

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CANON U.S.A., INC., AND CANON INC.,

Petitioners,

v.

SLINGSHOT PRINTING LLC,

Patent Owner.

Case No. IPR2023-00313

Patent No. 7,594,708

PETITION FOR *INTER PARTES* REVIEW OF

U.S. PATENT NO. 7,594,708

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I. INTRODUCTION

Pursuant to 35 U.S.C. § 311 and 37 C.F.R. § 42.100 et seq., Petitioners request *Inter Partes* Review (“IPR”) of claims 1-15 (“Challenged Claims”) of U.S. Patent No. 7,594,708 (“’708 Patent,” Ex.1001), purportedly owned by Slingshot Printing LLC (“Patent Owner”).

II. MANDATORY NOTICES

Real Party-in-Interest: The real parties-in-interest are **Canon U.S.A., Inc.** and **Canon Inc.**

Related Matters: The ’708 Patent was asserted against Petitioner Canon U.S.A., Inc. as well as Canon Solutions America, Inc. in *Slingshot Printing LLC v. Canon U.S.A., Inc., et al.*, No. 2:22-cv-01852 (E.D.N.Y.), filed on April 1, 2022. The ’708 Patent was previously asserted against HP Inc. in *Slingshot Printing LLC v. HP Inc.*, No. 6-20-cv-00048, reassigned as No. 1:20-00189 (W.D. Tex.), and dismissed with prejudice on March 24, 2021, following the parties’ joint stipulation of dismissal. Petitioners are not aware of the ’708 Patent being asserted against other parties.

Lead Counsel: Dion M. Bregman (Reg. No. 45,645); Back-up Counsel: Amanda S. Williamson (Reg. No. 73,683) and Jason E. Gettleman (Reg. No. 55,202).

Service: Service of any documents may be made to Morgan, Lewis & Bockius LLP, 1400 Page Mill Road, Palo Alto, CA, 94304 (Telephone: 650.843.4000; Fax: 650.843.4001). Petitioners consent to e-mail service at: CanonSlingshotIPRs@morganlewis.com.

III. IDENTIFICATION OF CLAIMS AND GROUNDS

'708 Patent: The '708 Patent, filed on December 30, 2005, has an earliest possible priority date of **December 30, 2005**. It is subject to the pre-AIA provisions of 35 U.S.C. §§ 102 and 103.

Benjamin: U.S. Patent No. 7,384,113 titled “Fluid Ejection Device with Address Generator” to Benjamin *et al.* (“Benjamin”; Ex.1004) was filed on **April 19, 2004** and published on June 10, 2008. It is prior art under 35 U.S.C. § 102(e).

Giere673: U.S. Patent No. 6,612,673 titled “System and Method for Predicting Thermal Conditions of an Inkjet Printing System” to Giere *et al.* (“Giere673”; Ex.1005) was filed on **April 29, 2002** and published **September 2, 2003**. It is prior art under 35 U.S.C. § 102(b).

Parish: U.S. Patent No. 7,163,272 titled “Inkjet Print Head” to Parish *et al.* (“Parish”; Ex.1006) was filed on **June 10, 2004** and published January 16, 2007. It is prior art under 35 U.S.C. § 102(e).

Giere178: U.S. Patent No. 6,565,178 titled “Temperature Measurement Device” to Giere *et al.* (“Giere178”; Ex.1007) was filed on **October 29, 2001** and published **May 20, 2003**. It is prior art under 35 U.S.C. § 102(b).

Yabe: U.S. Patent No. 6,527,367 titled “Ink Jet Recording Head and Ink Jet Recording Apparatus” to Yabe (“Yabe”; Ex.1008) was filed on **September 4, 2001** and published on **March 4, 2003**. It is prior art under 35 U.S.C. § 102(b).

Petitioners request that the Board find each of the Challenged Claims invalid on the following grounds:

Ground	Prior Art	Statutory Basis	Claims
1	Benjamin and Giere673	§ 103	1-3, 5-12, 14-15
2	Benjamin, Giere673, and Parish	§ 103	4, 13
3	Giere178	§ 103	1-3, 5-12, 14-15
4	Giere178 and Yabe	§ 103	1-3, 5-12, 14-15
5	Giere178 and Parish	§ 103	4, 13
6	Giere178, Yabe, and Parish	§ 103	4, 13

In his Declaration accompanying this Petition, Dr. Pond provides a thorough summary of the ’708 Patent (Ex.1002, ¶¶47-49), the prior art (Ex.1002, ¶¶60-106), as well as the relevant technology at issue in this matter (Ex.1002, ¶¶22-46).

IV. CERTIFICATION AND FEES

Petitioners certify that the '708 Patent is available for IPR and that Petitioners are not barred or estopped from requesting this IPR on the grounds identified herein.

Any additional fees may be charged to Deposit Account No. 50,0310 (Order No. 132261-00-0003).

V. PTAB DISCRETION SHOULD NOT PRECLUDE INSTITUTION

The PTAB should not discretionarily deny institution per *Fintiv* because the Petition is particularly strong in the underlying merits. *See, e.g., Apple Inc. v. RFCyber Corp.*, IPR2022-00412, Paper 11 at 33-34 (PTAB July 21, 2022); Interim Procedure for Discretionary Denials In AIA Post Grant Proceedings With Parallel District Court Litigation, PTO Director's Memorandum, 9 (June 21, 2022).

Moreover, the stage of the parallel district court litigation does not support denying institution based on the *Fintiv* factors:

Factor 1 favors institution because the district court has granted a temporary stay and will extend that stay upon the filing of this Petition. Exs.1021, 1022, 1023 at 10-11.

Factor 2 favors institution because the district court litigation is in its early stage with **no trial date set**. Trial cannot occur until **after** the last date set in the parties' Case Management Schedule, i.e., **October 25, 2024**. Ex.1024 at 2.

Moreover, the median time to trial in EDNY is 48.9 months (~4 years) such that the final written decision will be issued well before any trial date.

Factor 3 favors institution because the litigation was stayed in the early stages (e.g., no claim construction or dispositive motions have been filed). Exs.1021, 1022, 1023 at 10-11.

Factor 4 favors institution because Petitioners challenge every claim asserted in the litigation (claims 1-3, 5-6, 8-12, and 14-15) and multiple unasserted claims (claims 4, 7, and 13). *See* Ex.1025. Further, the invalidity contentions include some prior art cited in this Petition making it more efficient for the Board to handle the overlapping prior art.

Factor 5 is neutral because Petitioner Canon U.S.A., Inc. is a defendant in the district court litigation, but Petitioner Canon Inc. is not.¹

Factor 6 favors institution and is **dispositive** under the Guidance because the **unpatentability challenges here are compelling** and **rely on references that were not before the Office**. This IPR is the first challenge to the '708 Patent before the Board, which favors institution, and there is a strong public interest against "leaving bad patents enforceable." *Thryv, Inc. v. Click-To-Call Techs., LP*, 140 S. Ct. 1367, 1374 (2020).

¹ Canon Solutions America, Inc. in the litigation is not a real-party-in interest here.

Because all *Fintiv* factors favor institution or are neutral, Petitioners respectfully request that the Board decline discretionarily denying review.

VI. LEVEL OF SKILL

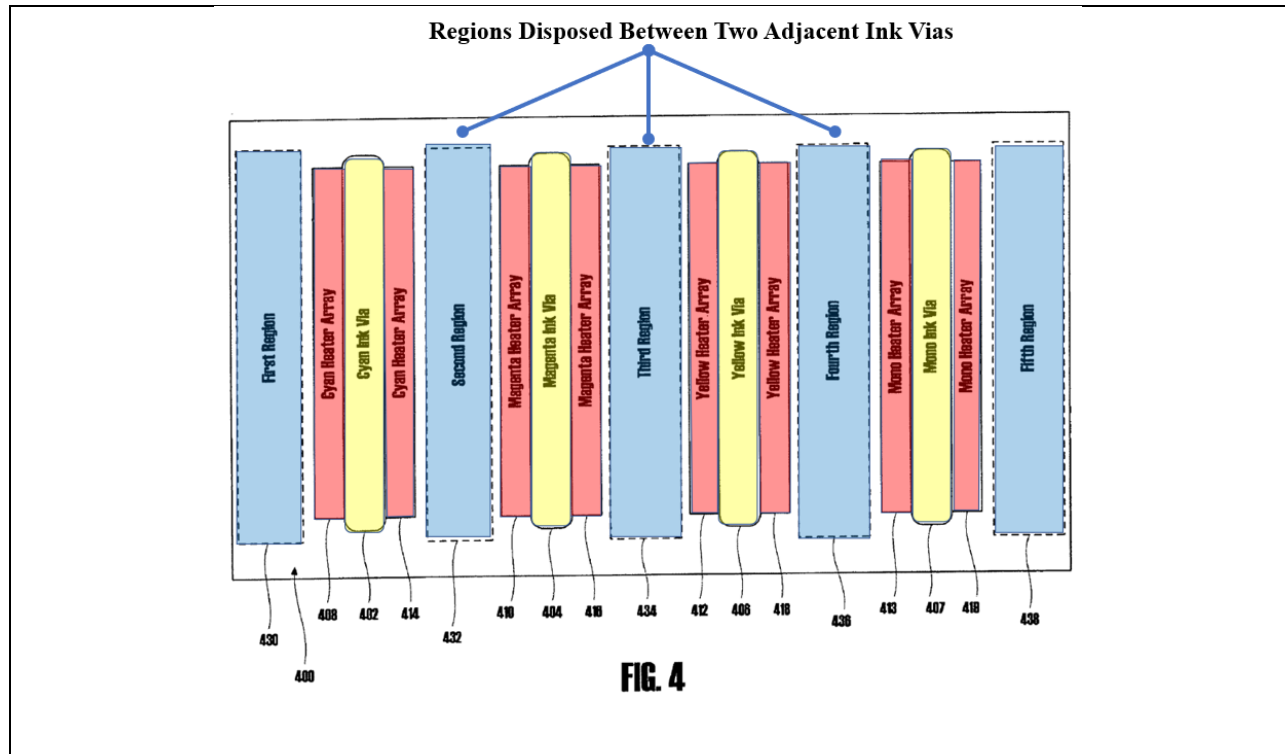
A person having ordinary skill in the art (“PHOSITA”) at the time of the alleged invention would have been a person holding a Bachelor’s or Master’s level college degree in Mechanical Engineering, Materials Science, Physics, Electrical Engineering, or a related field, and two years of training or experience in the design of inkjet printheads or semiconductor circuit layout. Ex.1002 ¶¶107-109.

VII. CLAIM CONSTRUCTION

A. “Adjacent”

Independent Claims 1 and 9 claim a heater chip comprising, *inter alia*, (1) “a plurality of ink vias [yellow]... each of the ink vias having two longitudinal sides,” (2) “a heater array [red] disposed adjacent each longitudinal side of the ink vias,” and (3) “a region [blue] disposed adjacent each heater array,” as shown in Figure 4 of the ’708 Patent below.

Ex.1001, Fig. 4



However, for those regions disposed between two adjacent ink vias (e.g., 432, 434, 436), claims 1 and 9 deviate from the Figure 4 by requiring not only that the region be disposed “adjacent each heater array,” but also that the “region ...includes two heater arrays.” *Id.* And since “only one region [is] disposed between two adjacent ink vias” and “each heater array being associated with their respective ink via,” claims 1 and 9 effectively require that any “region between two adjacent ink vias” be both “adjacent” to and “include” the *same* two heater arrays. Thus, as used in the ’708 Patent, the term adjacent means “next to and can include,”² such that a

² Prior art dictionaries consistently define “adjacent” as “next to.” See Ex.1012, Ex.1013.

region disposed “adjacent” each heater array can also “include” that adjacent heater array. This is consistent with the ’708 Patent specification describing “heaters within each region.” Ex.1001 at 7:45-50.

VIII. ARGUMENT

A. Ground 1: Benjamin in view of Giere673 Renders Obvious Claims 1-3, 5-12, and 14-15

1. Claims 1 and 9³

a. 1[P] “A chip for use with a printing device”

The preamble is non-limiting because it merely recites the purported invention’s use. *See, e.g., Kaidi LLC et al. v. Limoss US, LLC*, IPR2019-01184, Paper 16 at 12-13 (PTAB Dec. 11, 2019). To the extent it is found limiting, Benjamin discloses 1[P]. Ex.1002 ¶¶114-119.

Benjamin teaches “an inkjet printing system 20”—*e.g.*, an inkjet printer or other printing device—that comprises, among other things, (i) an “inkjet printhead assembly 22” (*yellow*) with at least “one printhead or **printhead die 40**” (*magenta*) that “causes characters, symbols, and/or other graphics or images to be printed upon [a] print medium 36” (*orange*) “such as paper. Ex.1004, 3:32-33; *see also* 1:32-38, 6:3-5, 8-10, Figs. 2, 3.

³ The limitations of claim 9 mirror those of claim 1, and therefore are disclosed by Benjamin-Giere673 for the same reasons as Claim 1. A full claim listing can be found in the Appendix.

Ex.1004, Fig. 1

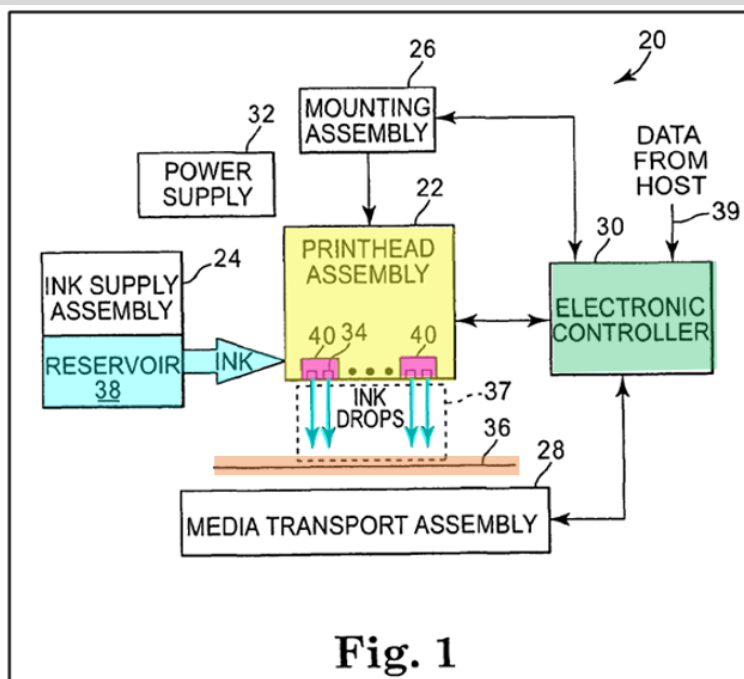


Fig. 1

A PHOSITA would have understood that the term “die” is another name for a chip such that the printhead die 40 used in Benjamin’s printing system 20 is synonymous with the term “chip for use with a printing device.” Ex.1002 ¶117. The ’708 Patent refers to printhead die as “**heater chips in the[] printheads.**” Ex.1001, 1:21-26; Ex.1002 ¶118.

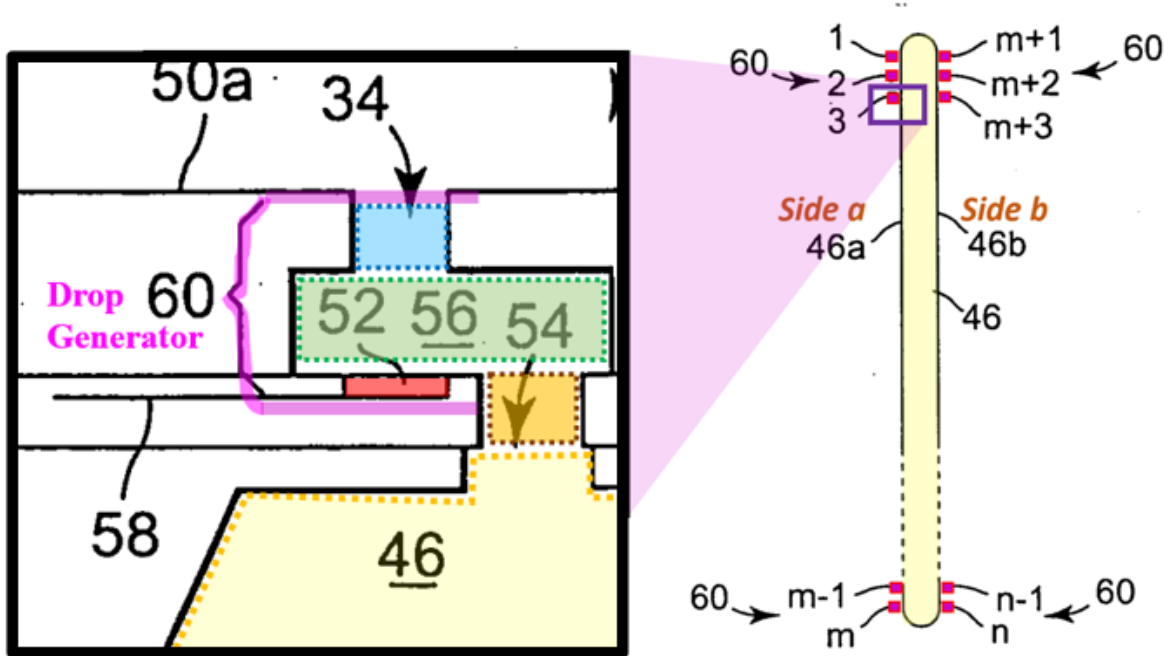
Accordingly, Benjamin discloses “**a chip** [e.g., printhead die] **for use with a printing device** [e.g., inkjet printer].” Ex.1002 ¶¶114-119.

b. 1[A] “a plurality of ink vias arranged parallel to one another, each of the ink vias having two longitudinal sides”

Benjamin discloses 1[A]. Ex.1002 ¶¶120-125.

Benjamin’s printhead includes one or more ink feed slots 46—each having two longitudinal sides “46a” and “46b”—and fluidically coupled to a column of drop generators 60 [*purple*] disposed on each of its longitudinal sides. Ex.1004, 5:53-54.

Ex.1004, Fig. 2



Benjamin teaches that the “printhead die 1700 includes . . . three ink fluid feed sources, here depicted as feed slots 1704 [*yellow*], 1706 [*magenta*] and 1708 [*cyan*],” which are arranged longitudinally and in parallel. Ex.1004, 63:20-24; 64:63, 66-65:1.

Ex.1004, Fig. 21

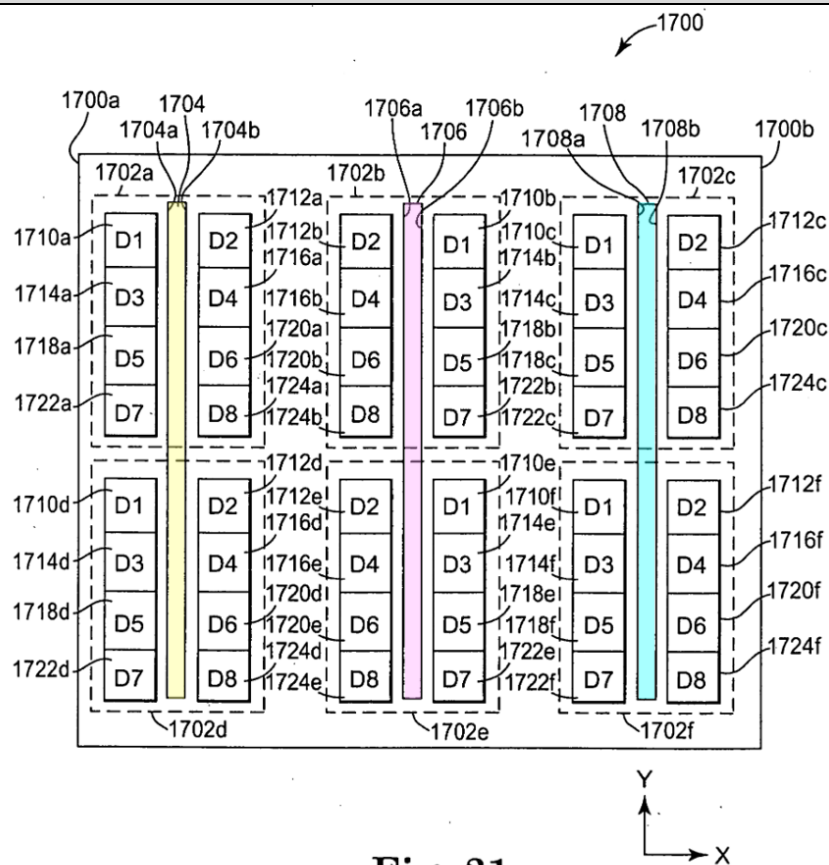


Fig. 21

Each ink feed slot has two longitudinal sides—longitudinal side a (*red*) and longitudinal side b (*green*)—that extend along the y-direction of the printhead die 1700—e.g., “ink feed slot 1704 includes opposing sides 1704 a and 1704 b . . .”

Ex.1004, 65:34-36; 66:37-39; 67:37-39; Fig. 21.

Ex.1004, Fig. 21

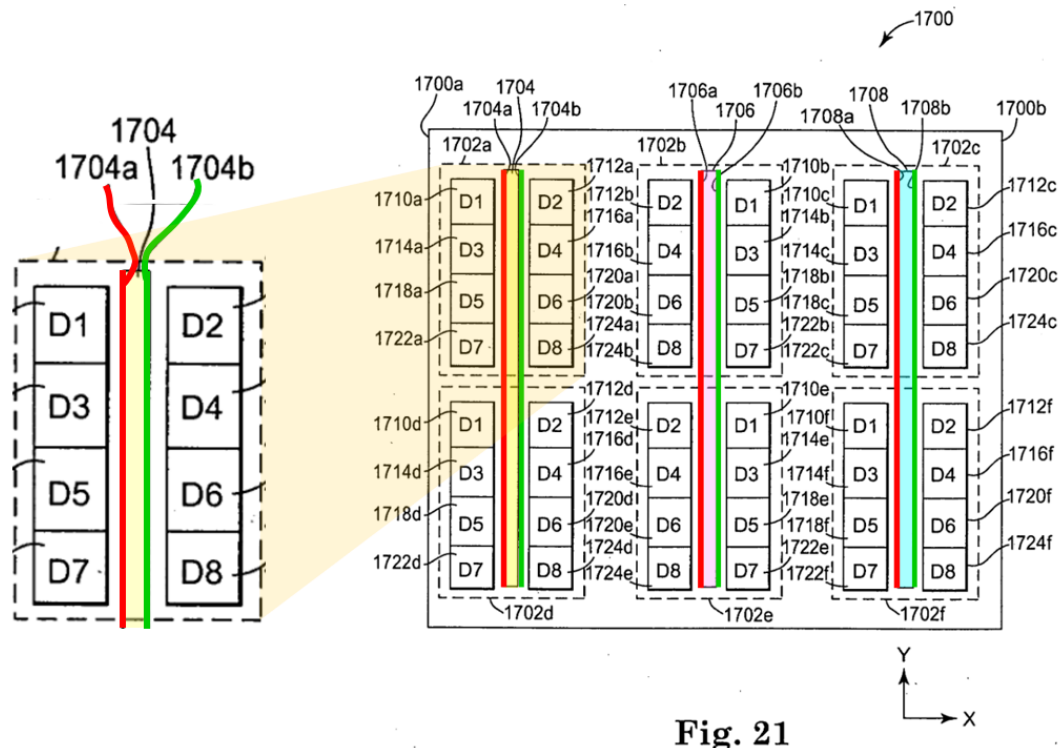


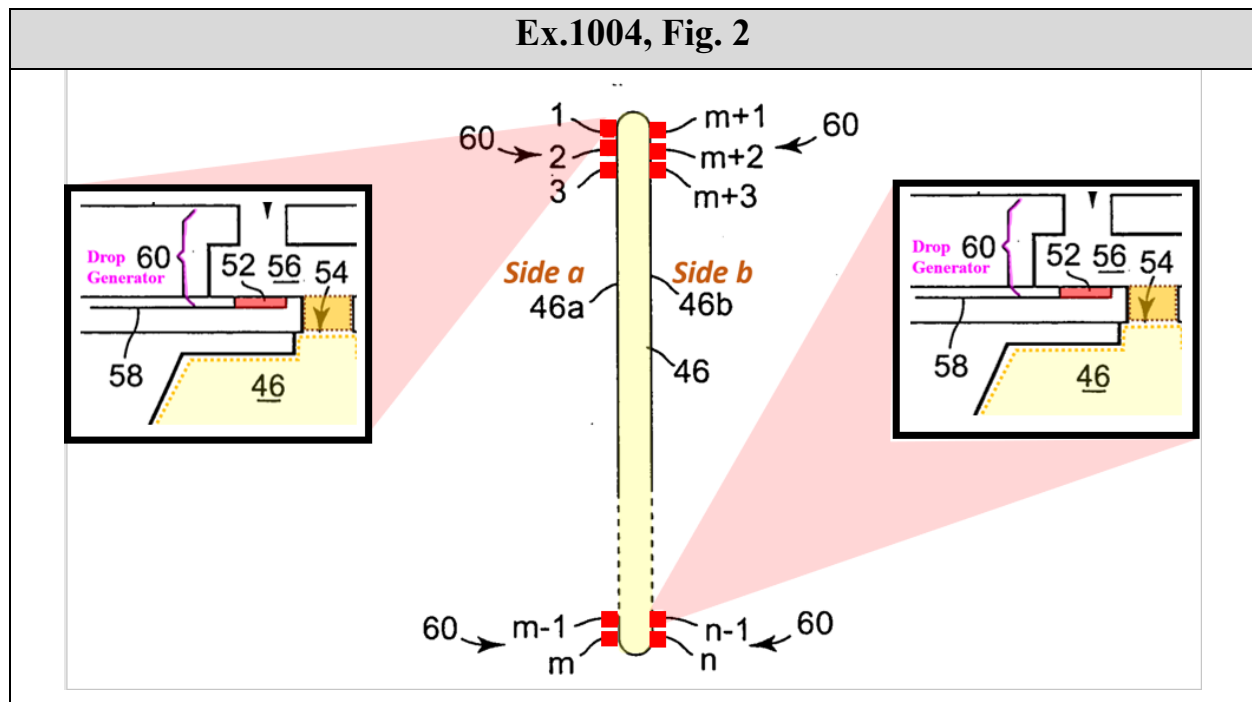
Fig. 21

Accordingly, Benjamin discloses “a **plurality of ink vias** [e.g., ink feed slots 1704] arranged parallel to one another, each of the ink vias having **two longitudinal sides** [e.g., sides 1704a and 1704b for ink feed slot 1704;].” Ex.1002 ¶¶120-125.

- c. **1[B] “a heater array disposed adjacent each longitudinal side of the ink vias such that each ink via is associated with two heater arrays disposed adjacent the two longitudinal sides of the ink via”**

Benjamin discloses 1[B]. Ex.1002 ¶¶126-134.

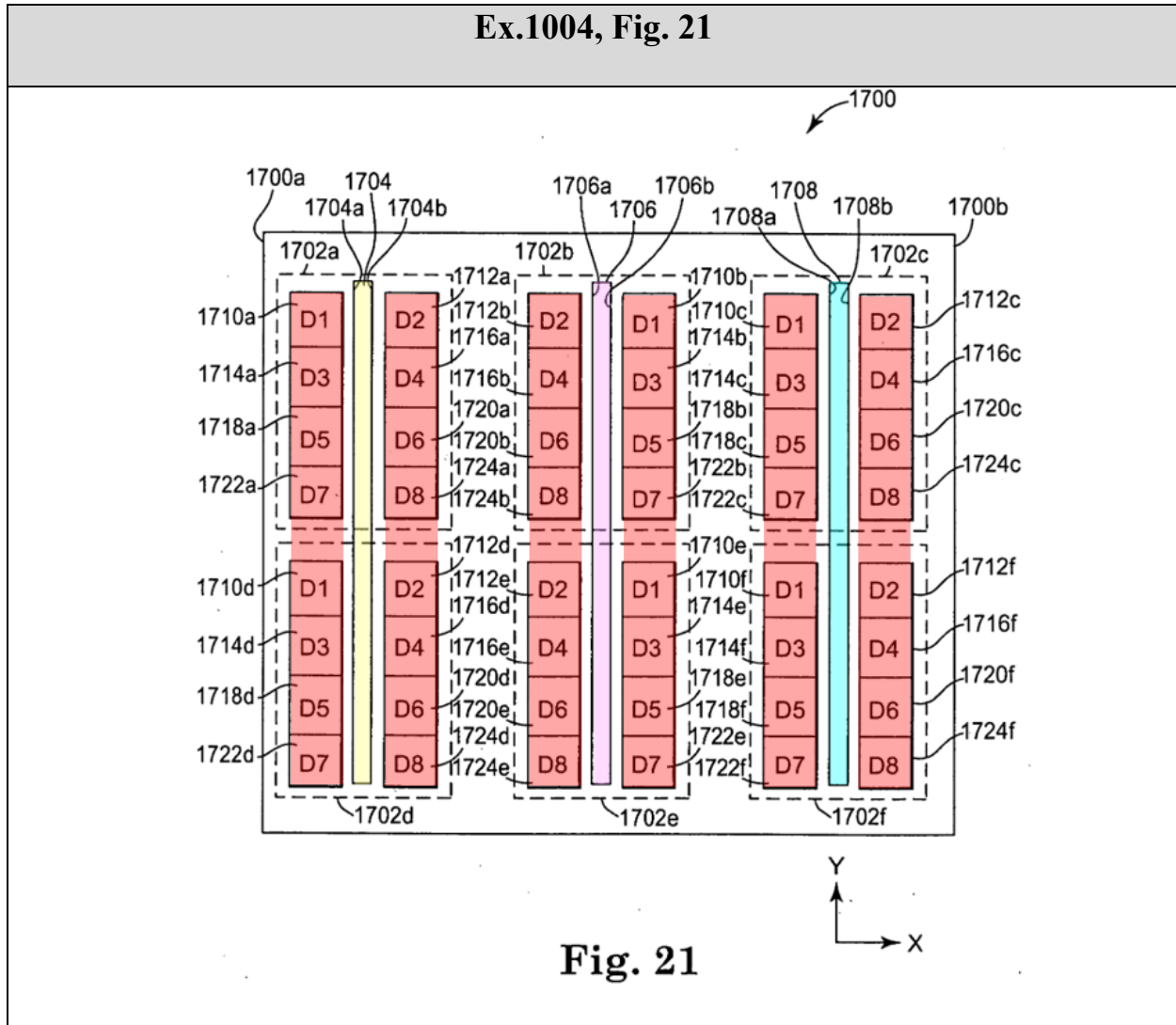
On each longitudinal side of the ink vias, Benjamin's printhead includes a "an array of printing or fluid ejecting elements 52" within drop generators 60. Ex.1004, 4:57-61; Fig. 2. "During printing, ink flows from ink feed slot 46 to vaporization chamber 56 via ink feed channel 54," and thereafter "[n]ozzle opening 34 is operatively associated with firing resistor 52 such that droplets of ink within vaporization chamber 56 are ejected through nozzle opening 34 (e.g., substantially normal to the plane of firing resistor 52) and toward print medium 36 upon energizing of firing resistor 52." Ex.1004, 5:5-21.



Referring to Figure 21, Benjamin teaches that the "printhead die 1700 includes six fire groups 1702a-1702f disposed along three ink fluid feed sources,

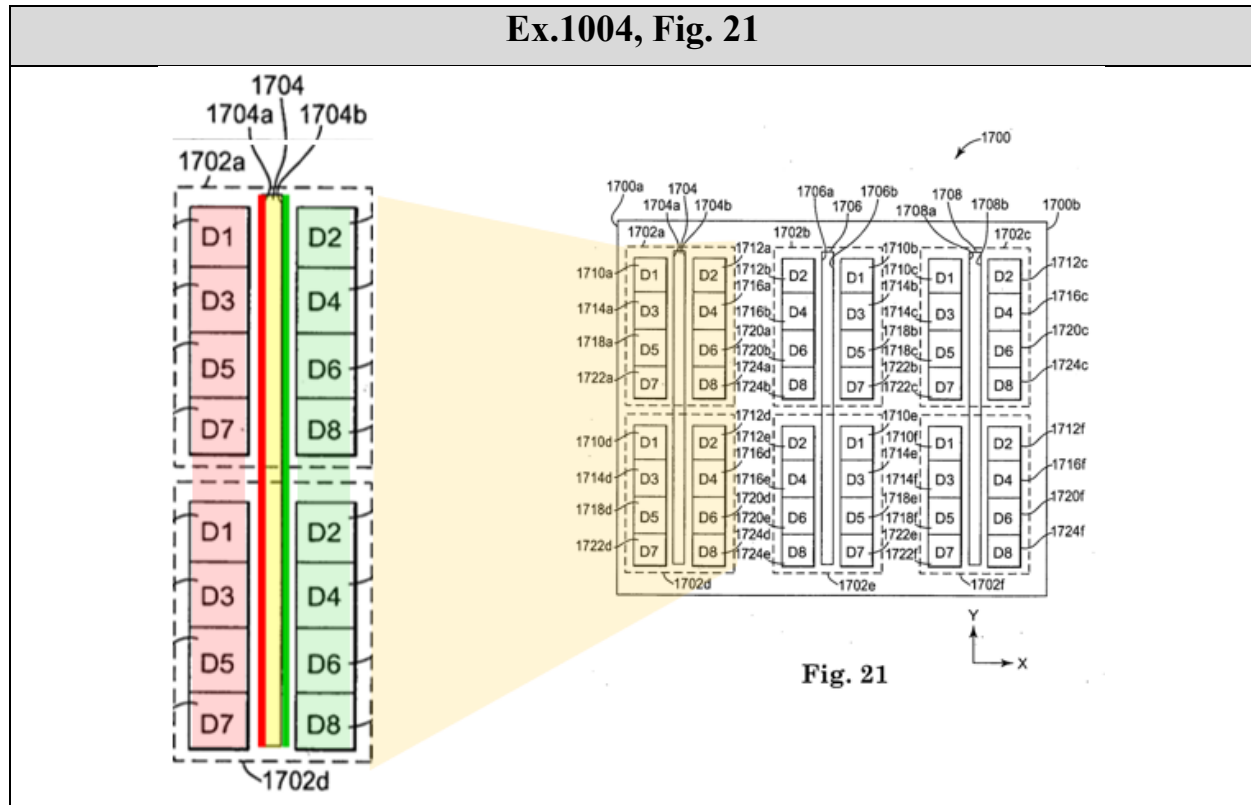
here depicted as feed slots 1704 [yellow], 1706 [cyan] and 1708 [purple].”

