

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Riley Reese et al.
U.S. Patent No.: 9,592,660 Attorney Docket No.: 56224-0006IP1
Issue Date: March 14, 2017
Appl. Serial No.: 14/574,237
Filing Date: December 17, 2014
Title: HEATED BUILD PLATFORM AND SYSTEM FOR THREE
DIMENSIONAL PRINTING METHODS

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**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 9,592,660 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

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EXHIBITS

EX1001	U.S. Patent No. 9,592,660 to Reese et al. (“the ’660 patent”)
EX1002	Prosecution History of the ’660 Patent (“the Prosecution History”)
EX1003	Declaration of Dr. Michael Hickner
EX1004	US 9,744,730 (“Comb”)
EX1005	US 2013/0310507 (“Tummala”)
EX1006	US 2016/0075091 (“Cable”)
EX1007	US 2016/0096326 (“Naware”)
EX1008	RESERVED
EX1009	US 2006/0054039 (“Kritchman”)
EX1010	Prosecution History of U.S. Appl. No. 15/422,303
EX1011	Evans, B. (2012). <i>Practical 3D Printers: The Science and Art of 3D Printing</i> . Apress.
EX1012	Sanladerer, T. (2014). <i>3D printing guides: Everything about heated beds!</i> https://toms3d.org/2014/12/21/3d-printing-guides-everything-about-heated-beds/
EX1013	Griffey, J. (2014). <i>Chapter 2: The Types of 3-D Printing</i> . https://journals.ala.org/index.php/ltr/article/view/4796/5747https://www
EX1014	MakerBot Industries (2010). <i>MakerBot Industries Thing-O-Matic 3D Printer</i> .

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- EX1019 AirWolf3D (2015). *Safety Data Sheet: WolfBite Premium Heatbed Adhesion Solution for ABS*.
- EX1020 Francis, L.F., et al. (2016). Chapter 6: Dispersion and Solution Processes, *Materials Processing: A Unified Approach to Processing of Metals, Ceramics and Polymers* (pp.415–512). Elsevier Inc.
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- EX1023 Huttunen-Saarivirta, E., et al. (2011). Corrosion protection of galvanized steel by polyimide coatings: EIS and SEM investigations, *Progress in Organic Coatings* (pp.269–278). Elsevier Inc.
- EX1024 Complaint (Document 1), *Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd. et al*, 2-24-cv-00644 (EDTX)

- EX1025 Lahiri, A. K. (2005). Chapter 5: Transport phenomena and metals properties, *Fundamentals of Metallurgy* (pp.178–236). Woodhead Publishing Ltd.
- EX1026 Friedr. Freek GmbH (2014). Cartridge Heaters.
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- EX1027 OMEGA Engineering (2012). *Introduction to Cartridge Heaters*.
<https://web.archive.org/web/20120302155433/http://www.omega.com/prodinfo/cartridgeheaters.html>
- EX1028 US 8,119,053
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<https://web.archive.org/web/20111023174514/http://www.makerbot.com/docs/stepstruder-mk6-plus/>
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<https://web.archive.org/web/20141009062559/www.mit.edu:80/~6.777/matprops/polyimide.htm>
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- EX1037 US 2013/0186549
- EX1038 US 5,124,192
- EX1039 US 3,179,634
- EX1100 December 9, 2024 stipulation sent by Petitioner's counsel to
Patent Owner's counsel
- EX1101 Docket Control Order (Document 34), *Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd. et al*, 2-24-cv-00644 (EDTX)

LISTING OF CLAIMS

Claim 1	
[1.pre]	A build apparatus for printing a 3D object of thermoplastics employing additive manufacturing methods, the apparatus comprising:
[1.a]	a build platform with a temperature control unit configured to control heating of the build platform;
[1.b]	a thermally conductive plate disposed adjacent to the build platform; and
[1.c]	a polymer coating attached to a surface of the thermally conductive plate
[1.c.i]	[a polymer coating...] which is capable of (i) facilitating adhesion to the 3D object during printing and
[1.c.ii]	[a polymer coating...which is capable of...] (ii) permitting removal of the 3D object once the 3D object has been formed and cooled without chemically or mechanically removing the polymer coating from 3D object and without damaging the polymer coating, the thermally conductive plate, or the 3D object,
[1.c.iii]	wherein the polymer coating is not a polymer tape.
Claim 2	
[2]	The build apparatus of claim 1, wherein the polymer coating is a polyimide.
Claim 3	
[3]	The build apparatus of claim 1, wherein the temperature control unit comprises heater cartridges that are spaced along a surface of the build platform.

Claim 4	
[4]	The build apparatus of claim 1, wherein the build platform comprises thermocouples situated at one or several locations to provide feedback to a controller for maintaining temperature set points.
Claim 5	
[5]	The build apparatus of claim 1, further comprising a ceramic or high temperature dielectric that insulates the build platform.
Claim 6	
[6]	The build apparatus of claim 1, wherein the build platform, the thermally conductive plate, and the polymer coating are able to withstand high temperature ranging between 150 degree Celsius and 300 degree Celsius.
Claim 7	
[7]	The build apparatus of claim 1, wherein the material for the thermally conductive plate comprises one or more of aluminum, steel, brass, ceramic, glass, or alloys with a low coefficient of thermal expansion (CTE).
Claim 8	
[8]	The build apparatus of claim 1, wherein the material for the build platform comprises one or more of aluminum, steel, brass, ceramic, glass, or alloys with a low coefficient of thermal expansion (CTE).
Claim 9	
[9]	The build apparatus of claim 1, wherein the thermally conductive plate thickness ranges from 0.025–0.5” and wherein the thickness is selected depending on the flexural character of the material.
Claim 10	
[10]	The build apparatus of claim 1, wherein the thickness of the polymer coating ranges from 0.001” to 0.1”.

Claim 11	
[11]	The build apparatus of claim 1, wherein a surface of the polymer coating includes nano-, micro-, or milli-meter scale features that increase adhesion to the 3D object.
Claim 12	
[12]	The build apparatus of claim 1, wherein the thermally conductive plate is flexible so as to allow for easier dissociation between the 3D object and the thermally conductive plate upon cooling and reduce damage to the polymer coating or the 3D object during removal of the 3D object.
Claim 13	
[13]	The build apparatus of claim 1, wherein the temperature control unit is a heater cartridge.
Claim 14	
[14]	The build apparatus of claim 1, wherein the build platform has a first coefficient of thermal expansion (CTE) and the thermally conductive plate has a second CTE, wherein the first CTE is greater than the second CTE.
Claim 15	
[15]	The build apparatus of claim 1, wherein the thermally conductive plate is non-magnetically secured to and removable from the build platform.

CONVENTIONS OF THE PETITION

- All emphases are added unless noted otherwise;
- Bold-italic emphases correlate to claim language;
- Quotations are generally from exhibits, not claim language; and
- The phrase “as discussed” and equivalent phrases incorporate fully the analysis of the cross-cited portion of the Petition.

Petitioner Shenzhen Tuozhu Technology Co., Ltd. petitions for IPR of claims 1–15 (“Challenged Claims”) of U.S. Patent No. 9,592,660 (“the ’660 patent”).

I. REQUIREMENTS FOR IPR—37 C.F.R. §42.104

A. Grounds for Standing—37 C.F.R. §42.104(a)

Petitioner certifies that the ’660 patent is available for IPR, and that Petitioner is not barred or estopped from requesting IPR.

B. Challenge and Relief Requested—37 C.F.R. §42.104(b)

Petitioner requests IPR of the Challenged Claims on the grounds below. Dr. Hickner provides supporting explanations and presents detailed corroborating evidence in an expert declaration cited throughout this Petition. EX1003, ¶45.

Asserted Grounds		
ID	Claims	Prior Art Basis
1A	1–13, 15	§103: Cable (US 2016/0075091), Naware (US 2016/0096326)
1B	1–2, 4, 6–12, 15	§103: Cable, Kritchman (US 2006/0054039)
1C	7–8, 14	§103: Cable, Naware or Kritchman, Comb (US 9,744,730)
2A	1–3, 5–15	§103: Comb, Tummala (US 2013/0310507)
2B	1–15	§103: Comb, Tummala, Kritchman

Each of the above identified references pre-dates the ’660 patent’s effective filing date of December 17, 2014.

Reference	Prior Art Date	Status
Comb (EX1004)	Filed Nov. 22, 2013	§102(a)(2)
Tummala (EX1005)	Published Nov. 21, 2013	§102(a)(1)
Cable (EX1006)	Filed Sep. 16, 2014	§102(a)(2)
Naware (EX1007)	Filed Nov. 21, 2014	§102(a)(2)
Kritchman (EX1009)	Published Mar. 16, 2006	§102(a)(1)

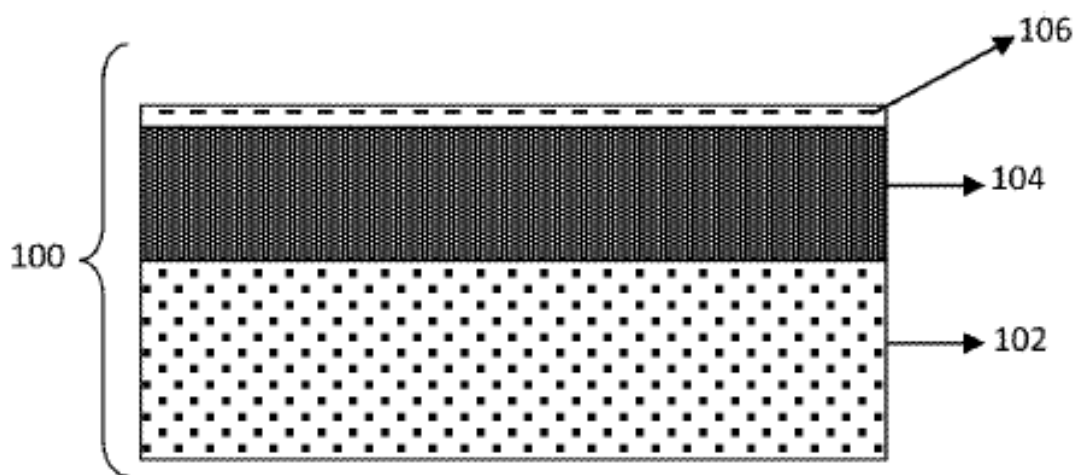
II. THE '660 PATENT

A. Pertinent Disclosure

The '660 patent relates to “3D printing of objects” and “developing a heated build platform for supporting the three-dimensional objects.” EX1001, 1:7–10; EX1003, ¶¶23–27. For example, the '660 patent describes “a heated build platform, a thin removable plate secured on top of the build platform, [and] a high temperature polymer coating applied over the removable plate...to maintain adhesion between 3D object and printing surface.” EX1001, Abstract.

According to the '660 patent, contemporaneous designs often employed “polyimide tape as a substrate on the build plate for 3D part adherence.” EX1001, 3:1–4, 1:33–34. But polyimide tape had certain well-known drawbacks. For one, “[a]pplying polyimide tape is a difficult process.” EX1001, 1:49–54. “Further, the adhesive for the polyimide tape can burn off under high temperatures...[and e]ven

if a part is built on an area of polyimide tape without debris or air bubbles, the tape can be easily damaged upon removal of the part.” EX1001, 1:54–60.



The '660 patent's Figure 1 (above) shows removable plate 104 “coated with thin layer of a high temperature polymer in order to impart better adherence properties both to the bottom layer of a 3D object and the plate 104 over the current methods of using polyimide [tape].” EX1001, 4:40–44. However, in the same breath, the '660 patent concedes that using a polymer coating was routine:

It may be obvious to a person skilled in the art that there exists a variety of coating methods and types of high temperature polymer coatings that can be used to create a coated layer 106 over the plate.

EX1001, 4:35–38. Employing known polymer coatings in the familiar setting of 3D printers with heated build platforms and removable plates is simply not inventive.

B. Prosecution History

The '660 patent was filed December 17, 2014 as Appl. No. 14/574,273 (“the '273 application”). The Examiner rejected the '273 application’s claims twice:

Action	Date	Prior Art Applied
Non-Final (EX1002, 136–148)	11/30/2015	US 8,282,380 (“Pax”), US 2007/0037509 (“Renz”), and US 2012/0133083 (“Zenere”) under §102
Final (EX1002, 97–108)	7/14/2016	US 2015/0145174 (“Comb”) under §102 Comb, Pax, and US 2010/0174392 (“Fink”) under §103

In response to the final rejection, the Applicant argued a patentable distinction over Comb based on an added limitation that required a polymer coating having:

a surface that (i) facilitates adhesion to the 3D object during printing and (ii) permits removal of the 3D object once the 3D object has been formed and cooled by the temperature control unit, wherein the temperature control unit cools the 3D object subsequent to formation, to permit removal of the 3D object from the thermally conductive plate without removal of the thermally conductive plate from the build platform.

EX1002, 77, 83–84. But the added limitation was not maintained throughout prosecution. It was deleted. Specifically, as part of a Notice of Allowance, the Examiner replaced the language above with Elements [1.c.i]–[1.c.iii] of the Challenged Claims. EX1002, 46. The Examiner then pronounced that Comb and the other prior art of record fail to teach a “polymer coating that is not a polymer tape...,” and the '660 patent issued soon thereafter. EX1002, 49.

On February 1, 2017, the Applicant filed Appl. No. 15/422,303 (“the ’303 application”) as a continuation of the ’660 patent. EX1010, 271. As shown below, proposed independent claim 19 of the ’303 application is similar to independent claim 1 of the ’660 patent, but largely narrower.

'660 Patent Issued Claim 1	Continuation Claim 19
1. <i>A build apparatus for printing a 3D object</i> of thermoplastics employing additive manufacturing methods, the apparatus <i>comprising</i>: <i>a build platform with a temperature control unit configured to control heating of the build platform;</i> <i>a thermally conductive plate disposed adjacent to the build platform; and a polymer coating attached to a surface of the thermally conductive plate which is capable of</i> <i>(i) facilitating adhesion to the 3D object during printing and</i> <i>(ii) permitting removal of the 3D object once the 3D object has been formed and cooled without chemically or mechanically removing the polymer coating from 3D object and without damaging the polymer coating, the thermally conductive plate, or the 3D</i>	19. <i>A build apparatus for use in printing a three-dimensional (3D) object, comprising:</i> <i>a build platform,</i> <i>a thermally conductive plate disposed adjacent to and in thermal communication with said build platform, and a coating adjacent to said thermally conductive plate, wherein said coating adjacent to said thermally conductive plate is configured to</i> <i>(i) secure at least a portion of said 3D object during printing</i> and while said thermally conductive plate is at one or more temperature set points, and <i>(ii) permit removal of said 3D object subsequent to printing and when said thermally conductive plate has cooled to a temperature below said one or more temperature set points which removal is without chemically or mechanically removing material from</i>

'660 Patent Issued Claim 1	Continuation Claim 19
<i>object</i> , wherein the polymer coating is not a polymer tape.	<i>said 3D object and without damaging said thermally conductive plate or said 3D object</i> <i>a temperature control unit in thermal communication with said build platform, wherein said temperature control unit is configured to supply heat to said build platform; and</i> a controller operatively coupled to one or more heating units, wherein said controller (i) uses feedback to detect one or more temperatures of said thermally conductive plate and (ii) directs said temperature control unit to supply heat to said build platform to maintain said one or more temperature set points while printing said 3D object.

EX1001, claim 1, EX1010, 93.

Notably, the same Examiner on the '660 patent rejected claim 19, finding all the overlapping limitations denoted above (with bold/color) taught by Comb. EX1010, 68–70. The '303 application's rejected claims never issued because the Applicant abandoned them. EX1010, 10.

The only non-overlapping limitation of the '660 patent's claim 1 not present in the '303 application's rejected and abandoned claim 19 is “wherein the polymer

coating is not a polymer tape.” To the extent the Examiner believed this broad negative limitation was enough to confer patentability, he was wrong. Comb’s disclosure is not limited to polymer tape, and the prior art is replete with non-tape polymer coatings. *See infra* §V.D.

III. LEVEL OF ORDINARY SKILL

The range of qualifications for a POSITA would have included a bachelor’s degree in Mechanical Engineering, Chemical Engineering, Materials Science, or a comparable field and at least two years of experience related to 3D printing. EX1003, ¶¶28–30. Additional experience could substitute for a formal degree or formal training (and vice versa). *Id.*

As Petitioner’s Dr. Hickner explains, a POSITA would have possessed pertinent background knowledge and understanding of the technologies employed by the ’660 patent, including heated printbeds (EX1003, ¶¶31–36), coverings for printbeds that use polymer tape (*id.*, ¶¶37–39), and printbed coverings that use polymer coatings (*id.*, ¶¶40–44). These technologies were developed and commercially adopted long before 2014. The ’660 patent’s claims would have been obvious given the mature state of the art and the advanced abilities of the POSITA.

IV. CLAIM CONSTRUCTION—37 C.F.R. §42.104(b)(3)

The analysis below proves the Challenged Claims obvious under any reasonable interpretation according *Phillips*. The Board need not resolve any

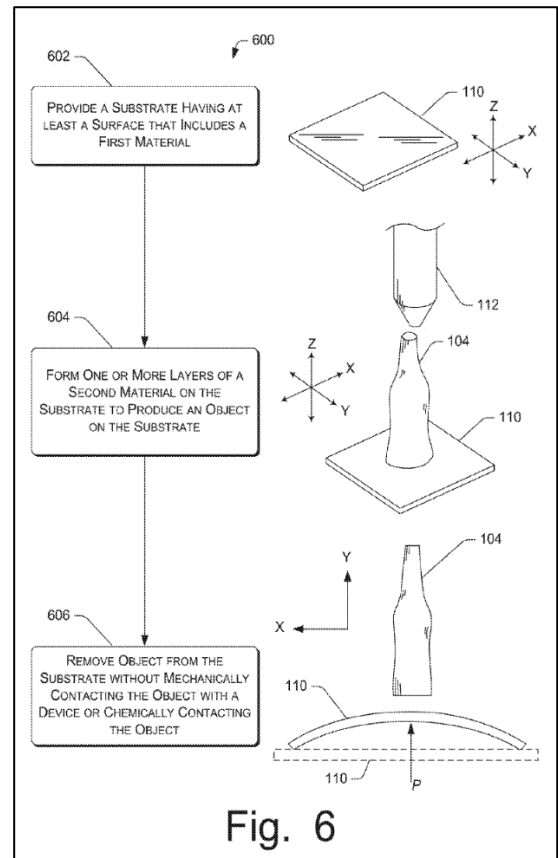
express constructions. *See Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011). Should any subsequent claim interpretation arise here or in the parallel district court proceeding, Petitioner reserves the right to address it.

V. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. GROUND 1A: Claims 1–13, 15 Are Obvious Over Cable and Naware

1. Cable (EX1006)

Like the '660 patent, Cable teaches a 3D printer that facilitates “removal of [a printed] object from [a] substrate...without mechanically contacting the object with a device or chemically contacting the object.” EX1006, Abstract, [0004], [0020], [0024]; EX1003, ¶¶46–49. Also like the '660 patent, Cable uses a flexible substrate, where “flexing or bending the substrate caus[es] the object to dislodge[.]” EX1006, [0020], [0078].



The substrate is “a ‘working surface’ for building the object” and “can be positioned on a [heated] platform...configured to support the substrate[.]” EX1006, [0034], [0044], [0045]. The substrate has a top layer “made of a first material,” such

as a thermoplastic polymer, which is selected to “promote good adhesion” and “can be manufactured by coating...the substrate.” EX1006, [0061], [0036].

