

DECLARATION
FOR UTILITY OR DESIGN APPLICATION

Attorney Docket No.
S697.12-0253

SPECIFICATION AND INVENTORSHIP IDENTIFICATION

This declaration is directed to the subject matter which is claimed in the application entitled ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS the specification of which having the above title and/or attorney docket number S697.12-0253

 x is attached hereto,
 was filed on as Appln. No.
 was amended on , and/or
 was described and claimed in PCT International Application No. filed on and as amended with any Preliminary Amendment filed with National Stage entry.

AUTHORIZATION TO PERMIT ACCESS TO APPLICATION BY PARTICIPATING OFFICE

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In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the above-identified patent application with respect to: 1) the above-identified patent application-as-filed; 2) any foreign application to which the above-identified patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the above-identified patent application; and 3) any U.S. application-as-filed from which benefit is sought in the above-identified patent application.

In accordance with 37 CFR 1.14(e), access may be provided to information concerning the date of filing the Authorization to Permit Access to Application by Participating Offices.

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STATEMENTS

I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent Office all information known to me to be material to patentability as defined in 37 C.F.R. 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part.

If the above-identified application is to be or was filed on or after September 16, 2012:

I declare that the above-identified application was made or authorized to be made by me.

I believe I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

If the above-identified application was filed before September 16, 2012:

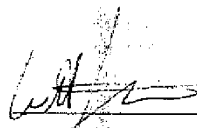
I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed, and for which a patent is sought, on the subject matter which is claimed in the above-identified application.

I declare that all statements made herein that are of my own knowledge are true and that all statements that are made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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DECLARATION
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Attorney Docket No.
S697.12-0253

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ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS

BACKGROUND

[0001] The present disclosure relates to additive manufacturing systems for printing or otherwise building three-dimensional (3D) parts with layer-based, additive manufacturing techniques. In particular, the present disclosure relates to purge operation techniques for use in extrusion-based additive manufacturing systems.

[0002] Additive manufacturing systems are used to print or otherwise build 3D parts from digital representations of the 3D parts (e.g., AMF and STL format files) using one or more additive manufacturing techniques. Examples of commercially available additive manufacturing techniques include extrusion-based techniques, jetting, selective laser sintering, powder/binder jetting, electron-beam melting, and stereolithographic processes. For each of these techniques, the digital representation of the 3D part is initially sliced into multiple horizontal layers. For each sliced layer, a tool path is then generated, which provides instructions for the particular additive manufacturing system to print the given layer.

[0003] For example, in an extrusion-based additive manufacturing system, a 3D part may be printed from a digital representation of the 3D part in a layer-by-layer manner by extruding a flowable part material. The part material is extruded through an extrusion tip or nozzle carried by a print head of the system, and is deposited as a sequence of roads on a substrate in an x-y plane. The extruded part material fuses to previously deposited part material, and solidifies upon a drop in temperature. The position of the print head relative to the substrate is then incremented along a z-axis (perpendicular to the x-y plane), and the process is then repeated to form a 3D part resembling the digital representation.

[0004] In fabricating 3D parts by depositing layers of a part material, supporting layers or structures are typically built underneath overhanging portions or in cavities of 3D parts under construction, which are not supported by the part material itself. A support structure may be built utilizing the same deposition techniques by which the part material is deposited. The host computer generates additional geometry acting as a support structure for the overhanging or free-

space segments of the 3D part being formed. Support material is then deposited from a second nozzle pursuant to the generated geometry during the printing process. The support material adheres to the part material during fabrication, and is removable from the completed 3D part when the printing process is complete.

SUMMARY

[0005] An aspect of the present disclosure is directed to a method for printing a 3D part with an additive manufacturing system. The method includes printing layers of the 3D part and of a support structure for the 3D part from multiple print heads or deposition lines using a layer-based, additive manufacturing technique, and switching the print heads or deposition line between stand-by modes and operating modes in-between the printing of the layers of the 3D part and the support structure. The method also includes performing a purge operation for each print head or deposition line switched to the operating mode, where the purge operation includes printing a layer of at least one purge tower from the print head or deposition line switched to the operating mode.

[0006] Another aspect of the present disclosure is directed to a method for printing a 3D part with an additive manufacturing system, which includes bringing a first print head or deposition line from a stand-by mode to an operating mode, printing a first layer of a purge tower from a support material using the first print head or deposition line in the operating mode, and printing a layer of a support structure from the support material using the first print head in the operating mode after printing the first layer of the purge tower. The method also includes bringing a second print head or deposition line from a stand-by mode to an operating mode, printing a second layer of the purge tower from a part material using the second print head or deposition line in the operating mode, and printing a layer of the 3D part from the part material using the second print head in the operating mode after printing the second layer of the purge tower.

[0007] Another aspect of the present disclosure is directed to a method for printing a 3D part with an additive manufacturing system, which includes printing a first layer of a support structure for the 3D part, printing a first layer of a purge tower from a part material, and printing a first layer of the 3D 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. The method also includes printing a

second layer of the purge tower from the support material, and printing a second layer of the support structure on at least a portion of the first layer of the 3D part from the support structure after printing the second layer of the purge tower.

DEFINITIONS

[0008] Unless otherwise specified, the following terms as used herein have the meanings provided below:

[0009] The terms "preferred" and "preferably" refer to embodiments of the invention that may afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful, and is not intended to exclude other embodiments from the scope of the present disclosure.

[0010] Directional orientations such as "above", "below", "top", "bottom", and the like are made with reference to a layer-printing direction of a 3D part. In the embodiments shown below, the layer-printing direction is the upward direction along the vertical z-axis. In these embodiments, the terms "above", "below", "top", "bottom", and the like are based on the vertical z-axis. However, in embodiments in which the layers of 3D parts are printed along a different axis, such as along a horizontal x-axis or y-axis, the terms "above", "below", "top", "bottom", and the like are relative to the given axis.

[0011] The term "providing", such as for "providing a print head", when recited in the claims, is not intended to require any particular delivery or receipt of the provided item. Rather, the term "providing" is merely used to recite items that will be referred to in subsequent elements of the claim(s), for purposes of clarity and ease of readability.

[0012] The terms "about" and "substantially" are used herein with respect to measurable values and ranges due to expected variations known to those skilled in the art (e.g., limitations and variabilities in measurements).

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a top, front perspective view of an additive manufacturing system in use with consumable assemblies for printing 3D parts, support structures, and a purge tower of the present disclosure.

[0014] FIG. 2A is a perspective view of a print head and guide tube for use with the additive manufacturing system.

[0015] FIG. 2B is an exploded perspective view of the print head.

[0016] FIG. 3A is a perspective view of a printed 3D part, support structure, and purge tower on a build substrate.

[0017] FIG. 3B is a top view of the printed 3D part, support structure, and purge tower on the build substrate.

[0018] FIG. 4 is a perspective view of a top portion of the purge tower.

[0019] FIG. 5 is a top view of a layer of the purge tower, illustrating a process for printing the layer.

[0020] FIG. 6 is a side view of simplified layers of a printed 3D part, support structure, and purge tower on a build substrate.

[0021] FIG. 7 is a side view of the printed 3D part, support structure, and purge tower on the build substrate.

[0022] FIG. 8 is a perspective view of a printed 3D part, support structure, purge tower, and a separate purge layer on a build substrate, which illustrates a first alternative purge tower embodiment.

[0023] FIG. 9 is a perspective view of a printed 3D part, support structure, and multiple purge towers on a build substrate, which illustrates a second alternative purge tower embodiment.

[0024] FIG. 10 is a perspective view of a top portion of a first alternative purge tower.

[0025] FIG. 11 is a top view of a layer of the first alternative purge tower, illustrating a process for printing the layer.

DETAILED DESCRIPTION

[0026] The present disclosure is directed to a method for printing 3D parts and support structures using an additive manufacturing system with the use of a purge tower (or multiple purge towers). As briefly mentioned above, in fabricating 3D parts by depositing layers of a part material, one or more support structures may be built underneath overhanging portions or in cavities of 3D parts under construction, which are not supported by the part material itself. The

support structures are preferably printed from a support material that is removable from the associated 3D part after the printing operation is completed.

[0027] To accomplish this, the additive manufacturing system may utilize multiple print heads or deposition lines, where a first print head or deposition line may be used to print the 3D part, and a second material print head or deposition line may be used to print the support structure. For ease of discussion, the following disclosure is made with reference to separate print heads for printing 3D parts and support structures, referred to as a "part print head" and a "support print head". Examples of such part and support print heads include those disclosed in Swanson et al., U.S. Publication Nos. 2010/0283172 and 2012/0164256. However, the method of the present disclosure is equally applicable for use with a single deposition head having multiple deposition lines for printing 3D parts and support structures. Examples of such deposition heads include those disclosed in Leavitt, U.S. Patent No. 7,625,200, and LaBossiere et al., U.S. Patent No. 7,604,470.

[0028] When printing with multiple print heads (or multiple deposition lines), each print head or deposition line is preferably switchable between an "operating mode" and a "stand-by mode". The operating mode is preferably a mode in which a liquefier assembly of the print head to be heated to its set point operating temperature(s) to generate a desired thermal gradient for melting the part or support material. In comparison, the stand-by mode is preferably a mode in which the liquefier assembly of the print head is cooled down from its operating mode to prevent its part or support material from thermally degrading, oozing or dripping out.

[0029] Additionally, in some embodiments, when switching between the operating mode and the stand-by mode, one or more of the print heads are may be lifted, pivoted, or otherwise moved relative to the build plane and/or each other, such as also disclosed in Leavitt, U.S. Patent No. 7,625,200, LaBossiere et al., U.S. Patent No. 7,604,470, and Swanson et al., U.S. Publication Nos. 2010/0283172 and 2012/0164256. For example, when switching from the operating mode to the stand-by mode, a print head may be lifted, pivoted, or otherwise moved away from the build plane by a small distance to prevent interference with the printed layers. Then, when subsequently switched back to its operating mode, the print head moved back to its original distance relative to the build plane for printing a subsequent layer.

[0030] Typically, when the part print head is in its operating mode to print a layer of the 3D part, the support print head is its stand-by mode, and vice versa. For example, after a 3D part

layer is completed, the additive manufacturing system may then switch the print heads such that the support print head is brought to its operating mode to print a layer of the support structure, and the part print head is brought to its stand-by mode. Then, after the support structure layer is completed, the additive manufacturing system may switch the print heads back such that the part print head is brought to its operating mode to print a layer of the support structure, and the part print head is brought to its stand-by mode.

[0031] When each print head is brought to its operating mode, it preferably undergoes a purge operation prior to printing the next layer. As discussed in Turley et al., U.S. Patent No. 7,744,364, a purge operation conventionally involves moving the given print head to a purge station, where it extrudes a strand of the part or support material into a purge bucket, optionally followed by a tip wipe operation.

[0032] This purge operation provides several desired functions. First, it frees any part or support material filament that may be adhered to the walls of the liquefier assembly, and verifies that the print head can extrude the part or support material. It also removes any entrained gases and degraded materials in the print head, and brings the print head to a known operating state for printing the subsequent layer, such as bringing a meniscus in the liquefier assembly to a substantially known position and raising the internal temperature of the liquefier assembly to a substantially steady-state condition. It also removes variable ooze that may hang from a nozzle of the liquefier assembly while the print head is idle or in its stand-by mode, and can account for variability of any voids in a tip pipe region of the nozzle. Additionally, for very low-volume-per-layer 3D parts, it may provide a minimum flow volume per layer to reduce the residence time-at-temperature for the part material.

[0033] However, the use of a purge station typically requires a sufficient amount of the part or support material to be extruded from the print head to have enough weight to fall away from the given print head and into a purge bucket. Furthermore, the purge station itself can take up a sizeable footprint in the additive manufacturing system, which may reduce the usable build volume for printing 3D parts. Moreover, the purge buckets periodically need to be emptied of the accumulate purged strands. This can inhibit the additive manufacturing system from functioning in a fully automated manner, such as in a printer farm.

[0034] As such, the method of the present disclosure is directed to a process in which the part and support print heads print a purge tower (or multiple purge towers) during the purge

operations. As discussed below, the purge tower allows each print head to achieve the above-discussed desired functions of a purge operation without requiring the use of a separate purge station. This can increase the useable build volume in the additive manufacturing system, as well as reducing the amount of part and support materials consumed during the purge operations and allowing the additive manufacturing system to operate in a fully automated manner.

[0035] FIG. 1 shows system 10 in use with two consumable assemblies 12, which illustrates a suitable additive manufacturing system for performing the method of the present disclosure to print 3D parts and support structures along with one or more purge towers. Each consumable assembly 12 is an easily loadable, removable, and replaceable container device that retains a supply of a consumable filament for printing with system 10. Typically, one of the consumable assemblies 12 contains a part material filament (“part material consumable assembly”), and the other consumable assembly 12 contains a support material filament (“support material consumable assembly”). However, both consumable assemblies 12 may be identical in structure.

[0036] In the shown embodiment, each consumable assembly 12 includes container portion 14, guide tube 16, print heads 18, where print heads 18 are individually referred to as part print head 18p (for the part material) and support print head 18s (for the support material). Container portion 14 may retain a spool or coil of a consumable filament, such as discussed in Mannella et al., U.S. Patent Application Nos. 13/334,910 and 13/334,921. Guide tube 16 interconnects container portion 14 and print head 18, where a drive mechanism of print head 18 (or of system 10) draws successive segments of the consumable filament from container portion 14, through guide tube 16, to a liquefier assembly of the print head 18.

[0037] In this embodiment, guide tube 16 and print head 18 are subcomponents of consumable assembly 12, and may be interchanged to and from system 10 with each consumable assembly 12. In alternative embodiments, guide tube 16 and/or print head 18 may be components of system 10, rather than subcomponents of consumable assemblies 12.

[0038] Suitable part and support materials for consumable assemblies 12 include those disclosed and listed in Crump et al., U.S. Patent No. 5,503,785; Lombardi et al., U.S. Patent Nos. 6,070,107 and 6,228,923; Priedeman et al., U.S. Patent No. 6,790,403; Comb et al., U.S. Patent No. 7,122,246; Batchelder, U.S. Patent Application Publication No. 2009/0263582; Hopkins et al., U.S. Patent Application Publication No. 2010/0096072; Batchelder et al., U.S. Patent

Application Publication No. 2011/0076496; and Batchelder et al., U.S. Patent Application Publication No. 2011/0076495.

[0039] System 10 is an additive manufacturing system for printing 3D parts or models and corresponding support structures (e.g., 3D part 20 and support structure 22) from the part and support material filaments, respectively, of consumable assemblies 12, using a layer-based, additive manufacturing technique. Additionally, as described further below, system 10 may also print purge tower 24 from the part and support materials during purge operations.

[0040] Suitable additive manufacturing systems for system 10 include extrusion-based systems developed by Stratasys, Inc., Eden Prairie, MN under the trademarks “FDM” and “FUSED DEPOSITION MODELING”. As shown, system 10 includes system casing 26, two bays 28, chamber 30, platen 32, platen gantry 34, head carriage 36, head gantry 38, z-axis motor 40, and a pair of x-y motors 42.

[0041] System casing 26 is a structural component of system 10 and may include multiple structural sub-components such as support frames, housing walls, and the like. In the shown embodiment, system casing 26 defines the dimensions of bays 28, and of chamber 30. Bays 28 are container bays configured to respectively receive container portions 14 of consumable assemblies 12. Typically, each of bays 28 may be intended to receive either a part material consumable assembly 12 or a support material consumable assembly 12.

[0042] In an alternative embodiment, bays 28 may be omitted to reduce the overall footprint of system 10. In this embodiment, container portions 14 may stand adjacent to system casing 26, while providing sufficient ranges of movement for guide tubes 16 and print heads 18. Bays 28, however, provide convenient locations for loading consumable assemblies 12.

[0043] Chamber 30 is an enclosed environment that contains platen 32 for printing 3D part 20 and support structure 22. Chamber 30 may be heated (e.g., with circulating heated air) to reduce the rate at which the part and support materials solidify after being extruded and deposited (e.g., to reduce distortions and curling). In alternative embodiments, chamber 30 may be omitted and/or replaced with different types of build environments. For example, 3D part 20 and support structure 22 may be built in a build environment that is open to ambient conditions or may be enclosed with alternative structures (e.g., flexible curtains).

[0044] Platen 32 is a platform on which 3D part 20, support structure 22, and purge tower 24 are printed in a layer-by-layer manner, and is supported by platen gantry 34. In some

embodiments, platen 32 may engage and support a build substrate 44, which may be a tray substrate as disclosed in Dunn et al., U.S. Patent No. 7,127,309, fabricated from plastic, corrugated cardboard, or other suitable material, and may also include a flexible polymeric film or liner, painter's tape, polyimide tape (e.g., under the trademark KAPTON from E.I. du Pont de Nemours and Company, Wilmington, DE), or other disposable fabrication for adhering deposited material onto the platen 32 or onto the build substrate 44. Platen gantry 34 is a gantry assembly configured to move platen 32 along (or substantially along) the vertical z-axis and is powered by z-axis motor 40.

[0045] Head carriage 36 is a unit configured to receive one or more removable print heads, such as print heads 18, and is supported by head gantry 38. Examples of suitable devices for head carriage 36, and techniques for retaining print heads 18 in head carriage 36, include those disclosed in Swanson et al., U.S. Publication Nos. 2010/0283172 and 2012/0164256.

[0046] As mentioned above, in some embodiments, guide tube 16 and/or print head 18 may be components of system 10, rather than subcomponents of consumable assemblies 12. In these embodiments, additional examples of suitable devices for print heads 18, and the connections between print heads 18 and head gantry 38 include those disclosed in Crump et al., U.S. Patent No. 5,503,785; Swanson et al., U.S. Patent No. 6,004,124; LaBossiere, et al., U.S. Patent Nos. 7,384,255 and 7,604,470; Batchelder et al., U.S. Patent No. 7,896,209; and Comb et al., U.S. Patent No. 8,153,182.

[0047] In the shown embodiment, head gantry 38 is a belt-driven gantry assembly configured to move head carriage 36 (and the retained print heads 18) in (or substantially in) a horizontal x-y plane above chamber 30, and is powered by x-y motors 42. Examples of suitable gantry assemblies for head gantry 38 include those disclosed in Comb et al., U.S. Patent No. 13/242,561.

[0048] In an alternative embodiment, platen 32 may be configured to move in the horizontal x-y plane within chamber 30, and head carriage 36 (and print heads 18) may be configured to move along the z-axis. Other similar arrangements may also be used such that one or both of platen 32 and print heads 18 are moveable relative to each other. Platen 32 and head carriage 36 (and print heads 18) may also be oriented along different axes. For example, platen 32 may be oriented vertically and print heads 18 may print 3D part 20 and support structure 22 along the x-axis or the y-axis.

[0049] System 10 may also include a pair of sensor assemblies (not shown) configured to read encoded markings from successive segments of the consumable filaments moving through guide tubes 16, such as disclosed in Batchelder et al., U.S. Patent Application Publication Nos. 2011/0117268, 2011/0121476, and 2011/0233804.

[0050] System 10 also includes controller 46, which is one or more control circuits configured to monitor and operate the components of system 10. For example, one or more of the control functions performed by controller 46 can be implemented in hardware, software, firmware, and the like, or a combination thereof. Controller 46 may communicate over communication line 48 with print heads 18, chamber 30 (e.g., with a heating unit for chamber 30), head carriage 36, motors 40 and 42, sensor assemblies 44, and various sensors, calibration devices, display devices, and/or user input devices. In some embodiments, controller 46 may also communicate with one or more of bays 28, platen 32, platen gantry 34, head gantry 38, and any other suitable component of system 10.

[0051] While illustrated as a single signal line, communication line 48 may include one or more electrical, optical, and/or wireless signal lines, allowing controller 46 to communicate with various components of system 10. Furthermore, while illustrated outside of system 10, controller 46 and communication line 48 may be internal components to system 10. System 10 and/or controller 46 may also communicate with one or more computer-based systems, such as computer 50, which may include computer-based hardware, such as data storage devices, processors, memory modules and the like for generating, storing, and transmitting tool path and related printing instructions to system 10, and may be external and/or internal to system 10. In some embodiments, controller 46 itself may perform one or more of the operations typically performed by computer 50 or other components of system 10, such as generating and storing tool path and related printing instructions, perform compiler functions, and the like.

[0052] During operation, controller 46 may direct z-axis motor 40 and platen gantry 34 to move platen 32 to a predetermined height within chamber 30. Controller 46 may then direct motors 42 and head gantry 38 to move head carriage 36 (and the retained print heads 18) around in the horizontal x-y plane above chamber 30. Controller 46 may also direct print heads 18 to selectively draw successive segments of the consumable filaments from container portions 14 and through guide tubes 16, respectively.

[0053] FIGS. 2A and 2B illustrate an example print head 18, which includes housing 18a, motor assembly 18b, drive mechanism 18c, and liquefier assembly 18d, where liquefier assembly 18d includes nozzle 18e. At each print head 18, motor assembly 18b and drive mechanism 18c feed successive segments of the consumable filament to liquefier assembly 18d, which thermally melts the received successive segments such that the consumable filament becomes a molten material. The molten material is then extruded from nozzle 18e and deposited onto platen 32 for printing 3D part 20, support structure 22, and purge tower 24 in a layer-by-layer manner.

[0054] As discussed in Swanson et al., U.S. Patent Application No. 13/587,002, nozzle 18e may have an axial channel any suitable length-to-diameter ratio. For example, in some embodiments, nozzle 18e may have an axial channel with a length-to-diameter ratio to generate high flow resistance, such as a ratio of about 2:1 to about 5:1. In other embodiments, nozzle 18e may have an axial channel with a length-to-diameter ratio to generate lower flow resistance, such as a ratio less than about 1:1. Accordingly, suitable length-to-diameter ratios for the axial channel of nozzle 18e may range from about 1:2 to about 5:1, where in some low-flow resistance embodiments, ratios ranging from about 1:2 to about 1:1 may be preferred for use with the method of the present disclosure.

[0055] After the print operation is complete, the resulting 3D part 32 and support structure 22 may be removed from chamber 30, and support structure 22 may be removed from 3D part 20. Purge tower 24 itself may be then recycled or otherwise discarded as desired. 3D part 20 may then undergo one or more additional post-processing steps.

[0056] As shown in FIG. 1, and further shown in FIGS. 3A and 3B, purge tower 24 may be printed at any suitable free location on build substrate 44 (i.e., at any location in the x-y build plane not occupied by 3D part 20 or support structure 22). As discussed further below, each layer of purge tower 24 is printed by either the part material or by the support material depending on when print heads 18 switch between their operating modes and their stand-by modes and perform the purge operations.

[0057] As further shown in FIGS. 4, purge tower 24 is printed in a layer-by-layer manner to define perimeter wall 52 and interior wall 54, where perimeter wall 52 has a diamond-shaped cross-sectional geometry in the x-y build plane that defines interior volume 56. Interior wall 54 resides inside interior volume 56, and, in the shown embodiment, bisects or substantially bisects

interior volume 56. This is a particularly suitable geometry for printing purge tower 24 at fast print rates and with low amounts of materials since, for each layer, perimeter wall 52 and interior start wall 54 may be printed from a single tool path. This accordingly reduces delays and material consumption during the purge operations. However, in other embodiments, one or more of the layers of purge tower 24 may be printed with two or more tool paths.

[0058] In alternative embodiments, purge tower 24 may have any suitable perimeter wall geometry that preferably defines an interior volume that is substantially enclosed in the x-y build plane for retaining an interior wall 52. Examples of suitable perimeter wall geometries include square walls, rectangular walls, circular walls, elliptical walls, and the like, where single-tool path, simple geometries are preferred for fast print rate purposes.

[0059] As shown in FIG. 5, each layer of purge tower 24 (referred to as layer 24a) is preferably printed along the same tool path 58, which has a start vertex 60, corner vertices 62a-62d, and stop vertex 64, and tool path segments 58a-58e extending therebetween. As mentioned above, controller 46 may direct one of print heads 18 to perform a purge operation by printing a layer 24a of purge tower 24 after the given print head 18 switches from its stand-by mode to its operating mode, and prior to printing a subsequent layer of 3D part 20 or support structure 22.

[0060] When performing the purge operation, controller 46 may direct head gantry 36 to move the print head 18 over to start vertex 60. Controller 46 may then direct a drive mechanism of the print head 18 to feed the part or support material filament to the print head 18 to extrude the part or support material. Controller 46 may also direct head gantry 36 to move the print head 18 along tool path segments 58a-58e in the direction of arrows 68a-68e. Upon reaching stop vertex 64, controller 46 may direct the print head 18 to stop extruding the part or support material to complete layer 24a.

[0061] This tool path pattern is beneficial for containing any excess stringing at the extrusion start up to a region within interior volume 56. In other words, perimeter wall 52 prevents any stringing that may occur from exiting purge tower 24, which could otherwise potentially interfere with the printing of 3D part 20 or support structure 22 due to the close proximity of purge tower 24 and 3D part 20 (compared to the offset locations of conventional purge stations).

[0062] The length of tool path segment 58a between start vertex 60 and the first corner vertex 62a may vary depending on the stringing conditions of the print head 18, which may be

based on multiple factors, such as the thermal properties of the print head 18, the composition of the part or support material, the extrusion rate and movement rate of print head 18, the temperature within chamber 30, the amount of degraded materials and gases accumulated in the print head 18 during its stand-by mode, and the like. The lengths of tool path segments 58b-58e may accordingly be based on the length of tool path segment 58a.

[0063] Furthermore, while illustrated as extending entirely across interior volume 56, tool path segment 58a may alternatively be shorter, such that start vertex may be positioned at any suitable location relative to the first corner vertex 62a to contain the excess stringing to a region within interior volume 56. Overall, the entire length of tool path 58 is preferably sufficient such that the print head 18 attains a known operating state for printing the subsequent layer of 3D part 20 or support structure 22, and more preferably such that print head 18 achieves all of the above-discussed desired functions of a purge operation (without requiring the use of a separate purge station).

[0064] Optionally, as shown, stop vertex 64 may alternatively function as another corner vertex, and tool path 58 may be directed across the top of layer 24a, such as illustrated by tool path segment 58f to a subsequent stop vertex 66 located outside of purge tower 24. However, when following tool path segment 58f, controller 46 preferably directs the print head 18 not to extrude any material. Instead, the movement of the print head along tool path segment 58f (or any other similar tool path segment) allows nozzle 18e of the print head 18 to wipe along perimeter wall 52 at tool path segment 58c. As such, purge tower 24 may also function as a tip wipe device, which further precludes the need for a separate purge station.

[0065] As mentioned above, each layer 24a of purge tower 24 is preferably printed along the same tool path 58. However, in situations in which purge tower 24 will be printed high enough that its height is substantially greater than its cross-sectional area, it can be beneficial to print the lower layers 24a of purge tower 24 with larger cross-sectional areas, with walls that slope or taper to small cross-sectional areas at the higher layers. This preferably prevents the portion of purge tower 24 from wobbling during the printing operation, which can otherwise impair the printing of subsequent layers.

[0066] Computer 50 (or controller 46) may generate tool path instructions for printing purge tower 24 at any suitable time before and/or during the printing operation. In a first embodiment, purge tower 24 may be generated when slicing and generating supports for 3D part

20. For example, upon receipt of a digital model for 3D part 20, computer 50 may run a pre-processing program to slice 3D part 20 into the separate layers, generate support structure 22, and generate tool paths for 3D part 20 and support structure 22. Examples of suitable pre-processing programs includes those developed by Stratasys, Inc., Eden Prairie, MN under the trademarks "INSIGHT" and "CATALYST", which may be modified to generate the tool paths (e.g., tool path 58) for each layer of purge tower 24.

[0067] In a second embodiment, the tool paths for purge tower 24 may be post-processed into the previously-generated tool path instructions with a separate post-processing program (after running the pre-processing program). This post-processing program may operated manually by a user, or may be invoked in an automated manner by the pre-processing program and/or controller 46.

[0068] In a third embodiment, the tool paths for purge tower 24 may be compiled by computer 50 during the printing operation. In this embodiment, when system 10 is printing a given layer, computer 50 may look ahead at the generated tool path instructions and identify when the next material switch will occur. At this point, computer 50 may compile and insert a tool path (e.g., tool path 58) for purge tower 24 in the timing sequence to occur after the next print head 18 switch. Preferably, computer 50 may also compute the amount of part or support material required to print the given layer of purge tower 24 to ensure that consumable assemblies 12 still have enough supplies of the part or support materials to complete the printing operation.

[0069] The particular material used for each layer 24a depends on which print head 18 will be switched from its stand-by mode to its operating mode for the given layer of 3D part 20 and support structure 22. This timing typically depends on when the tool paths for the layers of 3D part 20 and support structure 22 require material switching. For instance, FIG. 6 illustrates a simplified layer arrangement for a 3D part 70 and support structure 72 that may be printed with system 10, where 3D part 70 is printed from part print head 18p with part layers 70a-770d, and support structure 72 is printed from support print head 18s with support layers 72a-72d (shown with speckle fill). In this example, print heads 18 may also print purge tower 74 from the part and support materials during the purge operations.

