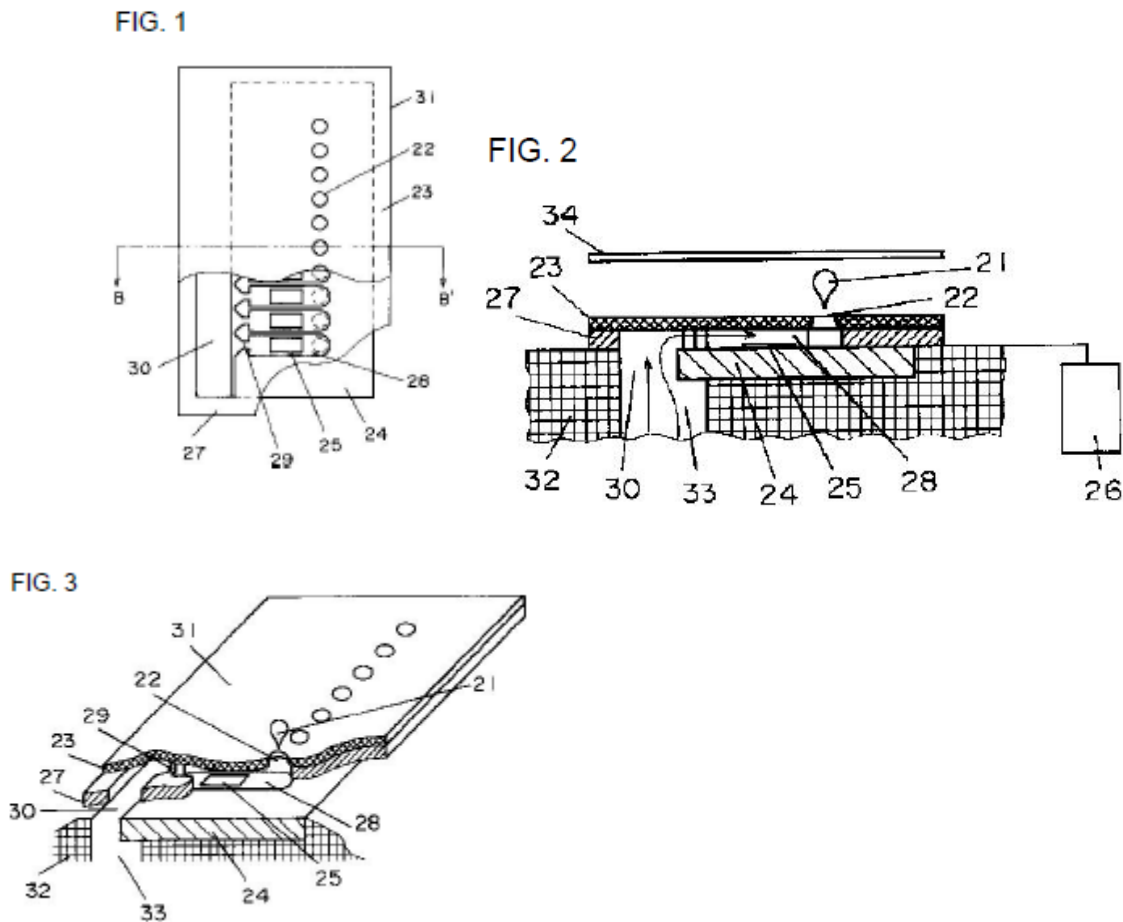


Figure 1 is a partial cross-sectional view of an inkjet head of Hamafuku, Figure 2 is a cross-sectional view taken along line B-B' of the inkjet head of Figure 1, and Figure 3 is a perspective view with a portion of the inkjet head cut away. *Id.* ¶ 44.

Hamafuku explains that

[In Figures 1–3], 21 represents ink; 22 represents a nozzle which is an ejection port for the ink 21; 23 represents a nozzle plate having the nozzle 22; 24 represents a substrate facing the nozzle plate 23; 25 represents a heater part for

generating bubbles, which is provided on the surface of the substrate 24 on the nozzle plate 23 side; 26 represents a signal generator that applies a voltage to the heater part 25; 27 represents a flow path member provided between the nozzle plate 23 and the substrate 24; 28 represents a pressure chamber including the nozzle plate 23, the substrate 24, and the flow path member 27; and 29 represents an ink flow path for supplying ink 21 to the pressure chamber 28.

....

30 represents a common ink chamber that supplies ink 21 to the pressure chamber 28 through the ink flow path 29; 31 represents an inkjet head including the nozzle plate 23, the substrate 24, the flow path member 27, and has an ink ejection part including a plurality of nozzles 22, the heater part 25, a pressure chamber 28, and an ink flow path 29; 32 represents an ink cartridge to which the inkjet head 31 is attached; and 33 represents an ink introduction groove, which is opened in ink cartridge 32 and supplies ink to the common ink chamber 30.

Ex. 1007 ¶¶ 17–18.

Hamafuku discloses that, given the structure of the disclosed printhead, “it is possible to achieve a high-density arrangement of ink ejection parts in a row, which would not have been possible with a conventional configuration unless the ink ejection parts are in a staggered arrangement.” Ex. 1007 ¶ 17. Hamafuku further explains that the result is “a miniature inkjet head that can form high density dots.” *Id.* ¶ 12.