Ex.1004, 63:21-24, 39-42.



A PHOSITA would have understood that Benjamin’s layout of printhead die 1700 disposes a heater array *adjacent* each longitudinal side of the ink feed slots 1704, 1706, and 1708 because looking at ink feed slot 1704 (*yellow below*), for example, the firing resistors from the left half of FG 1 (1702a) and FG4 (1702d) (*red*) collectively form an array of heaters lying near or close to longitudinal side

1704a (*red*) of ink feed slot 1704 (*yellow*); and the firing resistors from the right half of FG 1 (1702a) and FG4 (1702d) (*green*) collectively form an array of heaters lying near or close to longitudinal side 1704b (*green*) of ink feed slot 1704 (*yellow*). Ex.1002 ¶132.

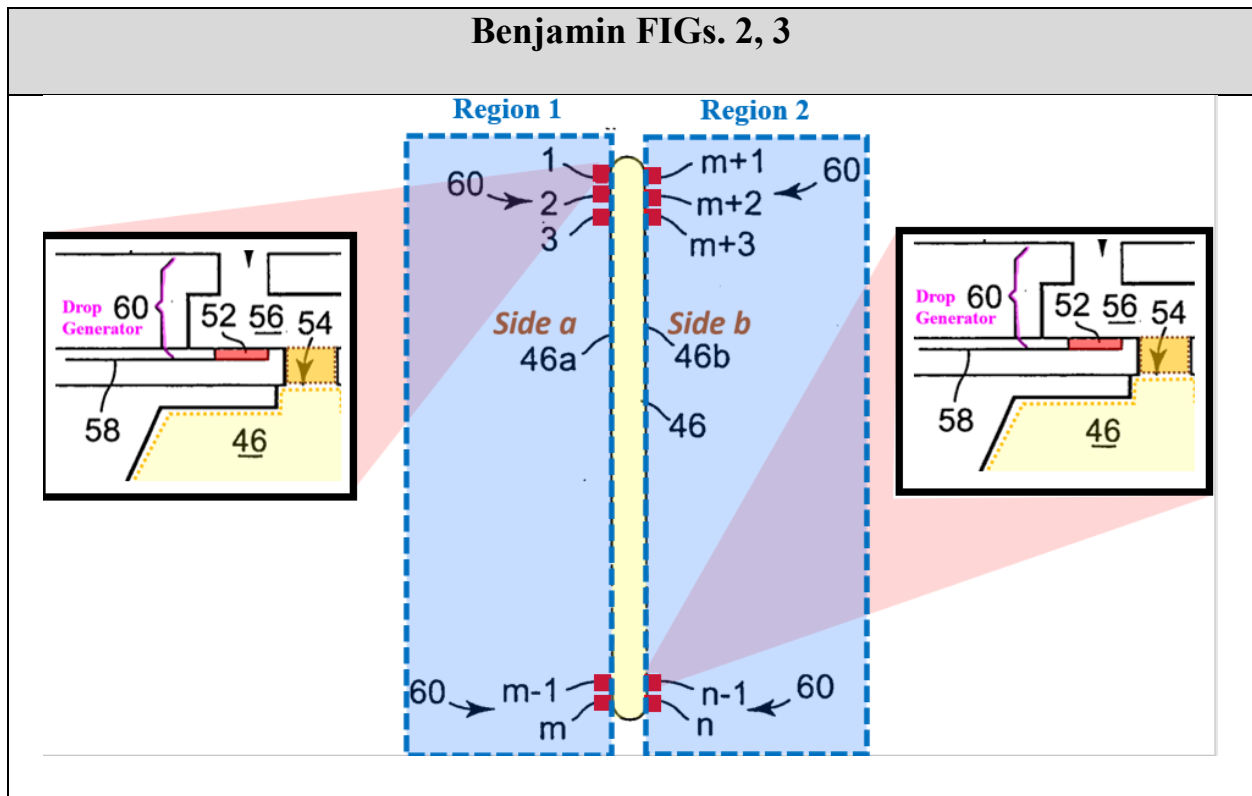


Accordingly, Benjamin discloses “**a heater array** [*e.g.*, a single vertical row of firing resistors 52 from FG1/FG4] disposed adjacent **each longitudinal side of the ink vias** [*e.g.*, sides 1704a and 1704 b for ink feed slot 1704] such that each ink via is associated with two heater arrays disposed adjacent the two longitudinal sides of the ink via.” Ex.1002 ¶¶126-134.

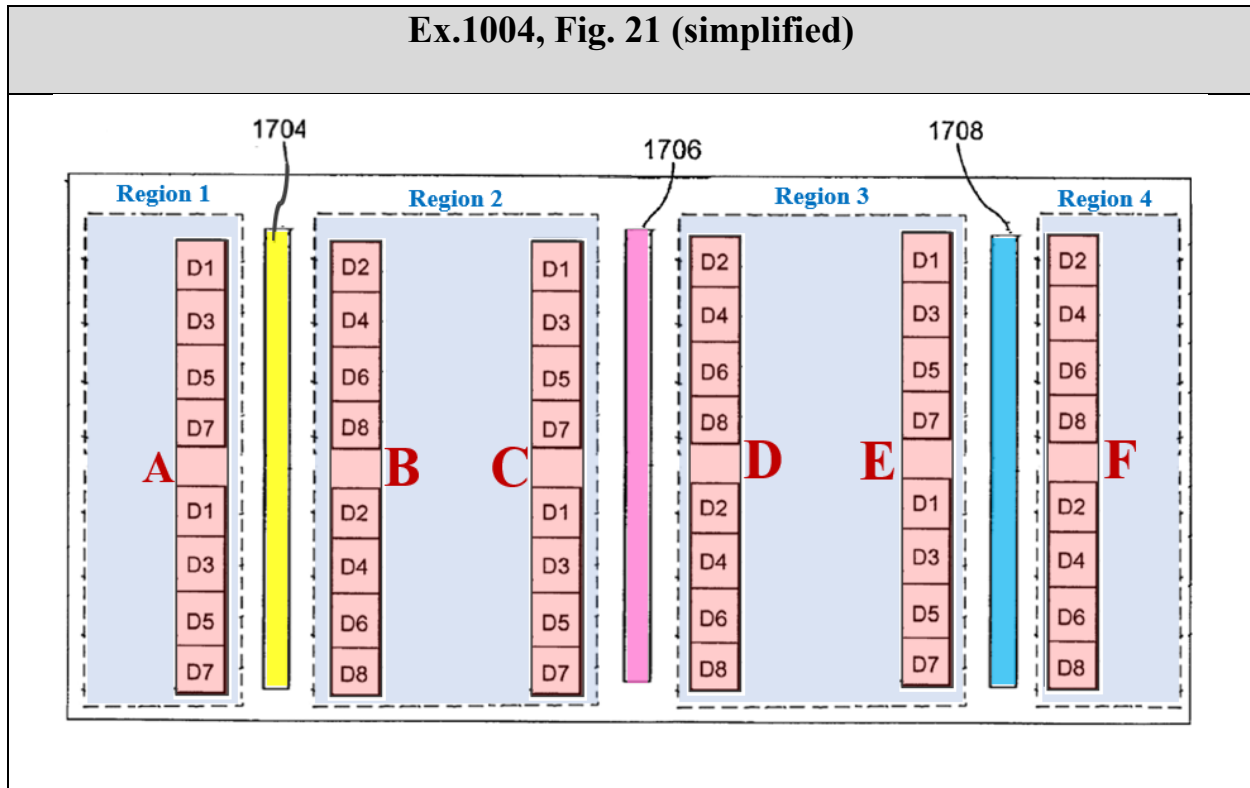
d. $1/C$ “a region disposed adjacent each heater array”

Benjamin discloses 1[C]. Ex.1002 ¶¶135-140.

Benjamin's printhead die discloses a region (e.g., Regions 1 and 2, *blue below*) adjacent to each array of firing resistors 52 [*red*] disposed on each longitudinal side of the ink feed slot [*yellow*]. Ex.1002 ¶136; Figs. 2, 3.



As seen in Figure 21 below, Benjamin also discloses at least one region on the printhead die 1700 (*e.g.*, Regions 1-4, *blue*) adjacent each heater array [column of firing resistors 52, *red*] on a longitudinal side of ink feed slots 1704 [*yellow*], 1706 [*magenta*], and 1708 [*cyan*] because each of those heater arrays is next to and can include a region. Ex.1002 ¶137.



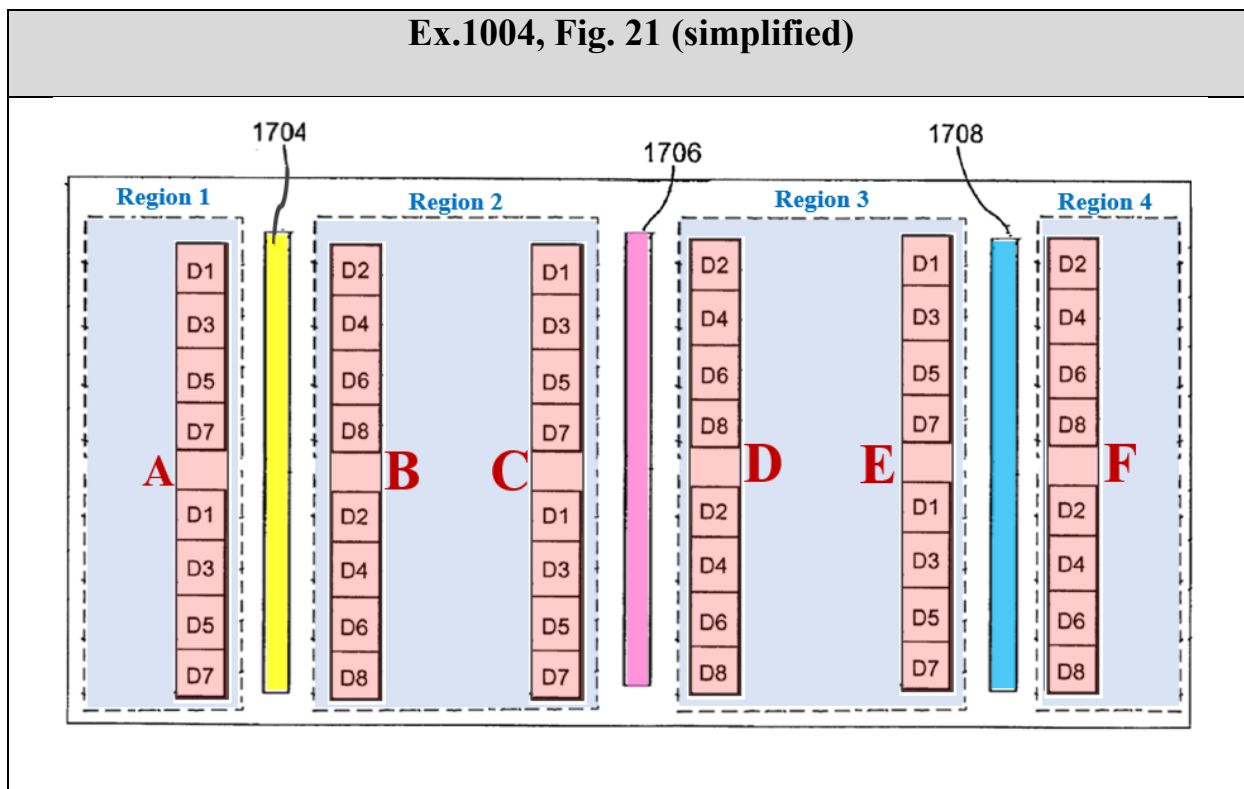
Accordingly, Benjamin discloses “a **region disposed adjacent each heater array** [e.g., Region 1 is next to and includes heater arrays B and C].” Ex.1002 ¶¶135-140.

- e. *1[D] “wherein only one region is disposed between two adjacent ink vias and wherein the region disposed between two adjacent ink vias includes two heater arrays each heater array being associated with their respective ink via”⁴*

Benjamin discloses 1[D]. Ex.1002 ¶¶141-148.

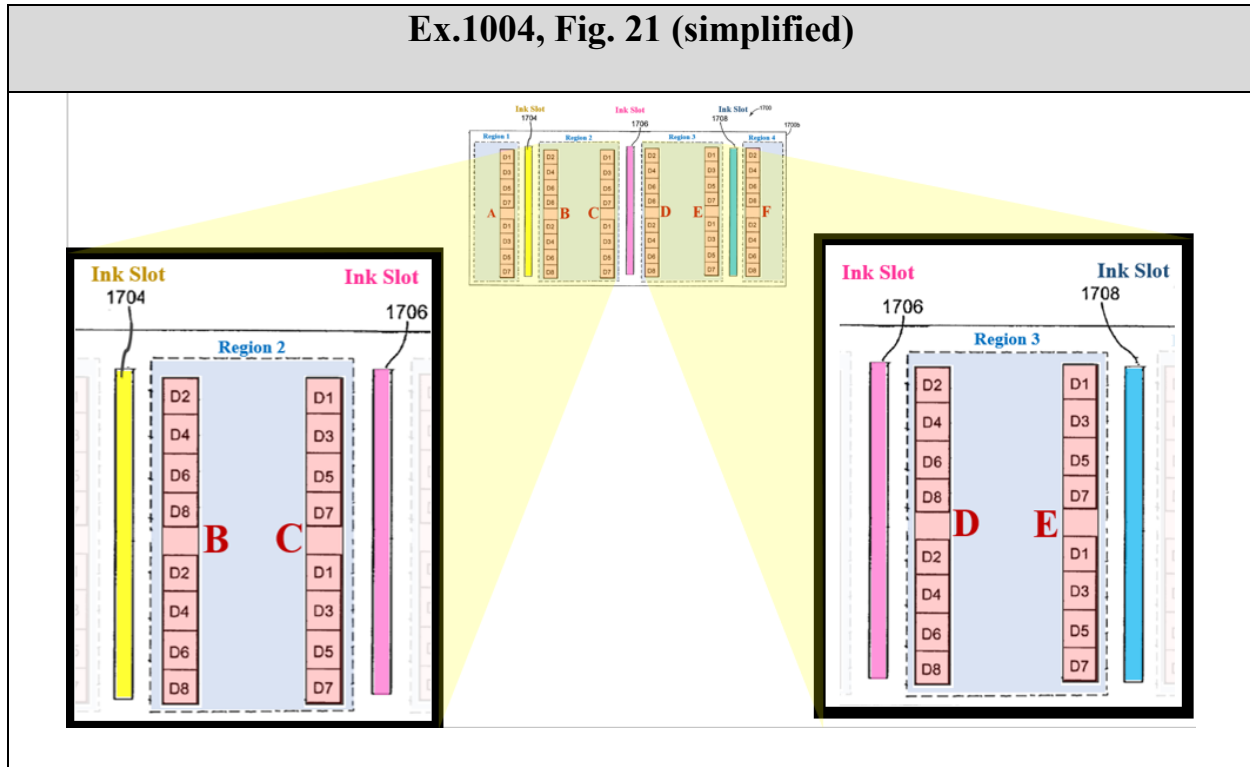
⁴ Petitioners reserve the right to argue that this limitation is indefinite in other forums.

Benjamin's printhead 1700 does not include one and only one region between two adjacent ink feed slots—e.g., only Region 2 is disposed between the yellow and magenta ink feed slots, and only Region 3 is disposed between the magenta and cyan ink feed slots. Ex.1002 ¶137. And each of those regions includes two heater arrays.



For example, Region 2 includes the heater arrays side 1704b of yellow ink via (Heater Array B) and those on side 1706a of the magenta ink via (Heater Array C), and Region 3 includes the heater arrays on side 1706b of the magenta ink via (Heater Array D) and those on side 1708a of the cyan ink via (Heater Array E).

See Ex.1002 ¶139. Each of the heater arrays “is fluidically coupled” to its associated ink via. Ex.1004, 6:1-2, 65:36-42, 66:41-43; Ex.1002 ¶146.

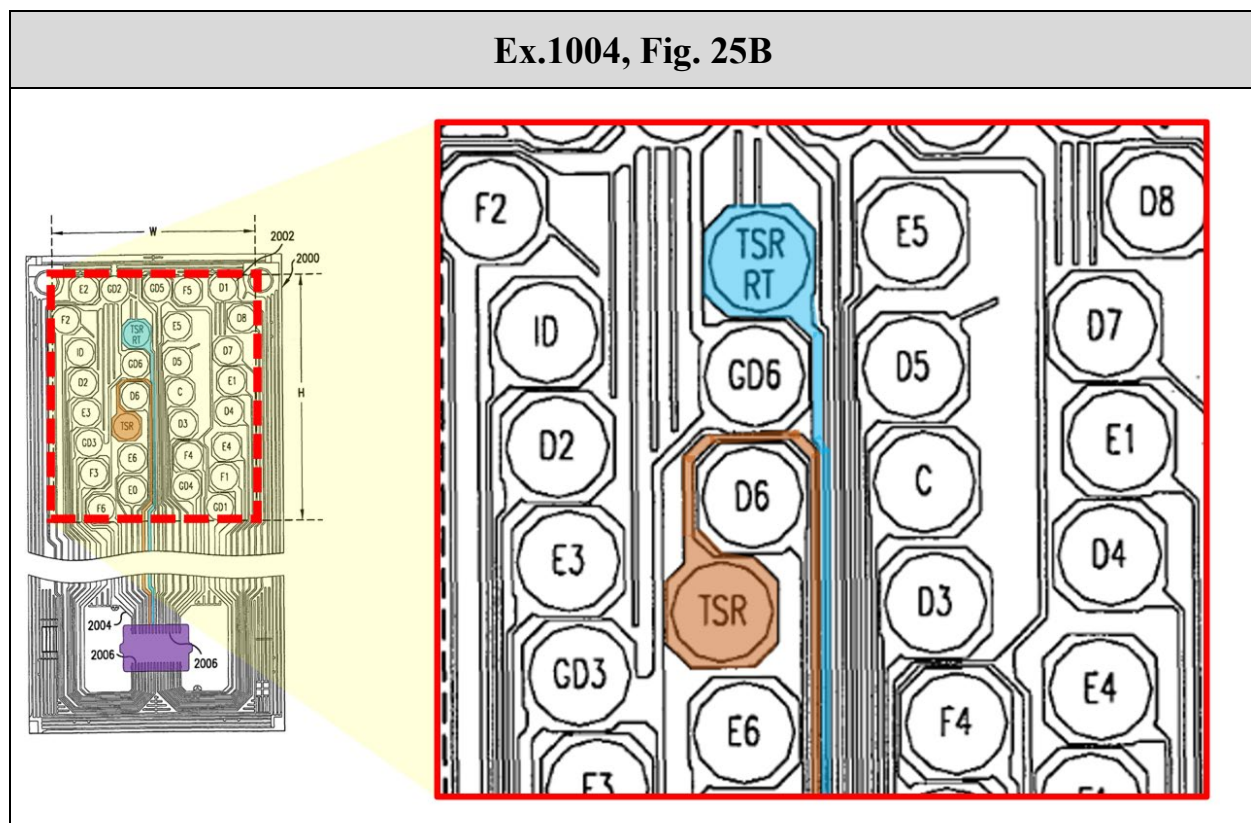


Accordingly, Benjamin discloses that “**only one region** is disposed between two adjacent ink vias [e.g., Region 2 between yellow and magenta vias] and wherein the region disposed between two adjacent ink vias includes two heater arrays [e.g., Heater Arrays B and C] each heater array being associated with their respective ink via [e.g., Heaters Array B and C associated with magenta and yellow ink vias, respectively].” Ex.1002 ¶¶141-148.

f. 1[E] “a single temperature sensing element disposed within each region”

Benjamin in view of Giere673 discloses 1[E]. Ex.1002 ¶¶149-169.

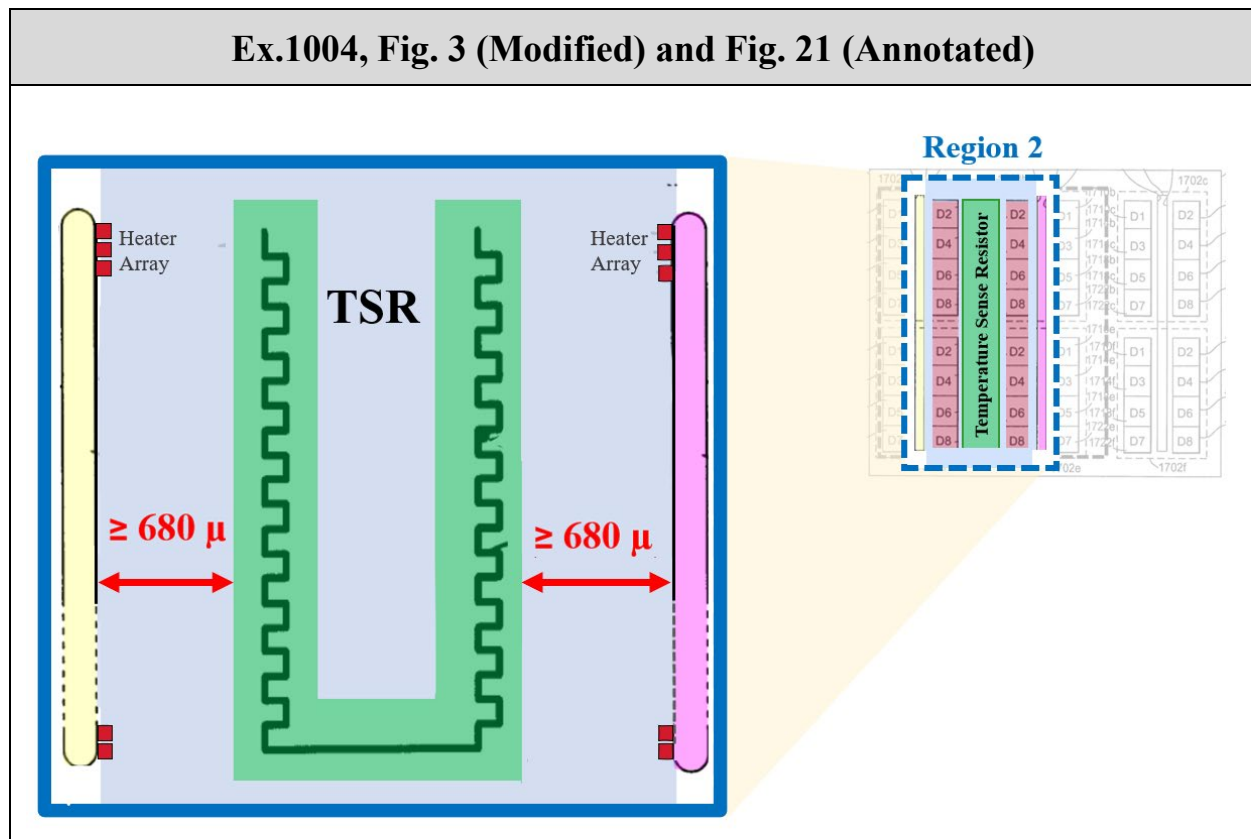
Benjamin’s printhead die includes a temperature sense resistor (TSR) that is coupled to a flex circuit via a “[t]emperature sense resistor contact area TSR (brown)” and “[a] temperature sense resistor return contact area TSR-RT (blue)” to determine a **temperature of the printhead die**, based upon a measurement of the resistor.” Ex.1004, 79:60-67; Ex.1004, 80:1-4; Ex.1002 ¶152.



Although Benjamin does not explicitly state *where* on the printhead die the TSR should be disposed, a PHOSITA would have looked to Giere673 for the

reasons described in Section VIII.A.2. Given the structural similarities between Benjamin and Giere673's printhead dies, a PHOSITA would have applied Giere673's teachings to Benjamin by (i) disposing a single TSR within a region of Benjamin's printhead formed between two adjacent heater arrays [*e.g.*, Region 2, *blue below*], and (ii) positioning the TSR equidistant from both heater array within the region but no less than approximately 680 μm inboard from the center of the heater arrays, as shown below, to ensure that the temperature value provided by the TSR reflects the mean temperature of the region. Ex.1002 ¶160-161.

Ex.1004, Fig. 3 (Modified) and Fig. 21 (Annotated)

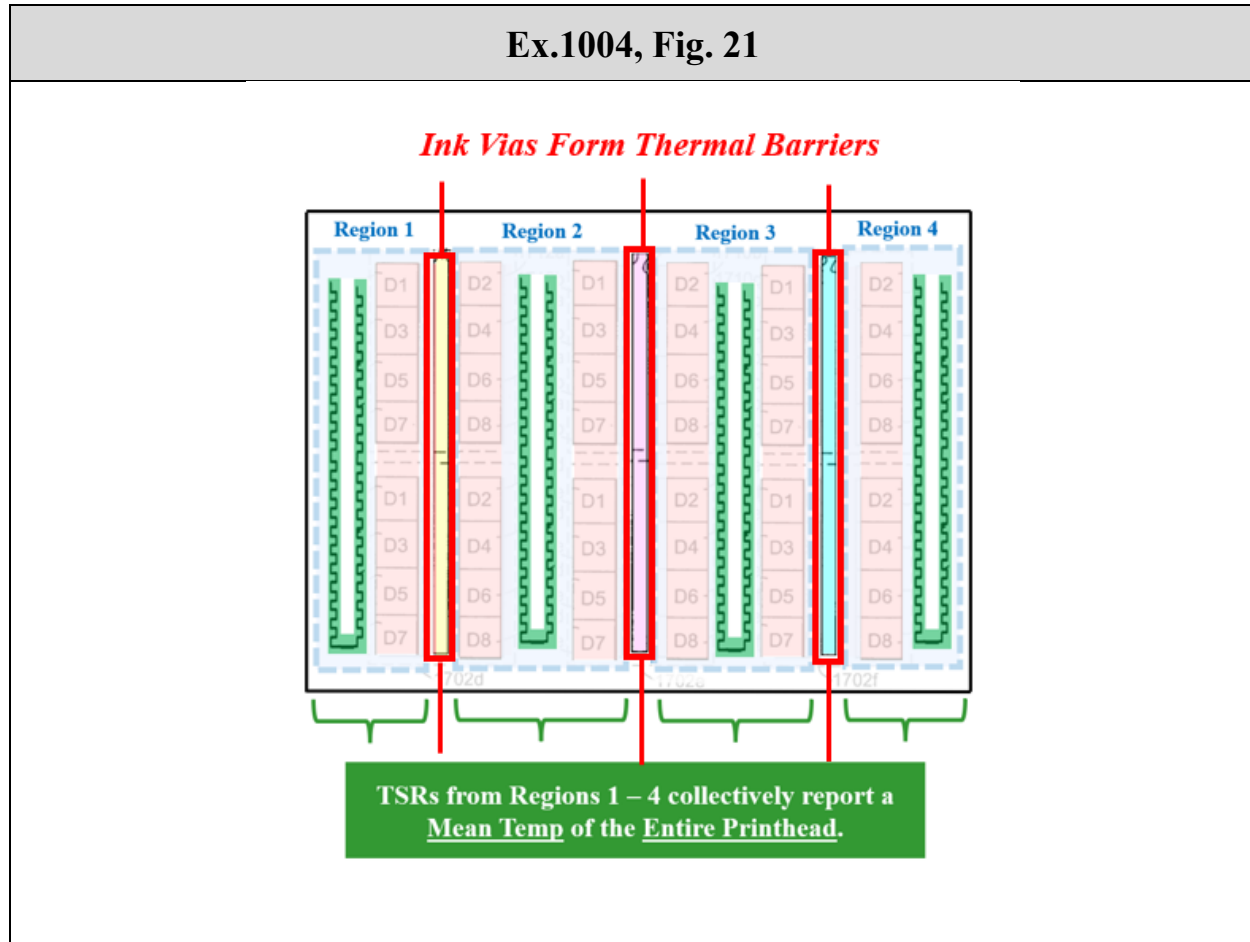


Moreover, a PHOSITA would have known that placing the TSR within Region 2 *alone* would not be an ideal location to accurately report the mean temperature of the entire printhead die, which both Ben and Giere⁶⁷³ attribute to meaningfully regulating operational temperature, because it was well known that ink vias act as thermal insulators between other regions, limiting the TSR's effective reading to the region between adjacent vias. Ex.1002 ¶161; Ex.1001, 5:52-55; Ex.1008, 3:16-21.

Even the '708 Patent admits that, during the prior art time period, it was well known to a PHOSITA that “ink vias [] act as thermal barriers between the colors,” and “without accurate temperature readings, the method of providing fire pulses to regulate thermal conditions [for a multi-via printhead] would also be subject to error.” Ex.1001, 2:28-29; 2:47-49. Therefore, prior art heater chips “provid[ed] for temperature sensing on a per-color basis” by placing “three temperature sensors 220, 222, and 224 [green below] in close proximity to each of the heater arrays, each situated on the same side of their respective vias,” thereby “ensuring that there is only a small amount of thermal crosstalk between the temperature sensors.” Ex.1001, 2:1-15.

Because “temperature sensing on a per-color basis” was well known, a PHOSITA would have also disposed a single TSR within each of the remaining

regions so that the temperature value *collectively* provided by the TSRs reflect the mean temperature of Benjamin's entire printhead die. Ex.1002 ¶188.



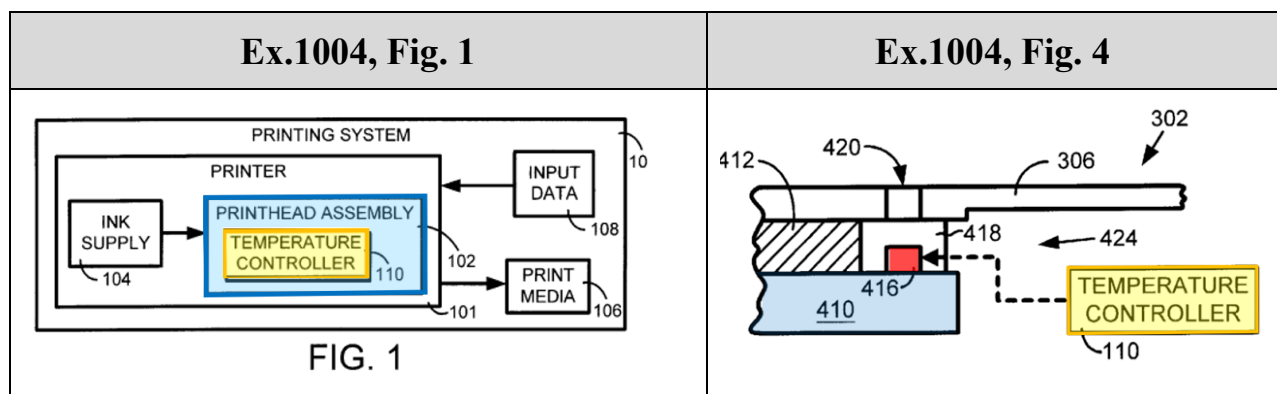
Accordingly, Benjamin-Giere673 discloses “a **single temperature sensing element** [e.g., TSR] disposed within each region [e.g., Regions 1-4].” Ex.1002 ¶¶149-169.

- g. 1[F] “the temperature sensing element operable to sense a temperature representative of the heater arrays adjacent to the region and”*

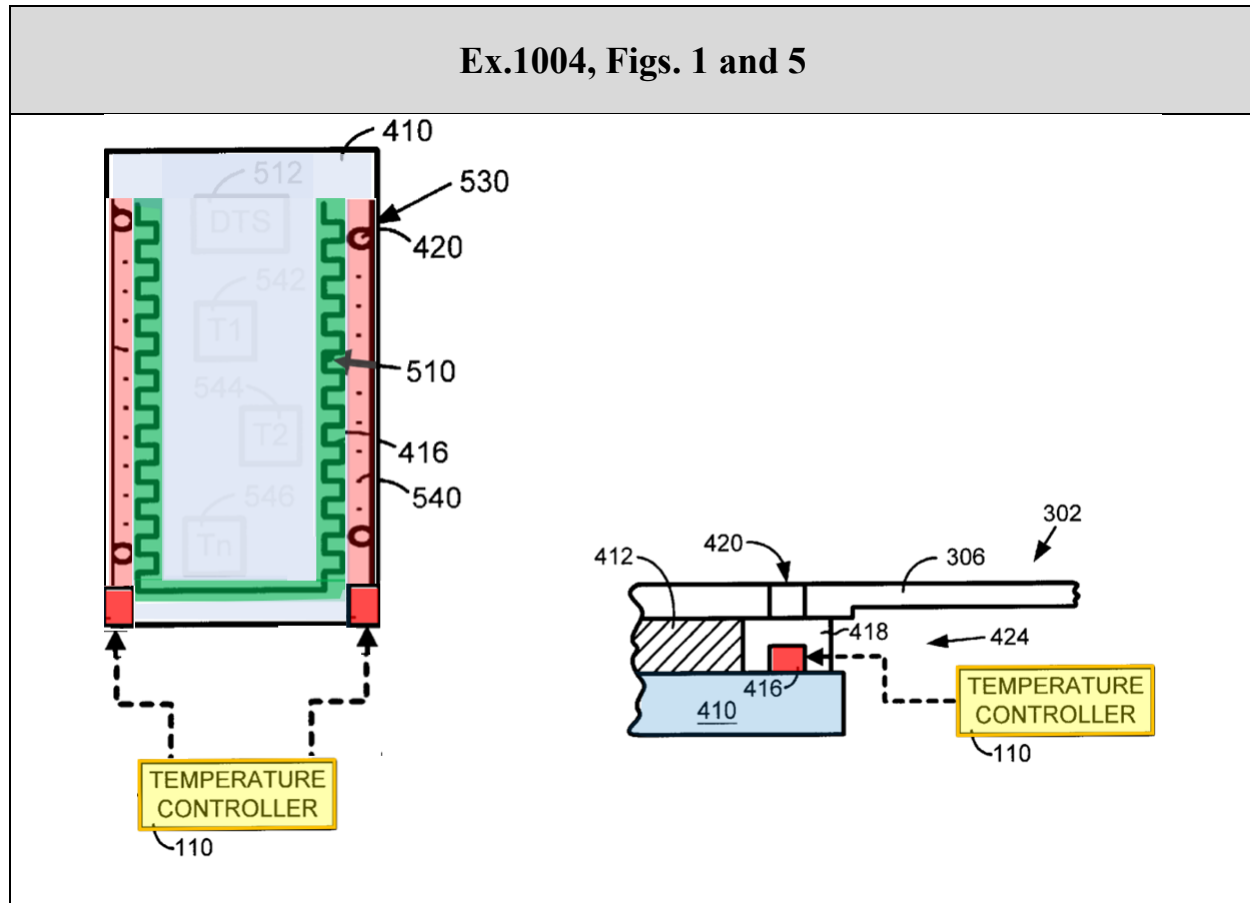
Benjamin-Giere673 discloses 1[F]. Ex.1002 ¶¶170-175.

