

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: William J. Swanson et al.
U.S. Patent No.: 9,421,713 Attorney Docket No.: 56224-0005IP1
Issue Date: August 23, 2016
Appl. Serial No.: 13/790,924
Filing Date: March 8, 2013
Title: ADDITIVE MANUFACTURING METHOD FOR
PRINTING THREE-DIMENSIONAL PARTS WITH
PURGE TOWERS

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**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 9,421,713 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

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EXHIBITS

EX1001	U.S. Patent No. 9,421,713 to Swanson et al. (“the ’713 Patent”)
EX1002	Excerpts from the Prosecution History of the ’713 Patent (“the Prosecution History”)
EX1003	Declaration of Dr. Michael A. Hickner
EX1004	U.S. Publication No. 2009/0035405 (“Leavitt”)
EX1005	Dual extruder PLA printing (Oct. 29, 2012), <i>available at</i> https://www.okob.net/wp/index.php/2012/10/29/dual-extruder-pla-printing/ (“RepRap Article”)
EX1006	x2 dual color print (Oct. 29, 2012), <i>available at</i> https://www.youtube.com/watch?v=ZAafPtKjZSc (“RepRap Video”)
EX1007	U.S. Publication No. 2003/0004600 (“Priedeman”)
EX1008	U.S. Publication No. 2014/0034214 (“Boyer”)
EX1009	KickStarter Campaign For Dual Extruder (2012), <i>available at</i> https://reprap.org/forum/read.php?1,137362,137887#msg-137887
EX1010	KISSlicer Quick-Start Guide (2012), <i>available at</i> https://web.archive.org/web/20121224171520/http://kisslicer.com/files/KISSlicerQuickStart.pdf#expand (“KISSlicer”)
EX1011	U.S. Patent No. 7,625,200 (“Leavitt-200”)
EX1012	U.S. Patent No. 7,604,470 (“LaBossiere”)
EX1013	Evans, <i>Practical 3D Printers, The Science And Art Of 3D Printing</i> (2012)

- EX1014 whistle_x2_body.stl (2012), *available at*
http://www.okob.net/wp/wp-uploads/2012/10/whistle_x2_body.stl
- EX1015 whistle_x2_text.stl (2012), *available at*
http://www.okob.net/wp/wp-uploads/2012/10/whistle_x2_text.stl
- EX1016 Declaration of Denis Bakin
- EX1017 Declaration of Jonathan Dummer
- EX1018 Declaration of Kathryn Talbot
- EX1019 December 17, 2024 stipulation sent by Petitioner's counsel to
Patent Owner's counsel
- EX1020 Docket Control Order (Document 34), *Stratasys, Inc. v. Shen-*
zhen Tuozhu Technology Co. Ltd. et al, 2-24-cv-00644 (EDTX)

LISTING OF CLAIMS

<u>Claim Element</u>	<u>Language</u>
[1pre]	A method for printing a three-dimensional part with an additive manufacturing system, the method comprising:
[1a]	printing layers of the three-dimensional part and of a support structure for the three-dimensional part from multiple print heads or deposition lines using a layer-based, additive manufacturing technique;
[1b]	switching the print heads or deposition line between stand-by modes and operating modes in-between the printing of the layers of the three-dimensional part and the support structure;
[1c]	performing a purge operation for each print head or deposition line switched to the operating mode, the purge operation comprising printing at least one purge tower in a layer-by-layer manner, wherein the layers of the at least one purge tower are printed from the print head or deposition line switched to the operating mode.
[2a]	The method of claim 1, wherein the multiple print heads or deposition lines comprise a first deposition line and a second deposition line, and
[2b]	wherein switching the deposition lines between the stand-by modes and the operating modes comprises: switching the first deposition line from the stand-by mode to the operating mode; and switching the second deposition line from the operating mode to the stand-by mode.
[5]	The method of claim 1, wherein the at least one purge tower has a cross-sectional area that reduces in height along an axis that is perpendicular to a build plane.
[6]	The method of claim 1, wherein the at least one purge tower is stopped at a highest layer at which there is a material change for the printed layers of the three-dimensional part and support structure.

<u>Claim Element</u>	<u>Language</u>
[7a]	The method of claim 1, and further comprising: generating tool path instructions for printing the layers of the three-dimensional part and of the support structure; and
[7b]	generating tool path instructions for printing the layer of the at least one purge tower.
[9]	The method of claim 7, wherein the generating of the tool path instructions for printing the layer of the at least one purge tower is performed prior to printing the layers of the three-dimensional part and of the support structure.
[16pre]	A method for printing a three-dimensional part with an additive manufacturing system, the method comprising:
[16a]	(a) printing a first layer of a support structure from a support material for the three-dimensional part;
[16b]	(b) printing a first layer of a purge tower from a part material;
[16c]	(c) printing a first layer of the three-dimensional part on at least a portion of the first layer of the support structure from the part material after printing the first layer of the purge tower;
[16d]	(d) printing a second layer of the purge tower from the support material; and
[16e]	(e) printing a second layer of the support structure on at least a portion of the first layer of the three-dimensional part from the support material after printing the second layer of the purge tower.
[17]	The method of claim 16, and further comprising repeating steps (b)-(e) for at least a portion of the three-dimensional part and support structure.

Petitioner Shenzhen TuoZhu Technology Co., Ltd. petitions for *Inter Partes* Review (“IPR”) of claims 1, 2, 5-7, 9, 16, and 17 (“the Challenged Claims”) of U.S. Patent No. 9,421,713 (“the ’713 Patent”).

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

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

Petitioners certify that the ’713 Patent is available for IPR, and Petitioners are not barred or estopped from requesting IPR.

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

Petitioners request IPR on grounds 1-3 listed below. An expert declaration from Dr. Michael Hickner supports each ground. *See* EX1003.

<u>Ground</u>	<u>Claims</u>	<u>Basis for Rejection</u>
1	1, 2, 5-7, 9, 16, 17	§103 – Obvious based on Leavitt (EX1004) in view of RepRap Article (EX1005) and RepRap Video (EX1006)
2A	1, 2, 6, 7, 9, 16, 17	§103 – Obvious based on Priedeman (EX1007) view of KISSlicer (EX1010)
2B	5	§103 – Obvious based on Priedeman in view of KISSlicer, RepRap Article and RepRap Video
3	1, 2, 6, 7, 9	§102 – Anticipated by Boyer (EX1008)

Grounds 1-3 rely on publications that all qualify as prior art under 35 U.S.C. §102 as shown below:

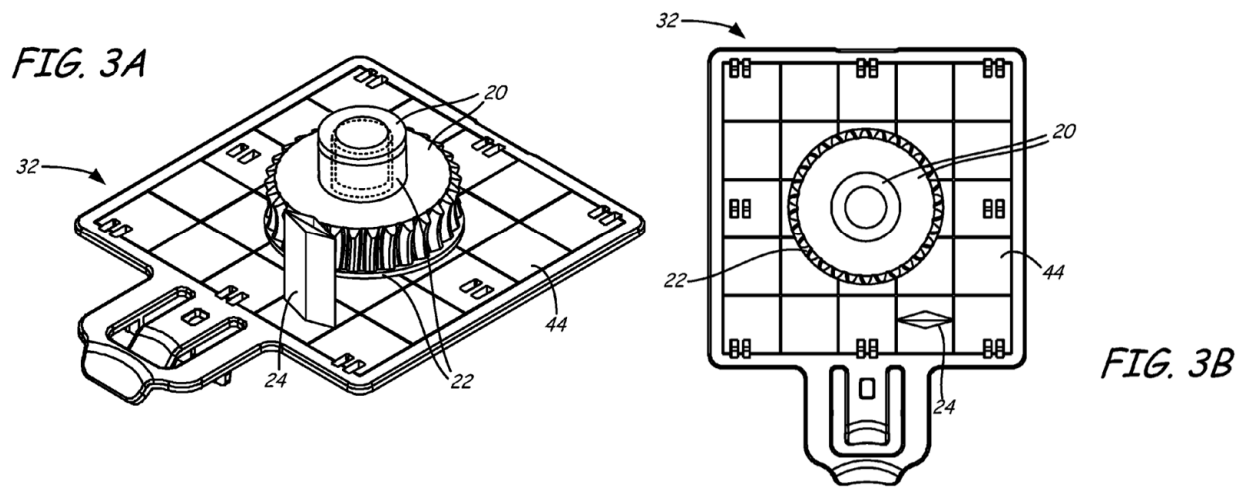
<u>Reference</u>	<u>Prior Art Status</u>
Leavitt	pre-AIA §102(b) – Published on Feb. 5, 2009
RepRap Article	pre-AIA §102(a) – Published by Oct. 29, 2012
RepRap Video	pre-AIA §102(a) – Published by Oct. 29, 2012
Priedeman	pre-AIA §102(b) – Published on Jan. 2, 2003
KISSlicer	pre-AIA §102(b) – Published by Feb. 15, 2012
Boyer	pre-AIA §102(e) – Filed on Sep. 21, 2012

Here, all but one of the prior art publications in Grounds 1-3 were published before the March 8, 2013 filing date of the '713 Patent, thereby qualifying as prior art under pre-AIA §§102(a)-(b). The only exception—Boyer—has an effective filing date prior to March 8, 2013 and qualifies as prior art under pre-AIA §102(e). This Petition is accompanied by testimony evidence confirming that the RepRap Article and the RepRap Video were published together in October 2012 and publicly accessible to interested persons in this field. EX1016, 1-2; EX1018, 1-9. Additionally, this Petition is accompanied by testimony evidence confirming that the KISSlicer Quick-Start Guide (“KISSlicer”) was published and made publicly accessible to interested persons in this field in February 2012—more than one year prior to the filing date of the '713 Patent. EX1017, 1-2.

II. SUMMARY OF THE '713 PATENT

A. Brief Description

Generally, the '713 Patent describes an “additive manufacturing system” and “method” for printing a 3D part 20 and support structure 22 using a “layer-based, additive manufacturing technique.” EX1001, 1:57-2:3, 3:41-51, 5:7-17, 5:60-67, 8:30-38, FIGS. 1, 3A-3B. The system includes multiple print heads or deposition lines for depositing layers of a “part material” to print 3D part 20 and depositing layers of a “support material” to print support structure 22. EX1001, 2:4-33, 3:41-51, 5:18-43, 8:30-38, FIGS. 1, 3A-3B.



In the preferred embodiment, each print head can toggle between an “operating mode” and a “stand-by mode.” EX1001, 1:57-2:33, 4:1-62, 7:65-8:9, 8:30-38, 10:38-51. When a particular print head or deposition line is toggled from the stand-by mode to the operating mode, the head would typically “purge” a portion of the material therein prior to depositing the next layer. EX1001, 4:39-62. The '713 Patent alleges an improvement to traditional purge operations—namely,

printing “a purge tower (or multiple towers)” directly on the build substrate
“without requiring the use of a separate purge station” within the 3D printer.

EX1001, 4:63-5:17, 8:39-53, FIGS. 3A-B, 6, 8-9.

B. Summary of the Prosecution History of the ’713 Patent

The ’713 Patent issued after a brief examination. *See* EX1002. The only Office Action included a §103 prior art rejection based on a single prior art reference. EX1002, 138-142. In response to the Office Action, Patent Owner made minor amendments to clarify that the purge tower is printed “in a layer-by-layer manner.” EX1002, 148-155. Patent Owner asserted that the prior art reference does not disclose a purge tower but instead discloses a “purge bucket” associated with the same issues remedied by the purge towers of the ’713 Patent. EX1002, 154. The Examiner allowed claims 1-20 shortly after receiving the Office Action response. EX1002, 163-165.

In the reasons for allowance, the Examiner asserted that “none of the prior art alone or in combination teach purging of one or more print heads by printing a purge tower” and “[t]he closest prior art discloses the use of wiping blades and purge buckets.” EX1002, 165. This conclusion, of course, was inaccurate. Multiple prior art publications described printing a purge tower directly on the build substrate, as demonstrated below. The ’713 Patent is ripe for review.

III. LEVEL OF ORDINARY SKILL

A person of ordinary skill in the art (“POSITA”) relating to the subject matter of the ’713 Patent would have had (1) at least a bachelor’s degree in Mechanical Engineering, Computer Engineering, Chemical Engineering, Materials Science, or a related field, and (2) at least two years of research or industry experience in 3D printing or materials used for 3D printing. EX1003, ¶14-16. Additional experience could substitute for a formal degree or formal training (and vice versa). EX1003, ¶14-16.

IV. CLAIM CONSTRUCTION

All claim terms should be construed according to the *Phillips* standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. §42.100. Except for the particular claim phrase noted below, Petitioner submits that no other claim term needs a formal construction for purposes of resolving controversies in this proceeding, especially in light of the noticeable overlap between the preferred embodiment of the ’713 Patent and the prior art/predictable combinations articulated in Grounds 1-2B. *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011); *Google Inc. v. Intellectual Ventures II LLC*, 701 Fed. Appx. 946, 956 (Fed. Cir. 2017) (“do not require construction” for purposes of “resolv[ing] the parties’ patentability arguments”); EX1003, ¶32-35.

A. printing layers “from multiple print heads or deposition lines” (claim 1)

Claim 1 requires a step of printing layers of the three-dimensional part and of a support structure “from multiple print heads or deposition lines,” which is subject to a first construction or an alternative construction. EX1003, ¶33. Under the first construction, Grounds 1-2B are applicable, and Ground 3 would be excluded from the claim scope. Under the alternative construction, all of Grounds 1-3 are applicable.

According to the first construction, the step of printing “from multiple print heads [plural] or deposition lines [plural]” requires a system having multiple deposition output ports. As explained in column 3 of the ’713 Patent, the multiple output ports were “accomplished” either in the form of multiple print heads (each having a respective output nozzle/tip for depositing material) or in the form of a single head having multiple output nozzles/tips. EX1001, 3:52-67 (“separate print heads”, or “single deposition head having multiple deposition lines for printing” like that of Leavitt-200 (EX1011) and LaBossiere (EX1012); EX1003, ¶34. This first construction is consistent with the actual text in claim 1, which requires that one “deposition line” (or a “print head”) can switch to a stand-by mode while another is switched an operating mode. EX1001, 15:49-58. Furthermore, this first construction excludes any system with a single head having a single deposition

output port (e.g., a single-extruder system), and therefore Ground 3 would be excluded from the claim scope under this first construction.

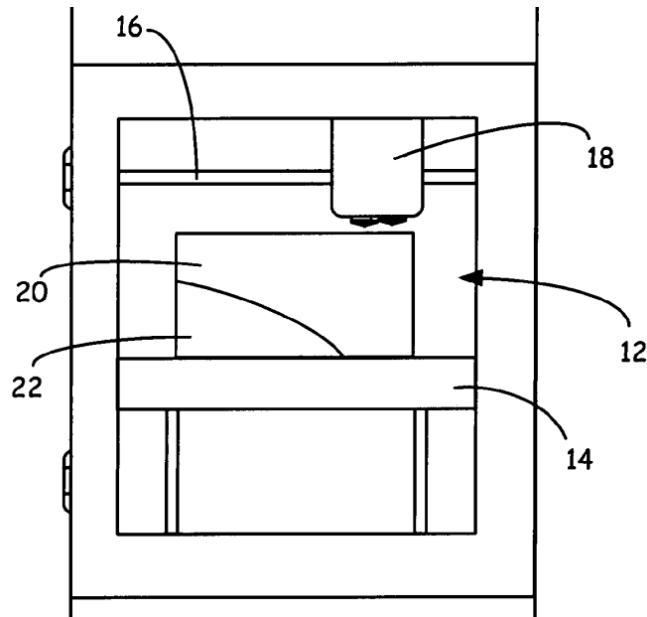
According to the alternative construction, the step of printing “from multiple print heads [plural] or deposition lines [plural]” encompasses not only the types of systems having multiple deposition output ports described above, but also a single extruder head having a single deposition output port to print different materials *at different times*. Under the alternative construction, all of Grounds 1-3 are applicable. EX1003, ¶35.

V. DETAILED EXPLANATION OF GROUNDS

A. GROUND 1: Leavitt in view of RepRap Article and RepRap Video would have rendered obvious claims 1, 2, 5-7, 9, 16, and 17

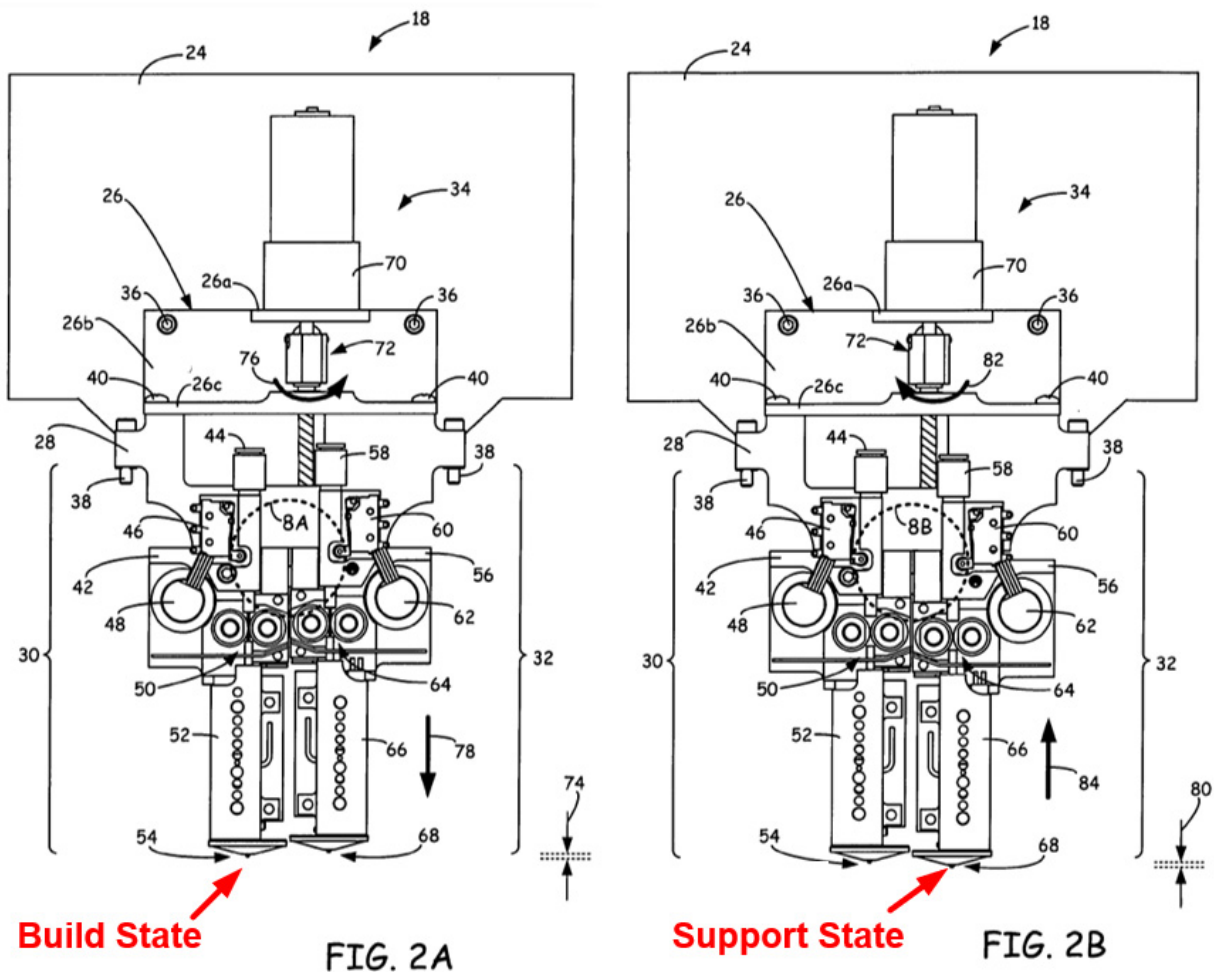
1. Leavitt

Similar to the '713 Patent, Leavitt describes a dual-extruder head 18 for printing a three-dimensional (3D) object 20 and support structure 22 on a build surface. EX1004, [0001]-[0006], [0020]-[0022], FIG. 1; EX1003, ¶36-39. The extrusion head 18 prints the 3D object 20 and support structure 22 according to a layer-by-layer additive manufacturing technique by toggling between a “build state” to deposit build material and a “support state” to deposit support material:



EX1004, [0020]-[0022], FIG. 1.