2. Imanaka

Imanaka discloses a liquid discharge head that may be used in ink jet printers. Ex. 1008, 1:7–38. Figure 2 of Imanaka is reproduced below.

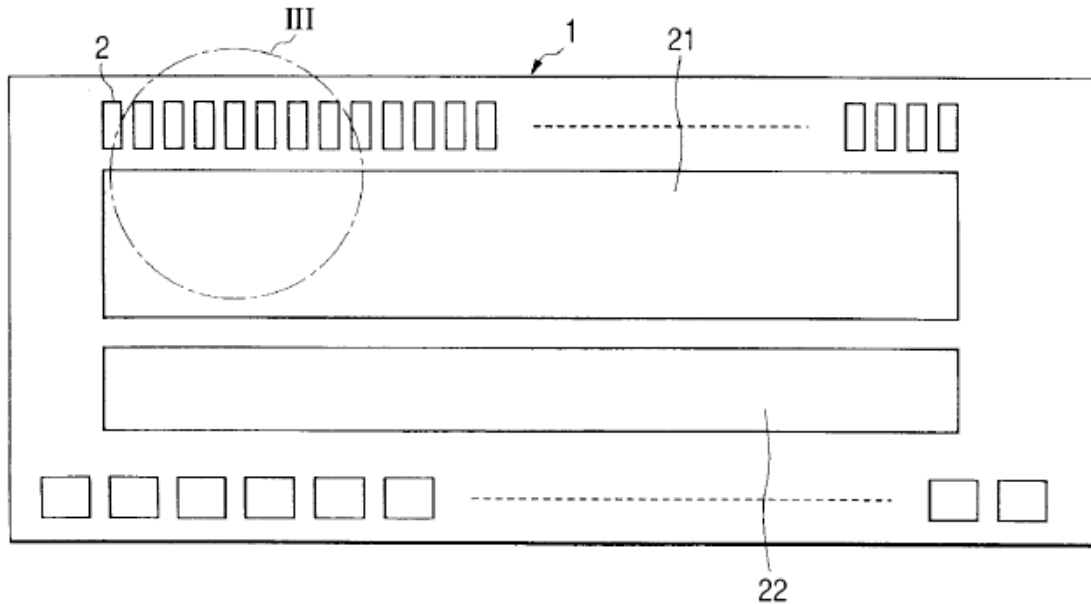


Figure 2 is a plan view showing the element substrate of Imanaka. *Id.* at 4:37–38. As shown in Figure 2, plural heat generating members 2 are arranged in parallel along an edge of element substrate 1. *Id.* at 6:63–66. In the central portion of substrate 1 is driver forming area 21, in which plural heater drivers 31 (not shown in Figure 2) are arrayed in the same direction as the array direction for heat generating members 2. *Id.* at 6:66–7:3. Opposite to heat generating member 2, “there is formed a shift register latch 22.” *Id.* at 7:3–6.

Figure 3 of Imanaka is reproduced below.

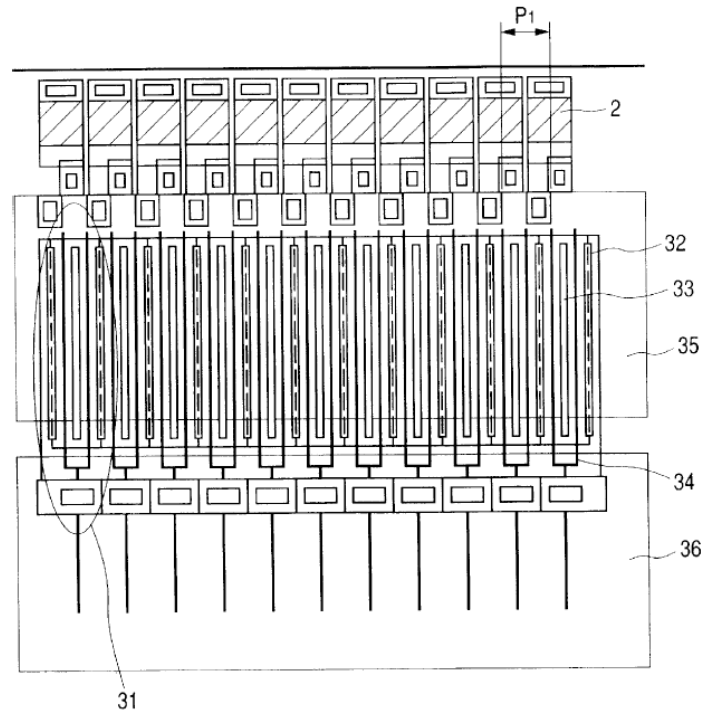


Figure 3 of Imanaka is a magnified view of portion III shown in Figure 2.

