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Build material supply unit

Abstract

A 3D printing system build material supply unit includes a tray with an opening that defines a spreading plane in which a recoater spreads build material. A double vane is rotatably mounted inside the tray with the rotation axis extending along the tray below the spreading plane and with each vane having convex front and rear sides. A controller controls rotation of the double vane such as to supply a dose of build material with the front side of one vane to the spreading plane by rotating the double vane into a trimming position in which the front side of the one vane approaches the spreading plane such that the dose of build material is enclosed between the front side of the vane and the spreading plane. Excess build material to be trimmed by the recoater accumulates on the other vane rear side and is lowered into the tray.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This application is a U.S. National Stage Application of PCT Application No. PCT/US2019/051737, filed Sep. 18, 2019, entitled “BUILD MATERIAL SUPPLY UNIT,” which is incorporated herein by reference.

BACKGROUND

(2) The description is related to a three-dimensional (3D) printing system. A 3D printer uses additive printing processes to make 3D objects from a digital 3D object model file. More particularly, the description is related to a build material supply unit for a 3D printing system to supply build material to the 3D printing system.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) Features of examples will be described, by way of example, in the following detailed description with reference to the accompanying drawings in which like reference numerals correspond to similar, though perhaps not identical, components. For the sake of brevity, reference numerals or features having a previously described function may or may not be described in connection with other drawings in which they appear.

(2) Non-limiting examples will now be described with reference to the accompanying drawings, in which:

(3) FIG. 1 shows a cross-section of an example of a build material supply unit for a 3D printing system.

(4) FIG. 2 shows a side view of a double vane of an example build material supply unit for a 3D printing system.

(5) FIG. 3 shows a cross-section of a double vane of an example build material supply unit for a 3D printing system.

(6) FIG. 3a schematically presents a controller which controls the double vane.

(7) FIG. 4 shows a perspective view of an example of a build material supply unit for a 3D printing system.

(8) FIG. 5 shows a side view of an example of a build material supply unit for a 3D printing system.

(9) FIG. 6-11 show examples of a method for supplying build material from a tray of a build material supply unit to a spreading plane in a 3D printing system.

DETAILED DESCRIPTION

(10) In some 3D printing systems, for example, a 3D object may be formed on a layer-by-layer basis where each layer is processed and combined with a subsequent layer until the 3D object is fully formed.

(11) In various 3D printing systems, a 3D object being produced may be defined from a 3D object model file. Information in such a 3D object model file comprises 3D geometric information that describes the shape of the 3D model. The 3D geometric information in a 3D object model file may define solid portions of a 3D object to be printed or produced. To produce a 3D object from a 3D object model, the 3D model information may be processed to provide 2D planes or slices of the 3D model. Each 2D slice generally comprises an image and/or data that may define an area or areas of a layer of build material as being solid object areas where the build material is to be solidified during a 3D printing process.

(12) In some powder-bed 3D printing systems, such as binder or fusing agent jetting systems, a 2D slice of a 3D object model may be produced by spreading a thin layer of build material over a print bed in a build unit of the 3D printing system. This layer of build material is to receive a functional agent such as a binding agent or a fusing agent. Conversely, areas of a build material layer that are not defined as object areas by a 2D slice comprise non-object areas where the build material is not to be solidified and will not receive a functional agent. The procedure of spreading build material and applying a functional agent is repeated until completion of the 3D object. In some such systems, energy, such as curing or fusing energy, may be applied to cause solidification of build material where an agent was applied.

(13) Within 3D printing systems, the term “build material” is to be generally understood as a physical substance that can be used to generate an object via 3D printing. Examples of build materials for additive manufacturing include polymers, crystalline plastics, semi-crystalline plastics, polyethylene (PE), polylactic acid (PLA), acrylonitrile butadiene styrene (ABS), amorphous plastics, Polyvinyl Alcohol Plastic (PVA), Polyamide (e.g., nylon), thermo(setting) plastics, resins, transparent powders, colored powders, metal powder, ceramics powder such as for example glass particles, and/or a combination of at least two of these or other materials wherein such combination may include different particles each of different materials or different materials in a single compound particle. Examples of blended build materials include alumide, which may include a blend of aluminum and polyamide, and plastics/ceramics blends. There exist more build materials and blends of build materials that can be managed by an apparatus of this disclosure. In some 3D printing systems, the build material is in powder form. In other 3D printing systems, the build material is in the form of paste material, solid material, slurry material or liquid material.