Leavitt's extrusion head 18 includes two deposition lines—a build liquefier pump 30 for extruding build material from a first nozzle and a support liquefier pump 32 for extruding support material from a second nozzle. EX1004, [0025]-[0039], FIGS. 2A-2B; EX1003, ¶37. Extrusion head 18 toggles between the build state where support liquefier pump 32 is raised above build liquefier pump 30 and the support state where support liquefier pump 32 is lowered below build liquefier pump 30. EX1004, [0029], [0031], [0034], [0035], FIGS. 2A-2B.



EX1004, FIGS. 2A-2B (annotated).

Leavitt explains that when extrusion head 18 is disposed in the build state, residual support material can “ooze” from the idle support liquefier pump 32.

EX1004, [0032]; EX1003, ¶38-39. This could potentially lead to residual support material dripping onto layers of the 3D object 20. A similar issue can arise when extrusion head 18 is disposed in the support state when residual build material drips onto layers of support structure 22. EX1004, [0035].

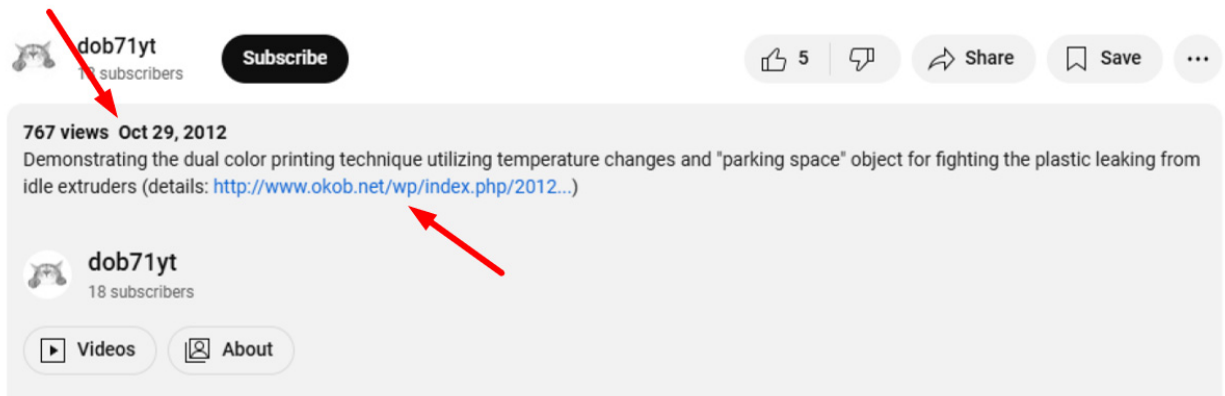
2. RepRap Article and RepRap Video

RepRap Article describes features of a dual-extruder system (the “RepRap X2” printer) for printing an object using two different materials. EX1005, 1; EX1003, ¶40-44. For example, the dual-extruder system includes an “extruder 0” that prints a part body using a first material and an “extruder 1” that prints text on the part body using a second material. EX1005, 1. When one of these extruders is active and the other is idle, the idle extruder is cooled to prevent excess molten material from leaking out of the idle extruder nozzle. EX1005, 1.

This dual-extruder system performs a purge operation every time that an extruder is switched to an operating mode. EX1003, ¶41. Specifically, RepRap Article’s system prints a purge tower—referred to as a “parking space” by the author—beside the dual color whistle. EX1005, 1. RepRap Article expressly teaches that printing the purge tower directly on the substrate serves to “prime” an idle extruder that is transitioning to an active state. EX1005, 1. Priming the extruder establishes a consistent flow and purges degraded material leftover from a previous active state. EX1005, 1.

The RepRap Article (EX1005) expressly directs the reader to the RepRap Video (EX1006) to visually demonstrate this dual-extruder system in action. EX1005, 1 (“[y]ou can see the full size video,” which “demonstrates ... the described technique”). In other words, the RepRap Article incorporates, or at least expressly suggests that the readers should view and learn from, the RepRap Video

for purposes of understanding this prior art technique for printing a purge tower adjacent to the 3D part. EX1003, ¶42. The RepRap Video is a YouTube video uploaded on the same date as RepRap Article, and this published video likewise includes a link back to the RepRap Article:



EX1018, Appendix B (annotated). Because the RepRap Article incorporates and instructs the reader to contemporaneously view the RepRap Video for the demonstrative example of what is taught in the written text, this Petition consistently cites to the respective exhibit numbers but will sometimes refer to the RepRap Article and RepRap Video collectively herein as “RepRap.” *See also, infra*, Footnote 1.

As shown in the RepRap Video, the 3D part (whistle) and the purge tower (referred to as a “parking space”) are printed on the same substrate using a layer-by-layer additive manufacturing technique. EX1006, 0:03-4:59. When printing is complete, the purge tower is located on the build substrate next to the 3D part,

where the purge tower includes layers of the first material (transparent) and second material (orange):



EX1006, 5:04.

3. *The Leavitt-RepRap Combination*

A POSITA would have been motivated to implement Leavitt's system to print a purge tower directly on the substrate in a layer-by-layer manner (as suggested by RepRap Article and RepRap Video) for purposes of achieving known benefits articulated below. EX1003, ¶52-57. In doing so, the predictable combination would have advantageously allowed Leavitt's extruder head "prime" some material out of the nozzle (including any oozed or inconsistently heated material at the tip) in a nearby but safe position on the substrate spaced from the 3D part. EX1003, ¶52 (citing to EX1005, 1). Multiple reasons would have motivated a POSITA to do so.

First, a POSITA would have been prompted to implement Leavitt's system with the purge tower suggestion of RepRap because doing so would result in

Leavitt's deposition lines 30 and 32 advantageously "priming" their nozzles before printing the layers of 3D object 20 and support structure 22. EX1005, 1 (establishing a "consistent flow of plastic"); EX1003, ¶53. Based on Leavitt's teaching, it was clear that the material at the nozzle tip of the idle liquefier pump would have an inconsistent texture (especially if a portion slightly oozed, [0032] ("may potentially ooze")), and a POSITA would have recognized from each of RepRap Article and RepRap Video that the "priming" of such material into the suggested purge tower would have advantageously avoided uneven deposition or defects imposed upon the 3D part. EX1003, ¶53.

Second, printing a purge tower on the build substrate next to the 3D part (as suggested by RepRap) would have beneficially allowed Leavitt's extruder head to prime such material and prepare the deposition line for operating mode in a prompt and efficient manner and with limited additional movement. EX1003, ¶54. Because the suggested purge tower is close to the 3D part on the build substrate, Leavitt's extrusion head 18 would not need to travel as far to perform the purge operation, thereby providing a time savings as compared to other purging procedures involving, for example, a purge bucket located outside the periphery of the build substrate. EX1003, ¶54.

Third, a POSITA would have understood that implementing Leavitt's system with RepRap Article's suggestion to lower the temperature of an idle

extruder would provide an improved approach for preventing the idle extruder from leaking oozed material while positioned over the 3D part. EX1003, ¶55. For example, a POSITA would have recognized that cooling Leavitt's deposition line 32 switched into the stand-by mode while deposition line 30 occupies the operating mode and extrusion head 18 is positioned above the 3D part would have advantageously decreased the likelihood of deposition line 32 dripping any oozed material along the 3D part. EX1003, ¶55; EX1004, [0032].

Fourth, a POSITA would have applied RepRap Video's teaching to print a purge tower on the substrate to Leavitt's system for using extruder head 18 to print a three-dimensional part and a support structure on a substrate because doing so would provide an efficient way to concentrate waste material for rapid disposal in the compact purge tower. EX1003, ¶56. Because RepRap's purge tower can be the same size or smaller than the 3D object, RepRap discloses a way to gather waste material in one place on the substrate so that the waste material can be rapidly collected (for disposal) when the 3D part is collected too. EX1003, ¶56.¹

¹ As noted above, the RepRap Article incorporates and directly links to the RepRap Video, and vice versa. EX1005, 1; EX1018, Appendix B. To the extent Patent

Finally, Leavitt, RepRap Article, and RepRap Video are directed to 3D printer systems that use additive manufacturing techniques to print objects using multiple materials. EX1003, ¶57. In this context, a POSITA would have possessed ample skill to successfully implement the combination as described above. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) (“when a patent ‘simply arranges old elements with each performing the same function it had been known to perform and yields no more than one would expect from such an arrangement, the combination is obvious”). Based upon the predictable mechanical components and software involved in the combination and the state of the art at the time, a

Owner contends that these are two unrelated publications, the evidence here confirms that a POSITA would have been motivated to consider one in view of the other (and in view of Leavitt’s dual-extruder teaching), especially because the RepRap Article expressly suggests the reader should view the RepRap Video to see the improved dual-extruder technique in action. EX1005, 1 (“[y]ou can see the full size video”); EX1003, ¶56. A POSITA was not a rigid automaton, and instead would have recognized the mutual links and context from these teachings in RepRap Article and RepRap Video. *Intel Corp. v. PACT XPP Schweiz AG*, 61 F. 4th 1373, 1379-80 (Fed. Cir. 2023) (“a person of ordinary creativity, not an automaton”).

POSITA would have reasonably expected success achieving the combination before the '713 Patent. EX1003, ¶57.

4. *Application to Challenged Claims*

Element [1pre]

Even if the preamble is treated as a limitation (which Petitioners do not concede), the Leavitt-RepRap combination provides the recited features. EX1003, ¶58-61. For example, Leavitt discloses an “extrusion-based layered deposition system” (system 10) which represents an ***additive manufacturing system***. EX1004, [0001], [0006], [0020], [0022] FIG. 1. System 10 ***prints a three dimensional part*** (e.g., 3D object 20) on a substrate. EX1004, [0020]-[0024], FIG. 1. Leavitt describes aspects of a “process”—a ***method***—for printing the ***three-dimensional part***. EX1004, [0002], [0004], [0023].

Element [1a]

As described above in connection with Element [1pre], *supra*, Leavitt’s system 10 ***prints a three-dimensional part*** (e.g., 3D object 20). EX1004, [0020]-[0024], FIG. 1. System 10 also ***prints a support structure*** 22 for 3D object 20. EX1004, [0020]-[0024], FIG. 1; EX1003, ¶62-66. ***Layers*** of 3D object 20 and support structure 22 are printed using an extrusion head 18. EX1004, [0004], [0020], [0023]. Leavitt discloses that “[e]xtrusion head 18 is a dual-tip extrusion head...for building 3D object 20 and support structure 22 on substrate 14 in a

layer-by-layer manner.” EX1004, [0020], *see also* [0023]. Extrusion head 18, 3D object 20, and support structure 22 are depicted below in FIG. 1:

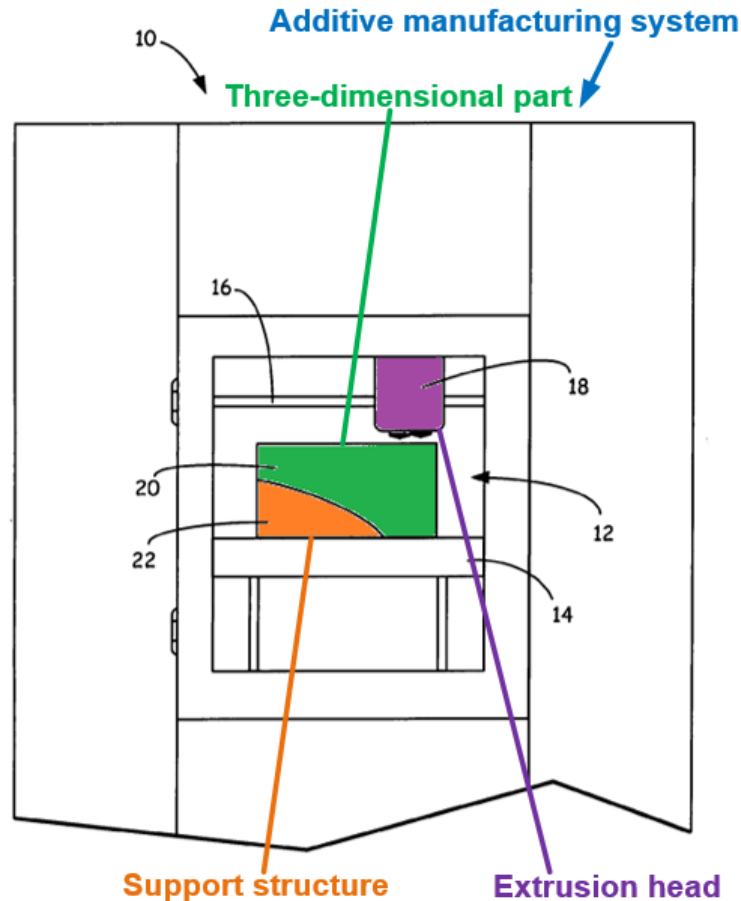
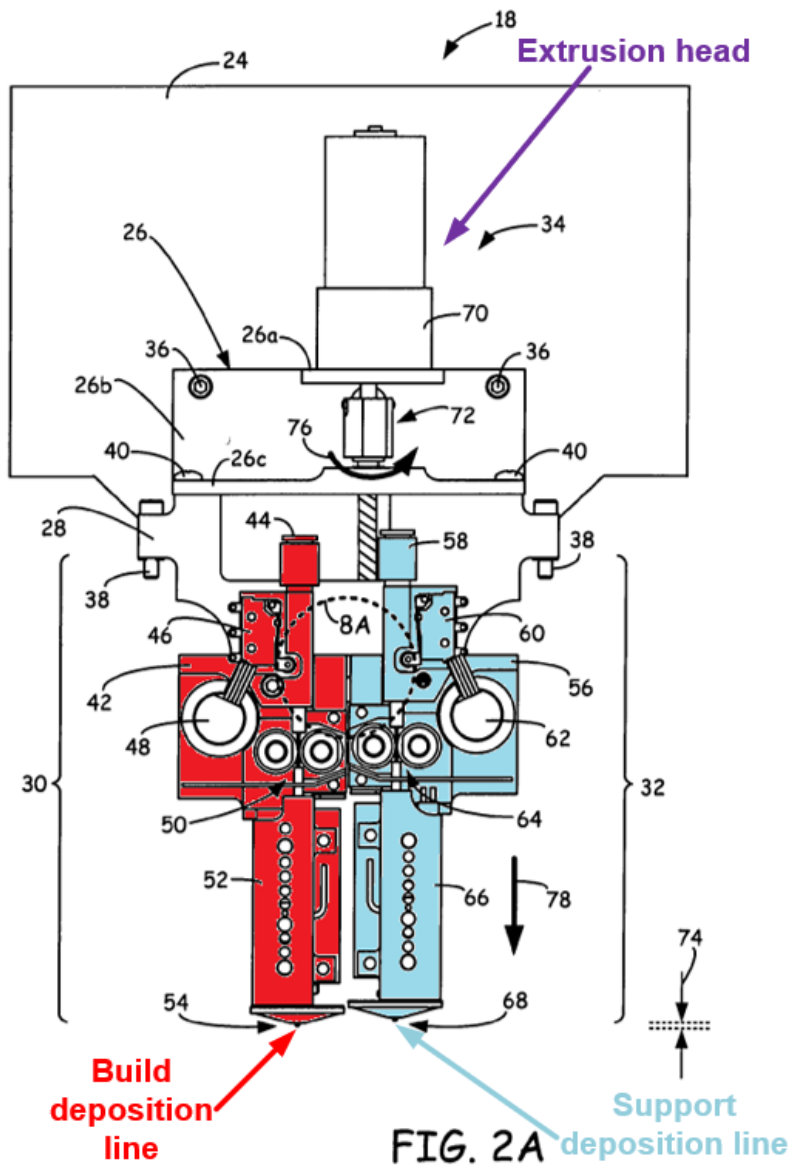


FIG. 1

EX1004, FIG. 1 (annotated).

Extrusion head 18 comprises *multiple deposition lines*—namely a “build” *deposition line* including a first output nozzle from build liquefier pump 30 (for printing 3D part 20) and a “support” *deposition line* including a second output nozzle from support liquefier pump 32 (for printing support structure 22). EX1004.