[0070] As shown, the first two printed layers 72a and 72b are for support structure 72. As such, prior to printing support layer 72a on build substrate 44, support print head 18s may be brought to its operating mode and undergo a purge operation by printing layer 74a of purge

tower 74 from the support material, preferably following the same tool path 58 discussed above for purge tower 24 (shown in FIG. 5). Support print head 18s may then print support layer 72a from the support material following designated tool paths. When support layer 72a is completed, platen gantry 34 may lower platen 32 and build substrate 44 downward along the z-axis by a single layer increment.

[0071] Then, because support layer 72b is also printed entirely from the support material, support print head 18s may print support layer 72b following designated tool paths, and then print layer 74b of purge tower 74 from the support material. Alternatively, if desired, the tool path configuration may be arranged such that support print head 18s prints layer 74b prior to printing support layer 72b. Support layer 72b is necessary for maintaining purge tower 74 at the same height as the printed layers of 3D part 70 and support structure 72.

[0072] When layers 72b and 74b are completed, platen gantry 34 may then lower platen 32 and build substrate 44 downward along the z-axis by a single layer increment. As can be seen, layers 70a and 72c are coplanar with each other. As such, because support print head 18s is the current print head 18 in its operating mode (part print head 18p is currently in its stand-by mode), support layer 72c may be printed prior to part layer 70a. Accordingly, support print head 18s may print support layer 72c from the support material following designated tool paths.

[0073] Then, print heads 18 may be switched such that support print head 18s is brought to its stand-by mode and part print head 18p is brought to its operating mode. Part print head 18p may then undergo a purge operation by printing layer 74c of purge tower 74 from the part material, preferably following the same tool path 58 discussed above for purge tower 24. Part print head 18p may then print part layer 70a from the part material following designated tool paths. When part layer 70a is completed, platen gantry 34 may lower platen 32 and build substrate 44 downward along the z-axis by a single layer increment.

[0074] The next layers 70b and 72d are also coplanar with each other. As such, because part print head 18p is the current print head 18 in its operating mode (support print head 18s is currently in its stand-by mode), part layer 70b may be printed prior to support layer 72d. Accordingly, part print head 18p may print part layer 70b from the part material following designated tool paths.

[0075] Then, print heads 18 may be switched back such that part print head 18p is brought to its stand-by mode and support print head 18s is brought to its operating mode.

Support print head 18s may then undergo a purge operation by printing layer 74d of purge tower 74 from the support material. Support print head 18s may then print support layer 72d from the support material following designated tool paths. When support layer 72d is completed, platen gantry 34 may lower platen 32 and build substrate 44 downward along the z-axis by a single layer increment.

[0076] Then, because support layer 70c is printed entirely from the part material, and because support print head 18s is the current print head 18 in its operating mode, print heads 18 may be switched such that support print head 18s is brought to its stand-by mode and part print head 18p is brought to its operating mode. Part print head 18p may then undergo a purge operation by printing layer 74e of purge tower 74 from the part material. Part print head 18p may then print part layer 70c from the part material following designated tool paths. When part layer 70a is completed, platen gantry 34 may lower platen 32 and build substrate 44 downward along the z-axis by a single layer increment.

[0077] Then, because part layer 70d is also printed entirely from the part material, and because part print head 18p is the current print head 18 in its operating mode, print head 18p may print part layer 70d following designated tool paths. At this point, because there are no further layers of support structure 72, there will be no further switching between operating and stand-by modes for print heads 18. In particular, purge tower 70 can be stopped at the highest layer at which there is a material change (i.e., a switch from part to support material, or vice versa) Accordingly, additional layers for purge tower 24 are no longer necessary, and may be omitted. On the other hand, if additional support layers for support structure 72 are to be subsequently printed, additional layers of purge tower may be printed from the part material with each layer of 3D part 70 until the next print head switching and purge operation is required.

[0078] FIG. 7 illustrates a suitable example for printing 3D part 20, support structure 22, and purge tower 24 in the same manner, where 3D part 20 has a base portion 20a, a shaft portion 20b, and an overhanging top portion 20c. Similarly, support structure 22 has an anchor portion 22a that supports and anchors base portion 20a to build substrate 44, and an upper portion 22b that supports overhanging top portion 20c and encapsulates shaft portion 20b.

[0079] As further shown, the layers of 3D part 20 and support structure 22 may be grouped into stack regions 76a-76e. At stack region 76a, the layers only include the support material for anchor portion 22a. Above that, at stack region 76b, each layer includes the part

material for base portion 20a and the support material for anchor portion 22a. Then, at stack region 76c, the layers only include the part material for base portion 20a. Above that, at stack region 76d, each layer includes the part material for shaft portion 20b and the support material for upper portion 22b. Finally, at stack region 76e, the layers only include the part material for overhanging top portion 20c.

[0080] As discussed above for purge tower 74 (shown in FIG. 6), the layers of purge tower 24 may also stagger and interlace between the part and support materials in patterns that are based on the layer patterns of stack regions 76a-76e. For example, prior to printing the layers for anchor portion 22a of support structure 22, support print head 18s may switch to its operating mode and perform a purge operation by printing a first layer of purge tower 24 onto build substrate 44 from the support material. Support print head 18s may then print the first layer of anchor portion 22a onto build substrate 44 from the support material.

[0081] The printing of purge tower 24 and anchor portion 22a may then be repeated for each layer in stack region 76a, where platen gantry 32 may incrementally lower platen 30 and platen substrate 44 downward by a single layer increment between each printed layer. As such, the layers of purge tower 24 at stack region 76a may be printed entirely from the support material, and purge tower 24 preferably has the same height as the printed layers of anchor portion 22a.

[0082] After the last layer in stack region 76a is completed, and platen gantry 32 lowers platen 30 and platen substrate 44 downward by a single layer increment, the situation changes because the next layer increment (i.e., the first layer in stack region 76b) includes a layer of base portion 20a (i.e., part material) and a layer of anchor portion 22a (i.e., support material). As such, because support print head 18s is the current print head 18 in its operating mode, support print head 18s may print the layer of anchor portion 22a from the support material. Print heads 18 may then be switched such that support print head 18s is brought to its stand-by mode and part print head 18p is brought to its operating mode. Part print head 18p may then undergo a purge operation by printing the next layer of purge tower 24 from the part material, and then print the layer for base portion 20a.

[0083] After the current layer is completed, platen gantry 32 may lower platen 30 and platen substrate 44 downward by a single layer increment, and part print head 18p may print the next layer of base portion 20a from the part material. Print heads 18 may then be switched such

that part print head 18p is brought to its stand-by mode and support print head 18s is brought to its operating mode. Support print head 18s may then undergo a purge operation by printing the next layer of purge tower 24 from the support material, and then print the layer for anchor portion 22a.

[0084] This back-and-forth switching may then be repeated for each layer in stack region 76b following the same pattern as discussed above for part layers 70a and 70b, support layers 72c and 72d (shown in FIG. 6), and purge tower layers 74c and 74d. As such, for stack region 76b, the layers of purge tower 24 have an interlaced pattern that switches back and forth between the part material and the support material on a layer-by-layer basis.

[0085] After the last layer in stack region 76b is completed, and platen gantry 32 lowers platen 30 and platen substrate 44 downward by a single layer increment, the situation changes again because the next layer (i.e., the first layer in stack region 76c) includes only the part material for base portion 20a. As such, if support print head 18s is currently the print head 18 in its operating mode, print heads 18 may be switched such that support print head 18s is brought to its stand-by mode and part print head 18p is brought to its operating mode. Part print head 18p undergo a purge operation by printing the next layer of purge tower 24 from the part material.

[0086] Alternatively, if part print head 18p is currently the print head 18 in its operating mode, it may remain in its operating mode, and print the next layer of purge tower 24 from the part material to maintain the height of purge tower 24. Part print head 18p may then print each successive layer of base portion 20a and purge tower 24 in stack region 76c from the part material, where platen gantry 32 may incrementally lower platen 30 and platen substrate 44 downward by a single layer increment between each printed layer. As such, the layers of purge tower 24 at stack region 76c may be printed entirely from the part material, and purge tower 24 preferably has the same height as the printed layers of base portion 20a.

[0087] After the last layer in stack region 76c is completed, and platen gantry 32 lowers platen 30 and platen substrate 44 downward by a single layer increment, the situation changes again because the next layer (i.e., the first layer in stack region 76d) includes a layer of shaft portion 20b (i.e., part material) and a layer of upper portion 22b (i.e., support material). As such, because part print head 18p is the current print head 18 in its operating mode at this point, part print head 18p may print the first layer of shaft portion 22b from the part material.

[0088] Print heads 18 may then be switched such that part print head 18p is brought to its stand-by mode and support print head 18s is brought to its operating mode. Support print head 18s may then undergo a purge operation by printing the next layer of purge tower 24 from the support material, and then print the first layer for upper portion 22b. The same back-and-forth switching as discussed above for stack region 76b may then be repeated for each layer in stack region 76d. As such, for stack region 76d, the layers of purge tower 24 have an interlaced pattern that switches back and forth between the part material and the support material on a layer-by-layer basis.

[0089] After the last layer in stack region 76b is completed, and platen gantry 32 lowers platen 30 and platen substrate 44 downward by a single layer increment, the situation changes again because the next layer (i.e., the first layer in stack region 76e) includes only the part material for overhanging top 20c. As such, if support print head 18s is currently the print head 18 in its operating mode, print heads 18 may be switched such that support print head 18s is brought to its stand-by mode and part print head 18p is brought to its operating mode. Part print head 18p undergo a purge operation by printing the next layer of purge tower 24 from the part material.

[0090] Alternatively, if part print head 18p is currently the print head 18 in its operating mode, it may remain in its operating mode, and print the next layer of purge tower 24 from the part material to maintain the height of purge tower 24. Part print head 18p may then print each successive layer of overhanging top in stack region 76e from the part material, where platen gantry 32 may incrementally lower platen 30 and platen substrate 44 downward by a single layer increment between each printed layer.

[0091] At this point, because there are no subsequent layers of support structure 22, no additional layers of purge tower 24 are required, as shown. As mentioned above, purge tower 24 can be stopped at the highest layer at which there is a material change (i.e., a switch from part to support material, or vice versa). As such, at stack region 76e, purge tower only requires a single part material layer if part print head 18p was required to be switched to its operating mode for a purge operation. Otherwise, subsequent layers of purge tower 24 may be omitted to reduce material consumption and printing time.

[0092] As discussed above, 3D part 20 is preferably printed on one or more layers of support structure 22 (i.e., anchor portion 22a) to anchor 3D part 20 to build substrate 44. This

can assist in reducing curl in 3D part 20 during the printing operation. However, alternative printing instructions may produce a situation where the first layer to be printed on build substrate 44 includes tool paths for the 3D part (i.e., part material) and tool paths for the support structure (i.e., support material). In this case, two purge operations will be required for printing the first layer.

[0093] However, because purge tower 24 needs to grow at the same layer rate as the 3D part/support structure, both purge operations cannot be stacked at purge tower 24. Instead, as shown in FIG. 8, one of the purge operations will require a second tool path location (as a single layer 78) laterally adjacent to the first layer of purge tower 24. The remaining purge operations may then be printed on top of the first layer of purge tower 24.

[0094] Alternatively, as shown in FIG. 9, two or more grown purge towers (referred to purge towers 24p and 24s) may be used. In this embodiment, purge tower 24p may be printed entirely from the part material, and purge tower 24s may be printed entirely from the support material. As such, for each layer of 3D part 20 and/or support structure 22, a layer of part material is printed for purge tower 24p and a layer of support material is printed for purge tower 24s. As can be appreciated, this embodiment is less preferred to that shown above with the integrated part/support material purge tower 24, but may function as a usable alternative for performing purge operations.

[0095] FIGS. 10 and 11 illustrate an alternative embodiment for purge tower 24, which includes a pair of interior walls 54a and 54b in lieu of a single interior wall 54. As shown in FIG. 11, each layer of this embodiment purge tower 24 may be printed with tool path 58, starting at start vertex 60, and printing a road of part or support material that follows tool path segments 58a-58f and around corner vertices 62a-62e, until stop vertex 64 is reached. As such, in this embodiment, both the start vertex 60 and the stop vertex 64 are located within interior volume 56.

[0096] This is beneficial for containing any excess stringing that may occur after the extrusion is stopped to the region within interior volume 56, along with any excess stringing that may occur at the start point, as discussed above. In this embodiment, stop vertex 64 may also optionally function as another corner vertex, and tool path 58 may be directed across the top of layer 24a, as illustrated by tool path segment 58g to a subsequent stop vertex 66 located outside of purge tower 24 to wipe nozzle 18e of the print head 18 to wipe along perimeter wall 52 at tool

path segment 58d (or any other suitable location along perimeter wall 52). As such, in this embodiment, purge tower 24 may also function as a tip wipe device, which further precludes the need for a separate purge station.

[0097] In some embodiments, system 10 may be operated in a continuous-build manner utilizing scaffolds, such as disclosed in Crump et al., U.S. Patent Application No. 13/587,009; Swanson et al., U.S. Patent Application No. 13/587,012; and Mannella, U.S. Patent Application No. 13/587,015. In these embodiments, separate purge towers 24 may be used with each subsequent 3D part, and may be formed on starter wedges along with each subsequent 3D part.

[0098] Accordingly, the method of the present disclosure for performing purge operations by printing one or more purge towers (e.g., purge towers 24 and 74) is beneficial for achieving the above-discussed desired functions of a purge operation without requiring the use of separate purge stations. Additionally, because the purge towers (e.g., purge towers 24 and 74) are generated as 3D parts/support structures, they may be implemented entirely by software/firmware changes to controller 46 and/or computer 50 rather than with hardware changes. As such, the above-discussed method may be readily retrofitted into existing additive manufacturing systems for immediate use. This is particularly useful for establishing printing farms of additive manufacturing systems, which may require full automation of the systems to print numerous 3D parts over extended durations (e.g., over days, weeks, or months).

[0099] Although the present disclosure has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the disclosure.

CLAIMS:

1. A method for printing a three-dimensional part with an additive manufacturing system, the method comprising:
 - 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;
 - 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;
 - performing a purge operation for each print head or deposition line switched to the operating mode, the purge operation comprising printing a layer of at least one purge tower from the print head or deposition line switched to the operating mode.
2. The method of claim 1, wherein the multiple print heads or deposition lines comprise a first deposition line and a second deposition line, and 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.
3. The method of claim 1, wherein the multiple print heads or deposition lines comprise a first print head and a second print head, and wherein switching the print heads between the stand-by modes and the operating modes comprises:
 - switching the first print head from the stand-by mode to the operating mode; and
 - switching the second print head from the operating mode to the stand-by mode.
4. The method of claim 1, wherein printing the layer of the at least one purge tower comprises:

printing along a first tool path segment between a start vertex and a first corner vertex;

printing along one or more additional tool path segments from the first corner vertex to a stop vertex, which at least partially encases the first tool path segment in a build plane.

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.

7. 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
generating tool path instructions for printing the layer of the at least one purge tower.

8. 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 after printing a portion of the layers of the three-dimensional part, after printing a portion of the layers of the support structure, or both.

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.

10. A method for printing a three-dimensional part with an additive manufacturing system, the method comprising:

bringing a first print head or deposition line from a stand-by mode to an operating mode;
 printing a first layer of a purge tower from a support material using the first print head or deposition line in the operating mode;
 printing a layer of a support structure from the support material using the first print head in the operating mode after printing the first layer of the purge tower;
 bringing a second print head or deposition line from a stand-by mode to an operating mode;
 printing a second layer of the purge tower from a part material using the second print head or deposition line in the operating mode; and
 printing a layer of the three-dimensional part from the part material using the second print head in the operating mode after printing the second layer of the purge tower.

11. The method of claim 10, wherein bringing the first print head or deposition line from the stand-by mode to the operating mode comprises heating a liquefier assembly of the first print head or deposition line.

12. The method of claim 10, and further comprising:

bringing the first print head or deposition line from the operating mode to the stand-by mode while bringing the second print head or deposition line from the stand-by mode to the operating mode;
 bringing the first print head or deposition line back from the stand-by mode to the operating mode;
 printing a third layer of a purge tower from the support material using the first print head or deposition line brought back to the operating mode;
 printing a layer of the support structure from the support material using the first print head brought back to the operating mode after printing the third layer of the purge tower.

13. The method of claim 10, and further comprising printing additional layers of the purge tower such that the purge tower maintains the same height perpendicular to a build plane the printed layers of the three-dimensional part and support structure.
14. The method of claim 10, wherein printing the first layer and the second layer of the one purge tower each comprises:
- printing along a first tool path segment between a start vertex and a first corner vertex;
 - printing along one or more additional tool path segments from the first corner vertex to a stop vertex, which at least partially encases the first tool path segment in a build plane.
15. The method of claim 14, wherein the one or more additional tool path segments define a diamond-shaped pattern in the build plane.
16. A method for printing a three-dimensional part with an additive manufacturing system, the method comprising:
- (a) printing a first layer of a support structure for the three-dimensional part;
 - (b) printing a first layer of a purge tower from a part material;
 - (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;
 - (d) printing a second layer of the purge tower from the support material; and
 - (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 structure 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.

18. The method of claim 17, wherein at least a portion of the layers of the purge tower are interlaced between the part material and the support material on a layer-by-layer basis.

19. The method of claim 16, wherein the purge tower comprises a perimeter wall and an interior wall printed from a single tool path, wherein for each printed layer of the purge tower, the interior wall is printed prior to the printing of the perimeter wall.

20. The method of claim 19, wherein the perimeter wall defines a diamond-shape cross-sectional geometry in a build plane.

ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS

ABSTRACT

A method for printing a three-dimensional part with an additive manufacturing system, the method including printing layers of the three-dimensional part and of a support structure for the three-dimensional part from multiple print heads or deposition lines, and 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. The method also includes performing a purge operation for each print head or deposition line switched to the operating mode, where the purge operation includes printing a layer of at least one purge tower from the print head or deposition line switched to the operating mode.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	S697.12-0253
		Application Number	
Title of Invention	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number		S697.12-0253	
		Application Number			
Title of Invention		ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS			
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Title of the Invention	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS		
Attorney Docket Number	S697.12-0253	Small Entity Status Claimed ☐	
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	S697.12-0253
		Application Number	
Title of Invention	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS		
Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	27367		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.			
Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			Add

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).			
			Remove
Application Number	Country i	Filing Date (YYYY-MM-DD)	Priority Claimed
			☐ Yes ☒ No
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Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices
--

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	S697.12-0253
		Application Number	
Title of Invention	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS		

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In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

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Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

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- ☒ Assignee
 ☐ Legal Representative under 35 U.S.C. 117
- ☐ Person to whom the inventor is obligated to assign.
 ☐ Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Assignee is an Organization check here. ☒

Organization Name Stratasys, Inc.

Mailing Address Information:

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Address 2			
City	Eden Prairie	State/Province	MN
Country ⁱ	US	Postal Code	55344
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number		S697.12-0253	
		Application Number			
Title of Invention	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS				
Email Address					
Additional Applicant Data may be generated within this form by selecting the Add button. Add					
Signature: Remove					
NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications					
Signature	/Brian R. Morrison/			Date (YYYY-MM-DD)	2013-03-08
First Name	Brian R.	Last Name	Morrison	Registration Number	58455
Additional Signature may be generated within this form by selecting the Add button. Add					

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

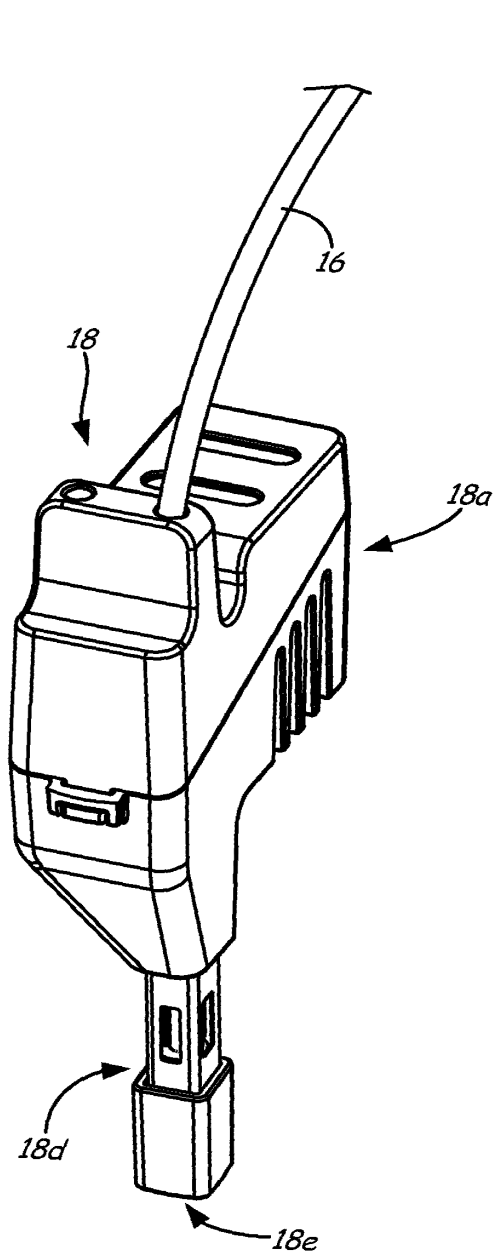


FIG. 2A

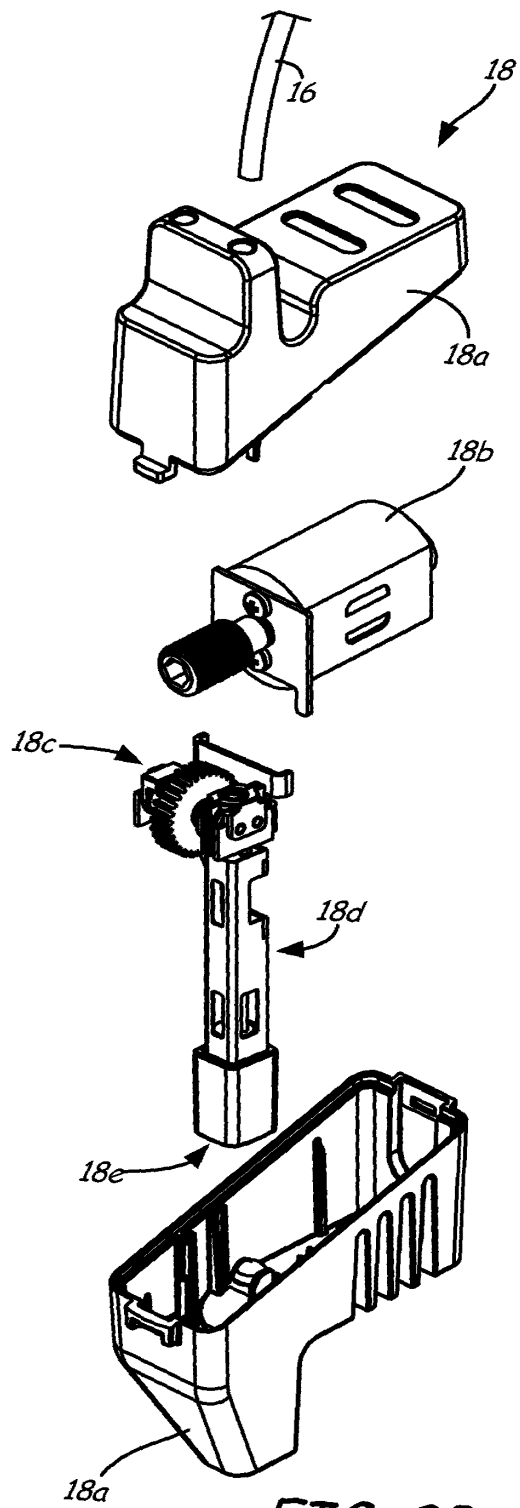


FIG. 2B

FIG. 3A

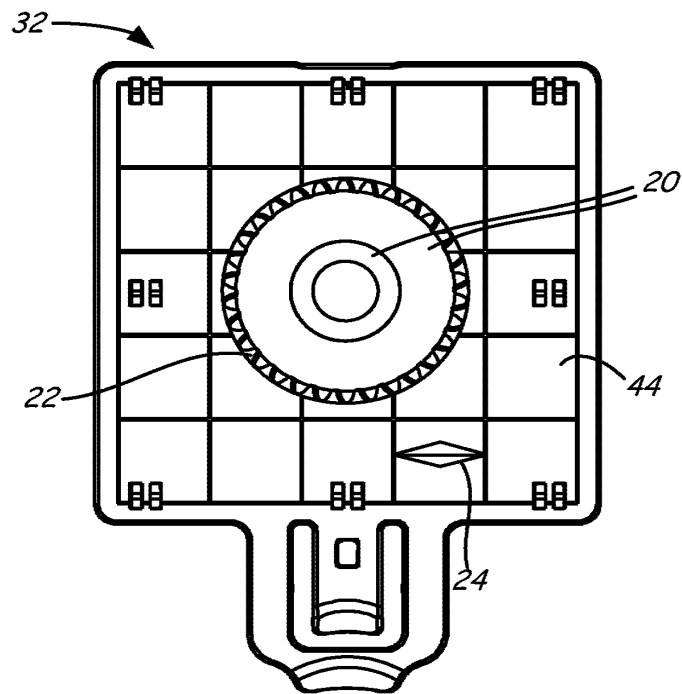
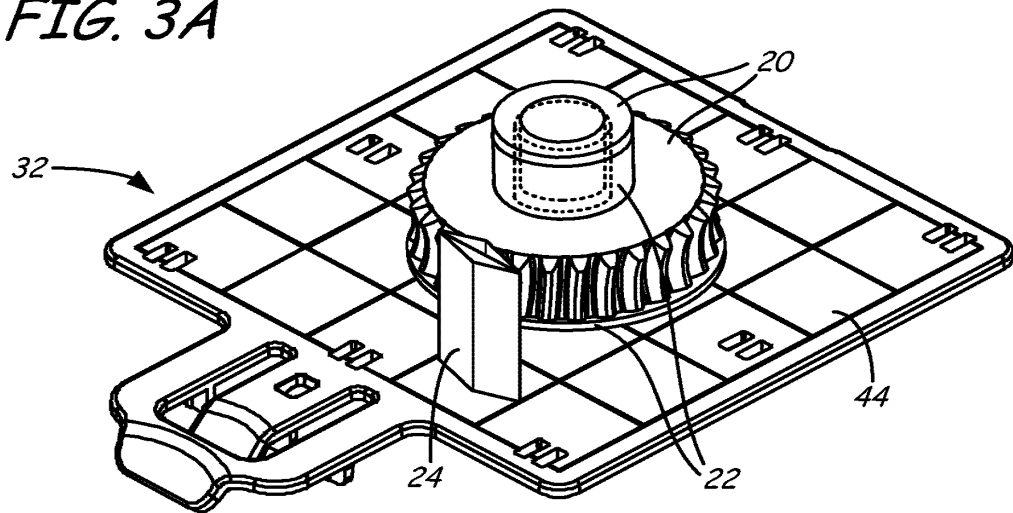