Giere673 teaches that the printing system 100 includes “a temperature control system 110 (*green*) for predicting dynamic thermal conditions of the printhead assembly 102,” including “the substrate” (*blue*). Ex.1005, 2:48-52; Figs. 1 and 4. To control the temperature of the substrate and the temperature of each ejection chamber or nozzle chamber, Giere673 teaches that “[t]he temperature controller 110 is coupled to multiple temperature sensors (not shown),” which “determine, at a given time, a mean or *average temperature of the substrate* and an *actual local temperature profile near designated ink ejection elements*.” Ex.1005, 2:57-62.

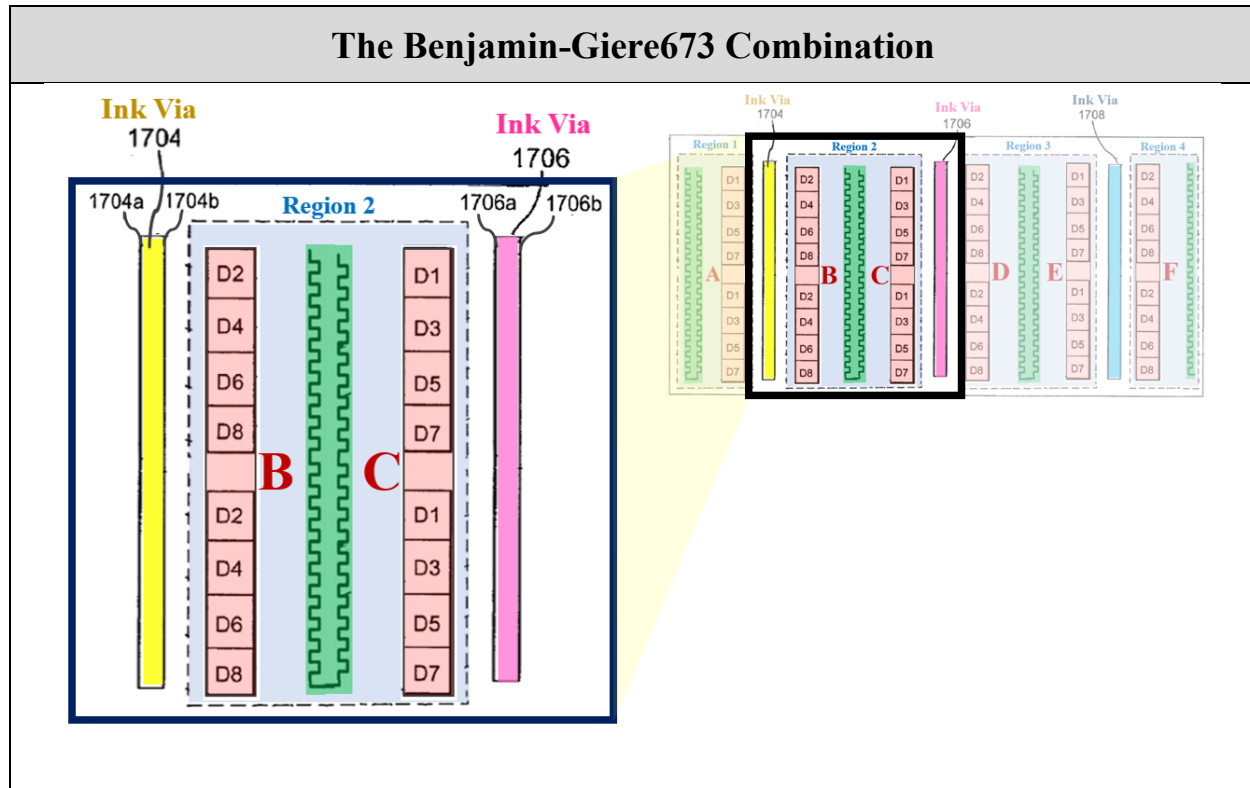
According to Giere673, “[t]he temperature controller 110 uses the input data 108 [supplied by the temperature sensors] to predict thermal conditions of particular ejection chambers for selectively firing the associated heating elements.” Ex.1005, 3:1-6, 2:62-65; Ex.1002 ¶171.



When viewed together with Figures 1 and 4, Figure 5 confirms that that “the temperature controller 110” is coupled to the TSRs that “provide an approximation of the mean temperature of the substrate” to “the temperature controller 110,” which it uses “to control the temperature.” Ex.1005, 4:49-5:5.



Further, because the ink feed slots 1704, 1706, and 1708 act as thermal insulators between the TSRs in adjacent regions, a PHOSITA would have understood that the temperature sensed by each TSR 510 would represent the temperature of the two heater arrays in its region. Ex.1002 ¶173-174.



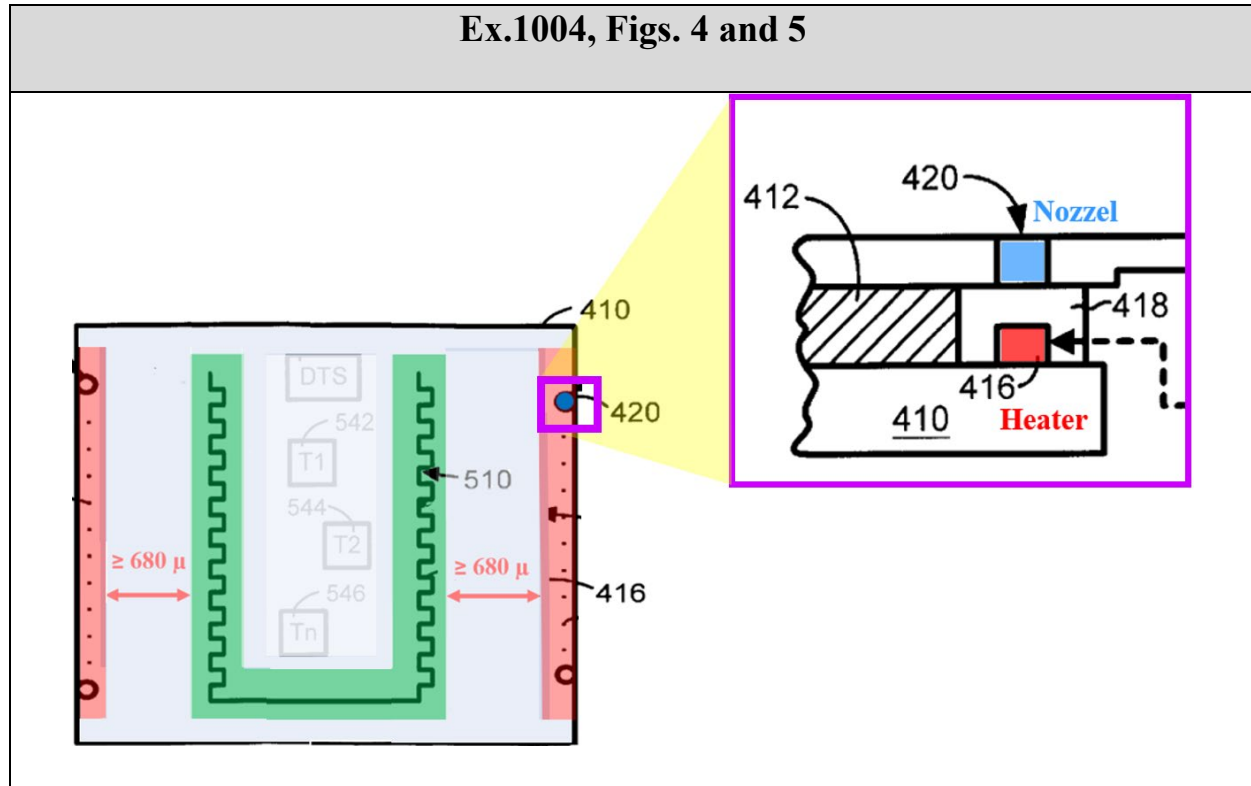
Accordingly, Benjamin-Giere673 discloses that the “**temperature sensing element** [*e.g.*, TSR 510 in Region 2] operable to **sense a temperature representative of the heater arrays adjacent to the region** [*e.g.*, mean temperature of Heater Arrays B and C].” Ex.1002 ¶¶170-175.

h. 1[G] “disposed at a predetermined distance away from adjacent heater arrays”

Benjamin-Giere673 discloses 1[G]. Ex.1002 ¶¶176-179.

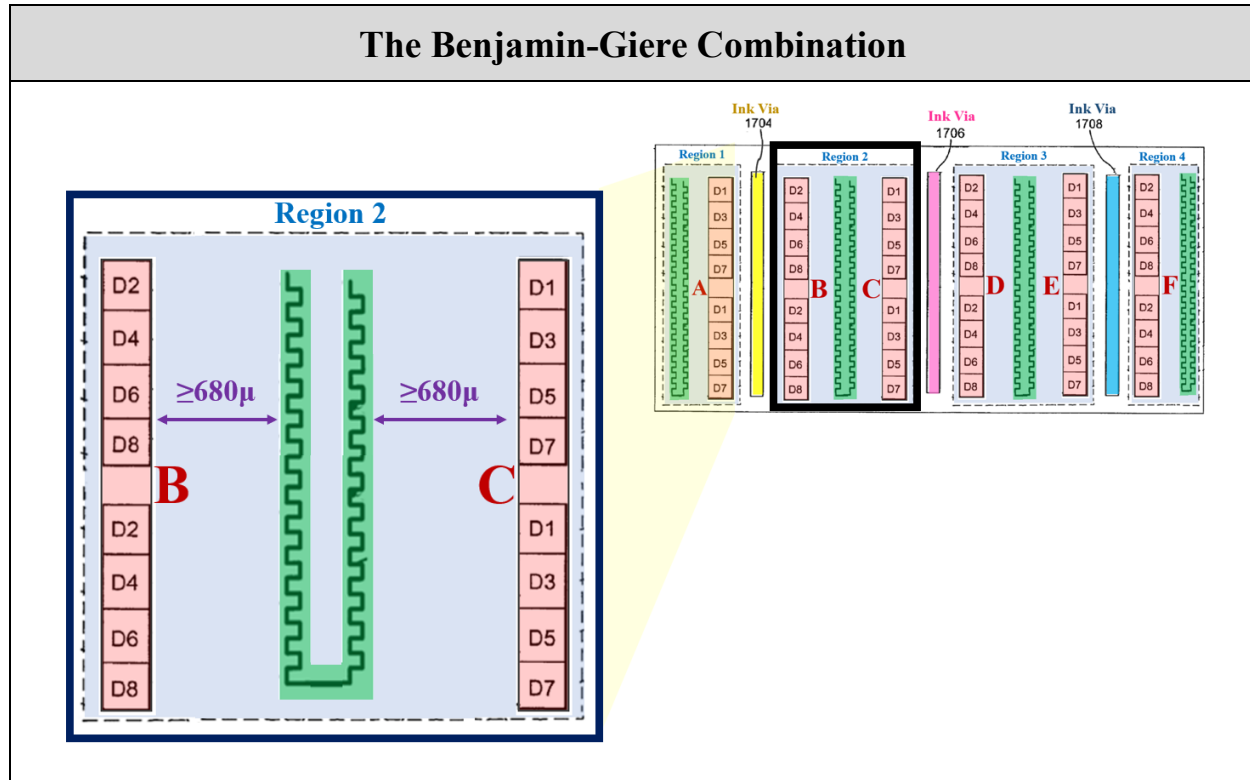
Giere673 teaches that “[t]he TSR 510 [*green in Fig. 4 below*] is located along the length of the substrate 410” at a predetermined distance “approximately 680 μm inboard from the center of the columns of ink ejection elements 416

[red],” which are positioned directly below the nozzle 420 [blue]. Ex.1005, 5:10-12.



A PHOSITA familiar with Giere673 would have been motivated to dispose a single TSR [e.g., TSR 510, *green below*] within each region of Benjamin’s printhead die [e.g., Regions 1-4, *blue*] and position each TSR equidistant from the two heater arrays with the region [e.g., heater arrays B and C in Region 2, *red*] and not less than “approximately 680 μ m inboard from the center of the [heater arrays]” so that, *individually*, each TSR provides a temperature value reflective of the temperature of its region, including the heater arrays within those regions, *and*

collectively, the values provided by the TSRs reflect the mean temperature of the entire printhead die. Ex.1002 ¶178.



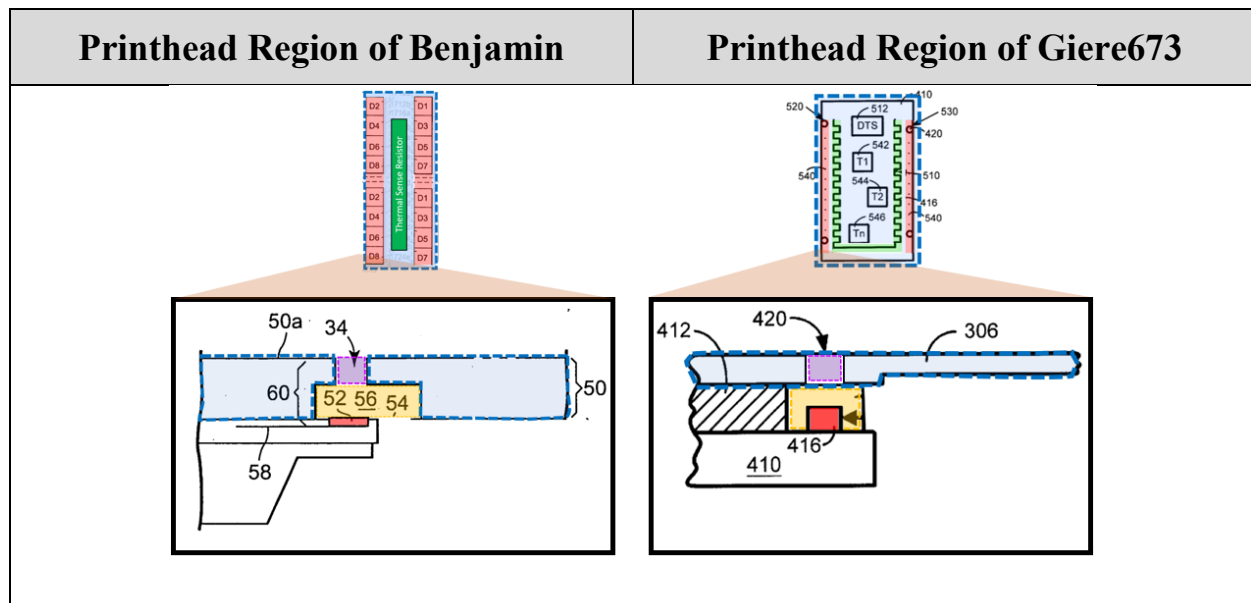
Accordingly, Benjamin-Giere673 discloses “dispos[ing] the **temperature sensing element** [e.g., TSR 510] at a **predetermined distance away** [e.g., 680 μ m] from **adjacent heater arrays** [i.e., e.g., heater arrays B-C). Ex.1002 ¶¶176-179.

2. Motivation to Combine Benjamin and Giere673

A PHOSITA would have been motivated to combine Benjamin and Giere673. Ex.1002 ¶¶179-198. Since Benjamin does not say *where* on the printhead die the TSR should be disposed, a PHOSITA would have looked beyond

Benjamin to identify an optimal location for the TSR and consulted analogous art for regulating the die's temperature based on a TSR reading, and in doing so, would combined Giere673 with Benjamin in the manner described above. *Id.*

First, Benjamin and Giere673 share the same assignee—*viz.*, Hewlett-Packard Development Company L.P. Ex.1004, 1; Ex.1005, 1—and both involve the same field of endeavour—*viz.*—regulating operational temperature of a printhead die for a printing device—and similar printing devices within that field. As seen below, the printhead dies of Benjamin and Giere673 both include at least two adjacent ink channels (*not shown*) for feeding ink into a chamber (*yellow below*) and at least two adjacent heater arrays (*red*) for vaporizing the ink within each channel and ejecting drops of the vaporized ink through a nozzle (*purple*) onto a print media, such as paper. Ex.1002 ¶¶180.



Benjamin and Giere673 address similar problems in their shared field— *viz.*, reduced print quality caused by the printhead die operating outside its optimal temperature—and both provide a similar solution to that problem— *viz.*, disposing a temperature sense resistor (TSR) on the printhead for determining the “mean temperature” of the printhead and using a controller to maintain the printhead at its optimal temperature by, for example, lengthening and shortening the firing pulses sent to the heater arrays. Ex.1005, 2:64; Ex.1002, ¶¶181. Also, like Benjamin, Giere673 optimizes the print quality of the inkjet printer based upon the temperature value provided by the TSR. Ex.1002 ¶¶181-95 (explaining in greater detail functional benefits motivating the combination).

Third, a PHOSITA would have also had a reasonable expectation of success adding the temperature controller 110 and TSRs 510 from Giere673 to the printhead die 1700 of Benjamin’s printhead assembly. Ex.1002 ¶196. Given the interchangeable nature of various features in the disclosed embodiments, it would have been a routine and obvious matter for a PHOSITA to combine, replace, and even modify various features from Benjamin’s various embodiments, as well as the embodiments of Giere673. Ex.1002 ¶197. Additionally, as explained above, the printing system components from Benjamin and Giere673 are common to all embodiments. As such, the simple, routine, and low-cost nature of adding a temperature controller and thermal sense resistors to a printhead assembly and

printhead die, respectively, would have further motivated a PHOSITA. Ex.1002 ¶197.

Finally, given that Benjamin and Giere673 expressly articulate the interchangeability and modification of the disclosed embodiments, a PHOSITA would have had a reasonable expectation of success in combining and modifying features of the embodiments together. *Id.* Thus, ample motivation existed for a PHOSITA to combine Benjamin and Giere673. Ex.1002 ¶¶180-198.

3. Claim 2 and 11

Claims 2 requires: “wherein the temperature sensing element comprises a temperature sensing resistor.” As discussed above, and incorporated here, Benjamin includes a “temperature sensing resistor,” and Giere673 discloses that a *thermal sense resistor* is a commonly used temperature sense resistor. Section VIII.A.1.f.; Ex.1005, 4:54-56; Ex.1002, ¶¶198-200

Accordingly, Benjamin-Giere673 discloses that “the temperature sensing element comprises a **temperature sensing resistor** [*i.e.*, TSR 510].” Ex.1002 ¶¶199-201. The limitation added by claim 11 mirrors that of claim 2, and is therefore disclosed for the same reasons. Ex.1002 ¶¶233-234.

4. Claims 3 and 12

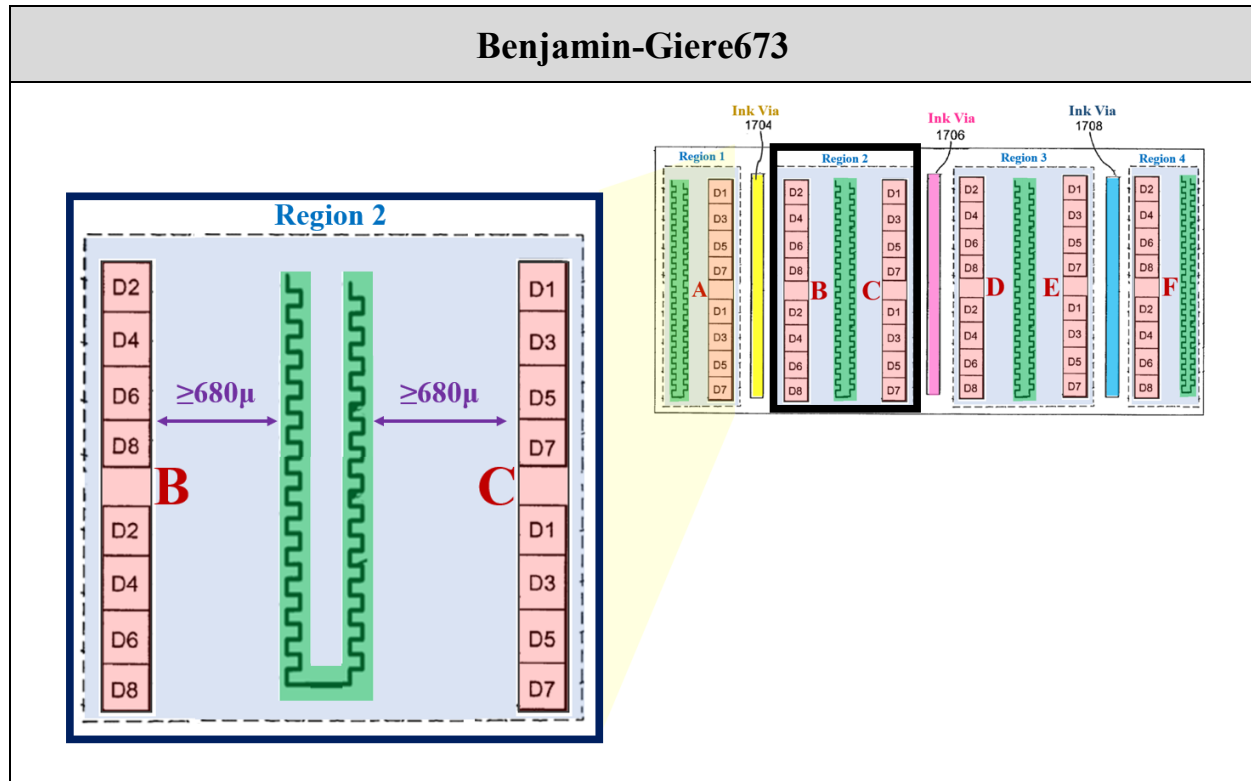
Claim 3 requires: “wherein the temperature sensing element comprises a thermal sense resistor.”

For the same reasons discussed in Section VIII.A.1.3(claims 2,11), incorporated here, Benjamin-Giere673 discloses that “the **temperature sensing element** [*i.e.*, measurement sensor] comprises a **thermal sense resistor** [*i.e.*, TSR 510].” Ex.1002 ¶¶202-204. The limitation added by claim 12 mirrors that of claim 3, and is therefore disclosed for the same reasons. Ex.1002 ¶¶235-236.

5. Claims 5 and 14

Claim 5 requires “wherein the predetermined distance is at least 300 microns,” which Benjamin-Giere673 discloses. Ex.1002 ¶¶205-207.

Giere673 teaches that “[t]he TSR 510 can have two legs that are **approximately 680 μ m inboard from the center of the columns of ink ejection elements 416.**” Ex.1005, 5:10-12. Since 1 μ m (micrometer) is equal to 1 μ (micron), the TSR 510 is approximately 680 microns from the center of the columns of ink ejection elements 416. Ex.1002 ¶206.

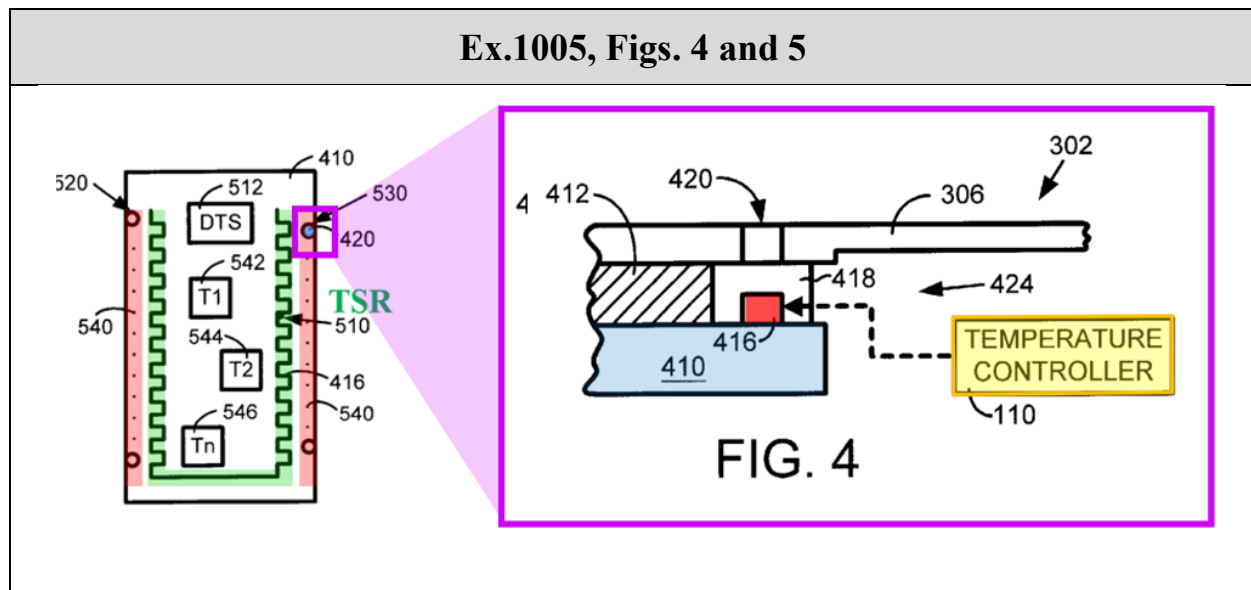


Accordingly, Benjamin-Giere673 discloses that “the predetermined distance is **at least 300 microns** [*i.e.*, approximately 680 microns].” Ex.1002 ¶¶205-207. The limitation added by claim 14 mirrors that of claim 5, and is therefore disclosed for the same reasons. Ex.1002 ¶¶204-206.

6. Claim 6

Claim 6 requires “wherein the temperature sensing element is positioned substantially planar to each of the adjacent heater arrays,” which Benjamin-Giere673 discloses. Ex.1002 ¶¶208-213.

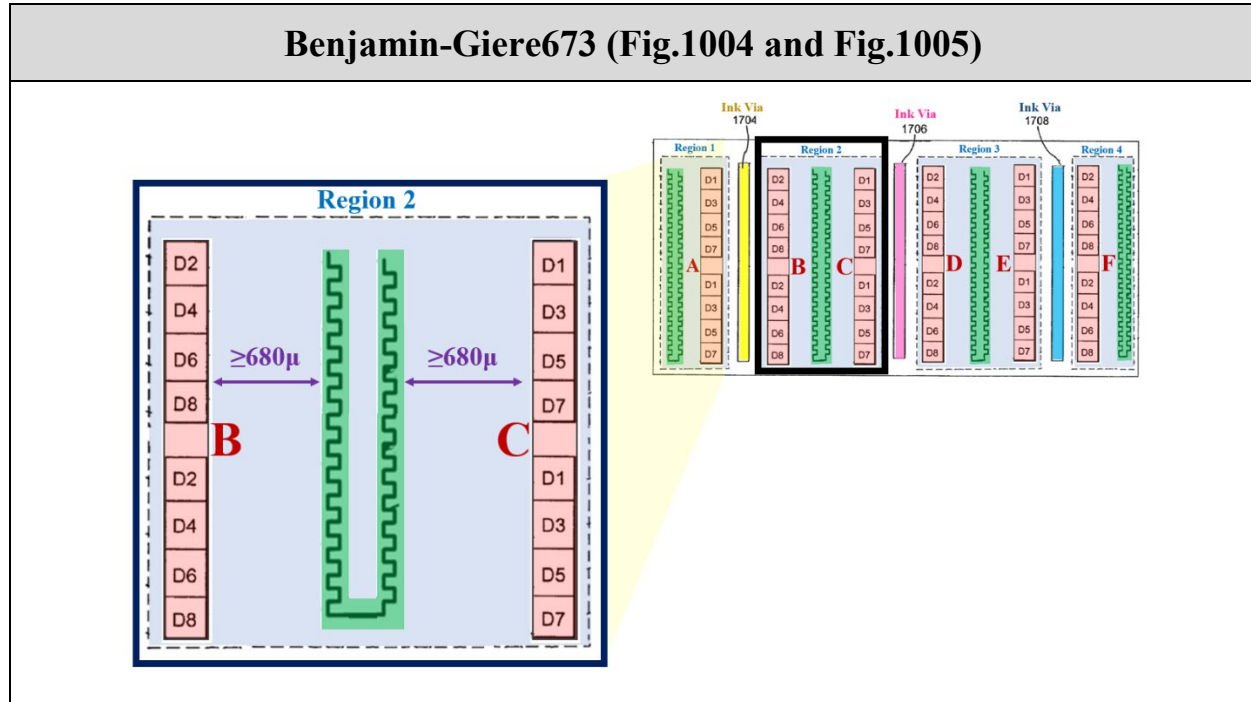
Giere673 teaching positioning a TSR (*green*) at a predetermined distance away from each of the two adjacent heating elements 416 within that region—*i.e.*, “approximately 680 μm *inboard from* the center of the columns of ink ejection elements 416,” which means that the TSR 510 must be substantially planar to the ink ejection elements 416, at least under the 708 Patent’s definition of the term. Ex.1002 ¶210; Ex.1001, 3:10. Moreover, Figures 2 and 4 of Giere673 confirm that TSR 510 is substantially planar to each column of firing elements 416 because Figure 5 shows the right leg of TSR 510 (*green*) spaced apart from nozzle 530 (*blue*), and Figure 4 shows firing elements 416 (*red*) directly under the nozzle 420 (*blue*). This means that TSR 510 is *substantially planar* because it is not “positioned directly above the [] heater arrays.” Ex.1001, 3:12-13; Ex.1002 ¶¶206-210.



By ensuring that the TSRs 510 are “not located adjacent to any particular heating element,” Giere673 discloses that the TSRs 510 can sense the “temperature of the substrate 410 after heat has moved from the heating elements to the TSR 510.” Ex.1005,4:58-60; *see also id.* at 4:60-61 (“The TSR 510 therefore reports a temperature that reflects heating element firings that have already occurred.”).

A PHOSITA, when adding Giere673’s TSRs 510 to Benjamin’s printhead die 1700, would likewise position the TSRs along the length of the substrate approximately 680 microns inboard from the center of the columns of “drop generators 60 disposed along each of the opposing ink feed slot sides,” so that the TSR (*green*) in the region between ink feed slot 1704 and 1706 is positioned substantially planar to the first array of drop generators 60 (*red*) disposed on side 1704b of ink feed slot 1704 and side 1706a of ink feed slot 1706, as shown below.

Benjamin-Giere673 (Fig.1004 and Fig.1005)



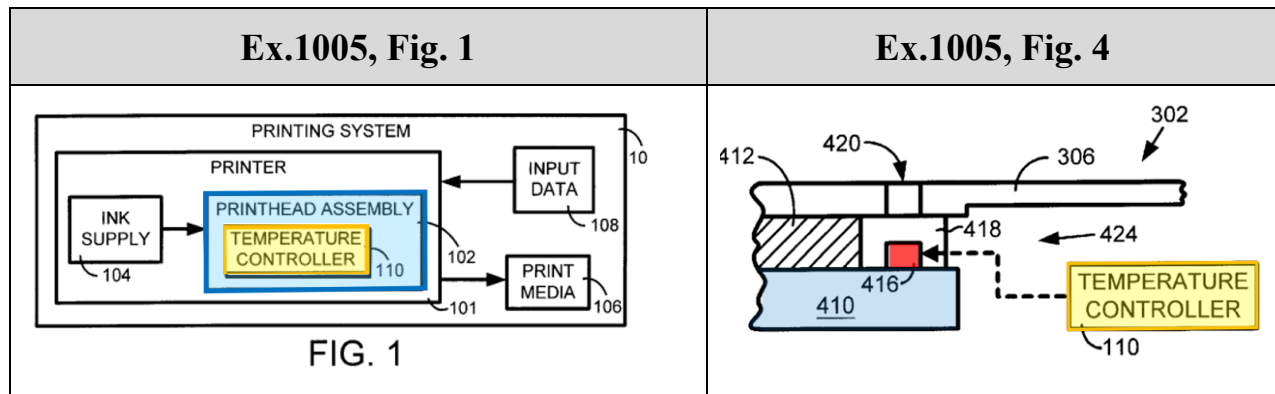
Accordingly, Benjamin-Giere673 further discloses that “the **temperature sensing element** [*i.e.*, TSR 510] is positioned substantially planar to each of the **adjacent heater arrays** [*e.g.*, Heater Array B and Heater Array C].” Ex.1002 ¶¶208-213. The limitation added by claim 15 mirrors that of claim 6, and is therefore disclosed for the same reasons. Ex.1002 ¶¶207-22.