Ex. 1001, 7:7. Imanaka explains that substrate 1 “employs heaters arranged with a high density, providing a resolution of 600 dpi (dot per inch) or higher in the recorded image.” *Id.* at 7:7–10. Heater drivers 31 for driving heat generating members 2 are arranged in a linear array and have the same pitch as heat generating members 2, which is selected in a range of 15 to 42 μm . *Id.* at 7:13–19. In one embodiment of Imanaka, the configuration depicted in Figure 3 has heat generating members with a pitch of 21 μm “so as to attain a resolution of 1200 dpi on the recorded image.” *Id.* at 7:44–48.

3. Analysis: Claim 1

a. Recitation 1[p]

Petitioner contends that Hamafuku discloses a printhead for an ink jet printer, pointing to Hamafuku’s disclosure of an “inkjet head” that is

attached to an “ink cartridge” and used in an “inkjet printer.” Pet. 50 (citing Ex. 1007 ¶¶ 13, 17, 18, 34, 39, Fig. 5).

Patent Owner does not contest that Hamafuku discloses the subject matter recited in the preamble of claim 1.

Upon review of the evidence and arguments of record, we determine that Hamafuku discloses the subject matter of the preamble of claim 1.¹¹

b. Limitation 1[a]

Petitioner contends that Hamafuku discloses a semiconductor substrate 24 that includes at least one ink feed edge and a plurality of ink ejection actuators 25 that are spaced a distance from the ink feed edge. Pet. 50–53 (citing Ex. 1007 ¶ 18–20, 34, Figs. 1–3; Ex. 1002 ¶¶ 274–279).

Patent Owner does not contest that Hamafuku discloses the subject matter of limitation 1[a].

Upon review of the evidence and arguments of record, we determine that Petitioner demonstrates by a preponderance of the evidence that Hamafuku discloses every element of limitation 1[a].

c. Limitation 1[b]

Petitioner contends that Hamafuku discloses that its ink ejection actuators can be made rectangular and that the shape of pressure chamber 28 can be elongated with respect to the flow of ink 21. Pet. 54 (Ex. 1007 ¶ 17; Ex. 1002 ¶ 282). Petitioner contends one of ordinary skill in the art would have understood that these rectangular ink ejection actuators would have an aspect ratio of between 1.5:1 to about 6:1, as recited in limitation 1[b],

¹¹ As there is no dispute that Hamafuku discloses the subject matter of the preamble of claim 1, we need not determine whether the preamble is limiting.

because (1) a comparison of the relative dimensions in Hamafuku's Figure 1 indicates a heater with a length that is twice its width, so an aspect ratio of at least 2.0:1 (*id.* at 56 (citing Ex. 1007, Fig. 1; Ex. 1002 ¶ 287)), (2) aspect ratios in the recited range were well known in the art and "had regularly been used to derive optimal printhead fabrication parameters (*id.* at 55 (citing Ex. 1002 ¶ 285)), and (3) it would have been obvious to select this ratio for use in Hamafuku because an aspect ratio of 2:1 would allow twice the number of nozzles to "fit into the same vertical row of 1 inch chip space" (*id.* (citing Ex. 1002 ¶ 286)); *see also id.* at 57 (asserting that Imanaka discloses an aspect ratio of 4.29:1).

Patent Owner does not dispute that Hamafuku teaches or suggests an aspect ratio of between 1.5:1 to about 6:1.

Upon review of Hamafuku and the arguments of record, we determine that Petitioner demonstrates by a preponderance of the evidence that Hamafuku teaches or suggests every element of limitation 1[b].

d. Limitation 1[c]

Petitioner contends that Hamafuku's flow path member 27 is a "thick film layer." Pet. 58–60 (citing Ex. 1007 ¶ 17, 19, Figs. 1–3; Ex. 1002 ¶¶ 294–295). And, to the extent it is determined that Hamafuku does not teach or suggest a "thick film layer," Petitioner contends that one of ordinary skill in the art would have sought to use such a layer in Hamafuku in view of Whitman. *Id.* at 60–61. In particular, Petitioner contends that one of ordinary skill in the art looking to implement Hamafuku's printhead, the precise dimensions of which are not disclosed in Hamafuku, would have looked to Whitman's beneficial teachings, including its teaching of "barrier

height (i.e., thick film layer), nozzle plate thickness, and nozzle plate separation from the transducer.” *Id.* at 87–88.

Patent Owner does not contest that flow path member 27 of Hamafuku is a “thick film layer” or that one of ordinary skill in the art would have sought to incorporate the dimensions of Whitman in Hamafuku, including the thick film layer.

Upon review of Hamafuku, Whitman, and the arguments of record, we determine that Petitioner demonstrates by a preponderance of the evidence that Hamafuku discloses a “thick film layer,” as recited in limitation 1[c]. Petitioner also persuasively explains why one of ordinary skill in the art would have utilized the dimensions of Whitman in Hamafuku, including its thick film layer. Thus, Petitioner demonstrates by a preponderance of the evidence that Hamafuku and Whitman disclose every element of limitation 1[c].

e. Limitation 1[d]

Petitioner contends that Hamafuku discloses a thick film layer (ink flow path member 27) having formed therein a plurality of ink feed chambers (pressure chamber 28) and ink feed channels (ink flow path 29) corresponding to the plurality of ink ejection actuators (heater part 25). Pet. 62 (citing Ex. 1007 ¶¶ 17–18, Fig. 1). Petitioner further contends that Whitman discloses the same general configuration and expressly notes the use of a thick film layer. *Id.* at 63 (citing Ex. 1005, 6:21–23, 6:51–54; Ex. 1002 ¶ 308). Thus, Petitioner contends that Hamafuku alone, or Hamafuku in combination with Whitman, discloses every element of limitation 1[d]. *Id.* at 62–64.