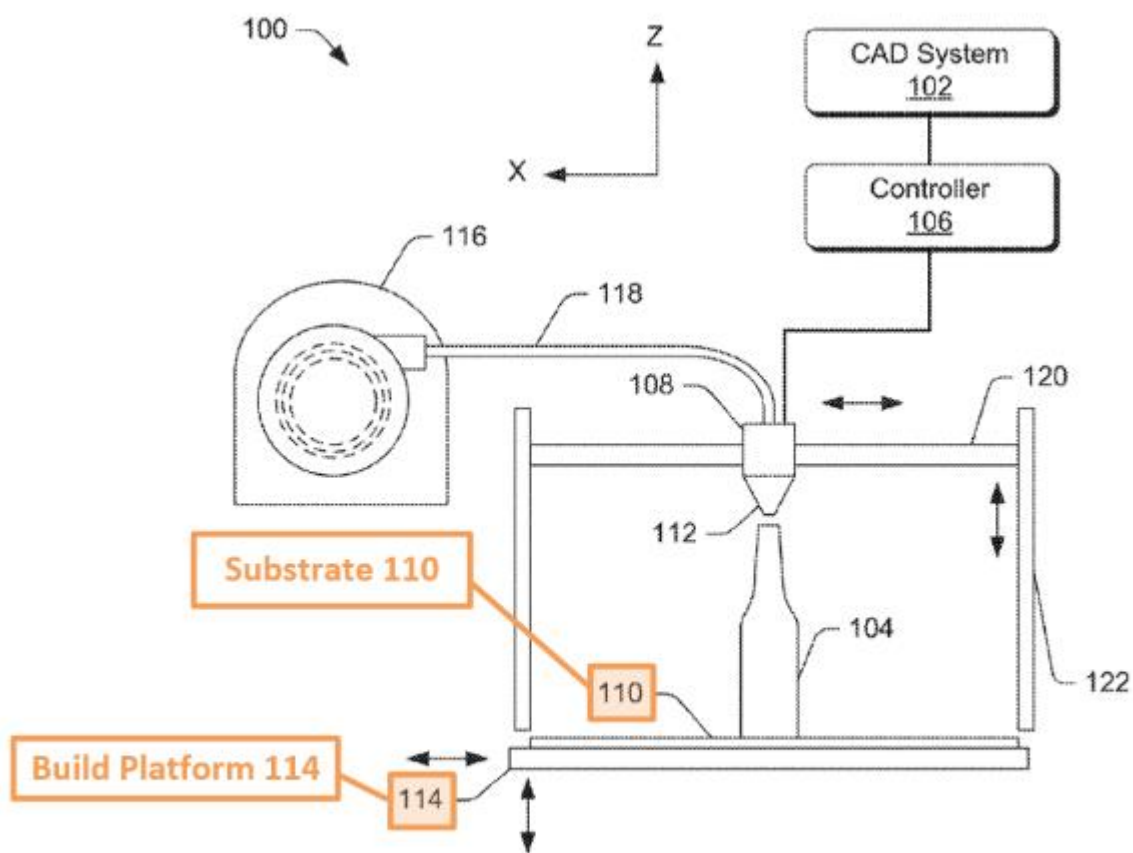
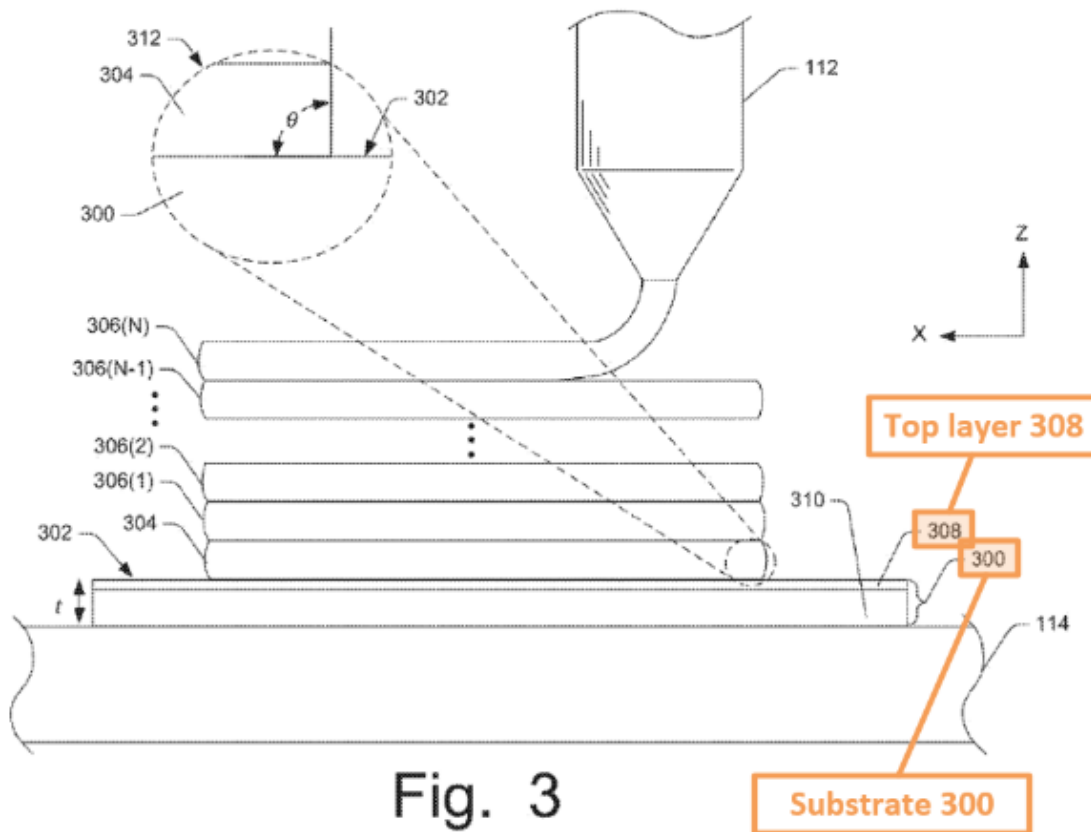


Fig. 1



EX1006, Figures 1 and 3; see also EX1003, ¶48 (explaining with reference to EX1006 at [0057–0058] that Cable’s Figures 1 and 3 “relate to the same embodiment”). According to Cable, “the object can be removed from the substrate with minimal, if any, damage to the substrate and/or the object and the substrate can be re-used.” EX1006, [0082] (reference number omitted).¹

¹ Throughout this Petition, general descriptions provided for Cable and other references and combinations thereof are incorporated into each subsection and mapping of the claims that includes citations to these references.

2. Naware (EX1007)

Naware describes a 3D printer having “a build plate with multiple heating/cooling zones so that the temperature distribution and the thermal gradient over the surface of the build plate can be controlled” to prevent “curling, warping, delamination, or distortion of the part being built.” EX1007, [0001], [0039]; EX1003, ¶¶50–52. Naware teaches an array of temperature control modules 34 in the build plate, each module “including heating/cooling mechanisms 38 and temperature sensors 40” and each module being “controlled by a controller.” EX1007, [0032–0033]. Consistent with Cable, Naware envisions embodiments where “a substrate is mounted on top of the build plate upon which the part or article is built.” EX1007, [0030].

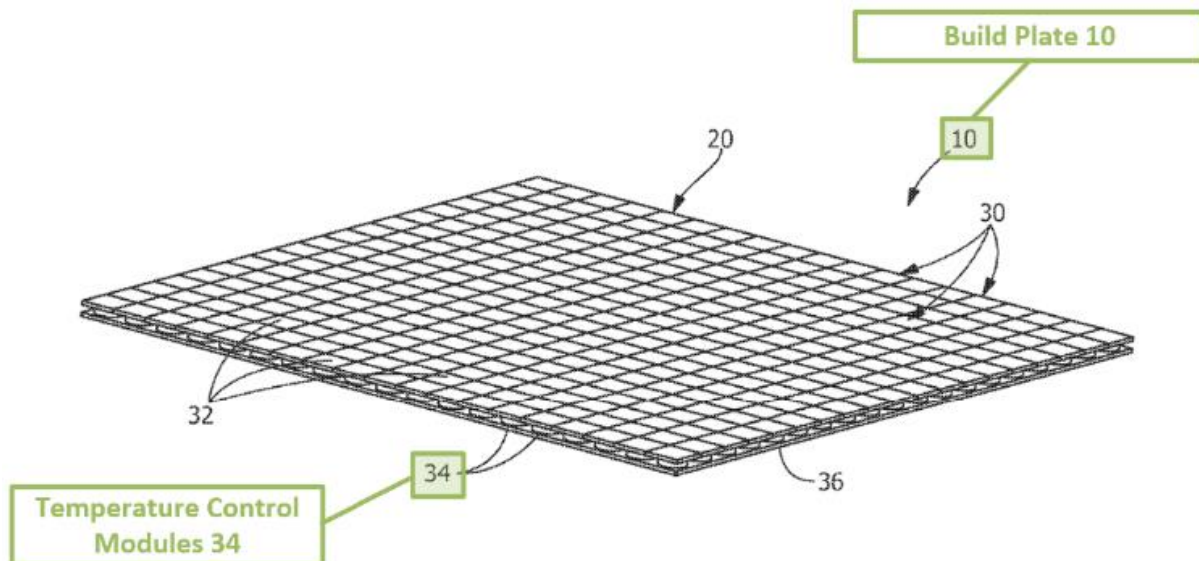
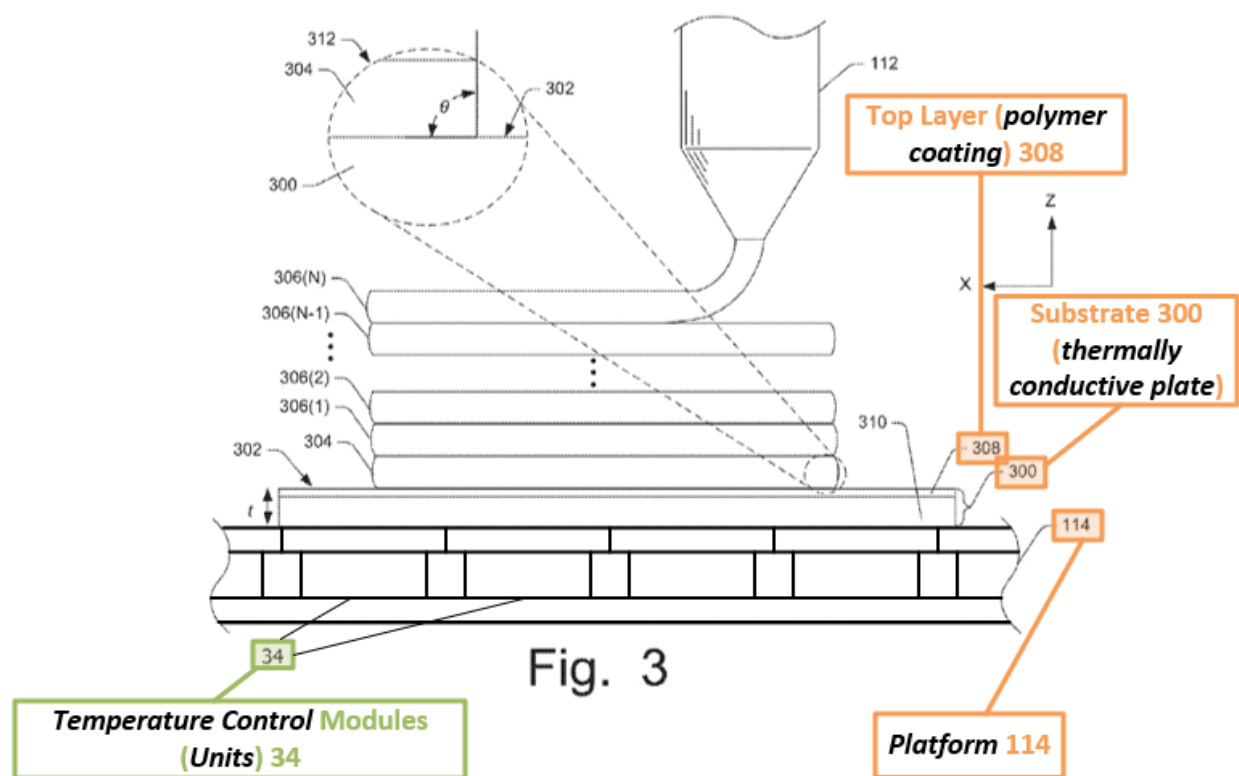


FIG. 2

EX1007, Figure 2.

3. Motivation to Combine

A POSITA would have been motivated to augment Cable based on Naware’s teachings to employ an array of temperature control modules as an integral heating source. EX1003, ¶¶53–65; *see also* EX1006, [0004]; EX1007, [0013], [0029]. The visual aid below² conceptually demonstrates the Cable-Naware Combination. EX1003, ¶53.



² This visual aid, adapted from Cable and Naware, is not proposing bodily incorporation, as a POSITA would readily adapt temperature control modules to the given constraints of a build platform. EX1003, ¶67.

The following reasons, taken separately or collectively, support the Cable-Naware Combination. EX1003, ¶¶54–65, ¶¶31–36.

First, a POSITA would have been prompted to pursue a combination with Naware based on Cable’s suggestions to do so. EX1003, ¶¶55–58. For example, Cable teaches a build platform that can be heated “by any suitable heating element.” EX1006, [0045]. A POSITA would have sought out and applied teachings from references in the same field, like Naware, that provide implementation details on heating elements for 3D printing build platforms (e.g., Naware’s temperature control modules). EX1003, ¶55.

Indeed, Naware’s teachings are complementary to Cable’s. EX1003, ¶56. Among other things, Naware identifies a variety of heating/cooling mechanism (e.g., micro/nano heaters, coils, heat pipes, etc.) and further explains that temperature sensors and an integral controller are packaged in the same module. *E.g.*, EX1007, [0032–0033]. From a POSITA’s perspective, Naware’s controllable heating elements integrated into a build platform are a natural and obvious extension of Cable. EX1003, ¶57. In short, Cable teaches a heated build platform and calls on the POSITA to implement this teaching via suitable solutions known in the art. Naware provides just that.

Second, heated build platforms were ubiquitous in 3D printing by 2014. EX1003, ¶¶58–60; ¶¶31–36. As the ’660 patent admits, “current 3D printing methods

involve heated build plate[s].” EX1001, 1:31–33, 1:44–46. There is no debate that heated build plates were a well-known solution to the equally well-known problem of increasing part adherence. EX1003, ¶60. Because Naware provides an effective approach for this known solution, a POSITA would incorporate Naware’s teachings in the context of Cable. *Id.*

Third, Naware identifies benefits and advantages in his heated build plate that a POSITA would have recognized are likewise applicable to Cable. EX1003, ¶¶61–64. For example, Naware’s design “solves the problems arising due to uncontrolled temperature distribution” by providing multiple “embedded temperature control mechanisms inside the build plate..., which optimizes the temperature control of the part or article being built.” EX1007, [0025]–[0027]. Naware’s design also “helps in controlling the adhesion, expansion and shrinkage, layer to layer bonding, [and] stress relaxation, etc. of the part or article being built or fabricated.” EX1007, [0025]. Naware enables selectively controlling the temperature of the build plate to preventing “curling, warping, and delaminating of the part or article being built.” EX1007, [0026]. More, the kind of systems that Naware sought to improve employ the same “Fused Deposition Modeling and Fused Filament Fabrication methods,” (EX1007, [0026]), that Cable disclosed, (EX1006, [0026]). Given that Naware and Cable are dealing with similar types of the 3D printers and because Cable generally discloses the notion of a heated build platform, a POSITA would have been

motivated to further optimize the heating mechanism, as taught by Naware, to achieve improved printing conditions and reduce part deformations. EX1003, ¶63.

Fourth, this predictable combination is merely substituting one known element (Cable's broad teaching of a heated build plate) for another known in the field (Naware's heated built plate design with temperature control modules) to obtain predictable results. EX1003, ¶¶64–65. Supplementing Cable based on Naware's teachings would not have disturbed the other aspects of Cable's 3D printer, and it would have produced substantially similar functionality to what Cable described. *Id.*

4. Reasonable Expectation of Success

A POSITA would have reasonably expected success in the above-discussed combination. EX1003, ¶¶66–67, ¶¶31–36. 3D printers with temperature-controlled heated build plates were well-known technologies at the time of the '660 patent in 2014, and these technologies had been successfully demonstrated in the real-world by then. *Id.* Thus, the result of the Combination would have been predictable to a POSITA, and the POSITA would have expected it to work. *Id.*

5. Claim Element Analysis

(a) Claim 1

Element [1.pre]: A build apparatus for printing a 3D object of thermoplastics employing additive manufacturing methods, the apparatus comprising:

The Cable-Naware Combination renders obvious Element [1.pre]. EX1003, ¶¶68–70. The Combination includes Cable’s “additive manufacturing” system (***build apparatus***). EX1006, [0026]; *see also* [0004], [0027], [0057]. The system includes a substrate that “can be positioned on a platform...as a ‘working surface’ for building the ***object***” via an extrusion-based “***printing***” process. EX1006, [0034], [0031], [0041] (explaining that the build material “can include a ***thermoplastic*** polymer”); *see also* [0002], [0057]. “An ***object*** can be produced by depositing a material, layer-by-layer according to a pattern, onto a surface of [the] substrate. The pattern in which the material is deposited may be based on ***three-dimensional (3D)*** model data...” EX1006, [0004]; *see also* [0027].

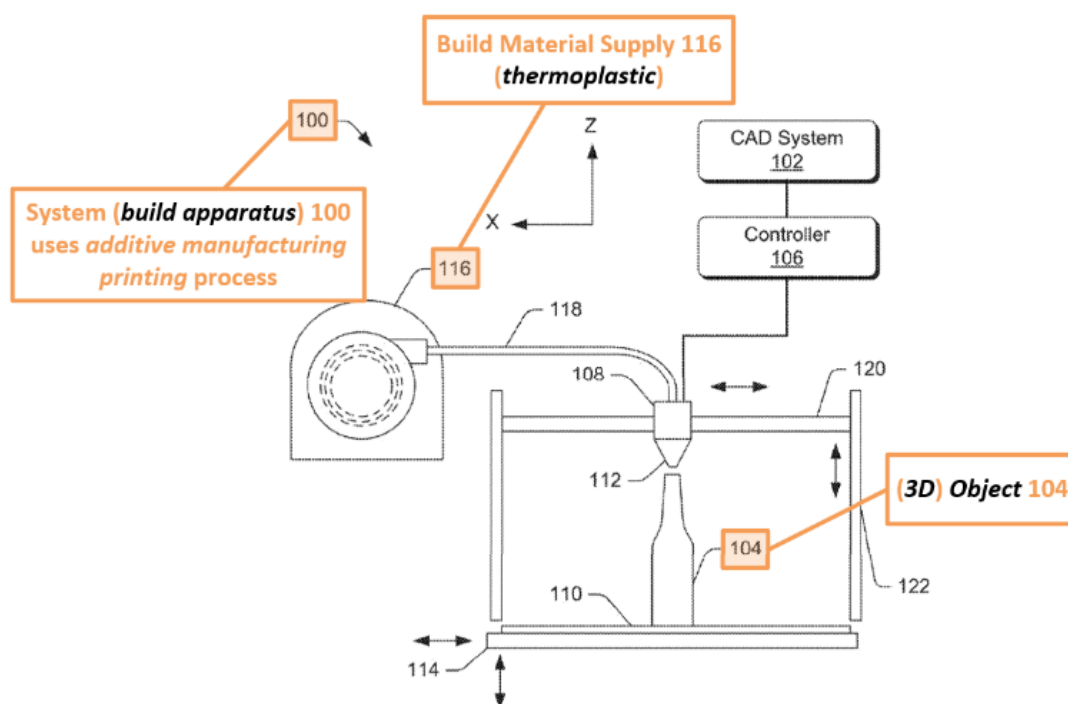


Fig. 1

EX1006, Figure 1 (annotated); *see also* Figures 2–6.