[0020]-[0023], [0025]-[0032], [0033] (“is then *deposited*”), [0037] (“is then *deposited*”), FIGS. 1-2B; EX1003, ¶63. Leavitt’s *multiple deposition lines* are depicted below in FIG. 2A:



EX1004, FIG. 2A (annotated).

The build ***deposition line*** of build liquefier pump 30 includes filament inlet 44, motor 48, drive wheel assembly 50, liquefier 52, and build tip 54. EX1004, [0027], FIGS. 2A-2B. To ***print*** the ***three-dimensional part*** (e.g., 3D object 20), motor 48 powers drive wheel assembly 50 to feed a build material filament through filament inlet 44 to liquefier 52. EX1004, [0028], FIGS. 2A-2B. Liquefier 52 melts the build material filament so that molten build material is extruded from build tip 54 to ***print layers*** of 3D object 20. EX1004, [0028], FIGS. 2A-2B; EX1003, ¶64.

The support ***deposition line*** of support liquefier pump 32 includes filament inlet 58, motor 62, drive wheel assembly 64, liquefier 66, and support tip 68. EX1004, [0029], FIGS. 2A-2B. To ***print*** the ***support structure*** 22, motor 62 powers drive wheel assembly 64 to feed a support material filament through filament inlet 58 to liquefier 66. EX1004, [0030], FIGS. 2A-2B. Liquefier 66 melts the support material filament so that molten support material is extruded from support tip 68 to ***print layers*** of support structure 22. EX1004, [0028], FIGS. 2A-2B; EX1003, ¶65.

Element [1b]

Leavitt's extrusion head 18 is configured to ***switch*** ("toggle") between a "build state" for depositing a build material to print the ***three-dimensional part*** (e.g., 3D object 20) and a "support state" for depositing a support material to print ***support structure*** 22. EX1004, [0022]-[0024], FIG. 1; EX1003, ¶67-76. Toggling

between the build state and the support state occurs *in-between* printing *layers* of the *three-dimensional part* (3D object 20) and the *support structure* 22. *Id.*

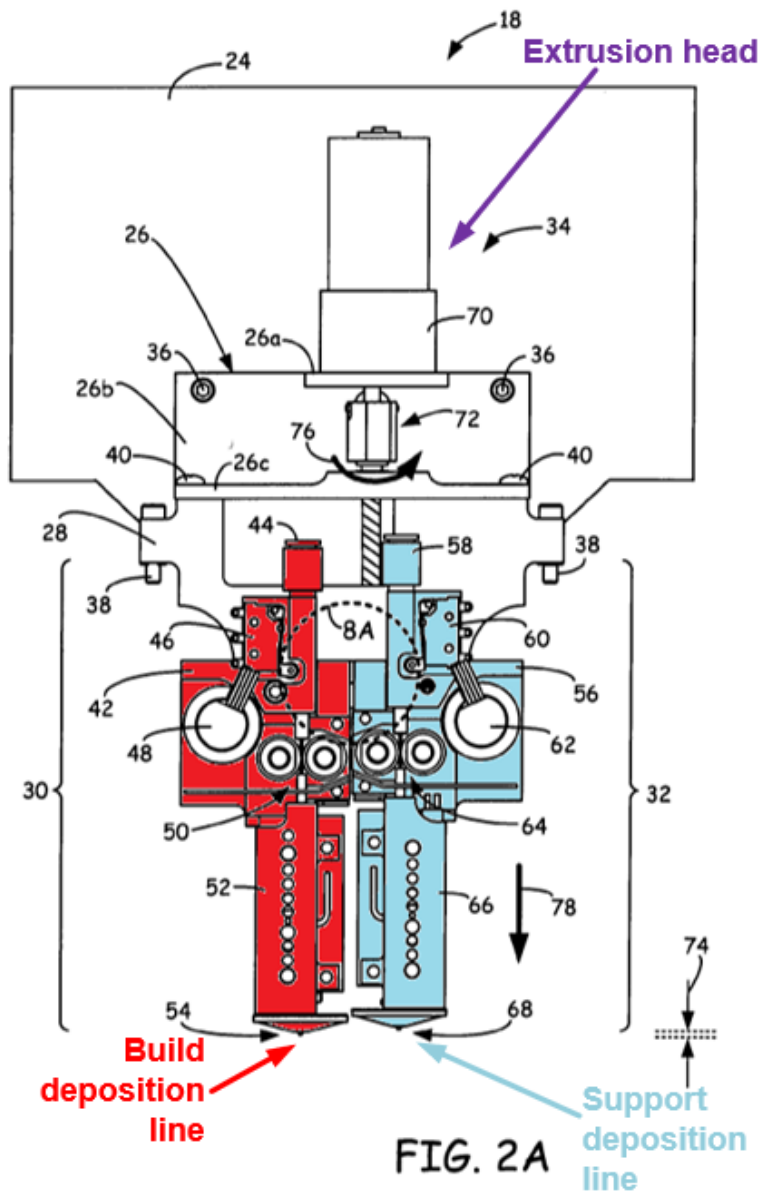
For example, Leavitt explains that “extrusion head 18 is initially positioned in the build state,² which allows extrusion head 18 to deposit the build material...to form a *layer* of 3D object 20.” EX1004, [0023]; EX1003, ¶68. After printing the *layer* of 3D object 20, “extrusion head 18 then toggles to the support state, which allows extrusion head 18 to deposit the support material...to form a *layer* of support structure 22.” EX1004, [0023]; EX1003, ¶68. Extrusion head 18 toggles back to the build state “[a]fter the layer of support structure 22 is complete” in order to print “a *subsequent layer* of 3D object 20.” EX1004, [0023]; EX1003, ¶69. Leavitt’s process of *switching* (“toggling”) between the build state and the support state “may be repeated until each layer of 3D object 20 and support structure 22 are complete.” EX1004, [0023], *see also* [0024] (“extrusion head 18 toggles...numerous times”); EX1003, ¶69.

² Extruder head 18 is not limited to initially being positioned in the build state.

Leavitt explains that extruder head 18 is initially positioned in the support state to print a layer of support structure 22, subsequently toggling to the build state to print a layer of 3D object 20. EX1004, [0023]; EX1003, ¶68.

This indicates that Leavitt's extrusion head 18 toggles *in-between* printing a layer of the 3D object 20 and printing a layer of support structure 22. EX1004, [0023], [0024]; EX1003, ¶70. Leavitt explains that toggling extrusion head 18 between the build state and the support state involves adjusting a relative position of support liquefier pump 32 and build liquefier pump 30 so that the pump actively extruding material is closer to the build surface than the idle pump. EX1004, [0025]-[0039], FIGS. 2A-2B.

Leavitt's extrusion head 18 includes *multiple deposition lines*. EX1004, [0025]-[0039], FIGS. 2A-2B; EX1003, ¶71; *supra*, Element [1a]. A build *deposition line* corresponding to build liquefier pump 30 can *switch* between an *operating mode* for depositing molten *build material* and a *stand-by mode* where build liquefier pump 30 sits idle. EX1004, [0032]-[0038], FIGS. 2A-2B. When build liquefier pump 30 is in the *operating mode*, support liquefier pump 32 is in a raised position so that support tip 68 is higher than build tip 54 by an offset distance 74. EX1004, [0032]. Leavitt's FIG. 2A, depicting extrusion head 18 in the "build state" and build liquefier pump 30 in the *operating mode*, is reproduced below:

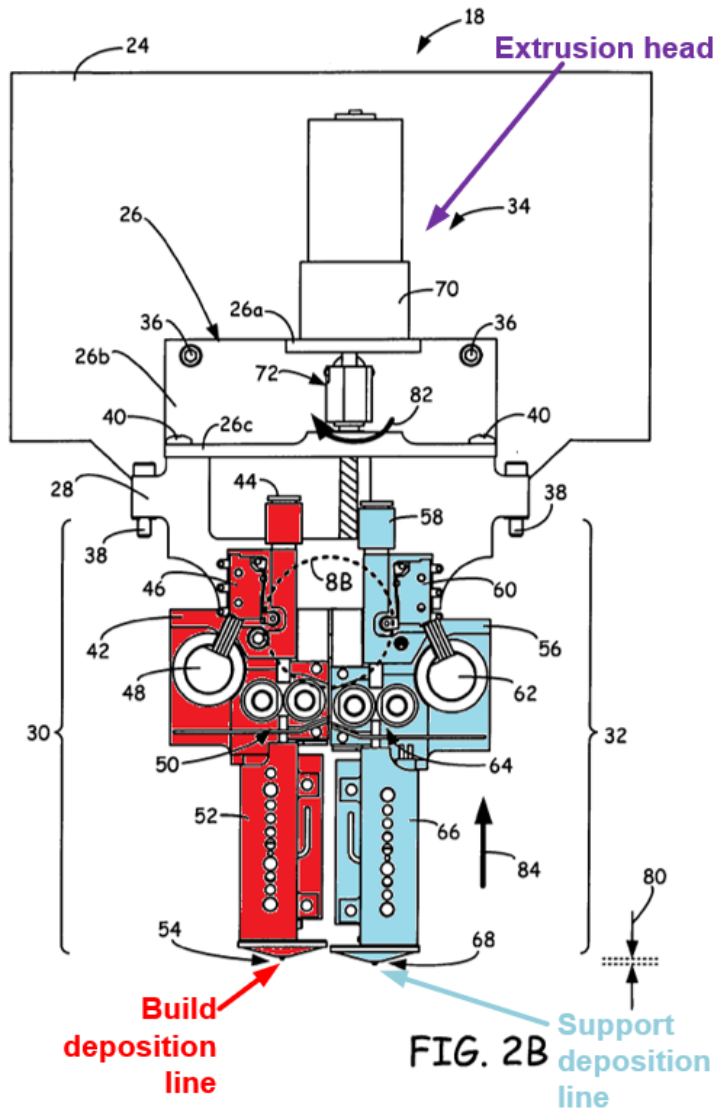


EX1004, FIG. 2A (annotated).

When build liquefier pump 30 is in the *operating mode* to “extrude roads of build material” as depicted above in FIG. 2A, the support *deposition line* (e.g., support liquefier pump 32) is sitting idle in the *stand-by mode*. EX1004, [0032]; EX1003, ¶71. After printing a layer of the 3D object 76, a toggle motor of the

extrusion head 18 causes support liquefier pump 32 transition to a lowered position where the support tip 68 extends below the build tip 54 by an offset distance.

EX1004, [0034]-[0035]. This position of extruder 18, referred to as the “support state,” is depicted below in FIG. 2B:



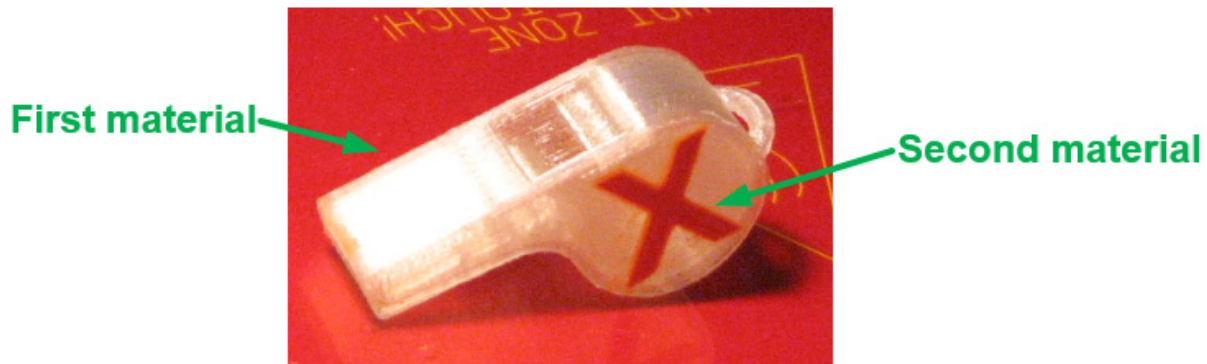
EX1004, FIG. 2B (annotated).

Transitioning the extrusion head 18 from the build state depicted in FIG. 2A to the support state depicted in FIG. 2A involves switching the support liquefier pump 32 from the *stand-by mode* to the *operating mode* and *switching* the build liquefier pump 30 from the *operating mode* to the *stand-by mode*. EX1004, [0034]-[0038], FIGS. 2A-2B; EX1003, ¶73. This allows support liquefier pump 32 to extrude roads of support material to *print a layer* of support structure 22 while build liquefier pump 30 sits idle. EX1004, [0035]. After this *layer* of support structure 22 is complete, the toggle motor of the extrusion head 18 causes the extrusion head 18 to transition from the support state back to the build state to *print* another *layer* of 3D object 20. EX1004, [0035]. In the predictable Leavitt-RepRap combination, extrusion head 18 would cool the idle *deposition line* and heat the active *deposition line*, further indicating that the *deposition lines* switch between an operating mode and stand-by mode. EX1005, 1; *supra*, §V.A.3.

Element [1c]

Leavitt explains that transitioning the *deposition lines* between actively extruding material and sitting idle presents an issue where excess material can leak from the idle *deposition line* and mix with material recently printed by the active *deposition line*. EX1004, [0032], [0035]; EX1003, ¶77. As discussed in §V.A.3, *supra*, RepRap discloses that, a *purge operation* is performed for *each deposition line* switched to the *operating mode*. EX1003, ¶78. RepRap Article, for example,

describes a 3D printer comprising *multiple deposition lines* each depositing a different material—including an “extruder 0” that deposits one material and an “extruder 1” that deposits another material. EX1005, 1. RepRap Article’s extruders are configured to print a 3D part by depositing both of these materials using a *layer-by-layer* technique where the printer alternates between depositing one material using “extruder 0” and depositing the other material using “extruder 1.” EX1005, 1. One example of an object that can be printed by RepRap Article’s extruders using two different materials is a 3D part (whistle), as depicted below:



EX1005, 1 (annotated).

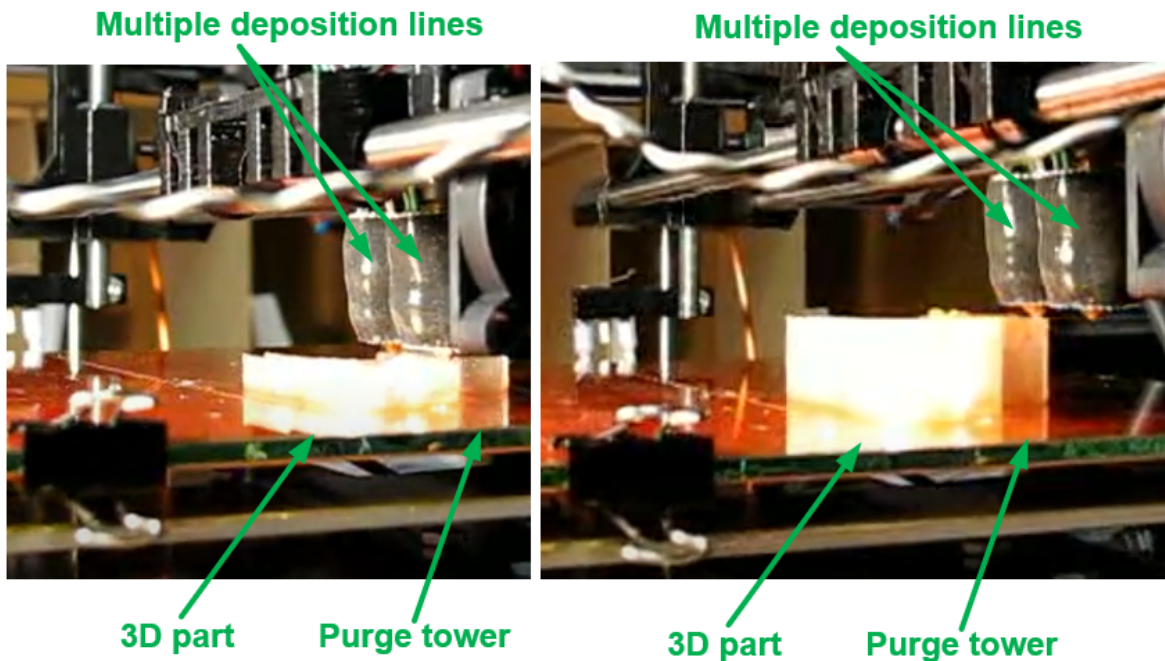
When an extruder of RepRap Article is idle, the temperature of the extruder is lowered to prevent leaking. EX1005, 1. RepRap Article explains that this leaking issue is “[o]ne of the most annoying problems with [] dual extruder printing.” EX1005, 1. By moving the extruder head over the purge tower (away from the 3D part) and lowering the temperature within an idle extruder, RepRap Article addresses a problem that Leavitt expressly acknowledges—residual material

oozing from the nozzle of an idle liquefier pump. EX1004, [0032], EX1005, 1; EX1003, ¶79.

When one of the extruders *switches* to an *operating mode* from the idle *stand-by mode*, that extruder performs a *purge operation* by printing the purge tower to establish “consistent flow” of material within the extruder before printing the 3D object. EX1005, 1. At the same time, the other (idle) extruder is also positioned over the purge tower and is cooled to prevent leaking. EX1005, 1 (“positions the nozzles above the ‘parking space’ object and change the active extruder while lowering the temperature of the idle”); EX1003, ¶80. RepRap’s extruders print a purge tower next to the 3D object on the build plane. EX1005, 1. Specifically, “extruder 0” *performs a purge operation* upon switching to the *operating mode* by printing at least one layer of the purge tower prior to printing the 3D object. EX1005, 1. The “extruder 1” performs a similar *purge operation* upon switching to the *operating mode*. EX1005, 1.

RepRap Video (incorporated and linked within in RepRap Article) depicts a printer including *multiple deposition lines* (e.g., “extruder 0” and “extruder 1”) simultaneously printing the 3D object and the purge tower using an *additive manufacturing technique*. EX1006, 0:03-4:59. A POSITA would have readily recognized that the 3D object and the purge tower are each printed in a *layer-by-layer manner* because RepRap Video depicts the extruders depositing layers of

material so that the 3D object and the purge tower are gradually built upwards from the print surface; EX1006, 0:03-4:59; EX1003, ¶81. The extruders, 3D object, and purge tower are depicted below at two different points in the printing process depicted by RepRap Video:



EX1006, 3:22, 4:36 (annotated).