Petitioner contends that one of ordinary skill in the art would have sought to use the thick film layer of Whitman in Hamafuku because Whitman discloses the “dimensions for barrier height (i.e., thick film layer), nozzle plate thickness, and nozzle plate separation from the transducer” and explains which dimensions are “especially beneficial.” Pet. 88 (citing Ex. 1005, 7:55–58, 8:9–14, 11:41–45).

Patent Owner does not dispute that Hamafuku, or Hamafuku in combination with Whitman, discloses every element of limitation 1[d]. Nor does Patent Owner contest that one of ordinary skill in the art would have sought to use the thick film layer of Whitman in Hamafuku.

Upon review of the evidence and arguments of record, we determine that Petitioner identifies where Hamafuku alone, or Hamafuku and Whitman, disclose every element of limitation 1[d]. Petitioner also provides a persuasive explanation as to why one of ordinary skill in the art would have combined the disclosures of Hamafuku and Whitman. Accordingly, we determine that Petitioner demonstrates by a preponderance of the evidence that Hamafuku alone, or Hamafuku in combination with Whitman, discloses every element of limitation 1[d].

f. Limitation 1[e]

Petitioner contends that Hamafuku discloses a nozzle plate (nozzle plate 23) attached to a thick film layer (flow path member 27). Pet. 64 (citing Ex. 1007 ¶¶ 17, 19; Ex. 1002 ¶ 311). And, to the extent Hamafuku is determined not to disclose a thick film layer, Petitioner contends that Hamafuku in combination with Whitman discloses both a thick film layer and the configuration recited in limitation 1[e]. *Id.* at 64–65.

Patent Owner does not dispute that Hamafuku, or Hamafuku in combination with Whitman, discloses every element of limitation 1[e].

Upon review of the evidence and arguments of record, we determine that Petitioner demonstrates by a preponderance of the evidence that Hamafuku alone, and Hamafuku in combination with Whitman, discloses every element of limitation 1[e].

g. Limitation 1[f]

Petitioner contends that Hamafuku discloses nozzle plate 23 that includes a plurality of nozzle holes 22 corresponding to a plurality of ink feed chambers. Pet. 66 (citing Ex. 1007 ¶ 17; Ex. 1002 ¶ 315).

Patent Owner does not dispute that Hamafuku discloses every element of limitation 1[f].

Upon review of the evidence and arguments of record, we determine that Petitioner demonstrates by a preponderance of the evidence that Hamafuku discloses every element of limitation 1[f].

h. Limitation 1[g]

(1) Hamafuku and Whitman – Parties’ Arguments

Petitioner contends that Hamafuku discloses both a printhead with a columnar nozzle array in which the heaters are arranged in a column and “a high density arrangement of ink ejection parts in a row,” which Hamafuku reports “would not have been possible with a conventional configuration unless the ink ejection parts are in a staggered arrangement.” Pet. 68 (quoting Ex. 1007 ¶ 17). According to Petitioner, at the time of the ’951 patent, “common ‘high-density’ heater/nozzle arrangements were considered to be at least 600 DPI up to 1200 DPI or more.” *Id.* (citing Ex. 1008, 7:7–10; Ex. 1025, 4:63–65, 6:32–34; Ex. 1002 ¶ 321). Thus, Petitioner contends

one of ordinary skill in the art would have understood that Hamafuku's "high density" ink ejection parts are spaced apart with a pitch of at least 600 DPI. *Id.* at 69 (citing Ex. 1002 ¶¶ 322–323).

Patent Owner contends that "Petitioner's assertion that Hamafuku's unexplained mention of a 'high-density arrangement of ink ejection parts in a row' discloses the claimed nozzle pitch must fail." PO Resp. 49. Patent Owner reasons that Hamafuku does not disclose the actual spacing between nozzles, and Hamafuku states that the volume of its droplets of ink are between 20–100 pL and the dots on the recording paper are 100–150 μm in diameter. *Id.* at 50 (citing Ex. 1007 ¶ 21). Mr. Dietl testifies that the disclosed volume of ink per dot is "quite large" and ink dots having a diameter of 100–150 μm would equal 170–254 dots per inch, which one of ordinary skill in the art would interpret as demonstrating that the printhead has a nozzle pitch of no more than 300 DPI. Ex. 2003 ¶ 70.

Petitioner does not provide any testimony from one of ordinary skill in the art to dispute Mr. Dietl's calculations of nozzle pitch in Hamafuku, but asserts in its Reply that Patent Owner's and Mr. Dietl's opinions are "inconsistent with Hamafuku's printhead structure dimensions and the state of art at the time." Pet. Reply 13. According to Petitioner, Hamafuku's nozzles can be 20 to 60 microns in size (Ex. 1007 ¶ 21) and printheads with 20 micron nozzles and a "high-density arrangement" had previously achieved a nozzle pitch of 800 DPI. Pet. Reply 13–14 (citing Ex. 1025).