7. Claim 7

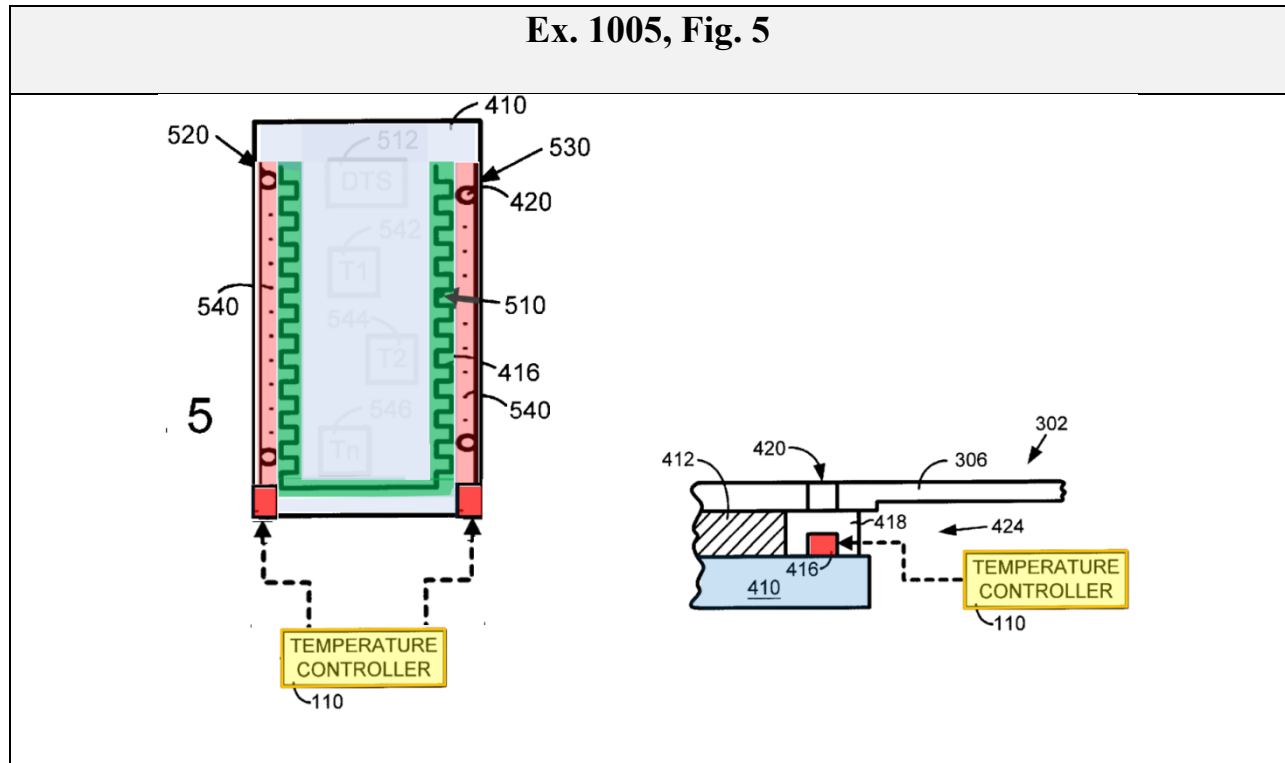
Claim 7 requires “at least one control element operable to receive a temperature measured by the temperature sensing element,” which Benjamin-Giere673 discloses. Ex.1002 ¶¶214-217.

To control the temperature of the substrate and the temperature of each ejection chamber or nozzle chamber, Giere673 teaches that “[t]he temperature

controller 110 is coupled to multiple temperature sensors (not shown),” which “determine, at a given time, a mean or *average temperature of the substrate* and an actual local temperature profile near designated ink ejection elements. Ex.1005, 2:57-62. Thereafter, “[t]he temperature controller 110 uses the input data 108 [supplied by the temperature sensors] to predict thermal conditions of particular ejection chambers for selectively firing the associated heating elements.” Ex.1005, 3:1-6; 2:62-65.



Giere673’s Figure 5, which shows “a top view of the substrate” and, when viewed together with Figure 4, confirms that “the temperature controller 110 of FIG. 1 is coupled to at least one measurement sensor, such as “a thermal sense resistor (TSR) 510” that “provide[s] an approximation of the mean temperature of the substrate” to “the temperature controller 110,” and the temperature controller 110 uses the mean temperature sensed by the TSR 510 “to control the temperature.” Ex.1005, 4:49-5:5.



Accordingly, Benjamin-Giere673 discloses that the heater chip further comprises “**at least one control element** [*i.e.*, temperature controller 100] operable to receive a temperature measured by the **temperature sensing element** [*i.e.*, TSR 510].” Ex.1002 ¶¶214-217.

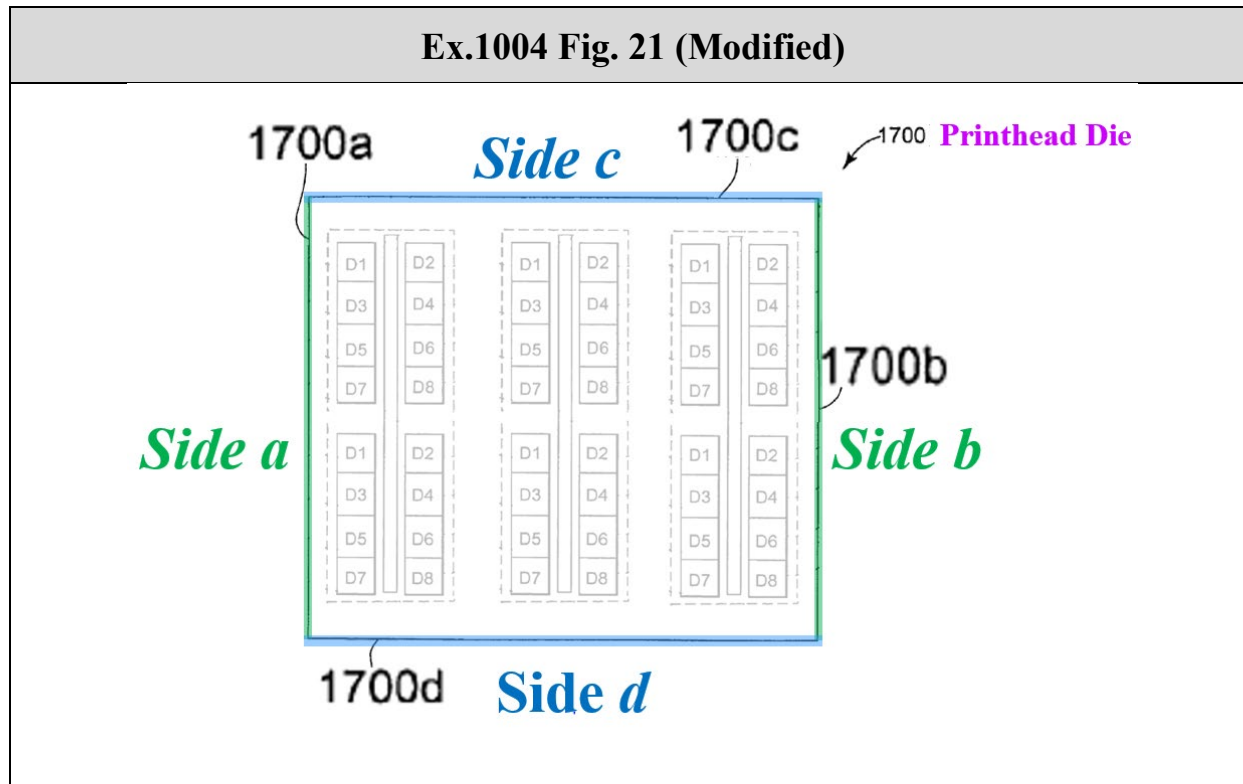
8. Claim 8

Claim 8 requires “wherein the chip has at least one edge and at least one region is disposed between one of the plurality of ink vias and the at least one edge,” which Benjamin-Giere673 discloses. Ex.1002 ¶¶218-223.

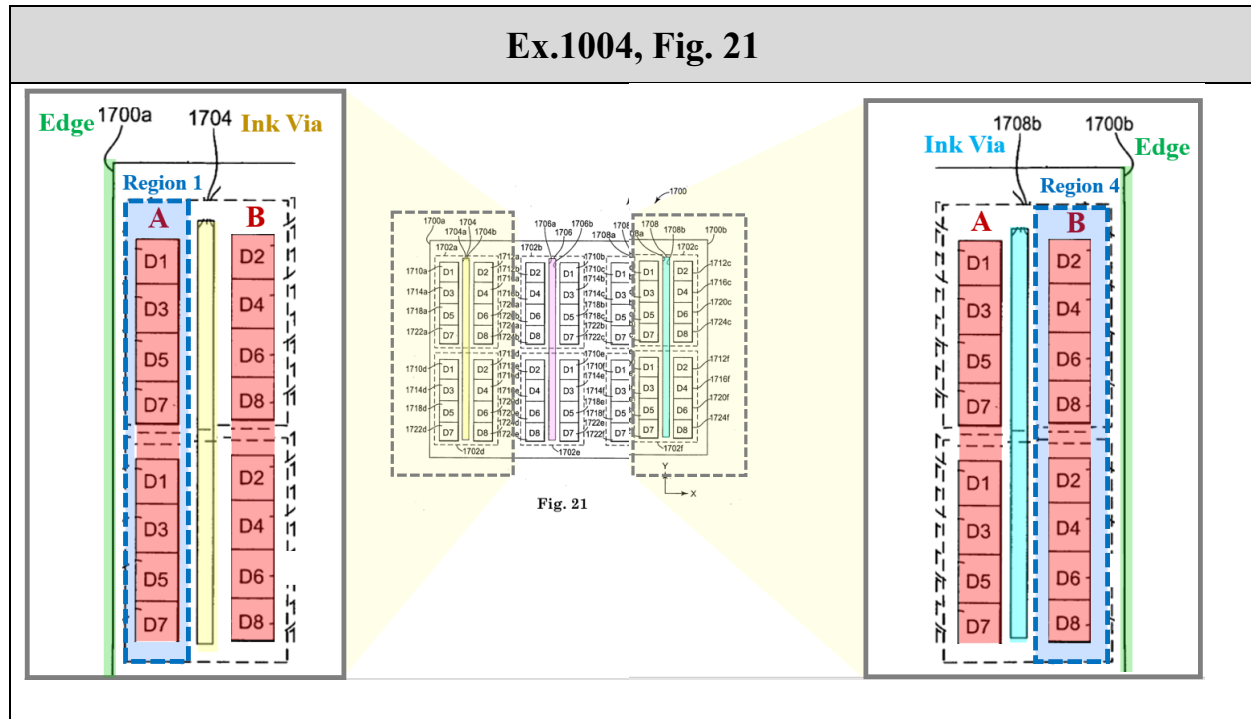
Benjamin’s printhead 1700 has a left and right edge (side 1700a and 1700b, green below) and top and bottom edge (side 1700c and 1700d, *blue*), each of which

converges with another edge to form a distinct corner of the printhead die 1700.

Ex.1004, 69:67-70:3.



As explained above in Section VIII.A.1.d and seen in Figure 21 below, Regions 1 and 4 are disposed between an ink feed slot and edge 1700a and edge 1700b, respectively (*green*). Ex.1002 ¶220.

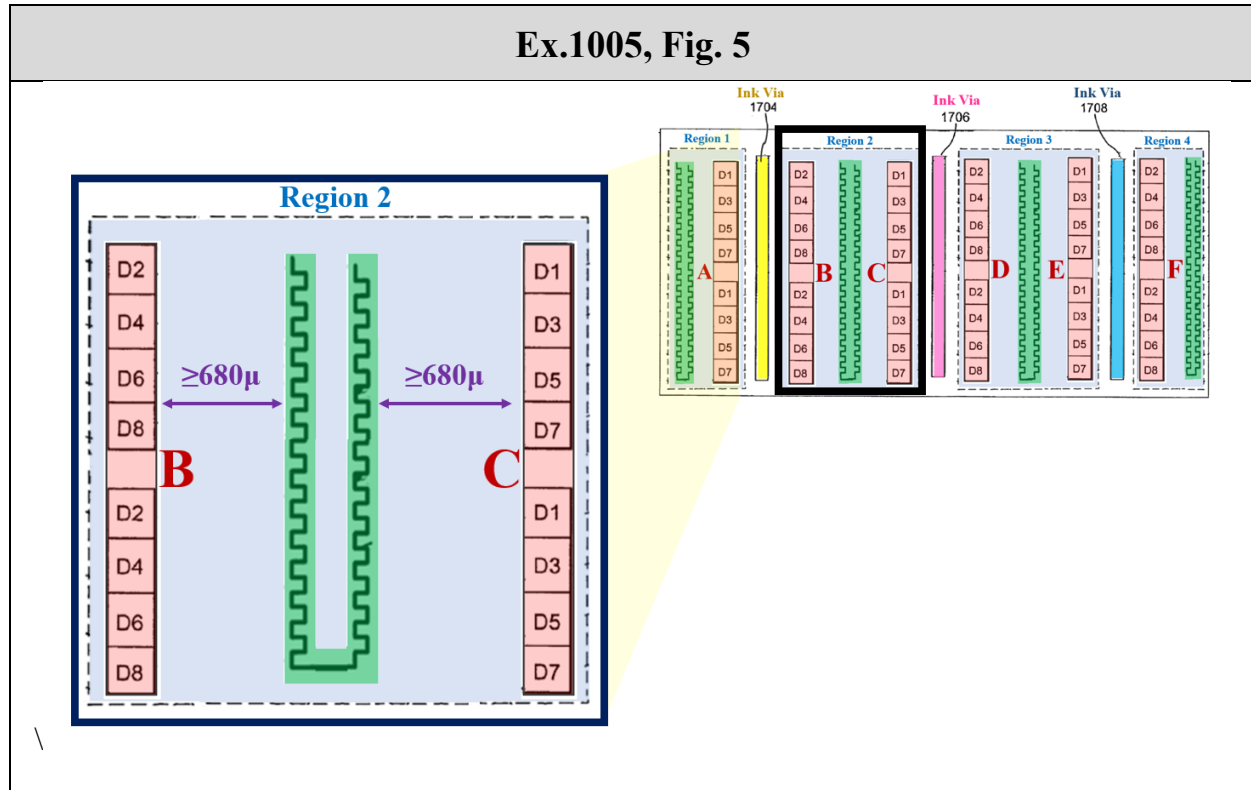


Accordingly, Benjamin-Giere673 further discloses that the “**heater chip**” [e.g., printhead die 1700] “has at least **one edge** [e.g., edge formed on side 1700a] and at least **one region is disposed between one of the plurality of ink vias and the at least one edge**” [e.g., region 1 disposed between ink feed slot 1704 and edge formed on side 1700a].” Ex.1002 ¶¶218-223.

9. Claim 10

Claim 10 requires “wherein positioning a temperature sensing element in the region comprises positioning a temperature sensing element in substantially a center portion of the region.” Benjamin-Giere673 discloses this limitation for the reasons in Section VIII.A.1[e]-[g], namely because it positions the TSR equidistant

from both heater arrays within Regions 2 and 3. Ex.1005, 4:57-59, 5:10-12; Ex.1002 ¶¶226-231.



B. Ground 2: Benjamin-Giere673 in Further View of Parish Renders Claims 4 and 13 Obvious

1. Claims 4 and 13

Claim 4 requires: “wherein the temperature sensing element comprises an n-type implant donor thermal sensing resistor,” which is disclosed by Benjamin-Giere673 in view of Parish.

While Benjamin-Giere673 discloses a TSR, it does not *explicitly* say that the TSR may comprise an n-type implant donor thermal sensing resistor. However,

Parish teaches that the “temperature sense resistor (TSR) 64” on the heater chip “can include a N-type source drain (NSD) material, a N-well layer material, a P-type source drain (PSD) material, a lightly doped drain (LDD) material or another suitable material.” Ex.1006, 5:35-39; Ex.1002 ¶¶242-244.

Accordingly, Benjamin-Giere673 in further view of Parish discloses that “the temperature sensing element [*e.g.*, TSRs] comprises an n-type implant donor thermal sensing resistor,” [*e.g.*, n-type TSR].” Ex.1002 ¶¶242-247. The limitation added by claim 13 mirrors that of claim 4, and is therefore disclosed for the same reasons. Ex.1002 ¶¶241-245.

2. Motivation to Modify Benjamin-Giere673 in View of Parish

Per Section VIII.A.2, a PHOSITA would have been motivated to combine Benjamin and Giere673. As for claims 4 and 13, a PHOSITA would have understood that an n-type TSR is a common material choice for thermal sensor resistors and well-known as particularly suited for use in printing applications. Ex.1002 ¶249. Thus, Benjamin and Giere673’s failure to identify a particular type of thermal sense resistor does not mean that the thermal sensor disclosed by those references does not already comprise an n-type implant donor thermal sense resistor. Ex.1002 ¶249.

Additionally, a PHOSITA would have been motivated to select an n-type implant donor thermal sensing resistor for any TSR disposed on a multi-via

printhead die, as taught by Parish, because doing so would improve the temperature control and compensation features of Benjamin-Giere673, particularly given that thermal sensors tooled from an n-type material are more precise and therefore provide more accurate readings than those from metal resistive elements, such as aluminium. Ex.1002 ¶250. For this reason, a PHOSITA wanting to make Benjamin-Giere673 in the manner described above for claim limitations 1[E] and 1[G], would have been motivated to look to another reference, such as Parish, to identify a thermal sense resistor with a material particularly suited for use in a printing device. Ex.1002 ¶251.

A PHOSITA would also have had a reasonable expectation of success of replacing each TSR within the printhead die of Benjamin-Giere673 with a n-type implant donor thermal sense resistor. Ex.1002 ¶252. Even the '708 Patent admits that n-type materials were well-known and understood by those skilled in the art. Ex.1001, 6:25-29. So too were the advantages of using NSD materials for temperature sense resistors on thermal inkjet. Ex.1014, 1:26-29; *id.*, 4:37-41.

Finally, a PHOSITA would have been further motivated by the simple and routine nature of using n-type resistors for the TSRs in Benjamin. Ex.1002 ¶254. Given that Benjamin and Giere673 expressly articulate the interchangeability and modification of the disclosed embodiments, a PHOSITA would have had a

reasonable expectation of success in combining and modifying features of the embodiments together. Ex.1002 ¶¶248-254`.

C. **GROUND 3: Giere178 In View of the Knowledge of a PHOSITA Renders Obvious Claims 1-3, 5-12, and 14-15**

1. **Claims 1 and 9⁵**

a. **1/P/ “A chip”**

The preamble is non-limiting because it merely recites the purported invention’s use. *See, e.g., Kaidi*, IPR2019-01184, Paper 16 at 12-13. To the extent it is found limiting, Giere178 discloses this limitation. Ex.1002 ¶¶257-265.

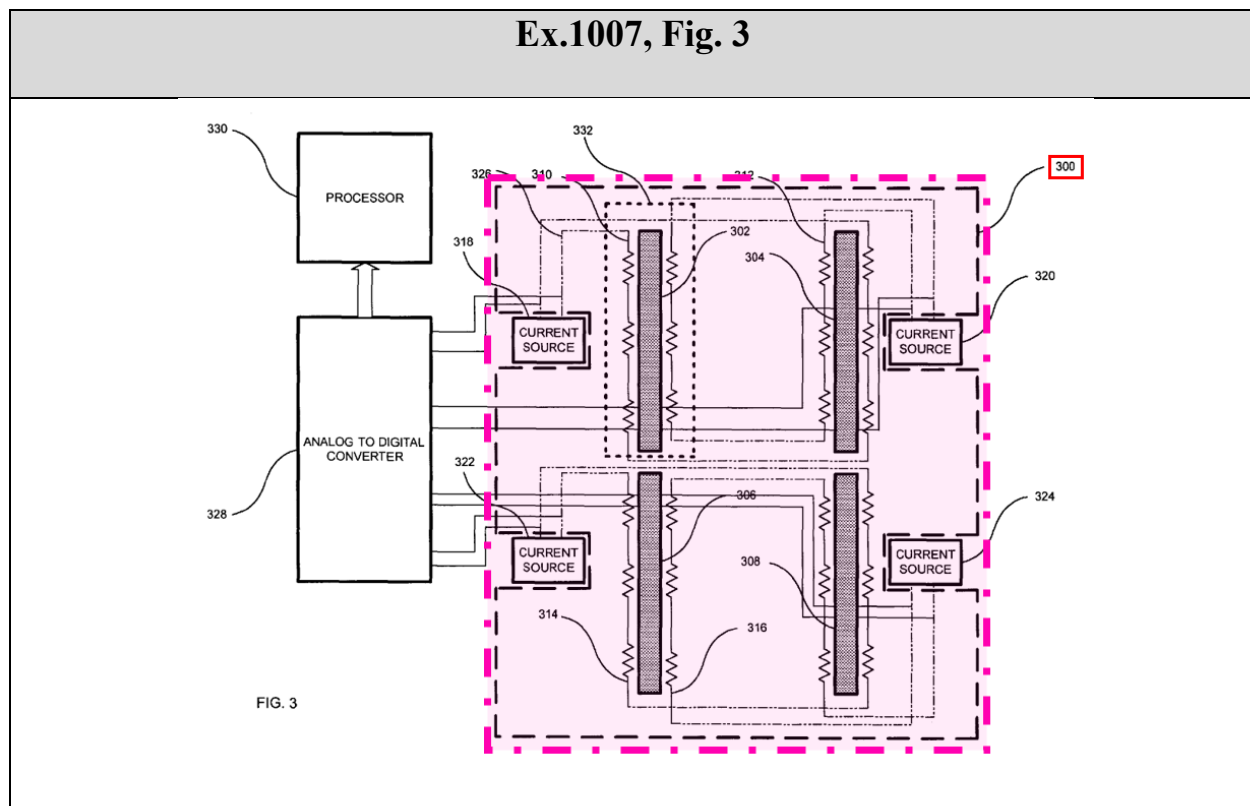
Giere178 discloses a printing device, such as an inkjet printer. Ex.1007, 7:1-17 (“embodiment of an imaging device, color inkjet printer 100....”). Giere178 notes that “[p]rinter 204 may include color inkjet printer 100 or other types of inkjet imaging devices.” Ex.1007, 7:30-31.

Giere178 further notes that a typical inkjet printhead comprises a silicon substrate having a plurality of thin layers. Ex.1007, 2:59-61 (“typical inkjet printhead (i.e., a silicon substrate having a plurality of thin film layers...).”). A PHOSITA would have understood that silicon is the most widely used material to form chips or dies used in computers and consumer electronics, such as printers.

⁵ The limitations of claim 9 mirror those of claim 1, and therefore are disclosed by Giere178 for the same reasons as claim 1. *See* Ex.1002 ¶¶349-350; Appendix.

Ex.1002 ¶260. Here, the silicon substrate described by Giere178 is synonymous with a silicon chip. *Id.*

In Figure 3 below, Giere178 discloses that the “**printhead is formed upon substrate 300.**” *Id.*, 8:43-44. Giere178 also notes that “**substrate 300 includes the structures of a typical printhead such as, ink feed slots, ink ejection chambers, firing resistors, etc.**” Ex.1007, 8:45-47.



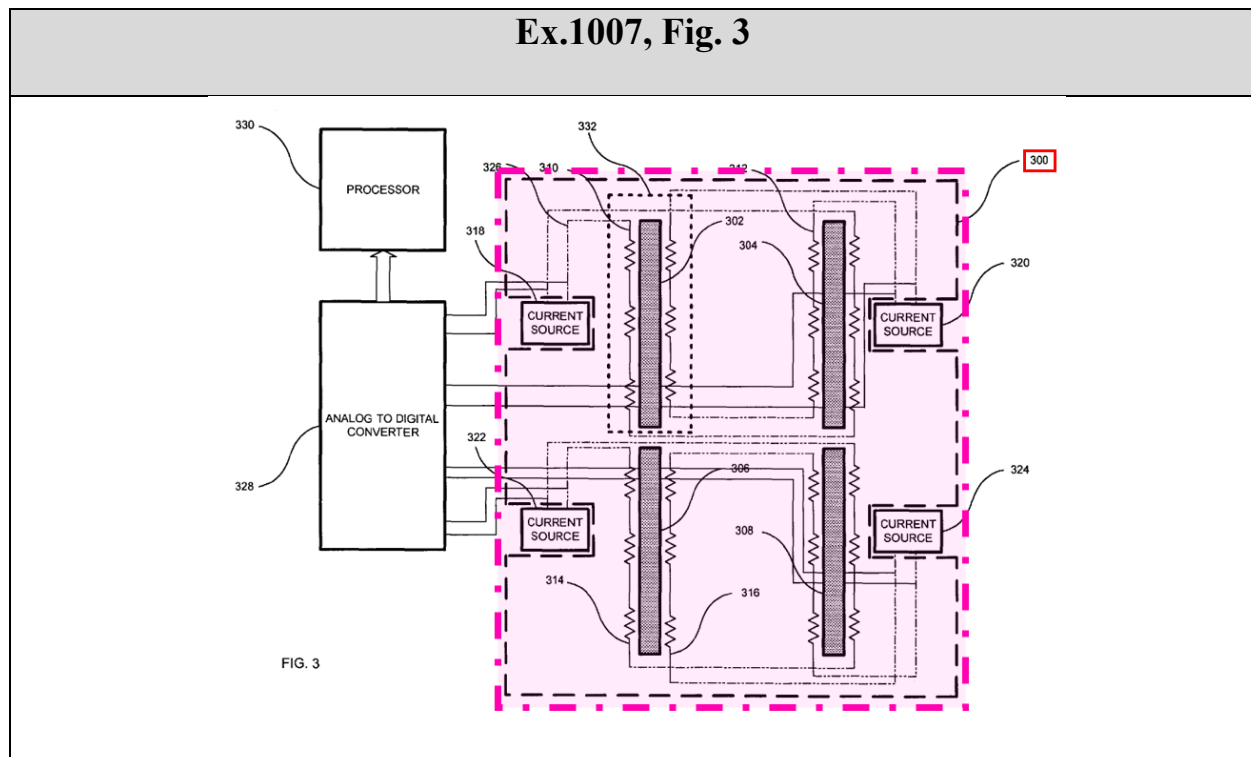
Accordingly, Giere178 discloses “a chip [e.g., printhead substrate 300] for use with a printing device [e.g., inkjet printer].” Ex.1002 ¶¶256-265.

b. 1[A] “Ink vias”

Giere178 discloses 1[A]. Ex.1002 ¶¶266-279.

The '708 Patent admits that *prior art* heater chips included a plurality of ink vias arranged parallel to one another, each of the ink via having two longitudinal sides. Ex.1002 ¶267, Figs. 1-2.

In Figure 3 of Giere178, illustrated below, it shows a “an embodiment of the temperature measurement system implemented upon an **embodiment of a printhead.**” Ex.1007, 8:41-43; *see below id.* at Fig. 3. Giere178 explains that printhead substrate 300 (*pink*) “**includes the structures of a typical printhead** such as, **ink feed slots**, ink ejection chambers, firing resistors, etc..” Ex.1007, 8:45-47.



A PHOSITA would have understood that “ink feed slots” are synonymous with “ink vias” as both are elongated holes formed in the substrate for allowing ink to pass from an ink reservoir to ink ejection chambers. Ex.1002 ¶269. Giere178 discloses inkjet printheads include an **“elongated hole** formed in the center of the bottom of the substrate.” Ex.1007, 3:36-39.

As Giere178 explains, **“ink then flows through a central slot in the substrate...and finally into the various ink ejection chambers.”** Ex.1007, 3:33-49. Thus, a PHOSITA would have understood the substrate’s elongated hole used for feeding ink to the ejection chambers to be an “ink feed slot” or “ink via,” i.e., a path to fluidly connect a supply of ink to one or more heaters. Ex.1002 ¶270.

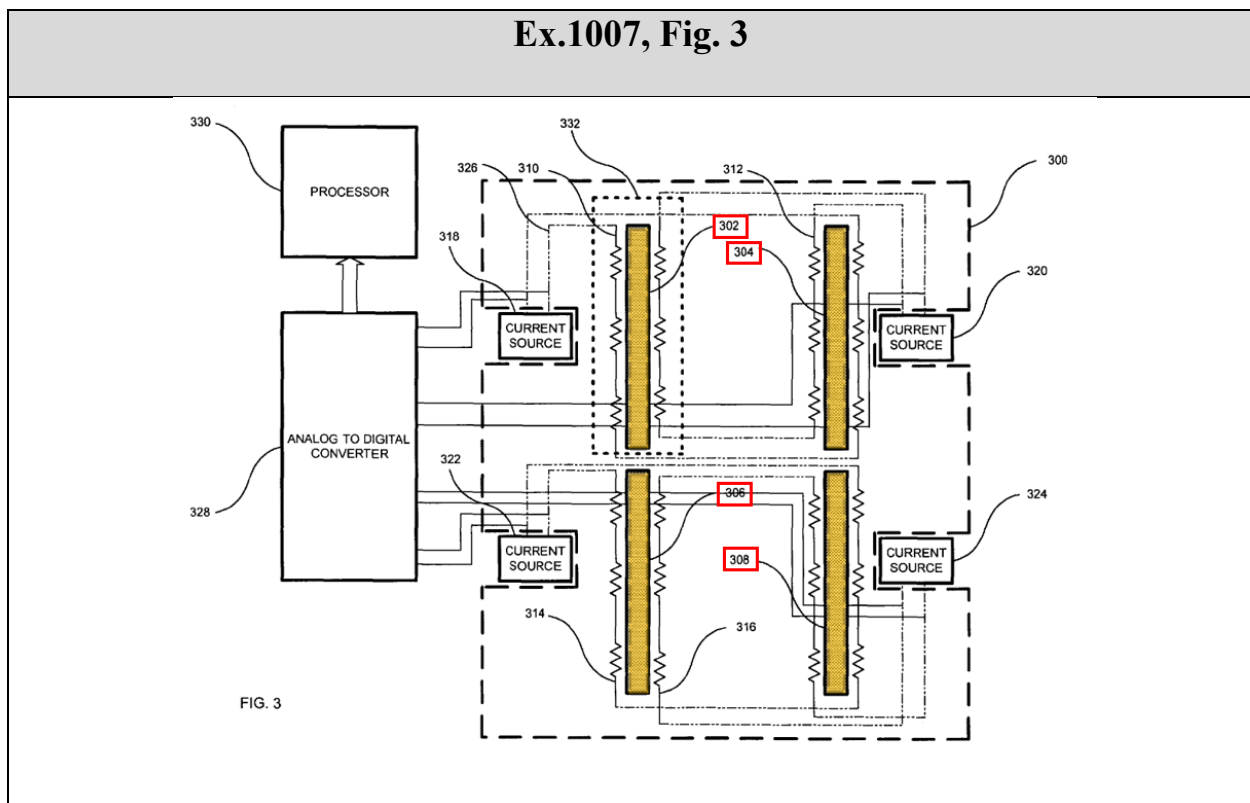
A PHOSITA would have also understood that Giere178’s four ink feed slots or ink vias are located in elongated regions 302, 304, 306, and 308 of substrate 300, shown in *orange* in Figure 3 below. Ex.1002 ¶271, 272.

When describing the substrate 300 as including “structures of a typical printhead” (Ex.1007 at 8:45-47), Giere178 states that **“[r]egions 302, 304, 306, and 308 each include an array of nozzles and associated firing resistors for ejecting ink.”** Because Giere178 describes these regions as including “nozzles and associated firing resistors” a PHOSITA would have understood that these regions must also include “ink ejection chambers” because, as Giere178 explains,

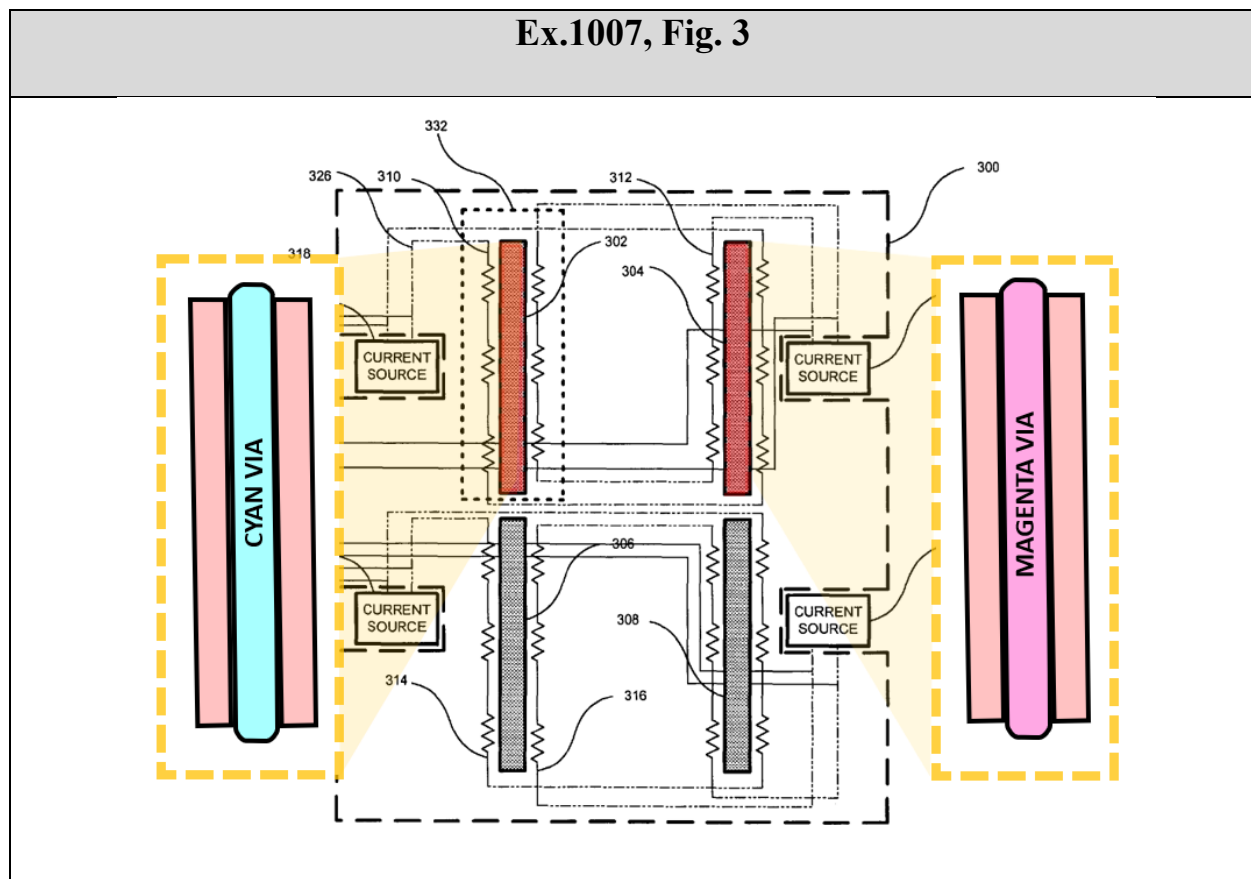
typical inkjet printheads have nozzles and firing resistors co-located with ink ejection chambers. Ex.1002 ¶270; *see also* Ex.1007, 2:59-3:4.