RepRap's *purge tower* is printed in a *layer-by-layer manner* through *purge operations* occurring when one of the extruders is switched to the *operating mode*. EX1003, ¶82. RepRap Video depicts the completed 3D part and purge tower next to each other on the build substrate:



EX1006, 5:04 (annotated).

In the Leavitt-RepRap combination, Leavitt's extruder head 18 would predictably perform a *purge operation* between each use of build liquefier pump 30 and support liquefier pump 32 (as suggested by RepRap). *Supra*, §V.A.3. This *purge operation* would involve printing a *purge tower* in a *layer-by-layer manner* with build liquefier pump 30 and support liquefier pump 32 printing at least one layer of the *purge tower* in response to switching from a *stand-by mode* to an *operating mode*, as taught by RepRap. EX1003, ¶76-84, *supra*, §V.A.3.

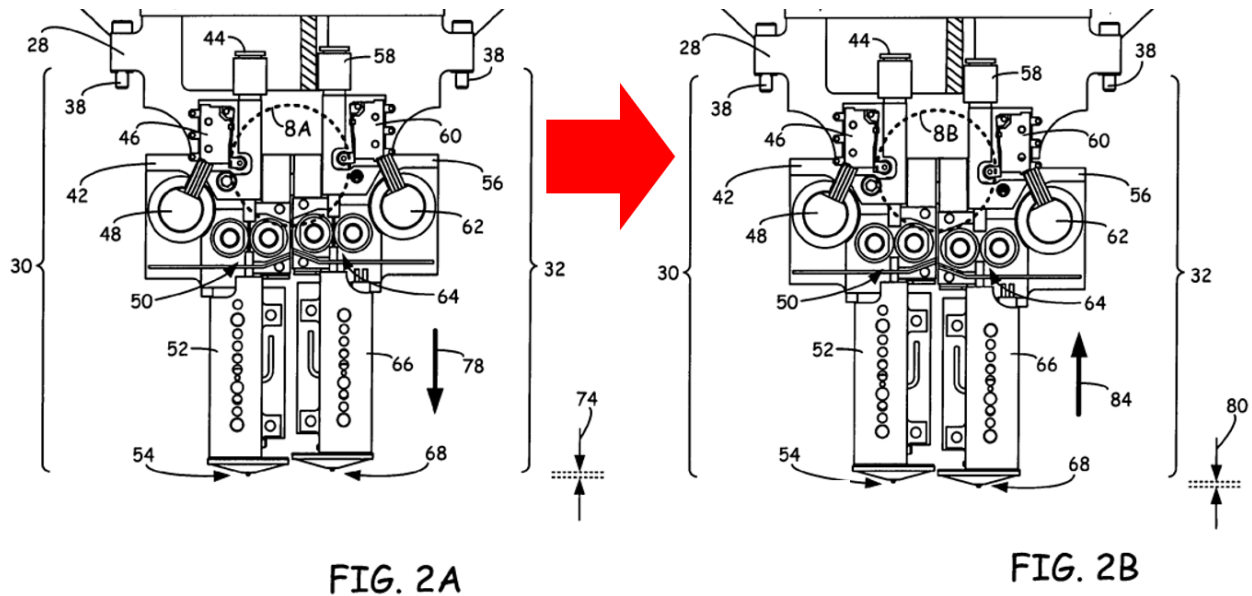
Element [2a]

Leavitt's *multiple deposition lines* include a build liquefier pump 30 representing a *first deposition line* and a support liquefier pump 32 representing a *second deposition line*. EX1004, [0025]-[0032], FIGS. 2A-2B; EX1003, ¶85-88; *supra*, Element [1a].

Element [2b]

When extrusion head 18 occupies the “build state,” build liquefier pump 30 occupies the *operating mode* for extruding build material and support liquefier pump 32 sits idle in the *stand-by* mode. EX1004, [0025]-[0039], FIG. 2A; EX1003, ¶89; *supra*, Element [1b]. When extrusion head 18 occupies the “support state,” support liquefier pump 32 occupies the *operating mode* for extruding build material, and build liquefier pump 30 sits idle in the *stand-by* mode. EX1004, [0025]-[0039], FIG. 2B; EX1003, ¶89; *supra*, Element [1b].

Switching Leavitt’s *multiple deposition lines* between the *stand-by modes* and *operating modes* comprises toggling extrusion head 18 between the build state and the support state. EX1003, ¶90. For example, when extrusion head 18 toggles from the build state to the support state, the support liquefier pump 32 moves downward in the direction of arrow 78 from a raised position depicted in FIG. 2A to a lowered position depicted in FIG. 2B. EX1004, [0032], [0034], FIGS. 2A-2B.



EX1004, FIGS. 2A-2B (annotated).

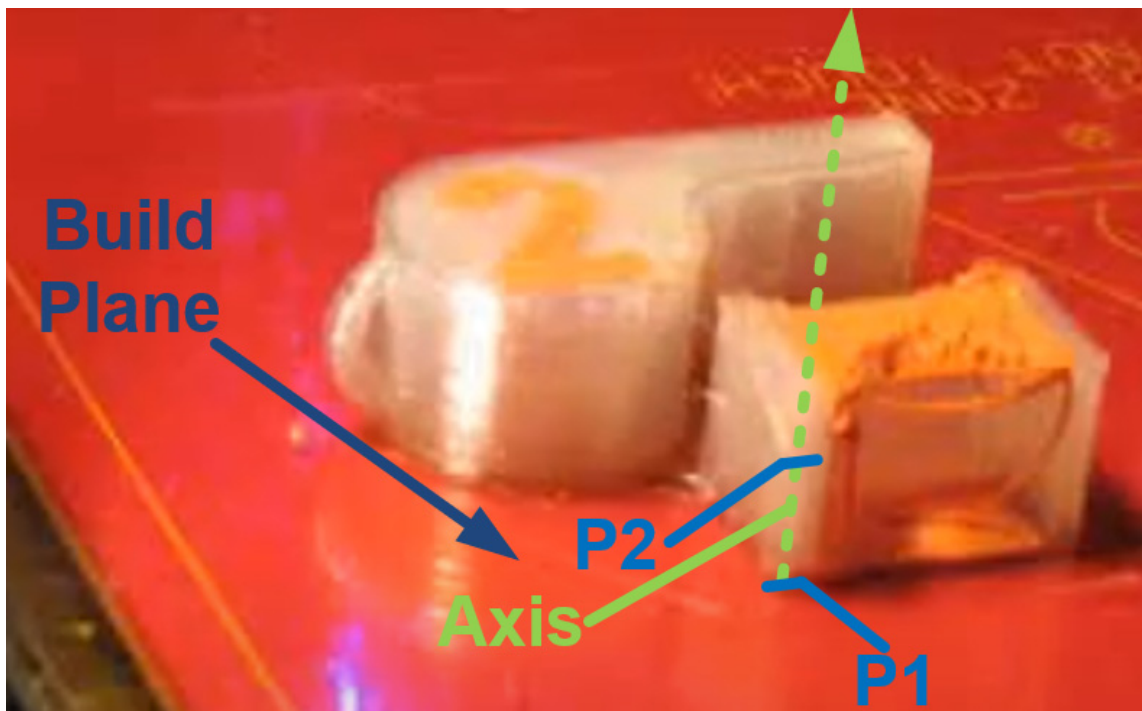
In the predictable Leavitt-RepRap combination, extrusion head 18 would cool the idle deposition line when transitioning to stand-by mode and heat the active deposition line when transitioning to operating mode per RepRap's teaching. EX1005, 1; *supra*, §V.A.3; EX1003, ¶91.

When extrusion head 18 occupies the build state, build liquefier pump 30 is in the *operating mode* to “extrude roads of build material” and support liquefier pump 32 is in the *stand-by mode*. EX1004, [0032], [0033], FIG. 2A. When extrusion head 18 occupies the support state, build liquefier pump 30 is in the *stand-by mode* and support liquefier pump 32 is in the *operating mode* to “extrude roads of support material.” EX1004, [0035]-[0037], FIG. 2B. Consequently, when the extrusion head 18 toggles from the build state to the support state, the *first*

(support) *deposition line* switches from the *stand-by mode* to the *operating mode* and the *second* (build) *deposition line* switches from the *operating mode* to the *stand-by mode*. EX1003, ¶89-93.

Claim [5]

RepRap teaches that the *purge tower* printed next to a three-dimensional part has a *cross-sectional area* that reduces in height along an *axis* that is perpendicular to a *build plane* defined by the substrate. EX1005, 1; EX1006, 5:01-5:05; EX1003, ¶94-97. For example, RepRap's *purge tower* has cross-sectional areas that differ between a first cross-sectional position (P1) at a base of the purge tower and a second cross-sectional position (P2) above P1 relative to the build plane:



EX1006, 5:04 (annotated).

As depicted above, the cross-sectional area of the purge tower at position P1 is greater than the cross-sectional area of the purge tower at position P2. EX1006, 5:04. This is because the cross-sectional area at position P1 includes a wide layer of orange material that fills most of the outer boundary of the purge tower. EX1003, ¶96. Much of the area where orange material is located in the P1 cross-section does not include such material in the P2 cross-section. EX1003, ¶96. Consequently, the cross-sectional area of the purge tower reduces in height along the axis perpendicular to the build plane from P1 to P2. EX1003, ¶96.

Claim [6]

In the predictable Leavitt-RepRap combination, extrusion head 18 would *stop* printing a *purge tower* at a *highest layer* at which there is a *material change* for the printed layers of the *three-dimensional part* (e.g., 3D object 20) and *support structure* 22. EX1004, [0022]-[0039], FIGS. 1-2B, EX1005, 1; EX1006, 0:01-5:15; EX1003, ¶98-102. For example, RepRap provides that when an extruder transitions out of an idle state upon a *material change*, the extruder prints a portion of a *purge tower* beside the three-dimensional part “before printing the actual object.” EX1005, 1; EX1003, ¶99. In the predictable Leavitt-RepRap combination, it would not be necessary for extruder head 18 to continue printing the *purge tower* after the last *material change* is complete. EX1003, ¶100-101. Just as the *purge tower* of RepRap *stops* with the last material that is used to print the 3D object,

Leavitt's extruder head 18 in the predictable Leavitt-RepRap combination would *stop* the *purge tower* at the *highest layer* at which extruder 18 *changes* between depositing the build material and depositing the support material. EX1004, [0022]-[0025], [0032]-[0039], FIGS. 1-2B, EX1005, 1; EX1006, 0:01-5:15; EX1003, ¶100-101.

Element [7a]

Leavitt discloses a controller for generating *tool path instructions* for printing *layers* of the *three-dimensional part* (e.g., 3D object 20) and of the *support structure* 22. EX1004, [0001]-[0006], [0020]-[0022]; EX1003, ¶103-108. Notably, Leavitt teaches that “[a]n extrusion-based layered deposition system...is used to build a 3D object from a computer-aided design (CAD) model in a layer-by-layer manner.” EX1004, [0002]. Leavitt also teaches that “[m]ovement of the extrusion head with respect to the substrate is performed under *computer control*, in accordance with build data” and “for each sliced *layer*, the host computer generates a *build path* for depositing roads of build material” to print a *three-dimensional part*. EX1004, [0003].

The system of Leavitt also generates *tool path instructions* for printing a *support structure*. EX1004, [0004] (“[t]he host computer generates additional geometry acting as a support structure...support material is then deposited...pursuant to the generated geometry”). EX1003, ¶106. Furthermore,

Leavitt specifically teaches that a “computer-operated controller” generates *instructions* (“signals”) to cause extrusion head 18 to move within a “horizontal x-y plane” to print 3D object 20 and support structure 22 “in a layer-by-layer manner.” EX1004, [0020]-[0022]; *see also* EX1005, 1 (describing “G-code” tool path instruction files); EX1013, 28 (corroborating the fact that “G-code” was instructions used by conventional printers to build objects layer-by-layer); EX1003, ¶107.

Element [7b]

When Leavitt’s system is implemented with the purge tower teachings of RepRap, the resulting system would *generate tool path instructions* for controlling Leavitt’s extruder 18 to print *layers* of the *at least one purge tower*. EX1004, [0020]-[0022]; EX1005, 1; EX1006; 0:01-4:59; EX1003, ¶109-112; *supra*, §V.A.3. For example, RepRap Article teaches a process for using “STL files” to print a 3D object using two different materials and a corresponding *purge tower*. EX1005, 1. EX1003, ¶109. These STL files can include one file for printing a body of the 3D object using a first material deposited by “extruder 0” and another file for printing text on the 3D object using another material deposited by “extruder 1.” EX1005, 1.

To generate the *tool path instructions* for printing a three-dimensional part and *purge tower* using multiple materials, RepRap discloses generating “G-code”

for each of the STL files and merging the G-code “layer-by-layer.” EX1005, 1.

Thus, when Leavitt’s extrusion head 18 is implemented with RepRap’s techniques for generating tool path instructions, the resulting system would generate G-code defining tool path instructions for printing each layer of the 3D object 20, support structure 22, and *purge tower*. EX004, [0020]-[0022]; EX1005, 1; EX1006; 0:01-4:59; EX1003, ¶110-111; *supra*, §V.A.3. RepRap clearly indicates that G-code defines tool path instructions for printing the purge tower as well as the object 20 and support structure 22. EX1005, 1 (e.g., “[t]he inserted G-code positions the nozzles above the “parking space” object...before letting the printing continue.”).

Claim [9]

In the predictable Leavitt-RepRap combination resulting from implementing Leavitt’s system with the teachings of RepRap, the resulting system would *generate tool path instructions* for printing layers of the *at least one purge tower prior to printing layers of the three-dimensional part* (e.g., 3D object 20) and the *support structure* 22. EX1004, [0002]-[0006], [0020]-[0022]; EX1005, 1; EX1006; 0:01-4:59; EX1003, ¶113-117; *supra*, §V.A.3. For example, Leavitt discloses a process for building a 3D object “from a computer-aided design (CAD) model” in a layer-by-layer manner.” EX1004, [0002]. Printing the 3D object is “performed under computer control, in accordance with build data that represents the 3D object.” EX1004, [0003]. To generate this build data, Leavitt’s system

generates a “build path” for each “sliced layer” of the CAD model prior to deposition. EX1004, [0003].

Because Leavitt indicates that the build data is generated for each “sliced layer” of a CAD model, Leavitt teaches that the tool path instructions for generating the 3D object 20 and support structure 22 are generated *prior* to *printing* the layers of 3D object 20 and support structure 22. EX1004, [0003], [0020]-[0022]; EX1003, ¶115. RepRap Article teaches similar techniques for using STL files to generate “G-code” of tool path instructions for controlling a system to print a three-dimensional part and purge tower layer-by-layer using two different materials. EX1005, 1; EX1003, ¶115 (citing to EX1014, 1 to corroborate the fact that the STL file was used for generating G-code tool path instructions to print a whistle body and corresponding portion of a purge tower, and citing to EX1015, 1 to corroborate same)). For instance, RepRap Article discloses techniques for *generating tool path instructions* by “slicing” STL files for the whistle body and the text to generate the “G-code” for each layer. EX1004, [0002], [0003]; EX1005, 1. EX1003, ¶116 Consequently, the system of the predictable Leavitt-RepRap combination generates *tool path instructions* for printing the *purge tower before* printing layers of 3D object 20 and support structure 22. EX1003, ¶113-117.

Element [16pre]

Supra, Element [1pre]. EX1003, ¶118-121.

Element [16a]

As described above, Leavitt discloses that extruder head 18 prints ***layers*** of a ***support structure*** 22 for a 3D object 20 using a ***layer-based, additive manufacturing technique***. EX1004, [0004], [0020]-[0039], FIGS. 1-2B; *supra* Element [1a]. Leavitt expressly discloses that extruder head 18 prints each ***layer*** of the ***support structure*** 22 from a ***support material***. EX1004, [0022]-[0023], [0029]-[0030], [0032], [0035]-[0037]. This means that Leavitt's extruder head 18 prints a ***first layer*** of ***support structure*** 22 from the ***support material*** for the ***three-dimensional part***. EX1003, ¶122-123.

Element [16b]

A POSITA would have been motivated to implement Leavitt's extruder head 18 with the teachings of RepRap so that extruder head 18 prints a layer of the ***purge tower*** each time that build liquefier pump 30 transitions from an idle state to an active state as taught by RepRap. EX1004, [0025]-[0027], [0032]-[0035], FIGS. 2A-2B; EX1005, 1; EX1006, 0:01-4:59; *supra*, Element [1c], *supra*, §V.A.3. Leavitt discloses that build liquefier pump 30 deposits a ***part material*** (e.g., "build material"). EX1004, [0027]-[0028], [0032]-[0033], [0035]. Consequently, in the predictable Leavitt-RepRap combination, extruder head 18 prints a ***first layer*** of the ***purge tower*** from the ***part material*** when the build liquefier pump 30 transitions from the idle state to the active state. EX1003, ¶124-125. As such, the

first layer of the *purge tower* is deposited prior to printing a *first layer* of the *three-dimensional part*.

Element [16c]

Leavitt discloses that extruder head 18 prints *layers* of a *three-dimensional part* (e.g., 3D object 20) using a *layer-based, additive manufacturing technique*.

EX1004, [0004], [0020]-[0039], FIGS. 1-2B. Leavitt expressly discloses that extruder head 18 prints each *layer* of 3D object 20 from a *part material* (e.g., “build material”). EX1004, [0022]-[0023], [0027]-[0028], [0032]-[0033], [0035].

Consequently, a *first layer* of 3D object 20 is printed from the *part material*.

EX1003, ¶126.

Leavitt explains that to build print object 20 and support structure 22, extrusion head 18 toggles between a “build state” depositing the build material and a “support state” depositing the support material. EX1004, [0022]. Leavitt also explains that extrusion head 18 can toggle between the build state and the support state in a layer-by-layer manner such that extrusion head 18 deposits a layer of support material after depositing a layer of build material and deposits another layer of build material after depositing the layer of support material. EX1004, [0023]; EX1003, ¶127.

Furthermore, Leavitt discloses that a layer of support structure 22 “may [] be used to vertically support subsequent layers of deposited build...materials.”