Patent Owner argues in its Sur-reply that Petitioner's assertion that Hamafuku's mention of a "high-density arrangement of ink ejection parts in a row" discloses the claimed nozzle pitch of at least 600 DPI is an inherency argument attempting to fill the gaps in Hamafuku's disclosures. Sur-reply 10. According to Patent Owner, use of the term "high density" in unrelated

prior art references falls far short of establishing a commonly accepted definition of “high density” that would support Petitioner’s arguments. *Id.* at 11–12.

(2) Hamafuku and Whitman – Analysis

Mr. Curley presents evidence that at the time of the filing of Hamafuku,¹² the term “high density” had been used to describe printheads with dot pitches of 600 DPI or greater. Ex. 1002 ¶ 55; Ex. 1008, 7:7–19, 7:44–48; Ex. 1025, 4:63–65; Ex. 1026, 5:50–62; Ex. 1027, 1:65–67. We agree with Patent Owner, however, that when the disclosures of Hamafuku are considered as a whole, there is insufficient evidence to conclude that the nozzle pitch of Hamafuku’s printhead is actually 600 DPI or greater.

As argued by Patent Owner, Hamafuku states that the inventive device of Figure 2 makes dots on a recording paper that are 100–150 μm in diameter, which Mr. Dietl calculates would result in only 170–254 dots per inch, assuming zero spacing between adjacent dots. PO Resp. 50 (citing Ex. 1007 ¶ 21; Ex. 2003 ¶ 70). Mr. Dietl persuasively argues that these disclosures indicate that the center-to-center nozzle spacing of Hamafuku (i.e., nozzle pitch) is “no more than 300” DPI. *Id.*; Ex. 2003 ¶ 70.

Petitioner does not dispute Patent Owner’s calculations of dot diameter or spacing in Hamafuku, but contends that Patent Owner has failed to show that the dot spacing disclosed in Hamafuku was not caused by other design considerations. Tr. 27:20–29:9. But this argument misapplies the relevant burden of persuasion. Given the evidence that the actual ink drops of Hamafuku indicate a nozzle pitch of 300 DPI, it was Petitioner’s burden

¹² Hamafuku was filed November 8, 1995 and published May 20, 1997. Ex. 1007, codes (22), (43).

to produce some evidence suggesting that the droplet diameter reported in Hamafuku was caused by factors other than nozzle pitch. *See In re Magnum Oil Tool Int'l, Ltd.*, 829 F.3d 1364, 1378–79 (Fed. Cir. 2016) (noting it is a petitioner's burden to support its claim of obviousness by a preponderance of the evidence). Petitioner has failed to produce such evidence.

As argued by Petitioner, Hamafuku utilizes 20 micron nozzles, a nozzle size which had previously been used to provide a print head with a nozzle pitch of 800 DPI. Pet. Reply 13–14 (citing Ex. 1025, 4:63–65, 8:47–50). There is no persuasive evidence of record, however, to demonstrate that all printheads with 20 micron nozzles will have a nozzle pitch of 800 DPI. And, given the express disclosures in Hamafuku suggesting that the device depicted in Figure 3 has a nozzle pitch of no more than 300 DPI, we are not persuaded that Petitioner demonstrates that the printhead of Hamafuku has a nozzle pitch of 600 DPI or greater, as recited in claim 1.

In view of the foregoing, we credit the testimony of Mr. Dietl that the dot diameters and spacing disclosed in Hamafuku indicate a nozzle pitch of no more than 300 DPI. Ex. 2003 ¶ 70. Accordingly, Petitioner fails to demonstrate by a preponderance of the evidence that Hamafuku (or the combination of Hamafuku and Whitman) teaches or suggests a nozzle pitch of 600 DPI or greater, as recited in claim 1.

(3) Hamafuku, Whitman, and Imanaka – Parties' Arguments

Petitioner contends that: (1) the pitch of the heater drivers in Imanaka “is selected in a range of 15 to 42 μm ,” (2) the pitch of the heater drivers is the same as the pitch of the heat generating members, (3) each heat generating member would have a corresponding nozzle; (4) a pitch of approximately 42.33 μm equates to a 600 dpi printhead; and (5) a pitch of 15

µm equates to a 1693 DPI printhead. Pet. 69–70, 70 n.39 (quoting Ex. 1008, 7:7–19; citing Ex. 1002 ¶ 327) (noting that Imanaka discloses that its heaters are “arranged with a high density”). To the extent it is determined that the evidence of record is insufficient to demonstrate that Hamafuku teaches or suggests a nozzle pitch of 600 dpi or greater, Petitioner contends one of ordinary skill in the art would have found it obvious “to modify Hamafuku’s inkjet printhead design to include the nozzle pitch disclosed in Imanaka.” *Id.* at 69.