A PHOSITA would have also understood that because regions 302, 304, 306, and 308 of substrate 300 include ink ejection chambers then they must also include ink feeds slots/vias because that is the structural arrangement of a typical printhead. Ex.1002 ¶270; Ex.1007, 8:45-47, 3:36-38.

Moreover, a PHOSITA would have understood that firing resistors (and corresponding ink ejection chambers) are necessarily disposed very close to ink feed slots/vias to ensure that ink can refill a chamber quickly after it has fired an ink drop. Ex.1002 ¶270.



Annotated Figure 3 below depicts an exemplary arrangement of these features with ink vias having corresponding heater arrays (pink) shown in regions 302 and 304.



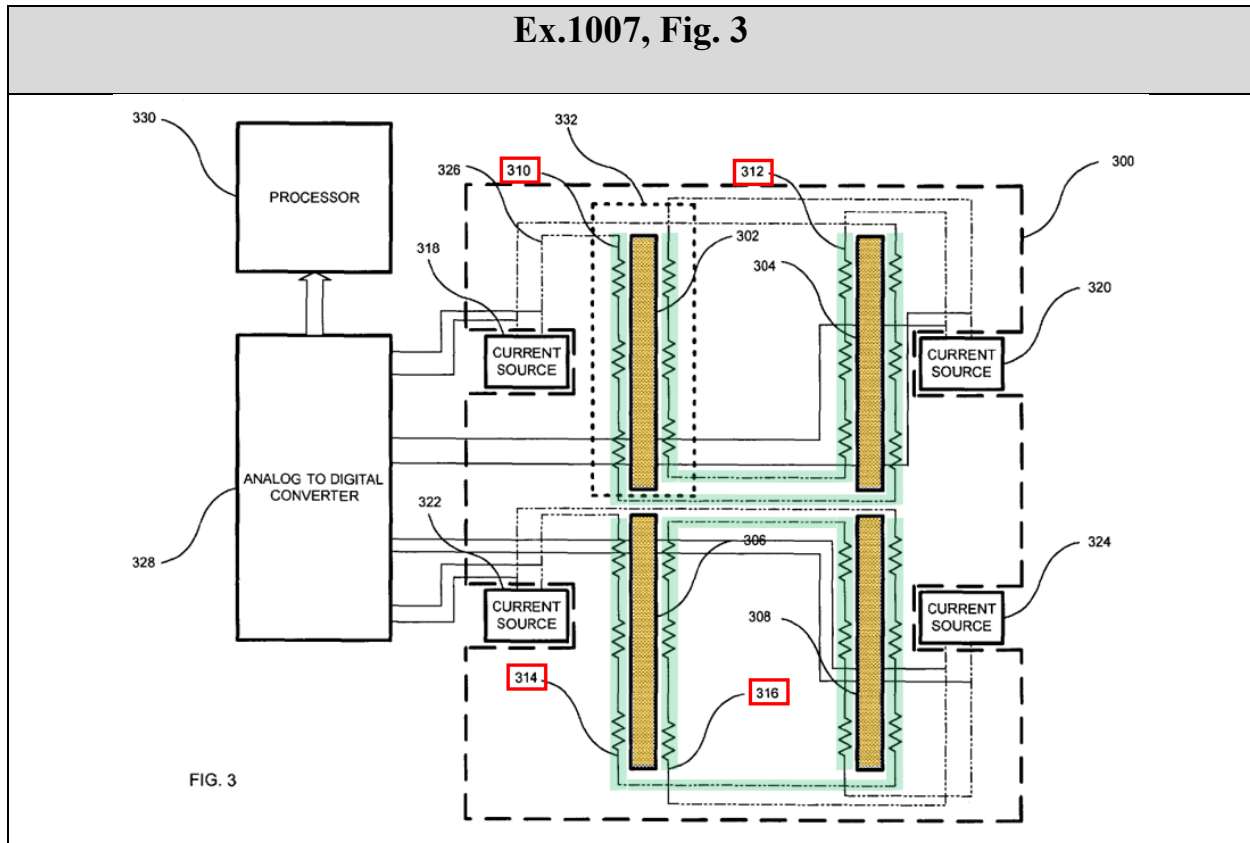
A PHOSITA would have also understood that Giere178 discloses an **ink via** in each of regions 302, 304, 306, and 308 because the component layout of Giere178's temperature management system requires measuring the substrate temperature on both sides of those regions where ink, fed from nearby ink feed

slots/vias, is being excessively fired from firing chambers and thereby generating excessive heat in the substrate. Ex.1002 ¶¶272-274.

As discussed in more detail below in Sections VIII.C.1.f-g, Giere178's temperature measurement system employs "temperature sensing elements" in different regions of the substrate 300 to detect the temperature of the substrate. Specifically, as shown in Figure 3 (below), Giere178 discloses that on either side of each region (302, 304, 306, and 308) [*orange*] "**resistive elements 310, 312, 314, and 316** [*green*]" are formed from material having a known temperature coefficient of resistivity." Ex.1007, 8:49-51; *see below id.* at Fig. 3.

Giere178 explains that the four "[r]esistive elements 310, 312, 314, and 316 are located so that they will each assume the temperature of the local region of substrate 300 on which they are placed." Ex.1007, 8:51-54; 10:3-8 ("measurement of the voltages can be used to estimate **changes in the temperature in the regions of substrate 300.**"); 9:29-33; 9:44-48; Fig. 3.

Using the measured substrate temperature from the local regions where the resistive elements are placed, Giere178 teaches that its system can adjust the firing resistor drive signals to control the substrate temperature at a desired temperature. Ex.1007, 9:50-54.



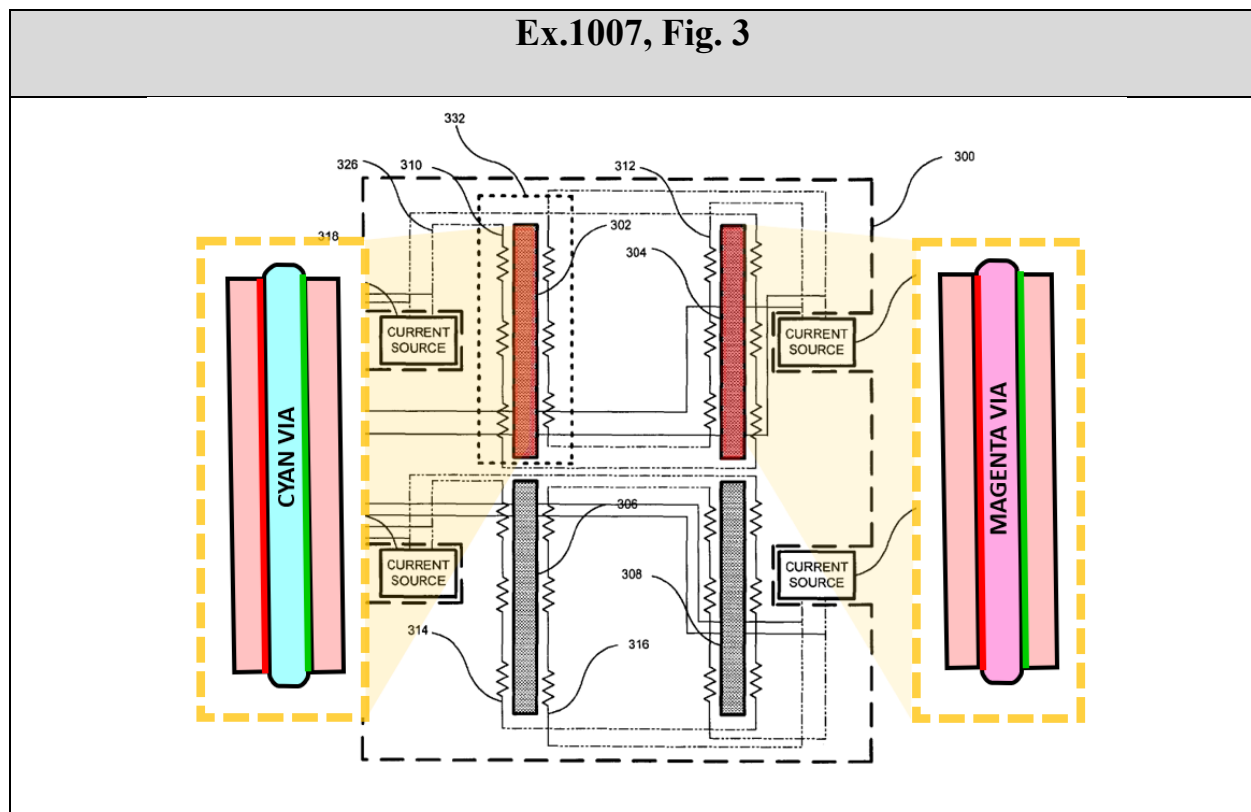
Thus, a PHOSITA would have understood that multiple arrays of firing resistors are located within regions 302, 304, 306, and 308 because temperature sensing elements are placed where the substrate temperature is most likely to be affected by the heat generated by those firing resistors—on *both* sides of regions 302, 304, 306, and 308. Ex.1002 ¶273; Ex.1007, 5:44-46 (“**Localized heating of the substrate can occur from firing nozzles at a greater frequency in a particular region of the printhead.**”); *id.* at 5:36-38; *id.* at 5:39-43; *id.* at 9:50-54.

Accordingly, a PHOSITA would have understood that ink feed slots/vias are necessarily disposed very close to firing resistors (and corresponding ink ejection

chambers) to ensure that ink can refill a chamber quickly after it has fired an ink drop. Ex.1002 ¶273.

A PHOSITA would have also understood that Giere178's temperature sensor layout (as described above with reference to Figure 3) indicates that there is an ink via in regions 302, 304, 306, and 308 because ink vias act as insulators preventing heat from a *single* heater array, for example, from reaching both sides of the region. Ex.1002 ¶274; Ex.1001, 6:64-66; Ex.1008, 3:18-20.

Giere178 further teaches that each ink feed slot in regions 302, 304, 306, and 308 has two longitudinal sides (e.g., red and green, below). Ex.1002 ¶275.



To the extent that Giere178 does not expressly disclose limitation 1[A], which it does, it also would have been obvious to a PHOSITA based on a PHOSITA's knowledge and Giere178's teachings. Ex.1002 ¶276.

For example, Giere178 also discloses that the basics of inkjet printing technology, including using ink feed slots (or vias) to feed a plurality of ink firing chambers, was known and disclosed in several Hewlett-Packard Journals, which are incorporated by reference in Giere178. Ex.1002, ¶277; Ex.1007 at 2:25-41; Ex.1017 at 64-68; Ex.1018, 58.

Moreover, a PHOSITA's knowledge that inkjet printheads typically had one or more ink vias with two heater arrays is confirmed by the '708 Patent's discussion of the prior art, as well as prior art references identified during prosecution of the '708 Patent. Ex.1002 ¶278; Ex.1001, 1:21-47; *see id.* at Figs. 1-2; *see also* Ex.1002, Section VII.A; *see also* Ex.1010, 4:61-63; Ex.1015, 2:61-63; *see also* Ex.1016 at 1:42-50, Fig.1.

Accordingly, Giere178 discloses “**a plurality of ink vias** (e.g., ink feed slot in each of regions 302, 304, 306, and 308) arranged parallel to one another, each of the ink via having two longitudinal sides.” This limitation also would have been obvious to a PHOSITA based on her knowledge and Giere178's teachings. Ex.1002 ¶¶266-279.

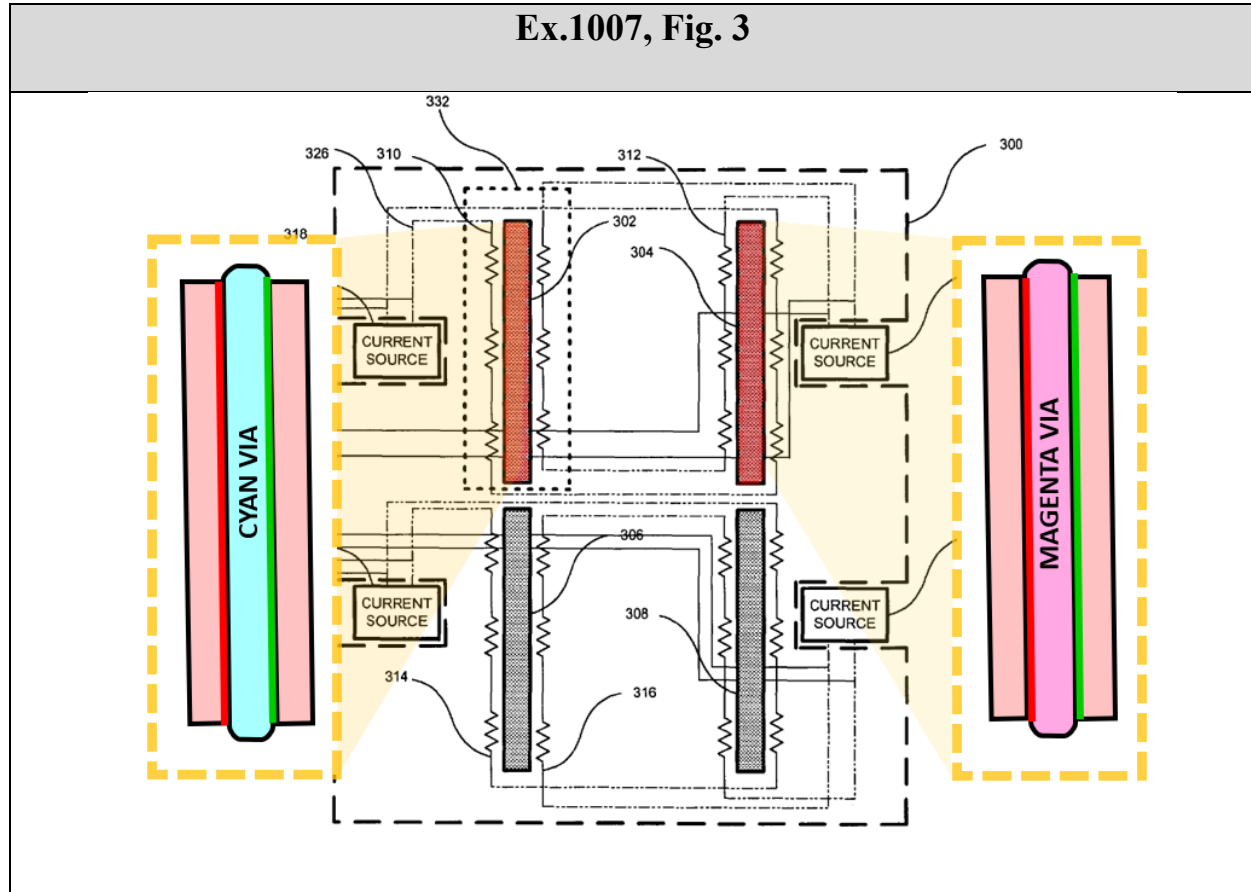
c. 1[B] “heater array”

Giere178 discloses 1[B]. Ex.1002 ¶¶280-287.

Giere178 discloses that printhead substrate 300 includes “**firing resistors.**” Ex.1007, 8:45-47. Giere178 further discloses that “[r]egions 302, 304, 306, and 308 each include an array of nozzles and associated **firing resistors for ejecting ink.**” Ex.1007, 8:47-49. A PHOSITA would have understood that the term “firing resistors” or “heaters” refers to electrical resistors that heat (vaporize) ink inside an ink ejection chamber to eject the ink from the nozzle. Ex.1002 ¶281; *see also* Ex.1007, 5:36-38. Thus, a PHOSITA would have understood that Giere178’s disclosure of “firing resistors for ejecting ink” in each of regions 302, 304, 306, and 308 means that each of these regions includes an arrangement of firing resistors, i.e., a heater array. Ex.1002 ¶282.

Annotated Figure 3 below depicts an exemplary arrangement of these features with ink vias shown in regions 302 and 304 and each having a heater array (*pink*) along each longitudinal side and each ink feed slot (e.g., cyan and magenta) is associated with two heater arrays (*pink*) disposed adjacent the two longitudinal sides (*red, green*) of the ink via. Ex.1002 ¶282-283. A PHOSITA would have understood that the heater arrays are necessarily disposed very close to ink feed slots/vias to ensure that ink can refill a firing chamber quickly (several kilohertz repetition rate) after it has fired an ink drop. Ex.1002 ¶282-283.

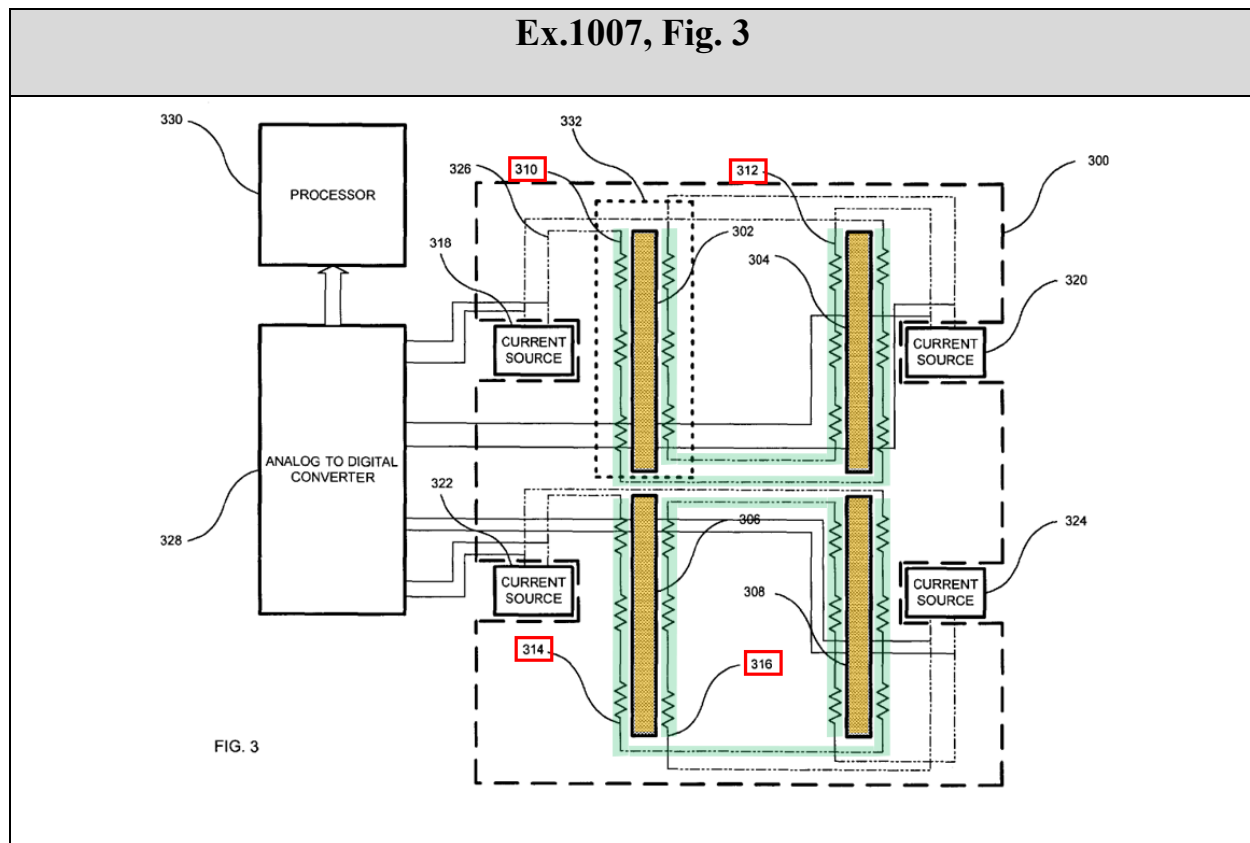
Ex.1007, Fig. 3



Additionally, a PHOSITA would have recognized that Giere178 discloses *two* heater arrays (*pink*) in each of regions 302, 304, 306, and 308 (as illustrated above for example) because the component layout of Giere178's temperature management system requires measuring the substrate temperature on both sides of those regions where excess heat would be generated by the two heater arrays. Ex.1002 ¶283.

As discussed in greater detail in Sections VIII.C.1.f-g, Giere178's temperature measurement system employs "temperature sensing elements" in

different regions of the substrate 300 to detect the temperature of the substrate. Specifically, as shown in Figure 3 (below), Giere178 discloses that on either side of each region (302, 304, 306, and 308) [orange] “resistive elements 310, 312, 314, and 316 [green] are formed.” Ex.1007, 8:49-51; Fig. 3. Giere178 notes that “[r]esistive elements 310, 312, 314, and 316 are located so that they will each assume the temperature of the local region of substrate 300 on which they are placed.” Ex.1007, 8:51-54, 10:3-8; *id.*, 9:29-33; 9:44-48; Fig. 3.



A PHOSITA would have understood that arrays of firing resistors are located on both sides of regions 302, 304, 306, and 308 because resistive elements (temperature sensors) are placed where the substrate temperature is most likely to be affected by the heat generated by those firing resistors. Ex.1002 ¶284; Ex.1007, 5:44-46 (“**Localized heating of the substrate can occur from firing nozzles at a greater frequency in a particular region of the printhead.**”); *id.*, 5:36-38; *id.*, 5:39-43.

Further, Giere178’s temperature sensor layout also indicates the presence of two heater arrays in regions 302, 304, 306, and 308 because each of those regions also includes an ink via (as discussed above in Section VIII.C.1.b [limitation 1A], incorporated here) that acts as an insulator preventing heat from a *single* heater array, for example, from reaching both sides of the region. Ex.1002 ¶285; Ex.1001 at 6:64-66; *see also* Ex.1008 at 3:18-20. In this case, because of the insulating ink via, the presence of temperature sensors [*green*] on either side of each region indicates that heat is being independently generated by two heater arrays on both sides of the region. Ex.1002 ¶285.

To the extent Giere178 does not expressly disclose limitation 1[B], it would also have been obvious to a PHOSITA, based on a PHOSITA’s knowledge and Giere178’s teachings with respect to the layout of temperature sensors on both sides of regions 302, 304, 306, and 308 as discussed above. Ex.1002 ¶286;

Ex.1007, 8:45-46; Ex.1002, Sections VII.A, XIII.A.2; *see also* Ex.1010 at 4:61-63; Ex.1015 at 2:61-63; *see also* Ex.1016 at 1:42-50, Fig.1.

Accordingly, Giere178 discloses “a heater array (e.g., Giere178’s array of “firing resistors”) disposed adjacent each longitudinal side of the ink vias (e.g., Giere178’s “ink feed slot”) such that each ink via is associated with two heater arrays disposed adjacent the two longitudinal sides of the ink via.” It also would have been obvious to a PHOSITA based on her knowledge and Giere178’s teachings that Giere178 discloses this limitation. Ex.1002 ¶¶280-287.

d. 1[C] “region”

Giere178 discloses 1[C]. Ex.1002 ¶¶288-294.

The ’708 Patent defines a “region” of the chip in relation to the location of ink vias on the chip *as illustrated in the patent’s figures*. Ex.1001, 5:55-6:3; *see below id.* at Fig. 5.

Ex.1001, Fig. 5

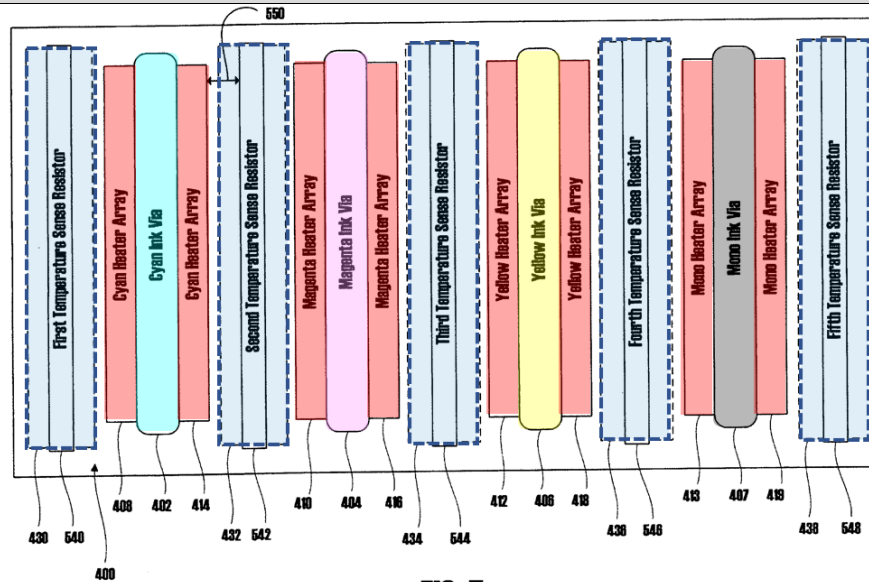
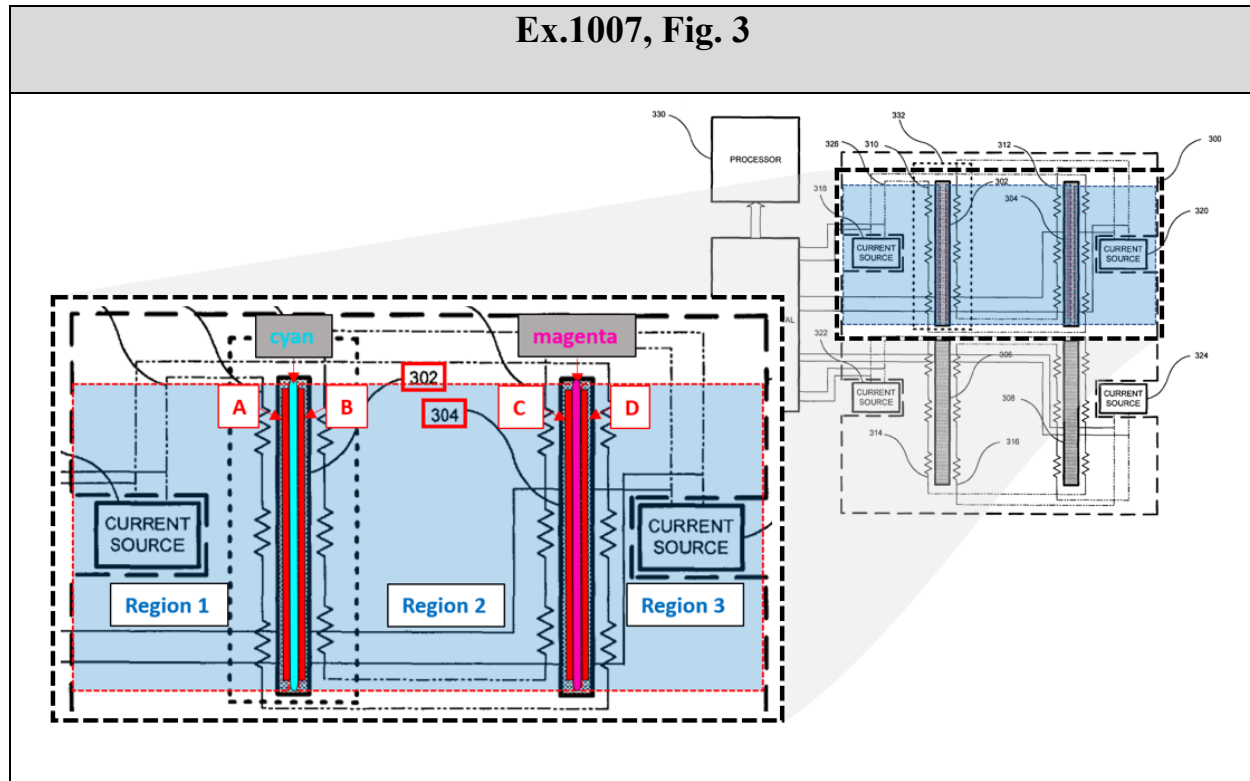


FIG. 5

Giere178 discloses a region adjacent each heater array and situated between two ink vias or between an ink via and an edge of the substrate. For example, as illustrated in Figure 3 (below), Giere178's substrate 300 includes at least three regions (Regions 1, 2, 3) wherein each region [*blue*] is also adjacent each heater array (e.g., array of firing resistors) [*red*].

Ex.1007, Fig. 3



Looking at the exemplary cyan ink via on printhead substrate 300, the firing resistors disposed on the right side of the cyan ink via form a heater array (Heater Array B, red) that is adjacent the region disposed between the cyan and magenta ink vias (Region 2, blue) because the array of firing resistors forming Heater Array B lie next to and are included in Region 2. Ex.1002 ¶290-291⁶; Ex.1012; Ex.1013. The same is true for every other heater array on Giere178's printhead substrate 300. Ex.1002 ¶291-293.

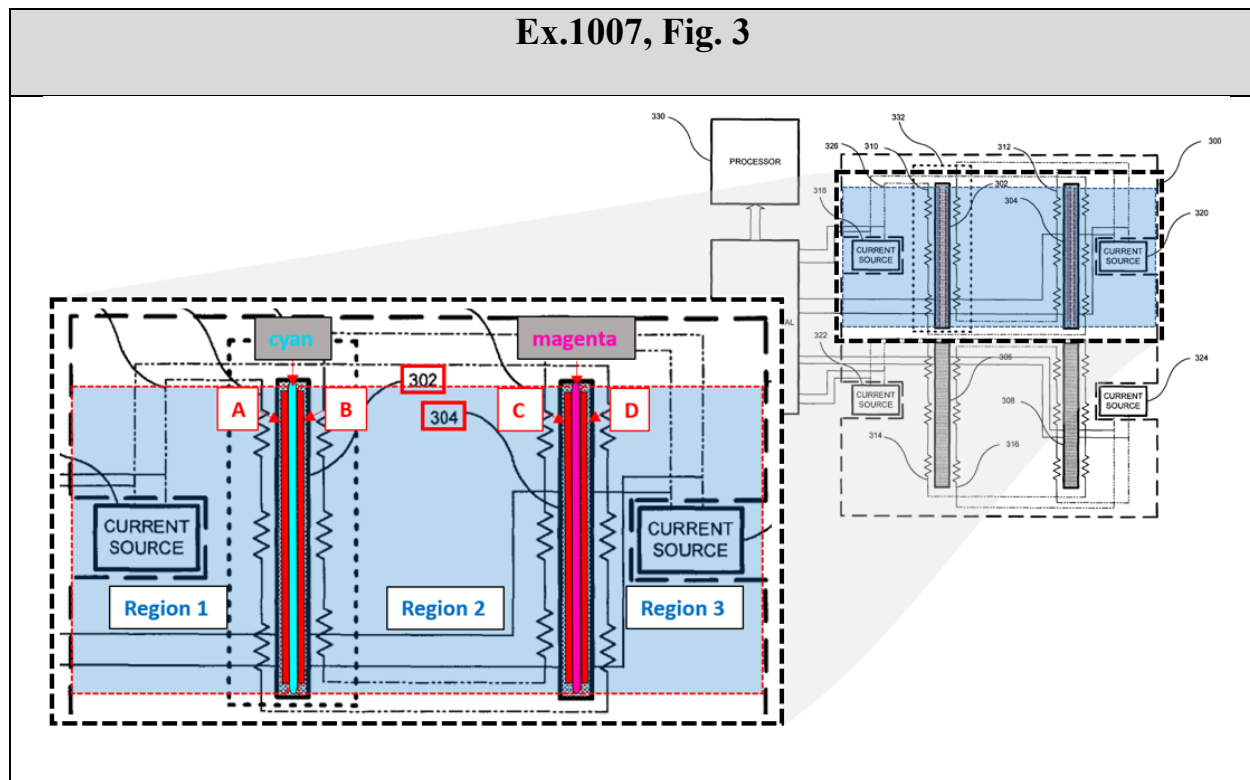
⁶ A POSITA relying on *patent figures* to show the region's location with respect to the ink vias and arrays is consistent with how the '708 Patent illustrates these relationships.

Accordingly, Giere178 discloses “a region disposed adjacent each heater array.” Ex.1002 ¶¶288-294.