FIG. 3B

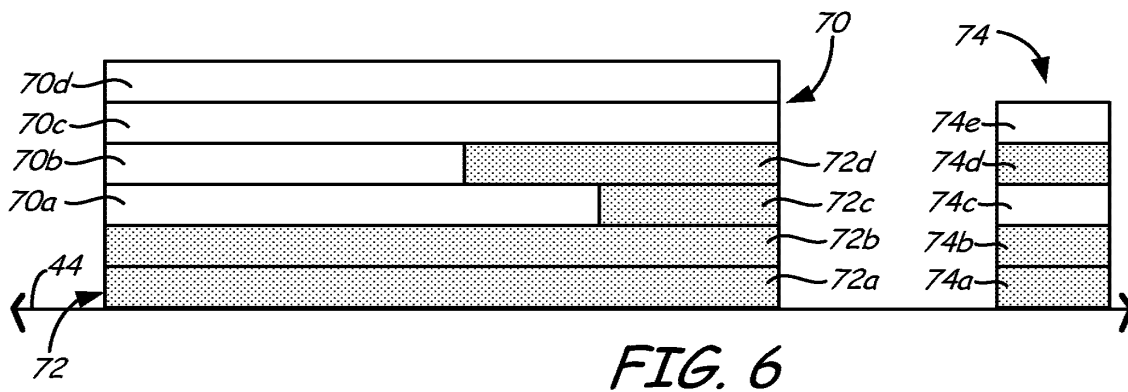
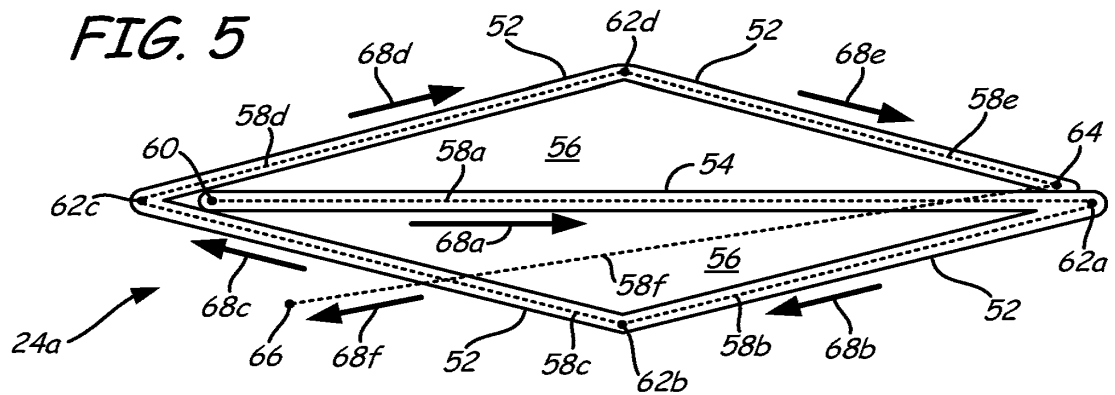
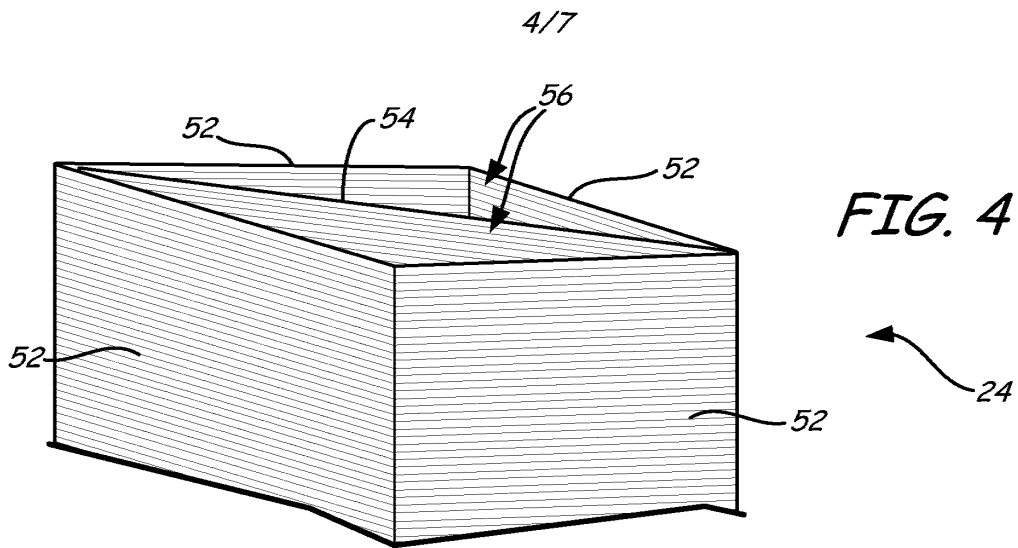


FIG. 7

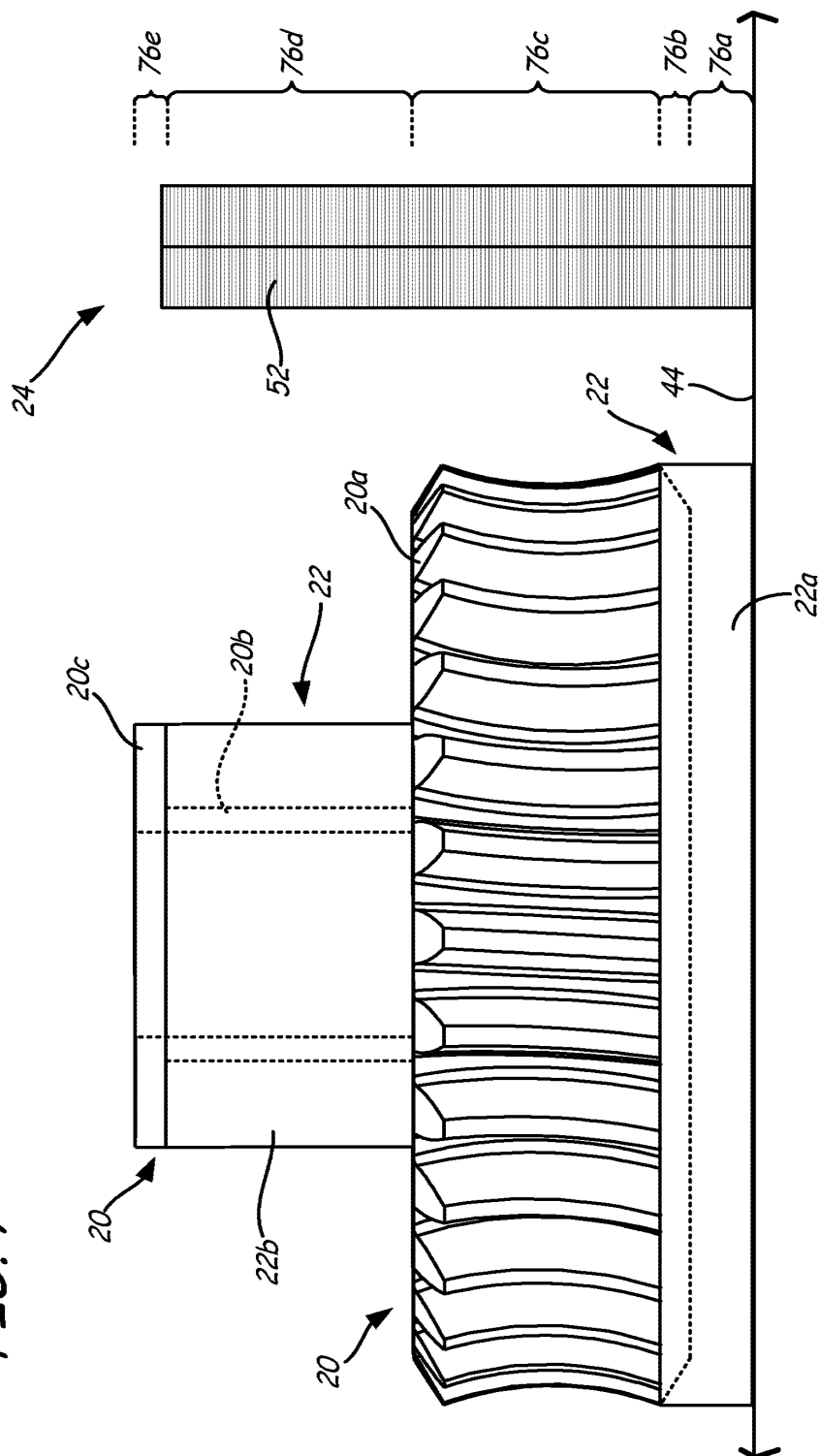
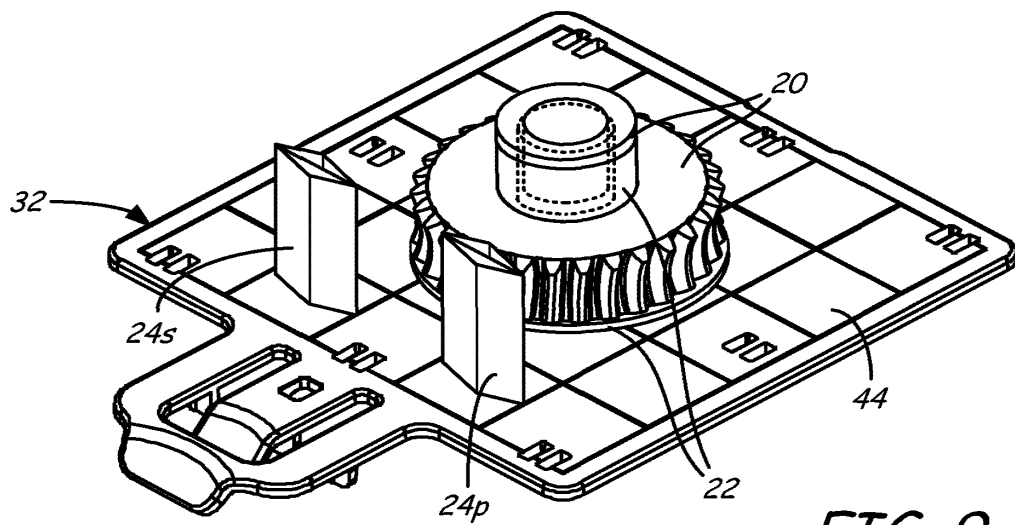
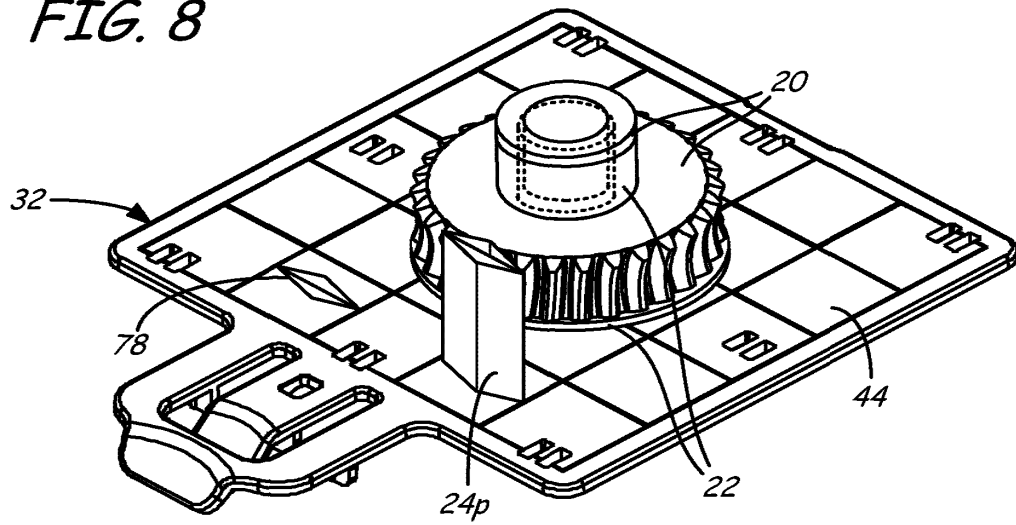
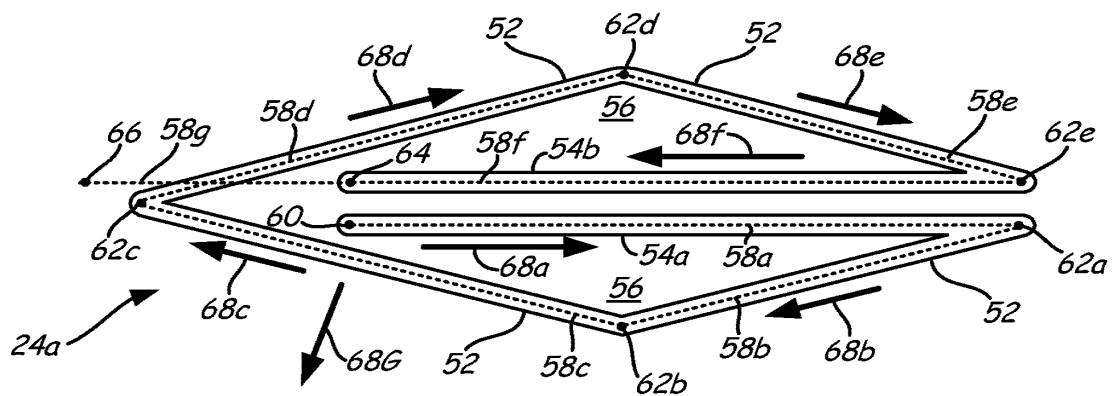
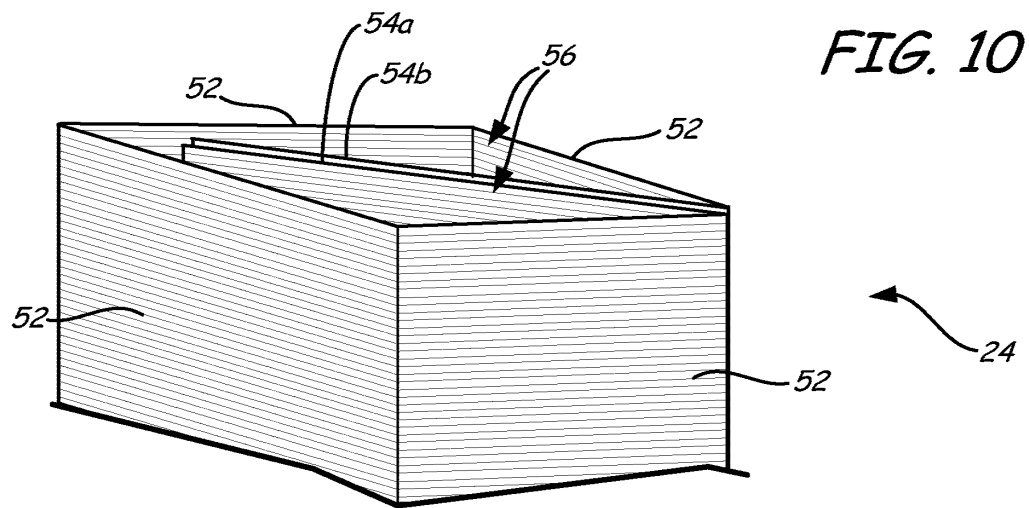


FIG. 8*FIG. 9*



Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS		
First Named Inventor/Applicant Name:		William J. Swanson		
Filer:		Brian Russell Vitt Morrison/Lisa Fuller		
Attorney Docket Number:		S697.12-0253		
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Utility application filing	1011	1	390	390
Utility Search Fee	1111	1	620	620
Utility Examination Fee	1311	1	250	250
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1260

Electronic Acknowledgement Receipt	
EFS ID:	15159048
Application Number:	13790924
International Application Number:	
Confirmation Number:	6040
Title of Invention:	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS
First Named Inventor/Applicant Name:	William J. Swanson
Customer Number:	27367
Filer:	Brian Russell Vitt Morrison/Lisa Fuller
Filer Authorized By:	Brian Russell Vitt Morrison
Attorney Docket Number:	S697.12-0253
Receipt Date:	08-MAR-2013
Filing Date:	
Time Stamp:	16:30:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$1260
RAM confirmation Number	4405
Deposit Account	231123
Authorized User	MORRISON, BRIAN
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File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	2013-03-08_Declaration_S697120253.pdf	124125	no	3
			5db01545ebbb434e31bdb33823518faa6a0b59fa		
Warnings:					
Information:					
2		2013-03--08_Application_S697120253.pdf	139531	yes	27
			fae32312721c06ecf3ae0004fac5f993e56b12c2		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	21	
	Claims		22	26	
	Abstract		27	27	
Warnings:					
Information:					
3	Application Data Sheet	2013-03-08_ADS_S697120253.pdf	998498	no	6
			5134f1eb15a36b94a40d54881cd232dc4aa76ecc		
Warnings:					
Information:					
4	Drawings-only black and white line drawings	2013-03-08_Drawings_S697120253.pdf	467014	no	7
			fd807e782ef5b9a1778c690b929c4767c386b90		
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	33379	no	2
			708f79c90736421ec47745fa6b5e09ef58c8da4f		
Warnings:					
Information:					
Total Files Size (in bytes):			1762547		

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New International Application Filed with the USPTO as a Receiving Office

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
13/790,924	03/08/2013	2861	1260	S697.12-0253	20	3

CONFIRMATION NO. 6040

27367

WESTMAN CHAMPLIN & KELLY, P.A.
SUITE 1400
900 SECOND AVENUE SOUTH
MINNEAPOLIS, MN 55402

FILING RECEIPT



OC000000060338038

Date Mailed: 04/15/2013

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

William J. Swanson, St. Paul, MN;
Ronald G. Schloesser, New Brighton, MN;
Gary Larson, Independence, MN;

Applicant(s)

Stratasys, Inc., Eden Prairie, MN

Assignment For Published Patent Application

STRATASYS, INC., Eden Prairie, MN

Power of Attorney: None

Domestic Applications for which benefit is claimed - None.

A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/790,924**

Projected Publication Date: 09/11/2014

Non-Publication Request: No

Early Publication Request: No
Title

ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH
PURGE TOWERS

Preliminary Class

347

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 13/790,924	
APPLICATION AS FILED - PART I							
(Column 1)		(Column 2)		SMALL ENTITY		OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	20	minus 20 = *			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *			OR	x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL		TOTAL	1600
APPLICATION AS AMENDED - PART II							
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY	
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=
	Application Size Fee (37 CFR 1.16(s))						
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	
(Column 1)		(Column 2)		(Column 3)		OTHER THAN SMALL ENTITY	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=
	Application Size Fee (37 CFR 1.16(s))						
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.							

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named		Confirmation No.: 6040
Inventor	: William J. Swanson	Group Art Unit: 2861
Appln. No.	: 13/790,924	Examiner:
Filed	: March 8, 2013	
For	: Additive Manufacturing Method for Printing Three-Dimensional Parts with Purge Towers	
Docket No.	: S697.12-0253	

INFORMATION DISCLOSURE STATEMENT

FILED ELECTRONICALLY ON MAY 8, 2013

The patents or publications listed on the enclosed PTO Form-1449 are submitted pursuant to 37 C.F.R. § 1.97. Copies of the patents or publications cited are enclosed, except as waived by the Official Gazette notice of August 5, 2003 regarding copies of U.S. Patents and Published Applications.

TIME OF FILING

An Information Disclosure Statement is being filed by the Applicant within any one of the following time periods:

1. x 1. Within three month of the filing date of a national application other than a Continued Prosecution Application (CPA);
2. Within three months of the date of entry of the national stage international application;
3. Before the mailing date of a first Office Action on the merits, or
4. Before the mailing of a first Office Action after the filing of a Request for Continue Examination (RCE).

METHOD OF PAYMENT

 x No fee is required.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

WESTMAN, CHAMPLIN & KELLY, P.A.

By: /Brian R. Morrison/

Brian R. Morrison, Reg. No. 58,455
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Minneapolis, Minnesota 55402-3244
Phone: (612) 334-3222
Fax: (612) 334-3312

BRM/laf

Substitute for forms 1449A/PRO and 1449B/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Complete if Known	
				Application Number	13/790,924
				Filing Date	March 8, 2013
				First Named Inventor	William J. Swanson
				Art Unit	2861
				Examiner Name	
Sheet	- 1 -	of	- 4 -	Attorney Docket Number	S697.12-0253

U.S. PATENT DOCUMENTS					
Exam. Init.*	Cite No.	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Classification
		Number-(Kind Code if Known)			
	A1	US- 5,121,329	06-09-1992	Crump	364/468
	A2	US- 5,169,081	12-08-1992	Goedderz	242/54
	A3	US- 5,303,141	04-12-1994	Batchelder et al.	364/149
	A4	US- 5,312,224	05-17-1994	Batchelder et al.	415/73
	A5	US- 5,340,443	08-23-1994	Crump	156/578
	A6	US- 5,503,785	04-02-1996	Crump et al.	264/40.7
	A7	US- 5,738,817	04-14-1998	Danforth et al.	264/603
	A8	US- 5,764,521	06-09-1998	Batchelder et al.	364/475.01
	A9	US- 5,866,058	02-02-1999	Batchelder et al.	264/237
	A10	US- 5,900,207	05-04-1999	Danforth et al.	264,603
	A11	US- 5,939,008	08-17-1999	Comb et al.	264/308
	A12	US- 5,968,561	10-19-1999	Batchelder et al.	425/375
	A13	US- 6,004,124	12-21-1999	Swanson et al.	425/375
	A14	US- 6,022,207	02-08-2000	Dahlin et al.	425/145
	A15	US- 6,054,077	04-25-2000	Comb et al.	264/40.7
	A16	US- 6,067,480	05-23-2000	Stuffle et al.	700/109
	A17	US- 6,070,107	05-30-2000	Lombardi et al.	700/119
	A18	US- 6,085,957	07-11-2000	Zinniel et al.	226/8
	A19	US- 6,129,872	10-10-2000	Jang	264/75
	A20	US- 6,228,923	05-08-2001	Lombardi et al.	524/425
	A21	US- 6,257,517	07-10-2001	Babish et al.	242/365.6
	A22	US- 6,547,995	04-15-2003	Comb	264/40.1
	A23	US- 6,645,412	11-11-2003	Priedeman, Jr.	264/219
	A24	US- 6,685,866	02-03-2004	Swanson et al.	264/308
	A25	US- 6,722,872	04-20-2004	Swanson et al.	425/225
	A26	US- 6,730,252	05-04-2004	Teoh et al.	264/178
	A27	US- 6,749,414	06-15-2004	Hanson et al.	425/130
	A28	US- 6,790,403	09-14-2004	Priedeman, Jr. et al.	264/442

*Examiner:	Date Considered:
EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

Substitute for forms 1449A/PRO and 1449B/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Complete if Known	
				Application Number	13/790,924
				Filing Date	March 8, 2013
				First Named Inventor	William J. Swanson
				Art Unit	2861
				Examiner Name	
Sheet	- 2 -	of	- 4 -	Attorney Docket Number	S697.12-0253

U.S. PATENT DOCUMENTS					
Exam. Init.*	Cite No.	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Classification
		Number-(Kind Code if Known)			
	A29	US- 6,814,907	11-09-2004	Comb	264/40.07
	A30	US- 6,869,559	03-22-2005	Hopkins	264/489
	A31	US- 2005/0129941	06-16-2005	Comb et al.	428/364
	A32	US- 6,923,634	08-02-2005	Swanson et al.	425/169
	A33	US- 6,976,627	12-20-2005	Culp et al.	235/462.01
	A34	US- 6,998,087	02-14-2006	Hanson et al.	264/308
	A35	US- 7,122,246	10-17-2006	Comb et al.	428/364
	A36	US- 7,127,309	10-24-2006	Dunn et al.	700/98
	A37	US- 2007/0003656	01-04-2007	LaBossiere et al.	425/375
	A38	US- 7,172,715	02-06-2007	Swanson et al.	264/39
	A39	US- 7,236,166	06-26-2007	Zinniel et al.	345/419
	A40	US- 7,261,533	08-28-2007	Wrosz et al.	425/110
	A41	US- 2007/0228590	10-04-2007	LaBossiere et al.	264/40.1
	A42	US- 7,306,152	12-11-2007	Culp et al.	235/462.01
	A43	US- 7,384,255	06-10-2008	LaBossiere et al.	425/190
	A44	US- 7,481,647	01-27-2009	Sambu et al.	425/436
	A45	US- 2009/0035405	02-05-2009	Leavitt	425/97
	A46	US- 2009/0173443	07-09-2009	Kozlak et al.	156/303.1
	A47	US- 7,572,121	08-11-2009	Wrosz et al.	425/110
	A48	US- 7,604,470	10-20-2009	LaBossiere et al.	425/131.1
	A49	US- 2009/0263582	10-22-2009	Batchelder	427/256
	A50	US- 2009/0273122	11-05-2009	Batchelder et al.	264/401
	A51	US- 2009/0274540	11-05-2009	Batchelder et al.	414/431
	A52	US- 7,625,200	12-01-2009	Leavitt	425/375
	A53	US- 2010/0100224	04-22-2010	Comb et al.	700/118
	A54	US- 2010/0096072	04-22-2010	Hopkins et al.	156/155
	A55	US- 2010/0096485	04-22-2010	Taatjes et al.	242/171

*Examiner:	Date Considered:
EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

Substitute for forms 1449A/PRO and 1449B/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Complete if Known	
				<i>Application Number</i>	13/790,924
				<i>Filing Date</i>	March 8, 2013
				<i>First Named Inventor</i>	William J. Swanson
				<i>Art Unit</i>	2861
				<i>Examiner Name</i>	
Sheet	- 3 -	of	- 4 -	<i>Attorney Docket Number</i>	S697.12-0253

U.S. PATENT DOCUMENTS					
Exam. Init.*	Cite No.	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Classification
		Number-(Kind Code if Known)			
	A56	US- 7,744,364	06-29-2010	Turley et al.	425/225
	A57	US- 2010/0283172	11-11-2010	Swanson	264/80
	A58	US- 2010/0327479	12-30-2010	Zinniel et al.	264/172.14
	A59	US- 2010/0096489	04-22-2010	Taatjes et al.	242/520
	A60	US- 7,896,209	03-01-2011	Batchelder et al.	26/53
	A61	US- 7,917,243	03-29-2011	Kozlak et al.	700/119
	A62	US- 2011/0074065	03-31-2011	Batchelder et al.	264/308
	A63	US- 2011/0076495	03-31-2011	Batchelder et al.	428/369
	A64	US- 2011/0076496	03-31-2011	Batchelder et al.	428/373
	A65	US- 7,938,351	05-10-2011	Taatjes et al.	242/171
	A66	US- 7,938,356	05-10-2011	Taatjes et al.	242/580
	A67	US- 2011/0117268	05-19-2011	Batchelder et al.	427/8
	A68	US- 2011/0121476	05-26-2011	Batchelder et al.	264/40.1
	A69	US- 2011/0186081	08-04-2011	Dunn et al.	134/18
	A70	US- 2011/0233804	09-29-2011	Batchelder et al.	264/40.4
	A71	US- 2011/0241947	10-06-2011	Scott et al.	343/700
	A72	US- 8,033,811	10-11-2011	Swanson et al.	425/375
	A73	US- 8,070,473	12-06-2011	Kozlak	425/375
	A74	US- 8,075,300	12-13-2011	Zinniel	425/445
	A75	US- 2012/0067501	03-22-2012	Lyons	156/64
	A76	US- 2012/0068378	03-22-2012	Swanson et al.	264/308
	A77	US- 2012/0070523	03-22-2012	Swanson et al.	425/96
	A78	US- 8,153,182	04-10-2012	Comb et al.	427/8
	A79	US- 2012/0162314	06-28-2012	Swanson et al.	347/37
	A80	US- 2012/0164256	06-28-2012	Swanson et al.	425/162
	A81	US- 8,221,669	07-17-2012	Batchelder et al.	264/308
	A82	US- 8,226,395	07-24-2012	Pax et al.	425/174.4

*Examiner:	Date Considered:
EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

Substitute for forms 1449A/PRO and 1449B/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Complete if Known	
				<i>Application Number</i>	13/790,924
				<i>Filing Date</i>	March 8, 2013
				<i>First Named Inventor</i>	William J. Swanson
				<i>Art Unit</i>	2861
				<i>Examiner Name</i>	
Sheet	- 4 -	of	- 4 -	<i>Attorney Docket Number</i>	S697.12-0253

U.S. PATENT DOCUMENTS					
Exam. Init.*	Cite No.	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Classification
		Number-(Kind Code if Known)			
	A83	US- 8,282,380	10-09-2012	Pax et al.	425/375
	A84	US- 8,287,794	10-16-2012	Pax et al.	264/308
	A85	US- 2013/0075957	03-28-2013	Swanson et al.	264/405
	A86	US- 2013/0078073	03-28-2013	Comb et al.	414/749.1

FOREIGN PATENT DOCUMENTS						
Exam. Init.*	Cite No.	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	Translation (Check if yes)
		Country Code-Number-Kind Code (if known)				
	B1					

NON PATENT LITERATURE DOCUMENTS			
Exam. Init.*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published	Translation (Check if yes)
	C1		

*Examiner:	Date Considered:
EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

Electronic Acknowledgement Receipt	
EFS ID:	15723827
Application Number:	13790924
International Application Number:	
Confirmation Number:	6040
Title of Invention:	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS
First Named Inventor/Applicant Name:	William J. Swanson
Customer Number:	27367
Filer:	Brian Russell Vitt Morrison
Filer Authorized By:	
Attorney Docket Number:	S697.12-0253
Receipt Date:	08-MAY-2013
Filing Date:	08-MAR-2013
Time Stamp:	15:12:44
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	2013-05-08_IDS_S697120253.pdf	69368 aea950ffe1621f5fd7ccf18eb216386b2f58876c	no	6

Warnings:

Information:

This is not an USPTO supplied IDS fillable form

Total Files Size (in bytes):

69368

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		13790924	
	Filing Date		2013-03-08	
	First Named Inventor	William J. Swanson et al.		
	Art Unit	1742		
	Examiner Name	Johnson, Christina Ann		
	Attorney Docket Number	S697.12-0253		

U.S. PATENTS							Remove	
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear		
	1							
If you wish to add additional U.S. Patent citation information please click the Add button.							Add	
U.S. PATENT APPLICATION PUBLICATIONS							Remove	
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear		
	1	20120258250	A1	2012-10-11	Luke M.B. Rodgers			
	2	20120304449	A1	2012-12-06	Jackson et al.			
If you wish to add additional U.S. Published Application citation information please click the Add button.							Add	
FOREIGN PATENT DOCUMENTS							Remove	
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ² j	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1	2012070052	WO	A1	2012-05-31	Ravich et al.		☒
	2	2012085914	WO	A1	2012-06-28	Belocon et al.		☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		13790924
	Filing Date		2013-03-08
	First Named Inventor	William J. Swanson et al.	
	Art Unit	1742	
	Examiner Name	Johnson, Christina Ann	
	Attorney Docket Number	S697.12-0253	

If you wish to add additional Foreign Patent Document citation information please click the Add button				Add
NON-PATENT LITERATURE DOCUMENTS				Remove
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵	
	1	International Search Report and Written Opinion dated June 25, 2014 for corresponding International Patent Application No. PCT/US2014/017915, filed February 24, 2014.	☒	
If you wish to add additional non-patent literature document citation information please click the Add button				
EXAMINER SIGNATURE				
Examiner Signature		Date Considered		
*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.				
¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.				