EX1004, [0023]. This means Leavitt teaches that the *first layer* of the *three-dimensional part* can be printed on *at least a portion* of the *first layer of the support structure* so that the first layer of the support structure vertically supports the first layer of the three-dimensional part. EX1003, ¶128. In the predictable Leavitt-RepRap combination, extruder head 18 prints the *first layer* of the *three-dimensional part after* printing the *first layer* of the *purge tower* with the part material to ensure a consistent flow of material in the build liquefier pump 30 as taught by RepRap. EX1003, ¶129-130.

Element [16d]

A POSITA would have been motivated to implement Leavitt's extruder head 18 with the teachings of RepRap so that Leavitt's extruder head 18 prints a layer of the *purge tower* each time that support liquefier pump 32 transitions from an idle state to an active state as taught by RepRap. EX1004, [0029]-[0036], FIGS. 2A-2B; EX1005, 1; EX1006, 0:01-4:59; EX1003, ¶131; *supra*, Element [1c], *supra*, §V.A.3. Leavitt discloses that support liquefier pump 32 deposits a *support material*. EX1004, [0029]-[0030], [0032], [0035]-[0037]. Consequently, in the predictable Leavitt-RepRap combination, extruder head 18 can print a *second layer* of the *purge tower* from the *support material* when the support liquefier pump 32 transitions from the idle state to the active state. EX1003, ¶131-133 (citing to

EX1005, 1 and EX1006, 5:04 which clearly demonstrate that RepRap's purge tower is printed using more than one material).

Element [16e]

Leavitt discloses that extruder head 18 prints *layers* of a ***support structure*** 22 using a ***layer-based, additive manufacturing technique***. EX1004, [0004], [0020]-[0039], FIGS. 1-2B. Leavitt expressly discloses that extruder head 18 prints each *layer* of ***support structure*** 22 from a ***support material***. EX1004, [0022], [0023], [0029], [0030], [0032], [0035]-[0037]. Consequently, Leavitt discloses that extruder head 18 prints a ***second layer*** of support structure 22 from the ***support material***. EX1003, ¶134.

Leavitt explains that to build print object 20 and support structure 22, extrusion head 18 toggles between a "build state" depositing the ***build material*** and a "support state" depositing the ***support material***. EX1004, [0022]. Leavitt also explains that extrusion head 18 can toggle between the build state and the support state in a layer-by-layer manner such that extrusion head 18 deposits a layer of support material after depositing a layer of build material and deposits another layer of build material after depositing the layer of support material. EX1004, [0023]. Leavitt explains that this toggling process can be "repeated until each layer of 3D object 20 and support structure 22 are complete." EX1004, [0024].

Furthermore, Leavitt discloses that a layer of support structure 22 “may [] be used to vertically support subsequent layers of deposited build and/or support materials.” EX1004, [0023]. This means Leavitt teaches that the *second layer* of the *support structure* 22 can be printed on *at least a portion* of the *first layer of the three-dimensional part* that is vertically supported by the *first layer* of the *support structure* 22 so that the first layer of the support structure vertically supports the first layer of the three-dimensional part. EX1003, ¶135-137. In the predictable Leavitt-RepRap combination, extruder head 18 prints the *second layer* of the *support structure* 22 *after* printing the *second layer* of the *purge tower* with the *support material* to ensure a consistent flow of material in the support liquefier pump 32 as taught by RepRap. EX1003, ¶135-137.

Claim [17]

Leavitt’s extrusion head 18 alternates between using a build material to print 3D part 20 and using a support material to print support structure 22. EX1004, [0004], [0022]-[0024], [0027]-[0029], [0032], [0033]. For example, Leavitt discloses that extrusion head 18 functions to extrude a layer of 3D object 20 in the build state, toggle to the support state to print a layer of support structure 22, toggle back to the build state to print another layer of 3D object 20 and repeat this process “until each layer of 3D object 20 and support structure 22 are complete.” EX1004, [0023]. This means that Leavitt expressly discloses *repeating steps (a), (c), and (e)*

which involve printing layers of the *three-dimensional part* (e.g., 3D part 20) and *support structure* 22. EX1003, ¶138-141.

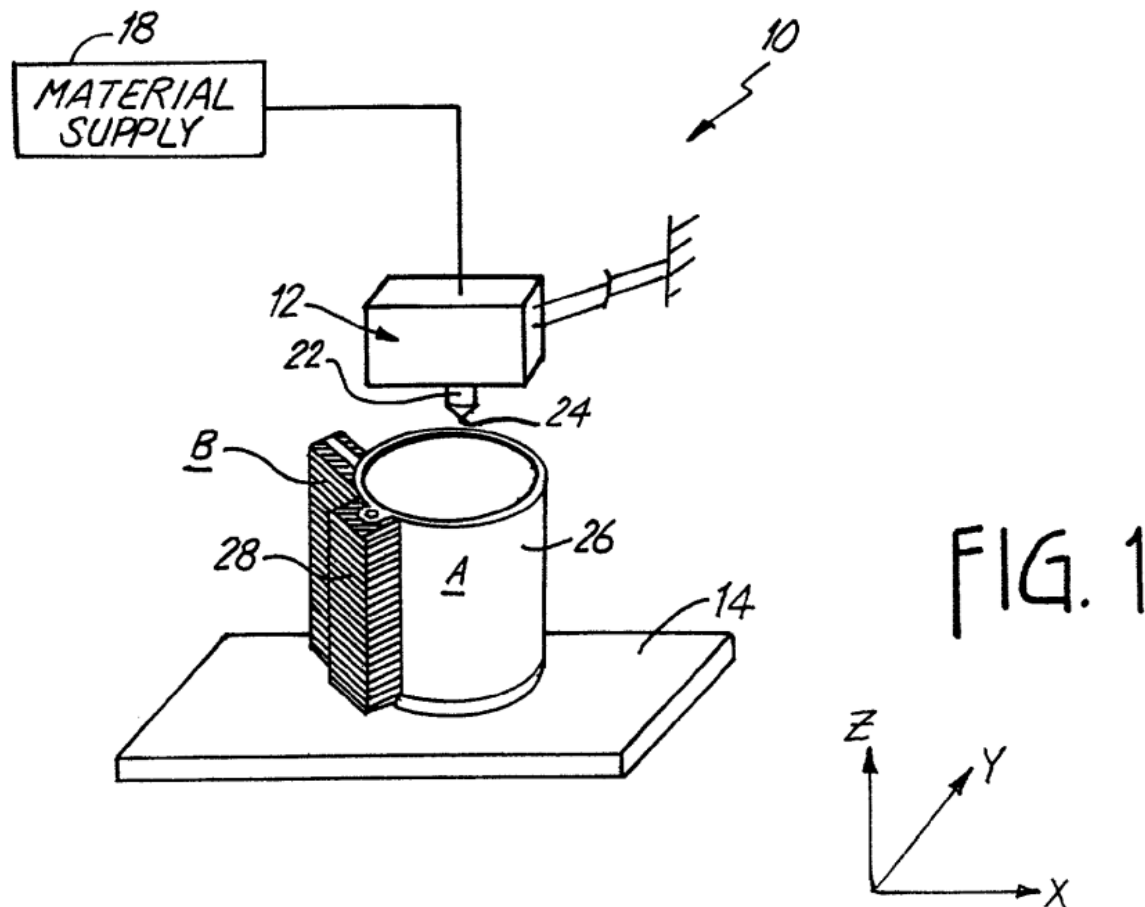
RepRap discloses printing one or more layers of a *purge tower* next to a three-dimensional part each time the 3D printer switches deposition lines/material. EX1005, 1; *supra*, Element [1c]. When Leavitt's extruder head 18 is implemented with the teachings of RepRap, extruder head 18 prints a layer of a *purge tower* each time that extruder head 18 toggles between the build state and the support state to switch printing materials as taught by RepRap. EX1004, [0022]-[0024], [0027]-[0029], [0032], [0033]; EX1005, 1. This means that when Leavitt's extruder 18 *repeats steps (a), (c), and (e)*, extruder 18 would also *repeat steps (b) and (d)* of claim 16 to "prime" each *deposition line* before printing the 3D object 20 and support structure 22 in the combination. EX1003, ¶138-141.

B. GROUND 2A: Priedeman in view of KISSlicer would have rendered obvious claims 1, 2, 6, 7, 9, 16, and 17

1. Priedeman

Priedeman discloses an extrusion apparatus 10 for building a three-dimensional model 26 and a support structure 28. EX1007, [0002]-[0011], [0013], [0016]-[0018], FIG. 1; EX1003, ¶44. Specifically, Priedeman's extrusion apparatus 10 includes at least one extrusion head 12 for depositing "modeling material A" to

print the model 26 and depositing “modeling material B” to print the support structure 28:

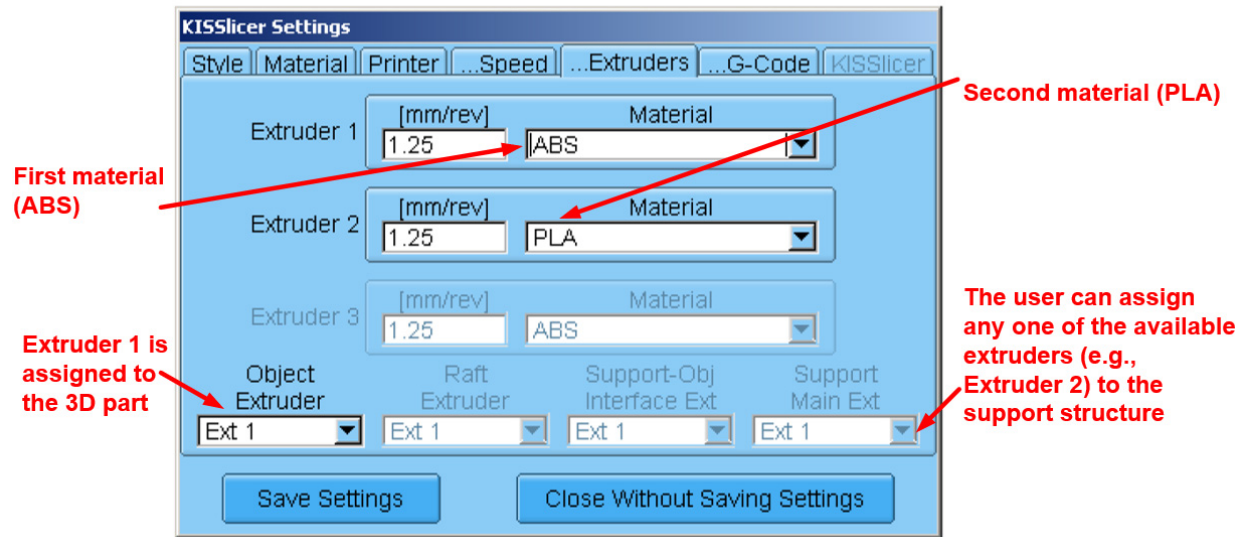


EX1007, [0016]-[0022], FIG. 1. Priedeman discloses that a single extrusion head can include two separate nozzles, one depositing material A and the other depositing material B. EX1007, [0018].

2. *KISSlicer*

KISSlicer describes software for controlling a multi-extruder system (e.g., like those described in Priedeman) to print a three-dimensional part and support

structure. EX1010, 1-11; EX1003, ¶45-48. Specifically, KISSlicer's software allows a user to select one material for deposition by "Extruder 1" and another material for deposition by "Extruder 2":



EX1010, 3 (annotated). As depicted above, KISSlicer's software also allows the user to select one extruder for printing the three-dimensional part and another extruder to print the support structure. EX1010, 3.

KISSlicer explains that when multiple extruders are used for printing, it is "extremely important" to clean the extruder tips "before every layer." EX1010, 9; EX1003, ¶47. KISSlicer's software controls the multi-extruder system by printing a purge tower—referred to as a "wipe pillar"—on the substrate next to the three-dimensional part and support structure at a position that "can be chosen" by the user. EX1010, 9. Specifically, KISSlicer suggests this layered purge tower

helpfully “reduces hairing” (an oozed thread). EX1010, 9; EX1003, ¶48. This is achieved because each layer of the purge tower performs a “priming” (or “wipe”) operation to extrude some filament from the nozzle “after a warm up.” EX1010, 10.

3. *The Priedeman-KISSlicer Combination*

Multiple reasons would have prompted a POSITA to implement Priedeman’s system to print a purge tower next to a three-dimensional part and support structure, as suggested by KISSlicer. EX1007, [0016]-[0022]; EX1010, 3, 5, 8-11; EX1003, ¶142-148.

In particular, a POSITA would have implemented Priedeman’s extruder to print a purge tower on the same substrate as 3D part (as suggested by) KISSlicer so as to (1) advantageously prime Priedeman’s nozzles when transitioning between materials, (2) quickly dispose of the priming material with limited additional movement in a compact purge tower, and (3) beneficially decrease the likelihood of molten material oozing from the idle nozzle onto the 3D part. EX1003, ¶143-146. Here, these known benefits were also previously explained in §V.A.3, *supra*.

Additionally, beyond these three reasons articulated above, the predictable combination would have advantageously allowed user selection/customization of parameters related to the purging operation. EX1003, ¶147. For instance, a POSITA would have recognized that the Priedeman-KISSlicer combination would

have achieved more flexible user customization of parameters affecting the main part and the purge tower (such as “layer thickness,” the “position” of the purge tower relative to the “main part,” and temperature within the extruders)—all of which a user would customize depending upon the desired build time/quality of a particular print project. EX1010, 3, 9; EX1003, ¶147.

Furthermore, a POSITA would have implemented Priedeman’s extruder based on KISSlicer’s suggestions because doing so would be the application of known techniques to a known system to achieve predictable results *KSR*, 550 U.S. at 417 (“simply arranges old elements with each performing the same function it had been known to perform”). For the reasons detailed above, and based upon the predictable mechanical components and software involved in the combination and the state of the art at the time for 3D printer systems like Priedeman and KISSlicer, a POSITA would have reasonably expected success achieving the combination before the ’713 Patent. EX1003, ¶148.

4. *Application to Challenged Claims*

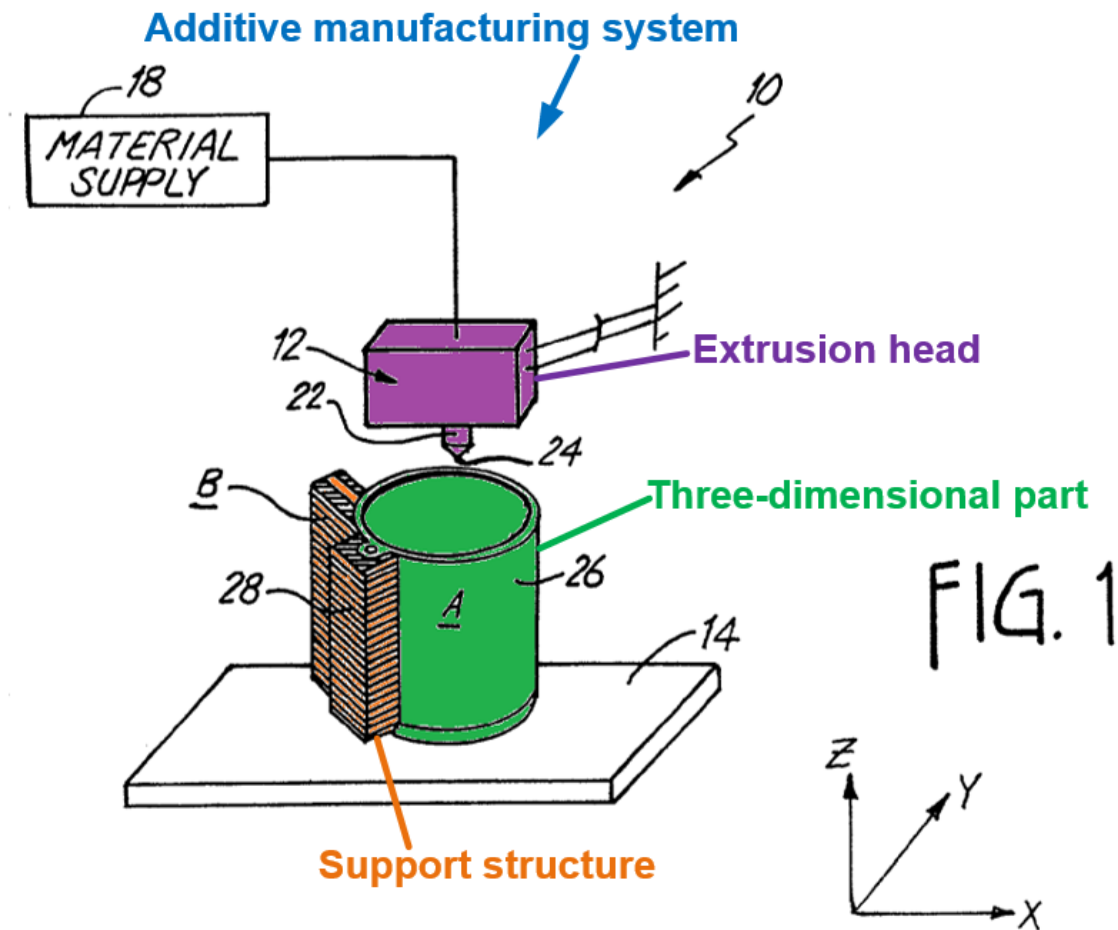
Element [1pre]

Even if the preamble is treated as a limitation (which Petitioners do not concede), the Priedeman-KISSlicer combination provides the recited features. EX1003, ¶149-152. Priedeman discloses an extrusion apparatus 10 including an extrusion head 12 which operates as an ***additive manufacturing system*** by printing

a three-dimensional model 26 and support structure 28 layer-by-layer according to “*additive* process techniques.” EX1007, [0006], [0015]-[0019]. Priedeman also discloses that extrusion apparatus 10 applies a “*method* for using...material to build” a *three-dimensional part* including model 26. EX1007, [0013], [0016]-[0018].

Element [1a]

As described above in connection with Element [1pre], Priedeman’s system 10 *prints layers* of a *three-dimensional part* (e.g., model 26) and a *support structure* 28. EX1007, [0006], [0013], [0015]-[0019]; EX1003, ¶153. For example, Priedeman’s extrusion head 12 “deposit[s] material onto the base 14 in multiple...*layers* to build” model 26 and support structure 28. EX1007, [0017], *see also* [0019] (“the modeling material A and the support material B are deposited... in horizontal *layers* from an extrusion head”). Priedeman’s extrusion head 12 for printing three-dimensional model 26 and support structure 28 is depicted below in FIG. 1:



EX1007, FIG. 1 (annotated).