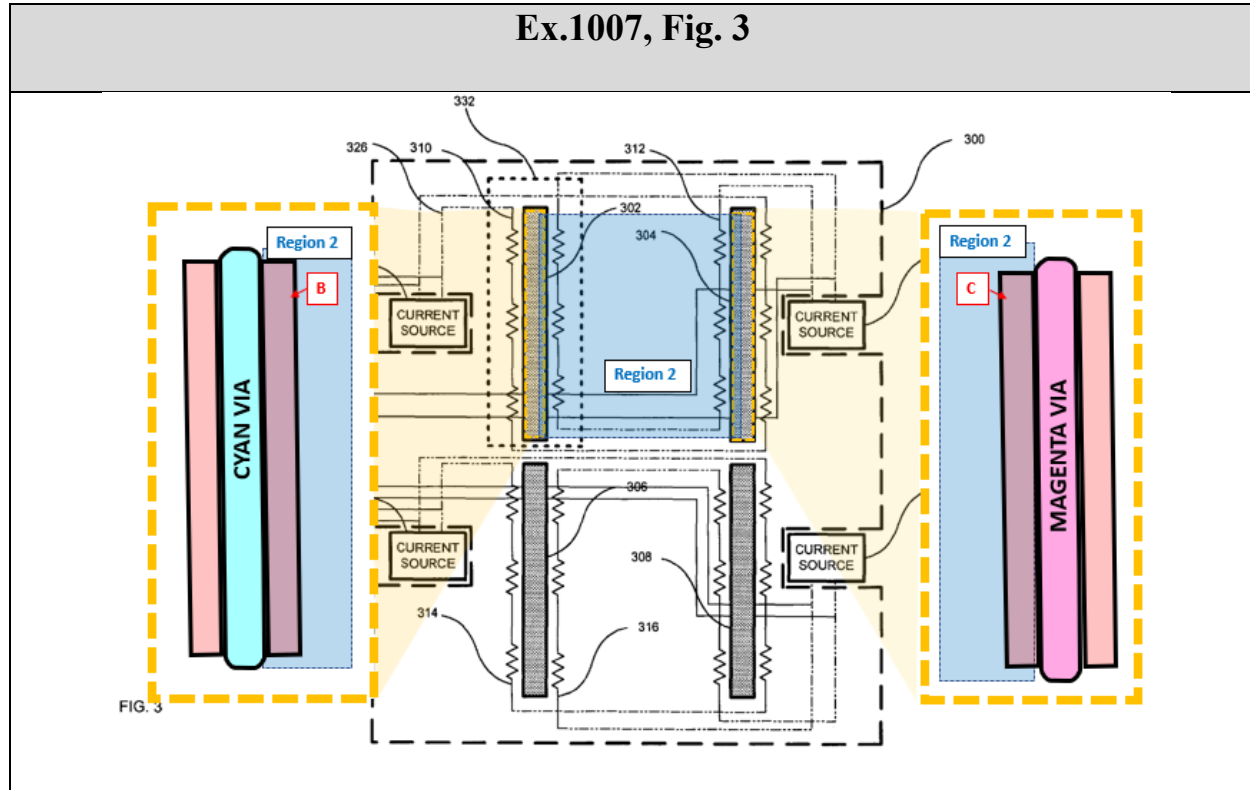
e. 1[D] “only one region”

Giere178 discloses 1[D]. Ex.1002 ¶¶295-299.

As seen below in Figure 3, Giere178 discloses only one region [Region 2, *blue*] disposed between two adjacent ink vias within regions 302 and 304 (e.g., ink feed slot for *cyan* ink in region 302 and ink feed slot for *magenta* ink in region 304). Ex.1002 ¶296. Region 2 is illustrated on the substrate with respect to the ink vias in Giere178’s regions 302 and 304, but there is a similarly situated Region between the ink vias in regions 306 and 308. *Id.*



Ex.1007, Fig. 3

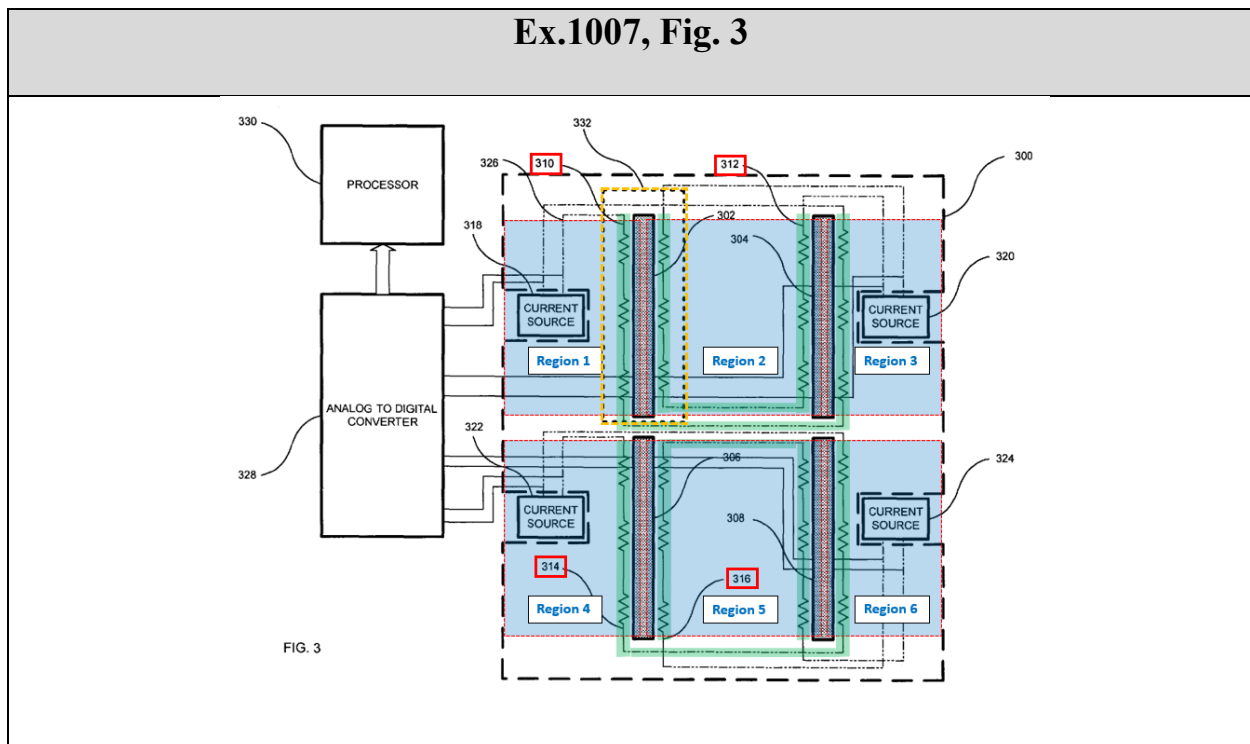


Accordingly, as shown above in annotated Fig. 3, Gier178 discloses that “**only one region** [e.g., Region 2 formed between ink feed slots in regions 302 and 304] is disposed between two adjacent ink vias and **wherein the region disposed between two adjacent ink vias includes two heater arrays** [e.g., firing resistors forming Heater Array B disposed on right side of the cyan ink feed slot in region 302, and firing resistors forming Heater Array C disposed on the left side of the magenta ink feed slot in region 304] **each heater array being associated with their respective ink via** [e.g., Heater Array B is associated with the ink feed slot in region 302 and Heater Array C is associated with the ink feed slot in region 304].” Ex.1002 ¶¶297-299.

f. 1[E] “single temperature sensing element”

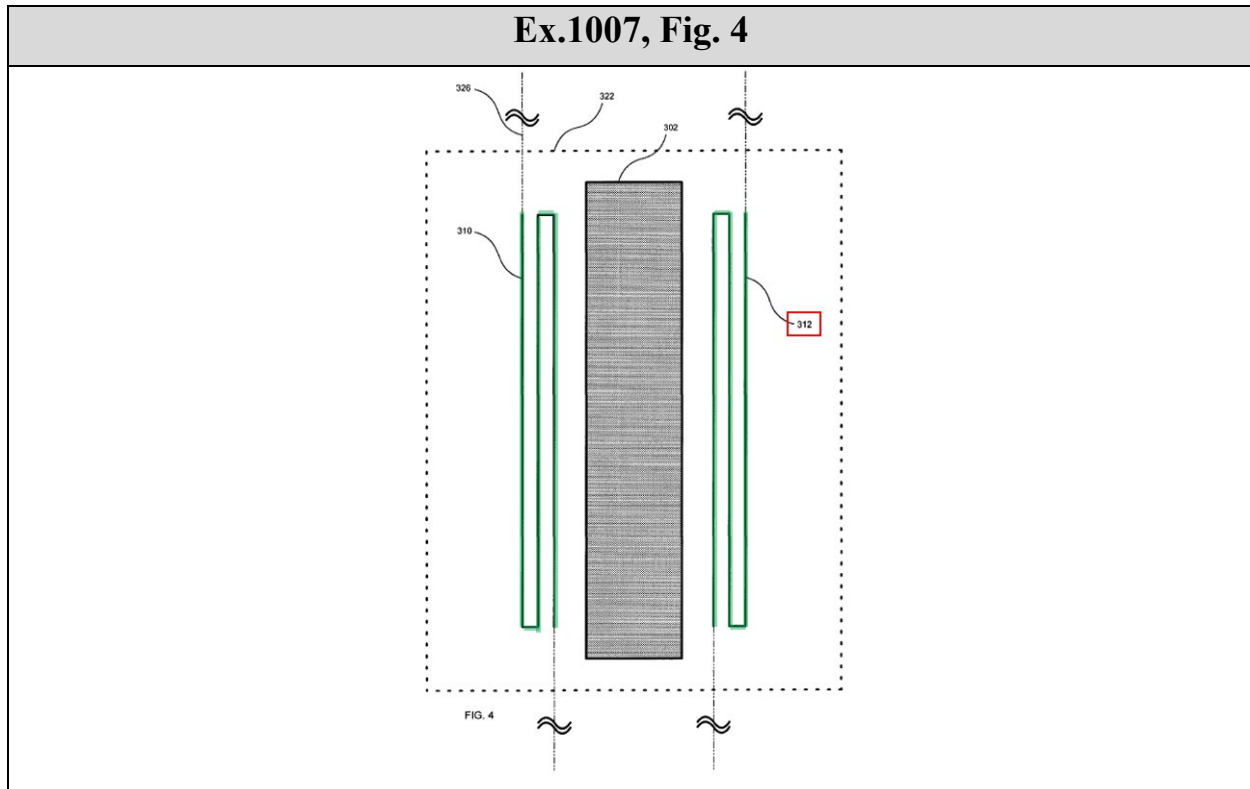
Giere178 discloses 1[E]. Ex.1002 ¶¶300-307.

Giere178’s temperature measurement system includes temperature sensing elements, *one* located in each region of the substrate 300, to detect the temperature of the substrate. Ex.1002 ¶301. Specifically, Giere178 discloses that on either side of each region (302, 304, 306, and 308), “resistive elements 310, 312, 314, and 316 [green] are formed from material having a known temperature coefficient of resistivity” and are “located so that they will each assume the temperature of the local region of substrate 300 on which they are placed.” Ex.1007, 8:49-51; 8:41-54.



The four resistive elements (310, 312, 314, and 316) are each temperature sensing elements. Ex.1002 ¶302. Just like the '708 Patent's temperature sensing element, Giere178 discloses that its resistive elements can have a serpentine path. Ex.1001, 1:57-59 ("metal serpentine temperature sense resistor 120."); Ex.1007, 10:24-29; 11:24-30. Therefore, Giere178's resistive elements are the same as an embodiment of the '708 Patent's "temperature sensing element." Ex.1002 ¶302.

Giere178's Figure 4 (below) is a schematic diagram corresponding to portion 332 (*orange*) in Figure 3 (above). Figure 4 illustrates the serpentine path of the resistive elements. Ex.1002 ¶303. The double-tildes indicate that the length of the resistive element continues outside of portion 332. *Id.* For example, the serpentine path of resistive element 312 extends across Region 2 (between regions 302 and 304), as illustrated in Figure 3 above.



As illustrated in Figure 3 above, each Region [Regions 1-6, *blue*] only includes a single temperature sensing element. As such, **each region has a resistive element and there are never two resistive elements in any one Region.** Ex.1002 ¶304-305. For example, as illustrated in Figure 3 (above) a single temperature sensing element, i.e., resistive element **312** [*green*] is included in Region 2. Regions 1 and 3 also include a single temperature sensing element, i.e., resistive element **310**. Region 5 includes a single temperature sensing element, i.e., resistive element **316**. And Regions 4 and 6 also include a single temperature sensing element, i.e., resistive element **314**. *Id.*

A PHOSITA would have also known that Giere178 includes a single temperature sensor in each region because it describes a problem of excessive *localized* heating in certain regions of the substrate without compensation for the substrate temperature change that can lead to degradation in print quality. Ex.1002 ¶306; Ex.1007, 5:36-51. Giere178 describes a solution to the localized heating issue by placing multiple temperature sensing “resistive elements” on the substrate—one in each region—“so that they will each assume the temperature of the local region of substrate [] on which they are placed.” Ex.1007, 8:51-54; *see also* Ex.1002, Sections IX.B.4, XIII.A.6-7, and XIV.C; Ex.1002 ¶306.

Accordingly, Giere178 discloses “a **single temperature sensing element** (e.g., resistive elements 310, 312, 314, or 316) **disposed within each region** (e.g., Regions 1 through 6).” Ex.1002 ¶¶300-307.

g. 1[F] “operable to sense a temperature”

Giere178 discloses 1[F]. Ex.1002 ¶¶308-311.

Giere178 discloses that “[r]esistive elements 310, 312, 314, and 316 are located so that they will each **assume the temperature of the local region of substrate 300 on which they are placed.**” Ex.1007, 8:51-54. Giere178 explains their operation—current sources 318, 320, 322, and 324 supply a substantially constant and known current to the resistive element 310, 312, 314, and 316 (Ex.1007, 8:55-60), and “the voltage resulting from the application of current to

each of resistive elements 310, 312, 314, and 316 changes according to temperature induced changes in the resistance, thereby providing **signals related to the temperatures of the regions.**” Ex.1007, 8:60-64; *see also id.*, 10:4-8; 9:44-48 (“measurement of the temperature change of regions of substrate 300 can be determined.”).

Giere178 further explains that the substrate temperature is based on the heat generated from the firing resistors (i.e., adjacent heater arrays). Ex.1007, 5:36-38 (“The **rate at which signals are supplied to [firing] resistors associated with the ink ejection chambers affects the temperature of the substrate of the printhead.**”); *id.* at 5:39-43; *id.* at 5:44-46; 9:50-54.

A PHOSITA would have understood that the substrate temperature is representative of the heater arrays adjacent to the region because the substrate temperature is a direct result of heat generated by the firing resistors. Ex.1002 ¶309-310. Thus, the resistive elements 310, 312, 314, and 316 are operable to sense a temperature representative of the heater arrays adjacent to the region because they are located so that they will each assume the temperature of the local region of substrate 300 on which they are placed. *Id.*

Further, because the ink feed slots with regions 302, 304, 306, and 308 act as thermal insulators between the regions, a PHOSITA would have understood that the resistive elements 310, 312, 314, and 316 are designed to sense the temperature

of the substrate region it is positioned in, and since each region includes two arrays of firing resistors, a PHOSITA would also have known that the temperature sensed by each resistive elements 310, 312, 314, and 316 would represent the temperature of the two heater arrays in its region. Ex.1002 ¶310.

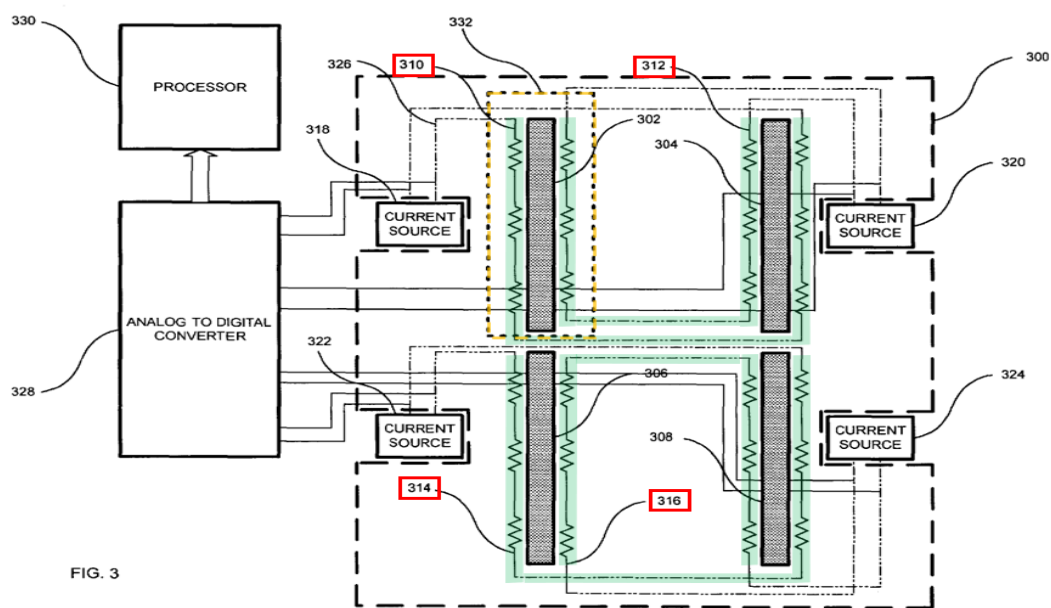
Accordingly, Giere178 discloses the “**temperature sensing element** [e.g., resistive elements 310, 312, 314, or 316] operable to sense a temperature representative of the heater arrays adjacent to the region [e.g., Region 2].” Ex.1002 ¶¶308-311.

h. 1[G] “predetermined distance”

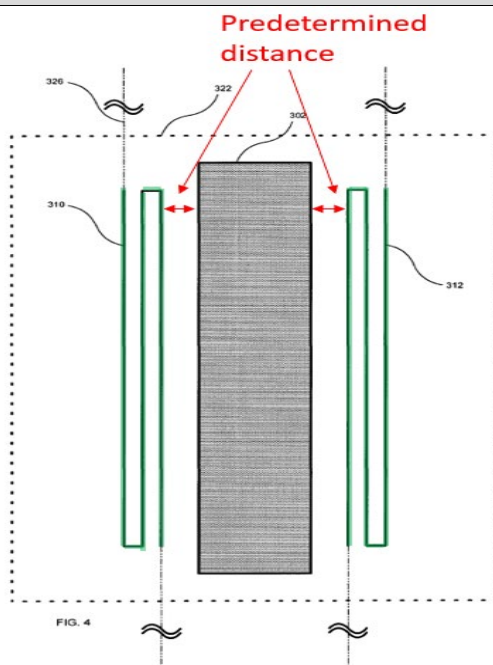
Giere178 discloses 1[G]. Ex.1002 ¶¶312-315.

Giere178’s resistive elements are disposed at a predetermined distance from the heater arrays. Ex.1002 ¶313. As illustrated in Figures 3 and 4 (below), resistive elements 310 and 312, for example, are located outside the regions 302 and 304 that include the firing resistors (i.e., heater arrays) for ejecting ink. *Id.* Because Giere178 discloses that its temperature sensing elements “assume the temperature of the local region of substrate 300 on which they are placed,” a PHOSITA would have understood that the temperature sensing elements are at a fixed distance away from the heater arrays that are located within regions 302, 304, 306, and 308. *Id.*; see also Ex.1002 ¶313-314.

Ex.1007, Fig. 3



Ex.1007, Fig. 4



Accordingly, Giere178 discloses a **temperature sensing element** (e.g., resistive elements 310, 312, 314, and 316) is disposed at a predetermined distance away from adjacent heater arrays. Ex.1002 ¶¶312-315.

2. Claims 2 and 11⁷

Giere178 discloses claim 1 and the additional limitations of claims 2 and 11. Ex.1002 ¶¶316-320, 356-357.

Giere178 discloses temperature sense resistors (i.e., resistive elements) that are metal resistors. Ex.1007, 8:51-54; *see also id.* at 8:65-9:1; 10:3-8; 8:60-64. Similar to the 708 Patent’s temperature sensing element, Giere178 further discloses that its resistive elements can be a metal serpentine path. *Id.*, *see also* Ex.1001, 1:57-59; 10:24-29, 11:24-30.

Accordingly, Giere178 discloses a “temperature sensing element [e.g., resistive elements 310, 312, 314, or 316] that comprises a temperature sensing resistor.” Ex.1002 ¶¶316-320.

3. Claims 3 and 12⁸

Giere178 discloses claim 2 and the additional limitations of claims 3 and 12. Ex.1002 ¶¶321-324.

⁷ For the reasons stated herein, Giere178 discloses claim 11. Ex.1002, ¶¶356-357.

⁸ For the reasons stated herein, Giere178 discloses claim 12. Ex.1002, ¶¶358-359.

The '708 Patent explains that a “thermal sense resistor (TSR)” is “typically used to sense the temperature of the silicon substrate.” Ex.1001, 1:56-57; 6:29-31.

A PHOSITA would have understood that Giere178’s resistive elements 310, 312, 314, and 316 are “thermal sense resistors” because induced changes in their resistance indicates a temperature change in the silicon substrate 300. Ex.1002 ¶323.

For example, Giere178 discloses “[t]he voltage resulting from the application of current to each of resistive elements 310, 312, 314, and 316 changes according to temperature **induced changes in the resistance**, thereby providing **signals related to the temperatures of the regions**.” Ex.1007, 8:60-64; *id.* at 10:3-8.

Accordingly, Giere178 discloses a “temperature sensing element comprises a thermal sense resistor [e.g., resistive elements 310, 312, 314, or 316].” Ex.1002 ¶¶321-324.

4. Claims 5 and 14⁹

Giere178 discloses claim 1 and the additional limitations of claims 5 and 14. Ex.1002 ¶¶325-328.

As discussed in Section VIII.C.1.h (limitation 1[G]), incorporated here, Giere178’s resistive elements are disposed at a predetermined distance from the

⁹ For the reasons stated herein, Giere178 discloses claim 14. Ex.1002, ¶¶360-361

heater arrays. Giere178 discloses that resistive elements (310, 312, 314, and 316) are located outside the regions (302, 304, 306, and 308) that include the nozzle arrays and associated firing resistors for ejecting ink. Ex.1002 ¶326. Thus, a PHOSITA would have understood that the temperature sensing elements are at a predetermined distance away from the heater arrays that are located within regions 302, 304, 306, and 308. Ex.1002 ¶326-327.

It would also have been obvious to a PHOSITA that Giere178's resistive elements could be located a predetermined distance of at least 300 microns from its heater arrays because Giere178 discloses resistive element layouts that include positioning the resistive element at *any point* within its respective region of substrate 300 without restriction on exactly where in that region the element must be placed. Ex.1002 ¶327; Ex.1007, Fig. 3; 8:51-54. In other words, a predetermined distance of 300 microns would be a design choice. *Id.*

Accordingly, it would have been obvious to a PHOSITA that Giere178's resistive elements could be located a “predetermined distance of at least 300 microns.” Ex.1002 ¶¶325-328.

5. Claims 6 and 15¹⁰

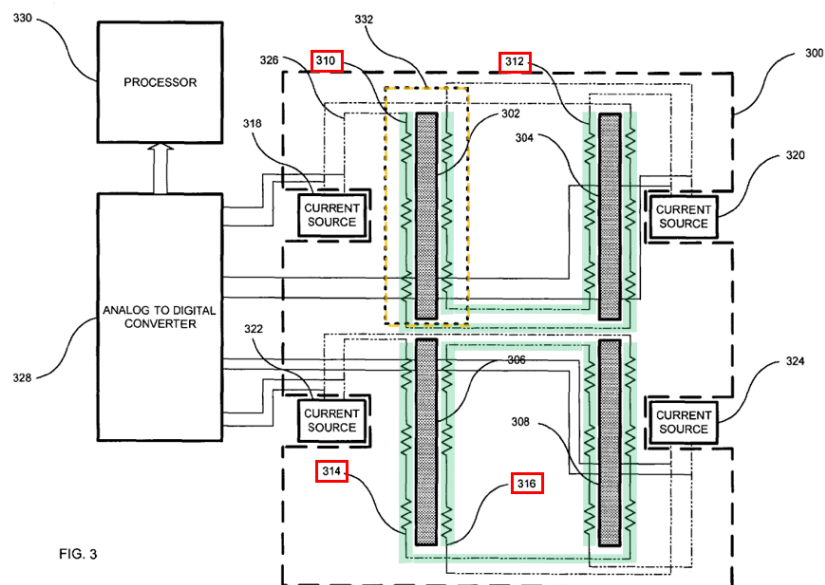
Giere178 discloses claim 1 and the additional limitations of claims 6 and 15. Ex.1002 ¶¶329-334.

¹⁰ For the reasons stated herein, Giere178 discloses claim 15. Ex.1002, ¶¶362-363.

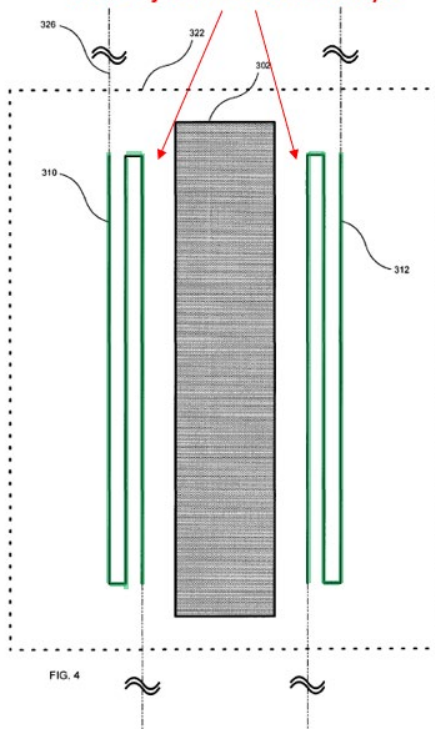
Giere178 defines a typical inkjet printhead as “a silicon substrate having a plurality of thin film layers, **structures built on the substrate**, and connections to the substrate.” Ex.1007, 2:59-61; 8:45-46. A PHOSITA would have understood that because structures built on a plurality of a substrate’s thin film layers each of the structures would be in substantially the same plane. Ex.1002 ¶330. As such, Giere178’s “resistive elements” are positioned substantially planar to each of the adjacent heater arrays (e.g., arrays of ink firing resistors in regions 302, 304, 306, and 308) because they are structures built on substrate 300. *Id.*

As illustrated in Figures 3 and 4 (below), resistive elements 310, 312, 314, and 316 are positioned substantially planar along the entire length of the ink via and heater array region, *but not positioned directly above or overlapping the ink via and heater array region*, as required by the ’708 Patent. Ex.1002 ¶331-333; Ex.1007, 10:23-26; Ex.1001, 3:11-13.

Ex.1007, Figs. 3 and 4



substantially planar to each of
 the adjacent heater arrays



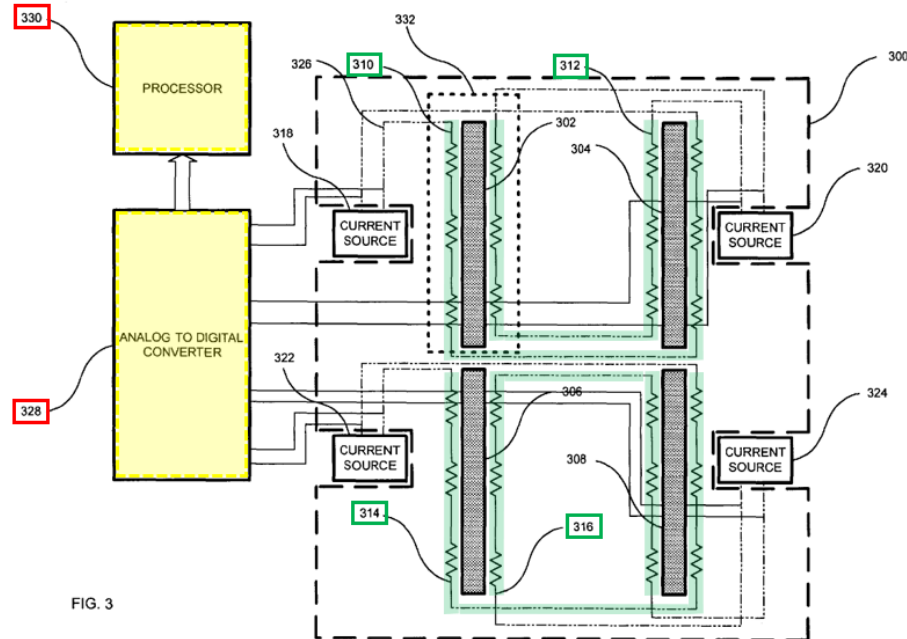
Accordingly, Giere178 discloses “temperature sensing element is positioned substantially planar to each of the adjacent heater arrays.” Ex.1002 ¶¶329-334.

6. Claim 7

Giere178 discloses claim 1 and the additional limitations of claim 7. Ex.1002 ¶¶335-344.

Giere178 discloses at least one control element (e.g., Analog to Digital Converter 328 and Processor 330) operable to receive a temperature measured by the temperature sensing element (e.g., resistive elements 310, 312, 314, and 316). Ex.1002 ¶336. As illustrated in Fig. 3 (below), Giere178 discloses “**analog to digital converter 328** [yellow] includes 4 channels that each **receive a voltage value related to the voltage across resistive elements 310, 312, 314, and 316**” and “[a]nalog to digital converter 328 converts each of the voltages it receives to corresponding digital values.” Ex.1007, 9:10-15; *see below id.*, Fig. 3. Giere178 further discloses that the digital values are received by “**processor 330** [yellow]” that converts them to “**digital values that are related to temperatures of substrate 300 in the vicinity of regions 302, 304, 306, and 308.**” Ex.1007, 9:29-33; *see below id.*, Fig. 3.

Ex.1007, Fig. 3



Giere178 further discloses that “[u]sing these temperature related digital values, **processor 330 operates an embodiment of a temperature compensation system.**” Ex.1007, 9:58-50. For example, “the temperature compensation system may adjust the pulse width of the drive signals supplied to the firing resistors so that the **temperature of substrate 300 is controlled** substantially at a desired temperature.” Ex.1007, 9:50-53; *see also id.*, 9:54-58; *id.* at 9:58-64.

Moreover, although Giere178 does not expressly direct a PHOSITA to place the control element (i.e., Analog to Digital Converter 328 and Processor 330) on substrate 300, it would have been within the possibilities available to a PHOSITA

to place the Analog to Digital Converter 328 and Processor 330 there. Ex.1002 ¶339. A PHOSITA would also have been motivated to do so as it would reduce the number of external connections from the substrate to the printer making the substrate design simpler and cheaper to manufacture, as well as improve the signal-to-noise reliability of the temperature sensor measurements. Ex.1002, ¶340-342. Indeed, such designs were known in the art and incorporated by reference into Giere178. Ex.1002 ¶343; Ex.1007, 8:27-40.

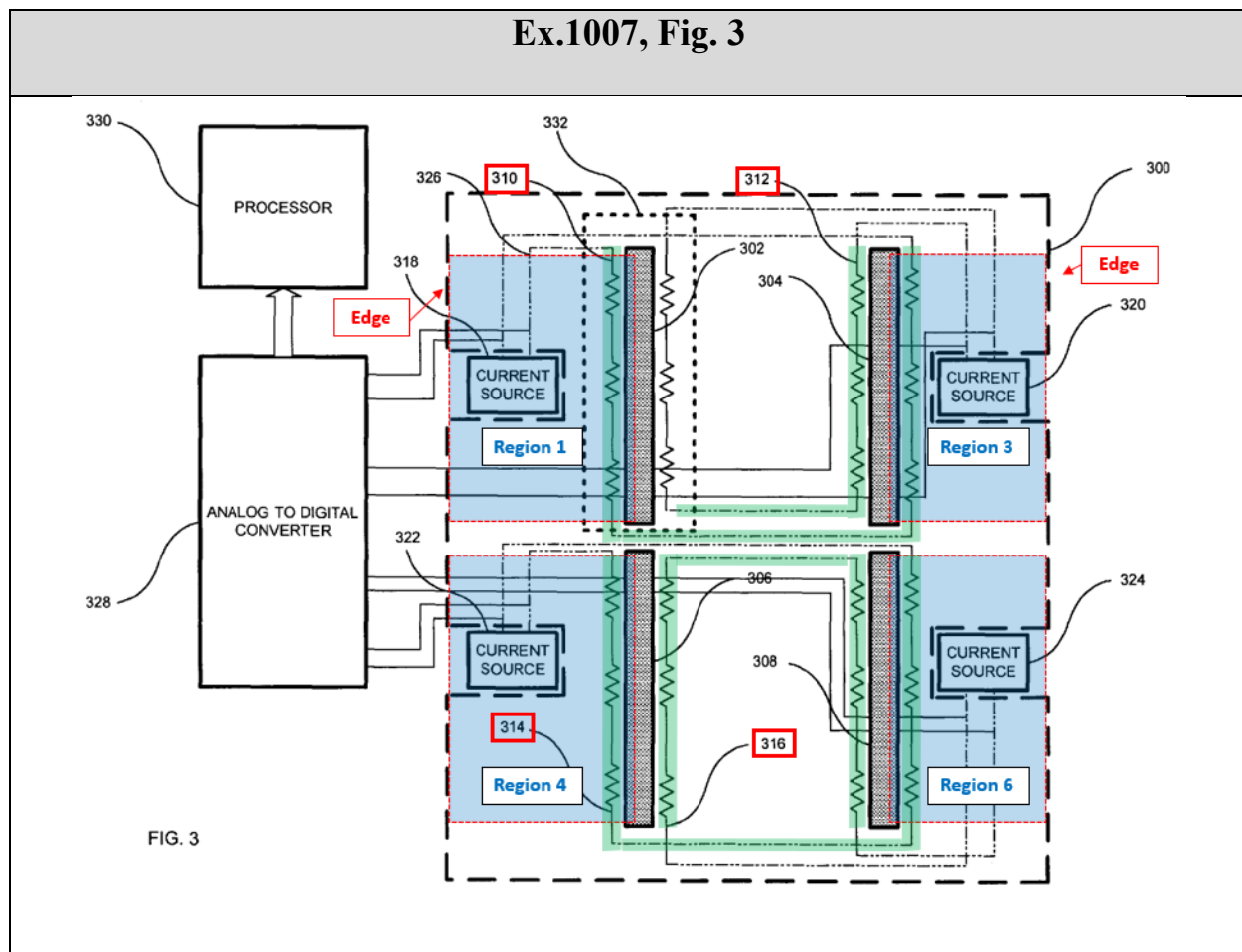
Accordingly, Giere178 discloses “at least one control element (e.g., Analog to Digital Converter 328 and Processor 330) operable to receive temperature measured by the temperature sensing element a temperature sensing element.” Ex.1002 ¶¶335-344.