Petitioner contends that one of ordinary skill in the art would have had reason to combine Hamafuku, Whitman, and Imanaka. Pet. 86. First, Petitioner contends that Hamafuku, Whitman, and Imanaka are all analogous art to the ’951 patent as they each address problems with the structural design of inkjet printheads. *Id.* at 86–87. Second, Petitioner contends that one of ordinary skill in the art would have sought to implement Imanaka’s heater design and spacing in Hamafuku because there was a desire in the art for printheads with higher resolution that operate at higher ejection frequencies, and the arrangement of Imanaka would advantageously provide for a high density nozzle pitch of up to 1200 DPI, as well as a more compact printhead (and potentially less costly printhead). *Id.* at 87–88 (citing Ex. 1008, 7:45–47, 7:53–58; Ex. 1002 ¶¶ 404–405; Ex. 1001, 1:11–46). Third, Petitioner contends that modifying Hamafuku’s printhead to include Imanaka’s and Whitman’s structures and dimensions would “have been an obvious combination of known prior art elements that yields a predictable result.” *Id.* at 89. Finally, Petitioner contends one of ordinary skill would have had a reasonable expectation of success in modifying Hamafuku’s printhead to include Imanaka’s and Whitman’s structures and dimensions because the “printhead components described in Hamafuku, Imanaka, and

Whitman were well-known at the time” and the ordinarily skilled artisan would have considered the combination “straightforward.” *Id.* at 90 (citing Ex. 1008, 1:24–27; Ex. 1007 ¶¶ 7–8; Ex. 1005, 1:13–25, 1:26–42; Ex. 1002 ¶¶ 43–60, 409).

Patent Owner contends that Petitioner’s arguments fail because “Hamafuku and Imanaka are directed to very different devices,” Petitioner fails to analyze the structures of Hamafuku, Whitman, and Imanaka, and Petitioner ignores “that Imanaka does not include other important claimed elements such as a thick film layer attached to a substrate or a nozzle plate attached to a thick film layer.” PO Resp. 52–53. Patent Owner also contends that the walls of Imanaka’s pressure chambers are made of silicon-based materials manufactured by thin film technology, and it is the use of these silicon-based materials that allowed Imanaka to achieve its narrow nozzle pitch. *Id.* at 53–54 (citing Ex. 1008, 6:50–61; Ex. 2003 ¶ 91).

(4) Hamafuku, Whitman, and Imanaka – Analysis

Petitioner persuasively demonstrates that, in the relevant time period, there was a desire to add more nozzles to inkjet printheads in order to improve performance, produce a higher quality image, and produce a more compact and less costly printhead. Ex. 1002 ¶¶ 403–405. Patent Owner and Mr. Dietl do not disagree. Ex. 1035, 16:18–17:17, 21:5–15, 40:12–42:11.

Patent Owner contends, however, that in arguing for the proposed combination, Petitioner fails to analyze the structures of Hamafuku, Whitman, and Imanaka, and ignores “that Imanaka does not include other important claimed elements such as a thick film layer attached to a substrate or a nozzle plate attached to a thick film layer.” PO Resp. 52. Patent Owner further contends that Imanaka discloses nozzles positioned parallel to the ink

flow path and a movable member in its ejection mechanism, and that Petitioner “make[s] no showing that the two designs are in any way compatible, [or] what specific modifications would supposedly have been made to Hamafuku based on Imanaka’s design and operating principles.” *Id.* at 53.

As noted by Patent Owner, Imanaka discloses a “side-shooter” configuration that differs from Hamafuku’s “top-shooter” design, and uses a moveable member to direct ink bubbles in the direction of the nozzle. PO Resp. 53 (citing Ex. 1008, 5:4–15, 6:7–21). The Petition, however, does not propose a bodily incorporation of Imanaka’s ink ejection system into Hamafuku’s inkjet printhead design. Pet. Reply 16–18. Rather, the Petition proposes using Imanaka’s high-density arrangement of heat generating members (each with a corresponding nozzle) in Hamafuku. Pet. 69–71. Thus, questions regarding Imanaka’s “side-shooter” design or its use of a flexible member to direct ink drops out the nozzle are not directly pertinent to the proposed combination.

As noted by Patent Owner, the components of Imanaka are made of silicon-based materials, manufactured using thin film technology. PO Resp. 53–54 (citing Ex. 1008, 6:50–61). We are not persuaded, however, that Imanaka’s preference for silicon-based materials would teach away from, or otherwise discourage, one of ordinary skill in the art from combining Hamafuku, Whitman, and Imanaka. Imanaka does not suggest that failure to use silicon-based materials would result in an inoperable device. Rather, Imanaka states that use of silicon-based materials may “improve the mechanical characteristics” and “reliability” of “the liquid discharge head.” Ex. 1008, 6:50–61. Given the considerable increase in printhead nozzle pitch and print resolution provided by Imanaka’s heater and nozzle pitch

configuration, we are not persuaded that a failure to capture the same improvement in mechanical characteristics and reliability from the use of silicon-based materials would prevent one of ordinary skill in the art from implementing Imanaka's nozzle pitch in Hamafuku and Whitman or counsel against this modification.