Element [1.a]: a build platform with a temperature control unit configured to control heating of the build platform;

The Combination renders obvious Element [1.a]. EX1003, ¶¶71–77. The Combination incorporates Cable’s “**platform** 114 that is configured to support [a] substrate” functioning “as a ‘working surface’ for **building** the object.” EX1006, [0034]; *see also* [0031], [0057]; EX1003, ¶¶71–73. “The **platform** 114 can be **heated**...by any suitable heating elements, such as electrical elements...or any other suitable heating element.” EX1006, [0045]; *see also* [0044] (“The object 104 can be formed in...a chamber or other enclosure where **temperature**,...can be **controlled**

and maintained at a desired level by elements **configured to control** temperature, pressure, etc.”). Patent Owner cannot credibly argue that Element [1.a]’s **temperature control unit** is distinguishable over Cable’s teachings of a **heated build platform**. After all, Patent Owner identifies the very same structure in its district court infringement allegations. See EX1024, p.12 (alleging infringement because “[t]he Bambu printers have a **heated build platform**...”).

Regardless, as an additional and alternative basis for finding Element [1.a] obvious, the Combination further incorporates Naware’s teachings regarding “a **build plate [(platform)]**” containing an array of modules, each including “[a] contact plate 32, **temperature control** module 34 [(unit)], and an insulating plate 36.” EX1007, [0031]; see also [0001]; *supra*, §V.A.3–4 (motivation and expectation of success); EX1003, ¶¶74–77.

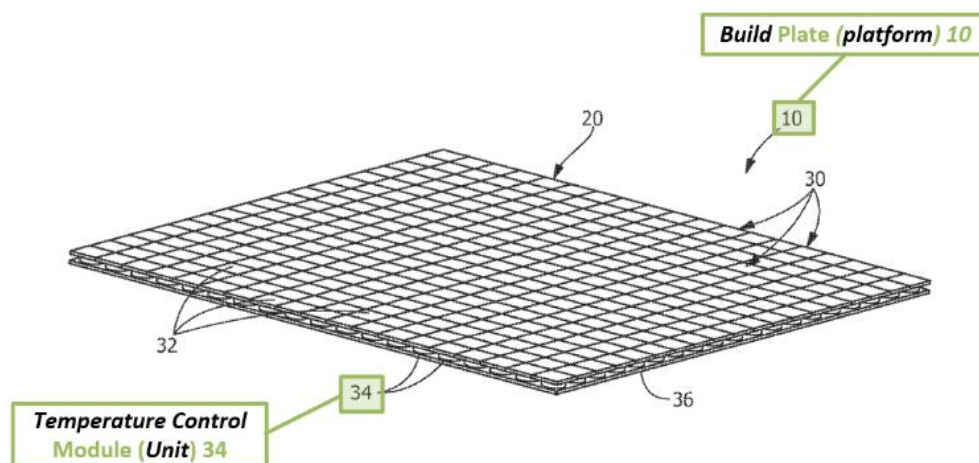
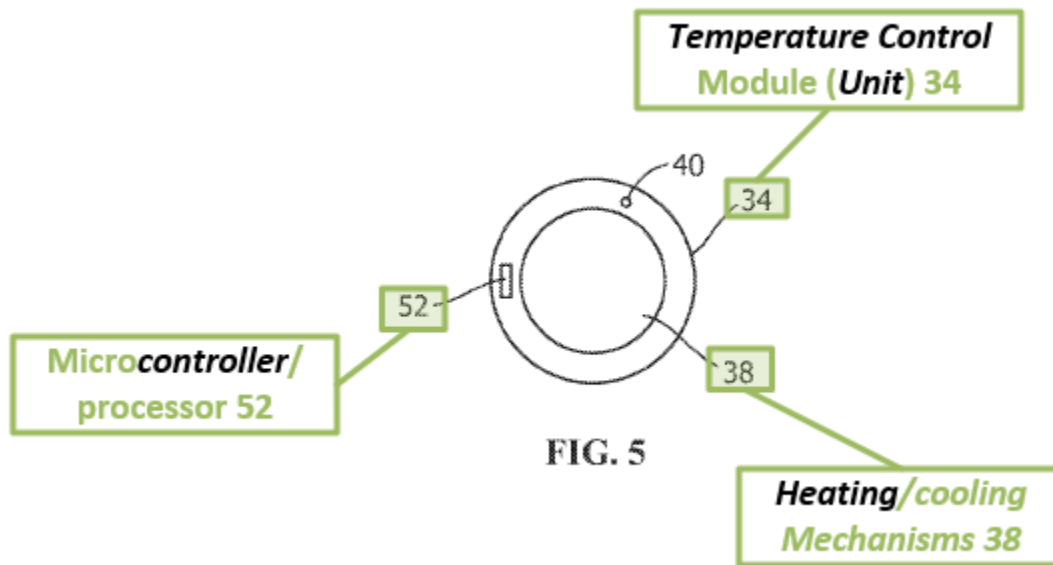


FIG. 2

EX1007, Figure 2 (annotated).

“Each [of the] **temperature control** modules 34 [(unit)] is a device which has the **ability to control the** temperature thereof and consequently, control the temperature of its respective modular element 30.” EX1007, [0032]. Accordingly, as shown in Naware’s Figure 5 (below), “the **temperature control** modules 34 [(units)] include **heating/cooling** mechanisms 38 and temperature sensors 40.” EX1007, [0032]. They also include “a **microcontroller/processor** 52,” which “communicate[s] with” the **heating/cooling** mechanisms 38 and temperature sensors 40 and “will set the temperature...based on a number of variable[s] or factors.” EX1007, [0034]; *see also* [0035] (“the **microcontroller/processor** 52 **controls** the temperature”).



EX1007, Figure 5 (annotated).

Element [1.b]: a thermally conductive plate disposed adjacent to the build platform; and

The Combination renders obvious Element [1.b]. EX1003, ¶¶78–81. For example, the Combination incorporates Cable’s flexible **plate**-like “substrate 110...positioned on a **platform** 114,” where the substrate 110 functions “as a ‘working surface’ for **building** the object.” EX1006, [0034–0035], Figures 1–6; *see also* [0031], [0057] (“The substrate [(**plate**)] 300 can be removably attached or fastened to the **platform** 114 in any suitable manner.”), [0061]; EX1003, ¶81. The substrate (**plate**) “can be made of any suitable material,” including “metal,” which a POSITA would understand to be **thermally conductive**. EX1006, [0077]; EX1003, ¶79. As seen in Figure 1 below, the substrate 110 (**thermally conductive plate**) sits **adjacent** to the **build platform** 114.

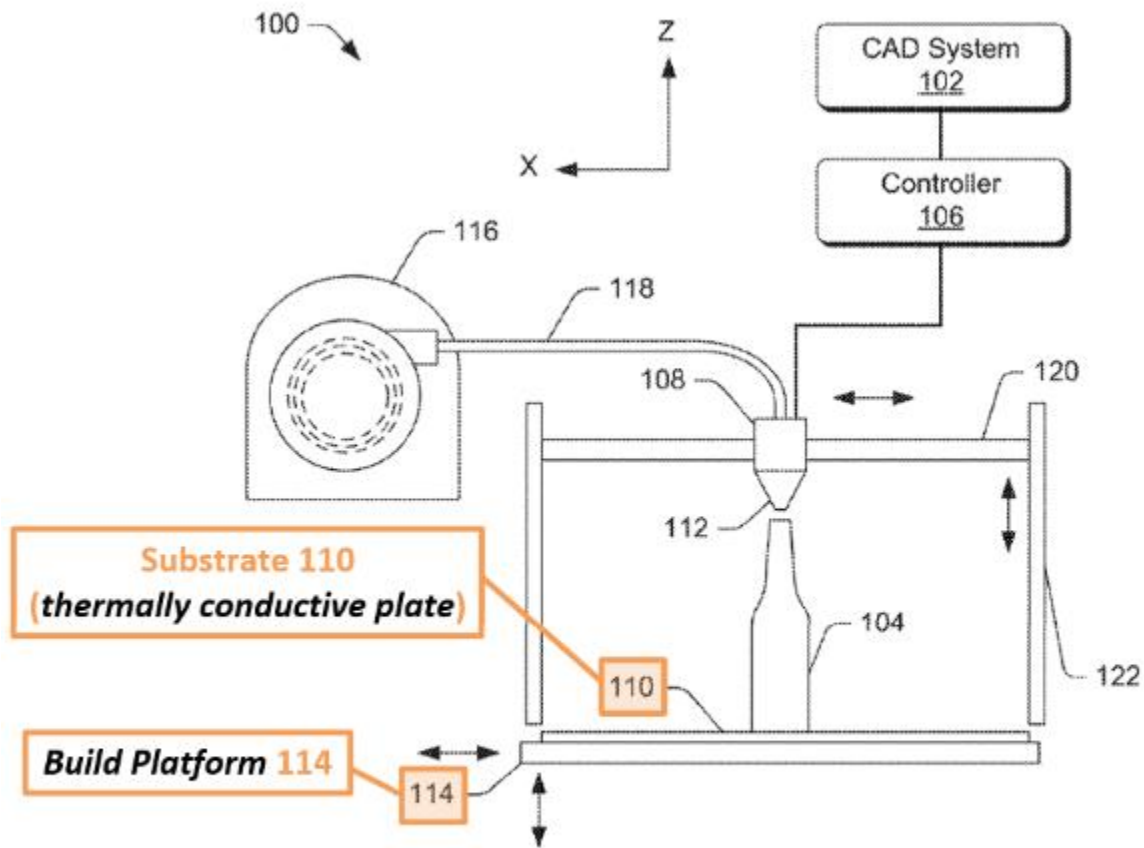


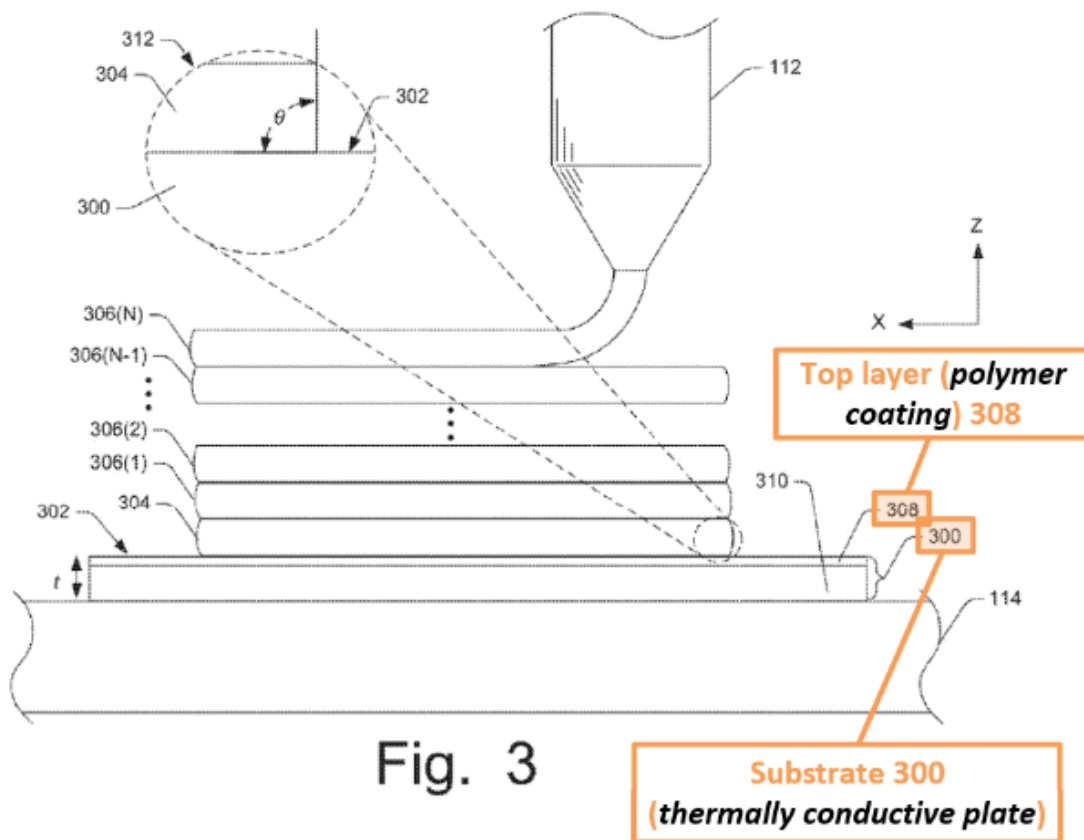
Fig. 1

EX1006, Figure 1 (annotated); *see also* Figure 3, [0057], [0061].

Element [1.c]: a polymer coating attached to a surface of the thermally conductive plate

The Combination renders obvious Element [1.c]. EX1003, ¶¶82–86. As discussed at Element [1.b], the Combination incorporates Cable’s substrate that is “manufactured by **coating** a main portion or body...with a first material (e.g., a thermoplastic **polymer**) to form [a] top layer.” EX1006, [0061] (reference numbers omitted); *see also* [0036] (“the substrate [] can include a **coating** of the **polymeric**

material”), [0057], [0082]. It is a “preformed” structure made “to be reused [] repeatedly.” EX1006, [0080], [0071]. Cable’s instruction to construct the top layer during the substrate manufacturing process to create a preformed and reusable component teaches and/or renders obvious to the POSITA that the **polymer coating** is permanently **attached to a surface of the** main body of the substrate (**plate**), as shown below. EX1003, ¶¶83–85.



EX1006, Figure 3 (annotated); see also [0057] (“A top layer of the substrate, such as the top layer shown in FIG. 3, including the first material can be formed (e.g., **coated**) on a main portion of the substrate.” (reference numbers omitted)).

Element [1.c.i]: [a polymer coating...] which is capable of (i) facilitating adhesion to the 3D object during printing and

The Combination renders obvious Element [1.c.i]. EX1003, ¶87. The Combination includes Cable’s teaching of a **polymeric coating** material chosen “to promote [(**facilitate**)] good **adhesion**” between the “substrate and the first layer during the formation [(**printing**)] of the **object**.” EX1006, [0061–0062]; *see also* [0023], [0036], [0052], [0080].

Element [1.c.ii]: [a polymer coating...which is capable of...] (ii) permitting removal of the 3D object once the 3D object has been formed and cooled without chemically or mechanically removing the polymer coating from 3D object and without damaging the polymer coating, the thermally conductive plate, or the 3D object,

The Combination renders obvious Element [1.c.ii]. EX1003, ¶¶88–92. For example, the Combination includes Cable’s disclosures regarding **removal** of the 3D object after printing. EX1006, [0023], [0044], [0052], [0067]. As discussed below, these disclosures teach, suggest, or otherwise render obvious the limitations of Element [1.c.ii].

To start, Cable teaches that “the **object** can be easily **removed** from the substrate...after the object has been produced [(**formed**)]...[b]y flexing the substrate...such that the object can ‘pop off.’” EX1006, [0052] (reference numbers omitted); *see also* [0023], [0067], [0079], Figures 1–6. Cable further teaches that the build material used to form the object is “gradual[ly] **cool[ed]**...as it is deposited

onto the substrate,” and the ***formed object cools*** more when the substrate is removed from the build platform. EX1006, [0044], [0052] (“[A]n individual can remove the substrate from the system after the object has been produced on the substrate, and then the individual can flex the substrate[.]” (reference number omitted)); EX1003, ¶¶89–90.

Next, Cable makes clear that the object is removed from the polymer-coated substrate ***without chemically or mechanically removing the polymer coating from 3D object***. As Cable explains, its substrate enables the object to be removed “without mechanically contacting the object with a device [or] chemically contacting the object.” EX1006, [0052]; *see also* [0004], [0006], [0020], [0023]. Just like the ’660 patent’s preferred embodiment, Cable teaches that using a flexible polymer-coated substrate allows the part to simply “pop off.” EX1006, [0067]; *see also* [0020], [0023], [0068–0078], [0036], [0061], [0080], Figures 5–6; EX1001, 5:5–31. Thus, “the object can delaminate from the substrate without leaving a residue that is visible to the eye” and “the bottom of the object can have a smooth finish that is aesthetically pleasing.” EX1006, [0067] (reference number omitted). There is no need to ***chemically or mechanically remove the coating from the 3D object***, because the coating remains behind. EX1006, [0052]. This approach results in “***no damage*** to the object and to the substrate,” such that the polymer-***coated*** substrate (***thermally conductive plate***) “can be re-used.” EX1006, [0052]; EX1003, ¶¶91–92.

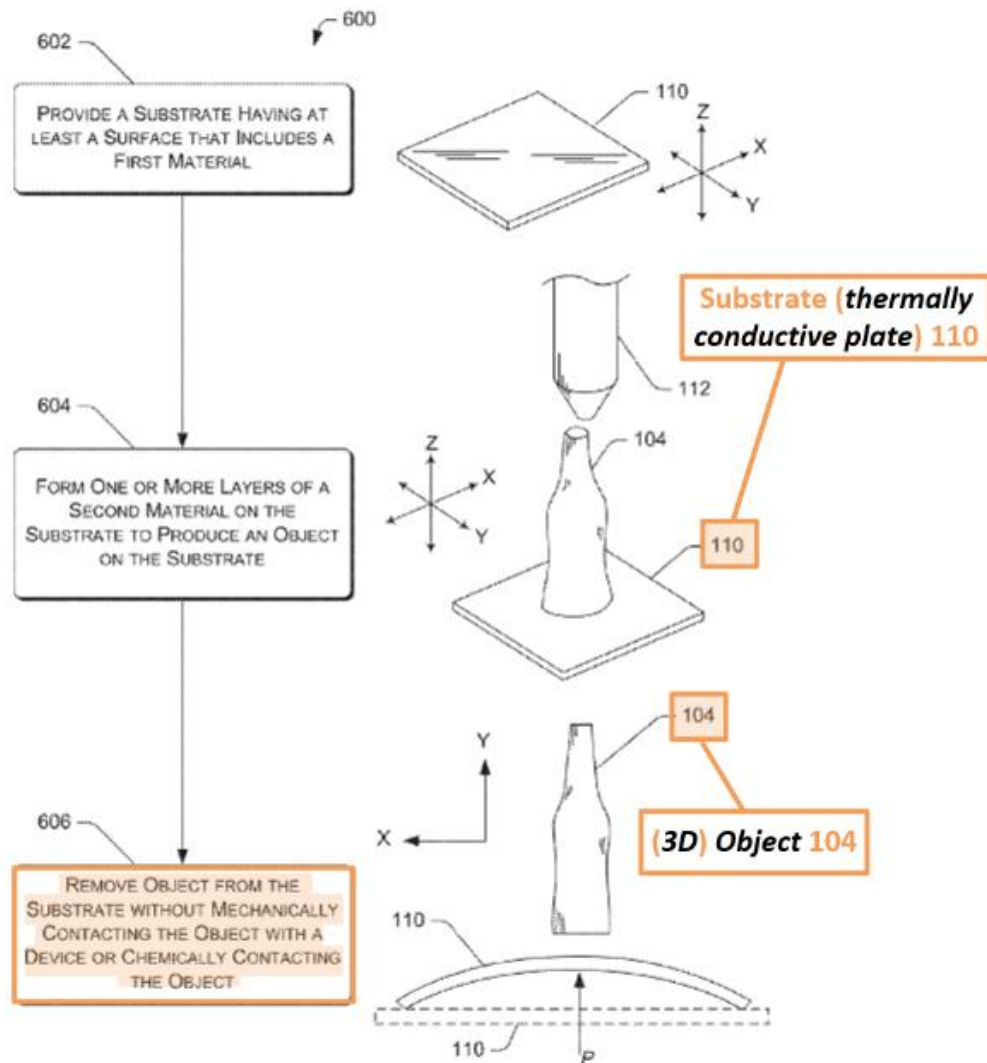


Fig. 6

EX1006, Figure 6 (annotated).

Element [1.c.iii]: wherein the polymer coating is not a polymer tape.

The Combination renders obvious Element [1.c.iii]. EX1003, ¶¶93–98. To a POSITA, Cable’s use of the term “**coating**,” connotes a structure that is **not tape**. EX1003, ¶¶93–95, ¶¶37–39, ¶44. Simply put, when skilled artisans talked about tape, they used the word “tape,” not “coating.” *Id.* Cable never mentions tapes while

discussing his embodiments and expressly distinguishes his embodiments from other known solutions like “painter’s tape.” EX1006, [0002].