(14) Some 3D printing systems may comprise, among others, a build platform, a build material storage, a printhead to apply the functional agent to the build material, a recoater, a control unit, a build material supply unit, and a user interface. In one example, the build material supply unit may be integrated into the build unit of the 3D printing system. In another example, a build unit may comprise one or multiple build material supply units. In one example, the 3D object may be generated on a build platform by alternatively applying a build material and a functional agent (and energy, where appropriate). In one example, the build material may be applied layer wise by the recoater moving in a spreading plane. In an example initial state, the spreading plane and the build platform may coincide, while the build platform may move downwards with increasing number of applied layers of build material.

(15) In example 3D printing systems that use powdered material, the powdered material may be conveyed from a powder storage unit to a build material supply unit and then to the build platform,

located next to the build material supply unit, and on which a 3D object is build layer by layer. An example build material supply unit provides a predetermined dose of build material, which is an amount of powder sufficient to form a layer on the build platform. The example build material supply unit may distribute the predetermined dose of build material uniformly along the length of the build platform. A recoater may spread the supplied build material across the build platform. The build material supply unit may as well reduce powdery build material that becomes airborne during the supplying. An example build material unit is further easy to dismantle for cleaning.

(16) Examples described relate to a mechanism that distributes build material from a build material inlet to a uniform, linear output for supplying to a build platform of a 3D printing system while minimizing airborne build material. In addition, the example apparatus described herein reduces the number of active parts because the mechanism has dosing and distributing functions, both of which are carried out during rotation of the mechanism. As such, the example build material supply unit is a simplified design and is compatible with a continuous feeding strategy, whereby material is continually input into the spreading plane, and the example 3D printing system can produce a dose of powder in a reduced time, increasing productivity. In addition, the simplified design reduces the number of failure modes, improving reliability and up time of the 3D printing system. Examples described herein may relate to binder jetting and other powder-bed 3D printing systems.

(17) FIGS. **1-11** show a build material supply unit **10** of a 3D printing system and related methods wherein like reference numerals correspond to the same components. Now referring to FIG. **1** which shows a cross-section of the build material supply unit **10** for a 3D printing system. The build material supply unit **10** comprises a tray **11**. The tray **11** comprises a build material supply opening **12**. The build material supply opening **12** defines a spreading plane **13** in which a recoater **16** of the 3D printing system spreads build material. The spreading plane coincides with the build platform of the 3D printing system in an initial state, joined together along a single edge. The build material supply unit **10** further comprises a double vane **14** that is rotatably mounted inside the tray **11**. The rotation axis **15** of the double vane **14** extends along the tray **11** below the spreading plane **13**. Each vane of the double vane **14** has a convex front side **17** and a rear side **18**.

(18) The build material supply unit **10** also comprises a controller **9** to control the rotation of the double vane **14**. By rotating the double vane **14** into a trimming position, shown in FIG. **6c**, a predetermined dose of build material with the front side **17** of one vane **19** of the double vane **14** is supplied to the spreading plane **13**. In the trimming position, the front side **17** of the one vane **19** approaches the spreading plane **13** such that the predetermined dose of build material is enclosed between the front side **17** of the one vane **19** and the spreading plane **13**. In the trimming position, the recoater **16** of the 3D printing system trims excess build material on the front side of the one vane **19** to the rear side **18** of the other vane **20**. The one vane **19** of the double vane and the other vane **20** of the double vane may be aligned in the same sense of rotation along which they are offset by an angle of 180 degrees. Thus, with half a turn of the double vane, the one vane **19** takes over the functions of the other vane **20** and vice versa. Excess build material may comprise the amount of build material loaded on the front side **17** of the one vane **19** that exceeds the predetermined dose of build material. In some examples, the double vane **14** may be rotated in a single direction. This direction may determine the front side **17** and the rear side **18** of a vane as seen from the rotating direction. The excess build material trimmed to the rear side **18** of the other vane **20** will be lowered into the tray **11** upon further rotation of the double vane **14**. In some examples, the predetermined dose of build material may be in the order of a few grams of build material. In some examples, predetermined dose of build material may be one of the following: 6 grams, 8 grams, 10 grams, 12 grams, 14 grams, and 16 grams.

(19) In an example, the tray **11** may comprise a circular cross-section below the spreading plane. The semi-circular of the tray **11** may be arranged to the evolute of the rotating double vane **14** below the spreading plane **13**. The distance between the rotation axis **15** of the double vane **14** to the build material supply opening **12** may be adopted to avoid interference of the recoater **16**,

which moves within the spreading plane **13**, with the double vane **14** in the trimming position shown in FIG. **6c** or in the supply position shown in FIG. **6e**?. In an example material supply unit **10**, the distance between the rotation axis **15** of the double vane **14** to the build material supply opening **14** may be in the order of about ten millimeters.