In this case, there was a known desire to increase nozzle pitch in inkjet printheads, Imanaka's heater and nozzle configuration had been used in the art to achieve this goal, and there is no suggestion that combining the teachings of Hamafuku, Whitman, and Imanaka was beyond the skill of an ordinarily skilled artisan. *See Intel Corp. v. PACT XPP Schweiz AG*, 61 F.4th 1373, 1381 (Fed. Cir. 2023). Thus, we credit the testimony of Mr. Curley that one of ordinary skill in the art would have sought to use Imanaka's heater and nozzle pitch in Hamafuku in order to provide a more compact and higher density printhead. Ex. 1002 ¶¶ 404–05.

A conclusion of obviousness requires a reasonable expectation of success. *Intelligent Bio-Systems, Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1365 (Fed. Cir. 2016). This inquiry asks whether one of ordinary skill in the art would have had a reasonable expectation of combining the references to achieve what is claimed in the patent-at-issue. *Id.* at 1367. The inquiry does not look to whether unclaimed elements or functions would or would not also be achieved, or whether “one would reasonably expect the prior art reference to operate as those references intended once combined.” *Id.*

The claims of the '951 patent do not require the printhead to operate in any particular manner or achieve any particular operational parameters. Ex. 1001, 6:51–8:62. And, Mr. Curley credibly testifies that all of the components described in Hamafuku, Imanaka, and Whitman “were well-

known at the time” and “it would have been straightforward for a [person of ordinary skill in the art] to modify Hamafuku’s printhead to include Imanaka and Whitman’s structures and dimensions.” Ex. 1002 ¶ 409 (asserting that the combined system of Hamafuku, Whitman, and Imanaka “would work”).

Patent Owner contends one of ordinary skill in the art would not have had a reasonable expectation of success in achieving the claimed nozzle spacing in Hamafuku’s printhead using the dimensions of “Imanaka’s specialized all silicon pressure chambers and components arranged therein.” PO Resp. 55. As noted above, however, Petitioner does not propose to use the specific components of Imanaka’s pressure chambers, such as the moveable member. Pet. Reply 16–17. Moreover, Imanaka does not require silicon-based materials in its design and discloses how to reduce the size of the heaters (and corresponding driver circuitry) to achieve 600 DPI and higher nozzle arrangements. And, although the use of non-silicon-based materials may reduce, to some degree, the mechanical characteristics and reliability of the resulting printhead, there are no mechanical or reliability requirements recited in the challenged claims.

Patent Owner contends Petitioner fails to acknowledge that “nozzle spacing is limited by, among other things, the amount of thick film layer needed to construct walls between ink channels and bubble chambers that can withstand the expected operating pressures.” PO Resp. 54. According to Mr. Curley, it was through the use of silicon-based materials that Imanaka was able to achieve a narrow pitch. Ex. 2003 ¶¶ 91–92 (asserting that moving the chamber walls of Hamafuku closer together would risk damage from the nearby heater elements).

We are not persuaded by this argument. First, Patent Owner points to no disclosure in Imanaka that silicon-based materials are required, much less

a disclosure that such materials were the reason for achieving its recited nozzle pitch. Second, Imanaka discloses that any film with suitable mechanical strength and heat resistance could be used, and there is no persuasive evidence or argument indicating that the thick film layers of Hamafuku or Whitman would not have sufficient mechanical strength and heat resistance. Pet. Reply 10–11, 19. Indeed, the printhead of the '951 patent has a higher nozzle pitch than Imanaka and the '951 patent specification discloses no concerns regarding the type of material used in the thick film layer, or any concerns with using a polymeric material. *See* Ex. 1001, 5:38–43; *compare* Ex. 1001, 6:66–67 (claiming a nozzle pitch “from about 600 to about 2400 dpi”), *with* Ex. 1008, 7:16–19 (disclosing a nozzle pitch selected in the range of 15 to 42 μm ¹³).

In view of the foregoing, we determine that Petitioner sufficiently explains why one of ordinary skill in the art would have sought to combine Hamafuku, Whitman, and Imanaka to arrive at the claimed invention with a reasonable expectation of success. Accordingly, Petitioner demonstrates by a preponderance of the evidence that claim 1 would have been obvious¹⁴ over the combined disclosures of Hamafuku, Whitman, and Imanaka.

4. Analysis: Claims 2–4, 6, 9, 10, 20, and 24

Petitioner identifies where Hamafuku, Whitman, and Imanaka disclose every limitation of claims 2–4, 6, 9, 10, 20, and 24. Pet. 73–79, 82–86.

¹³ As discussed above, Petitioner presents evidence that a nozzle pitch of 42 μm equates to a 600 dpi printhead and a nozzle pitch of 15 μm equates to a 1693 dpi printhead. Pet. 69–70 n.39

¹⁴ Patent Owner did not introduce evidence of objective indicia of nonobviousness in this proceeding.

Patent Owner does not contest that each limitation of these claims is disclosed in these references, apart from its arguments above regarding claim 1.

Upon review of Petitioner's arguments and supporting evidence, we determine that Petitioner demonstrates by a preponderance of the evidence that claims 2–4, 6, 9, 10, 20, and 24 would have been obvious in view of Hamafuku, Whitman, and Imanaka.