As an additional basis for addressing Element [1.c.iii], it would have been obvious to pursue a non-tape solution for implementing Cable’s polymer coating. First, as the ’660 patent concedes, the difficulties/drawbacks of polymer tapes like Kapton tape were well documented, which would have prompted a POSITA to choose any one of the “variety” of admittedly known alternatives. EX1001, 1:31–64, 4:35–38; EX1003, ¶96, ¶¶40–43 (discussing known coating techniques). Second, Cable makes clear that the layers of the substrate—including the top layer of polymer coating—can have “any suitable laminar arrangement.” EX1006, [0078]. Cable does not compel the tape solution that Element [1.c.iii] forbids and non-tape solutions were within the design space that a POSITA would have considered for fabricating Cable’s coated flexible substrate. EX1003, ¶¶97–98.

(b) **Claim 2**

Element [2]: The build apparatus of claim 1, wherein the polymer coating is a polyimide.

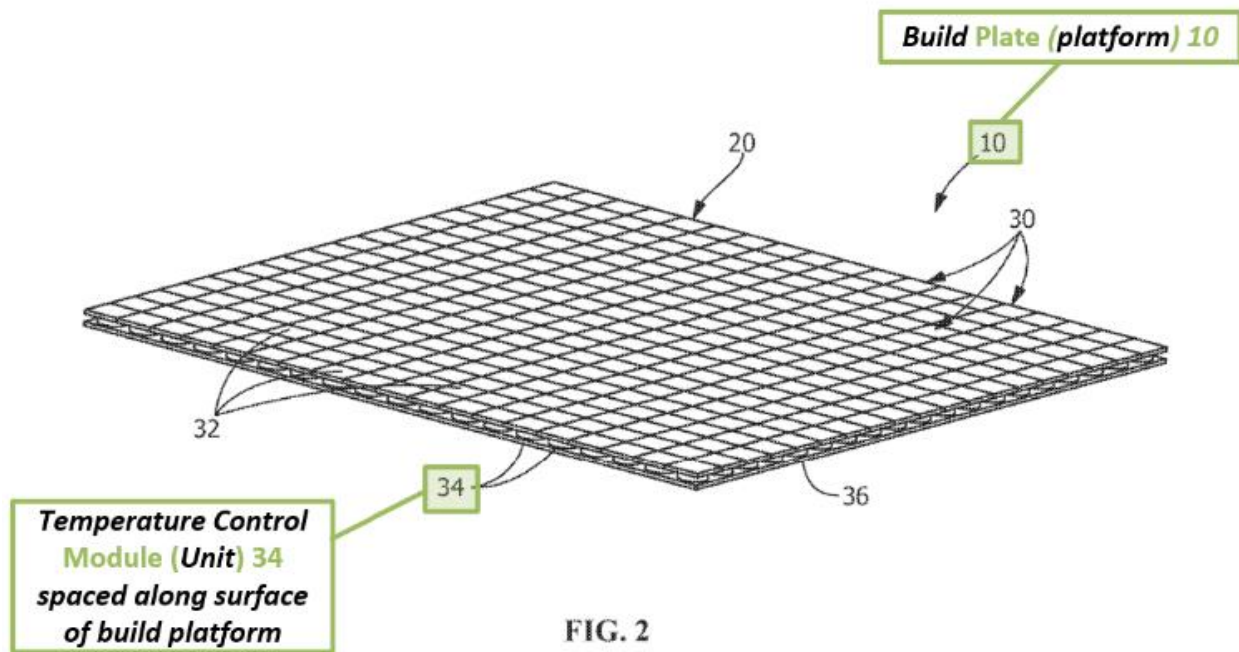
The Combination renders obvious Claim 2. EX1003, ¶¶99–101. Among the list of known polymers, Cable specifically identifies “polyetherimide” for its coating. EX1006, [0036]. According to Patent Owner’s infringement allegations, PEI (polyetherimide) is a member of the ***polyimide*** family. Regardless, ***polyimide***

was a well-known and popularized polymer material known to promote part adhesion during 3D printing. EX1003, ¶100, ¶37. The '660 patent concedes as much. EX1001, 1:31–34. At the very least, **polyimide** is an obvious variant of Cable's disclosed list of polymers that would have been readily apparent to a POSITA applying mere common sense and ordinary creativity to the design problem of selecting an appropriate polymer coating material. EX1003, ¶¶100–101, ¶¶42–43; EX1021, 1:60–2:25 (dip coating polyimide on metal substrates), EX1022, Abstract (polyimide resin), [0074].

(c) **Claim 3**

Element [3]: The build apparatus of claim 1, wherein the temperature control unit comprises heater cartridges that are spaced along a surface of the build platform.

The Combination renders obvious Claim 3. EX1003, ¶¶102–105. As discussed above at Element [1.a], the Combination incorporates Naware's teachings to accommodate a **build** plate (**platform**) with “multiple numbers of zones or modular elements,” each of which “consists of [a] contact plate, **temperature control** module [(**unit**)], and an insulating plate.” EX1007, [0031] (reference numbers omitted). As shown below, Naware teaches a configuration where the modular elements—and their constituent **temperature control units**—**are spaced along a surface of the build platform**. EX1003, ¶103.



EX1007, Figure 2 (annotated).

Per Naware, the **temperature control units** may incorporate a heating mechanism in the form of “micro/nano heaters, coils, heat pipes, micro/nano channels, thermo-electric coolers, electromagnetic induction heating or a combination of them.” EX1007, [0032], Figure 5. From a POSITA’s perspective, Naware’s disclosure of modular units with integral heating mechanisms teaches, suggests, or otherwise renders obvious the claimed **heater cartridges**. EX1003, ¶104. To wit, Naware’s reference to heating elements that are “housed inside” of a modular housing is consistent with a POSITA’s understanding of a conventional and commercially available heater cartridge, and to the extent it is argued Naware does

not disclose heater cartridges it would be obvious to use them as a commonplace, readily available solution. EX1007, [0032]; EX1003, ¶¶104–105.

(d) **Claim 4**

Element [4]: The build apparatus of claim 1, wherein the build platform comprises thermocouples situated at one or several locations to provide feedback to a controller for maintaining temperature set points.

The Combination renders obvious Claim 4. EX1003, ¶¶106–107. As discussed at Elements [1.a] and claim 3, the Combination incorporates Naware’s supplemental teaching of a **build** plate (**platform**) having an array of distributed modular elements, each featuring a temperature control module with “heating/cooling mechanisms and temperature sensors.” EX1007, [0031] (references numbers omitted), [0001]. The temperature sensors can take the form of “any known sensor...capable of measuring the temperature,” (EX1007, [0032]), which a POSITA would have understood to teach, suggest, or otherwise render obvious the well-known option of **thermocouples**—one of a finite number of interchangeable solutions for measuring surface temperature. EX1003, ¶106.

Naware further explains how each of the temperature control modules “is controlled by a micro**controller**/processor,” which can be “positioned proximate to or in the temperature control module.” EX1007, [0034]. The temperature sensors (**thermocouples**) “communicate with” (**provide feedback to**) the micro**controller**,

and the micro**controller** “will *set* the *temperature*...based on a number of variable[s] or factors.” EX1007, [0034]; *see also generally* [0030–0035]; EX1003, ¶107.

(e) **Claim 5**

Element [5]: The build apparatus of claim 1, further comprising a ceramic or high temperature dielectric that insulates the build platform.

The Combination renders obvious Claim 5. EX1003, ¶¶108–109. For example, the Combination incorporates Naware’s supplemental teaching of a ***build*** plate (***platform***) with an array of modular elements, each of which includes “an ***insulating*** plate” as the bottom surface. EX1007, [0031], Figures 2–4. Understanding that Naware’s modular elements include electrical circuitry and heating elements, a POSITA would have been motivated to make the menial design choice of selecting ***a ceramic or high temperature dielectric*** material for fabricating the insulating plate. EX1003, ¶109. As the POSITA would have appreciated, these classes of materials were known to possess suitable properties to effectuate Naware’s goal of thermally and electrically ***insulating the build platform***. *Id.*

(f) Claim 6

Element [6]: The build apparatus of claim 1, wherein the build platform, the thermally conductive plate, and the polymer coating are able to withstand high temperature ranging between 150 degree Celsius and 300 degree Celsius.

The Combination renders obvious Claim 6 for multiple reasons, taken individually or collectively. EX1003, ¶¶110–113.

First, Cable teaches that the build material may be heated up to “about 360° Celsius.” EX1006, [0032]. Accordingly, a POSITA would have been motivated to provision the ***build platform, the thermally conductive plate, and the polymer coating*** (see Elements [1.a]–[1.c.iii], *supra*) to ***withstand high temperatures*** up to and including the lower claimed range of ***between 150 degrees Celsius and 300 degrees Celsius***. EX1003, ¶110. Second, Cable teaches that the ***build platform*** can be heated up to “about 125° Celsius.” EX1006, [0045]. A POSITA looking to implement Cable’s teaching would have been motivated to provision the ***build platform*** and the mating ***conductive plate*** and ***polymer coating*** using a modest safety factor. EX1003, ¶111. As a result, the provisioned components would be able to ***withstand high temperatures*** up to and including ***150 degrees Celsius***, the lower bound of the claimed range. *Id.*

Third, Cable discloses “metal” as a suitable building material, (EX1006, [0007]), and a POSITA would have appreciated that most metals ***are able to***

withstand high temperatures ranging between 150 degrees Celsius and 300 degrees Celsius. EX1003, ¶112.

Fourth, in the context of a 3D printing apparatus like that of the Combination, the ability of the constituent components to *withstand high temperatures* was a known result-effective variable, such that a POSITA would have arrived at the claimed range by mere routine optimization. EX1003, ¶113; *see also* EX1001, 1:31–40 (admitting that state-of-the-art high-temperature thermoplastics required the build “plate to be *in the range of 150–300 °C*”).

(g) **Claim 7**

Element [7]: The build apparatus of claim 1, wherein the material for the thermally conductive plate comprises one or more of aluminum, steel, brass, ceramic, glass, or alloys with a low coefficient of thermal expansion (CTE).

The Combination renders obvious Claim 7. For example, the Combination incorporates Cable’s teaching of a substrate (*thermally conductive plate*, per Element [1.b]) comprised of “pliable wood, metal, plastic, rubber, or any other suitably resilient material.” EX1006, [0077]; EX1003, ¶114 (explaining that *aluminum* and *steel* are well-known metallic materials for printing substrates).

(h) **Claim 8**

Element [8]: The build apparatus of claim 1, wherein the material for the build platform comprises one or more of aluminum, steel, brass, ceramic, glass, or alloys with a low coefficient of thermal expansion (CTE).

The Combination renders obvious Claim 8. For example, per Cable, the Combination includes a ***build platform*** that is “attached or fastened to,” and structurally “supports,” a removable substrate. EX1006, [0034]. The ***build platform*** is also heated—e.g., up to “about 125° Celsius”—and conducts heat toward the substrate to “promote an anti-warping effect on the build material used to form the object.” EX1006, [0045]. These mechanical and thermal design requirements would have taught, suggested, or otherwise rendered obvious to a POSITA that the ***build platform comprises one or more*** well-known materials, such as ***aluminum*** or ***steel***, both of which were commonly used in the field of 3D printing and additive manufacturing and would have enabled meeting the requirements. EX1003, ¶115.

(i) **Claim 9**

Element [9]: The build apparatus of claim 1, wherein the thermally conductive plate thickness ranges from 0.025–0.5” and wherein the thickness is selected depending on the flexural character of the material.

The Combination renders obvious Claim 9. EX1003, ¶¶116–117. For example, the Combination incorporates Cable’s teaching of a substrate (***thermally conductive plate***, per Element [1.b]) with a ***thickness ranging from*** “1 mm to about

2 mm [0.039 inches to about 0.079 inches],” which renders obvious the claimed range by establishing a subordinate range or at least an overlapping range. EX1006, [0076]; EX1003, ¶116. Cable further teaches, suggests, or otherwise renders obvious to a POSITA that the characteristics of the substrate (**plate**), including its **thickness**, are **selected depending on the flexural character of the material**. EX1006, [0068] (“The ability for the substrate to bend or **flex**...can be influenced by the first **material** of the substrate and [its] dimensions[.]”) (reference numbers omitted)); [0076–0078] (substrate characteristics must preserve the ability “to **flex** or bend resiliently for enabling removal of the object”); EX1003, ¶117.

(j) **Claim 10**

Element [10]: The build apparatus of claim 1, wherein the thickness of the polymer coating ranges from 0.001” to 0.1”.

The Combination renders obvious Claim 10. EX1003, ¶¶118–119. As discussed at Element [9], Cable teaches a substrate with a **thickness ranging from** “1 mm to about 2 mm [0.039 inches to about 0.079 inches].” EX1006, [0076]. More, as discussed at Elements [1.c]–[1.c.iii], the substrate includes a “top layer” formed by **coating** a main body/portion of the substrate with a **polymeric** material. EX1006, [0036], [0061], [0080]. From these teachings in Cable, a POSITA would have gleaned **that the thickness range of the polymer coating** is subordinate to or at least overlaps the claimed range of **from 0.001” to 0.1”**. EX1003, ¶118. For one,

the POSITA would have understood that the maximum coating thickness is a subdivision of the maximum substrate thickness (2 mm or 0.079”), both of which are less than 0.1”. EX1003, ¶118. Additionally, the POSITA would have been motivated to select a minimum coating thickness—a result effective variable, as taught by Cable—at or above the claimed lower bound (0.001”) as a matter of routine optimization. EX1006, [0068–0069], [0076], [0078]; EX1003, ¶119.

(k) **Claim 11**

Element [11]: The build apparatus of claim 1, wherein a surface of the polymer coating includes nano-, micro-, or milli-meter scale features that increase adhesion to the 3D object.

The Combination renders obvious Claim 11. EX1003, ¶¶120–122. As discussed at Elements [1.c]–[1.c.iii], Cable teaches a ***polymeric coating*** material chosen “to promote good ***adhesion***” between the “substrate and the first layer during the formation of the ***object***.” EX1006, [0061–0064]; *see also* [0023], [0036], [0052], [0080]. According to Cable, increased object/part adhesion is achieved by increasing the “surface energy” of the substrate surface contacting the object—here, the ***polymer coating surface***. EX1006, [0061–0064]. As a POSITA would have known, surface texturing, e.g., creating ***nano-, micro-, or milli-meter scale features***, is a conventional and obvious technique for increasing surface energy and, thus, object/part adhesion. EX1003, ¶¶121–122; EX1032, 4:1-8 (micron scale texture).

(l) Claim 12

Element [12]: The build apparatus of claim 1, wherein the thermally conductive plate is flexible so as to allow for easier dissociation between the 3D object and the thermally conductive plate upon cooling and reduce damage to the polymer coating or the 3D object during removal of the 3D object.

The Combination renders obvious Claim 12 for the same or substantially the same reasons discussed above at Element [1.c.ii] (discussing the ***flexibility*** of the substrate (***thermally conductive plate***) in connection with Cable's part/object removal process, which mimics the '660 patent's embodiment). EX1003, ¶123.

(m) Claim 13

Element [13]: The build apparatus of claim 1, wherein the temperature control unit is a heater cartridge.

The Combination renders obvious Claim 13 for the same or substantially the same reasons discussed above at Claim [3]. EX1003, ¶124.

(n) Claim 15

Element [15]: The build apparatus of claim 1, wherein the thermally conductive plate is non-magnetically secured to and removable from the build platform.

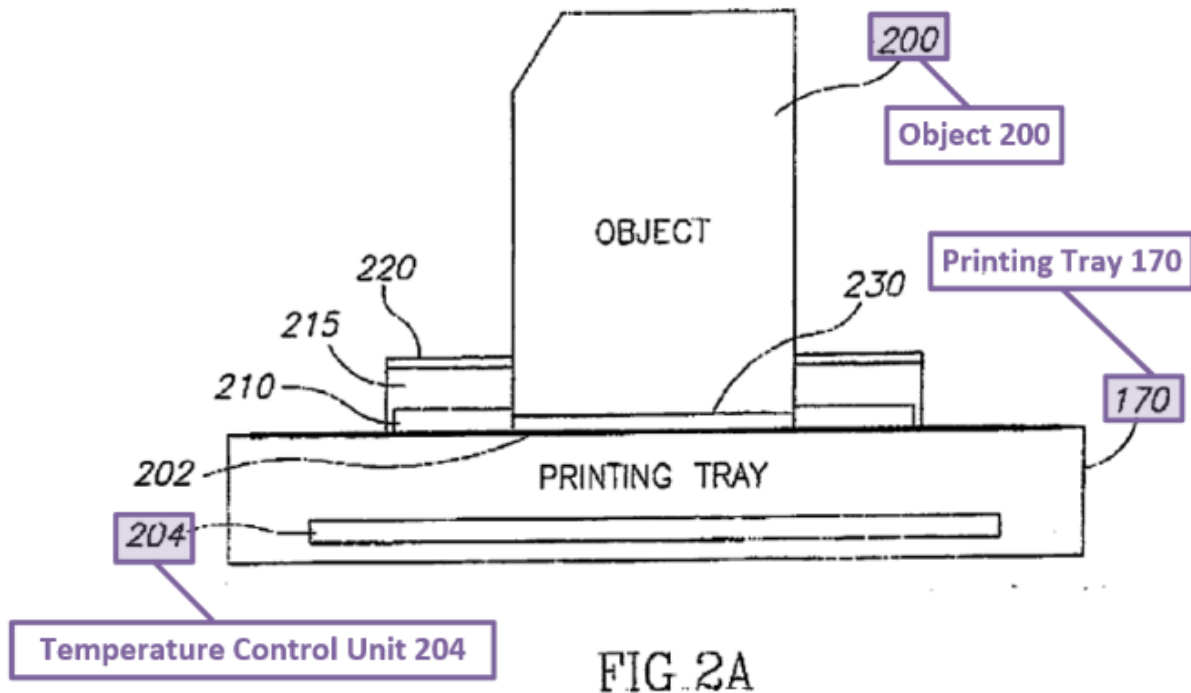
The Combination renders obvious Claim 15. EX1003, ¶125. Per Cable, the Combination includes a substrate (***thermally conductive plate***) that ***is non-magnetically secured to and removable from the build platform*** via “bolts, clamps, hooks, latches, locks, nails, nuts, pins, screws, slots, retainers, adhesive, Velcro®, tape, or any other suitable attachment.” EX1006, [0034].

B. GROUND 1B: Claims 1–2, 4, 6–12, 15 Are Obvious Over Cable and Kritchman

Ground 1B incorporates the analysis of Ground 1A for several claim elements, specifically those elements that rely on Cable’s teachings. Kritchman’s supplementary teachings, when combined with Cable, provide an alternative to Naware for finding Element [1.a] of Claim 1 and Claim 4 obvious.

1. Kritchman (EX1009)

Kritchman teaches 3D printer with a printing tray having a temperature control unit. EX1009, [0007]; EX1003, ¶¶126–127. “The temperature control unit may include, for example, a heating source” and “temperature sensors.” EX1009, [0007]. “The temperature control unit may be integrated into the printing tray” to provide pre-heating “prior to printing of a 3-D object.” EX1009, [0007], [0095].