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	13790924
	Filing Date	2013-03-08
	First Named Inventor	William J. Swanson et al.
	Art Unit	1742
	Examiner Name	Johnson, Christina Ann
	Attorney Docket Number	S697.12-0253

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Brian R. Morrison/	Date (YYYY-MM-DD)	2014-07-14
Name/Print	Brian R. Morrison	Registration Number	58,455

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PATENT COOPERATION TREATY

PCT/US2014/017915

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference S697.50-0253/BRM	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US2014/017915	International filing date (<i>day/month/year</i>) 24 February 2014 (24.02.2014)	(Earliest) Priority Date (<i>day/month/year</i>) 08 March 2013 (08.03.2013)
Applicant STRATASYS, INC.		

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (See Box No. II)

3. ☐ **Unity of invention is lacking** (See Box No. III)

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/017915**A. CLASSIFICATION OF SUBJECT MATTER****B29C 67/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B29C 67/00; A01J 21/00; F21V 29/00; B05D 1/38; B23P 17/00; B29C 37/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: three-dimensional, 3-D, print, additive manufacturing, head, purge tower, purge, switch, change, alter, operating mode, stand-by mode

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2012-085914 A1 (OBJET LTD.) 28 June 2012 See abstract; claims 1, 4.	1-20
A	US 2012-0258250 A1 (RODGERS, L. M. B.) 11 October 2012 See abstract; claims 1-20.	1-20
A	WO 2012-070052 A1 (OBJET LTD.) 31 May 2012 See abstract; claims 1-20	1-20
A	US 2012-0164256 A1 (SWANSON, W. J. et al.) 28 June 2012 See abstract; claims 1-16.	1-20
A	US 2012-0304449 A1 (JACKSON, N. et al.) 6 December 2012 See abstract; claims 1-65.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

25 June 2014 (25.06.2014)

Date of mailing of the international search report

25 June 2014 (25.06.2014)

Name and mailing address of the ISA/KR

International Application Division
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/017915

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2012-085914 A1	28/06/2012	CN 103429075 A EP 2654412 A1	04/12/2013 30/10/2013
US 2012-0258250 A1	11/10/2012	US 8460755 B2 WO 2012-138842 A1	11/06/2013 11/10/2012
WO 2012-070052 A1	31/05/2012	CN 103347682 A EP 2643148 A1 US 2013-0241114 A1	09/10/2013 02/10/2013 19/09/2013
US 2012-0164256 A1	28/06/2012	EP 2655046 A1 US 2012-0161350 A1 US 2012-0162305 A1 US 2012-0162314 A1 US 2012-0164330 A1 US 8419996 B2 US 8465111 B2 US 8647102 B2 US 8663533 B2 WO 2012-088253 A1 WO 2012-088253 A8 WO 2012-088257 A1 WO 2012-088257 A8	30/10/2013 28/06/2012 28/06/2012 28/06/2012 28/06/2012 16/04/2013 18/06/2013 11/02/2014 04/03/2014 28/06/2012 28/06/2012 28/06/2012 15/11/2012
US 2012-0304449 A1	06/12/2012	WO 2012-166525 A1	06/12/2012

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
MORRISON, BRIAN R.

WESTMAN, CHAMPLIN & KOEHLER, P.A. 900 SECOND
AVENUE SOUTH, SUITE 1400 MINNEAPOLIS MN 55402-
3319 USA

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing
(day/month/year) 25 June 2014 (25.06.2014)

Applicant's or agent's file reference
S697.50-0253/BRM

FOR FURTHER ACTION

See paragraph 2 below

International application No.
PCT/US2014/017915

International filing date (day/month/year)
24 February 2014 (24.02.2014)

Priority date(day/month/year)
08 March 2013 (08.03.2013)

International Patent Classification (IPC) or both national classification and IPC

B29C 67/00(2006.01)i

Applicant
STRATASYS, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsu-ro, Seo-gu, Daejeon
Metropolitan City, 302-701, Republic of Korea
Facsimile No. +82-42-472-7140

Date of completion of this opinion
25 June 2014 (25.06.2014)

Authorized officer

HONG, Sung Ran

Telephone No. +82-42-481-5405



WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2014/017915

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

- ☒ the international application in the language in which it was filed
- ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

a. (means)

- ☐ on paper
- ☐ in electronic form

b. (time)

- ☐ in the international application as filed.
- ☐ together with the international application in electronic form.
- ☐ subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US2014/017915

**Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	1-20	YES
	Claims	NONE	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	NONE	NO

2. Citations and explanations :

References are made to the following documents:

D1: WO 2012-085914 A1 (OBJET LTD.) 28 June 2012
D2: US 2012-0258250 A1 (RODGERS, L. M. B.) 11 October 2012
D3: WO 2012-070052 A1 (OBJET LTD.) 31 May 2012
D4: US 2012-0164256 A1 (SWANSON, W. J. et al.) 28 June 2012
D5: US 2012-0304449 A1 (JACKSON, N. et al.) 6 December 2012

2.1 Novelty and Inventive Step

2.1.1 Concerning Claims 1 to 9

The subject matter of claim 1 relates to a method for printing a three-dimensional part with an additive manufacturing system.

D1, which is considered to be the closest prior art to the subject matter of claim 1, discloses a method for forming three-dimensional objects, layer by layer, the method comprising: generating image data that includes cross sectional layers of a three-dimensional object to be printed and of a support construction; and selectively dispensing, layer by layer, according to the image data building materials and reusable material from different dispensing heads, wherein the reusable material includes surplus material collected to be reused during formation of the three-dimensional object (See claim 1 in D1).

The subject matter of claim 1 differs from that of D1 in the presence of a purge tower. In addition, this feature is not disclosed in any other available prior art documents. Accordingly, claim 1 is not anticipated by any of the documents D1-D5, nor is it obvious by the documents, taken alone or in combination. Therefore, claim 1 is novel and involves an inventive step under PCT Article 33(2) and (3).

Continued on Supplemental Box

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2014/017915

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Box No. V

Claims 2 to 9 are dependent on claim 1, directly or indirectly, therefore, claims 2 to 9 are novel and involve an inventive step under PCT Article 33(2) and (3).

2.1.2 Concerning Claims 10 to 15

The subject matter of claim 10 relates to a method for printing a three-dimensional part with an additive manufacturing system.

D1, which is considered to be the closest prior art to the subject matter of claim 10, discloses a method for forming three-dimensional objects, layer by layer, the method comprising: generating image data that includes cross sectional layers of a three-dimensional object to be printed and of a support construction; and selectively dispensing, layer by layer, according to the image data building materials and reusable material from different dispensing heads, wherein the reusable material includes surplus material collected to be reused during formation of the three-dimensional object (See claim 1 in D1).

The subject matter of claim 10 differs from that of D1 in the presence of a purge tower. In addition, this feature is not disclosed in any other available prior art documents. Accordingly, claim 10 is not anticipated by any of the documents D1-D5, nor is it obvious by the documents, taken alone or in combination. Therefore, claim 10 is novel and involves an inventive step under PCT Article 33(2) and (3).

Claims 11 to 15 are dependent on claim 10, directly or indirectly, therefore, claims 11 to 15 are novel and involve an inventive step under PCT Article 33(2) and (3).

2.1.3 Concerning Claims 16 to 20

The subject matter of claim 16 relates to a method for printing a three-dimensional part with an additive manufacturing system.

D1, which is considered to be the closest prior art to the subject matter of claim 16, discloses a method for forming three-dimensional objects, layer by layer, the method comprising: generating image data that includes cross sectional layers of a three-dimensional object to be printed and of a support construction; and selectively dispensing, layer by layer, according to the image data building materials and reusable material from different dispensing heads, wherein the reusable material includes surplus material collected to be reused during formation of the three-dimensional object (See claim 1 in D1).

Continued on The Next Page

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2014/017915

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Previous Page

The subject matter of claim 16 differs from that of D1 in the presence of a purge tower. In addition, this feature is not disclosed in any other available prior art documents. Accordingly, claim 16 is not anticipated by any of the documents D1-D5, nor is it obvious by the documents, taken alone or in combination. Therefore, claim 16 is novel and involves an inventive step under PCT Article 33(2) and (3).

Claims 17 to 20 are dependent on claim 16, directly or indirectly, therefore, claims 17 to 20 are novel and involve an inventive step under PCT Article 33(2) and (3).

2.2 Industrial Applicability

Claims 1 to 20 are industrially applicable under PCT Article 33(4).

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization

International Bureau

(43) International Publication Date
31 May 2012 (31.05.2012)



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B29C 67/00 (2006.01)

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(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/417,436 28 November 2010 (28.11.2010) US

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(74) Agents: **G.E. EHRLICH (1995) LTD.** et al.; 11 Menachem Begin Road, 52681 Ramat Gan (IL).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

— with international search report (Art. 21(3))

— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: SYSTEM AND METHOD FOR ADDITIVE MANUFACTURING OF AN OBJECT

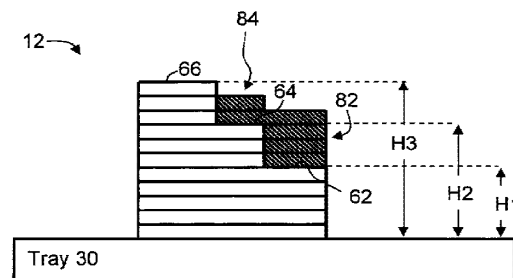


FIG. 3

(57) Abstract: A method of additive manufacturing of a three-dimensional object is disclosed. The method comprises sequentially forming a plurality of layers in a configured pattern corresponding to the shape of the object. Each layer is formed by dispensing at least one modeling material to form an uncured layer, and curing the uncured layer by radiation. In various exemplary embodiments of the invention the method comprises, for at least one layer, forming a stack of sacrificial radiation-protective layers to cover an exposed portion of the layer, such that an upper layer of the stack remains exposed during formation of any subsequent layer of the plurality of layers.

WO 2012/070052 A1

SYSTEM AND METHOD FOR ADDITIVE MANUFACTURING OF AN OBJECT

RELATED APPLICATION

This application claims the benefit of priority from U.S. Application No. 5 61/417,436, filed on November 28, 2010, the contents of which are hereby incorporated by reference as if fully set forth herein.

FIELD AND BACKGROUND OF THE INVENTION

The present invention, in some embodiments thereof, relates to Additive 10 Manufacturing (AM) of an object, more particularly, but not exclusively, to a system and method for additive manufacturing of an object while reducing curing-induced discoloration of the object or part of the object.

Additive manufacturing is generally a process in which a three-dimensional (3D) object is manufactured utilizing a computer model of the objects. Such a process is used 15 in various fields, such as design related fields for purposes of visualization, demonstration and mechanical prototyping, as well as for rapid manufacturing (RM).

The basic operation of any AM system consists of slicing a three-dimensional computer model into thin cross sections, translating the result into two-dimensional position data and feeding the data to control equipment which manufacture a three- 20 dimensional structure in a layerwise manner.

Additive manufacturing entails many different approaches to the method of fabrication, including three-dimensional printing, laminated object manufacturing, fused deposition modeling and others.

In three-dimensional printing processes, for example, a building material is 25 dispensed from a dispensing head having a set of nozzles to deposit layers on a supporting structure. Depending on the building material, the layers may then be cured or solidified using a suitable device. The building material may include modeling material, which forms the object, and support material, which supports the object as it is being built. Various three-dimensional printing techniques exist and are disclosed in, 30 *e.g.*, U.S. Patent Nos. 6,259,962, 6,569,373, 6,658,314, 6,850,334, 7,183,335, 7,209,797, 7,225,045, 7,300,619, 7,479,510, 7,500,846, 7,658,976 and 7,962,237, and U.S.

Published Application No. 20100191360, all of the same Assignee, the contents of which are hereby incorporated by reference.

AM facilitates rapid fabrication of functioning prototypes with minimal investment in tooling and labor. Such rapid prototyping shortens the product development cycle and improves the design process by providing rapid and effective feedback to the designer. AM can also be used for rapid fabrication of non-functional parts, *e.g.*, for the purpose of assessing various aspects of a design such as aesthetics, fit, assembly and the like. Additionally, AM techniques have been proven to be useful in the fields of medicine, where expected outcomes are modeled prior to performing procedures. It is recognized that many other areas can benefit from rapid prototyping technology, including, without limitation, the fields of architecture, dentistry and plastic surgery where the visualization of a particular design and/or function is useful.

Several AM techniques allow additive formation of objects using more than one modeling material. For example, U.S. Published Application No. 20100191360 of the present Assignee, the contents of which are hereby incorporated by reference, discloses a system which comprises an additive manufacturing apparatus having a plurality of dispensing heads, a building material supply apparatus configured to supply a plurality of building materials to the fabrication apparatus, and a control unit configured for controlling the fabrication and supply apparatus. The system has several operation modes. In one mode, all dispensing heads operate during a single building scan cycle of the fabrication apparatus. In another mode, one or more of the dispensing heads is not operative during a single building scan cycle or part thereof.

SUMMARY OF THE INVENTION

According to an aspect of some embodiments of the present invention there is provided a method of additive manufacturing of a three-dimensional object. The method comprises sequentially forming a plurality of layers in a configured pattern corresponding to the shape of the object. Each layer is formed by dispensing at least one modeling material to form an uncured layer, and curing the uncured layer by radiation. In various exemplary embodiments of the invention the method comprises, for at least one layer, forming a stack of sacrificial radiation-protective layers to cover an exposed

portion of the layer, such that an upper layer of the stack remains exposed during formation of any subsequent layer of the plurality of layers.

According to some embodiments of the invention the invention the method comprises removing the stack.

5 According to some embodiments of the invention the stack is removed by a jet of pressurized aqueous liquid.

According to some embodiments of the invention the number of layers in the stack is selected so as to block at least 90% of the radiation.

10 According to some embodiments of the invention the method comprises forming a plurality of the stacks, wherein each stack has at least 10 layers.

According to some embodiments of the invention the sacrificial radiation-protective layers are made, at least in part, from a three-dimensional printing support material.

15 According to some embodiments of the invention the sacrificial radiation-protective layers are made, at least in part, from a water soluble material.

According to some embodiments of the invention the sacrificial radiation-protective layers are characterized by a modulus of elasticity which is lower than a modulus of elasticity characterizing the modeling material once cured.

20 According to some embodiments of the invention the sacrificial radiation-protective layers comprise unpolymerizable material.

25 According to an aspect of some embodiments of the present invention there is provided a computer software product, comprising a computer-readable medium in which program instructions are stored, which instructions, when read by a computerized controller of an additive manufacturing system, cause the system to execute at least some operations of the method described herein.

30 According to an aspect of some embodiments of the present invention there is provided a system for additive manufacturing of a three-dimensional object. The system comprises; a dispensing unit configured for dispensing at least one type of modeling material to form an uncured layer; a curing unit configured for curing the uncured layer by radiation; and a controller configured for operating the dispensing unit and the curing unit to sequentially form a plurality of layers in a configured pattern corresponding to the shape of the three-dimensional object, and a stack of radiation-protective layers

covering an exposed portion of at least one layer, such that an upper layer of the stack remains exposed during formation of any subsequent layer of the plurality of layers.

According to some embodiments of the invention the number of layers in the stack is selected so as to block at least 90% of the radiation.

5 According to some embodiments of the invention there is a plurality of the stacks, wherein each stack has at least 10 layers. According to some embodiments of the invention each stack has at least 100 layers.

According to some embodiments of the invention the stack is selected such as to form an object which is generally uniform in color.

10 According to some embodiments of the invention the stack is selected such as to form an object which is generally uniform in lack of color.

According to some embodiments of the invention the controller is configured for calculating at least one of a thickness and a number of layers in the stack based on a type of a radiation-protective material used for forming the stack.

15 Unless otherwise defined, all technical and/or scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention pertains. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of embodiments of the invention, exemplary methods and/or materials are described below. In case of conflict, the patent
20 specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and are not intended to be necessarily limiting.

Implementation of the method and/or system of embodiments of the invention can involve performing or completing selected tasks manually, automatically, or a combination thereof. Moreover, according to actual instrumentation and equipment of
25 embodiments of the method and/or system of the invention, several selected tasks could be implemented by hardware, by software or by firmware or by a combination thereof using an operating system.

For example, hardware for performing selected tasks according to embodiments of the invention could be implemented as a chip or a circuit. As software, selected tasks
30 according to embodiments of the invention could be implemented as a plurality of software instructions being executed by a computer using any suitable operating system. In an exemplary embodiment of the invention, one or more tasks according to exemplary

5

embodiments of method and/or system as described herein are performed by a data processor, such as a computing platform for executing a plurality of instructions. Optionally, the data processor includes a volatile memory for storing instructions and/or data and/or a non-volatile storage, for example, a magnetic hard-disk and/or removable media, for storing instructions and/or data. Optionally, a network connection is provided as well. A display and/or a user input device such as a keyboard or mouse are optionally provided as well.

BRIEF DESCRIPTION OF THE DRAWINGS

10 Some embodiments of the invention are herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the invention. In this regard, the description taken with the drawings makes apparent to those skilled in the art how
15 embodiments of the invention may be practiced.

In the drawings:

FIGs. 1A and 1B are schematic illustration of an additive manufacturing system according to some embodiments of the present invention;

FIGs. 2A and 2B are schematic illustrations of an object having regions of
20 different heights;

FIG. 3 is a schematic illustration exemplifying the formation of a stack of radiation-protective layers during manufacturing of an object having regions of different heights; and

FIGs. 4A and 4B are schematic illustrations exemplifying the formation of a
25 stack of radiation-protective layers and support layers during manufacturing of an object having regions of different heights and an overhang feature.

DESCRIPTION OF SPECIFIC EMBODIMENTS OF THE INVENTION

The present invention, in some embodiments thereof, relates to Additive
30 Manufacturing (AM) of an object, more particularly, but not exclusively, to a system and method for additive manufacturing of an object while reducing curing-induced discoloration.

Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not necessarily limited in its application to the details of construction and the arrangement of the components and/or methods set forth in the following description and/or illustrated in the drawings and/or the Examples. The invention is capable of other embodiments or of being practiced or carried out in various ways.

The method and system of the present embodiments manufacture three-dimensional objects in a layerwise manner by forming a plurality of layers in a configured pattern corresponding to the shape of the objects.

The term "object" as used herein refers to a whole object or a part thereof.

Each layer is formed by additive manufacturing apparatus which scans a two-dimensional surface and patterns it. While scanning, the apparatus visits a plurality of target locations on the two-dimensional layer or surface, and decides, for each target location or a group of target locations, whether or not the target location or group of target locations is to be occupied by building material, and which type of building material is to be delivered thereto. The decision is made according to a computer image of the surface.

In some embodiments of the present invention the AM comprises three-dimensional printing. In these embodiments a building material is dispensed from a dispensing head having a set of nozzles to deposit building material in layers on a supporting structure. The AM apparatus thus dispenses building material in target locations which are to be occupied and leaves other target locations void. The apparatus typically includes a plurality of dispensing heads, each of which can be configured to dispense a different building material. Thus, different target locations can be occupied by different building materials. The types of building materials can be categorized into two major categories: modeling material and support material. The support material serves as a supporting matrix or construction for supporting the object or object parts during the fabrication process and/or other purposes, e.g., providing hollow or porous objects. Support constructions may additionally include modeling material elements, e.g. for further support strength.

The modeling material is generally a composition which is formulated for use in Additive manufacturing and which is able to form a three-dimensional object on its own, *i.e.*, without having to be mixed or combined with any other substance.

5 The final three-dimensional object is made of the modeling material or a combination of modeling and support material or modification thereof (*e.g.*, following curing). All these operations are well-known to those skilled in the art of solid freeform fabrication.

In some exemplary embodiments of the invention an object is manufactured by dispensing two or more different modeling materials, each material from a different
10 dispensing head of the AM. The materials are optionally and preferably deposited in layers during the same pass of the printing heads. The materials and combination of materials within the layer are selected according to the desired properties of the object.

A representative and non-limiting example of a system **10** suitable for AM of an object **12** according to some embodiments of the present invention is illustrated in FIGs.
15 1A-B. System **10** comprises an additive manufacturing apparatus **14** having a dispensing unit **21** which comprises a plurality of dispensing heads. Each head preferably comprises an array of one or more nozzles **22**, as illustrated in FIG. 1B, through which a building material **24** is dispensed.

Preferably, but not obligatorily, apparatus **14** is a three-dimensional printing
20 apparatus, in which case the dispensing heads are printing heads, and the building material is dispensed via inkjet technology. This need not necessarily be the case, since, for some applications, it may not be necessary for the additive manufacturing apparatus to employ three-dimensional printing techniques. Representative examples of additive manufacturing apparatus contemplated according to various exemplary embodiments of
25 the present invention include, without limitation, binder jet – powder-based apparatus, fused deposition modeling apparatus and fused material deposition apparatus.

Each dispensing head is optionally and preferably fed via a building material reservoir which may optionally include a temperature control unit (*e.g.*, a temperature sensor and/or a heating device), and a material level sensor. To dispense the building
30 material, a voltage signal is applied to the dispensing heads to selectively deposit droplets of material via the dispensing head nozzles, for example, as in piezoelectric inkjet printing technology. The dispensing rate of each head depends on the number of

nozzles, the type of nozzles and the applied voltage signal rate (frequency). Such dispensing heads are known to those skilled in the art of solid freeform fabrication.

Preferably, but not obligatorily, the overall number of dispensing nozzles or nozzle arrays is selected such that half of the dispensing nozzles are designated to dispense support material and half of the dispensing nozzles are designated to dispense modeling material, i.e. the number of nozzles jetting modeling materials is the same as the number of nozzles jetting support material. In the representative example of Figure 1A, four dispensing heads **21a**, **21b**, **21c** and **21d** are illustrated. Each of heads **21a**, **21b**, **21c** and **21d** has a nozzle array. In this Example, heads **21a** and **21b** can be designated for modeling material/s and heads **21c** and **21d** can be designated for support material. Thus, head **21a** can dispense a first modeling material, head **21b** can dispense a second modeling material and heads **21c** and **21d** can both dispense support material. In an alternative embodiment, heads **21c** and **21d**, for example, may be combined in a single head having two nozzle arrays for depositing support material. .

Yet it is to be understood that it is not intended to limit the scope of the present invention and that the number of modeling material depositing heads (modeling heads) and the number of support material depositing heads (support heads) may differ. Generally, the number of modeling heads, the number of support heads and the number of nozzles in each respective head or head array are selected such as to provide a predetermined ratio, a , between the maximal dispensing rate of the support material and the maximal dispensing rate of modeling material. The value of the predetermined ratio, a , is preferably selected to ensure that in each formed layer, the height of modeling material equals the height of support material. Typical values for a are from about 0.6 to about 1.5.

As used herein the term “about” refers to $\pm 10\%$.

For example, for $a = 1$, the overall dispensing rate of support material is generally the same as the overall dispensing rate of the modeling material when all modeling heads and support heads operate.

In a preferred embodiment, there are M modeling heads each having m arrays of p nozzles, and S support heads each having s arrays of q nozzles such that $M \times m \times p = S \times s \times q$. Each of the $M \times m$ modeling arrays and $S \times s$ support arrays can be manufactured as a separate physical unit, which can be assembled and disassembled from the group of

arrays. In this embodiment, each such array optionally and preferably comprises a temperature control unit and a material level sensor of its own, and receives an individually controlled voltage for its operation.

Apparatus **14** can further comprise a curing unit which can comprise one or more radiation sources **26**, which can be, for example, an ultraviolet or visible or infrared lamp, or other sources of electromagnetic radiation, or electron beam source, depending on the modeling material being used. Radiation source **26** serves for curing or solidifying the modeling material.

The dispensing head and radiation source are preferably mounted in a frame or block **28** which is preferably operative to reciprocally move over a tray **30**, which serves as the working surface. According to the common conventions, tray **30** is positioned in the X-Y plane. Tray **30** is preferably configured to move vertically (along the Z direction), typically downward. In various exemplary embodiments of the invention, apparatus **14** further comprises one or more leveling devices **32**, e.g. a roller **34**. Leveling device **32** serves to straighten, level and/or establish a thickness of the newly formed layer prior to the formation of the successive layer thereon. Leveling device **32** preferably comprises a waste collection device **36** for collecting the excess material generated during leveling. Waste collection device **36** may comprise any mechanism that delivers the material to a waste tank or waste cartridge.

In use, the dispensing heads of unit **21** move in a scanning direction, which is referred to herein as the X direction, and selectively dispense building material in a predetermined configuration in the course of their passage over tray **30**. The building material typically comprises one or more types of support material and one or more types of modeling material. The passage of the dispensing heads of unit **21** is followed by the curing of the modeling material(s) by radiation source **26**. In the reverse passage of the heads, back to their starting point for the layer just deposited, an additional dispensing of building material may be carried out, according to predetermined configuration. In the forward and/or reverse passages of the dispensing heads, the layer thus formed may be straightened by leveling device **32**, which preferably follows the path of the dispensing heads in their forward and/or reverse movement. Once the dispensing heads return to their starting point along the X direction, they may move to another position along an indexing direction, referred to herein as the Y direction, and

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continue to build the same layer by reciprocal movement along the X direction. Alternately, the dispensing heads may move in the Y direction between forward and reverse movements or after more than one forward-reverse movement. The series of scans performed by the dispensing heads to complete a single layer is referred to herein
5 as a single scan cycle.

Once the layer is completed, tray **30** is lowered in the Z direction to a predetermined Z level, according to the desired thickness of the layer subsequently to be printed. The procedure is repeated to form three-dimensional object **12** in a layerwise manner.

10 In another embodiment, tray **30** may be displaced in the Z direction between forward and reverse passages of the dispensing head of unit **21**, within the layer. Such Z displacement is carried out in order to cause contact of the leveling device with the surface in one direction and prevent contact in the other direction.

System **10** optionally and preferably comprises a building material supply
15 apparatus **50** which comprises the building material containers or cartridges and supplies a plurality of building materials to fabrication apparatus **14**.

A control unit **52** controls fabrication apparatus **14** and optionally and preferably also supply apparatus **50**. Control unit **52** preferably communicates with a data processor **54** which transmits digital data pertaining to fabrication instructions based on
20 computer object data, *e.g.*, a CAD configuration represented on a computer readable medium in a form of a Standard Tessellation Language (STL) format or the like. Typically, control unit **52** controls the voltage applied to each dispensing head or nozzle array and the temperature of the building material in the respective printing head.

Once the manufacturing data is loaded to control unit **52** it can operate without
25 user intervention. In some embodiments, control unit **52** receives additional input from the operator, *e.g.*, using data processor **54** or using a user interface **16** communicating with unit **52**. User interface **16** can be of any type known in the art, such as, but not limited to, a keyboard, a touch screen and the like. For example, control unit **52** can receive, as additional input, one or more building material types and/or attributes, such
30 as, but not limited to, color, characteristic distortion and/or transition temperature, viscosity, electrical property, magnetic property. Other attributes and groups of attributes are also contemplated.

Some embodiments contemplate the fabrication of an object by dispensing different materials from different dispensing heads. These embodiments provide, *inter alia*, the ability to select materials from a given number of materials and define desired combinations of the selected materials and their properties. According to the present
5 embodiments, the spatial locations of the deposition of each material with the layer is defined, either to effect occupation of different three-dimensional spatial locations by different materials, or to effect occupation of substantially the same three-dimensional location or adjacent three-dimensional locations by two or more different materials so as to allow post deposition spatial combination of the materials within the layer, thereby to
10 form a composite material at the respective location or locations.

Any post deposition combination or mix of modeling materials is contemplated. For example, once a certain material is dispensed it may preserve its original properties. However, when it is dispensed simultaneously with another modeling material or other dispensed materials which are dispensed at the same or nearby locations, a composite
15 material having a different property or properties to the dispensed materials is formed.

The present embodiments thus enable the deposition of a broad range of material combinations, and the fabrication of an object which may consist of multiple different combinations of materials, in different parts of the object, according to the properties desired to characterize each part of the object.

20 Further details on the principles and operations of an AM system such as system **10** is found in U.S. Published Application No. 20100191360, the contents of which are hereby incorporated by reference.