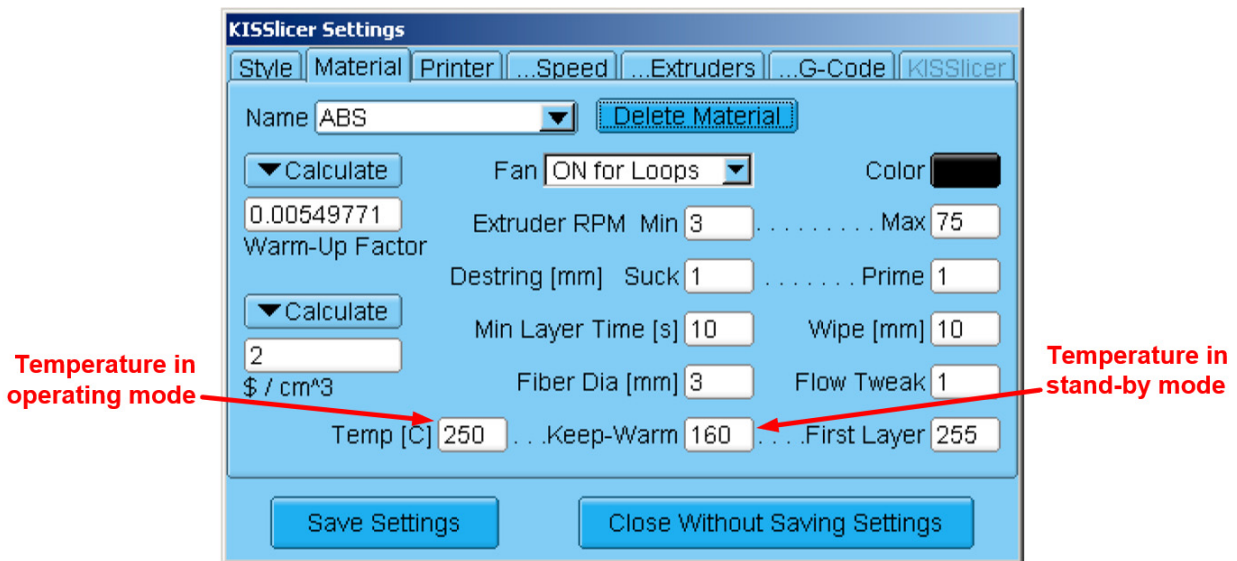
In one embodiment, extrusion apparatus 10 includes a single extrusion head that includes a first *deposition line* (“nozzle”) for printing *layers* of three-dimensional model 26 and a second *deposition line* (“nozzle”) for printing *layers* of support structure 28. EX1007, [0018]-[0022]; *supra*, §V.B.1. Therefore, Friedeman’s extrusion apparatus 10 uses a *layer-based, additive manufacturing technique* to print *layers* of the *three-dimensional part* and the *support structure*. EX1007, [0003]-[0008], [0016]-[0019], FIG. 1; EX1003, ¶154-155.

Element [1b]

Priedeman' extrusion apparatus 10 deposits modeling material A and support material B “in coordination” to print model 26 and support structure 28 using ***multiple deposition lines*** (e.g., “nozzles”). EX1007, [0016]-[0018]; *supra*, Element [1a]. The modeling and support materials are deposited in horizontal ***layers*** from respective extrusion heads or nozzles. EX1007, [0028]. EX1007, [0028], [0029]. Priedeman also discloses that heated material can be “sitting idle” in an inactive extruder. EX1007, [0022]. Thus, Priedeman suggests that a nozzle can occupy a ***stand-by mode*** when sitting idle or occupy an ***operation mode*** when extruding material. EX1003, ¶156-157.

Much like Priedeman's extrusion apparatus 10 uses one extruder head or nozzle to deposit modeling material A and use another extruder head or nozzle to deposit support material B, KISSlicer's software controls a multi-extruder system to print a ***three-dimensional part*** with a first material using one extruder (e.g., “Extruder 1”) and a ***support structure*** with a second material using another extruder (e.g., “Extruder 2”). EX1010, 5, 8, 11; EX1003, ¶158; *supra*, §V.B.2. KISSlicer's extruders ***switch*** between an active ***operating mode*** corresponding to a higher temperature (e.g., 250 °C) for melting the material during use and an idle ***stand-by mode*** for maintaining the material at a lower “Keep-Warm” temperature

(e.g., 160 °C). EX1010, 3, 10. Keep-Warm is an “idle temperature” used “when printing with multiple materials.” EX1010, 3, 10; EX1003, ¶159-160.



EX1010, 3 (annotated).

KISSlicer explains that each of the extruders transitions out of the *stand-by mode* and into the *operating mode* to prepare the extruder for printing one or more layers of the *three-dimensional part* or *support structure*. EX1010, 10 (“*after a warm up* the printer will...prime...to ensure the printer is ready”); EX1003, ¶161. This priming occurs “before every layer to clean the extruder tip.” EX1010, 9. Consequently, when Priedeman’s extrusion apparatus 10 is implemented with KISSlicer’s techniques for temperature control and nozzle priming, the resulting nozzles would switch between a lower temperature in the *stand-by mode* and a higher temperature in the *operating mode in-between* the printing of the layers of

the *three-dimensional part* (e.g., model 26) and *support structure* 28. EX1007, [0016]-[0022]; EX1010, 3, 5, 9, 10; EX1003, ¶156-164; *supra*, §V.B.3.

Element [1c]

Priedeman acknowledges that printing material can “ooze” or “drain uncontrollably” from an idle extruder when the temperature is too high. EX1007, [0022]. As described above in Element [1b], *supra*, KISSlicer explains that a temperature of an extruder is decreased in the idle *stand-by mode* and subsequently increased when transitioning to the active *operating mode*. EX1010, 3, 5, 9, 10. Implementing Priedeman’s extruder apparatus 10 to lower the temperature of idle extruders as suggested by KISSlicer would decrease a likelihood of build material draining uncontrollably onto base 14. EX1003, ¶165-166; *supra* §V.B.3.

Furthermore, KISSlicer teaches that it is “extremely important in dual head prints” to print one or more layers of a *purge tower* “before every layer” of the 3D part or support structure. EX1010, 9. This *purge operation* occurs “after a warm up” when the extruder *switches* from the idle *stand-by mode* to the active *operating mode*. EX1010, 10. KISSlicer describes the purge operation as “priming” the extruder for subsequent printing. EX1010, 10.

KISSlicer explains that priming the extruder is done “to ensure the printer is ready” to print the three-dimensional part or support structure. EX1010, 10. This means that KISSlicer’s software prints a *purge tower* in a *layer-by-layer* manner as

“Extruder 1” and “Extruder 2” alternate between *stand-by mode* and the *operating mode*. EX1003, ¶167. Each time that one of “Extruder 1” or “Extruder 2” heats up to *switch* to the *operating mode*, that extruder prints one or more layers of the *purge tower* before printing the three-dimensional part or support structure.

EX1003, ¶167-168. Consequently, when extruder apparatus 10 is implemented with the nozzle priming teachings of KISSlicer, the resulting system would perform a *purge operation* by printing a *purge tower* in a *layer-by-layer manner*, the layers of the purge tower printed by a nozzle previously switched to the *operating mode*. EX1010, 3, 5, 9, 10; EX1003, ¶165-170; *supra* §V.B.3.

Element [2a]

Priedeman discloses at least one embodiment where extrusion apparatus 10 comprises a single extrusion head with *multiple deposition lines*—including a *first deposition line* “nozzle” for dispensing the model material A to build model 26 and a *second deposition line* “nozzle” for dispensing the support material B to build the support structure 28. EX1007, [0016]-[0018]; *supra*, Element [1a]; EX1003, ¶171-173.

Element [2b]

When Priedeman’s extrusion apparatus 10 is implemented with the temperature control teachings of KISSlicer, Priedeman’s first *deposition line* and second *deposition line* alternate between an idle *stand-by mode* corresponding to a

lower nozzle temperature for preserving material during nonuse and an active *operating mode* corresponding to a higher nozzle temperature for melting material during use. EX1007, [0016]-[0022]; EX1010, 3, 5, 9-11; EX1003, ¶174-176; *supra*, Elements [1b]-[1c]; *supra*, §V.B.3. This means that when one of Priedeman's *deposition line* nozzles *switches* from the *stand-by mode* to the *operating mode* to deposit material, the other *deposition line* nozzle *switches* from the *operating mode* to the *stand-by mode* to sit idle. EX1007, [0016]-[0018]; EX1010, 3, 5, 9-11.

Claim [6]

In the predictable Priedeman-KISSlicer combination, extrusion head 18 would *stop* printing a *purge tower* at a *highest layer* at which there is a *material change* for the printed layers of the *three-dimensional part* (e.g., model 26) and *support structure* 28. EX1007, [0016]-[0022], FIG. 1; EX1010, 9, 10; EX1003, ¶177-179. For example, KISSlicer explains that “before every layer” when an extruder warms up as part of a *material change*, the extruder prints a portion of a *purge tower* beside the *three-dimensional part* and *support structure*. EX1010, 9, 10. In the predictable Priedeman-KISSlicer combination, it would not be necessary for extrusion apparatus 10 to continue printing the *purge tower* after the last *material change* is complete. EX1003, ¶178.

Element [7a]

Priedeman's extrusion is "controlled so as to deposit material...in multiple passes and layers to build the *three-dimensional* model 26 and further to build the *support structure* 28." EX1007, [0017]. This means that Priedeman's extrusion apparatus 10 *generates tool path instructions* to cause the extrusion head to deposit material according to these "multiple passes and *layers*" for printing the model 26 and support structure 28. EX1007, [0016]-[0018]; EX1003, ¶180-184. Priedeman teaches techniques for *generating tool path instructions* using a CAD model, the instructions defining areas for controlling Priedeman's extruders to deposit material. EX1007, [0003], [0004]; EX1003, ¶182.

KISSlicer discloses that *tool path instructions* for printing material layers (such as the model and support structure layers of Priedeman) are generated from an "STL file." EX1010, 6; EX1003, ¶183. After the user has selected print parameters, KISSlicer's software creates a "print file" by "slicing" the STL file to generate *tool path instructions* for each layer. EX1010, 9. A POSITA would have recognized that slicing an STL file to generate tool path instructions was a known technique by 2012. EX1013, 28. EX1003, ¶183.

Element [7b]

When Priedeman's system is implemented with the teachings of KISSlicer, the resulting system would *generate tool path instructions* ("print file") for controlling Priedeman's extrusion apparatus 10 to print *layers* of the at least one

purge tower. EX1007, [0002]-[0004], [0016]-[0022]; EX1010, 9, 10; EX1003, ¶185. KISSlicer discloses that its software controls a dual extruder system to print one or more layers of a ***purge tower*** “before every layer” of the three-dimensional part and support structure “to clean the extruder tip.” EX1010, 9. To control the dual extruders to print the ***purge tower***, KISSlicer’s software generates ***tool path instructions*** for printing each layer of the ***purge tower*** just as the software generates ***tool path instructions*** for printing layers of the ***three-dimensional part*** and ***support structure***. EX1003, ¶185-186.

Claim [9]

Priedeman discloses an extrusion apparatus 10 that prints three-dimensional parts and support structures by depositing material in a predetermined pattern according to a three-dimensional CAD model that defines characteristics of the printed object. EX1007, [0003], [0004], [0015]-[0018]; *supra*, Element [7a]. Because the “predetermined pattern” for each layer is defined by the CAD model for the entire object, This means that extrusion apparatus 10 generates the tool path instructions prior to printing model 26 and support structure 28. EX1003, ¶188. KISSlicer discloses a similar process for generating a “print file” for the tool path of each layer of a ***three-dimensional part***, ***support structure***, and ***purge tower*** based on an STL file. EX1010, 6, 7. Consequently, the system of the Priedeman-KISSlicer combination ***generates tool path instructions*** for printing ***layers*** of a

purge tower prior to printing *layers* of a *three-dimensional part* and *support structure*. EX1003, ¶187-189.

Element [16pre]

Supra, Element [1pre]. EX1003, ¶190-193.

Element [16a]

Priedeman discloses that extrusion apparatus 10 deposits material “in multiple passes and layers” to build *three-dimensional* model 26 and *support structure* 28. EX1007, [0017]; EX1003, ¶194; *supra* Element [1a]. Extrusion apparatus 10 deposits *layers* of three-dimensional model 26 using a “*modeling material A*” and deposits *layers* of support structure 28 using a “*support material B*.” EX1007, [0018], [0019], [0022]. This means that extrusion apparatus 10 prints the *first layer* of *support structure* 28 from the *support material B*. EX1003, ¶194-195.

Element [16b]

A POSITA would have been motivated to implement Priedeman’s extrusion apparatus 10 with the teachings of KISSlicer so that extrusion apparatus 10 prints a layer of the *purge tower* each time that a *deposition line* (“nozzle”) transitions from an idle state to an active state as taught by KISSlicer. EX1007, [0016]-[0018], FIG. 1; EX1010, 9, 10; EX1003, ¶196; *supra*, Element [1c], *supra*, §V.B.3. Priedeman discloses that one of the extrusion heads or nozzles of extrusion

apparatus 10 deposits a ***part material*** (e.g., “modeling material A”). EX1007, [0018]-[0022]. EX1003, ¶197. Consequently, in the predictable Priedeman-KISSlicer combination, extrusion apparatus 10 prints a ***first layer*** of the ***purge tower*** from the ***part material*** when the print head or nozzle depositing modeling material A transitions from the idle state to the active state. EX1003, ¶197-198.

Element [16c]

As described above, Priedeman’s extrusion apparatus 10 deposits ***layers*** of three-dimensional model 26 using a ***part material*** (“modeling material A”). EX1007, [0018], [0019], [0022]; *supra*, Element [16a]. This means that extrusion apparatus 10 prints the ***first layer*** of the ***three-dimensional part*** (e.g., model 26) from the ***part material*** (e.g., modeling material A). EX1003, ¶199.

In the Priedeman-KISSlicer combination, extrusion apparatus 10 alternates between depositing the modeling material A to build model 26 and the depositing the support material B to build support structure 28 so that model 26 and support structure 28 are built in a ***layer-by-layer manner*** concurrently with the ***purge tower***. EX1007, [0016]-[0022], FIG. 1; EX1010, 9, 10; EX1003, ¶200. When the extrusion apparatus 10 switches to depositing the ***part material*** (e.g., modeling material A), extrusion apparatus 10 prints a ***first layer*** of a ***purge tower*** before printing the ***first layer*** of model 26. EX1010, 9, 10; *supra*, Element [1c].

Consequently, in the predictable Priedeman-KISSlicer combination, extrusion system 10 prints the *first layer* of the *three-dimensional part* (e.g., model 26) *after* printing the *first layer* of the *purge tower*. EX1003, ¶201. Priedeman describes “additional geometry acting as a support structure for the overhanging or free-space segments of the object being formed.” EX1007, [0007]. Priedeman therefore teaches that the *first layer* of the *three-dimensional part* can be printed on *at least a portion* of the *first layer* of the *support structure* so that *support structure* vertically supports the *three-dimensional part* (e.g., model 26). EX1003, ¶201-202.

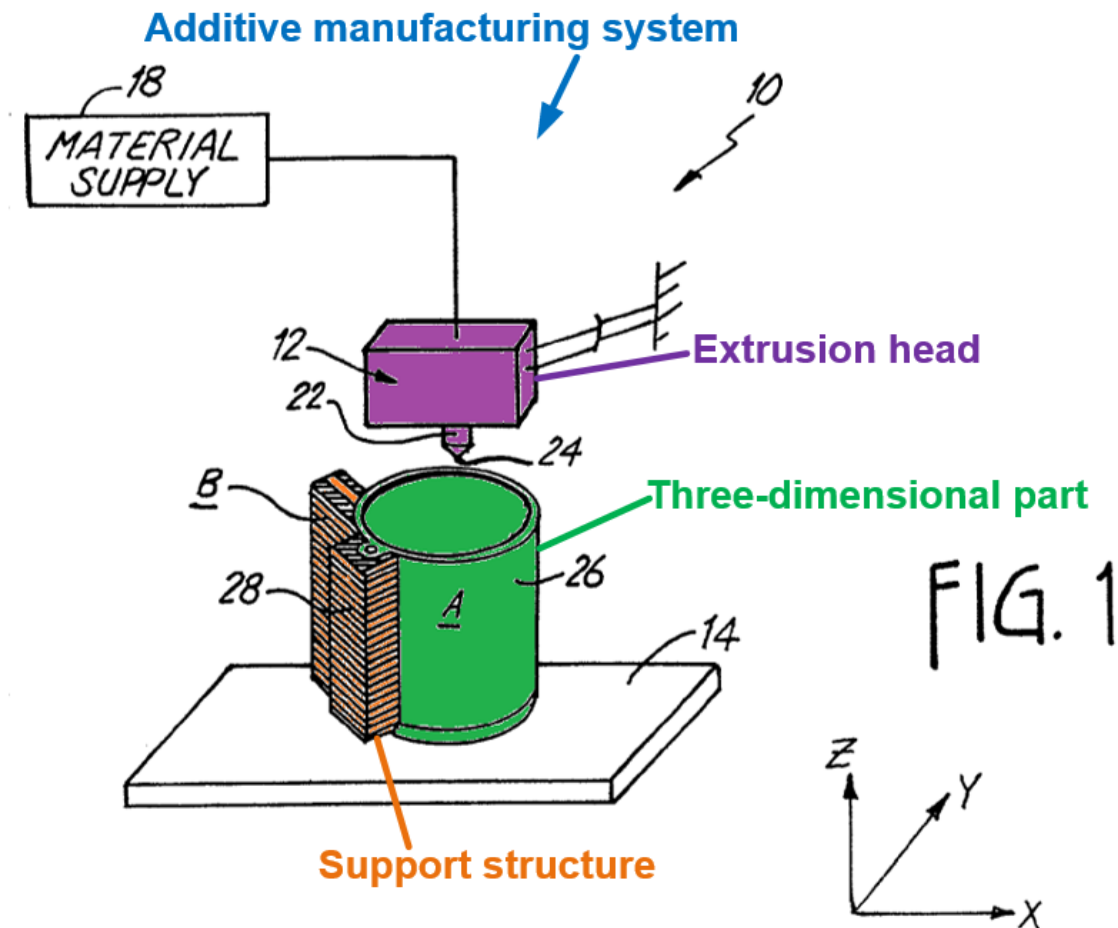
Element [16d]

A POSITA would have been motivated to implement Priedeman’s extrusion apparatus 10 with the teachings of KISSlicer so that extrusion apparatus 10 prints a layer of a *purge tower* each time that a *deposition line* (“nozzle”) transitions from an idle state to an active state as taught by KISSlicer. EX1007, [0016]-[0018], FIG. 1; EX1010, 9, 10; EX1003, ¶203; *supra*, Element [1c], *supra*, §V.B.3. Priedeman discloses that one of the extrusion heads or nozzles of extrusion apparatus 10 deposits a *support material* B. EX1007, [0018]-[0022]. Consequently, in the predictable Priedeman-KISSlicer combination, extrusion apparatus 10 prints a *second layer* of the *purge tower* from the *support material* B when the print head

or nozzle depositing **support material B** transitions from the idle state to the active state; EX1003, ¶203-204.