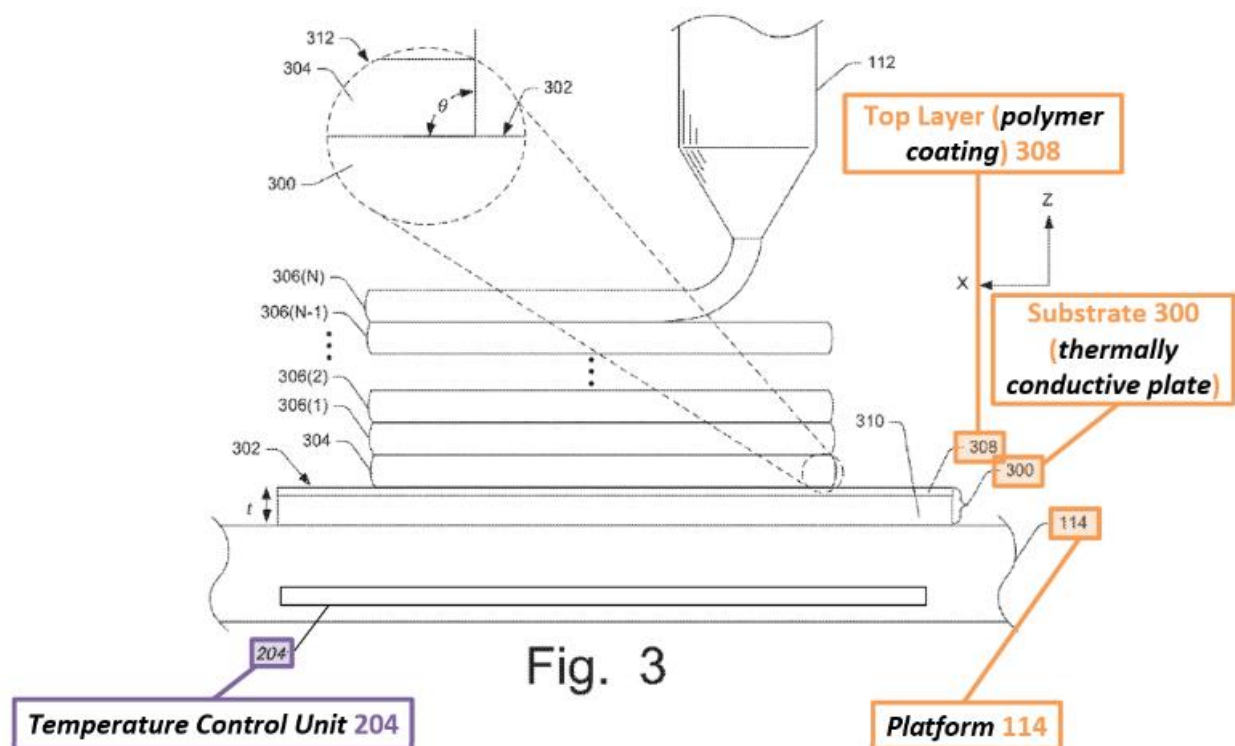


EX1009, Figure 2A (annotated).

2. Motivation to Combine and Reasonable Expectation of Success

A POSITA would have been motivated to augment Cable by employing Kritchman's teachings of a temperature control unit integral within a build tray. EX1003, ¶¶128–136; EX1006, [0004]; EX1009, [0007], [0095]. The visual aid below³ conceptually demonstrates the Cable-Kritchman Combination.

³ This visual aid is not proposing a bodily incorporation.



The following reasons, taken separately or collectively, support the Cable-Kritchman Combination. EX1003, ¶¶129–135.

First, a POSITA would have looked to Kritchman based on Cable’s suggestions to do so. EX1003, ¶130. For example, Cable teaches a build platform heated “by any suitable heating element.” EX1006, [0045]. Kritchman proposes a heating element integrating a temperature control unit (heating elements, sensors, and all) into the build platform (what Kritchman calls a “printing tray”). *E.g.*, EX1009, [0007], [0095].

Second, heated build platforms were ubiquitous in 3D printing by 2014. EX1003, ¶¶131, ¶¶31–36. The '660 patent admits that “[t]he current 3D printing

methods involve heated build plate[s].” EX1001, 1:31–33, 1:44–46. Because Kritchman provides a known solution, it would have been axiomatic for a POSITA to implement Kritchman in Cable. EX1003, ¶132.

Third, a POSITA would have recognized that Kritchman’s integrated temperature control unit promotes a modular system, which carries the known advantage of simplifying installation, replacements, and repairs. EX1003, ¶133.

Fourth, Kritchman’s integrated temperature control unit within the build platform as a modular item is one of a finite number of known solutions to practically constructing a heated build platform. EX1003, ¶134. A POSITA would have been motivated to consider this predictable design choice. *Id.* Per Kritchman, control functions can be either centralized or distributed—i.e., “spread across units.” EX1009, [0073]; EX1003, ¶134 (“binary choice”).

Fifth, a POSITA would have understood the Combination to have yielded a predictable result from combining known prior art elements according to known methods. EX1003, ¶135. Each element in combination merely performs the same function as it does separately. *Id.* It would have been well within the POSITA’s level of skill to implement such a combination with a reasonable expectation of success given the relatively advanced state of the art. *Id.*

3. Claim Element Analysis

(a) Claim 1

Elements [1.pre], [1.b], [1.c], [1.c.i], [1.c.ii], [1.c.iii]

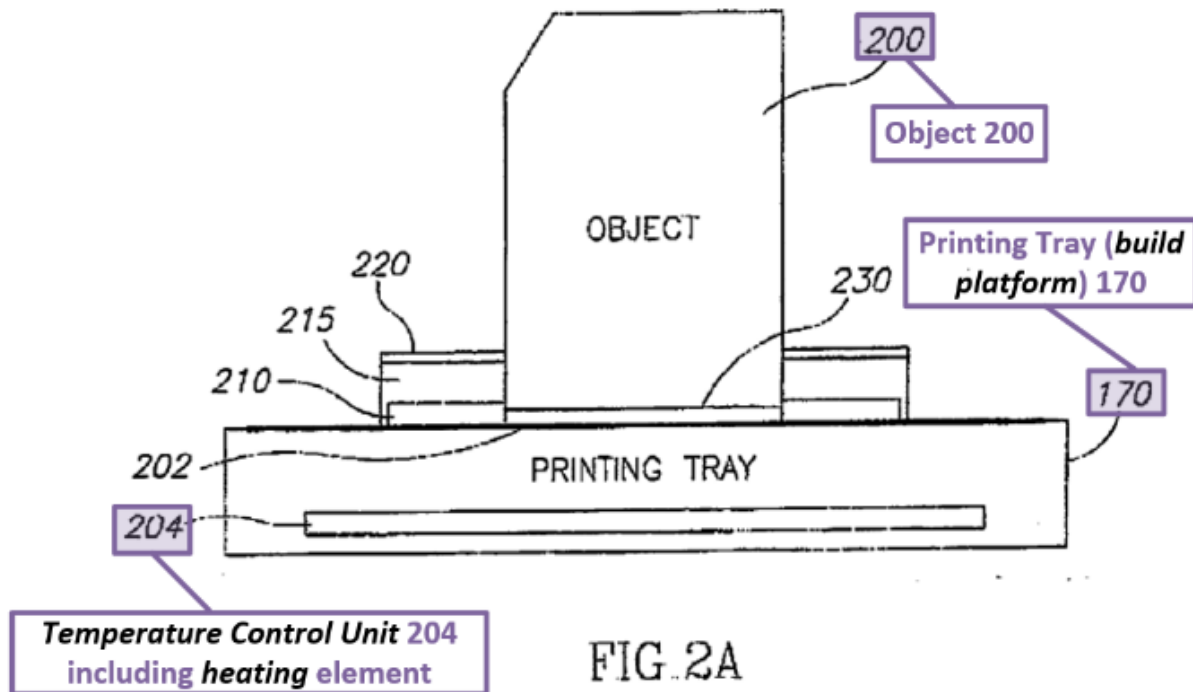
The Cable-Kritchman Combination renders obvious Elements [1.pre], [1.b], [1.c], [1.c.i], [1.c.ii], [1.c.iii] for the same reasons discussed above in Ground 1A at §V.A.5.(a). EX1003, ¶137.

Element [1.a]⁴

The Combination renders obvious Element [1.a]. EX1003, ¶¶138–139. The Combination includes Cable’s teaching of an additive manufacturing system with a build platform. EX1006, [0034]; *see also* [0031], [0057]. Additionally, as discussed at §§V.B.1–2, the Combination further incorporates Kritchman’s teaching to “integrate[]” the componentry of a **temperature control unit within a build platform** (what Kritchman calls a “printing tray”). EX1009, [0007] (explaining that the **temperature control unit “controls the temperature”** and includes “**heating** elements and/or temperature sensors”); *see also* [0027], [0073], [0091], [0095]–[0096] (“[P]rinting tray 170 [(**build platform**)] may be warmed [(**heated**)] prior to printing of a 3-D object, to a temperature that is, for example, close to the glass transition

⁴ Despite representing the limitations here and below in shorter form, Petitioner has addressed all aspects of the limitations.

point of the modeling and/or support materials, by, for example, **a temperature control unit 204.**”), Figures 1, 2A, 2D, cls. 133–137.



EX1009, Figure 2A (annotated).

(b) **Claim 2**

The Combination renders obvious Claim 2 for the same reasons discussed in Ground 1A above at §V.A.5.(b). EX1003, ¶140.

(c) **Claim 4**

The Combination renders obvious Claim 4. EX1003, ¶¶141–143. Kritchman’s temperature control unit includes “temperature sensors.” EX1009, [0007]; *see also* [0027], [0073], [0091]–[0096], Figures 1, 2A, 2D, cls. 133–137. Kritchman further teaches using a “**controller** that operates the...heating elements

according to a sensor reading and required **temperature” set point**. EX1009, [0027]. Temperature sensors were well known in the prior art, and a POSITA would have understood that thermocouples were one of a finite number of known solutions for sensing temperature. EX1003, ¶143. A POSITA would have been motivated to consider thermocouples as a design choice in the selection of sensors. *Id.*

(d) Claims 6–12 and 15

The Combination renders obvious Claims 6–12 and 15 for the same reasons discussed above in Ground 1 at §V.A.5.(f)–(l), (n). EX1003, ¶144.

C. GROUND 1C: Claims 7–8, 14 Are Obvious Over Cable, Naware or Kritchman, and Comb

In Ground 1C, Comb’s supplementary teachings are incorporated with the above-discussed Cable-Naware (Ground 1A) and Cable-Kritchman (Ground 1B) Combinations to reach the features of dependent claims 7–8 and 14. The relied upon teachings from Comb are limited to menial material-selection issues and do not disturb other aspects of Cable-Naware or Cable-Kritchman.

1. Motivation to Combine and Reasonable Expectation of Success

As discussed above (*see, e.g.*, §V.A.1, §V.A.5.(a).Elements[1.a]–[1.b]), Cable teaches a substrate comprised of “metal” (EX1006, [0077]), and a heated, thermally conductive platform that structurally supports the substrate, (EX1006, [0034], [0045]). As discussed below (*see, e.g.*, §V.D.1, §V.D.5.(a).Elements[1.a]–

[1.b], §V.D.5.(e)–(g)), Comb teaches a platen plate (analogous to Cable’s “platform” fabricated from aluminum and a base sheet (analogous to Cable’s “substrate”) fabricated from steel. For at least the following reasons, taken individually or collectively, a POSITA would have been motivated to employ Comb’s preferred materials for fabricating Cable’s platform and substrate, and the POSITA would have had a reasonable expectation of success in doing so. EX1003, ¶¶149–153.

First, a POSITA would have been motivated to employ Comb’s preferred materials because they represent recognized solutions to the material-selections left generalized in Cable. EX1003, ¶¶150–151. Implementing a known solution is obvious as a matter of law.

Second, Cable’s identification of “metal” would have prompted the POSITA to seek out Comb’s complementary disclosure of specific types of metal—namely, aluminum and steel. EX1003, ¶152.

Third, the POSITA would have appreciated that Comb’s preferred materials, aluminum and steel, are advantageous in the context of Cable’s substrate and build platform being inexpensive, available and easy to fabricate. EX1003, ¶153.

2. Claim Element Analysis

(a) Claim 7

The Cable-Naware/Kritchman-Comb Combination renders obvious Claim 7. EX1003, ¶154. As discussed at §V.C.1 (motivation-to-combine), the Combination

incorporates Cable's teaching of a flexible substrate (*thermally conductive plate*) and Comb's supplemental teaching of *steel* as a preferred *material*. EX1006, [0077], [0034–0035], [0031], [0052], [0057], [0067], [0082], Figures 1–6; EX1004, 8:17–33, 8:51–9:11, Figure 5, 6:17–23, 6:64–7:6, 7:29–37.

(b) Claim 8

The Combination renders obvious Claim 8. EX1003, ¶155. As discussed at §V.C.1 (motivation-to-combine), the Combination incorporates Cable's teaching of a *build platform* and Comb's supplemental teaching of *aluminum* as a preferred *material*. EX1006, [0034], [0057], [0045], [0080], [0031], Figures 1, 3; EX1004, 7:29–32, 6:64–7:6, 11:12–20, Figures 2–7.

(c) Claim 14

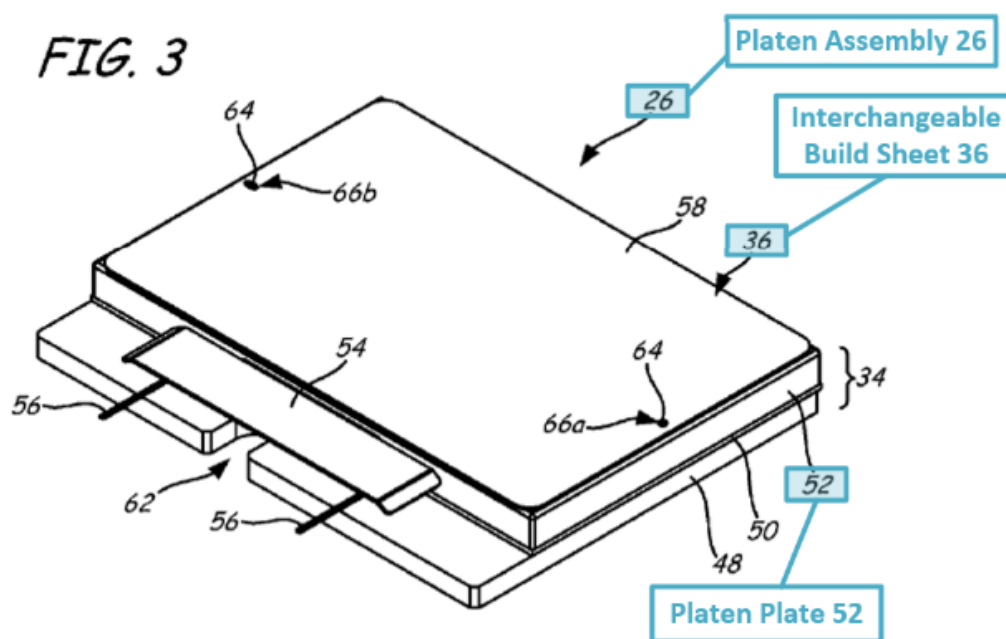
The Combination renders obvious Claim 14. As discussed at §V.C.1 (motivation-to-combine), the Combination includes a steel substrate (*thermally conductive plate*) and an aluminum *build platform*. EX1006, [0077], [0034–0035], [0031], [0045], [0052], [0057], [0067], [0080], [0082], Figures 1–6; EX1004, 7:29–37, 8:17–33, 6:64–7:6, 6:17–23, 8:51–9:11, 11:12–20, Figures 2–7. As would have been well known to a POSITA, *the (first) coefficient of thermal expansion* of aluminum *is greater than the (second) coefficient of thermal expansion* of steel. EX1003, ¶156.

D. GROUND 2A: Claims 1–3, 5-15 Are Obvious Over Comb and Tummala

1. Comb (EX1004)

Comb’s disclosure “relates to additive manufacturing systems for printing three-dimensional (3D) parts.” EX1004, 1:6–10; EX1003, ¶¶145–148. Comb describes “a platen assembly for use in [such] additive manufacturing systems,” one that facilitates use of “removable and interchangeable build sheets during printing operations.” EX1004, 3:43–51; *see also* 4:42–5:17.

With reference to Figures 2–8, Comb describes a platen assembly 26 with a platen plate 52 that supports an interchangeable build sheet 36. EX1004, 6:64–7:6; *see also generally* 6:24–7:28, Figures 2–3.



EX1004, Figure 3 (annotated).

Comb's "[p]laten plate 52 is a heatable platen" provided with "heating elements 56" that are "configured to heat and maintain platen plate 52 at an elevated temperature." EX1004, 7:29–32, 8:9–16, 11:12–20, Figures 3, 5–7. The build sheet 36 is a "multiple-layer" construction "having a top film 36a laminated on or otherwise adhered to a metallic base sheet 36b." EX1004, 8:17–26. According to Comb, the top film 36a "may be derived from one or more polymeric coatings, tapes, or other lamina." EX1004, 8:27–50, Figures 5–6; *see also* 8:17–26, 13:17–24.

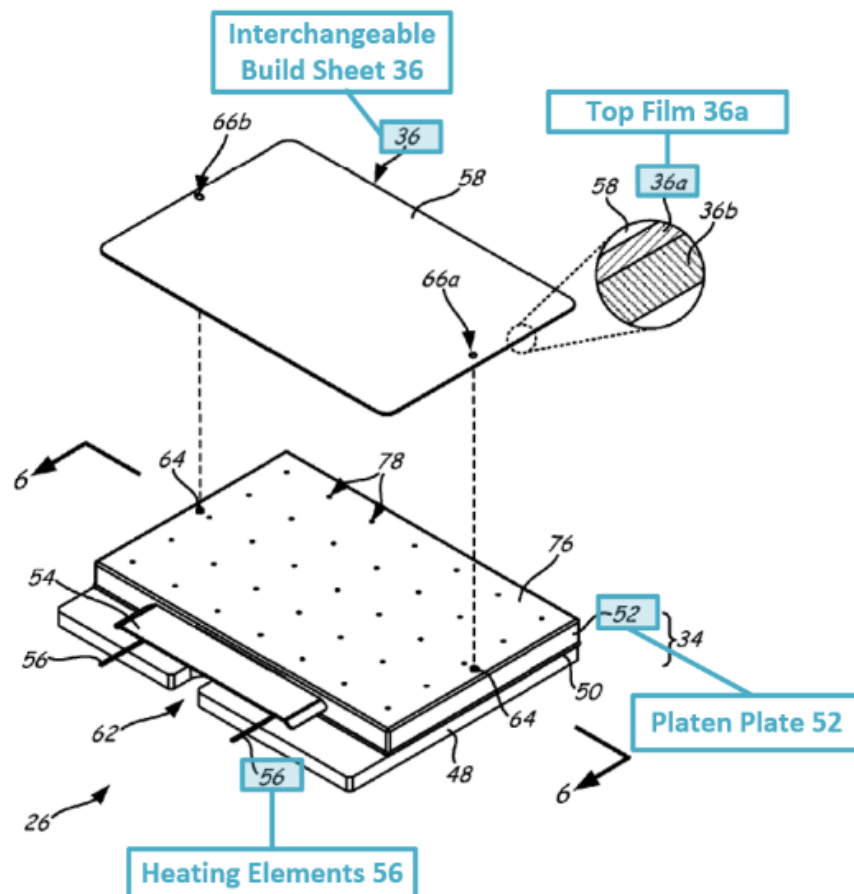


FIG. 5

EX1004, Figure 5 (annotated).

2. Tummala (EX1005)

Tummala is about “three dimensional (3D) printing systems.” EX1005, [0002]; EX1003, ¶¶157–161. As Tummala explains, “[a] weak bond between the extruded print material...and the surface of the print pad can cause the extruded print material to separate from the print pad prematurely,” which “can lead to a failed print process and/or to imperfections in the printed 3D object.” EX1005, [0005]. On the other hand, “a strong bond...[can] make it difficult to remove the printed 3D object,” which “can require a user to employ a hand tool such as a scraper” that may do “damage to the printed 3D object and/or the surface of the print pad.” *Id.*

Tummala proposed a polymer material “that provides satisfactory bonding of the extruded print material...to the print pad during the print process yet [also] enables the printed material to be easily separated from the print pad after the print process.” EX1005, [0007]. Similar to Comb, Tummala’s material, sometimes referred by Tummala to as an adhesive, is applied to “the build surface of the print pad” as a coating of “uniform thickness.” EX1005, [0063]; *see also* [0052], [0023], [0034], [0043], [0045]. Tummala’s coating is not applied as a tape. In some embodiments, the coating initially takes the form of “a viscous gel at room temperature” and is easily applied, optionally in a desired “pattern.” EX1005, [0052]–[0053]. “[P]roviding tackiness throughout the print process,” and “a hard or

glassy consistency” once cooled, Tummala’s coating “act[s] as both a bonding agent and a releasing agent.” EX1005, [0049], [0046].