Typically, dispensing unit **21** scans tray **30** in several passes. This operation is applied when the width of dispensing unit **21** is smaller than the width of tray **30** and/or
25 when several objects are built on the same tray during a single additive manufacturing batch.

When object **12** comprises regions having varying heights, higher regions of the object being printed require more layers of modeling material than lower regions. A representative situation is illustrated in FIG. 2A. Shown in FIG. 2A is object **12** in an
30 embodiment in which the object includes a region **62** of height H1, a region **64** of height H2, and a region **66** of height H3, where $H1 < H2 < H3$. The layers **70** are shared by all three regions **62**, **64** and **66**.

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Since object **12** is formed in a layerwise manner from bottom to top, during the formation of the layers above height H1, the uppermost layer of region **62** remains exposed, and during the formation of layers above height H2, both the uppermost layer of region **62** and the uppermost layer of region **64** remain exposed, while the dispensing unit **21** continues the scan process of dispensing and curing each of the layers above heights H1 and H2, respectively. Due to their prolonged exposure, the aggregate amount of curing radiation for these uppermost layers is larger than for any other layer. It was found by the present inventors that such over curing results in discoloring of at least the uppermost layers of the exposed lower height region or regions (regions **62** and **64** in the present example). The discoloration effect can also extend to layers below the uppermost layer due to penetration of the curing radiation through the modeling material. The situation is illustrated in FIG. 2B, showing a discoloration over the exposed parts of the two uppermost layers **72** of region **62**, and the two uppermost layers **74** of region **64**.

One form of discoloration of the modeling material due to over-curing is an undesired coloration of exposed areas, i.e. layers or parts of layers in exposed areas compared to that in the unexposed areas of the objects being formed.

Over-curing alternatively produces another form of discoloration of the modeling material, where overexposure causes the material to take on a yellowish hue, thus producing regions of yellowed material where the material is over-exposed to radiation, compared to areas which are not subject to the effects of over-radiation.

For example, when printing the object depicted in Fig. **2B** using a building material having the trade name Objet® VeroWhite RGD830 (Objet Ltd., Israel), a white opaque material when cured, over-curing causes a yellowing or browning of the upper exposed layer parts **72** and **74**, while the remainder of the object is a white opaque color.

In another example, when printing the object depicted in Fig. **2B** using a building material having the trade name Objet® VeroClear RGD810 (Objet Ltd., Israel), a virtually colorless transparent material when cured, over-curing causes a yellowing or browning of the material at layer parts **72** and **74**, which is visible through the colorless transparent material, while the remainder of the object is virtually colorless and transparent throughout.

The same yellowing or browning due to over-curing may occur in other colored, opaque materials, or colored, transparent materials, for example the building materials having the trade names Objet® FullCure®720 RGD720, Objet® VeroGray RGD850, and other modeling materials.

5 The present inventors have devised a technique which reduces or prevents curing-induced discoloration. The methods of the present embodiments thus provide an object which is uniform in coloration throughout the object. In various exemplary embodiments of the invention control unit **52** operates dispensing unit **21** to form a stack of radiation-protective layers covering the exposed portion of one or more of the layers
10 (e.g., regions **62** and **64** in the above example). A schematic illustration of these embodiments is illustrated in FIG. 3. As shown, regions **62** and **64** at heights H1 and H2, respectively, are covered by stacks generally shown at **82** and **84**. The stacks are made from a material with sufficiently high absorption or reflection coefficient to the wavelength of the curing radiation applied by radiation source **26**.

15 The stacks are optionally and preferably formed by dispensing unit **21** during the buildup of object **12**, at the same time as layers of the object being formed at the same height. Thus In these embodiments, the part of the layer for forming the object and the radiation-protective part of the layer are made in the same scan of the dispensing heads. For example, the lowermost layer of stack **82** is formed when the z level of tray **30** is
20 adjusted for the layer immediately above (e.g., on top of) the uppermost layer of region **62**. Thus, the amount of radiation arriving to the low heights regions of the object (regions **62** and **64** in the present example) is gradually reduced during and as a result of the buildup of the stacks.

 In various exemplary embodiments of the invention at least one of the stacks is
25 not covered by modeling material layers from above. In other words, such a stack of radiation-protective layers can be covered by additional radiation-protective layers but is preferably not covered by a modeling material layer. Thus, during the formation of any modeling material layer subsequent to i.e. higher than the uppermost layer of the low height region(s) of object **12**, the uppermost layer of the low height region(s), being the
30 uppermost layer of the protective stack is exposed and protects the modeling material layers beneath it from the effects of excess curing. Once the uppermost layer of the stack is formed, it remains exposed until object **12** is completed.

The overall height or the number of radiation-protective layers is optionally and preferably selected by control unit **52** based on the type of radiation-protective material which is used for forming the stack. For example, materials with strong radiation absorption, can provide shielding from the radiation with fewer layers (*e.g.*, one layer),
5 while for materials with lower radiation absorption, a larger number of layers is preferred. In some embodiments of the present invention the number of layers in the stack is selected so as to block at least 90% or at least 93% or at least 96% or at least 99% of the curing radiation emitted by source **26**. Typically, the number of layers in the stack is at least 10 (*e.g.*, more than 10) layers, or at least 30 (*e.g.*, more than 30) layers,
10 or at least 60 (*e.g.*, more than 60) layers, or at least 90 (*e.g.*, more than 90) layers, for example, 100 layers or more.

Typically, but not necessarily, the respective layer has a thickness which is about 15 microns. In some embodiments, the respective layer has a thickness of at least 5 microns, *e.g.*, about 5 microns, or about 10 microns, or about 15 microns or about 30
15 microns. Other thicknesses are not excluded from the scope of the present invention.

In some embodiments of the present invention the controller calculates at least one of a thickness and a number of layers in the stack based on a type of a radiation-protective material used for forming the stack. Optionally and preferably the thickness and/or number of layers is calculated based on the transmission coefficient of the
20 radiation-protective material for the curing radiation. The calculation can be by a preprogrammed analytical function, or via a lookup table which can be stored, for example, in a memory medium accessible by the controller.

In some embodiments of the present invention a plurality of stacks is formed, wherein the number of layers of two or more of these stacks is as indicated above.

25 The radiation-protective layers are sacrificial layers. That is, they are deposited during the build up of object **12** but they are not part of the objects itself. Once the object is completed, the stack can be removed using any technique that selectively removes the radiation-protective layers generally without damaging the modeling material layers.

30 It is recognized that during the additive manufacturing of the object additional sacrificial layers can be formed. A representative example of such a configuration is illustrated in FIGs. 4A and 4B. FIG. 4A illustrates a configuration which includes, in

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addition to protective stacks **82** and **84**, several support layers **92** formed for supporting the upper layers **94** of object **12** while upper layers **94** are being formed. Such support layers are made of support material, optionally including also modeling material elements for reinforcement, and are also sacrificial since they are not part of the final object. Once the object is completed all sacrificial layers are removed, leaving only the modeling material layers. The removal of the protective stacks **82** and **84**, reveals the low-height regions **62** and **64**, and the removal of support layers **92** reveals a void or recess **96** beneath upper layers **94** which form an overhang above recess **96**.

The difference between the two types of sacrificial layers, is that while the uppermost layer of support layers **92** is eventually covered by the bottommost layer of modeling layers **94**, the uppermost layers of stacks **82** and **84** preferably remain exposed once the buildup of object **12** is completed. In some embodiments of the present invention the number of layers in the stack is larger than the number of layers in any of the support regions **92**. In some embodiments of the present invention the number of layers in the stack is less than the number of layers in any of the support regions **92**.

In various exemplary embodiments of the invention, for at least 50% of the layers or at least 60% of the layers or at least 70% of the layers or at least 80% of the layers or at least 90% of the layers *e.g.*, all the layers of the stack, the dimensions of the layer are more than 1.7 mm or more than 1.8 mm or more than 1.9 mm or more than 2 mm in at least one of the X direction or the Y direction. In some embodiments of the present invention, the dimensions of the layer are more than 2mm by 2 mm.

In an aspect of some embodiments of the present invention there is provided a method suitable for additive manufacturing of a three-dimensional object. The method can be executed using an AM system, *e.g.*, system **10**. The method comprises sequentially forming a plurality of layers in a configured pattern corresponding to the shape of the object. The formation of each layer comprises dispensing at least one modeling material to form an uncured layer, and curing uncured layer by radiation, as further detailed hereinabove. For at least one of the layers, the method forms a stack of sacrificial radiation-protective layers to cover an exposed portion of that layer, as further detailed hereinabove. In some embodiments of the present invention the method removes the stack once the object buildup is completed.

The radiation-protective layers of the stacks can be made from any material which is suitable for additive manufacturing (*e.g.*, three-dimensional printing) and which has a sufficiently high absorption or reflection coefficient to the wavelength of the curing radiation applied by radiation source 26. In various exemplary embodiments of the invention the radiation-protective layers are removable so as to allow them to be detached from the modeling layers following manufacturing.

It was surprisingly found by the present inventors that support materials which have traditionally been used for forming supporting layers beneath overhangs or curved object features, have adequate radiation absorption coefficient for use as radiation-protective layers above low-height regions of the object. In experiments performed by the present inventors stacks of layers made of support material, optionally including also modeling material elements for reinforcement, unexpectedly prevented the effects of discoloration in the low-height regions.

In some embodiments of the present invention the radiation-protective layers are made, at least in part, from a water soluble support material. This allows removal of the sacrificial layers using water or other aqueous liquid. For example, a jet of pressurized aqueous liquid (*e.g.*, water) can be directed to the object, so as to selectively remove the sacrificial layers while maintaining the modeling layers intact and undamaged.

In some embodiments of the present invention the radiation-protective layers are characterized by a modulus of elasticity which is lower than a modulus of elasticity characterizing the modeling material once cured. Radiation-protective layers of reduced modulus of elasticity are advantageous from the standpoint of removal procedure. When the radiation-protective layers have a lower modulus of elasticity than the modeling layers, they can be easily detached from the modeling layers by wet or dry mechanical treatment, wherein the elasticity of the modeling layers prevents the modeling layer from being damaged by the treatment. Representative examples of mechanical treatment including, without limitation, dry peeling and use of liquid jets.

In some embodiments of the present invention the radiation-protective layers are made of a material which comprises a combination of an unpolymerizable component and a polymerizable component. Such material in addition can optionally form a very thin separation region between the radiation-protective layers and the modeling layers when deposited alone, *e.g.*, without reinforcing modeling material elements, at the

interface between the two layer part types (objet layer part and protective layer part) during layer formation. Such thin separation facilitates removal of the protective layer stack from the object and is likewise removed from the object, after completion of the manufacturing process. Preferably, the material of the radiation-protective layers contains at least 50 % weight of unpolymerizable component.

In various exemplary embodiments of the invention the material of the radiation-protective layers has a sufficiently low oxygen solubility so as to allow the protective covering layers to reduce or protect from oxygen penetration.

A representative example of a material suitable for forming the radiation-protective layers of the present embodiments is a three-dimensional printing support material, such as, but not limited to, FullCure® 705 marketed by Objet Ltd. Optionally and preferably, the support material is mixed with a certain amount (*e.g.*, 25 % weight) of modeling material.

In some embodiments, the method and/or system manufactures an object which is generally uniform in color. In some embodiments, the method and/or system manufactures an object which is generally uniform in lack of color.

The uniformity in color or lack of color can be measured, for example, using a spectrophotometer. A suitable spectrophotometer is, for example, X-Rite SP62, (X-Rite, USA). This technique is particularly useful for colored objects. Another technique includes use of digital imaging for acquiring an image of the object. A suitable digital camera is, for example, Canon Powershot A650 IS, Canon USA, Inc. This technique is particularly useful for transparent objects.

A yellow index can be calculated, for example, according to the equation:

$$\text{Yellow Index} = 100 - \text{Blue} / [(\text{Blue} + \text{Red} + \text{Green})/3] * 100,$$

where, Blue, Red, Green are the intensities of respective colors obtained. The values of the Blue, Red and Green intensities can be obtained using any image processing algorithm known in the art. A representative example of such an algorithm is ImageJ software, which is a Java-based image processing program (National Institute of Health, USA).

The yellow index can be used as a color uniformity descriptor, wherein values which are greater than 0 correspond to a color which is more yellow, and values which are less than 0 correspond to a color which is more blue. In various exemplary

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embodiments of the invention the object formed by the method and system of the present embodiments is characterized by a yellow index which is from about -1 to about 3.3, or from about -1 to about 2, or from about -1 to about 1, or from about -0.5 to about 0.5, or from about -0.1 to about 0.1, *e.g.*, 0.

5 One or more operations of the method of the present embodiments is implemented by a computer. Computer programs implementing the method of the present embodiments can commonly be distributed to users on a distribution medium such as, but not limited to, a floppy disk, a CD-ROM, a flash memory device and a portable hard drive. From the distribution medium, the computer programs can be
10 copied to a hard disk or a similar intermediate storage medium. The computer programs can be run by loading the computer instructions either from their distribution medium or their intermediate storage medium into the execution memory of the computer, configuring the computer to act in accordance with the method of this invention. All these operations are well-known to those skilled in the art of computer systems.

15 The computer implemented method of the present embodiments can be embodied in many forms. For example, it can be embodied in on a tangible medium such as a computer for performing the method operations. It can be embodied on a computer readable medium, comprising computer readable instructions for carrying out the method operations. In can also be embodied in electronic device having digital
20 computer capabilities arranged to run the computer program on the tangible medium or execute the instruction on a computer readable medium.

It is expected that during the life of a patent maturing from this application many relevant modeling materials for AM will be developed and the scope of the term modeling material is intended to include all such new technologies *a priori*.

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As used herein the term "about" refers to $\pm 10\%$.

The word "exemplary" is used herein to mean "serving as an example, instance or illustration." Any embodiment described as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments and/or to exclude the
30 incorporation of features from other embodiments.

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The word "optionally" is used herein to mean "is provided in some embodiments and not provided in other embodiments." Any particular embodiment of the invention may include a plurality of "optional" features unless such features conflict.

The terms "comprises", "comprising", "includes", "including", "having" and their
5 conjugates mean "including but not limited to".

The term "consisting of" means "including and limited to".

The term "consisting essentially of" means that the composition, method or structure may include additional ingredients, steps and/or parts, but only if the additional ingredients, steps and/or parts do not materially alter the basic and novel characteristics
10 of the claimed composition, method or structure.

As used herein, the singular form "a", "an" and "the" include plural references unless the context clearly dictates otherwise. For example, the term "a compound" or "at least one compound" may include a plurality of compounds, including mixtures thereof.

Throughout this application, various embodiments of this invention may be
15 presented in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the invention. Accordingly, the description of a range should be considered to have specifically disclosed all the possible subranges as well as individual numerical values within that range. For example, description of a range such
20 as from 1 to 6 should be considered to have specifically disclosed subranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

Whenever a numerical range is indicated herein, it is meant to include any cited
25 numeral (fractional or integral) within the indicated range. The phrases "ranging/ranges between" a first indicate number and a second indicate number and "ranging/ranges from" a first indicate number "to" a second indicate number are used herein interchangeably and are meant to include the first and second indicated numbers and all the fractional and integral numerals therebetween.

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It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination

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in a single embodiment. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination or as suitable in any other described embodiment of the invention. Certain features described in the context of various
5 embodiments are not to be considered essential features of those embodiments, unless the embodiment is inoperative without those elements.

Although the invention has been described in conjunction with specific
10 embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

All publications, patents and patent applications mentioned in this specification
15 are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention. To the extent that
20 section headings are used, they should not be construed as necessarily limiting.

WHAT IS CLAIMED IS:

1. A method of additive manufacturing of a three-dimensional object, comprising sequentially forming a plurality of layers in a configured pattern corresponding to the shape of the object, said forming comprising, for each layer, dispensing at least one modeling material to form an uncured layer, and curing said uncured layer by radiation,

wherein the method comprises, for at least one layer, forming a stack of sacrificial radiation-protective layers to cover an exposed portion of said layer, such that an upper layer of said stack remains exposed during formation of any subsequent layer of said plurality of layers.

2. The method according to claim 1, further comprising removing said stack.

3. The method according to claim 2, wherein said removing is by a jet of pressurized aqueous liquid.

4. The method according to any of claims 1-3, wherein a number of layers in said stack is selected so as to block at least 90% of said radiation.

5. The method according to any of claims 1-4, comprising forming a plurality of said stacks, wherein each stack has at least 10 layers.

6. The method according to claim 5, wherein each stack has at least 100 layers.

7. The method according to any of claims 1-6, wherein said sacrificial radiation-protective layers are made, at least in part, from a three-dimensional printing support material.

8. The method according to any of claims 1-6, wherein said sacrificial radiation-protective layers are made, at least in part, from a water soluble material.

9. The method according to any of claims 1-6, wherein said sacrificial radiation-protective layers are characterized by a modulus of elasticity which is lower than a modulus of elasticity characterizing said modeling material once cured.

10. The method according to any of claims 1-6, wherein said sacrificial radiation-protective layers comprise unpolymerizable material.

11. The method according to any of claims 1-10, wherein said forming said stack is done such that the object is generally uniform in color.

12. The method according to any of claims 1-10, wherein said forming said stack is done such that the object is generally uniform in lack of color.

13. A computer software product, comprising a computer-readable medium in which program instructions are stored, which instructions, when read by a computerized controller of an additive manufacturing system, cause said system to execute the method according to any of claims 1-10.

14. A system for additive manufacturing of a three-dimensional object, comprising;

a dispensing unit configured for dispensing at least one type of modeling material to form an uncured layer;

a curing unit configured for curing said uncured layer by radiation; and

a controller configured for operating said dispensing unit and said curing unit to sequentially form a plurality of layers in a configured pattern corresponding to the shape of the three-dimensional object, and a stack of sacrificial radiation-protective layers covering an exposed portion of at least one layer, such that an upper layer of said stack remains exposed during formation of any subsequent layer of said plurality of layers.

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15. The system according to claim 14, wherein a number of layers in said stack is selected so as to block at least 90% of said radiation.

16. The system according to any of claims 14 and 15, comprising forming a plurality of said stacks, wherein each stack has at least 10 layers.

17. The system according to claim 16, wherein each stack has at least 100 layers.

18. The system according to any of claims 14-17, wherein said stack is selected such as to form an object which is generally uniform in color.

19. The system according to any of claims 14-17, wherein said stack is selected such as to form an object which is generally uniform in lack of color.

20. The system according to any of claims 14-19, wherein said controller is configured for calculating at least one of a thickness and a number of layers in said stack based on a type of a radiation-protective material used for forming said stack.

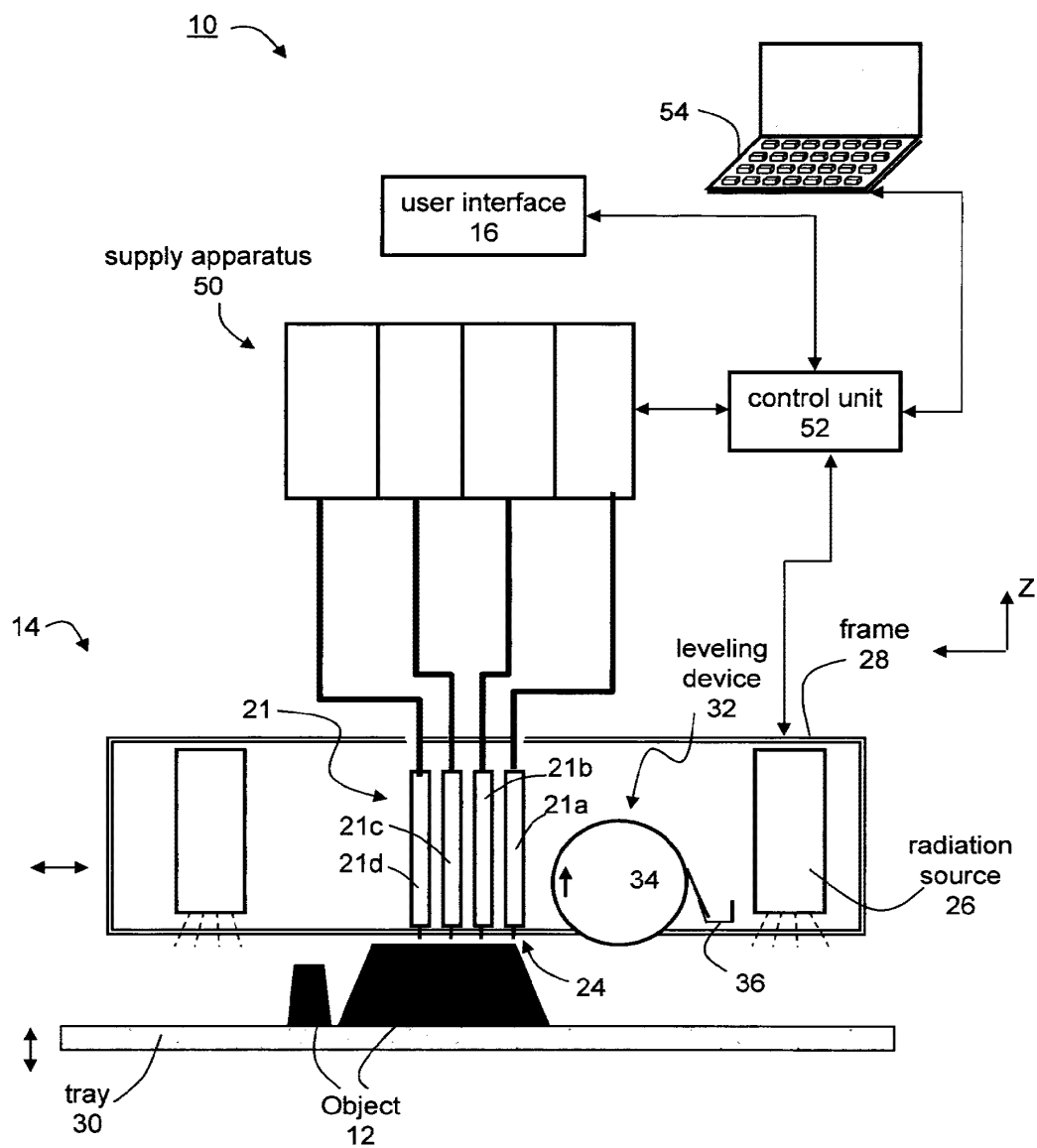


FIG. 1A

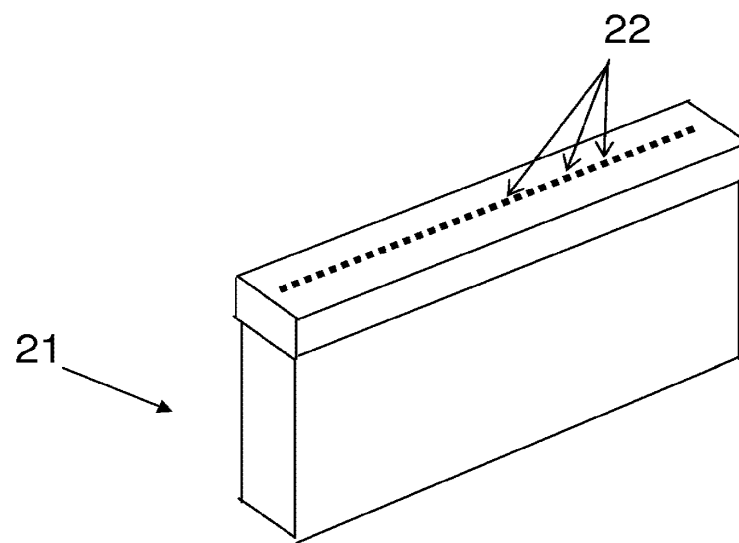


FIG. 1B

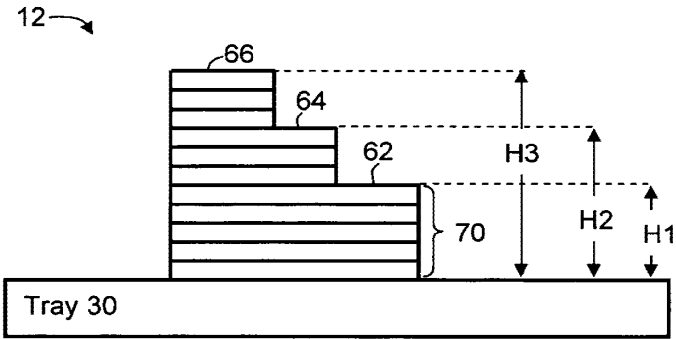


FIG. 2A

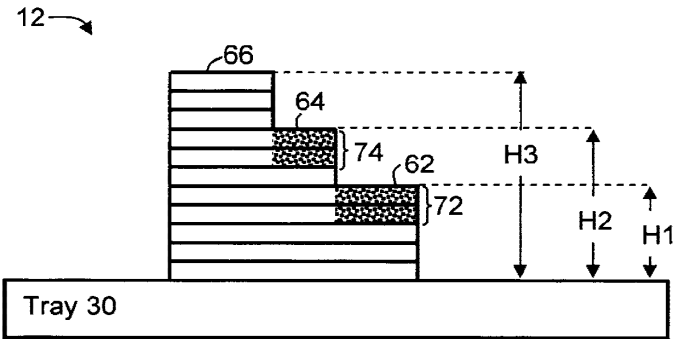


FIG. 2B

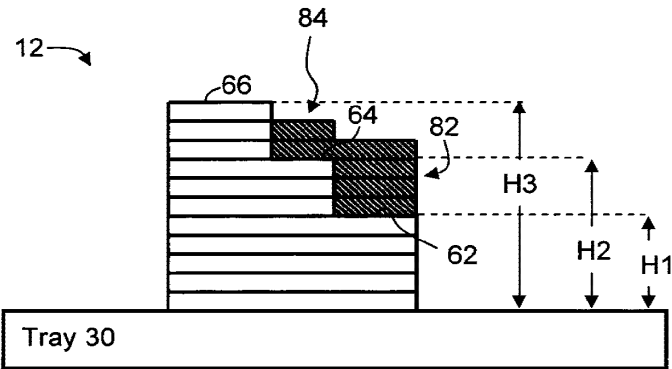


FIG. 3

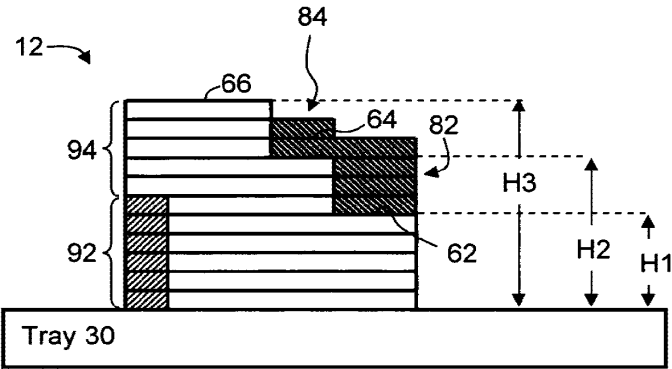


FIG. 4A

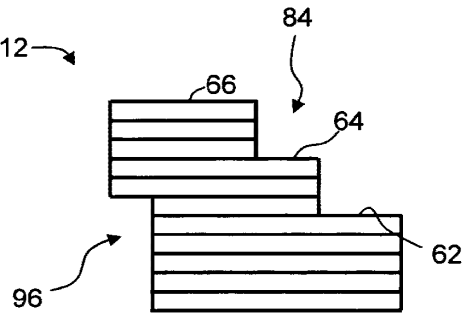


FIG. 4B

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
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ADD.

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 2004/050323 A1 (OBJET GEOMETRIES LTD [IL]; KRITCHMAN ELIAHU M [IL]; GOTHAIT HANAN [IL]) 17 June 2004 (2004-06-17) paragraph [0001] figures 2a, 2b, 2e paragraph [0029] - paragraph [0036] paragraph [0080] - paragraph [0087] paragraph [0093] - paragraph [0098] -----	1-11, 13-19 20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004050323	A1	17-06-2004	AT 411888 T 15-11-2008
		AU 2003286397	A1 23-06-2004
		EP 1590149	A1 02-11-2005
		EP 2199068	A2 23-06-2010
		EP 2295227	A2 16-03-2011
		HK 1089128	A1 31-07-2009
		US 2006054039	A1 16-03-2006
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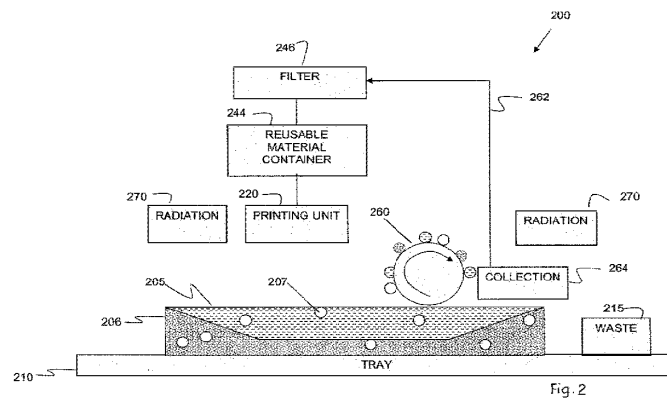
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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(54) Title: METHOD AND SYSTEM FOR REUSE OF MATERIALS IN ADDITIVE MANUFACTURING SYSTEMS



(57) Abstract: Embodiments of the present invention are directed to a system and method for reusing surplus material generated by an Additive Manufacturing system in the process of manufacturing a 3-dimensional (3D) object. Surplus material removed from deposited layers and purged material used for printing head maintenance are transferred to back to the printing system to be deposited within subsequent layers. The reusable material may be deposited within the boundaries of a cross section of the 3-dimensional object to become part of 3D object or outside the boundaries of a cross section of the 3-dimensional object as part of the support construction, which is removed from the finished product. According to embodiments of the invention, a portion of the waste material for disposal may be deposited and cured layer by layer to form a waste block, concurrently with printing the layers of the 3D dimensional object. The fully cured waste block may be then disposed of in a safe manner.