Element [16e]

Priedeman's extrusion apparatus 10 deposits **layers** of support structure 28—including a **second layer**—using a **support material B**. EX1007, [0018], [0019], [0022]; EX1003, ¶205; *supra*, Element [16a]. Priedeman's extruder apparatus 10 deposits a layer of **support material** for each layer of **part material**, as demonstrated by the equal heights of the part and support structure:



EX1007, FIG. 1 (annotated). This means extrusion apparatus 10 alternates between depositing the modeling material A to print model 26 and the depositing the support material B to print support structure 28 in a *layer-by-layer manner* concurrently with printing *purge tower*. EX1007, [0016]-[0022], FIG. 1; EX1010, 9, 10; EX1003, ¶205. When the extrusion apparatus 10 switches to depositing the *support material* after depositing the *part material*, a POSITA would have been motivated to implement extrusion apparatus 10 to print a *second layer* of the *purge tower* before printing the *second layer* of *support structure* 28 as suggested by KISSlicer to prime the extruder head or nozzle for printing. EX1010, 9, 10; *supra*, Element [1c]; *supra*, §V.B.3. Consequently, in the predictable Priedeman-KISSlicer combination, extrusion system 10 prints the *second layer* of the *support structure* 28 *after* printing the *second layer* of the *purge tower*. EX1003, ¶205.

Priedeman describes “additional geometry acting as a support structure for the overhanging or free-space segments of the object being formed.” EX1007, [0007]. This means Priedeman teaches that the *second layer* of the *support structure* 28 can be printed on *at least a portion* of the *first layer* of the *three-dimensional part* (e.g., model 26) so that *support structure* 28 vertically supports other material above the *first layer* of the *three-dimensional* model 26. EX1003, ¶206-207.

Claim [17]

The extrusion apparatus 10 of Priedeman uses a “modeling material A” and “support material B” to print three-dimensional model 26 and support structure 28. EX1007, [0018]-[0022]. When the extrusion apparatus 10 of Priedeman is implemented with the idle cooling and purge teachings of KISSlicer, the resulting system alternates between depositing the modeling material A to print the build model 26 and depositing the support material B to print support structure 28. This means that the Priedeman-KISSlicer combination provides *repeating* steps (a), (c), and (e) which involve printing layers of the *three-dimensional part* (e.g., model 26) and *support structure* 28 in an alternating fashion. EX1003, ¶208-210. The system deposits a layer of support structure for each layer of part material, as demonstrated by the equal heights of the part and support structure, and therefore the resulting system repeats the process of alternating between part material and support material layers. EX1003, ¶208-210; *supra*, Element [16e].

As described above in connection with Element [1c], KISSlicer discloses a process for printing a *purge tower* next to a *three-dimensional part* and *support structure* specifically to “prime” an extruder that is transitioning out of an idle state and into an active state to print the *three-dimensional part* or *support structure*. EX1010, 9-11; EX1003, ¶211. When Priedeman’s extrusion apparatus 10 is implemented with the teachings of KISSlicer, extrusion apparatus 10 prints a

one or more layers of a *purge tower* each time that the extrusion apparatus 10 transitions between materials as taught by KISSlicer. EX1010, 9, 10. This means that when Priedeman's extrusion apparatus 10 repeats steps (a), (c), and (e), extrusion apparatus 10 would also repeat steps (b) and (d) of claim 16 to "prime" a nozzle for depositing the part material and a nozzle for depositing the support material. EX1003, ¶211-212.

C. GROUND 2B: Priedeman in view of KISSlicer, RepRap Article, and RepRap Video would have rendered obvious claim 5

1. The Priedeman-KISSlicer-RepRap combination

As previously described, (Ground 1, Claim [5]), RepRap plainly suggested a conventional purge tower having a cross-sectional area at the base that is larger than an area in other regions (above the base). *Supra*, Ground 1 Claim [5] (citing EX1005, 1; EX1006, 5:01-5:05). Based on RepRap's suggestion, a POSITA would have been motivated to implement the resulting purge tower of the Priedeman-KISSlicer combination (Ground 2A) in this manner to advantageously construct a more stable, less top-heavy tower. EX1003, ¶213; *Intel*, 61 F. 4th at 1379-80 (the POSITA is "a person of ordinary creativity, not an automaton").

2. *Applicant to Claim 5*

Claim [5]

The Friedeman-KISSlicer-RepRap combination would have provided this predictable option based on RepRap teaching that the *purge tower* printed next to a three-dimensional part can have cross-sectional areas that differ between a larger cross-sectional area at a base and a reduced cross-sectional area at a higher position. EX1003, ¶214-216; *supra*, Ground 1 analysis of [5] (annotating position (P1) and (P2)).

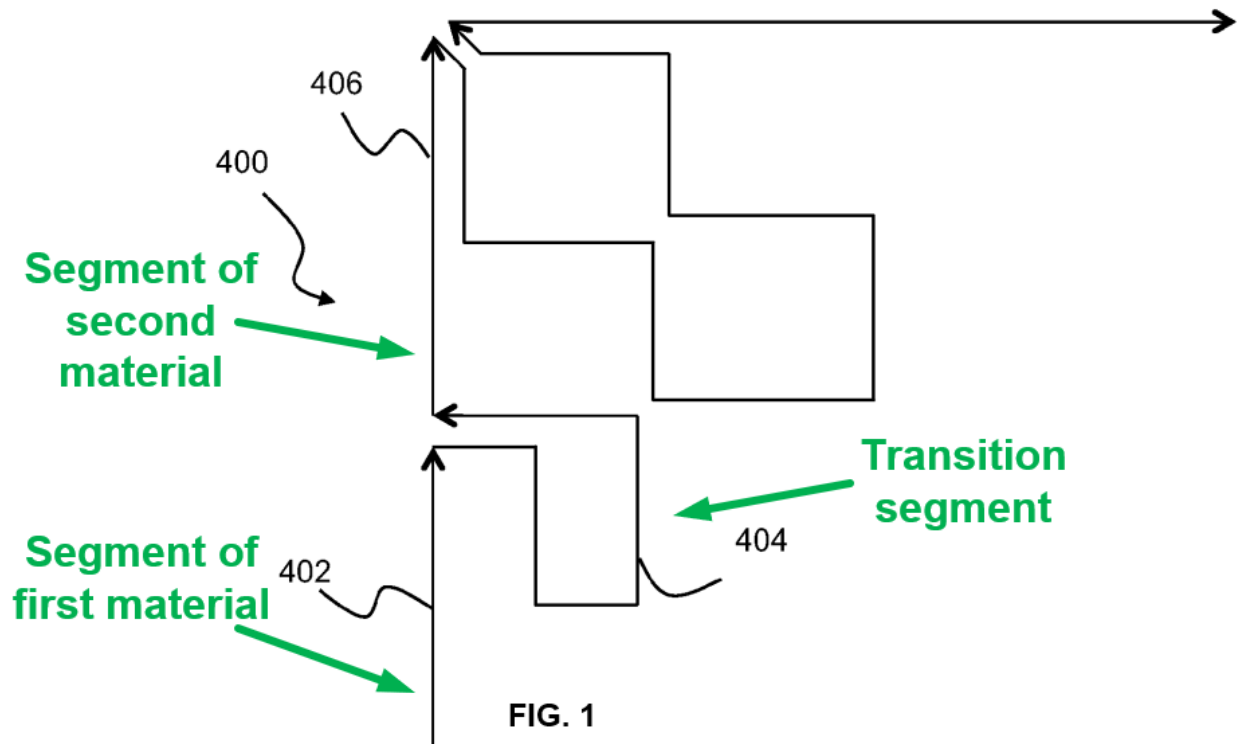
D. GROUND 3: Boyer anticipates claims 1, 2, 6, 7, and 9

1. *Boyer*

Boyer describes a printer including an extruder for printing three-dimensional parts using two different materials—much like the printer of the '713 Patent. EX1008, [0003], [0025]-[0029], FIG. 2; EX1003, ¶49-51. One embodiment of Boyer's printer comprises a single extrusion head (with a single output tip) that deposits a first material and a second material *at different times*. EX1008, [0025]-[0029], FIG. 2. In this embodiment, Boyer's printer can deposit a first material to print a three-dimensional part and a second material to print a support structure. EX1008, [0025]-[0029], [0032]-[0044], FIGS. 2, 4-5.

To print an object and support structure using two different materials, Boyer discloses that the extruder can alternate between depositing a segment of the first

material and depositing a segment of the second material. EX1008, [0032]-[0034], FIG. 4. When Boyer's printer alternates between materials, the printer can deposit a "transition segment" to purge material that adheres to the inside walls of the extruder that will subsequently print a segment of the object or support structure. EX1008, [0032]-[0034], FIG. 4; EX1003, ¶50. An example of a tool path that can be printed Boyer's extruder is depicted below in FIG. 4:



EX1008, FIG. 4 (annotated).

Boyer's printer can deposit successive layers by depositing two different materials according to two-dimensional tool paths such as the one depicted above in FIG. 4. EX1008, [0012], [0024]. This means that Boyer's "transition segments"

from purge towers because Boyer's printer deposits layers on top of one another.

EX1003, ¶51.

2. *Application to Challenged Claims*

Element [1pre]

To the extent the preamble is treated as a limitation, Boyer provides the recited features. EX1003, ¶217-220. For example, Boyer discloses a printer that can “build a three-dimensional object by depositing lines of build material in successive layers.” EX1008, [0018], [0024]-[0029], FIGS. 1-2. In several cases, Boyer discloses that its printer can perform a ***method*** for using multiple build materials to print a three-dimensional part. EX1008, [0012], [0029], [0035].

Element [1a]

Boyer discloses that the printer can print “successive ***layers***” of a ***three-dimensional part***, each layer representing a “two-dimensional pattern” derived from a cross-section of the three-dimensional part. EX1008, [0024]. To deposit these successive layers, Boyer's extruder deposits “***multiple*** build materials.” EX1008, [0015]-[0018], [0025]-[0029], [0032]-[0044], FIGS. 2, 4-5. Boyer discloses that the printer is configured to print layers of the ***three-dimensional part*** using a first build material (“main structure”) and print layers of a “sacrificial ***support structure***” for the three-dimensional part using a second build material. EX1008, [0044] (“build materials may be deposited in an object”); EX1003, ¶221.

According to the alternative claim construction (*supra* §IV.A), Boyer discloses an extruder 200 including **multiple deposition lines** that use a **layer-based additive manufacturing technique** to print **layers** of the **three-dimensional part** and the **support structure**. EX1008, [0025]-[0029], FIG. 2; EX1003, ¶222, *supra* §V.C.1. Namely, extruder 200 includes a first **deposition line** corresponding to a first feed 210 for **depositing** the first build material 214 and a second **deposition line** corresponding a second feed 212 for **depositing** the second build material 216. EX1008, [0025], [0026], FIG. 2. Boyer's extruder 200 is depicted below in FIG. 2 (annotated):

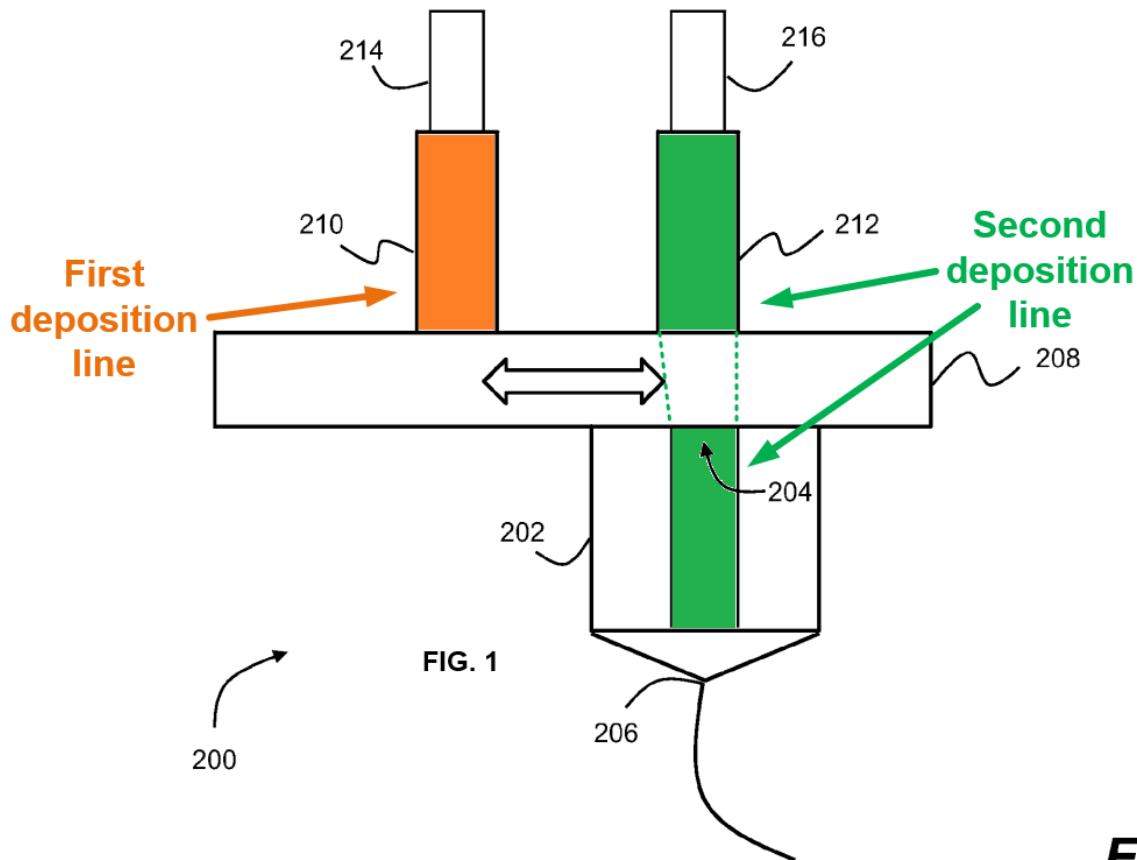


Fig. 2

Again, consistent with the alternative claim construction (*supra* §IV.A), Boyer expressly discloses that extrusion head 202 can transition between the first feed 210 of the first **deposition line** and the second feed 212 of the second **deposition line** by sliding along filament changer 208. EX1008, [0025]; EX1003, ¶223. Although Boyer's figures do not depict the example where extrusion head 202 is aligned with first feed 210, the modified version of FIG. 2 below depicts this example consistent with Boyer's description in paragraph [0025]:

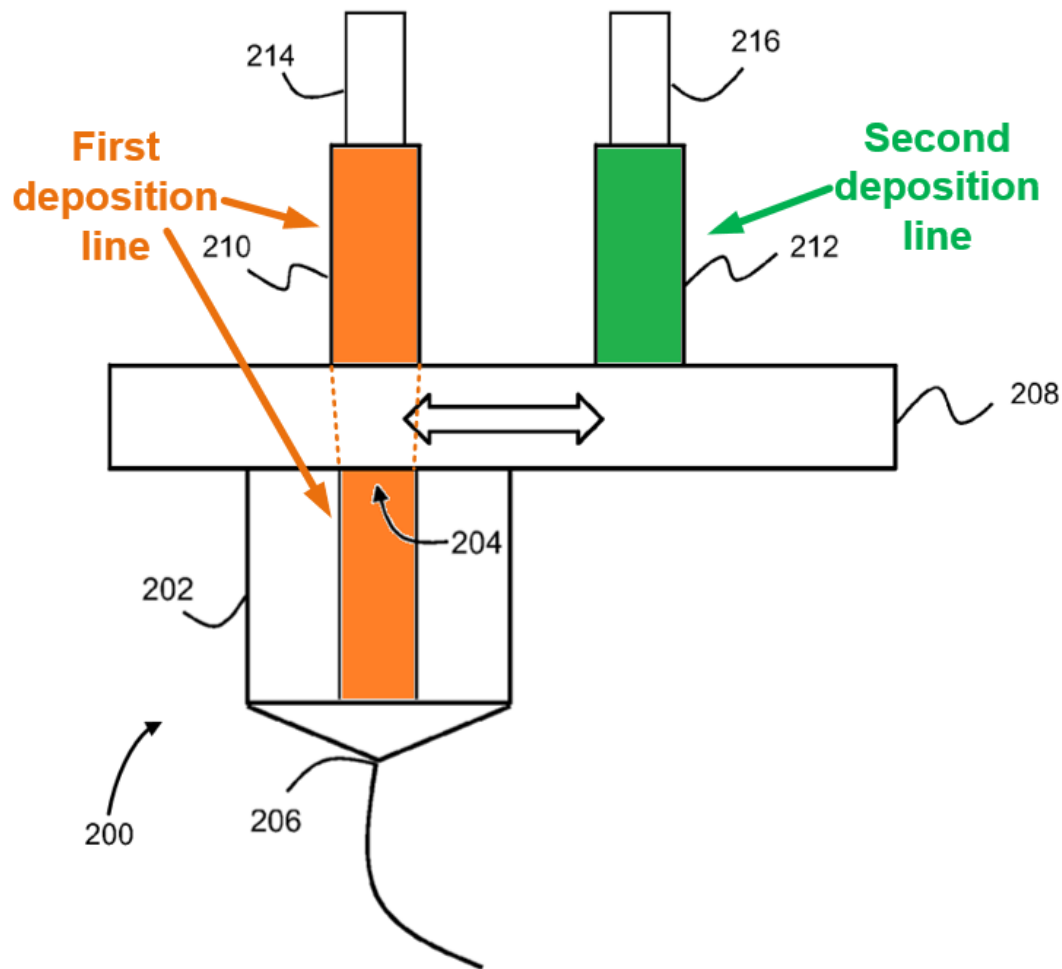


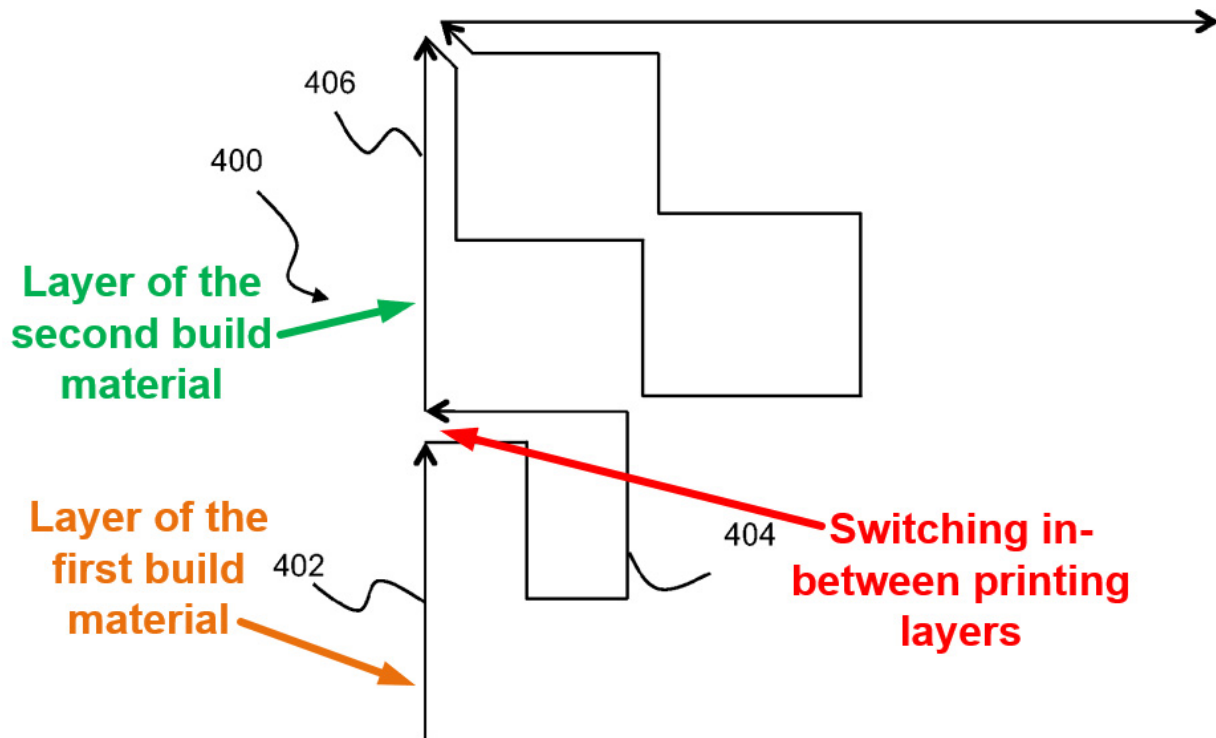
Fig. 2

EX1008, FIG. 2 (modified and annotated). Consequently, Boyer's extruder 200 includes *multiple deposition lines* that can fabricate a *three-dimensional part* and *support structure* object by changing between "two different build materials." EX1008, [0025], [0028], [0032]; EX1003, ¶221-225.

Element [1b]

According to the alternative claim construction (*supra* §IV.A), the transition of extrusion head 202 between alignment with first feed 210 and alignment with second feed 212 causes the *multiple deposition lines* of extruder 200 to *switch* between *stand-by* modes and *operating modes*. EX1008, [0025]-[0027], FIG. 2. EX1003, ¶226-227. This is because the *deposition line* in alignment with extrusion head 202 is configured to actively extrude build material via nozzle 206 in the *operating mode*, whereas the *deposition line* not in alignment with extrusion head 202 sits idle in the *stand-by mode*. EX1003, ¶227.

This *switching* of the multiple deposition lines between *stand-by modes* and *operating modes* occurs *in-between* printing layers of Boyer's "multiple build materials." EX1008, [0026], [0032]-[0037], FIGS. 4-5; EX1003, ¶228-229. For example, Boyer discloses that the printer can fabricate three-dimensional parts by "depositing successive layers of material in two-dimensional patterns." EX1008, [0018], *see also* [0024]. One of these two-dimensional patterns representing a layer of an object printed with multiple materials is depicted below in Boyer's FIG. 4:



EX1008, FIG. 4 (annotated).

To print according to the tool path of FIG. 4, Boyer's extruder 200 prints first segment 402 by extruding first build material 214 from the first *deposition line* when extruder head 202 is aligned with first feed 210. EX1008, [0025]-[0029], [0032], FIG. 2, FIG. 4; EX1003, ¶230. Boyer's extruder 200 prints third segment 406 from the second *deposition line* when extruder head 202 is aligned with second feed 212. EX1008, [0025]-[0029], [0032], FIG. 2, FIG. 4. *In-between* printing the first segment 402 (using part material) and the third segment 406 (using support material), the first *deposition line switches* from the *operating mode* to the *stand-by mode* and the second *deposition line switches* from the

stand-by mode to the *operating mode* when extruder head 202 transitions from alignment with first feed 210 to alignment with second feed 212. EX1008, [0025]-[0029], [0032]-[0034], [0044], FIG. 2, FIG. 4; EX1003, ¶226-232.

Element [1c]

Boyer's FIG. 4 shows an example "cross section of a multi-material build" where the first segment 402 is printed from a first material and the third segment 406 is printed from a second material. EX1008, [0032]; EX1003, ¶233. For example, Boyer's extruder 200 prints the first segment 402 with first build material 214 using the first *deposition line* when extruder head 202 is aligned with the first feed 210. EX1008, [0025]-[0029], [0034], FIG. 2, FIG. 4. After printing the first segment 402, Boyer's first *deposition line* switches to the *stand-by mode* and Boyer's second *deposition line* switches to the *operating mode* when extrusion head 202 transitions from alignment with first feed 210 to alignment with second feed 212. EX1008, [0025]-[0029], [0034], FIG. 2, FIG. 4.

Upon the second *deposition line* switching to the *operating mode*, extruder 200 performs a *purge operation* by printing transition segment 404 using the second *deposition line*. EX1008, [0032]; EX1003, ¶234. After the *purge operation*, extruder 200 prints the third segment 406 with second build material 216 using the second *deposition line* when extruder head 202 is aligned with the second feed 212. EX1008, [0025]-[0029], [0034], FIG. 2, FIG. 4. Boyer discloses

that more than one material change can occur in each layer printed by the extruder 200. EX1008, [0034]. Consequently, Boyer's extruder 200 will, in some cases, perform a ***purge operation*** each time there is a material change where one of the ***deposition lines*** transitions from the ***stand-by mode*** to the ***operating mode***.

EX1008, [0032]-[0034], [0037]-[0043], FIGS. 4-5; EX1003, ¶235. In addition to transition segment 404 corresponding to one material change (e.g., change from first material 214 to second material 216), Boyer's FIG. 4 depicts another transition segment corresponding to another material change (e.g., a change from second material 216 back to first material 214):

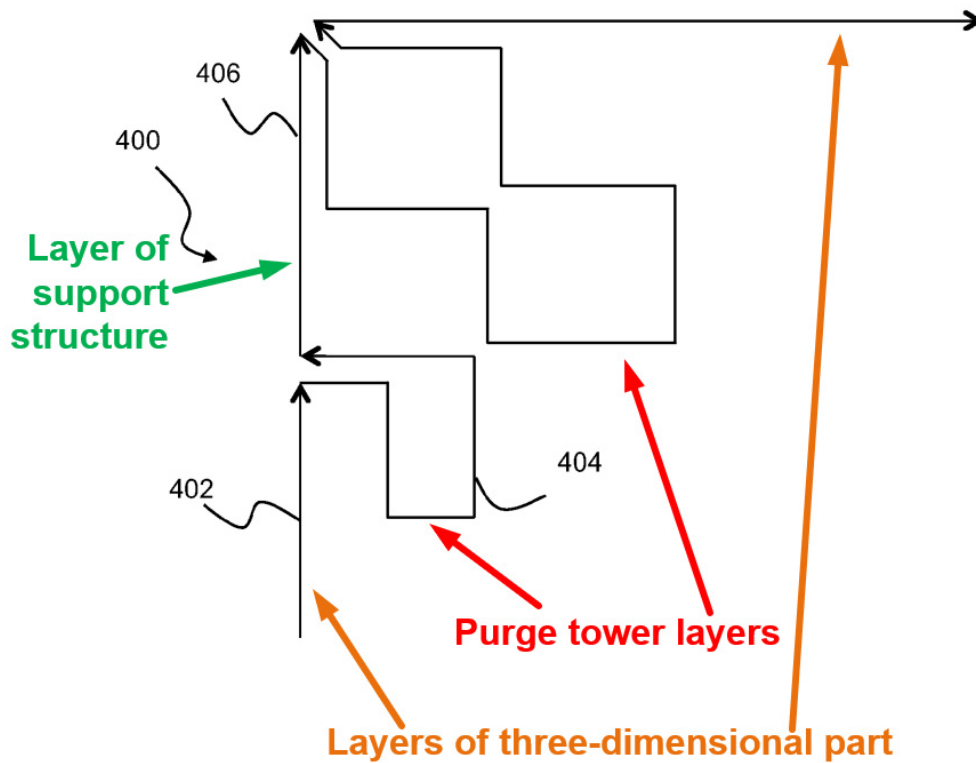


Fig. 4

EX1008, FIG. 4 (annotated).

Indeed, after extruder 200 prints the third segment 406, the extruder head 202 can slide back to alignment with first feed 210 so that the first *deposition line* transitions back to the first operating mode for depositing the first build material 214; EX1008, [0025]-[0029], [0032]-[0034], FIG. 2, FIG. 4. EX1003, ¶236. Following this material switch, the extruder 200 can perform another *purge operation* as depicted in FIG. 4 before printing another segment of the *three-dimensional part*. EX1008, FIG. 4.

As described above, Boyer discloses that the printer fabricates three-dimensional parts by “depositing successive layers of material in two-dimensional patterns.” EX1008, [0018], *see also* [0024]; EX1003, ¶237; *supra*, Elements [1pre]-[1b]. By describing tool path 400 as a “cross-section” of a multi-material build, Boyer teaches that layers printed using a similar two-dimensional tool path can exist above and/or below FIG. 4’s cross-section. EX1008, [0018], [0024], [0032]-[0034], FIG. 4. To form a three-dimensional part, two-dimensional layers such as the one depicted in FIG. 4 are stacked on top of one another so that the transition segments of FIG. 4 correspond to *purge towers* printed in a *layer-by-layer* manner. EX1008, [0032]-[0044], FIGS. 4-5; EX1003, ¶237-238.

Element [2a]

Boyer discloses techniques for using a printer to build three-dimensional parts by depositing multiple build materials in successive layers. EX1008, [0002], [0003], [0024], [0025], [0029], [0032]-[0034], FIG. 2, FIG. 4. As described above, Boyer discloses one embodiment where the printer comprises a single extruder 200 including *multiple deposition lines*. EX1008, [0025]-[0029], FIG. 2; *supra*, Element [1a]; *supra*, §V.C.1. These *multiple deposition lines* include a first *deposition line* where extrusion head 202 is aligned with first feed 210 for depositing first build material 214 and a second *deposition line* where extrusion

head 202 is aligned with second feed 212 for depositing second build material 216.

EX1008, [0025]-[0029], FIG. 2; EX1003, ¶239-242.

Element [2b]

To build a three-dimensional part by depositing multiple build materials, Boyer's extruder 200 transitions between using the first ***deposition line*** to deposit the first material 214 and using the second ***deposition line*** to deposit the second build material 216. EX1008, [0025]-[0029], FIG. 2; EX1003, ¶243-245; *supra*, Element [1a]; *supra*, §V.C.1. This transition occurs when the extrusion head 202 slides horizontally over filament changer 208 to change between alignment with first feed 210 and alignment with second feed 212 to ***switch*** the ***deposition lines*** between the ***stand-by modes*** and the ***operating modes***. EX1008, [0026]. For instance, when extrusion head 202 slides horizontally from being aligned with second feed 212 (as depicted in FIG. 2) to being aligned with first feed 210 (as depicted in a modified version of FIG. 2), the first deposition line ***switches*** from the ***stand-by mode*** to the ***operating mode*** for depositing the first material 214 and the second deposition line ***switches*** from the ***operating mode*** for depositing the second material 216 to the ***stand-by mode***:

Claim [6]

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Element [7a]

Boyer's printer can generate ***tool path instructions*** for printing one or more three-dimensional parts. EX1008, [0013], [0019], [0020], [0028], [0032]-[0034], [0036]-[0044], FIGS. 1, 2, 4-5; EX1003, ¶250-255. Specifically, Boyer discloses that "[t]he processor may...control an x-y-z positioning assembly...along with the extruder 200 and the filament changer 208 to fabricate an object from a three-dimensional model." EX1008, [0028] *see also* [0018]. Furthermore, Boyer expressly discloses a process for printing a three-dimensional part using multiple materials that begins "by determining a tool path for an extruder to fabricate an object from a three-dimensional model." EX1008, [0036]-[0040], FIG. 5. Boyer discloses that extruder 200 can use separate materials for a ***three-dimensional part*** and a ***support structure***. EX1008, [0044]. Consequently, Boyer discloses that the printer can generate ***tool path instructions*** for printing the ***layers*** of the ***three-dimensional part*** and ***support structure***. EX1003, ¶252-255.

Element [7b]

Boyer also discloses generating ***tool path instructions*** for printing at least one ***layer*** of a ***purge tower*** from a ***print head*** or ***deposition line*** switched to the operating mode. EX1008, [0032]-[0040] ("identifying a transition"), FIGS. 4-5. Boyer's multi-material build is not limited to materials having different colors. Boyer expressly discloses that the multiple materials used to print the object can

include separate materials for a *three-dimensional part* and a *support structure*.

EX1008, [0044]. Consequently, Boyer discloses *generating tool path instructions* for printing the *layer* of the *at least one purge tower*. EX1003, ¶256-258.

Claim [9]

Boyer discloses that generating the *tool path instructions* for the *three-dimensional part*, the *support structure*, and the *at least one purge tower* occurs prior to printing *layers* of the *three-dimensional part* and the *support structure*.

EX1008, [0035]-[0044], FIG. 5. For example, Boyer discloses that “a print may be initiated based upon tool instructions including the tool path and transitions described above.” EX1008, [0041]. Thus, printing the *layers* of the *three-dimensional part* and the *support structure* (“initiat[ion]” of the print job) occurs after the tool path instructions for the object (part and support structure) and the transitions (purge tower(s)) are generated. EX1003, ¶259-261.

VI. DISCRETIONARY DENIAL IS NOT JUSTIFIED

A. The Petition’s New Prior Art and Errors Made During Prosecution Warrant Institution—35 U.S.C. § 325(d)

This Petition does not present a situation where “the same or substantially the same prior art or arguments” were previously presented. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 (Feb. 13, 2020 (Precedential)). More specifically, regarding Part 1 of the *Advanced Bionics* framework, Ground 1 relies upon RepRap Article (EX1005) and RepRap

Video (EX1006), Grounds 2A-B rely upon KISSlicer (EX1010), and Ground 3 relies on Boyer (EX1008), each of which teaches a prior art example of a “purge tower”—the alleged improvement asserted in the ’713 patent (col. 5:7-17). *Supra*, Section II.A-B. These references were never addressed in any Office Action or remarks during prosecution. Indeed, they were never cited at all, and thus never considered in combination with Leavitt or Priedeman as articulated above. For this reason alone, such “new, noncumulative prior art asserted in the Petition” weighs against discretionary denial. *Oticon Medical AB v. Cochlear Ltd.*, IPR2019-00975, Paper 15 at 20 (Oct. 16, 2019 (§§II.B and II.C precedential)). And even if Part 2 of the *Advanced Bionics* framework is addressed, it is clear from the examiner’s reasons for allowance that there was a material error because RepRap, KISSlicer, and Boyer all suggested that which was mistakenly believed to be missing from the prior art. *Supra*, Section II.B.

B. The *Fintiv* Factors Weigh in Favor of Institution—35 U.S.C. § 314(a)

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.

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 or earlier, nearly contemporaneous with the theoretical start of jury selection on June 1, 2026 in the District Court. *See* EX1020.

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. *See* EX1020.

Factor 4 favors institution as Petitioner has made a stipulation not to pursue the IPR grounds in District Court. *See* EX1019.

Factor 5 is neutral. Although the parties in the parallel litigation are the same, there is no indication that the parallel litigation will reach a jury trial before the conclusion of this IPR.

And finally, 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 Deposit Account No. 06-1050.

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

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

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

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

Petitioner is not aware of any disclaimers, reexamination certificates, or other petitions for IPR of the '713 Patent. The '713 patent was asserted in *Stratasys, Inc. v. Shenzhen Tuozechu Technology Co. Ltd. et al.*, EDTX-2-24-cv-00645 (complaint service date: September 11, 2024). That case has been consolidated with EDTX-2:24-CV-644, which involves the same plaintiff and defendants. Additionally, the '713 patent is the subject of a declaratory judgment action (for non-infringement) in *BambuLab USA, Inc. et al. v. Stratasys, Inc.*, WDTX-1-24-cv-01511 (filed on December 9, 2024). The parties are also involved in concurrent case no. IPR2025-00257.

C. Lead And Backup Counsel Under 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 IPR56224-0005IP1@fr.com

(referencing No. 56224-0005IP1).

Respectfully submitted,

Dated December 17, 2024

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Attorneys for Petitioner

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 13,760 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated December 17, 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 17, 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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