3. Motivation to Combine

A POSITA would have recognized that Comb and Tummala are pursuing the same idea: a build sheet/print pad covered with a polymer that facilitates the easy, non-damaging removal of a printed 3D part. *See supra*, §§V.D.1–2. Comb broadly teaches a polymer applied as a coating, tape, or other lamina, and Tummala provides the complimentary teaching of similar polymers applied by coating in a form other than tape. Some of Tummala’s examples can be applied as a “gel.” In view of Tummala, a POSITA would have found it obvious to not limit its application of Comb’s polymer materials to tapes, and instead would have followed Comb’s teaching to apply the polymer as a “coating. . . or other lamina.” EX1003, ¶162, ¶164. The ’660 patent even admits applying polymer as a coating was obvious. *See*, EX1001, 4:35-38. Recognizing that many of the materials identified by Comb are the same materials identified by Tummala or have similar properties as Tummala’s materials, and that Tummala advocates applying the material as a gel, a POSITA would have alternatively also found it obvious to apply Comb’s polymer as a gel. *Compare, e.g.*, EX1004, 8:26 (polyimide, polylactic acid) and EX1005, [0028], [0031], [0034] (polyimide, polylactic acid). EX1003, ¶162. Alternatively, a

POSITA would have found it obvious to apply Tummala's polymer as a gel in place of Comb's material. *Id.*

Comb depicts its top coating 36a as the top surface of its build sheet 36, and the manner of coating pursuant to the Comb-Tummala Combination would not change that. The visual aid below⁵ conceptually demonstrates applying Tummala's coating according to the Comb-Tummala Combination. EX1003, ¶163.

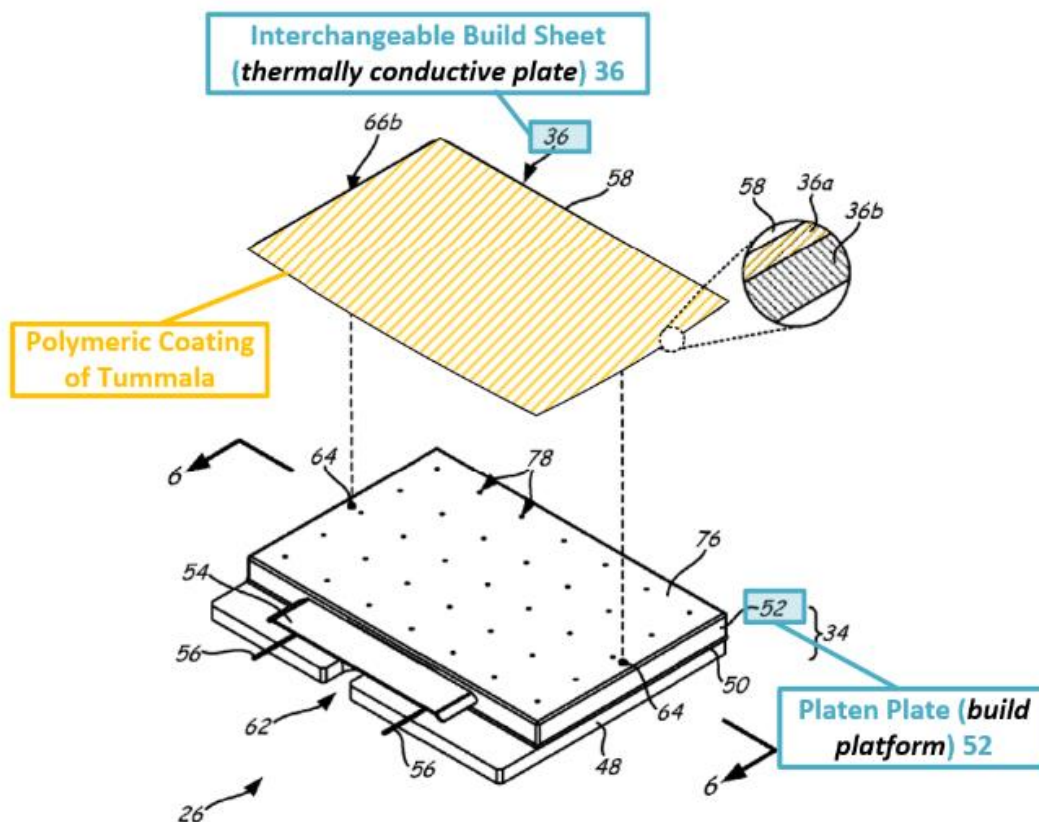


FIG. 5

⁵ This visual aid is not proposing a bodily incorporation.

The following reasons, taken separately or collectively, support the Comb-Tummala Combination. EX1003, ¶¶164–176.

First, a POSITA would have appreciated that applying a coating to a build substrate surface in a manner other than tape, as taught by Tummala (EX1005, [0045], [0052]), may be significantly easier and more manufacturable on a large scale than applying multiple strips of tape, an approach known to cause user frustration. EX1003, ¶¶41-42, ¶167. Tummala further teaches advantages of applying the polymer as “a viscous gel” and to provide a “layer [that] can be continuous” and “uniform” while being easily applied by a user in a variety of different patterns. EX1005, [0052]–[0055], [0057], [0063]; EX1003, ¶168.

Second, a POSITA would have been prompted to pursue this the Comb-Tummala combination by Comb itself. EX1003, ¶¶164–165. For example, Comb identifies “coatings” in a disjunctive list apart from “tapes, or other lamina.” EX1004, 8:27–42; *see also* 8:43–50 (“tape or other coating”). Accordingly, a POSITA would have understood Comb contemplated polymeric coatings beyond tape. EX1003, ¶44, ¶164. Looking to implement Comb’s teaching of non-tape coatings, the POSITA would have sought complementary teachings from references in the same field, like Tummala, for additional implementation details. *Id.* More, the ’660 patent concedes it would have been “obvious to a person skilled in the art that there exists a variety of coating methods and types of high temperature polymer

coatings.” EX1001, 4:35–38. Tummala teaches such example coating methods and coatings. Moreover, a POSITA knew that polyimide coatings, a type of coating advocated by both Tummala and Comb, could be applied as a fluid. EX1003, ¶43; *see also*, EX2021, 1:60-2:25 (dip coating metal substrates), EX2022, Abstract (polyimide resin).

Third, a POSITA would have, alternatively, used Tummala’s polymer coating which provides “satisfactory bonding of the extruded print material (or support material) to the print pad during the print process” while still “enabl[ing] the printed material to be easily separated from the print pad after the print process.” EX1005, [0007]–[0008]; *see also* [0003]–[0006]; EX1003, ¶168. The POSITA would have viewed the advantages espoused by Tummala as complementary to Comb’s stated desire to remove the printed 3D part “cleanly” in a manner where the build sheet “retains its integrity” and “may be reused,” (EX1004, 13:6–16), making the Comb-Tummala Combination a natural and collaborative pairing of known elements. EX1003, ¶¶169–170.

Fourth, a POSITA would have sought Tummala’s polymer advantages in Comb; it having “a high thermal or heat resistance,” “a decomposition temperature of greater than about 300°C,” and “a glass transition temperature below 120°C,” such as “between about 50°C and about 90°C.” EX1005, [0049]–[0051]; *see also* [0023], [0046], [0060]; EX1003, ¶¶171–172. Such a coating “has a rubbery

consistency above its glass transition temperature, providing tackiness throughout the print process,” and “reduced tackiness or a hard or glassy consistency below its glass transition temperature, permitting the adhesive to act as a releasing agent.” *Id.*

Fifth, either predictable combination of Comb and Tummala, applying Tummala’s teaching to consider other application methods than tape or using Tummala’s coatings, follows the familiar pattern of merely substituting one element (Comb’s broad teachings of a polymeric coating) for another known in the field (Tummala’s teachings about application or polymer) to obtain predictable results. *KSR*, 550 U.S. at 416; *Lackey*, 371 Fed. at 82; EX1003, ¶173. Supplementing Comb’s build plate based on Tummala’s teachings would not have disturbed the other aspects of Comb’s system, and it would have produced substantially similar functionality to what Comb described. EX1003, ¶173.

4. Reasonable Expectation of Success

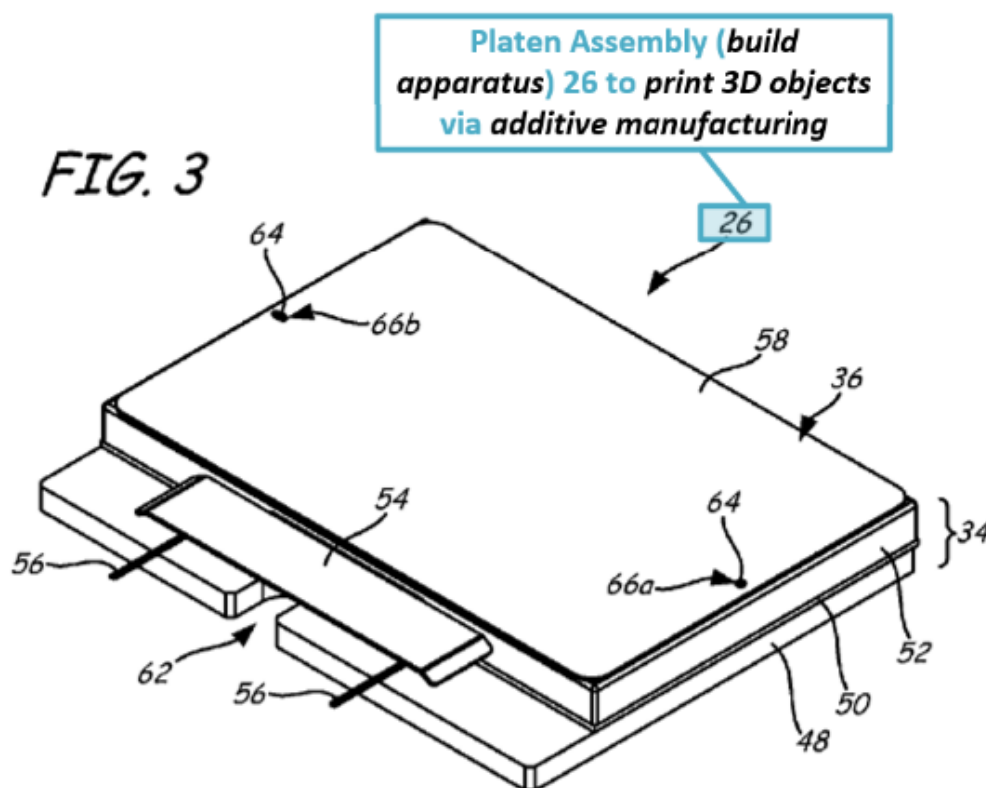
A POSITA would have reasonably expected success in the above-discussed combination. EX1003, ¶¶174–176. Polymer materials and methods of applying them to items like Comb’s build plate were well understood by the time of the ’660 patent. *Id.* 3D printers with polymer-coated build substrates were also well-known at the time and had been successfully implemented in the real-world by then. *Id.* Thus, the result of the Comb-Tummala Combination would have been predictable to a POSITA, and the POSITA would have expected it to work. *Id.*

5. Claim Element Analysis

(a) Claim 1

Element [1.pre]: A build apparatus...

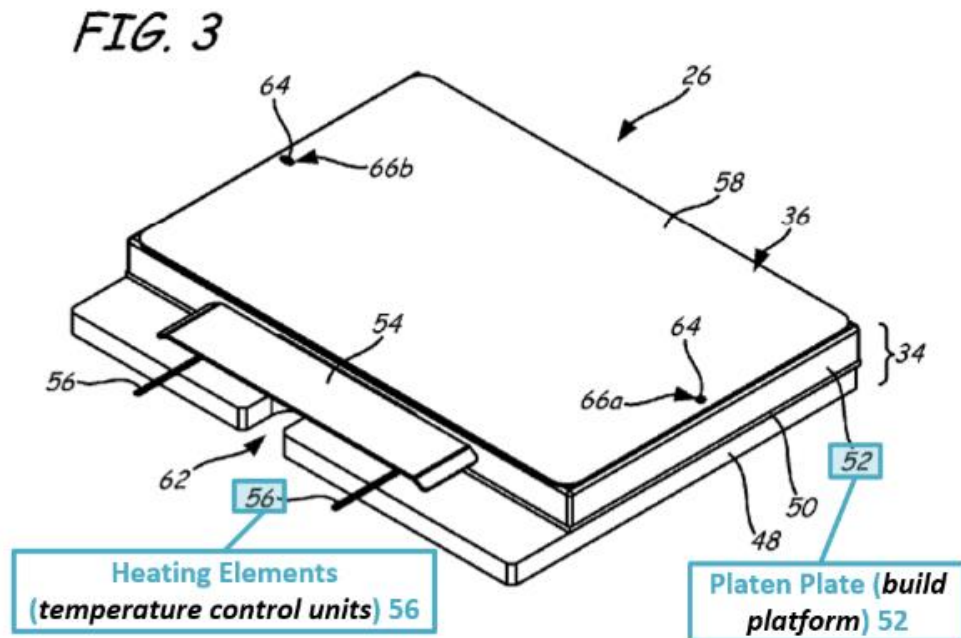
The Comb-Tummala Combination renders obvious Element [1.pre]. EX1003, ¶177. Per Comb, for example, the Combination includes a ***build apparatus*** in the form of “a platen assembly for use in ***additive manufacturing*** systems...to ***print 3D*** parts [(***objects***)] and support structures” from ***thermoplastic*** polymeric materials like “ABS [acrylonitrile butadiene styrene].” EX1004, 3:43–48; *see also* 3:52–58, 6:64–65, 8:9–16; EX1003, ¶177.



EX1004, Figure 3 (annotated).

Element [1.a]: a build platform...

The Combination renders obvious Element [1.a]. EX1003, ¶¶178–186 For example, the Combination includes Comb’s platen assembly 26, which features a platen plate 52 (***build platform***) that supports an interchangeable build sheet 36 on a gantry mechanism. EX1004, 6:64–7:6; *see also generally* 6:24–7:28, Figures 2–3; EX1003, ¶178. “Platen plate 52 is a heatable platen” provided with “lateral openings 84” that receive “heating elements 56.” EX1004, 7:29–32, 11:12–20, Figures 3, 5–7. *See also* EX1037, [0068], [0074]. The heating elements 56 (***temperature control unit***) are ***configured to control heating of the*** platen plate 52 (***build platform***) “conductively.” EX1004, 7:29–32, 8:9–16, 11:12–20.

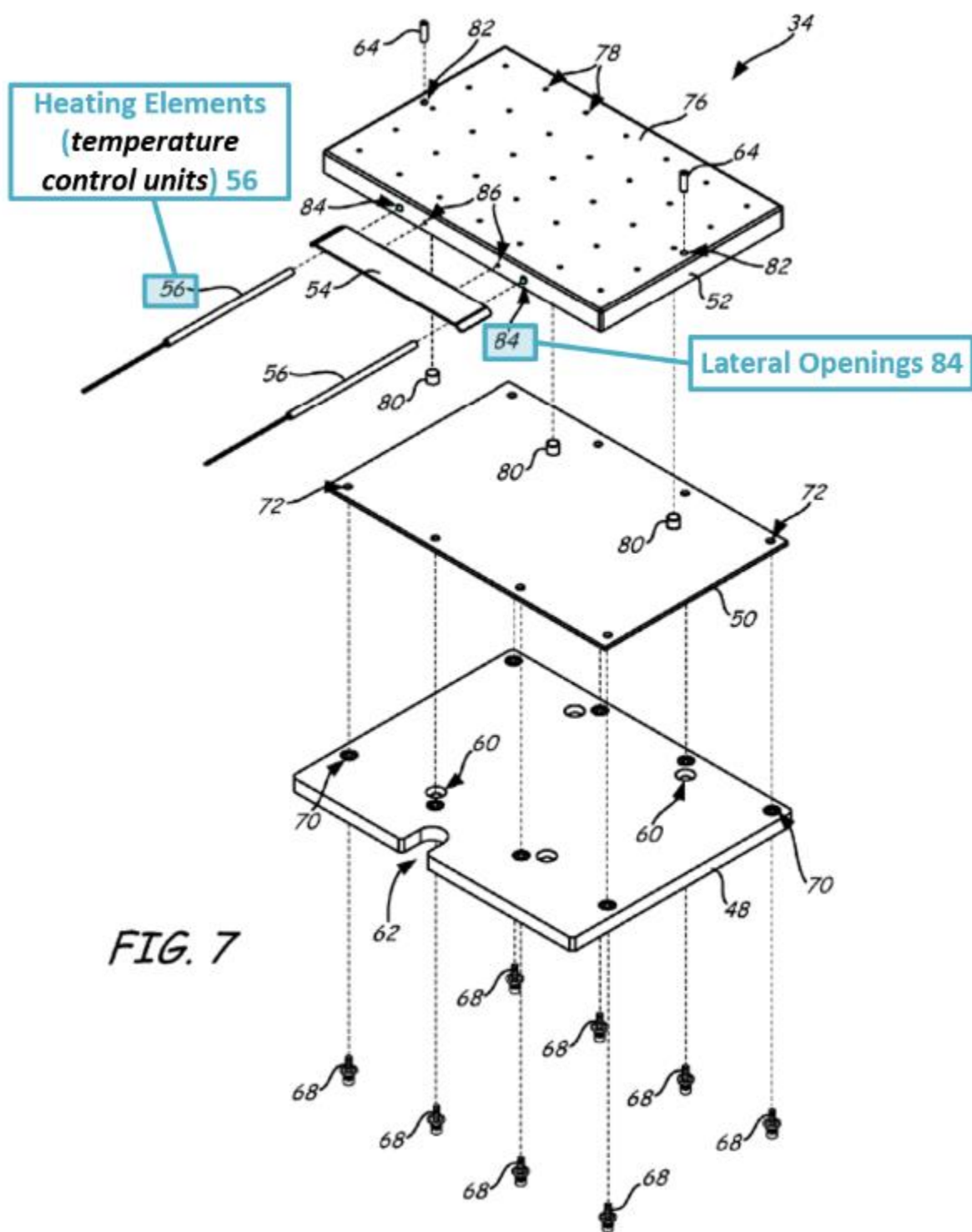


EX1004, Figure 3 (annotated). As discussed, Patent Owner cannot credibly argue non-obviousness regarding Element [1.a] over Comb’s teachings of a ***heated build***

platform because this structure is the basis of Patent Owner’s infringement allegations. See EX1024, p.12 (alleging infringement because “[t]he Bambu printers have a **heated build platform...**”).

To the extent the claim term **temperature control unit** is interpreted as requiring the generic “heater cartridges” referenced in the ’660 patent’s specification and dependent claims, Comb’s teachings viewed through the lens of a POSITA are still sufficient to establish obviousness. EX1001, 3:14–31 (the ’660 patent describing a build platform 102 carrying heater cartridges 202 “acting as temperature control means”), cl.3, cl.13, Figure 2; EX1003, ¶181.

First, Comb illustrates and describes the above-discussed heating elements 56 in a manner that suggests a cartridge-type form factor. EX1003, ¶¶182-183. Comb’s Figures 6–7, for example, depict each of heating elements 56 as including an elongated cylindrical sheath receiving lead wires, the conventional construction of a heater cartridge. *Id.* According to Comb, these heating elements 56 are received “in a tight-fit manner” by the lateral openings 84 in platen plate 52 to facilitate “conductive[] heat[ing],” just as a POSITA would have understood conventional heater cartridges to function. EX1004, 11:12–31; EX1003, ¶¶182–183.