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METHOD AND SYSTEM FOR REUSE OF MATERIALS IN ADDITIVE MANUFACTURING SYSTEMS

BACKGROUND

[001] In three-dimensional printing, building materials are selectively jetted from one or more printing heads or dispensers and deposited onto a fabrication tray in consecutive layers according to pre-determined image data. The layers may include cross sections of the three-dimensional object to be formed and of a support construction that is later removed from the finished object. The building materials may be UV polymerizable compositions, e.g. photopolymers, which are polymerized, solidified, conditioned or cured after deposition, for example, by ultraviolet (UV) radiation.

[002] Prior to solidifying the layer, a leveling device may remove a surplus portion of the material dispensed in the layers. The collected surplus material is generally disposed of as waste inherent to the printing process.

[003] It is common practice to perform a periodic maintenance process during the printing process, for example "purging" of the printing heads, e.g. once every 10 minutes, depending on the materials being used and other system characteristics. This procedure is intended to flush the printing heads and in this way reduce the risk of nozzles clogging. Nozzle clogging maybe the result of for example dust accumulation, remnants of solidified material that may accumulate within and/or around the nozzle orifices of the printing head, i.e. on the orifice plate, for example due to proximity of a UV light source and/or reflection of UV light. The printing head is moved to a purge unit where building material is provided to the nozzles and discharged from the nozzles so that material elements clogging the nozzle orifices and/or accumulating on the orifice plate may be removed together with the material used for the purging process. The purged material is collected and considered as waste, to be disposed of together with the waste collected from the leveling device.

[004] It may not be desirable, e.g. for environmental reasons, to dispose of such waste by using standard methods as a sewerage system or a municipal waste removal service,

and laws or regulations may prohibit this as well. Instead, the waste material for disposal should be pre-treated and/or fully cured and safely disposed of.

BRIEF DESCRIPTION OF THE DRAWINGS

[005] The subject matter regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention, however, both as to organization and method of operation, together with objects, features and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanied drawings in which:

[006] Fig. 1 is a schematic illustration of an exemplary 3D printing system according to embodiments of the invention;

[007] Fig 2 is a schematic illustration of an exemplary printing system and printing process according to embodiments of the invention; and

[008] Fig. 3 is a flowchart diagram of a method of printing 3D objects according to embodiments of the invention.

[009] It will be appreciated that for simplicity and clarity of illustration, elements shown in the drawings have not necessarily been drawn accurately or to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity or several physical components included in one functional block or element. Further, where considered appropriate, reference numerals may be repeated among the drawings to indicate corresponding or analogous elements. Moreover, some of the blocks depicted in the drawings may be combined into a single function.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[010] In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those of ordinary skill in the art that the present invention may be practiced without these specific details. Various modifications to the described embodiments will be apparent to those with skill in the art, and the general principles defined herein may be applied to other embodiments. Therefore, the present invention is not intended to be limited to the particular embodiments shown and described, but is to be accorded the widest scope consistent with the principles and novel features herein

disclosed. In other instances, well-known methods, procedures, components and circuits may not have been described in detail so as not to obscure the present invention.

[011] The terms "layer" and "object layer" are used throughout the specification and claims to describe any lamina or film that may represent a cross-section or slice of a three-dimensional (3D) object. A layer may be formed and adhere to previously formed and adhered layers in a "layer by layer" fashion to create, build up or form the 3D object.

[012] The terms "X direction" and "Y direction" as used throughout the specification and claims refer to directions horizontally parallel to a fabrication tray that are indicative of relative movement between a dispensing head (printing head) or a printing assembly and the fabrication tray during selective dispensing of material from nozzles of the dispensing head onto the fabrication tray. The relative movement may be achieved by moving the dispensing head while the tray is kept motionless, by moving the fabrication tray while keeping the dispensing head motionless or by moving both the printing head and the fabrication tray relative to one another. The X direction may be the scanning direction while the Y direction may be the indexing direction. The term "Z direction" as used herein throughout the specification and claims refers to a direction perpendicular to both the X and Y directions. The Z direction is indicative of the vertical direction in which the consecutive layers are formed.

[013] The terms "dispensing head", "printing head" or "head" as used herein are interchangeable and refer to printing heads each having one or more nozzles, e.g. an array of nozzles for dispensing, i.e. depositing droplets of liquid building materials in layers onto a fabrication tray to or onto the surface of previously printed layers of the 3D object being formed.

[014] It is noted that the term "building material" as used herein may include model or "modeling" material, support or "supporting" material, and/or any suitable combination of modeling material and/or supporting material, used in the building, forming, modeling, printing or other construction of three-dimensional (3D) objects or models. Building material may include modeling material used to create models, material used to modify such material (e.g., dyes, fillers, etc), support material, or other material used

in the creation of objects, whether or not appearing in the final object. The building materials may be ultraviolet polymerizable liquid or gel materials e.g. photopolymer materials, which solidify or become solid or gel-like upon curing. Examples of modeling and support materials are Objet® FullCure®720 RGD720, FullCure®705, respectively, both provided by Objet Ltd., Rehovot, Israel. It should be understood, however, by those skilled in the art that embodiments of the invention are not limited to building materials that are liquid at room temperature. According to some embodiments the building materials may be solid or semi solid at room temperature and may be heated to become liquid to enable transfer via tubes or pipes to dispensing heads for deposition.

[015] Embodiments of the present invention are directed to a system and method for reusing waste material generated by an Additive Manufacturing (AM) apparatus in the process of producing three-dimensional (3D) objects. Although embodiments of the invention will be described for ease of explanation with respect to selective deposition modeling (SDM), solid freeform fabrication (SFF) or 3D printing, it should be realized that the invention is not limited to such systems and may be utilized in other AM systems.

[016] According to embodiments of the invention, the method may include generating image data that includes cross sectional layers of a three-dimensional object to be printed and of a support construction and selectively dispensing, layer by layer, according to the image data building materials and reusable material from different dispensing heads, wherein the reusable material includes surplus material collected to be reused during formation of the three-dimensional object.

[017] According to embodiments of the present invention, surplus material is removed from layers deposited in the process of manufacturing a 3-dimensional (3D) object. The surplus material, instead of being disposed of as waste material, is transferred back to the printing system to be deposited in subsequent printing layers. This surplus (i.e. waste) material may be deposited within the boundaries of a cross section of the 3-dimensional object to become part of the 3D object or outside the boundaries of the 3D object cross section as part of a support construction, which is subsequently removed from the finished product.

[018] The surplus material i.e. waste material removed from the deposited layer/s may include a mixture of two or more compositions, for example one or more modeling material compositions mainly used for producing the 3D object or model and support material compositions mainly used for forming the support construction. The surplus material may include un-polymerized liquid components, as well as partly-polymerized or gel-like components and polymerized solid particles which may not be suitable for reuse. According to embodiments of the invention, the surplus material is filtered to remove polymerized solid particles, prior to being delivered to a liquid surplus material container and/or dispenser for reuse in printing, in the case of useable liquid surplus material, or to a waste container for disposal, in the case of polymerized material.

[019] In some embodiments, building materials that are discharged or purged from the nozzles during maintenance of the printing head nozzle orifice plate are collected in a purge unit. Likewise, surplus or waste material thus collected may include un-polymerized liquid material as well as partly-polymerized, gel-like or polymerized solid material elements, and likewise be filtered before being delivered either to a liquid surplus material container and/or dispenser for reuse, or a waste container that collects polymerized waste material for disposal. Throughout the specification and claims the term "surplus material" is used to describe both material collected from the deposited layers and material collected in the purging operation.

[020] Some embodiments of the invention are directed to a method of disposing of waste material generated by an additive manufacturing (AM) system where at least a portion of the surplus material removed from deposited layers and/or material discharged during purging and not intended for reuse may be deposited and cured layer by layer to form a waste block, concurrently with printing the layers of the 3D dimensional object. The cured waste block may be then disposed of in an environmentally safe manner. In other embodiments, substantially the entire surplus material is recycled and reused as a building material.

[021] Reference is now made to Fig. 1, which is a schematic illustration of an exemplary three-dimensional (3D) printing system according to embodiments of the invention. A three-dimensional dispensing or printing system 100 may include a fabrication platform or tray 110, a printing unit 120 having one or more printing heads 122a, 122b, 122c, and a material supply unit or system 140. Material supply unit 140

may include two or more primary or new material containers or cartridges 142 and one or more reusable material containers 144. Reusable material container/s 144 may be a container dedicated to collection and supply of surplus material for dispensing which may comprise part of the printing system and/or material supply unit, i.e. internal to the printing and/or material supply system, or be separate from, e.g. external to the printing and/or the material supply system.

[022] System 100 may further include a positioning or conveyance unit 150, a leveling device 160, one or more curing units or radiation sources 170, a controller 180 and a purge unit 190. Leveling unit 160 may be in a form of a roller. The roller may level and/or establish a predetermined thickness of a deposited layer by collecting surplus material deposited during a pass of the printing heads over the fabrication tray. Surplus material may be removed from the roller e.g. by a blade or other method and collected in a bath (not shown). The surplus material thus removed is then conveyed via tube 162 to filter 146 where the surplus material is filtered to remove solidified particles and the filtered liquid is transferred to reusable material container 144 for reuse. Solidified waste material is transferred to a waste disposal container 148 for disposal. Alternatively or additionally the filter may be located between container 144 and printing unit 120.

[023] Purge unit 190 may comprise a bath (not shown) from which building materials discharged from the printing head/s during maintenance of the printing head/s orifice plate/s are conveyed via tube 192 to filter 146 where the surplus material is filtered to remove solidified particles and the filtered liquid transferred to reusable material container 14 for reuse and solidified particles are transferred to waste disposal container 148 for disposal. The purge operation may be performed for nozzles that were previously used to print modeling material using the same modeling material. Likewise, the purge operation may be performed for nozzles that were previously used to print support material using the same modeling material. The purge operation may further be performed for nozzles that were previously used to print reusable material using the reusable or recycled material. The purged materials, as aforesaid, may be collected and filtered, and transported to the same reusable waste container 144 or to a separate reusable material container for reuse.

[024] In one embodiment of the invention, purged materials may be collected and filtered separately according to their type and intended use. For example, purged modeling material may be reused for printing of the 3D object and optionally part of the support construction, purged support material may be reused in printing support constructions, and purged material may be reused for parts of the model or support constructions.

[025] Radiation source 170 may be a UV light source, however it should be appreciated that embodiments employing other radiation sources or curing units, such as infrared units are also included within the scope of the invention. It will be appreciated, however, by those skilled in the art that in other embodiments of the invention, light of any other suitable spectrum may be used.

[026] The curing may be carried out after the deposition of each layer or after the deposition of more than one layer. Although in the exemplary embodiment of Fig. 1, a single radiation unit is illustrated, it should be understood to a person skilled in art that the invention is not limited in this respect and according to embodiments of the present invention any suitable number of radiation units may be used.

[027] Printing unit 120 may be, for example, an ink jet unit or dispenser having one or more dispensing units (dispensers), for example, ink jet printing heads 122a, 122b, 122c. Each printing head may include a plurality of dispensing nozzles 123 arranged in an array of one or more rows along the longitudinal axis of the printing head. Material containers 142 may supply building materials to the printing heads, a different building material for each printing head. For example modeling material may be supplied to printing head 122a and support material may be supplied to printing head 122c. In an embodiment of the present invention, reusable material may be supplied to a separate printing head, e.g. printing head 122b. In some embodiments, two different modeling materials may be deposited and thus one modeling material may be supplied to printing head 122a and another modeling material supplied to printing head 122b, while support material is supplied to printing head 122c. Reusable material can thus be supplied to printing head 122b instead of a second modeling material, or be supplied to an additional separate printing head (not shown) when a second modeling material is supplied to printing head 122b.

[028] Printing unit 120 may be coupled to positioning unit 150 to enable movement of the printing unit over fabrication tray 110 and/or the object/s in process of being printed on the fabrication tray in both X and Y directions. Alternatively or additionally, fabrication tray may be coupled to a conveyance unit (not shown) to enable relative movement between the printing unit and the object being printed. It should be realized that in other embodiments or for certain applications, both the fabrication tray and the printing unit may be stationary. Printing unit 120, tray 110 or both may move in the Z direction. For example, in some embodiments of the invention, printing unit 120 may be at a fixed location in the Z direction and fabrication tray or platform 110 may be capable of moving in the Z direction away from printing unit 120, e.g. gradually being lowered approximately a layer thickness distance from the printing unit or printing heads, to ensure that during printing the vertical distance between the printing heads and the top layer of the object to be printed remains constant.

[029] In some embodiments, a printing file, bitmap or other collection of print data may be prepared and/or provided and/or programmed, for example, by a computing platform connected to 3D printer system 100 or by controller 180. The printing file may be used to determine, for example, the order and configuration of deposition of building materials via, for example, movement of and activation and/or non-activation of one or more nozzles 123 of printing head(s) 122a-c, according to a bitmap of each layer of the 3D object to be built.

[030] Controller 180 may be suitably coupled and/or connected to various components of system 100, such as printing unit 120, printing heads 122a-c, material supply system 140, leveling unit 160 and others. For example, controller 120 may control valves, pumps, switches, compression or inflation devices, positioning units, dispensing units, leveling devices, curing devices, or any other system components.

[031] Controller 180 may be implemented using any suitable combination of hardware and/or software. Controller 180 may include, for example, a processor 182, a memory unit 184, software code 186 and input/output interface 188. Other configurations may be used for a controller or control unit. Control functionality may be spread across units, and not all control functionality may be within system 100.

[032] Controller 180 may be included within, or may include, a computing device such as a personal computer, a desktop computer, a mobile computer, a laptop computer, a server computer, or workstation (and thus part or all of the functionality of controller 182 may be external to 3D printer system 100). Controller 182 may be of other configurations, and may include other suitable components. For example, a separate unit, such as a personal computer or workstation, or a processing unit within a supply source such as a cartridge may provide some control or data storage capability. Processor 182 may include conventional devices, such as a Central Processing Unit (CPU), a microprocessor, a "computer on a chip", a micro controller, etc. Memory 184 may include conventional devices such as Random Access Memory (RAM), Read-Only Memory (ROM), or other storage devices, and may include mass storage, such as a CD-ROM or a hard disk.

[033] Controller 180 may utilize computer object data (COD) representing an object and a support construction, if needed. The data may include bitmaps of layers that may include positions of various building materials including modeling material, support material and reusable material. For example, controller's computer aided design (CAD) data in Stereo Lithography (STL) format. Other data types or formats may be used. In some embodiments, controller 180 may include a CAD system. The CAD Controller 180 may convert such data to instructions for the various units within 3D printer system 100 to print a 3D object. Controller 180 may include non-transitory computer-storage medium having stored thereon instructions for printing unit 120 to print according to the bitmaps. Controller 180 may be located inside or outside the printing apparatus. Controller 180 may be located outside of printing system 100 and may communicate with printing system 100, for example, over a wire and/or using wireless communications. In alternate embodiments, controller 180 may be partially external to system 100. For example, an external control or processing unit (e.g., a personal computer, workstation, computing platform, or other processing device) may provide some or all of the printing system control capability.

[034] Reference is now made to Fig. 2, which is a schematic illustration of an exemplary printing process according to embodiments of the invention. An exemplary system 200 may include a fabrication tray 210, a printing unit 220, two radiation sources 270 and a leveling device or planarizer, for example in the form of a roller 260.

Although, two radiation sources are illustrated in Fig. 2, embodiments of the invention are not limited in this respect and any other number of radiation sources is likewise applicable.

[035] As shown in Fig. 2, the surplus material may be a mixture of modeling material, support material, and reused material. A three dimensional object 205 supported by a support construction 206 is being formed on a fabrication tray 210 by depositing in layers building materials from printing unit 220 and curing the deposited layer by radiation sources 270. Three-dimensional object 205 may include predominantly at least one modeling material but may also include support material. The support construction 206 may include predominantly at least one support material and may further include in certain locations within the support construction a modeling material to provide desired mechanical characteristics. Leveling device 260 may collect surplus material from the liquid layer prior to curing. The surplus material may be collected by a bath 264 and conveyed to filter 246 via tube 262. Filtered liquid waste may then be conveyed to reusable material container 244. The filtered reusable material is delivered to the printing unit 220. Based on the layer structure, the surplus material collected by the leveling device may include modeling material, support material, reused material or any combination thereof.

[036] The reusable material may be used for building both the 3D object and the support construction. Accordingly, both object 205 and support construction 206 may include predesigned areas of reused or recycled materials 207. The locations and shape of these areas are chosen to match the desired characteristics of the 3D object and support structure. For example, the thermo-mechanical properties desired for the 3D objects may impose some limitation on the amount of reused waste material that can be re-used as a building material. According to some embodiments, the reused material may be used within bulky areas of the support construction. The reused material may be deposited as non continuous relatively small phases within a continuous bulky phase. Alternatively, the used material may be scattered within the continuous phase.

[037] According to some embodiments, in order to dispose of excess uncured waste material that cannot be used for recycling, the 3D object may be formed concurrently with a waste block 215. According to other embodiments waste block 215 may be formed separately and non-concurrently with printing 3D object 205. Like layers of the

3D object, waste block 215 layers are cured thus rendering the material of waste block 215 easily and safely disposable.

[038] Reference is now made to Fig. 3, which is a flowchart diagram of a method of printing 3D objects according to embodiments of the invention. According to embodiments of the invention, print data may be prepared for depositing building material, support material and recycled or reusable material in layers to form a three-dimensional object with its support construction and optionally a waste block for safe disposal (box 300). Then, for each layer, jetting commands are sent to one or more printing heads based on the print data, the suitable materials are delivered to the printing heads and one or more materials may be deposited to form a liquid or semi liquid layer on the fabrication tray or on previously formed layers (box 310). Then, a leveling device may collect surplus material from the layer (box 320). The layer may include two separate portions, a first portion associated with the 3D object and/or its support construction and a separate portion associated with a waste block. In some embodiments, only the portion associated with the 3D object may be planarized by the leveling device. Next, both portions of the layer (if existing) may be cured by radiation (box 330) and the collected surplus material may be conveyed to a filter (box 340) to remove any polymerized portions prior to using the filtered waste material as a building material within subsequent layers. Filtered reusable waste is collected and conveyed (box 350) back to the system for deposition of new layers (box 310). As shown by box 360, the printing unit may be moved to a service or maintenance area. The maintenance may include a purging operation, during which the purged building materials may be collected and conveyed to a filter (box 340) to remove any polymerized elements, before being collected and conveyed to the system (box 350) for deposition within new layers (box 310).

[039] Although embodiments of the invention are not limited in this regard, discussions utilizing terms such as, for example, "processing," "computing," "calculating," "determining," "establishing", "analyzing", "checking", or the like, may refer to operation(s) and/or process(es) of a computer, a computing platform, a computing system, or other electronic computing device which may be included in a printing machine, that may manipulate and/or transform data represented as physical (e.g., electronic) quantities within the computer's registers and/or memories into other

data similarly represented as physical quantities within the computer's registers and/or memories or other information storage medium that may store instructions to perform operations and/or processes by the printing machine or elements, parts, modules or units of a printing machine.

[040] Some embodiments of the present invention may be implemented in software for execution by a processor-based system. For example, embodiments of the invention may be implemented in code and may be stored on a computer-storage medium having stored thereon instructions which can be used to program a system to perform the instructions. The computer-storage medium may include, but is not limited to, any type of disk including floppy disks, optical disks, compact disk read-only memories (CD-ROMs), rewritable compact disk (CD-RW), and magneto-optical disks, semiconductor devices such as read-only memories (ROMs), random access memories (RAMs), such as a dynamic RAM (DRAM), erasable programmable read-only memories (EPROMs), flash memories, electrically erasable programmable read-only memories (EEPROMs), magnetic or optical cards, or any type of media suitable for storing electronic instructions, including programmable storage devices.

[041] Such a system may include components such as, but not limited to, a plurality of central processing units (CPU) or any other suitable multi-purpose or specific processors or controllers, a plurality of input units, a plurality of output units, a plurality of memory units, and a plurality of storage units. Such system may additionally include other suitable hardware components and/or software components.

[042] Although embodiments of the invention are not limited in this regard, the terms "plurality" and "a plurality" as used herein may include, for example, "multiple" or "two or more". The terms "plurality" or "a plurality" may be used throughout the specification to describe two or more components, devices, elements, units, parameters, or the like. For example, "a plurality of printing heads" may include two or more printing heads.

[043] While certain features of the invention have been illustrated and described herein, many modifications, substitutions, changes, and equivalents may occur to those of ordinary skill in the art. It is, therefore, to be understood that the appended claims are

intended to cover all such modifications and changes as fall within the true spirit of the invention.

CLAIMS

What is claimed is:

1. A method for forming three-dimensional objects, layer by layer, the method comprising:
 - generating image data that includes cross sectional layers of a three-dimensional object to be printed and of a support construction; and
 - selectively dispensing, layer by layer, according to the image data building materials and reusable material from different dispensing heads, wherein the reusable material includes surplus material collected to be reused during formation of the three-dimensional object.
2. The method of claim 1, further comprising:
 - applying radiation to at least partially solidify layers deposited on a printing platform.
3. The method of claim 1, wherein the surplus material comprises surplus material removed from previously deposited layers.
4. The method of claim 1, wherein the surplus material comprises surplus material collected during a purge operation.
5. The method of claim 1, further comprising:
 - filtering and removing solid particles from the surplus material prior to dispensing.
6. The method of claim 1, wherein dispensing layer by layer further comprises dispensing the reusable material to form a separate waste block adjacent to the three dimensional object.
7. The method of claim 1, wherein the reusable material forms part of the three-dimensional object.

8. The method of claim 1, wherein the reusable material forms part of the support construction.
9. The method of claim 1, further comprising:
 - collecting purging materials used during maintenance operations and conveying the purging materials for re-use in a three-dimensional printing process.
10. The method of claim 1, wherein the building materials and reusable material are photo-curable materials in a liquid form at room temperature.
11. The method of claim 1, wherein the photo-curable materials and reusable material are in a solid or semi-solid form at room temperature.
12. A printing system for forming three-dimensional objects, layer by layer, the system comprising:
 - dispensing heads for depositing layers of a three-dimensional object to be formed and of support construction;
 - two or more containers that hold building materials for forming the three-dimensional object and the support construction;
 - a container that holds reusable material and provides the reusable material to the one of the dispensing heads; and
 - a leveler that removes surplus material from previously deposited layers;wherein the reusable material includes surplus material collected from said leveler to be reused during formation of the three-dimensional object.
13. The printing system of claim 12, further comprising a curing unit.
14. The printing system of claim 12, wherein the one or more dispensing heads are one or more inkjet printing heads.
15. The printing system of claim 12, further comprising:

a controller to control the formation of the three dimensional object.

16. The printing system of claim 12 further comprising:

a purge unit for purging clogged printing heads, and wherein said reusable material comprises surplus material collected from said purge unit to be reused during formation of the three-dimensional object.

1/3

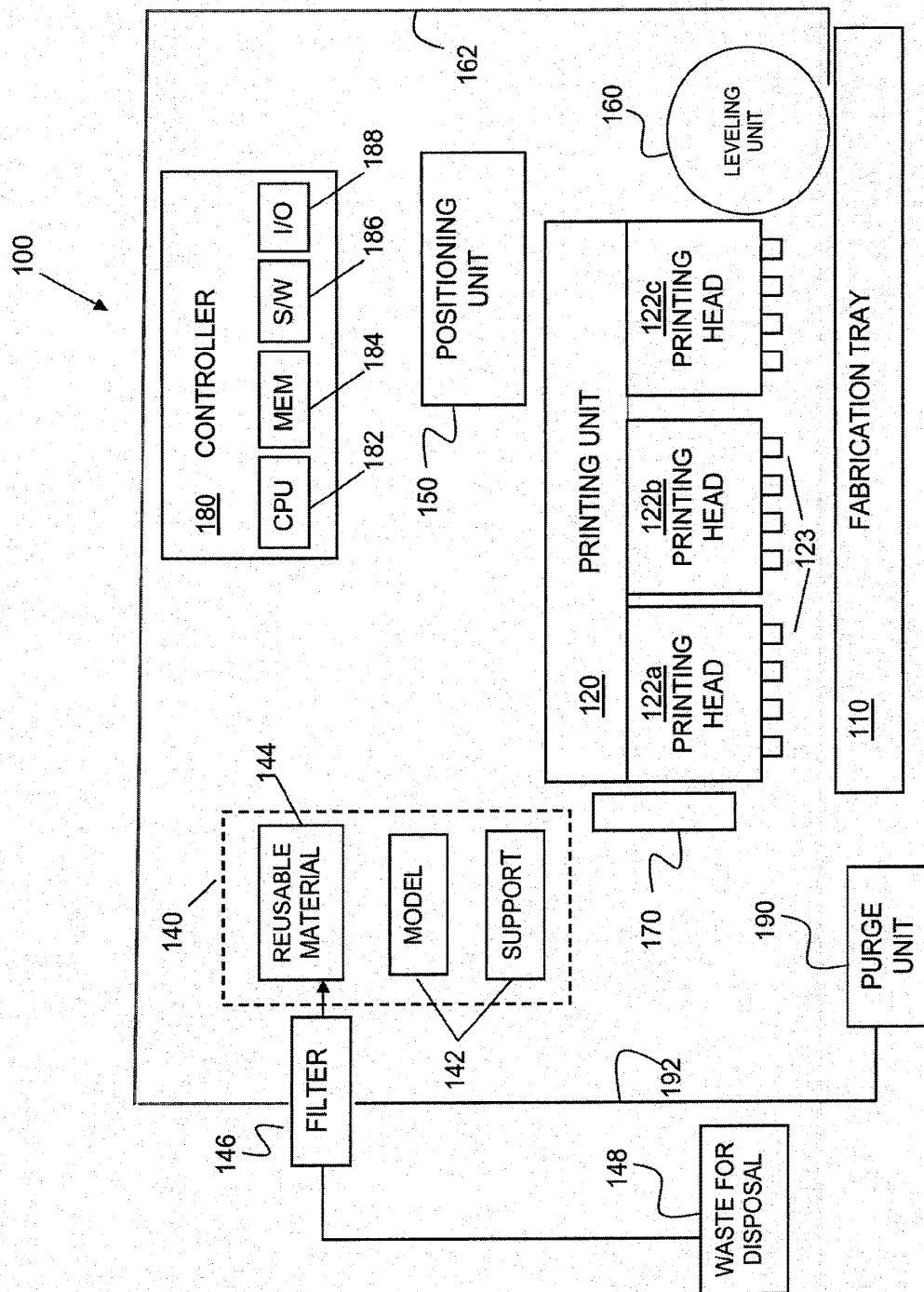
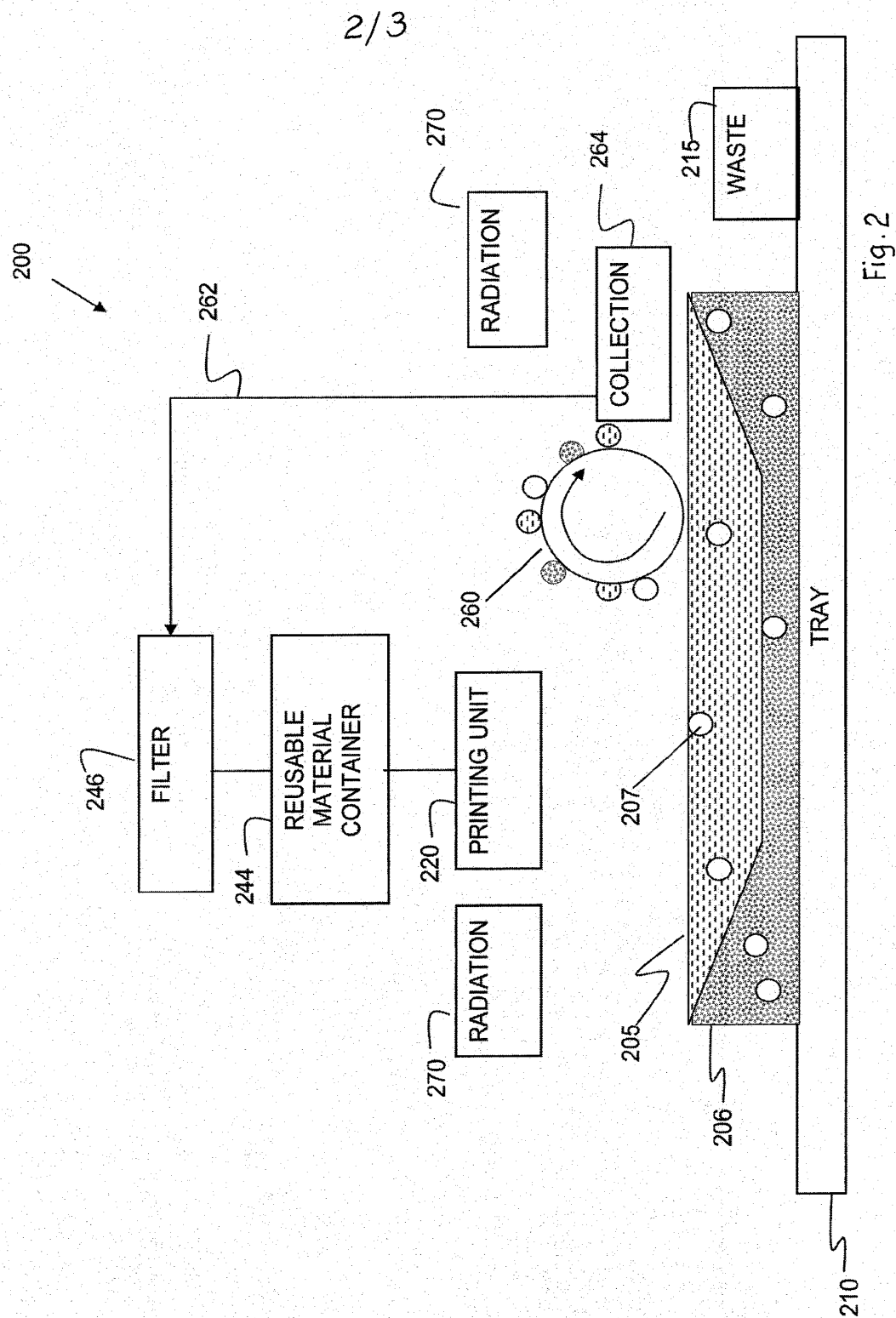