5. Analysis: Claims 7, 21, and 22

Claims 7 and 22 both require “wherein the ink feed edge comprises an ink feed slot, and wherein the semiconductor substrate contains two or more ink feed slots.” Ex. 1001, 7:17–19, 8:25–27. Claim 21 requires “wherein the ink feed edge comprises an ink feed slot, and wherein the plurality of heater resistors are disposed on both sides of the ink feed slot.” *Id.* at 8:21–24.

Petitioner acknowledges that Hamafuku does not expressly disclose “two or more ink feed slots,” but contends that it would have been an obvious design choice to include an ink feed edge on each of the outer edges of substrate 24 of Hamafuku. Pet. 77–79 (citing Ex. 1002 ¶¶ 361–362); *see id.* at 80 (noting that Whitman discloses a multi-color printhead chip that utilizes three ink vias or channels 216). Petitioner contends that adding a second column of nozzles would advantageously increase the number of dots on the page by adding a second column of heater/chamber/nozzles. *Id.* at 77–80. Thus, Petitioner contends Hamafuku, or Hamafuku in combination with Whitman, discloses every limitation of claims 7, 21, and 22. *Id.* at 81, 85.

Patent Owner contends one of ordinary skill in the art would not have used multiple ink feed slots in Hamafuku because using a single ink feed slot was “one of the main ways in which Hamafuku purports to provide a miniaturized device,” and Hamafuku explains that its single-chamber design eliminates the need for holes in substrate 24. PO Resp. 58–61. Patent Owner further contends that using two ink feed slots in Hamafuku “would increase the size of the print head by requiring additional silicon substrate surface area.” *Id.* at 61.

As noted by Patent Owner, Hamafuku specifically contemplates using only one ink feed slot in its printhead and notes that this “eliminat[es] the need for holes in the substrate 24 for forming the common ink chamber.” Ex. 1007, code (57), ¶ 10. Often, however, a particular combination will have simultaneous advantages and disadvantages and this does not necessarily obviate motivation to combine. *See Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006). Here, although use of two ink feed slots in Hamafuku would increase the size of the printhead and potentially require drilling substrate 24, we find Petitioner’s argument persuasive that one of ordinary skill in the art, seeking to increase the number of dots on a page, would have found it obvious to use two ink feed slots in Hamafuku. The choice of whether to create more dots versus a smaller printhead would be a design choice determined based on which features are desired for a particular application.

In view of the foregoing, and for the reasons set forth in the Petition, we determine that Petitioner demonstrates by a preponderance of the evidence that claims 7, 21, and 22 would have been obvious in view of the combined disclosures of Hamafuku, Whitman, and Imanaka.

G. Obviousness in View of Hamafuku, Whitman, Imanaka, and Cleland

Claim 5 depends from claim 1 and further requires “wherein the nozzle holes comprise oblong nozzle holes having a long axis to diameter ratio greater than about 1.15.” Ex. 1001, 7:10–12. Petitioner contends that the subject matter of claim 5 would have been obvious in view of the combined disclosures of Hamafuku, Whitman, Imanaka, and Cleland. Pet. 90–91.

In support of its argument, Petitioner identifies where Cleland discloses oblong nozzle holes having a long axis to diameter ratio of 2:1 to 5:1, i.e., greater than about 1.15. Pet. 90–91. Petitioner also persuasively argues that one of ordinary skill in the art would have sought to use the oblong nozzle holes of Cleland in view of Cleland’s disclosure that such nozzles provide “increased control over the direction of the ink droplet” and “reliable placement of ink dots on the medium,” and “reduce[] . . . satellite droplets and spray.” *Id.* at 92 (citing Ex. 1006, 10:55–62, 11:24–31; Ex. 1002 ¶ 422).

Patent Owner does not contest that Cleland discloses the subject matter of claim 5, apart from its argument with respect to claim 1 above. PO Resp. 61. Nor does Patent Owner contest that one of ordinary skill in the art would have sought to combine Cleland with Hamafuku, Whitman, and Imanaka. *Id.*

Upon review of the parties’ arguments and supporting evidence, we determine that Petitioner demonstrates by a preponderance of the evidence that claim 5 would have been obvious in view of Hamafuku, Whitman, Imanaka, and Cleland.

IV. CONCLUSION¹⁵

For the foregoing reasons, we determine that Petitioner demonstrates by a preponderance of the evidence that claims 1–7, 9, 10, 20–22, and 24 are unpatentable. Our conclusions are summarized in the following table.

Claim(s)	35 U.S.C. §	Reference(s)/Basis	Claim(s) Shown Unpatentable	Claims Not Shown Unpatentable
1–3, 6, 9, 10	103	Powers, Whitman		1–3, 6, 9, 10
4, 5, 7, 20–22, 24	103	Powers, Whitman, Cleland		4, 5, 7, 20–22, 24
1–4, 6, 7, 9, 10, 20–22, 24	103	Hamafuku, Imanaka, Whitman	1–4, 6, 7, 9, 10, 20–22, 24	
5	103	Hamafuku, Imanaka, Whitman, Cleland	5	
Overall Outcome			1–7, 9, 10, 20– 22, 24	

¹⁵ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

ORDER

For the foregoing reasons, it is:

ORDERED that Petitioner demonstrates that challenged claims 1–7, 9, 10, 20–22, and 24 of the '951 patent are unpatentable; 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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