EX1004, Figure 7 (annotated).

Second, it would have been an obvious design choice to implement heater cartridges, which could be easily obtained as off-the-shelf or catalog components and were well-known by those skilled in the art to facilitate conductive heating in the manner described by Comb. EX1003, ¶184.

To the extent the claim term ***temperature control unit*** is interpreted as requiring an electronic controller to regulate operation of heating elements, Comb’s teachings viewed through the lens of a POSITA are still sufficient to establish obviousness. EX1003, ¶¶185-186. Indeed, Comb expressly teaches a “controller 22, which is one or more control circuits, microprocessor-based engine control systems..., and which is configured to operate the components of system 10 in a synchronized manner[.]” EX1004, 5:49–54. Heating elements 56 are “components of system 10” and, thus, operated by controller 22. EX1004, 11:13–31; EX1003, ¶185. Additionally, it would have been obvious to a POSITA as a matter of common knowledge and common sense to employ an electronic controller—like controller 22—to implement Comb’s teaching that heating elements 56 are “configured to heat and maintain platen plate 52 at an elevated temperature,” which “may vary depending on the composition of the part and support materials.” EX1004, 8:9–16; EX1003, ¶¶185–186.

Element [1.b]: a thermally conductive plate...

The Combination renders obvious Element [1.b]. EX1003, ¶187. Comb’s platen assembly 26, with a platen plate 52 that supports a “multiple-layer” interchangeable build sheet 36 “having a top film 36a laminated on or otherwise adhered to a metallic base sheet 36b.” EX1004, 8:17–26. As shown below, base sheet 36b is thin, flexible *plate disposed adjacent to* the platen plate 52 (*build platform*). EX1004, 8:51–9:11, Figure 5; *see also* 6:17–23, 6:64–7:6, 7:29–37, 8:23–26, Figure 6. Moreover, Comb teaches that base sheet 36b (plate) is “steel,” which is *thermally conductive*. EX1004, 8:23–26; *see also* 8:27–33; EX1003, ¶187.

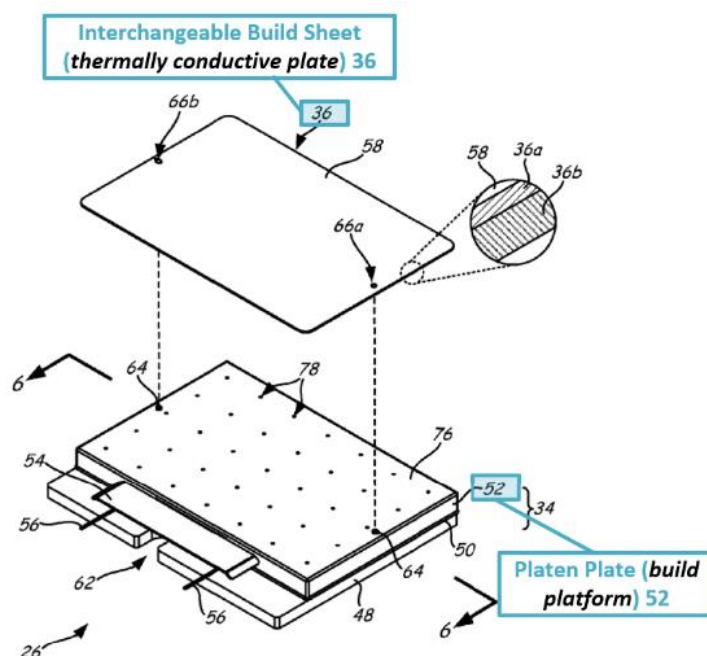


FIG. 5

EX1004, Figure 5 (annotated).

Element [1.c]: a polymer coating...

The Combination renders obvious Element [1.c]. EX1003, ¶¶188–190. The build sheet 36 includes “a top film 36a.” EX1004, 8:17–26. According to Comb, the top film 36a “may be derived from one or more **polymeric coatings**, tapes, or other lamina” and is **attached**—e.g., “adhered”—**to a top planar surface of** the base sheet 36b (**thermally conductive plate**, per Element [1.b]). EX1004, 8:27–50, Figures 5–6; *see also* 8:17–26, 13:17–24; EX1003, ¶188.

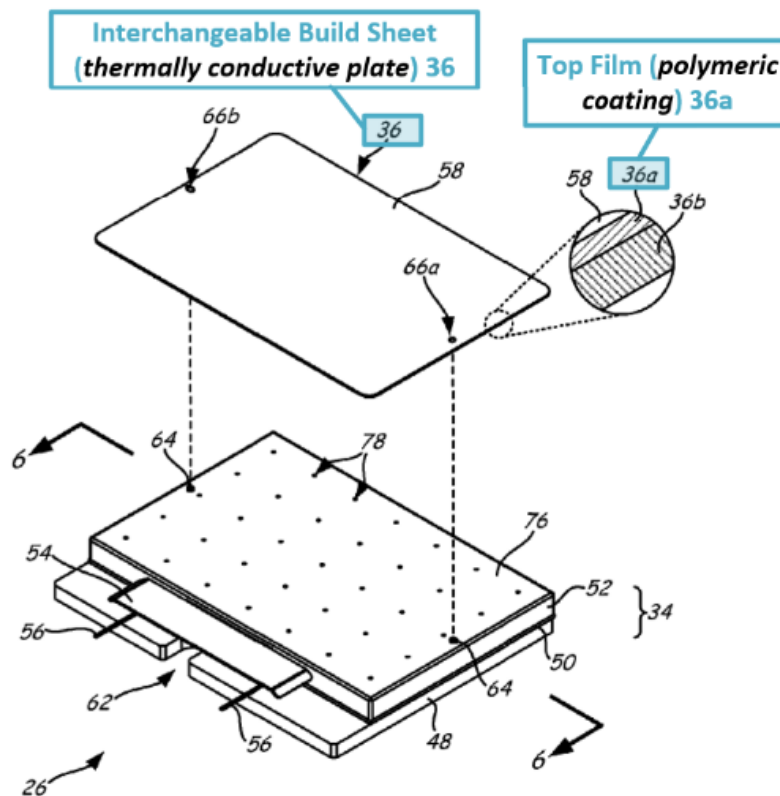


FIG. 5

EX1004, Figure 5 (annotated).

As an additional and alternative basis for finding Element [1.c] obvious, the Comb-Tummala Combination incorporates Tummala's teachings regarding the formulation of a polymer with "satisfactory bonding of the extruded print material...to the print pad during the print process yet enables the printed material to be easily separated from the print pad after the print process." EX1005, [0007]; *see supra*, §§V.D.3–4 (motivation and expectation of success). Tummala's coating includes at least one "**polymeric** component," such as "polyimide," and can be **attached** "to a...print pad **surface**" as a gel "**coating**." EX1005, [0028], [0034], [0045], [0052]; *see also* [0043], [0063]; EX1003, ¶¶189–190.

Element [1.c.i]: ...capable of (i) facilitating adhesion to the 3D object during printing...

The Combination renders obvious Element [1.c.i]. EX1003, ¶191. Per Comb, its polymer **coating is capable of facilitating** "good **adhesion to the part**...used in the system." EX1004, 8:43–50, 13:36–48; *see also supra*, Element [1.pre] (Comb's 3D "part" is a **3D object**). Additionally, and likewise discussed at Element [1.c], the Combination further incorporates Tummala's teachings regarding the formulation of a **polymeric coating** "that provides satisfactory bonding of the extruded print material [(**3D object**)]." EX1005, [0007]; *see also id.*, [0023], [0028], [0034], [0043], [0045], [0052], [0063]; *see also supra*, §§V.D.3–4 (motivation and expectation of success).

Element [1.c.ii]: (ii) permitting removal of the 3D object once the 3D object has been formed and cooled without chemically or mechanically removing the polymer coating from 3D object and without damaging the polymer coating, the thermally conductive plate, or the 3D object,

The Combination renders obvious Element [1.c.ii]. EX1003, ¶¶192–206. As discussed at Elements [1.c]–[1.c.i], the Combination includes Comb’s platen assembly 26, which features a platen plate 52 that supports a “multiple-layer” interchangeable build sheet 36 “having a top film 36a” derived from a “***polymeric coating***” that facilitates adherence to a printed ***3D object***. EX1004, 8:17–50, 13:36–48. As was also discussed, the Combination further includes Tummala’s teachings regarding the formulation of such an adhesive ***polymeric coating***. See EX1005, [0007], [0023], [0028], [0034], [0043], [0045], [0052], [0063]; *see also supra*, §§V.D.3–4 (motivation and expectation of success).

The breadth of Element [1.c.ii]’s claim language (e.g., ***capable of...***) combined with the extensive disclosures of Comb and Tummala yields multiple bases, taken individually or collectively, for finding obviousness.

First, the Combination’s inclusion of Comb’s teachings about a build sheet 36 featuring a base sheet 36b (***thermally conductive plate***, per Element [1.b]) and a top film 36a (***polymer coating***, per Element [1.c]), as supplemented by Tummala, would have rendered obvious to a POSITA the claimed ***polymer coating capabilities*** of

Element [1.c.ii]. As detailed below, Comb teaches a removal process that tracks both the '660 patent's embodiment and Patent Owner's infringement allegations.

Comb explains that “[a]fter the printing operation is completed, the build sheet 36, with the resulting 3D part 38 and support structure 40, may be removed from platen plate 52.” EX1004, 12:37–39. A POSITA would have appreciated that after “the printing operation is completed” (*3D object that has been formed*, per Element [1.pre]) at least some *cooling* has occurred and the part has hardened. EX1003, ¶193; *see also* EX1004, 8:9–16.

Comb describes how, “[a]fter removal from platen plate 52, the thin, flexible nature of build sheet 36 allows [(*permits*)] 3D part 38 [(*3D object*)] and support structure 40 to be *removed* by flexing build sheet 36.” EX1004, 12:49–51. “This flexing of the build sheet 36 amplifies the stresses induced at the bending line of action, causing delamination of 3D part 38.” EX1004, 12:51–55. A POSITA would have understood that flexing the build sheet 36 to effect *removal* via delamination shows how readily and easily the 3D part is removed from Comb's top film 36a. EX1003, ¶¶194–195. Indeed, Comb's intent was to improve upon “[e]arlier systems” that “involved prying the 3D part off with [a] crow bar-like device or chisel” or even “a band saw.” EX1004, 4:9–19.

Comb also explains that the 3D part 38 is removed “cleanly,” such that the build sheet 36 “retains its integrity” and “may be reused.” EX1004, 13:6–9. From

this, a POSITA would have understood Comb as disclosing, or found it obvious to provide, **removal** of the 3D part **without damaging** the build sheet's constituent components, including the base sheet 36b (**thermally conductive plate**, per Element [1.b]) and the top film 36a (**polymer coating**, per Element [1.c]). EX1003, ¶196. Because the top film 36a “retains its integrity” and the part is removed “cleanly,” a POSITA would understand or find it obvious to provide that none of the polymer coating remains adhered to the 3D object, meaning there is no need for **chemically or mechanically removing the polymer coating from 3D object**. EX1003, ¶197. Finally, based on Comb's description of a “clean[]” **removal** together with the ease of removal by flexing the build sheet 36, a POSITA would have understood Comb as disclosing, or found it obvious to provide, removal of the 3D part **without damaging** the 3D part 38 (**3D object**). EX1003, ¶197. Again, Comb's purpose was to avoid “solution[s] of removal...[that] could damage the 3D part or platen.” EX1004, 4:9–19.

Notably, the Examiner who allowed the '660 patent agreed Comb discloses these limitations. *See supra*, §II(B).

Tummala also shares Comb's teaching to provide print/build surface covered in a **polymer** material that “provides satisfactory bonding...yet enables the printed material to be easily separated,” a solution to known problems in the art where the user was forced to “employ a hand tool such as a scraper...which can lead to

damage.” EX1007, [0005]–[0008]; *see also* [0046], [0049]–[0050], TABLE 1. Consistent with Comb, Tummala also sought to provide an adhesive ***polymer coating*** that addressed a “need” in the art “to remove all of the extruded print material or support material of a previous print process prior to beginning a new print process” for the purpose of enabling “reusable” print pads. EX1007, EX1007, [0005]–[0008], [0045] (coating integrity preserved). So, just as the above-discussed teachings of Comb provide or render obvious the claimed coating capability of Element [1.c.ii], so too does the Comb-Tummala Combination employing Tummala’s polymer material in lieu of Comb’s. EX1003, ¶¶198–200.

Patent Owner could not credibly contest this mapping based on its infringement allegations in district court, which identify “flexing the build plate” as a technique for removing a printed 3D object from a build plate “without chemically or mechanically removing the polymer coating and without damaging the polymer coating.” EX1024, 12. Further still, “flexibility of the plate” is disclosed in the ’660 patent’s specification as a characteristic that “allows for easier dissociation between the 3D object and the removable plate” and “reduces the possibility of damage to the high temperature polymer coating [] or the 3D object.” EX1001, 5:5–8.

Second, the claimed ***polymer coating capabilities*** of Element [1.c.ii] are nothing more than a desired result of Comb’s above-discussed delamination ***removal*** process that a POSITA would have been motivated and equipped to achieve by

making the routine material-selection choice that Comb set forth. EX1003, ¶201. Comb teaches, for example, that the material of the film 36a (***polymer coating***) can be “customiz[ed]” so as “to individually tailer the adhesion and/or peeling characteristics to particular part and/or support materials.” EX1004, 13:36–48. In this way, Comb encourages the POSITA to select a coating material that optimizes delamination of the part—i.e., ***permits removal without chemically or mechanically removing the polymer coating from 3D object and without damaging the polymer coating, the thermally conductive plate, or the 3D object.*** EX1003, ¶201.

Third, Comb’s disclosure further establishes obviousness because the claimed polymer coating capabilities of Element [1.c.ii] are a “natural result” of Comb’s teachings.⁶ *Par Pharm., Inc. v. TWi Pharm., Inc.*, 773 F.3d 1186, 1195 (Fed. Cir. 2014) (“[I]nherency must be limited when applied to obviousness, and is present only when the limitation at issue is the natural result of the combination of prior art elements.” (internal quotes omitted)). Because Element [1.c.ii] speaks in an unqualified fashion to what the claimed ***polymer coating*** is merely ***capable of***, it reads on any prior art coating that would have been reasonably expected to achieve

⁶ To be clear, this third line of reasoning based on the capabilities being “natural result” is separate and distinct from the first and second analyses above based on a POSITA’s knowledge and understanding of Comb’s teachings and suggestions.

the claimed **capabilities** under some, even if not all, conditions. *See ParkerVision, Inc. v. Qualcomm Inc.*, 903 F.3d 1354, 1361 (Fed. Cir. 2018) (“[A] prior art reference may anticipate or render obvious an apparatus claim—depending on the claim language—if the reference discloses an apparatus that is reasonably capable of operating so as to meet the claim limitations, even if it does not meet the claim limitations in all modes of operation.”). Both Comb and Tummala teach such a **polymer coating**, and in fact advocate broadly for many different polymer coatings including some of the same as the ’660 patent. EX1003, ¶¶202–206; EX1001, 3:8-10; EX1004 8:27-42, 13:24; EX1005, [0028]-[0034].

As discussed, Comb teaches a build sheet 36 including a top film 36a derived from a “**polymeric coating**” and adhered directly to the top surface of a metallic base sheet 36b (**thermally conductive plate**, per Element [1.b]). EX1004, 8:17–50. Among the suitable “polymeric materials, Comb identifies “polycarbonates” and “polyimides.” EX1004, 13:21–24. The base sheet 36b and the top film 36a are thin—e.g., between 10–30 mils and 5–10 mils, respectively—to maintain “sufficient flexibility to remove 3D part 38 and support structure 40 after a printing operation is completed.” EX1004, 8:51–65.

A POSITA would have recognized that the natural result of employing such a **polymer coating** is that the coating is at least **capable of permitting removal of the 3D object once the 3D object has been formed and cooled without chemically or**

mechanically removing the polymer coating from 3D object and without damaging the polymer coating, the thermally conductive plate, or the 3D object. EX1003, ¶203. Polymer coatings were known at the time of the '660 patent in 2014 to provide these capabilities, having been described as such in the literature and even sold as commercial products. *Id.* Comb further discloses the same operative structural details—i.e., a polyimide coating applied directly to the surface of a thin and flexible metallic conductive plate—as are identified in the '660 patent's specification. EX1003, ¶¶204–206 (comparing excerpts of EX1004, 8:23–25, 12:49–51, 8:27–29 with EX1001, 3:63–66, 4:3–4, 4:30–33). *See Arbutus Biopharma Corp. v. Modernatx, Inc.*, 65 F.4th 656, 664 (Fed. Cir. 2023) (“To anticipate, the prior art need only meet the inherently disclosed limitation to the same extent as the patented invention.”); *King Pharm., Inc. v. Eon Labs., Inc.*, 616 F.3d 1267, 1276 (Fed. Cir. 2010) (affirming a district court's inherency finding where “the only steps” deemed necessary in the patent-in-suit to achieve the claimed result were “undeniably disclosed in the prior art”).

Element [1.c.iii]: ...not a polymer tape.

The Combination renders obvious Element [1.c.iii]. EX1003, ¶¶207–208. To start, the Combination includes Comb's teaching that the top film 36a “may be derived from one or more ***polymeric coatings***, tapes, or other lamina.” EX1004, 8:27–33; *see also* 8:43–50 (“The top film 36a, as an adhesive tape or other

coating...”). That Comb identifies **polymeric coatings** in a disjunctive list of alternatives including “tapes” makes clear to the POSITA coatings and tapes are distinct alternatives—i.e., **the polymer coating is not a polymer tape** (and vice versa). EX1003, ¶207.

As an additional and alternative basis for finding Element [1.c.iii] obvious, the Comb-Tummala Combination incorporates Tummala’s teachings regarding the formulation of an **adhesive polymeric coating** “that provides satisfactory bonding of the extruded print material [(3D object)].” EX1005, [0007]; *see also id.*, [0023], [0028], [0034], [0043], [0045], [0052], [0063]; *see also supra*, §§V.D.3–4 (motivation and expectation of success). As discussed at Element [1.c], Tummala teaches that the polymer coating can be applied to a print pad as a gel. EX1005, [0045], [0052]; *see also* [0063] (“The adhesive can be applied to the build surface of the print pad in such a manner as to provide a layer of adhesive” that is “substantially uniform”). As a POSITA would have understood a **polymer coating** applied as a gel is **not a polymer tape**. EX1003, ¶208.

(b) **Claim 2**

The Combination renders obvious Claim 2. EX1003, ¶¶209–210. As discussed at Elements [1.c]–[1.c.ii], the Combination includes teachings from Comb and Tummala that **the polymer coating is a polyimide**. *See* EX1004, 8:17–50, 13:17–

24 (“*polyimides*”), 13:36–48; EX1005, [0028] (“*polyimide*”), [0031], [0034] (“*polyimide*”), [0043], [0045], [0052], [0063].

(c) **Claim 3**

The Combination renders obvious Claim 3. EX1003, ¶¶211–213. As discussed at Element [1.a], a POSITA would have understood that Comb teaches, suggests, or otherwise renders obvious that heating elements 56 (*temperature control unit*) are implemented in the form of *heater cartridges*. See EX1004, 11:12–31, Figures 3, 5–8. Additionally, Comb teaches that “heating elements 56 extend through lateral openings 84,” which, as shown below, *are spaced along a side surface of* the platen plate 52 (*build platform*, per Element [1.a]). See EX1004, 11:12–31, Figure 6.