Fig. 1



3/3

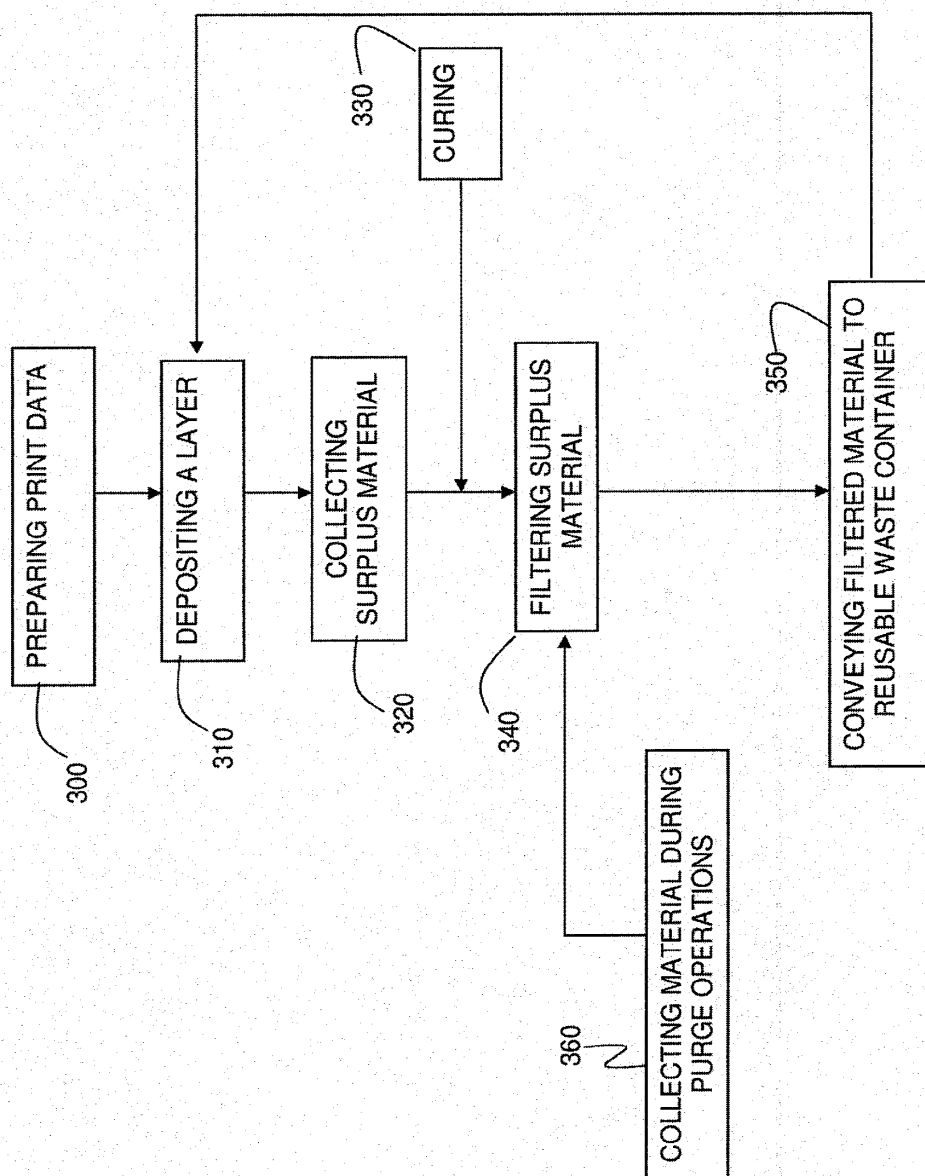


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL 11/00960

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - A01J 21/00 (2012.01) USPC - 425/375 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC(8): A01J 21/00 (2012.01) USPC: 425/375 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched additional USPC: 264/112, 264/113, 264/308, 264/449, 264/450, 264/451, 264/452, 264/453, 425/375 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PubWEST(PGPB,USPT,USOC,EPAB,JPAB); Google Patents, Google Search terms used: Additive Manufacturing, layer, reusable, recycle, reuse, additive, surplus, three-dimensional, 3-D, radiation, purge, collect, print, printing, waste, powder, ink, inkjet, chamber, collect, collection, cross section, support, substrate, heads, dispensing		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/0241404 A1 (Allaman et al.) 02 October 2008 (02.10.2008) Fig 5; para [0014-0015]; para [0030-0034]; para [0038]; para [0044]; para [0051-0053]; para [0056-0064]; para [0081]; para [0086]; para [0094]; para [0097]; para [0147]; para [0151-0154]	1-16
X	US 2008/0211132 A1 (Feenstra) 04 September 2008 (04.09.2008) Fig 1; para [0035-0040]; para [0050]; para [0061-0063]	1, 12
A	US 7,037,382 B2 (Davidson et la.) 02 May 2006 (02.05.2006) col 8, ln 37-42	1-16
A	US 2008/0111271 A1 (KOSHNEVIS) 15 May 2008 (15.05.2008), para [0045]	1-16
☐ Further documents are listed in the continuation of Box C. ☐		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 04 May 2012 (04.05.2012)		Date of mailing of the international search report 15 MAY 2012
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201		Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

Electronic Acknowledgement Receipt	
EFS ID:	19568862
Application Number:	13790924
International Application Number:	
Confirmation Number:	6040
Title of Invention:	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS
First Named Inventor/Applicant Name:	William J. Swanson
Customer Number:	27367
Filer:	Brian Russell Vitt Morrison/Katherine Schultz
Filer Authorized By:	Brian Russell Vitt Morrison
Attorney Docket Number:	S697.12-0253
Receipt Date:	14-JUL-2014
Filing Date:	08-MAR-2013
Time Stamp:	13:49:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	2014-07-14_Supplemental-IDS_S697120253.pdf	612246 f87de373add76963aea2ceae0df11806f55bf56	no	4

Warnings:

Information:

2	Non Patent Literature	ISR-WO.pdf	420881	no	8				
			2729ac14aaf978cacc416617d3acd9988045b61e						
Warnings:									
Information:									
3	Foreign Reference	WO2012070052A1.pdf	1350086	no	30				
			f407a7f53fb033467a178fc94b50d930a784f23d						
Warnings:									
Information:									
4	Foreign Reference	WO2012085914A1.pdf	1188211	no	21				
			d905dbe17bd5173a6b9cf99e4df8a75e3c4b9987						
Warnings:									
Information:									
Total Files Size (in bytes):			3571424						
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.									



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/790,924	03/08/2013	William J. Swanson	S697.12-0253

CONFIRMATION NO. 6040

27367

WESTMAN CHAMPLIN & KOEHLER, P.A.
SUITE 1400
900 SECOND AVENUE SOUTH
MINNEAPOLIS, MN 55402

PUBLICATION NOTICE



OC000000070688775

Title:ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS

Publication No.US-2014-0252684-A1

Publication Date:09/11/2014

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <http://pair.uspto.gov/>. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/790,924	03/08/2013	William J. Swanson	S697.12-0253	6040
27367 7590 05/05/2015 WESTMAN CHAMPLIN & KOEHLER, P.A. SUITE 1400 900 SECOND AVENUE SOUTH MINNEAPOLIS, MN 55402			EXAMINER GRUN, ROBERT J	
			ART UNIT 1744	PAPER NUMBER
			MAIL DATE 05/05/2015	DELIVERY MODE PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 13/790,924	Applicant(s) SWANSON ET AL.	
	Examiner ROBERT J. GRUN	Art Unit 1744	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on March 8, 2013.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

- 5) ☒ Claim(s) 1-20 is/are pending in the application.
5a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 6) ☐ Claim(s) ____ is/are allowed.
- 7) ☐ Claim(s) ____ is/are rejected.
- 8) ☐ Claim(s) ____ is/are objected to.
- 9) ☒ Claim(s) 1-20 are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some** c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date ____.
- 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____.
- 4) ☐ Other: ____.

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-15, drawn to a method of printing a three dimensional part using an additive manufacturing system having multiple printing heads, classified in B29C 67/0062.

II. Claims 16-20, drawn to method of printing a three dimensional part using an additive manufacturing system, classified in B29C 67/0092.

2. The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are directed to distinct methods, where patentability in the independent claims of each invention is based on divergent process requirements. The differences between these inventions are numerous and significant to the extent that the inventions constitute prima facie patentably distinct combinations, absent evidence to the contrary. This can readily and clearly be demonstrated by a side-by-side comparison of the independent claims. For instance, Independent claim I requires multiple print heads, but does not require a part material which is separate from a support material as in invention II. Similarities of the independent claims are merely superficial, since certain significant limitations in one of the inventions find no counterpart in the other invention(s) and vice versa. For this reason, it would be a serious burden for the examiner to consider both groups of process claims since the search and examination for one of the independent claims would not be required for the other independent claim.

Presently, no claim is generic. Rejoinder of the non-elected method group will be considered, upon indication of allowable subject matter, depending on the basis thereof.

3. Restriction for examination purposes as indicated is proper because all these inventions listed in this action are independent or distinct for the reasons given above and there would be a serious search and/or examination burden if restriction were not required because one or more of the following reasons apply:

- (a) the inventions have acquired a separate status in the art in view of their different classification;
- (b) the inventions have acquired a separate status in the art due to their recognized divergent subject matter;
- (c) the inventions require a different field of search (for example, searching different classes/subclasses or electronic resources, or employing different search queries);
- (d) the prior art applicable to one invention would not likely be applicable to another invention;

Art Unit: 1744

(e) the inventions are likely to raise different non-prior art issues under 35 U.S.C. 101 and/or 35 U.S.C. 112, first paragraph..

4. **Applicant is advised that the reply to this requirement to be complete must include (i) an election of an invention to be examined even though the requirement may be traversed (37 CFR 1.143) and (ii) identification of the claims encompassing the elected invention.**

5. The election of an invention may be made with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable upon the elected invention.

6. Should applicant traverse on the ground that the inventions are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the inventions to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103 or pre-AIA 35 U.S.C. 103(a) of the other invention.

7. A telephone call was made to Brian R. Morrison on May 3, 2015 to request an oral election to the above restriction requirement, but did not result in an election being made.

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT J. GRUN whose telephone number is (571)270-5521. The examiner can normally be reached on Monday-Friday 10:30am-8pm (except first Friday of the bi-week).

9. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Yogendra Gupta can be reached on (571) 272-1316. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

10. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR

Art Unit: 1744

or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ROBERT J. GRUN/
Examiner, Art Unit 1744

<i>Index of Claims</i> 	Application/Control No. 13790924	Applicant(s)/Patent Under Reexamination SWANSON ET AL.
	Examiner ROBERT J GRUN	Art Unit 1744

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47										
CLAIM		DATE								
Final	Original	05/03/2015								
	1	÷								
	2	÷								
	3	÷								
	4	÷								
	5	÷								
	6	÷								
	7	÷								
	8	÷								
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	17	÷								
	18	÷								
	19	÷								
	20	÷								

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named		Confirmation No.: 6040
Inventor	: William J. Swanson	Group Art Unit: 1744
Appln. No.	: 13/790,924	Examiner: Grun, Robert J
Filed	: March 8, 2013	
For	: ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS	
Docket No.	: S697.12-0253	

RESPONSE TO RESTRICTION REQUIREMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

I hereby certify that this correspondence is being facsimile transmitted to the USPTO, EFS-Web transmitted to the USPTO, or deposited with the United States Postal Service with sufficient postage in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)] on June 30, 2015.
Signature Peter J. Ims
Printed Name Peter J Ims

Sir:

This is in response to the Office Action dated May 5, 2015, in which claims 1-20 were subject to a Restriction Requirement. Applicants hereby elect to prosecute the invention of Group I, claims 1-15, with traverse.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

WESTMAN, CHAMPLIN & KOEHLER, P.A.

By: Peter J. Ims
Peter J. Ims, Reg. No. 48,774
900 Second Avenue South, Suite 1400
Minneapolis, Minnesota 55402-3244
Phone: (612) 334-3222
Fax: (612) 334-3312

PJI:meb

Electronic Acknowledgement Receipt	
EFS ID:	22788565
Application Number:	13790924
International Application Number:	
Confirmation Number:	6040
Title of Invention:	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS
First Named Inventor/Applicant Name:	William J. Swanson
Customer Number:	27367
Filer:	Peter John Ims/Megan Boyle
Filer Authorized By:	Peter John Ims
Attorney Docket Number:	S697.12-0253
Receipt Date:	30-JUN-2015
Filing Date:	08-MAR-2013
Time Stamp:	16:34:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Response to Election / Restriction Filed	2015-6-30_Response_Restriction_Requirement_S697120253.pdf	48700 a95cd4f7ac49d60b7dfec7c4c852ea82fb94b042	no	1

Warnings:

Information:

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/790,924	03/08/2013	William J. Swanson	S697.12-0253	6040
27367 7590 10/13/2015 WESTMAN CHAMPLIN & KOEHLER, P.A. SUITE 1400 900 SECOND AVENUE SOUTH MINNEAPOLIS, MN 55402			EXAMINER GRUN, ROBERT J	
			ART UNIT 1744	PAPER NUMBER
			MAIL DATE 10/13/2015	DELIVERY MODE PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 13/790,924	Applicant(s) SWANSON ET AL.	
	Examiner ROBERT J. GRUN	Art Unit 1744	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 30 June 2015.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

- 5) ☒ Claim(s) 1-20 is/are pending in the application.
5a) Of the above claim(s) 16-20 is/are withdrawn from consideration.
- 6) ☐ Claim(s) ____ is/are allowed.
- 7) ☒ Claim(s) 1-15 is/are rejected.
- 8) ☐ Claim(s) ____ is/are objected to.
- 9) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some** c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date ____.
- 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____.
- 4) ☐ Other: ____.

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DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.

Election/Restrictions

2. Applicant's election of Group I (Claims 1-15) in the reply filed on June 30, 2015 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.01(a)).

3. Accordingly, Claims 16-20 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on June 30, 2015 (as described above).

Claim Rejections - 35 USC § 103

4. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. Claims 1-15 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Swanson et al. (US Patent 8,033,811).

- Regarding Claim 1: Swanson et al. disclose a method for printing a three-dimensional part with an additive manufacturing system, the method comprising: printing layers of the three-dimensional part and of a support

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structure for the three-dimensional part from multiple print heads or deposition lines using a layer-based, additive manufacturing technique; 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; performing a purge operation for each print head or deposition line switched to the operating mode, the purge operation comprising printing a layer of at least one purge tower from the print head or deposition line switched to the operating mode.

- Regarding Claim 2: Swanson et al. disclose the invention as described above in the rejection of claim 1. Swanson et al. further disclose wherein the multiple print heads or deposition lines comprise a first deposition line and a second deposition line, and 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.
- Regarding Claim 3: Swanson et al. disclose the invention as described above in the rejection of claim 1. Swanson et al. further disclose wherein the multiple print heads or deposition lines comprise a first print head and a second print head, and wherein switching the print heads between the stand-by modes and the operating modes comprises: switching the first print head from the stand-by mode to the operating mode; and switching the second print head from the operating mode to the stand-by mode.
- Regarding Claim 4: Swanson et al. disclose the invention as described above in the rejection of claim 1. Swanson et al. further disclose wherein printing the layer of the at least one purge tower comprises: printing along a first tool path segment between a start vertex and a first corner vertex; printing along one or more additional tool path segments from the first corner vertex to a stop vertex, which at least partially encases the first tool path segment in a build plane.
- Regarding Claim 5: Swanson et al. disclose the invention as described above in the rejection of claim 1. Swanson et al. further disclose 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.
- Regarding Claim 6: Swanson et al. disclose the invention as described above in the rejection of claim 1. Swanson et al. further disclose 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.

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- Regarding Claim 7: Swanson et al. disclose the invention as described above in the rejection of claim 1.
Swanson et al. further disclose the method comprising: generating tool path instructions for printing the layers of the three-dimensional part and of the support structure; and generating tool path instructions for printing the layer of the at least one purge tower.
- Regarding Claim 8: Swanson et al. disclose the invention as described above in the rejection of claim 7.
Swanson et al. further disclose wherein the generating of the tool path instructions for printing the layer of the at least one purge tower is performed after printing a portion of the layers of the three-dimensional part, after printing a portion of the layers of the support structure, or both.
- Regarding Claim 9: Swanson et al. disclose the invention as described above in the rejection of claim 7.
Swanson et al. further disclose 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.
- Regarding Claim 10: Swanson et al. disclose method for printing a three-dimensional part with an additive manufacturing system, the method comprising: bringing a first print head or deposition line from a stand-by mode to an operating mode; printing a first layer of a purge tower from a support material using the first print head or deposition line in the operating mode; printing a layer of a support structure from the support material using the first print head in the operating mode after printing the first layer of the purge tower; bringing a second print head or deposition line from a stand-by mode to an operating mode; printing a second layer of the purge tower from a part material using the second print head or deposition line in the operating mode; and printing a layer of the three-dimensional part from the part material using the second print head in the operating mode after printing the second layer of the purge tower.
- Regarding Claim 11: Swanson et al. disclose the invention as described above in the rejection of claim 10.
Swanson et al. further disclose wherein bringing the first print head or deposition line from the stand-by mode to the operating mode comprises heating a liquefier assembly of the first print head or deposition line.
- Regarding Claim 12: Swanson et al. disclose the invention as described above in the rejection of claim 10.
Swanson et al. further disclose the method comprising: bringing the first print head or deposition line from the operating mode to the stand-by mode while bringing the second print head or deposition line from the stand-by

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mode to the operating mode; bringing the first print head or deposition line back from the stand-by mode to the operating mode; printing a third layer of a purge tower from the support material using the first print head or deposition line brought back to the operating mode; printing a layer of the support structure from the support material using the first print head brought back to the operating mode after printing the third layer of the purge tower.

- Regarding Claim 13: Swanson et al. disclose the invention as described above in the rejection of claim 10.

Swanson et al. further disclose the method comprising printing additional layers of the purge tower such that the purge tower maintains the same height perpendicular to a build plane the printed layers of the three-dimensional part and support structure.

- Regarding Claim 14: Swanson et al. disclose the invention as described above in the rejection of claim 10.

Swanson et al. further disclose the method wherein printing the first layer and the second layer of the one purge tower each comprises: printing along a first tool path segment between a start vertex and a first corner vertex; printing along one or more additional tool path segments from the first corner vertex to a stop vertex, which at least partially encases the first tool path segment in a build plane.

- Regarding Claim 15: Swanson et al. disclose the invention as described above in the rejection of claim 10.

Swanson et al. further disclose the method wherein the one or more additional tool path segments define a diamond-shaped pattern in the build plane.

Conclusion

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT J. GRUN whose telephone number is (571)270-5521. The examiner can normally be reached on Monday-Friday 10:30am-8pm (except first Friday of the bi-week).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Yogendra Gupta can be reached on (571) 272-1316. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

8. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more

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information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ROBERT J. GRUN/
Examiner, Art Unit 1744



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BIB DATA SHEET

CONFIRMATION NO. 6040

SERIAL NUMBER 13/790,924	FILING or 371(c) DATE 03/08/2013 RULE	CLASS 264	GROUP ART UNIT 1744	ATTORNEY DOCKET NO. S697.12-0253		
APPLICANTS STRATASYS, INC., Eden Prairie, MN INVENTORS William J. Swanson, St. Paul, MN; Ronald G. Schloesser, New Brighton, MN; Gary Larson, Independence, MN; ** CONTINUING DATA ***** ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 04/09/2013						
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and /Robert J. Grun/ Acknowledged Examiner's Signature		☐ Met after Allowance Initials	STATE OR COUNTRY MN	SHEETS DRAWINGS 7	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 3
ADDRESS WESTMAN CHAMPLIN & KOEHLER, P.A. SUITE 1400 900 SECOND AVENUE SOUTH MINNEAPOLIS, MN 55402 UNITED STATES						
TITLE ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS						
FILING FEE RECEIVED 1260	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit			

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	293	((William) near2 (Swanson)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
L2	13	((Ronald) near2 (Schloesser)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
L3	98	((Gary) near2 (Larson)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
L4	0	("STRATASYS, INC.").AANM.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
L5	1480	"264/308".CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
L6	1063	"264/401".CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
L7	2	"US 20140252684"	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2015/10/05 14:14
L8	1178	((B29C67/0055 OR B29C67/0096).CPC.)	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2015/10/05 14:14
L9	2	("20120258250" "20120304449").PN.	US-PGPUB; USPAT	OR	OFF	2015/10/05 14:14
L10	58	("20050129941" "20070003656" "20070228590" "20090035405" "20090173443" "20090263582" "20090273122" "20090274540" "20100096072" "20100096485" "20100096489" "20100100224" "20100283172" "20100327479" "20110074065" "20110076495" "20110076496" "20110117268" "20110121476" "20110186081" "20110233804" "20110241947" "20120067501" "20120068378" "20120070523" "20120162314"	US-PGPUB; USPAT	OR	OFF	2015/10/05 14:14

		"20120164256" "20130075957" "20130078073" "6814907" "6869559" "6923634" "6976627" "6988087" "7122246" "7127309" "7172715" "7236166" "7261533" "7306152" "7384255" "7481647" "7572121" "7604470" "7625200" "7744364" "7896209" "7917243" "7938351" "7938356" "8033811" "8070473" "8075300" "8153182" "8221669" "8226395" "8282380" "8287794").PN.				
L12	11506	("3D" or "3d" or (three-dimensional)) near5 printing	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2015/10/05 14:41
L13	115	12 and purge	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2015/10/05 14:42

EAST Search History (Interference)

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10/ 5/ 2015 2:43:11 PM**C:\ Users\ rgrun\ Documents\ EAST\ Workspaces\ 13790924.wsp**

Search Notes 	Application/Control No. 13790924	Applicant(s)/Patent Under Reexamination SWANSON ET AL.
	Examiner ROBERT J GRUN	Art Unit 1744

CPC- SEARCHED		
Symbol	Date	Examiner
B29C67/0055	10/5/2015	RJG
B29C67/0096	10/5/2015	RJG

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
264	308 and 401	10/5/2015	RJG

SEARCH NOTES		
Search Notes	Date	Examiner
Inventors and Assignee were searched but did not reveal pertinent prior art.	10/5/2015	RJG
EAST text search.	10/5/2015	RJG

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/ROBERT J GRUN/ Examiner.Art Unit 1744	
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<i>Index of Claims</i> 	Application/Control No. 13790924	Applicant(s)/Patent Under Reexamination SWANSON ET AL.
	Examiner ROBERT J GRUN	Art Unit 1744

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant
 ☐ CPA
 ☐ T.D.
 ☐ R.1.47

CLAIM		DATE								
Final	Original	05/03/2015	10/05/2015							
	1	÷	✓							
	2	÷	✓							
	3	÷	✓							
	4	÷	✓							
	5	÷	✓							
	6	÷	✓							
	7	÷	✓							
	8	÷	✓							
	9	÷	✓							
	10	÷	✓							
	11	÷	✓							
	12	÷	✓							
	13	÷	✓							
	14	÷	✓							
	15	÷	✓							
	16	÷	N							
	17	÷	N							
	18	÷	N							
	19	÷	N							
	20	÷	N							

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor :	William J. Swanson	Confirmation No.: 6040
Appln. No. :	13/790,924	Group Art Unit: 1744
Filed :	March 8, 2013	Examiner: Grun, Robert J.
For :	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS	
Docket No. :	S697.12-0253	

AMENDMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

I hereby certify that this correspondence is being facsimile transmitted to the USPTO, EFS-Web transmitted to the USPTO, or deposited with the United States Postal Service with sufficient postage in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)] on January 13, 2016.

Signature: /Peter J. Ims/
Printed Name: Peter J. Ims

Sir:

This is in response to the Office Action mailed on October 13, 2015. Please amend the above-identified application as follows:

AMENDMENT TO THE CLAIMS

1.(Currently Amended) A method for printing a three-dimensional part with an additive manufacturing system, the method comprising:

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;
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;
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.

2. (Original) The method of claim 1, wherein the multiple print heads or deposition lines comprise a first deposition line and a second deposition line, and 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.

3. (Original) The method of claim 1, wherein the multiple print heads or deposition lines comprise a first print head and a second print head, and wherein switching the print heads between the stand-by modes and the operating modes comprises:

switching the first print head from the stand-by mode to the operating mode; and
switching the second print head from the operating mode to the stand-by mode.

4. (Original) The method of claim 1, wherein printing the layer of the at least one purge tower comprises:

printing along a first tool path segment between a start vertex and a first corner vertex;

printing along one or more additional tool path segments from the first corner vertex to a stop vertex, which at least partially encases the first tool path segment in a build plane.

5. (Original) 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. (Original) 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.

7. (Original) 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
generating tool path instructions for printing the layer of the at least one purge tower.

8. (Original) 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 after printing a portion of the layers of the three-dimensional part, after printing a portion of the layers of the support structure, or both.

9. (Original) 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.

10. (Currently Amended) A method for printing a three-dimensional part with an additive manufacturing system, the method comprising:

 bringing a first print head or deposition line from a stand-by mode to an operating mode;

 printing a first layer of a purge tower printed in a layer-by-layer manner from a support material using the first print head or deposition line in the operating mode;

 printing a layer of a support structure from the support material using the first print head in the operating mode after printing the first layer of the purge tower;

 bringing a second print head or deposition line from a stand-by mode to an operating mode;

 printing a second layer of the purge tower from a part material using the second print head or deposition line in the operating mode; and

 printing a layer of the three-dimensional part from the part material using the second print head in the operating mode after printing the second layer of the purge tower.

11. (Original) The method of claim 10, wherein bringing the first print head or deposition line from the stand-by mode to the operating mode comprises heating a liquefier assembly of the first print head or deposition line.

12. (Original) The method of claim 10, and further comprising:

bringing the first print head or deposition line from the operating mode to the stand-by mode while bringing the second print head or deposition line from the stand-by mode to the operating mode;
bringing the first print head or deposition line back from the stand-by mode to the operating mode;
printing a third layer of a purge tower from the support material using the first print head or deposition line brought back to the operating mode;
printing a layer of the support structure from the support material using the first print head brought back to the operating mode after printing the third layer of the purge tower.

13. (Original) The method of claim 10, and further comprising printing additional layers of the purge tower such that the purge tower maintains the same height perpendicular to a build plane the printed layers of the three-dimensional part and support structure.

14. (Original) The method of claim 10, wherein printing the first layer and the second layer of the one purge tower each comprises:

printing along a first tool path segment between a start vertex and a first corner vertex;
printing along one or more additional tool path segments from the first corner vertex to a stop vertex, which at least partially encases the first tool path segment in a build plane.