7. Claim 8

Giere178 discloses claim 1 and the additional limitations of claim 8. Ex.1002 ¶¶345-348.

Giere178 states that a “typical inkjet printhead” is a silicon substrate having a plurality of thin film layers, structures built on the substrate, and connections to the substrate.” Ex.1007, 2:59-61. Giere178 further discloses that substrate 300, as shown in Figure 3 below, is a typical printhead. A PHOSITA would have understood that the substrate (300) of a typical printhead is a rectangular substrate that has four sides (edges). Ex.1002 ¶346.

As seen in Figure 3 below, substrate 300 includes at least one edge (e.g., Right edge) and at least one region (e.g., Region 3) disposed between one of the plurality of ink vias (e.g., magenta ink via in region 304) and the at least one edge (e.g., Right edge). Ex.1002 ¶347.



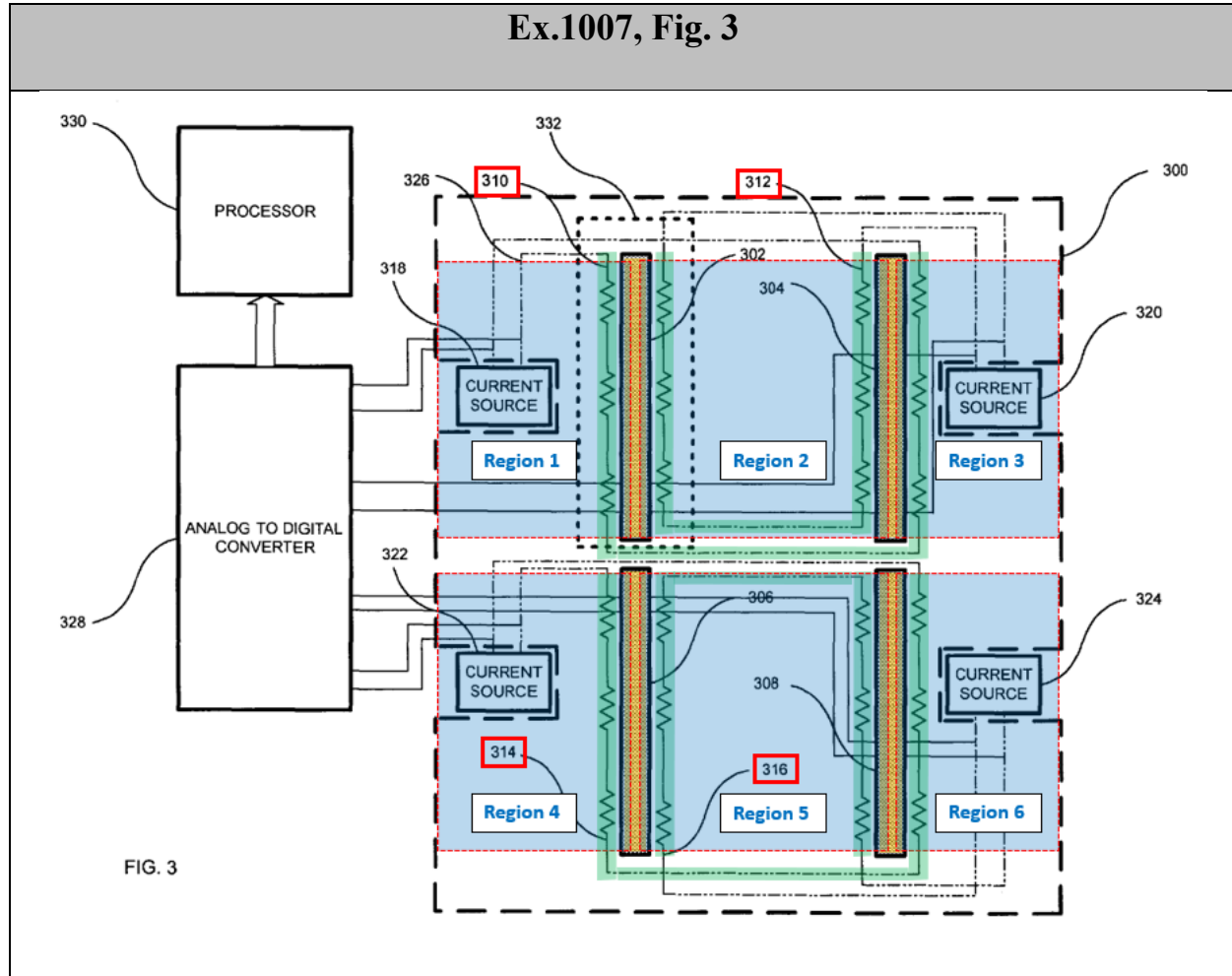
Accordingly, Gierel78 discloses a chip has at least one edge and at least one region is disposed between one of the plurality of ink vias and the at least one edge. Ex.1002 ¶¶345-348.

8. Claim 10

Giere178 discloses claim 1 and the additional limitations of claim 10. Ex.1002 ¶¶351-355.

A PHOSITA reviewing Figure 3 of Giere178 would have understood that claim 10’s “the temperature sense resistor [e.g., resistive element 312, *green below*]” is at least in *substantially* a center portion—if not exactly in the center—of the region (Region 2) disposed between the two heater arrays in region 302 and 304, especially since Giere178 states that “[r]esistive elements 310, 312, 314, and 316 are located so that they will each assume the temperature of the *local region* of substrate 300 on which they are placed.” Ex.1002 ¶352; Ex.1007 at 8:51-54.

A PHOSITA would have understood that placing the element in *substantially* a center portion would achieve the goal of the element assuming the temperature of the local region of substrate 300. Ex.1002 ¶352.

Ex.1007, Fig. 3

Accordingly, Giere178 discloses positioning the temperature sensing element (e.g., resistive elements 312) in the region comprises positioning a temperature sensing element in substantially a center portion of the region (e.g., Region 2 as illustrated in Fig. 3, above). Ex.1002 ¶¶351-355.

D. Ground 4: Giere178 in View of Yabe Renders Obvious Claims 1-3, 5-12, and 14-15

1. Claims 1 and 9¹¹

a. 1/P

For the reasons discussed above in Section VIII.C.1.a, incorporated here, Giere178 discloses **a chip** [e.g., printhead substrate] **for use with a printing device** [e.g., inkjet printer]. Ex.1002 ¶¶365-370.

b. 1/A

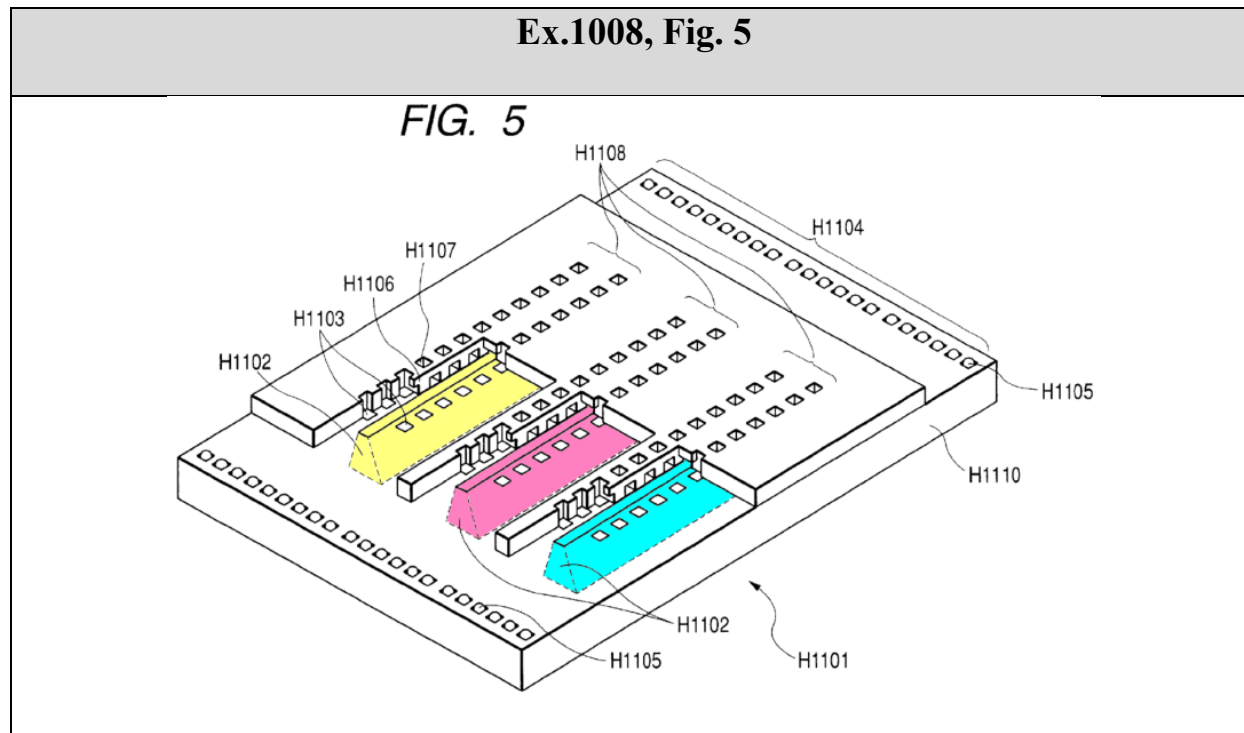
For the reasons discussed above in Section VIII.C.1.b, incorporated here, Giere178 discloses this limitation. Ex.1002 ¶¶371-372.

Yabe also discloses this limitation. Ex.1002 ¶¶373-379.

With respect to Figure 5 (below), Yabe discloses a recording element base plate (H1101) for discharging three colors of ink. Yabe discloses that “[t]hree ink supply ports H1102 [yellow, magenta, cyan] are formed in parallel, and electrothermal converting devices H1103 and ink discharge ports H1107 are formed on both sides having each of the ink supply ports H1102 between them.” Ex.1008, 8:46-51; 7:60-62; *see also id.* at Figs. 1, 3. A PHOSITA understands that the term “ink supply ports” is synonymous with “ink vias.” Ex.1008, 8:39-43; *id.* at 8:11-21; *see also* Ex.1002 ¶376.

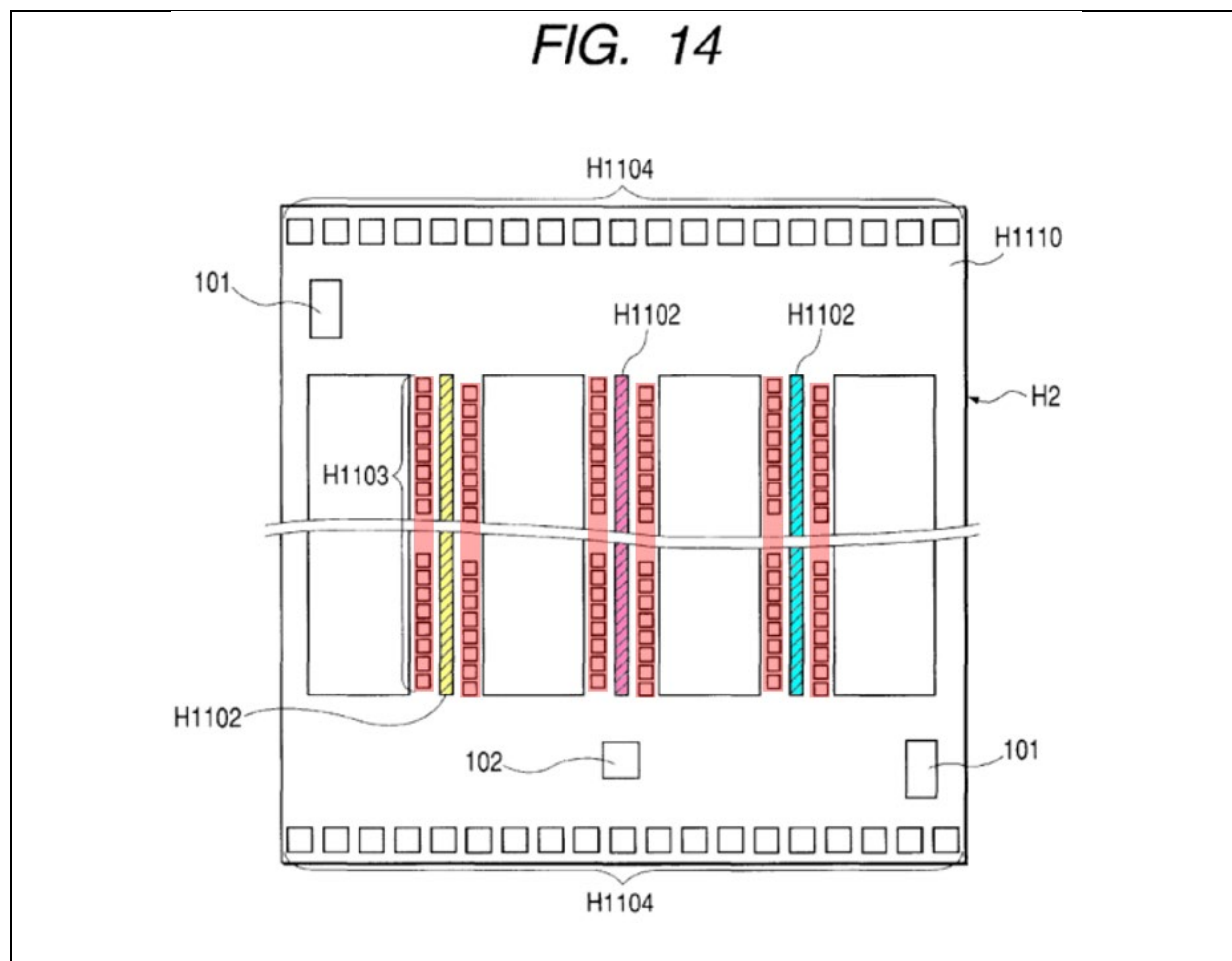
¹¹ The limitations of claim 9 mirror those of claim 1. *See* Full Listing of Claims Appendix, incorporated here. As such, for the reasons stated herein, Claim 9 is also obvious in view of Giere178 and Yabe. Ex.1002 ¶¶349-350.

Ex.1008, Fig. 5



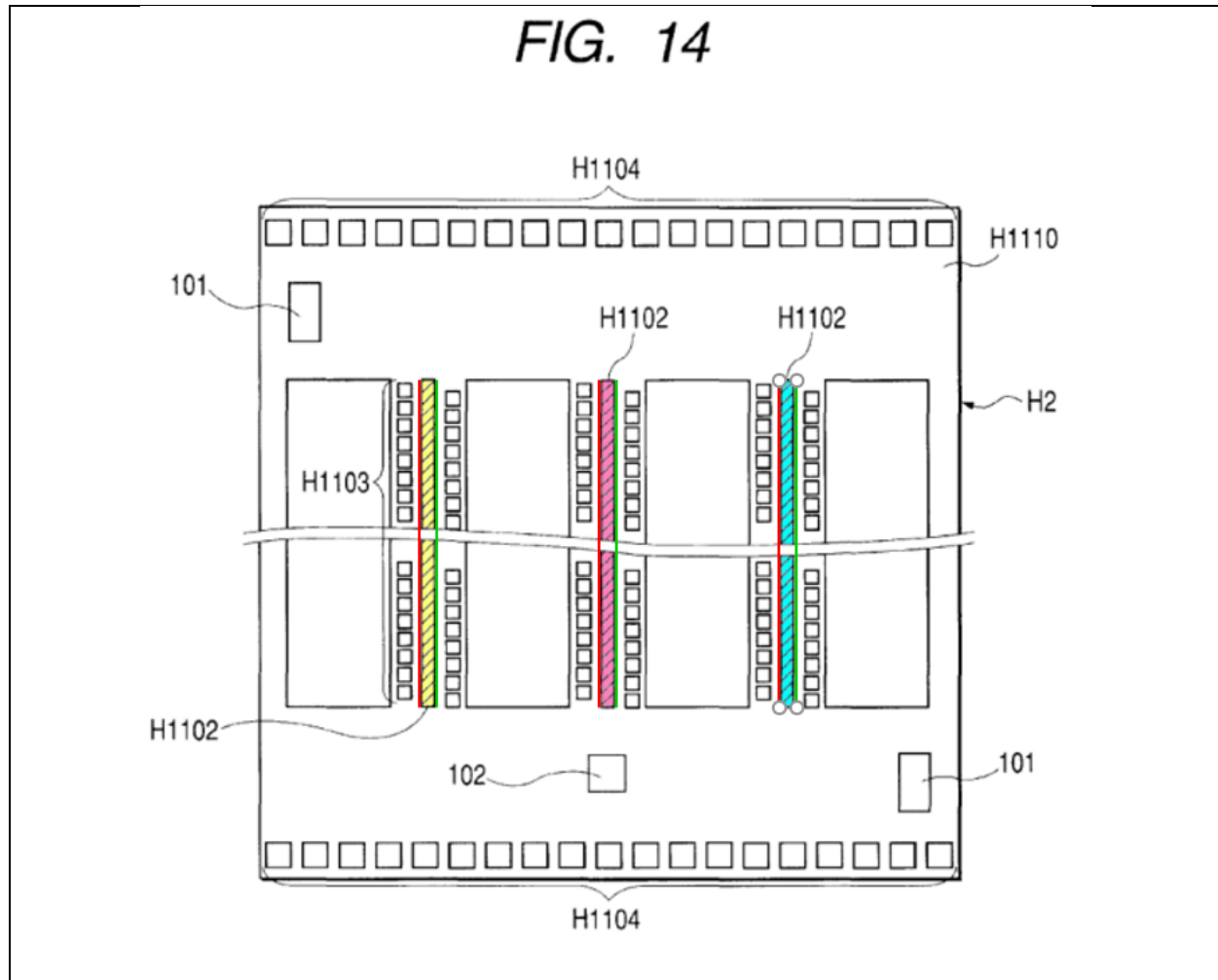
Yabe's Fig. 14, shown below, illustrates a layout for the heater board that corresponds to the layout shown in Yabe's Fig. 5. Ex.1008, 16:31-34; *see also id.*, Fig. 5. Figure 14 illustrates a "plurality of ink supply ports H1102 [yellow, magenta, cyan]" arranged parallel to one another. Ex.1008, 16:43; *see below id.*, Fig. 14.

Ex.1008, Fig. 14



As illustrated in Fig. 14, Yabe also teaches that each ink supply port H1102 has two longitudinal sides (e.g., *green* and *red*). Ex.1002 ¶378.

Ex.1008, Fig. 14



Accordingly, Yabe discloses a “plurality of ink vias [i.e., ink supply ports H1102 (yellow, magenta, cyan)] arranged parallel to one another, each of the ink via having two longitudinal sides.” Ex.1002 ¶¶371-379.

c. 1/B

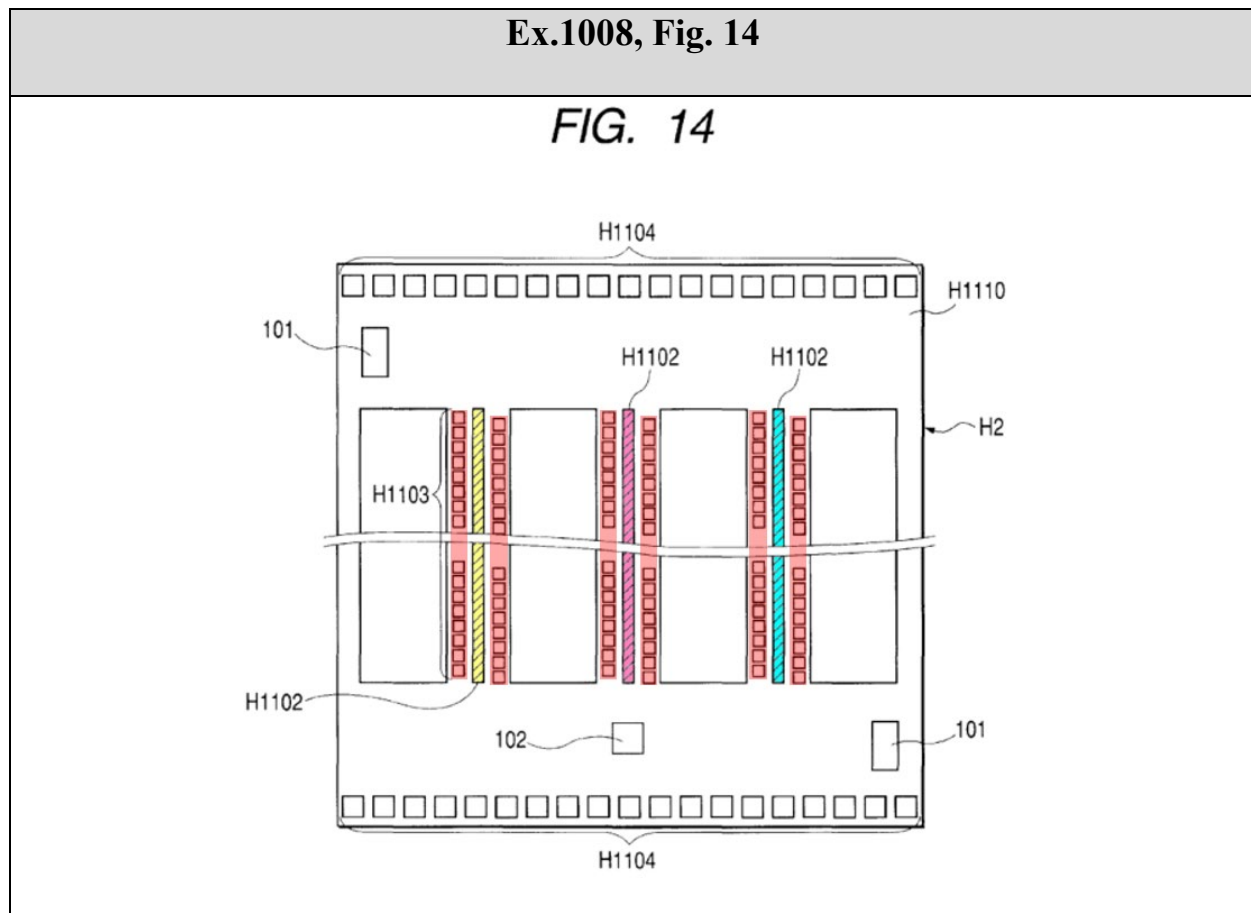
For the reasons discussed above in Section VIII.C.1.c, incorporated here, Giere178 discloses this limitation. Ex.1002 ¶¶380-381.

Yabe also discloses this limitation. Ex.1002 ¶¶382-389.

Yabe discloses heaters (i.e., electrothermal converting devices H1103) in a line (e.g., an array) that generate thermal energy for creating film boiling in ink in accordance with electric signals. Ex.1008, 16:31-34 (“**electrothermal converting devices (heaters) H1103** for the recording element base plate H1101 represented in FIG. 5.”); *id.* at 7:27-31; 8:38-43; 12:6-11; 8:21-23; 8:47-51.

Yabe also teaches that each ink feed slot is *associated with* the two heater arrays because each ink feed slot provides ink to the devices H1103 through an ink flow path. Ex.1008, 7:56-62; *see also id.* at 8:38-43.

Ex.1008, Fig. 14



Accordingly, as illustrated in Figure 14 above, Yabe discloses “a heater array [e.g., electrothermal converting devices H1103, *pink*] disposed adjacent each longitudinal side of the ink vias [e.g., ink supply ports H1102] such that each ink via is associated with two heater arrays disposed adjacent the two longitudinal sides of the ink via. Ex.1002 ¶¶ 382-389.

d. 1/C

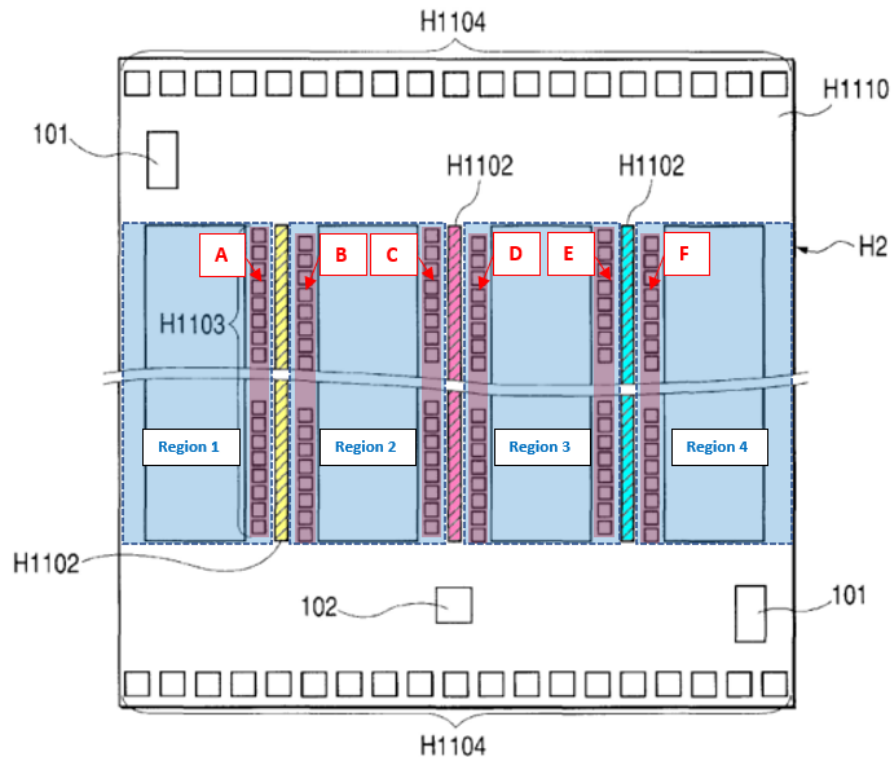
For the reasons discussed above in Section VIII.C.1.d, incorporated here, Giere178 discloses this limitation. Ex.1002 ¶¶ 390-391.

Yabe also discloses this limitation. Ex.1002 ¶¶ 392-397.

As illustrated in Figure 14 below, Yabe discloses regions [Regions 1, 2, 3, and 4, **blue**] adjacent each heater array (e.g., electrothermal converting devices H1103) and situated either between two ink vias (e.g., ink supply ports H1102) or between an ink via and an edge of the silicon substrate (H1110).

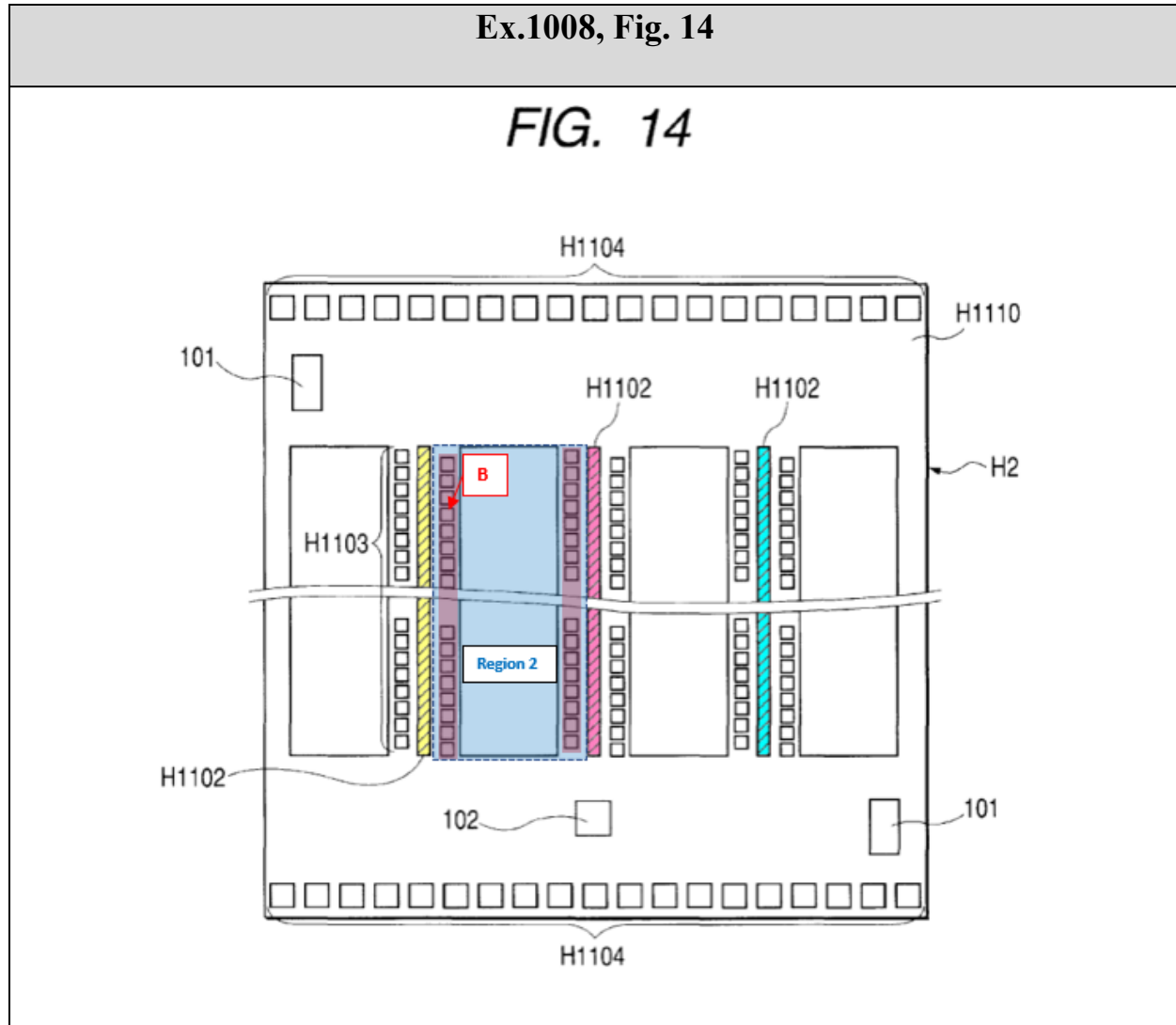
Ex.1008, Fig. 14

FIG. 14



For example, looking at the yellow ink supply port (H1102, far left) on chip H1110, the firing resistors disposed on the right side of the yellow ink supply port form a heater array (Heater Array B, *red*) that is *adjacent* the region disposed between the yellow and magenta ink supply ports (Region 2, *blue*) because Yabe discloses that the column of heaters forming Heater Array B is next to and included in Region 2. Ex.1002 ¶395; *see also* Section VII.B. This adjacent

arrangement example is illustrated below. The same is true for every other heater array on Yabe's substrate H1110. Ex.1002 ¶395-396.



Accordingly, Yabe discloses a region (e.g., Region 1, 2, 3, 4) disposed adjacent each heater array (e.g., electrothermal converting devices H1103, A-F). Ex.1002 ¶391-397.

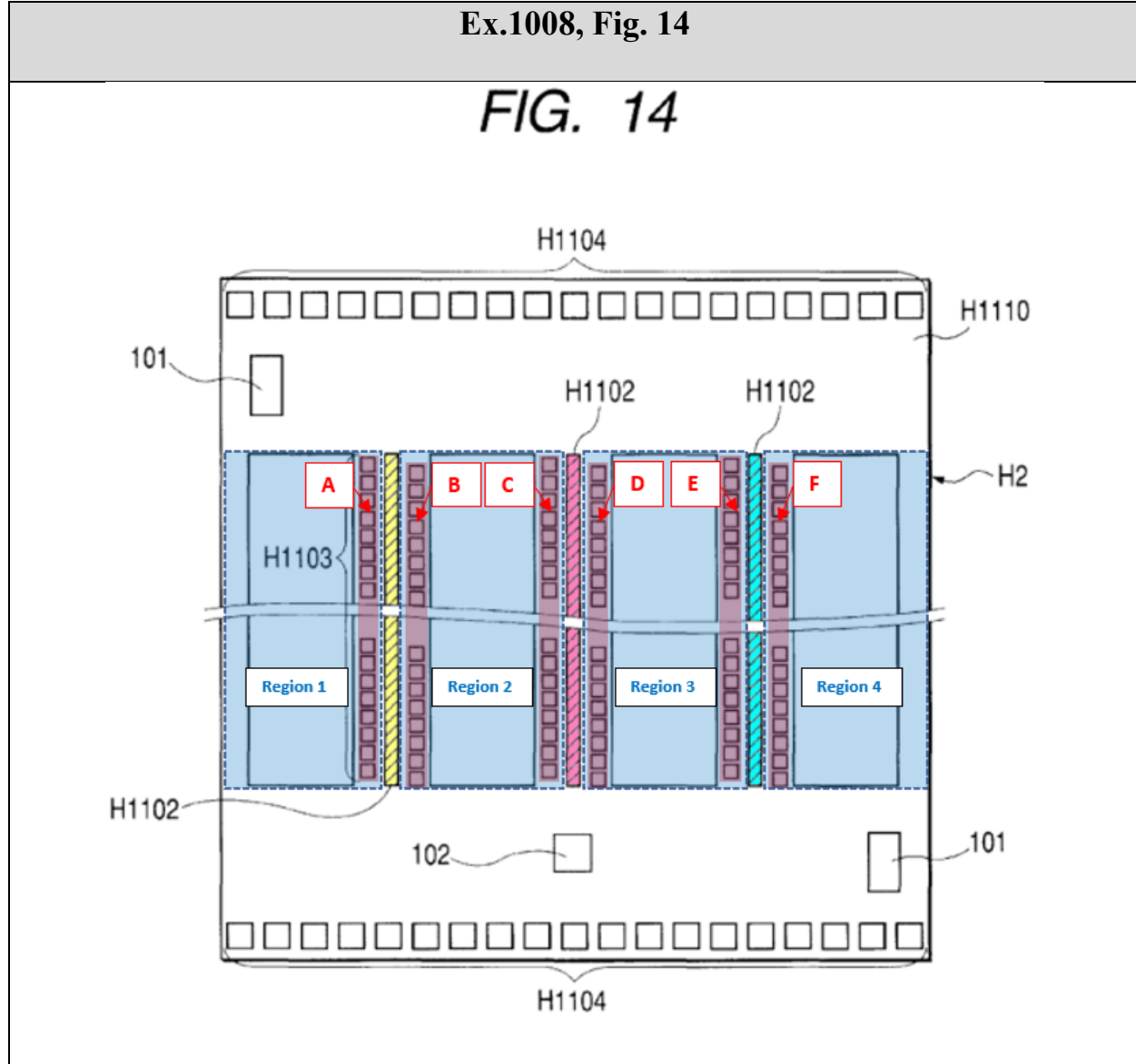
e. **1/D1**

For the reasons discussed above in Section VIII.C.1.e, incorporated here, Giere178 discloses this limitation. Ex.1002 ¶¶398-399.