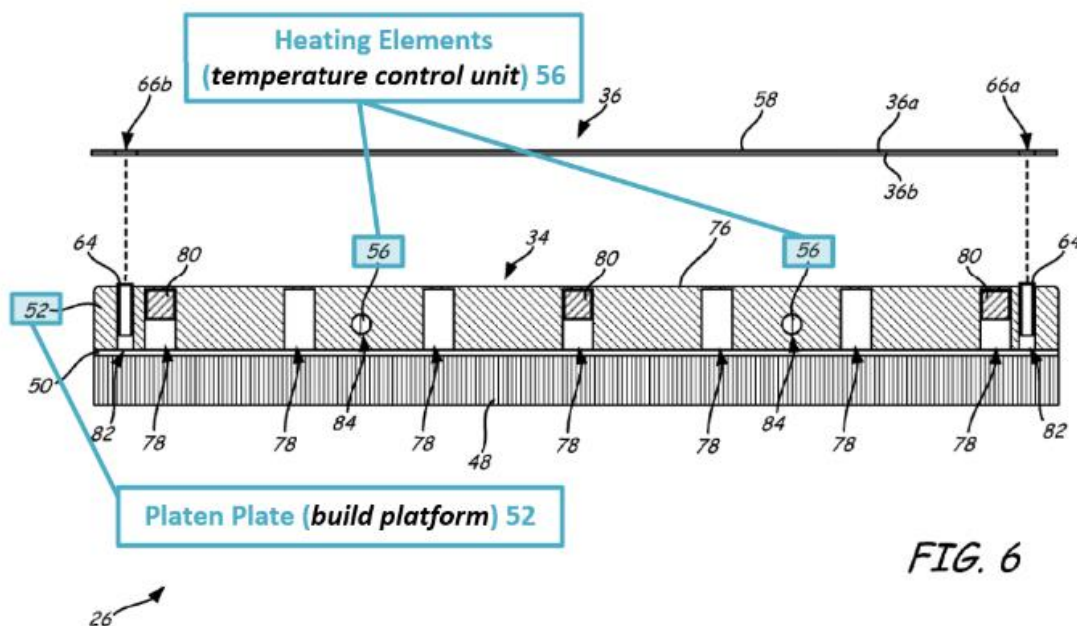


FIG. 6

EX1004, Figure 6 (annotated).

(d) **Claim 5**

The Combination renders obvious Claim 5. EX1003, ¶214. For example, the Combination includes Comb’s teaching regarding an “[i]nsulator 50” provided as “one or more liners or standoffs disposed between gantry adaptor 48 and platen plate 52.” EX1004, 7:16–28, Figure 3. As a POSITA would have known, placing an insulator between two components insulates those components from one another. EX1003, ¶214. Thus, the POSITA would have appreciated that the liner/standoff **material** of insulator 50 **insulates the** platen plate 52 (**build platform**, per Element [1.a]) with respect to the gantry adaptor 48. Additionally, Comb identifies “mica” as an exemplary material of insulator 50, which is a well-known **high-temperature dielectric**. EX1003, ¶214.

(e) **Claim 6**

The Combination renders obvious Claim 6. EX1003, ¶¶215–216. To start, the Combination includes Comb’s teachings that the platen plate 52 (**build platform**, per Element [1.a]) is “preferably fabricated from...aluminum” and the base sheet 36b (**thermally conductive plate**, per Element [1.b]) is “derived from...steel.” See EX1004, 7:29–32, 8:17–26. As a POSITA would have understood, aluminum and steel are materials **able to withstand high temperature ranging between 150 degree Celsius and 300 degree Celsius**. EX1003, ¶215. Additionally, as discussed at Element [1.c] and Claim 2, Comb and Tummala regarding a **polymer coating** made

from polyimide. See EX1004, 8:17–50, 13:17–24, 13:36–48; EX1005, [0028], [0031], [0034], [0043], [0045], [0052], [0063]. Polyimide is a material **able to withstand high temperature ranging between 150 degree Celsius and 300 degree Celsius**. EX1003, ¶216; see also EX1005, [0051]; EX1031, p.3.

(f) **Claim 7**

The Combination renders obvious Claim 7 for at least the same reasons discussed above regarding Claim 6 (explaining that Comb teaches **steel** as an exemplary **material** for the build sheet 36b (**thermally conductive plate**)). EX1003, ¶¶215–218.

(g) **Claim 8**

The Combination renders obvious Claim 8 for at least the same reasons discussed above regarding Claim 6 (explaining that Comb teaches **aluminum** as an exemplary **material** for the platen plate 52 (**build platform**)). EX1003, ¶¶215–220.

(h) **Claim 9**

The Combination renders obvious Claim 9. EX1003, ¶¶221–222. For example, Comb teaches that “[s]uitable thicknesses for base sheet 36b [(**thermally conductive plate**)] may range from about 5 mils to about 100 mils, and more preferably from about 5 mils to about 50 mils, and even more preferably from about 10 mils to about 30 mils.” EX1004, 8:51–65. The ranges Comb describes overlap the claimed range of 0.025–0.5” and, thus, create at least a presumption of

obviousness. Comb further teaches that “these thicknesses for build sheet 36b” are ***selected*** to achieve “sufficient flexibility to remove 3D part 38 and support structure 40 after a printing operation is completed.” EX1004, 8:51–65. As would have been apparent and obvious to a POSITA, the degree of flexibility for build sheet 36b (***thermally conductive plate***) depends on its dimensions—including its ***thickness***—and the ***flexural character of the material*** from which it is made. EX1003, ¶222.

(i) **Claim 10**

The Combination renders obvious Claim 10. EX1003, ¶223. For example, Comb teaches that “suitable thicknesses for top film 36a [(***polymer coating***)] may range from about 1 mil to about 30 mils, more preferably from about 5 mils to about 20 mils, and even more preferably from about 5 mils to about 10 mils,” all of which fall within the claimed range of ***0.001” to 0.1”***. *Id.*

(j) **Claim 11**

The Combination renders obvious Claim 11. EX1003, ¶224. For example, Comb teaches that the “top film 36a [(***polymer coating***)] may optionally be ***surface treated*** or otherwise conditioned ***to increase its adhesive*** properties (e.g., ***texturing***).” EX1004, 8:43–50. As would have been apparent and obvious to a POSITA, surface treating a coating to add texture involves adding ***nano-, micro-, or milli-meter scale features***. EX1003, ¶224; *see*, EX1032, 4:1-8 (micron scale texture).

(k) **Claim 12**

The Combination renders obvious Claim 12 for the same or substantially the same reasons discussed above at Element [1.c.ii] (discussing the *flexibility* of base sheet 36b (*thermally conductive plate*) in connection with Comb's part removal/delamination process). EX1003, ¶¶225–226.

(l) **Claim 13**

The Combination renders obvious Claim 13 for the same or substantially the same reasons discussed above at Element [1.a] (explaining that Comb teaches, suggests, or otherwise renders obvious that heating elements 56 (*temperature control unit*) would be implemented as *heater cartridges*). EX1003, ¶¶178–186, ¶227.

(m) **Claim 14**

The Combination renders obvious Claim 14. EX1003, ¶228. As discussed above at claims 6–8, Comb teaches that the platen plate 52 (*build platform*) can be fabricated from aluminum and the base sheet 36b (*thermally conductive plate*) can be fabricated from steel. See EX1004, 7:29–32, 8:17–26. As would have been well known to a POSITA, *the (first) coefficient of thermal expansion* of aluminum *is greater than the (second) coefficient of thermal expansion* of steel. EX1003, ¶228.

(n) **Claim 15**

The Combination renders obvious Claim 15. EX1003, ¶¶229–230. For example, although Comb’s preferred embodiments feature magnetic-based solutions for removably securing the base sheet 36b to the platen plate 52, Comb also acknowledges that it was known in the art to use materials that lack magnetic properties. Specifically, Comb discusses an analogous system that employs “[f]lexible plastic trays” and uses **non-magnetic** “snap features” to **removably secure** them “in a reasonably flat condition.” EX1004, 4:20–29. Tummala likewise discloses non-magnetic “print pad[s]” with an “aluminum print surface” or “a polycarbonate print surface.” EX1005, [0019].

A POSITA would have been motivated to pursue a predictable variation of Comb’s preferred embodiments that further include a **non-magnetic** solution—e.g., snap features—for **removably securing** the base sheet 36b (**thermally conductive plate**) to the platen plate 52 (**build platform**). EX1003, ¶230. Doing so would make the additive manufacturing system as a whole more adaptable by accommodating a broader class of base sheet materials (e.g., aluminum). *Id.*

E. GROUND 2B: Claims 1–15 Are Obvious Over Comb, Tummala, and Kritchman

Ground 2B incorporates the analysis of Ground 2A for several claim elements. Kritchman’s supplementary teachings provide an additional/alternative basis for finding Element [1.a] of Claim 1 and Claim 4 obvious.

1. Motivation to Combine and Reasonable Expectation of Success

Kritchman teaches the concept of integrating the temperature control unit as a whole into a platform (what Kritchman calls a “printing tray”). *See supra*, §V.B.1, §V.B.3.(a).Element[1.a]; EX1003, ¶¶126–127. The following reasons, taken separately or collectively, support the Comb-Tummala-Kritchman Combination.

First, a POSITA would have recognized that Kritchman’s teaching to integrate the temperature control unit into the build platform promotes a modular system design, which carries the known advantage of simplifying upgrades, replacements, and repairs. EX1003, ¶232.

Second, Kritchman’s teaching of integrating the componentry of the temperature control unit within the build platform as a modular item is one of a finite number of known solutions to practically constructing a heated build platform. EX1003, ¶233. A POSITA would have been motivated to consider this predictable design choice. *Id.* As Kritchman acknowledges, control functions can be either centralized or distributed—i.e., “spread across units.” EX1009, [0073].

Third, a POSITA would have understood the Combination would have yielded a predictable result from combining known prior art elements according to known methods. EX1003, ¶234. Each element in combination merely performs the same function as it does separately. *Id.* It would have been well within the POSITA’s level of skill to implement such a combination with a reasonable expectation of success given the relatively advanced state of the art at the time. EX1003, ¶235.

2. Claim Element Analysis

(a) Claim 1

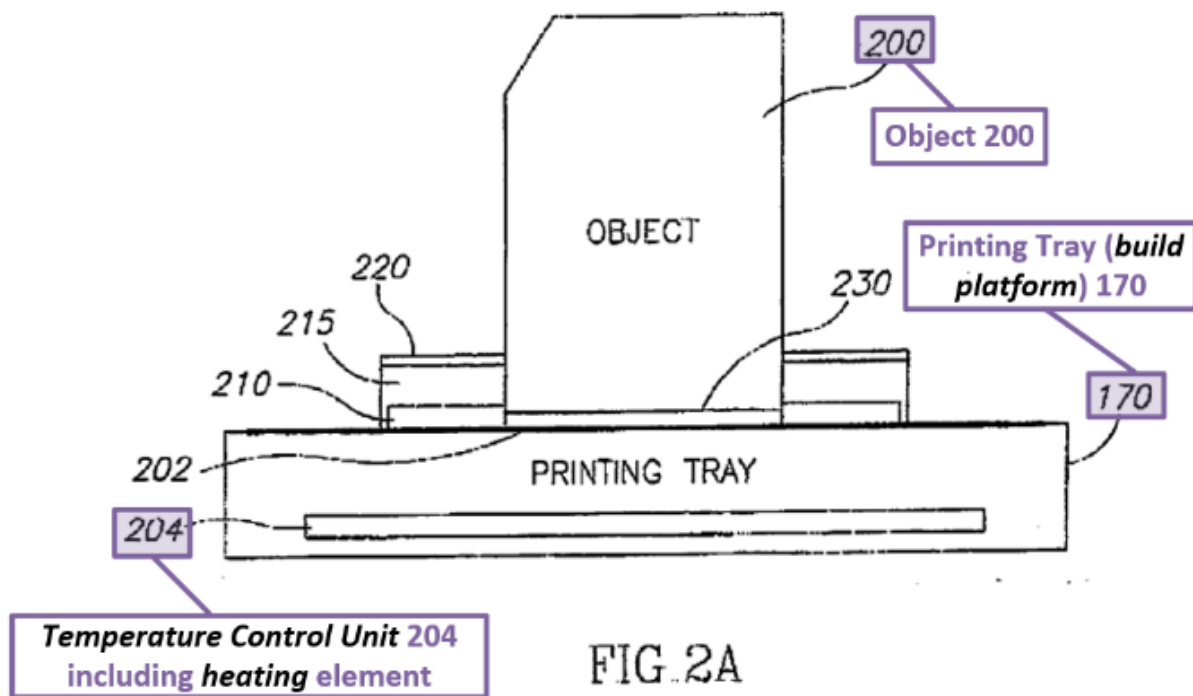
Elements [1.pre], [1.b], [1.c], [1.c.i], [1.c.ii], [1.c.iii]

The Comb-Tummala-Kritchman Combination renders obvious Elements [1.pre], [1.b], [1.c], [1.c.i], [1.c.ii], [1.c.iii] for the same reasons discussed above in Ground 2A at §V.D.5.(a); *see also*, EX1003, ¶¶236–238.

Element [1.a]

The Comb-Tummala-Kritchman Combination renders obvious Element [1.a]. EX1003, ¶¶178–186, ¶239. The Combination includes Comb’s platen assembly 26 with a platen plate 52 (**build platform**) that supports an interchangeable build sheet 36. EX1004, 6:64–7:6; *see also generally* 6:24–7:28, Figures 2–3; EX1003, ¶¶178–186, ¶239. “Platen plate 52 is a heatable platen” that receives “heating elements 56.” EX1004, 7:29–32, 8:9–16, 11:12–20, Figures 3, 5–7. The heating elements 56 **control heating of the** platen plate 52 (**build platform**) “conductively.” EX1004,

7:29–32, 8:9–16, 11:12–20. The Combination incorporates Kritchman’s teaching to “integrate[]” the componentry of a **temperature control unit within a build platform**. EX1009, [0007] (explaining that the **temperature control unit “controls the temperature”** and includes “**heating** elements and/or temperature sensors”); see also [0027], [0073], [0091]–[0096], Figures 1, 2A, 2D, cls. 133–137.



EX1009, Figure 2A.

(a) **Claims 2–3**

The Combination renders obvious Claims 2–3 for the same reasons discussed above in Ground 2A at §§V.D.5.(b)–(c). EX1003, ¶240.

(b) **Claim 4**

The Combination renders obvious Claim 4. EX1003, ¶¶241–244. Again, this Combination incorporates Kritchman’s teaching to “integrate[]” the componentry of a temperature control unit at a **location** within a **build platform** (what Kritchman calls a “printing tray”). EX1009, [0007]; *see also* [0027], [0073], [0091], [0095]–[0096], Figures 1, 2A, 2D, cls. 133–137. In addition to heating elements, Kritchman discloses “temperature sensors.” EX1009, [0007]. Kritchman further teaches a “**controller** that operates the...heating elements according to a sensor reading and required **temperature**” **set point**. EX1009, [0027]. Temperature sensors were well known in the prior art, and a POSITA would have understood that thermocouples were one of a finite number of known solutions for sensing temperature. EX1003, ¶ 244. A POSITA would have been motivated to consider thermocouples given the temperature-sensing in Kritchman. *Id.*

(c) **Claims 5–15**

The Combination renders obvious Claims 5–15 for the same reasons discussed above in Ground 2A at §§V.D.5.(d)–(n). EX1003, ¶¶214–230, ¶245.

VI. ANALYSIS ON DISCRETION

A. 35 U.S.C. §325(d)—*Advanced Bionics*

1. Part 1, *Becton Factors* (a), (b), (d)

Neither Cable nor Kritchman in Grounds 1A–1C were cited or discussed during prosecution of the '660 patent. Nor are their teachings cumulative of those addressed on the prosecution record. Although the Examiner identified Naware, he did not consider Naware in the context of Cable, an uncited reference.

Similarly for Grounds 2A–2B, the Examiner considered Comb, but not the combination of Comb and Tummala, an uncited supplemental reference that addresses the “not a polymer tape” limitation (Element [1.c.iii]) that the Examiner erroneously deemed allowable. *See* EX1002, p.49.

More, the arguments set forth in this Petition are not the same or substantially similar to those set forth in the prosecution record. Indeed, the prosecution record is sparse on the Challenged Claims, which were heavily amended by the Examiner and simply pronounced “novel” in conclusory fashion without detailing the prior art. *See* EX1002, p.49.

2. Part 2, *Becton Factors* (c), (e), (f)

As to Grounds 1A–1C, the Examiner materially erred by failing to search the prior art thoroughly, which would have led to the discovery of Cable during prosecution of the '660 patent.

As to Grounds 2A–2B, the Examiner also erred in his cursory evaluation of Comb. Although the Examiner initially relied on Comb in a rejection, he withdrew that rejection prematurely in view of an Examiner’s Amendment. Again, the Examiner simply pronounced the claims “novel” over Comb and other cited references without an analysis of Comb’s disclosure. EX1002, p.49. This material error is further underscored, not only by this Petition’s analysis in Ground 2A, which relies on passages within Comb that the Examiner plainly overlooked, but also by the Examiner’s own analysis when rejecting a similar—and largely narrower—claim during prosecution of the now-abandoned ’303 application. *See supra*, §II.B.

Deficiencies in the examination process aside, the Examiner simply did not have access to all that this Petition brings to bear. The extensive expert testimony and corroborating evidence submitted here provide key insights on the advanced state of the art at the time of the ’660 patent and a POSITA’s understanding and motivations during that time. Had the Examiner known what the Petition now proves, the Challenged Claims would not have been granted.

B. 35 U.S.C. §314(a)—*Fintiv*

The *Fintiv* precedent should not be followed here because it exceeds the Director’s authority, is arbitrary and capricious, and was adopted without notice-and-comment rulemaking. Even if considered, the factors favor institution.

The Petition is being filed before an answer has been filed in the parallel District Court action and concurrently with a Motion to Dismiss. Factor 1 is neutral since there is no evidence that, if the action is maintained and a stay is requested, the court will deny a stay. Factor 2 is neutral because any final written decision in this proceeding will issue in mid-June 2026, nearly contemporaneous with the July 1, 2026 trial date set by the District Court. EX1101. Factor 3 favors institution because there has been little investment by the court and the Markman hearing is scheduled for December 3, 2025, well after institution. EX1101. Factor 4 favors institution as Petitioner has made a stipulation not to pursue the IPR grounds in District Court. EX1100. Petitioner's Motion to Dismiss further favors institution under Factor 6, because if granted there will be no potential overlap of issues between the IPR and parallel District Court action.

VII. PAYMENT OF FEES—37 C.F.R. §42.103

Petitioner authorizes the Patent and Trademark Office to charge any fees to Deposit Account No. 06-1050.

VIII. MANDATORY NOTICES—37 C.F.R §42.8(a)(1)

A. Real Party-In-Interest—37 C.F.R. §42.8(b)(1)

In addition to Petitioner, Bambulab Limited, Shanghai Lunkuo Technology Co. Ltd., Tuozhu Technology Limited, and Bambulab USA Inc. are listed as potential real parties-in-interest.

B. Related Matters—37 C.F.R. §42.8(b)(2)

Petitioner is not aware of any disclaimers, reexamination certificates or petitions for inter partes review for the '660 patent. The '660 patent is the subject of civil action: *Stratasys, Inc. v. Shenzhen Tuozhu Technology Co. Ltd. et al*, 2-24-cv-00644 (EDTX), filed August 8, 2024.

C. Lead And Back-Up Counsel—37 C.F.R. §42.8(b)(3)

Petitioner provides the following designation of counsel.

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D. Service Information

Please address all correspondence and service to the address listed above. Petitioner consents to electronic service by email at IPR56224-0006IP1@fr.com (referencing No. 56224-0006IP1).

Respectfully submitted,

Dated: December 9, 2024

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CERTIFICATION UNDER 37 CFR §42.24

Under the provisions of 37 CFR §42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter partes* Review totals 13,918 words, which is less than the 14,000 allowed under 37 CFR §42.24.

Dated: December 9, 2024

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on December 9, 2024, a complete and entire copy of this Petition for *Inter partes* Review, Power of Attorney, and all supporting exhibits were provided via Federal Express, to the Patent Owner by serving the correspondence address of record as follows:

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