15. (Original) The method of claim 14, wherein the one or more additional tool path segments define a diamond-shaped pattern in the build plane.

16. (Withdrawn) A method for printing a three-dimensional part with an additive manufacturing system, the method comprising:

- (a) printing a first layer of a support structure for the three-dimensional part;
- (b) printing a first layer of a purge tower from a part material;
- (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;
- (d) printing a second layer of the purge tower from the support material; and
- (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 structure after printing the second layer of the purge tower.

17. (Withdrawn) 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.

18. (Withdrawn) The method of claim 17, wherein at least a portion of the layers of the purge tower are interlaced between the part material and the support material on a layer-by-layer basis.

19. (Withdrawn) The method of claim 16, wherein the purge tower comprises a perimeter wall and an interior wall printed from a single tool path, wherein for each printed layer of the purge tower, the interior wall is printed prior to the printing of the perimeter wall.

20.(Withdrawn) The method of claim 19, wherein the perimeter wall defines a diamond-shape cross-sectional geometry in a build plane.

REMARKS

This is in Response to the Office Action dated October 13, 2015. Claims 1-20 are pending. Claims 15-20 are withdrawn. Claims 1-15 stand rejected. Claim 1 and 10 have been amended. Support for amendments to claim 1 and 10 can be found, for example, in paragraph [0057] of the Specification. No new matter has been added.

CLAIM REJECTIONS – 35 U.S.C. § 103

Claims 1-15 were rejected under pre-AIA 35 U.S.C. § 103(a) as being unpatentable over Swanson et al. (U.S. Patent No. 8,033,811). The Office Action indicated that Swanson et al. disclose the claimed methods.

Applicant respectfully disagrees. Applicant asserts that the purge operation claimed in the present claims relates to printing a purge tower not to purging by the use of a purge bucket as disclosed in Swanson et al. See Swanson et al., Col.6, lines 47-55. Applicant has amended independent claims 1 and 10 to more clearly indicate that the purging operation includes printing a purge tower in a layer-by-layer manner. Support for this amendment can be found in the paragraph [0057] of the Specification. Applicant asserts that this is not disclosed in Swanson et al. Furthermore, a purge station or purge bucket of Swanson et al. has the disadvantages as disclosed in paragraph [0033] of the present Specification.

Applicant asserts that printing a purge tower in a layer-by-layer manner as claimed in the present method can be advantageous as disclosed in paragraph [0034] of the present Specification and includes the elimination of a purge station which can increase the build volume in the build chamber and also eliminates the necessity of manually emptying accumulated purged strands from the purge buckets.

Based on the claim amendments and the above discussion, Applicant asserts that claims, as written, are patentable over the cited art. Applicant respectfully requests the allowance of the claims.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

WESTMAN, CHAMPLIN & KOEHLER, P.A.

By: /Peter J. Ims/
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PJI:mcb

Electronic Acknowledgement Receipt	
EFS ID:	24610518
Application Number:	13790924
International Application Number:	
Confirmation Number:	6040
Title of Invention:	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS
First Named Inventor/Applicant Name:	William J. Swanson
Customer Number:	27367
Filer:	Peter John Ims/Megan Boyle
Filer Authorized By:	Peter John Ims
Attorney Docket Number:	S697.12-0253
Receipt Date:	13-JAN-2016
Filing Date:	08-MAR-2013
Time Stamp:	14:28:48
Application Type:	Utility under 35 USC 111(a)

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File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		2015-1-13_Amendment_S6971 20253.pdf	42766 31a684289c3a321653337beb0a7a9b5c7a1bd0d0	yes	8

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	8
Warnings:			
Information:			
Total Files Size (in bytes):		42766	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.			

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 13/790,924		Filing Date 03/08/2013		☐ To be Mailed	
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO									
APPLICATION AS FILED – PART I									
(Column 1)		(Column 2)							
FOR	NUMBER FILED	NUMBER EXTRA		RATE (\$)		FEE (\$)			
☒ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A		390			
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A					
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A					
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		X \$ =					
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		X \$ =					
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).							
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))									
* If the difference in column 1 is less than zero, enter "0" in column 2.						TOTAL		390	
APPLICATION AS AMENDED – PART II									
(Column 1)		(Column 2)		(Column 3)					
AMENDMENT	01/13/2016	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X \$80 =		0	
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X \$420 =		0	
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
						TOTAL ADD'L FEE		0	
(Column 1)		(Column 2)		(Column 3)					
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	*	Minus	**	=	X \$ =			
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X \$ =			
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
						TOTAL ADD'L FEE			
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.									

LIE
/TER JACKSON WOODRUFF/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

27367 7590 05/02/2016
WESTMAN CHAMPLIN & KOEHLER, P.A.
SUITE 1400
900 SECOND AVENUE SOUTH
MINNEAPOLIS, MN 55402

EXAMINER

GRUN, ROBERT J

ART UNIT

PAPER NUMBER

1744

DATE MAILED: 05/02/2016

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/790,924	03/08/2013	William J. Swanson	S697.12-0253	6040

TITLE OF INVENTION: ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	08/02/2016

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

**Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

27367 7590 05/02/2016
WESTMAN CHAMPLIN & KOEHLER, P.A.
SUITE 1400
900 SECOND AVENUE SOUTH
MINNEAPOLIS, MN 55402

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/790,924	03/08/2013	William J. Swanson	S697.12-0253	6040

TITLE OF INVENTION: ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	08/02/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
GRUN, ROBERT J	1744	264-308000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
- (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
- 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____



UNITED STATES PATENT AND TRADEMARK OFFICE

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/790,924	03/08/2013	William J. Swanson	S697.12-0253	6040

EXAMINER
GRUN, ROBERT J

ART UNIT	PAPER NUMBER
1744	

27367 7590 05/02/2016
WESTMAN CHAMPLIN & KOEHLER, P.A.
SUITE 1400
900 SECOND AVENUE SOUTH
MINNEAPOLIS, MN 55402

DATE MAILED: 05/02/2016

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 13/790,924	Applicant(s) SWANSON ET AL.	
	Examiner ROBERT J. GRUN	Art Unit 1744	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to amendments and arguments filed January 13, 2016.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-20. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some *c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|--|--|
| 1. ☒ Notice of References Cited (PTO-892) | 5. ☒ Examiner's Amendment/Comment |
| 2. ☒ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date _____ | 6. ☒ Examiner's Statement of Reasons for Allowance |
| 3. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material | 7. ☐ Other _____. |
| 4. ☐ Interview Summary (PTO-413),
Paper No./Mail Date _____. | |

/ROBERT J. GRUN/
Examiner, Art Unit 1744

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.

Election/Restrictions

2. Claims 1-20 are allowable. The restriction requirement between Groups I and II, as set forth in the Office action mailed on May 5, 2015, has been reconsidered in view of the allowability of claims to the elected invention pursuant to MPEP § 821.04(a). **The restriction requirement is hereby withdrawn as to any claim that requires all the limitations of an allowable claim.** Specifically, the restriction requirement of Group II is WITHDRAWN. Claims 16-20, directed to a three-dimensional printing method is no longer withdrawn from consideration because the claim(s) requires all the limitations of an allowable claim.

3. In view of the above noted withdrawal of the restriction requirement, applicant is advised that if any claim presented in a continuation or divisional application is anticipated by, or includes all the limitations of, a claim that is allowable in the present application, such claim may be subject to provisional statutory and/or nonstatutory double patenting rejections over the claims of the instant application.

4. Once a restriction requirement is withdrawn, the provisions of 35 U.S.C. 121 are no longer applicable. See *In re Ziegler*, 443 F.2d 1211, 1215, 170 USPQ 129, 131-32 (CCPA 1971). See also MPEP § 804.01.

EXAMINER'S AMENDMENT

5. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.
6. Authorization for this examiner's amendment was given in a telephone interview with Peter Ims on April 18, 2016.
7. The application has been amended as follows: Claim 16 is amended as follows: A method for printing a three-dimensional part with an additive manufacturing system, the method comprising: (a) printing a first layer of a support structure from a support material for the three-dimensional part; (b) printing a first layer of a purge tower from a part material; (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; (d) printing a second layer of the purge tower from the support material; and (e) printing a second layer of the support structure on at least

Art Unit: 1744

a portion of the first layer of the three-dimensional part from the support [[structure]] material after printing the second layer of the purge tower.

REASONS FOR ALLOWANCE

8. Claims 1-20 are allowed.

9. The following is an examiner's statement of reasons for allowance: none of the prior art alone or in combination teach purging of one or more print heads by printing a purge tower. The closest prior art discloses the use of wiping blades and purge buckets.

10. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT J. GRUN whose telephone number is (571)270-5521. The examiner can normally be reached on Monday-Friday 10:30am-8pm (except first Friday of the bi-week).

12. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Yogendra Gupta can be reached on (571) 272-1316. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

13. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ROBERT J. GRUN/
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Notice of References Cited	Application/Control No. 13/790,924		Applicant(s)/Patent Under Reexamination SWANSON ET AL.	
	Examiner ROBERT J. GRUN		Art Unit 1744	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
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	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

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*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)
20160417

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Part of Paper No.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2	"US 20140252684"	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/17 14:15
S1	293	((William) near2 (Swanson)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
S2	13	((Ronald) near2 (Schloesser)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
S3	98	((Gary) near2 (Larson)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
S4	0	("STRATASYS, INC.").AANM.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
S5	1480	"264/308".CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
S6	1063	"264/401".CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/10/05 14:13
S8	1178	((B29C67/0055 OR B29C67/0096).CPC.)	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2015/10/05 14:14
S9	2	("20120258250" "20120304449").PN.	US-PGPUB; USPAT	OR	OFF	2015/10/05 14:14
S10	58	("20050129941" "20070003656" "20070228590" "20090035405" "20090173443" "20090263582" "20090273122" "20090274540" "20100096072" "20100096485" "20100096489" "20100100224" "20100283172" "20100327479" "20110074065" "20110076495" "20110076496" "20110117268" "20110121476" "20110186081" "20110233804" "20110241947" "20120067501" "20120068378" "20120070523" "20120162314"	US-PGPUB; USPAT	OR	OFF	2015/10/05 14:14

		"20120164256" "20130075957" "20130078073" "6814907" "6869559" "6923634" "6976627" "6988087" "7122246" "7127309" "7172715" "7236166" "7261533" "7306152" "7384255" "7481647" "7572121" "7604470" "7625200" "7744364" "7896209" "7917243" "7938351" "7938356" "8033811" "8070473" "8075300" "8153182" "8221669" "8226395" "8282380" "8287794").PN.				
S11	11506	("3D" or "3d" or (three-dimensional)) near5 printing	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2015/10/05 14:41
S12	115	S11 and purge	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2015/10/05 14:42
S13	301	((William) near2 (Swanson)).INV.	US- PGPUB; USPAT; USOCR	OR	OFF	2016/04/16 21:19
S14	18	((Ronald) near2 (Schloesser)).INV.	US- PGPUB; USPAT; USOCR	OR	OFF	2016/04/16 21:19
S15	99	((Gary) near2 (Larson)).INV.	US- PGPUB; USPAT; USOCR	OR	OFF	2016/04/16 21:19
S16	1541	"264/308".CCLS.	US- PGPUB; USPAT; USOCR	OR	OFF	2016/04/16 21:19
S17	1107	"264/401".CCLS.	US- PGPUB; USPAT; USOCR	OR	OFF	2016/04/16 21:19
S18	1576	((B29C67/0055 OR B29C67/0096).CPC.)	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/16 21:19
S19	14043	("3D" or "3d" or (three-dimensional)) near5 printing	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/16 21:19
S20	154	S19 and purge	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/16 21:19
S22	1	("8033811").PN.	US- PGPUB; USPAT;	OR	OFF	2016/04/16 21:25

			USOCR			
S23	18217	("3D" or "3d" or (three-dimensional) or (extrusion extruded extrude)) near5 printing	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/16: 21:41
S24	125	S19 and ((purg\$3 waste excess replacement) near2 (tower build pile heap section))	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/16: 21:42
S25	58	("20050129941" "20070003656" "20070228590" "20090035405" "20090173443" "20090263582" "20090273122" "20090274540" "20100096072" "20100096485" "20100096489" "20100100224" "20100283172" "20100327479" "20110074065" "20110076495" "20110076496" "20110117268" "20110121476" "20110186081" "20110233804" "20110241947" "20120067501" "20120068378" "20120070523" "20120162314" "20120164256" "20130075957" "20130078073" "6814907" "6869559" "6923634" "6976627" "6988087" "7122246" "7127309" "7172715" "7236166" "7261533" "7306152" "7384255" "7481647" "7572121" "7604470" "7625200" "7744364" "7896209" "7917243" "7938351" "7938356" "8033811" "8070473" "8075300" "8153182" "8221669" "8226395" "8282380" "8287794").PN.	US-PGPUB; USPAT	OR	OFF	2016/04/16: 21:43
S26	6412	purg\$3 near4 ((build near2 platform) support platform substrate)	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/16: 22:08
S27	19	S26 and S23	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/16: 22:08
S28	598	purge near2 structure	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/16: 22:23
S29	0	("2015/0093588").URPN.	USPAT	OR	OFF	2016/04/16: 22:39
S30	0	("2015/0251357").URPN.	USPAT	OR	OFF	2016/04/16: 22:40
S31	0	("2015/0251357").URPN.	USPAT	OR	OFF	2016/04/16: 22:40
S32	11286	(purg\$3 or prime) near4 ((build near2 platform) support platform substrate)	US-PGPUB; USPAT;	OR	OFF	2016/04/16: 23:27

			USOCR; DERWENT			
S33	28	S23 and S32	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/16 23:27
S34	115964	(purge clean\$3 prime calibrat\$4) near4 (wall tower structure)	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/17 00:06
S35	121	S34 and S23	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/17 00:07
S37	1576	((B29C67/0055 OR B29C67/0096 OR B29C67/0096).CPC.)	US- PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2016/04/17 00:27

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S38	1069	((B29C67/0055 OR B29C67/0096 OR B29C67/0096).CPC.)	US-PGPUB; USPAT	OR	OFF	2016/04/17 00:27
S39	58546	(purg\$3 clean\$3 prime calibrat\$4) near4 (wall tower structure)	US-PGPUB; USPAT	OR	OFF	2016/04/17 00:28
S40	9696	("3D" or "3d" or (three-dimensional)) near5 printing	US-PGPUB; USPAT	OR	OFF	2016/04/17 00:28
S41	104	S39 and S40	US-PGPUB; USPAT	OR	OFF	2016/04/17 00:28
S42	51398	(purg\$3 clean\$3 prime calibrat\$4) near4 (layer)	US-PGPUB; USPAT	OR	OFF	2016/04/17 11:06
S43	9696	("3D" or "3d" or (three-dimensional)) near5 printing	US-PGPUB; USPAT	OR	OFF	2016/04/17 11:07
S44	183	S43 and S42	US-PGPUB; USPAT	OR	OFF	2016/04/17 11:07

4/17/2016 2:48:28 PM**C:\Users\rgrun\Documents\EAST\Workspaces\13790924.wsp**

Search Notes 	Application/Control No. 13790924	Applicant(s)/Patent Under Reexamination SWANSON ET AL.
	Examiner ROBERT J GRUN	Art Unit 1744

CPC- SEARCHED		
Symbol	Date	Examiner
B29C67/0055	10/5/2015	RJG
B29C67/0096	10/5/2015	RJG
Searches were updated.	4/17/2016	RJG

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
264	308 and 401	10/5/2015	RJG
	Searches were updated.	4/17/2016	RJG

SEARCH NOTES		
Search Notes	Date	Examiner
Inventors and Assignee were searched but did not reveal pertinent prior art.	10/5/2015	RJG
EAST text search.	10/5/2015	RJG
Searches were updated.	4/16/2016	RJG
EAST text search.	4/16/2016	RJG
Google keyword search (purge cleaning calibration) wiht (tower wall structure layer) in various combinations however all art found was not prior art.	4/16/2016	RJG
Internet Archive Search (Wayback) with websites found in the above search but none of the websites found were prior art.	4/16/2016	RJG

INTERFERENCE SEARCH

/ROBERT J GRUN/ Examiner.Art Unit 1744	
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US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
	See PG Search Report.		

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**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**

(Use as many sheets as necessary)

Sheet	- 1 -	of	- 4 -	Application Number	13/790,924
				Filing Date	March 8, 2013
				First Named Inventor	William J. Swanson
				Art Unit	2861
				Examiner Name	
				Attorney Docket Number	S697.12-0253

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		Number-(Kind Code if Known)			
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Date Considered:

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**INFORMATION DISCLOSURE
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Sheet	- 2 -	of	- 4 -	Application Number	13/790,924
				Filing Date	March 8, 2013
				First Named Inventor	William J. Swanson
				Art Unit	2861
				Examiner Name	
				Attorney Docket Number	S697.12-0253

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/R. J. G.	A55	US- 2010/0096485	04-22-2010	Taatjes et al.	242/171

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Sheet	- 3 -	of	- 4 -	Application Number	13/790,924
				Filing Date	March 8, 2013
				First Named Inventor	William J. Swanson
				Art Unit	2861
				Examiner Name	
				Attorney Docket Number	S697.12-0253

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STATEMENT BY APPLICANT**

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Sheet	- 4 -	of	- 4 -	Application Number	13/790,924
				Filing Date	March 8, 2013
				First Named Inventor	William J. Swanson
				Art Unit	2861
				Examiner Name	
				Attorney Docket Number	S697.12-0253

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Exam. Init.*	Cite No.	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Classification
		Number-(Kind Code if Known)			
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		Country Code-Number-Kind Code (if known)				
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NON PATENT LITERATURE DOCUMENTS

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Receipt date: 07/14/2014

13790924 - GAU: 1744

Doc code: IDS

PTO/SB/08a (01-10)

Doc description: Information Disclosure Statement (IDS) Filed

Approved for use through 07/31/2012. OMB 0651-0031

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	13790924
	Filing Date	2013-03-08
	First Named Inventor	William J. Swanson et al.
	Art Unit	~~1742~~
	Examiner Name	~~Johnson, Christina Ann~~
	Attorney Docket Number	S697.12-0253

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Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
/RG/	1	20120258250	A1	2012-10-11	Luke M.B. Rodgers	
/RG/	2	20120304449	A1	2012-12-06	Jackson et al.	

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Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ² j	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T ⁵
/RG/	1	2012070052	WO	A1	2012-05-31	Ravich et al.		☒
/RG/	2	2012085914	WO	A1	2012-06-28	Belocon et al.		☒

Receipt date: 07/14/2014

13790924 -- GAU: 1744

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	13790924
Filing Date	2013-03-08
First Named Inventor	William J. Swanson et al.
Art Unit	1742
Examiner Name	~~Johnson, Christina Ann~~
Attorney Docket Number	S697.12-0253

If you wish to add additional Foreign Patent Document citation information please click the Add button				Add
NON-PATENT LITERATURE DOCUMENTS				Remove
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵	
/RG/	1	International Search Report and Written Opinion dated June 25, 2014 for corresponding International Patent Application No. PCT/US2014/017915, filed February 24, 2014.	☒	
If you wish to add additional non-patent literature document citation information please click the Add button				
EXAMINER SIGNATURE				
Examiner Signature	/ROBERT GRUN/		Date Considered	10/05/2015
*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.				
¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.				

Issue Classification 	Application/Control No. 13790924	Applicant(s)/Patent Under Reexamination SWANSON ET AL.
	Examiner ROBERT J GRUN	Art Unit 1744

CPC						
Symbol					Type	Version
B29C		67	/	0055	F	2013-01-01
B29C		67	/	0096	I	2013-01-01
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CPC Combination Sets						
Symbol			Type	Set	Ranking	Version

		Total Claims Allowed:	
		20	
(Assistant Examiner)	(Date)		
/ROBERT J GRUN/ Examiner, Art Unit 1744	04/17/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	10	3A

Issue Classification 	Application/Control No. 13790924	Applicant(s)/Patent Under Reexamination SWANSON ET AL.
	Examiner ROBERT J GRUN	Art Unit 1744

US ORIGINAL CLASSIFICATION						INTERNATIONAL CLASSIFICATION													
CLASS		SUBCLASS				CLAIMED					NON-CLAIMED								
264		401				B	2	9	C	67 / 00 (2006.01.01)									
CROSS REFERENCE(S)																			
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)																		
264	308																		

		Total Claims Allowed:	
		20	
(Assistant Examiner) /ROBERT J GRUN/ Examiner, Art Unit 1744	(Date) 04/17/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	10	3A

Issue Classification 	Application/Control No. 13790924	Applicant(s)/Patent Under Reexamination SWANSON ET AL.
	Examiner ROBERT J GRUN	Art Unit 1744

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	17	17												
2	2	18	18												
3	3	19	19												
4	4	20	20												
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15	15														
16	16														

		Total Claims Allowed:	
		20	
(Assistant Examiner) /ROBERT J GRUN/ Examiner, Art Unit 1744	(Date) 04/17/2016	O.G. Print Claim(s) 10	O.G. Print Figure 3A
(Primary Examiner)	(Date)		

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
 or **Fax** (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

27367 7590 05/02/2016
WESTMAN CHAMPLIN & KOEHLER, P.A.
SUTTE 1400
900 SECOND AVENUE SOUTH
MINNEAPOLIS, MN 55402

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/790,924	03/08/2013	William J. Swanson	S697.12-0253	6040

TITLE OF INVENTION: ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	08/02/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
GRUN, ROBERT J	1744	264-308000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list

- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
 (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 Westman, Champlin & Koehler, P.A.
 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

Stratasys, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Eden Prairie, Minnesota

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

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☐ Publication Fee (No small entity discount permitted)
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- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
☐ Applicant asserting small entity status. See 37 CFR 1.27
☐ Applicant changing to regular undiscounted fee status.

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NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature

Peter J. Ings

Date

July 25, 2016

Typed or printed name

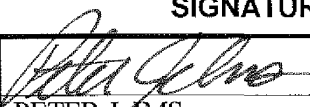
Peter J. Ings

Registration No.

48,774

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

Note: This form is to be submitted with a Power of Attorney to identify the application to which the Power of Attorney is directed.

Application Number	<u>13/790,924</u>		
Filing Date	<u>2013-03-08</u>		
First Named Inventor	<u>William J. Swanson</u>		
Title	<u>ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS</u>		
Art Unit	<u>1744</u>		
Examiner Name	<u>GRUN, ROBERT J</u>		
Attorney Docket Number	<u>S697.12-0253</u>		
SIGNATURE of Patent Practitioner			
Signature		Date	<u>July 25, 2016</u>
Name	<u>PETER J. IMS</u>	Telephone	<u>612-334-3222</u>
Registration Number	<u>48,774</u>		

POWER OF ATTORNEY

Principal's Name: Stratasys, Inc.

Principal's Address: 7665 Commerce Way, Eden Prairie, MN 55344

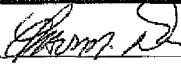
Principal hereby revokes all previous powers of attorney given in the application identified in the attached transmittal letter (the APPLICATION).

Principal hereby appoints Practitioner(s) associated with the following Customer Number as its attorney(s) or agent(s) to prosecute the APPLICATION and to transact all business in the United States Patent and Trademark Office connected therewith. Principal hereby ratifies all previous actions taken by the Practitioner(s) in connection with the APPLICATION:

27,367

Principal is empowered to act in the APPLICATION because Principal is the sole owner of the entire right, title and interest of the APPLICATION, one owner of a collection of owners of the entire right, title and interest of the APPLICATION, a person to whom at least one inventor is under an obligation to assign the APPLICATION, and/or a person who otherwise has sufficient proprietary interest to act as Applicant for the APPLICATION.

SIGNATURE of Principal

Signature		Date	April 2, 2013
Name	Larry Doerr		
Title	Executive Vice President		

Electronic Patent Application Fee Transmittal				
Application Number:		13790924		
Filing Date:		08-Mar-2013		
Title of Invention:		ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS		
First Named Inventor/Applicant Name:		William J. Swanson		
Filer:		Peter John Ims/Megan Boyle		
Attorney Docket Number:		S697.12-0253		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				960

Electronic Acknowledgement Receipt	
EFS ID:	26443611
Application Number:	13790924
International Application Number:	
Confirmation Number:	6040
Title of Invention:	ADDITIVE MANUFACTURING METHOD FOR PRINTING THREE-DIMENSIONAL PARTS WITH PURGE TOWERS
First Named Inventor/Applicant Name:	William J. Swanson
Customer Number:	27367
Filer:	Peter John Ims/Megan Boyle
Filer Authorized By:	Peter John Ims
Attorney Docket Number:	S697.12-0253
Receipt Date:	25-JUL-2016
Filing Date:	08-MAR-2013
Time Stamp:	15:57:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$960
RAM confirmation Number	3071
Deposit Account	231123
Authorized User	IMS, PETER J.
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	2016-7-25_Issue_Fee_S697120253.pdf	89042	no	1
			1dc09820c17f5fea474a1524a847d05d979ee28		

Warnings:

Information:

2	Power of Attorney	2016-7-25_Executed_POA_S697120253.pdf	94806	no	2
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Warnings:

Information:

3	Fee Worksheet (SB06)	fee-info.pdf	30944	no	2
			0ef280a9beedc0b51caadbac3466d464c9192281		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/790,924	03/08/2013	William J. Swanson	S697.12-0253

CONFIRMATION NO. 6040

POA ACCEPTANCE LETTER

27367

WESTMAN CHAMPLIN & KOEHLER, P.A.

SUITE 1400

900 SECOND AVENUE SOUTH

MINNEAPOLIS, MN 55402



OC000000084632986

Date Mailed: 07/26/2016

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 07/25/2016.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/nhorne/

Receipt date: 05/09/2013

13790924 CAU: 1744
Complete if Known

Substitute for forms 1449A/PRO and 1449B/PTO

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**

(Use as many sheets as necessary)

Sheet	- 1 -	of	- 4 -	Application Number	13/790,924
				Filing Date	March 8, 2013
				First Named Inventor	William J. Swanson
				Art Unit	2861
				Examiner Name	
				Attorney Docket Number	S697.12-0253

U.S. PATENT DOCUMENTS

Exam. Init.*	Cite No.	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Classification
		Number-(Kind Code if Known)			
R. J. C.	A1	US- 5,121,329	06-09-1992	Crump	364/468
	A2	US- 5,169,081	12-08-1992	Goedderz	242/54
	A3	US- 5,303,141	04-12-1994	Batchelder et al.	364/149
	A4	US- 5,312,224	05-17-1994	Batchelder et al.	415/73
Changes applied	A5	US- 5,340,443 ³	08-23-1994	Crump	156/578
to document,	A6	US- 5,503,785	04-02-1996	Crump et al.	264/40.7
/C.L./	A7	US- 5,738,817	04-14-1998	Danforth et al.	264/603
5/11/2016	A8	US- 5,764,521	06-09-1998	Batchelder et al.	364/475.01
	A9	US- 5,866,058	02-02-1999	Batchelder et al.	264/237
	A10	US- 5,900,207	05-04-1999	Danforth et al.	264,603
	A11	US- 5,939,008	08-17-1999	Comb et al.	264/308
	A12	US- 5,968,561	10-19-1999	Batchelder et al.	425/375
	A13	US- 6,004,124	12-21-1999	Swanson et al.	425/375
	A14	US- 6,022,207	02-08-2000	Dahlin et al.	425/145
	A15	US- 6,054,077	04-25-2000	Comb et al.	264/40.7
	A16	US- 6,067,480	05-23-2000	Stuffle et al.	700/109
	A17	US- 6,070,107	05-30-2000	Lombardi et al.	700/119
	A18	US- 6,085,957	07-11-2000	Zinniel et al.	226/8
	A19	US- 6,129,872	10-10-2000	Jang	264/75
	A20	US- 6,228,923	05-08-2001	Lombardi et al.	524/425
	A21	US- 6,257,517	07-10-2001	Babish et al.	242/365.6
	A22	US- 6,547,995	04-15-2003	Comb	264/40.1
	A23	US- 6,645,412	11-11-2003	Priedeman, Jr.	264/219
	A24	US- 6,685,866	02-03-2004	Swanson et al.	264/308
	A25	US- 6,722,872	04-20-2004	Swanson et al.	425/225
	A26	US- 6,730,252	05-04-2004	Teoh et al.	264/178
	A27	US- 6,749,414	06-15-2004	Hanson et al.	425/130
R. J. C.	A28	US- 6,790,403	09-14-2004	Priedeman, Jr. et al.	264/442

Examiner:*Date Considered:**

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.



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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/790,924	08/23/2016	9421713	S697.12-0253	6040

27367 7590 08/03/2016
WESTMAN CHAMPLIN & KOEHLER, P.A.
SUITE 1400
900 SECOND AVENUE SOUTH
MINNEAPOLIS, MN 55402

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 530 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

William J. Swanson, St. Paul, MN;
Ronald G. Schloesser, New Brighton, MN;
Gary Larson, Independence, MN;
STRATASYS, INC., Eden Prairie, MN

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