Yabe also discloses this limitation. Ex.1002 ¶¶400-403.

As seen in Figure 14 below, Yabe's substrate H1110 includes only one region (Region 2, blue) disposed between adjacent ink vias (i.e., yellow ink supply slot H1102 and magenta ink supply slot H1102). Region 2 also includes two heater arrays (e.g., Heater Array B and Heater Array C, electrothermal converting devices H1103 [*pink*]) where each heater array is associated with their respective ink via (e.g., yellow ink is supplied to Heater Array B, and magenta ink is supplied to Heater Array C). Similarly, Region 3 is disposed between Heater Arrays D and E, each heater array being associated with their respective ink via (magenta and cyan). Ex.1002 ¶402.

Ex.1008, Fig. 14



Accordingly, Yabe discloses “only one region [e.g., Region 2 or 3] is disposed between two adjacent ink vias [e.g., H1102] and wherein the region disposed between two adjacent ink vias includes two heater arrays [e.g., Heater Arrays B,C, Heater Arrays C,D] each heater array being associated with their respective ink via.” Ex.1002 ¶¶ 398-403.

f. **1/E, 1/F, and 1/G**

For the reasons discussed above in Section VIII.C.1.f-h, incorporated here, Giere178 discloses these limitations. Ex.1002 ¶¶ 404-412.

Additionally or alternatively, Giere178, when combined with Yabe as described in Section VIII.D.3, below also discloses these limitations. *Id.*

2. Claims 2, 3, 5-8, 10-12, and 14-15

For the reasons discussed above in Sections VIII.C.2-8, incorporated here, Giere178 discloses the limitations of claims 2, 3, 5-8, 10-12, and 14-15. Ex.1002 ¶¶ 413-414.

Additionally or alternatively, Giere178, when combined with Yabe as described in Section VIII.D.3 below, also discloses the limitations of these claims. *Id.*

3. Motivation to Combine Giere178 and Yabe

A PHOSITA would have been motivated to arrive at the Giere178-Yabe Combination. Ex.1002 ¶¶415-445.

First, Giere178 and Yabe are analogous to the claimed subject matter in the '708 Patent because they are all within the same field of endeavour and address similar problems—namely, sensing the temperature of a heater chip with multiple ink vias. Ex.1002 ¶416.

The '708 Patent, titled “Methods and apparatuses for sensing temperature of multi-via heater chips,” purports to solve “a need in the industry for heater chips that can provide for monitoring and regulating the various regions of a heater chip at a desired temperature when heater arrays are placed on both sides of the ink vias.” Ex.1001, Title; *see also id.* at 2:50-54, claim 1.

Similar to the '708 Patent, Giere178 and Yabe are generally directed to heater chips with multiple ink vias and a heater array disposed on both sides of each ink via, and more specifically, to sensing the temperature of the heater chip region disposed on each side of the ink vias. Ex.1002 ¶417. And just like the '708 Patent, Giere178 and Yabe accomplish this by sensing the mean temperature of the region disposed between two adjacent ink vias. *Id.*

For example, Giere178 discloses substrate 300 includes the structures of a typical printhead such as, **ink feed slots, ink ejection chambers, firing resistors,** etc. Ex.1002 ¶418.

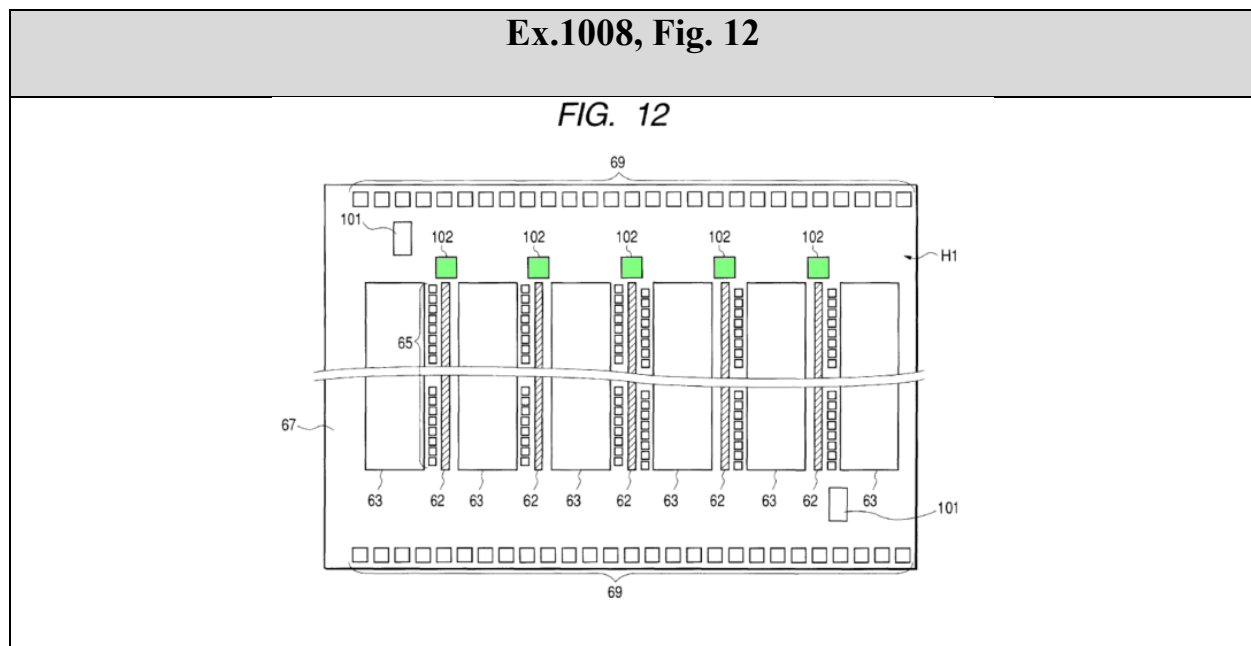
Like the '708 Patent, Giere178 uses a temperature sense resistor (e.g., resistive elements 310, 312, 314, and 316) in the region between ink feed slots to **“assume the temperature of the local region of substrate 300 on which they are placed.”** Ex.1007, 8:53-54.

Giere178 discloses that by using these resistive elements “a measurement of the temperature change of regions of substrate 300 can be determined” to avoid degradation in print quality. Ex.1007, 9:46-48; *see also id.* at 9:50-64; 5:39-52.

Similar to the '708 Patent, Yabe also discloses a plurality of ink vias each having a heater array on either side. Ex.1008, 8:47-51.

Yabe discloses a means for efficiently measuring and controlling the temperature of the heater board of a printhead having plural ink vias with associated heater arrays on either side to maintain high quality printing. Ex.1008, 3:55-62; *see also id.* at 3:45-54; 3:17-27. For example, Yabe’s Figure 12 shows a plurality of “temperature detecting means 102 [green]” that are sensors used to detect heat radiating throughout the heater board H1.

Ex.1008, Fig. 12



Not only do Yabe and Giere178 share the same field of endeavour and solve the same problem, the U.S. Patent Office also grouped the '708 Patent, Giere178, and Yabe under the same technology classification—class 347. Ex.1001 (U.S. Cl.); Ex.1007 (U.S. Cl.); Ex.1008 (U.S. Cl.). Giere178 and the '708 Patent also share sub-classes—347/17 (temperature or pressure of device or component thereof).

For at least these reasons, Giere178 and Yabe are analogous art and would have been considered by a PHOSITA attempting to solve the problem identified in the '708 Patent. Ex.1002 ¶416-425.

Second, upon considering Giere178, a PHOSITA would have been motivated to incorporate Yabe's printhead die design (e.g., ink vias having two adjacent heater arrays with regions in between the vias) into Giere178's substrate 300 to arrive at the Giere178-Yabe Combination. Ex.1002 ¶426.

Notably, Yabe provides express motivation for a PHOSITA to modify Giere178's printhead to include a plurality of ink vias each having two heater arrays. Ex.1002 ¶427.

Yabe explains that printheads having higher image quality and faster printing capability are desired. Ex.1008 at 2:23-26; 2:31-33. As such, according to Yabe, to attain more precise images at faster recording speeds, "it is considered effective to **adopt the structure of the so-called side shooter type** where ink

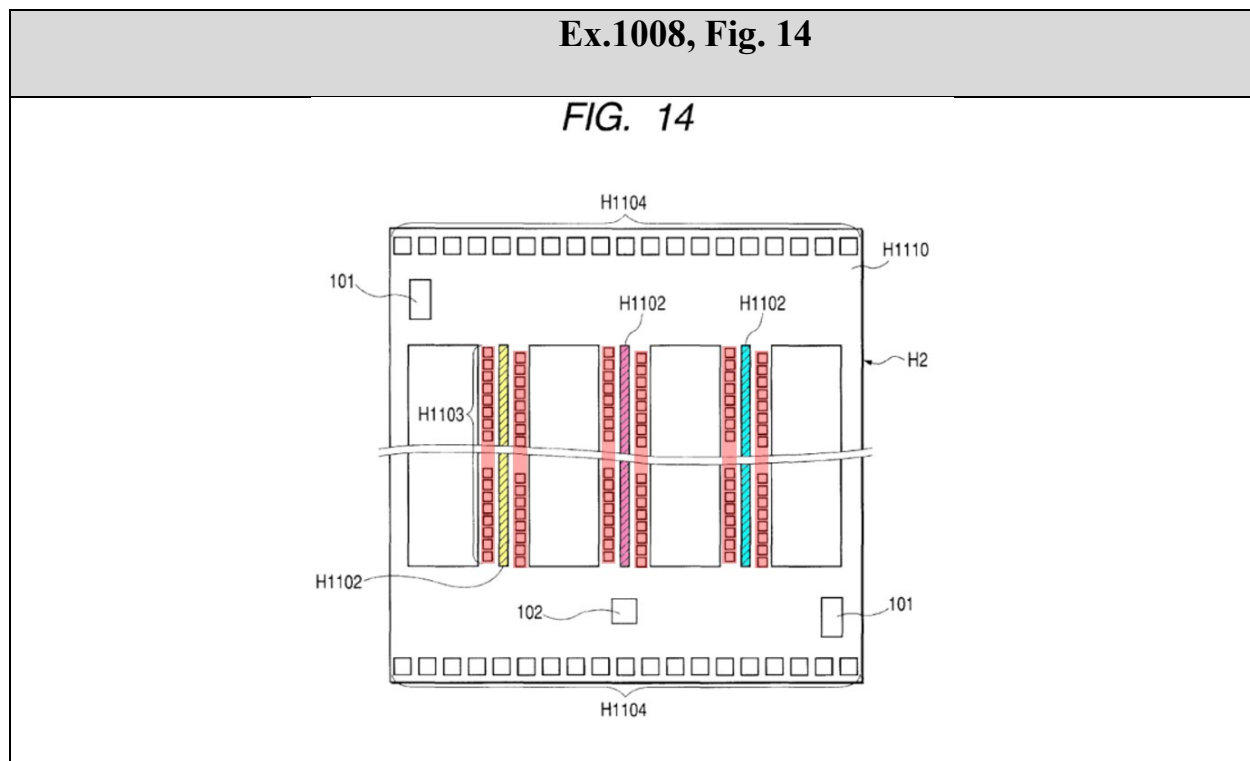
droplets are discharged in the direction perpendicular to the heater board....” Ex.1008, 2:34-40. The “side shooter type” printhead, as illustrated in Yabe’s Figures 5 and 14, uses a **plurality of ink vias** wherein “the ink supply into the head is made from the reverse side of each heat generating resistive element of the heater board by way of the **through opening that penetrates the heater board [i.e., ink vias]**.” Ex.1008, 2:41-43; *see also id.*, 3:16-18. Using ink vias to pass ink from directly from behind the printhead allows the printhead to be more compact thereby improving precision and speed because ink travels a shorter distance to reach the ink ejection chamber. Ex.1008, 2:43-47.

Yabe also emphasizes that using a **plurality** of ink supply vias (ports) on a single printhead chip can be used to form images with high precision and speed. Ex.1008, 5:19-23.

Yabe further explains that there is a tendency to increase the number of ink drops, heaters, and ink supply ports on a printhead to meet the industry necessity for higher precision of recorded images at higher recording speed. Ex.1008, 3:35-39. Accordingly, a PHOSITA would have been motivated to include **two** heater arrays for every ink via as it results in double the number of ink drops (compared to one heater-one via) that can be ejected to the print medium and, therefore, faster printing and higher image quality. Ex.1002 ¶431. A PHOSITA would have also been motivated to include additional heater arrays because using more heaters, and

therefore, more nozzles (i.e., discharge ports) is useful for discharging different color inks where different arrays are associated with different colors, as taught in Yabe. Ex.1008, 2:50-54; 3:55-62.

Yabe also notes that highly precise printing can be achieved by a printhead having heater arrays on both sides of an ink via deviated by $1/2$ pitch from each other because the discharge ports to complement each other thereby improving printhead precision by doubling the number of printed dots per inch of paper. Ex.1002 ¶434-435; *see also* Ex.1008 at 13:54-62. Yabe discloses the offset pitch arrangement of two heater arrays (H1103, *pink*) for any given ink via in Figure 14 (below).



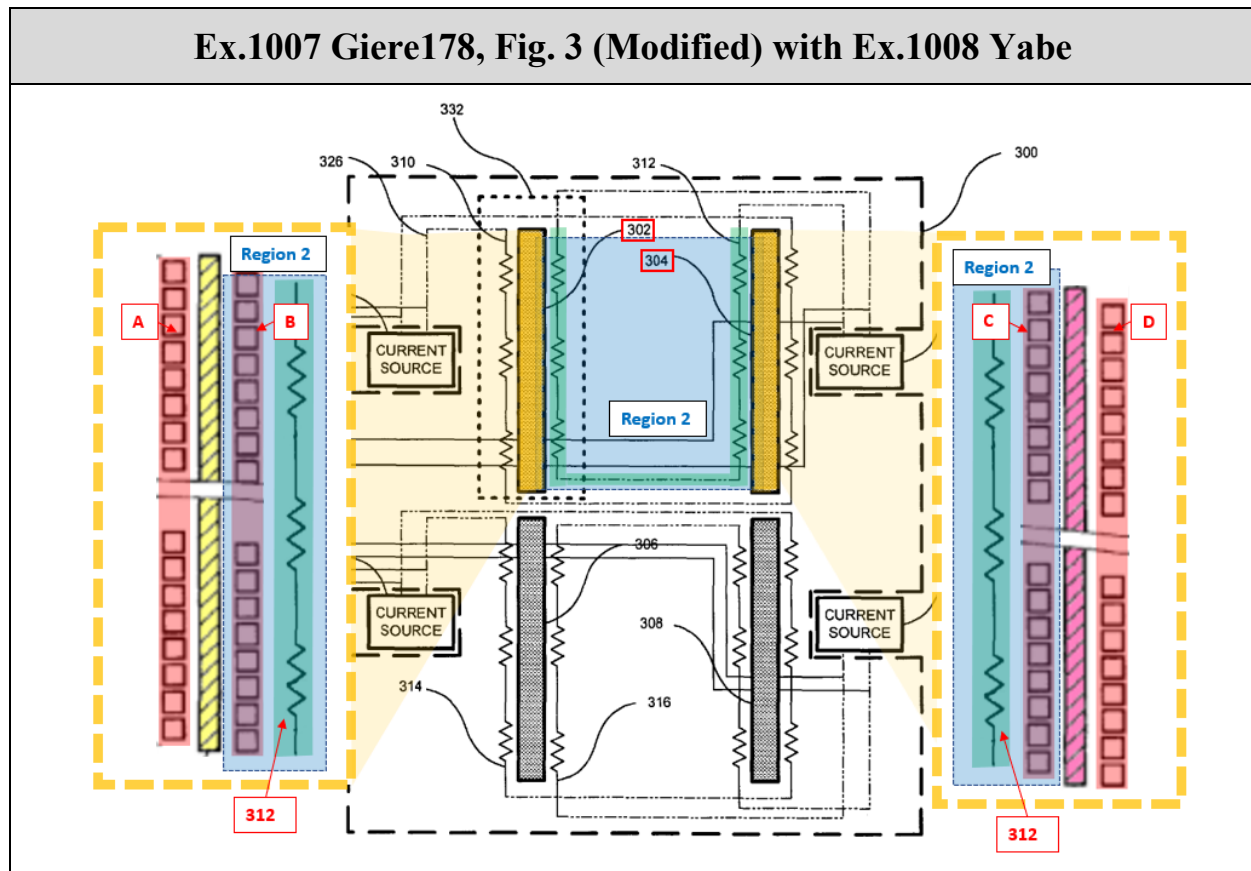
Giere178 also provides express motivation for a PHOSITA to modify Giere178's printhead to include the claimed ink via and dual heater array arrangement, as taught by Yabe. Ex.1002 ¶436. A PHOSITA would have understood that Giere178, like Yabe, was also driven to maintain high print quality. *Id.*

For example, Giere178 explains that an increase in printhead temperature caused by firing nozzles at high frequency can result in a degradation in print quality. Ex.1005, 5:36-51.

Giere178 also explains that "the mass of ejected ink drops increases as the temperature of the structure surrounding the ink ejection chamber increases." Ex.1007, 5:23-25. Because of the excessive quantity of ink applied per drop (mass), print quality can degrade with undesirable shifts in hue, chroma, and the luminance of regions, as well as reduction in the sharpness of the edges when the image is formed onto paper. Ex.1007, 5:62-6:3. Giere178 also discloses a "temperature management system" to control these undesirable effects that temperature can have on print quality.

Thus, a PHOSITA in view of Giere178 would look to apply his temperature management system to printheads having a *plurality of ink vias and adjacent heater arrays*, as taught by Yabe, to maintain high quality printing. Ex.1002 ¶436-437.

Accordingly, a PHOSITA would have been motivated to incorporate Yabe's printhead die design (e.g., ink vias have two adjacent heater arrays with regions in between the vias) into Gierel78's substrate 300. Ex.1002 ¶437. In his declaration (Ex.1002), Dr. Pond describes the exemplary arrangement of the Gierel78-Yabe Combination illustrated below. Ex.1002 ¶437.



It also would have been obvious to a PHOSITA to add a plurality of ink vias each with adjacent heater arrays, as taught by Yabe, to Gierel78's substrate based on a PHOSITA's knowledge at the time. Ex.1002 ¶438.

For example, a PHOSITA's understanding that inkjet printheads typically had one or more ink vias with two heater arrays is corroborated by the '708 Patent's discussion of the prior art, as well as prior art references identified during prosecution of the '708 Patent. Ex.1002 ¶438; Ex.1001, 1:21-47; *see id.* Figs. 1- 2; *see also* Ex.1010 at 4:61-63; *see also* Ex.1015 at 2:61-63; Ex.1016 1:42-50, Fig.1.

A PHOSITA would also have had a reasonable expectation of success of adding the ink feed slots and associated heater arrays from Yabe to the Giere178 printhead. Ex.1002 ¶439.

Giere178 also confirms the interchangeable nature of the various embodiments. Ex.1007, 12:57-61.

Moreover, as discussed above in Sections VIII.C.1.b and VIII.C.1.c, Giere178's temperature sensor layout (as illustrated in the Giere178 Figure 3 excerpt below, *green*) indicates to a PHOSITA that Giere178 is designed to support a plurality of ink vias arranged parallel to one another and a heater array disposed adjacent each ink via so that each ink via is associated with two heater arrays. Ex.1002 ¶440-443.

Lastly, it would have been a routine and obvious matter for a PHOSITA to combine, replace, and even modify various features from Giere178 to incorporate the features of Yabe. Ex.1002 ¶444.

Accordingly, ample motivation existed for a PHOSITA to make the Giere178-Yabe Combination. Ex.1002 ¶¶415-445.

E. Ground 5: Giere178 In view of Parish Renders Obvious Claims 4 and 13

Giere178 does not explicitly say that resistive elements 310, 312, 314, and 316 are a “n-type implant donor thermal sensing resistor,” as required by claims 4 and 13. Parish discloses this limitation. Ex.1002 ¶¶446-452.

Parish teaches that the temperature sense element is or comprises a temperature sense resistor (TSR) 64,” which “can include a **N-type source drain (NSD) material...or another suitable material.**” Ex.1006, 5:35-39.

Accordingly, the Giere178-Parish Combination discloses that “the temperature sensing element [*i.e.*, resistive elements 310, 312, 314, and 316] comprises an n-type implant donor thermal sensing resistor.” Ex.1002 ¶¶446-452.

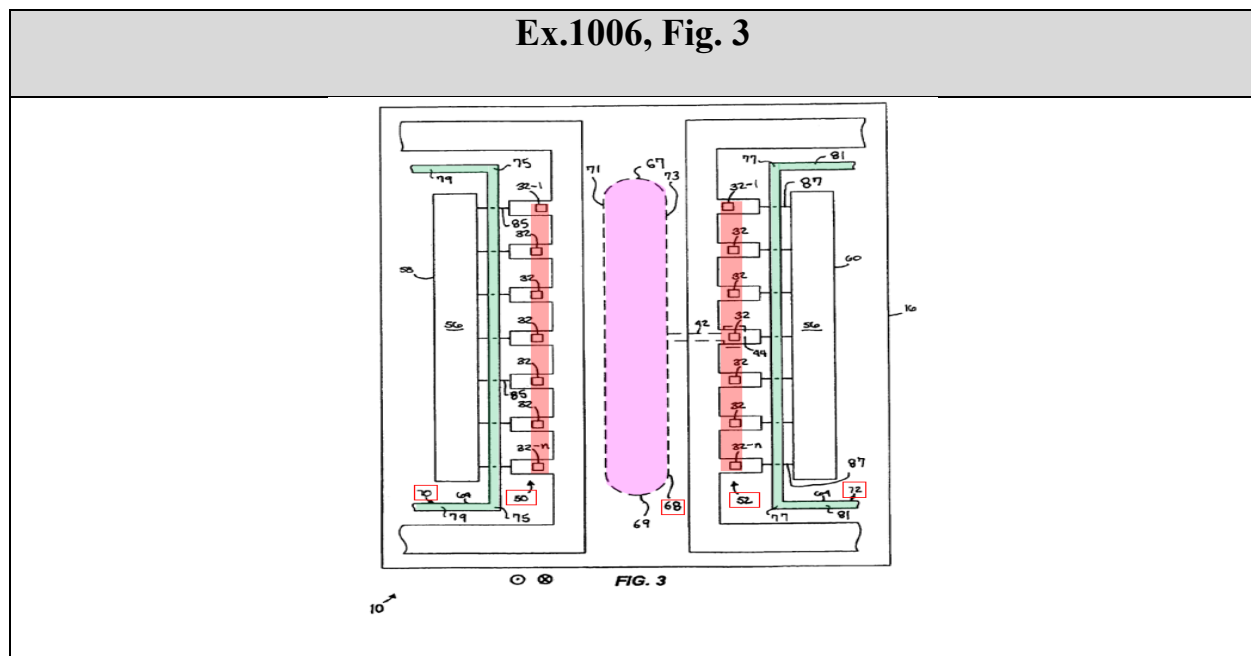
1. Motivation to Combine Giere178 and Parish

A PHOSITA would have been motivated to arrive at the Giere178-Parish Combination. Ex.1002 ¶¶ 453-474.

First, Giere178 and Parish are analogous to the claimed subject matter in the ’708 Patent because they are both within the same field of endeavour and address similar problems—namely, sensing the temperature of a heater chip with multiple ink vias. Ex.1002 ¶¶ 454-462.

As discussed above in Section VIII.D.3 and incorporated here, like the '708 Patent, Giere178 discloses sensing the mean temperature of the heater chip region disposed between two adjacent ink vias. Ex.1002 ¶455.

Parish, like the '708 Patent, discloses a printhead chip having an ink via with heater arrays on either side. For example, with respect to Figure 3 (below), Parish discloses that “[a] portion of the inkjet print head 10, particularly the substrate (e.g., chip) 16, [includes]...heating elements 32 are arranged into a **first heating array 50** [red] and a **second heating array 52** [red].” Ex.1006, 4:39-41. Parish further states that “**the array of actuators substantially parallel the longitudinal extent of the ink via 68** [magenta] on either sides 71, 73 thereof....” Ex.1006, 6:8-10.



Parish further discloses that printhead chip 16 includes temperature sense resistors (TSRs). Ex.1006, 5:30-34. Parish discloses that “TSR’s 70, 72 [*green*] have a longitudinal extent that is substantially parallel along and to an entire length of [heater] arrays 50, 52, [*red*].” Ex.1006, 6:6-9. As such, “each TSR is able to sense local heating per an entire array and not just a portion thereof.” Ex.1006, 6:17-18; 6:46-47.

Finally, like the ’708 Patent, Parish recognizes that the ink via in the printhead chip “acts as a thermal insulator between each array 50, 52”. Ex.1006, 6:19-20. To address that problem, Parish incorporates heater arrays [50, 52, *red*] and TSRs [70, 72, *green*] on both sides of the ink via [68, *magenta*].

Second, upon considering Giere178, a PHOSITA would have been motivated to incorporate a temperature sensing element comprising an n-type implant donor thermal sensing resistor as expressly taught by Parish to the printhead of Giere178, to arrive at the Giere178-Parish Combination. Ex.1002 ¶463.

Parish provides express motivation for a PHOSITA to modify Giere178’s printhead to include temperature sensing element comprising an n-type implant donor thermal sensing resistor. Ex.1002 ¶464. For example, Parish discloses that a broad choice of materials are suitable as a temperature sense resistor (TSR), such as “**N-type source drain (NSD) material.**” Ex.1006, 5:35-39.

Upon considering Giere178, a PHOSITA would have been motivated to add an n-type implant donor thermal sensing resistor as a temperature sense resistor, as taught by Parish, because doing so would improve the effectiveness of Giere178's temperature compensation system as n-type implant donor thermal sensing resistors are more precise than, for example, Giere178's metal (e.g., aluminium) resistive element. Ex.1002, ¶465-470. In fact, Giere178 encourages modifications to its system that improve the precision of the results. Ex.1002 ¶467.

A PHOSITA would also have had a reasonable expectation of success of adding n-type implant donor thermal sensing resistors (as taught by Parish) as Giere178's thermal sensing elements because the advantages of using NSD materials for temperature sense resistors on inkjet printheads (over metal temperature sense resistors, for example) were well-known. Ex.1002 ¶¶471-472.

Lastly, it would have been a routine and obvious matter for a PHOSITA to combine, replace, and even modify various features from Giere178 to incorporate the features of Parish. Ex.1002 ¶473. The simple and routine nature of adding n-type implant donor thermal sensing resistors (as taught by Parish) to Giere178 would have further motivated a PHOSITA. *Id.*

Thus, ample motivation existed for a PHOSITA to make the Giere178-Parish Combination. Ex.1002 ¶¶453-474.

F. Ground 6: Giere178 and Yabe In Further View of Parish Renders Obvious Claims 4 and 13

As explained above in Section VIII.E and incorporated here, the Giere178-Parish Combination discloses this limitation. The Giere178-Yabe-Parish Combination also discloses this limitation Ex.1002 ¶¶475-481.

A PHOSITA would have been motivated to arrive at the Giere178-Yabe-Parish Combination. Ex.1002 ¶¶482-507.

IX. SECONDARY CONSIDERATIONS

To the extent that Patent Owner raises any secondary considerations arguments in its Preliminary Response, Petitioners request authorization to respond thereto before any Institution Decision.

X. CONCLUSION

Trial should be instituted, and the Challenged Claims should be cancelled as unpatentable.

Dated: January 20, 2023

Respectfully Submitted,

/ Dion M. Bregman /
Dion M. Bregman (Reg. No. 45,645)

U.S. PATENT NO. 7,594,708 – Listing of Challenged Claims

No.	Claim Limitations
Claim 1[p]	A chip for use with a printing device, comprising:
1[a]	a plurality of ink vias arranged parallel to one another, each of the ink via having two longitudinal sides;
1[b]	a heater array disposed adjacent each longitudinal side of the ink vias such that each ink via is associated with two heater arrays disposed adjacent the two longitudinal sides of the ink via;
1[c]	a region disposed adjacent each heater array, wherein only one region is disposed between two adjacent ink vias and wherein the region disposed between two adjacent ink vias includes two heater arrays each heater array being associated with their respective ink via; and
1[d]	a single temperature sensing element disposed within each region, the temperature sensing element operable to sense a temperature representative of the heater arrays adjacent to the region and disposed at a predetermined distance away from adjacent heater arrays.
Claim 2	The chip of claim 1, wherein the temperature sensing element comprises a temperature sensing resistor.
Claim 3	The chip of claim 2, wherein the temperature sensing element comprises a thermal sense resistor.
Claim 4	The chip of claim 3, wherein the temperature sensing element comprises an n-type implant donor thermal sensing resistor.
Claim 5	The chip of claim 1, wherein the predetermined distance is at least 300 microns.
Claim 6	The chip of claim 1, wherein the temperature sensing element is positioned substantially planar to each of the adjacent heater arrays.
Claim 7	The chip of claim 1, further comprising at least one control element operable to receive a temperature measured by the temperature sensing element.
Claim 8	The chip of claim 1, wherein the chip has at least one edge and at least one region is disposed between one of the plurality of ink vias and the at least one edge.
Claim 9[p]	A method of fabricating chips for use with a printing device, comprising:
9[a]	arranging a plurality of ink vias parallel to one another, wherein each of the ink via has two longitudinal sides;

No.	Claim Limitations
9[b]	placing a heater array adjacent each longitudinal side of the ink via such that each ink via is associated with two heater arrays placed adjacent its longitudinal sides;
9[c]	defining a region adjacent each heater array such that there is only one region between two ink vias and the region between two adjacent ink vias includes arrays each heater array being associated with its respective ink via; and
9[d]	positioning a single temperature sensing element disposed within each region, wherein the temperature sensing element is operable to sense a temperature representative of the heater arrays adjacent to the region and is disposed at a predetermined distance away from adjacent heater arrays.
Claim 10	The method of claim 9, wherein positioning a temperature sensing element in the region comprises positioning a temperature sensing element in substantially a center portion of the region.
Claim 11	The method of claim 9, wherein positioning a temperature sensing element in the region comprises positioning a temperature sensing resistor in the region.
Claim 12	The method of claim 9, wherein positioning a temperature sensing element in the region comprises positioning a thermal sense resistor in the region.
Claim 13	The method of claim 11, wherein positioning a temperature sensing element in the region comprises positioning an n-type implant donor thermal sensing resistor in the region.
Claim 14	The method of claim 9, wherein positioning a temperature sensing element in the region between the adjacent heater arrays comprises positioning the temperature sensing element at least 300 microns from each of the adjacent heater arrays.
Claim 15	The method of claim 9, wherein positioning a temperature sensing element in the region between the adjacent heater arrays comprises positioning the temperature sensing element substantially planar to each of the heater arrays.

CERTIFICATION OF COMPLIANCE WITH TYPE-VOLUME LIMITS

This Petition includes 13,864 words, as counted by Microsoft Word, and is therefore in compliance with the 14,000-word limit established by 37 C.F.R. 42.24(a)(1)(i). Accordingly, pursuant to 37 C.F.R. 42.24(d), lead counsel for Petitioner hereby certifies that this Petition complies with the applicable type-volume limits.

Dated: January 20, 2023

Respectfully Submitted,

/ Dion M. Bregman /

Dion M. Bregman, Reg. No. 45,645

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. 42.6(4) and 42.105, lead counsel for Petitioners hereby certify that on January 20, 2023, copies of this Petition and all supporting exhibits were sent via Priority Mail Express to the correspondence address of record for the '708 Patent:

133676 - Goldberg Segalla LLP
711 3rd Avenue, Suite 1900
New York, NY 10017

A courtesy copy of this Petition and supporting exhibits was also served via email on January 20, 2023 on Patent Owner's counsel of record in the district court litigation against Slingshot Printing LLC involving this patent.

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Dated: January 20, 2023

Respectfully Submitted,

/ Dion M. Bregman /

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