(20) An example double vane **14** may comprise a double bent blade. Yet another example double vane **14** may be a sheet metal with two parallel longitudinal bends. In some examples, the double vane **14** may be made of stainless-steel. In another example, the double blade **14** may be made of aluminum. In yet another example, the double vane **14** may be made of a metal other than aluminum or stain-less steel. In further examples, the double vane may be made of a material that comprises a certain sturdiness. The double vane **14** may be easily replaceable and easy to clean. The double vane **14** may be arranged to meet the requirements of a certain printing process. It represents a robust system for dosing and feeding build material to a 3D printing system.

(21) The example double vane **14** may comprise two vanes. In one example, the vanes of the double vane **14** are aligned in the same sense of rotation along which they are offset by an angle of 180 degrees. In another example, the double vanes are offset by an angle different from 180 degrees. In one example, the convex front side **17** of a vane of the double vane **14** may be formed in a curved shape. In another example, the convex front side **17** of the one vane of the double vane **14** may be angularly bent. In yet another example the convex front side **17** of the double vane is rather slightly bent such with a shallow angle of curvature. In some examples, the double vane may comprise a number of vanes that is greater than two. In some other examples, the double vane may comprise an even number of vanes.

(22) In some examples, the rear side **18** of the other vane of the double vane **14** may be concave. In other examples, the rear side **18** of the other vane of the double vane **14** may be flat. In yet other examples, the surface of the rear side **18** of the double vane **14** may be ripped or bent. The rear side of the vane helps reduce the amount of powder that becomes airborne by decreasing the height that the build material falls freely into the tray **11** after trimming. Without the rear side **18** of the other vane **20** the build material would freely fall down to the bottom of the tray along a distance corresponding to the diameter of the vane. The “other” vane prevents or at least strongly reduces this free fall to a slipping down around double the distance between the rotation axis and the spreading plane. The height of the rotation axis **15** of the double vane **14** with respect to the spreading plane **13** may be arranged to further avoid the development of airborne build material.

(23) In some examples, the recoater **16** may be a roller. In other examples, the recoater **16** may be a counter-rotating roller. In another example, the recoater **16** may be a slider or blade. In some examples, the recoater **16** may comprise a carriage to move the recoater **16**. The recoater **16** may be arranged to move over the build material supply opening **12**. An example 3D printing system may comprise more than one recoater **16**. In another example, for a 3D printing system comprising two parallel build material supply units **10**, the recoater **16** may move across a printing platform in a first direction to deposit a first layer of powder from one build material supply unit **10** on one side of the build platform and then moves in a second, opposite, direction to deposit another layer of powder from a second build material supply unit **10** on the other side of the build platform.

(24) In some examples, a 3D printing system may comprise one build material supply unit **10** located next to the build platform. In another example, a 3D printing system may comprise two or more build material supply units **10** located next to the build platform. In an example 3D printing system, the at least one build material supply unit **10** may be arranged to minimize the travel distance of the build material from the build material supply unit **10** to the build platform.

(25) FIG. **2** shows a side view of an example double vane **14** of an example build material supply unit **10** for a 3D printing system. The build material supply unit **10** may comprise deflectors **21** to uniformly distribute build material which is accumulated on the rear side **18** of the vanes of the double vane **14** over the length of the tray **11**. The tray **11** extends along the rotation axis **15** of the double vane **14**.

(26) In some examples, the deflectors **21** are provided on the rear side **18** of the other vane and the convex front side **17** of the one vane of the double vane **14**. The double vane **14** may be arranged such that the deflectors **21** extend from the rear side **18** of one vane **19** partly to the convex front side **17** of the other vane **20**. In some examples, the deflectors **21** are inclined with respect to the rotation axis **15** of the double vane **14** such as to distribute build material accumulated in the trimming position on the rear side **18** of one vane **19** over the length of the tray **11** upon trimming of excess build material and upon further rotation of the double vane **14**.

(27) In some examples, the deflectors **21** of the double vane **14** may be regularly spaced along the rotation axis **15** of the double vane **14**. In this way, the build material accumulated by the rear side **18** of the vane and guided by the deflectors **21** is evenly distributed along the length of the tray **11**.

(28) FIG. 3 shows a cross-section of an example double vane **14** of an example build material supply unit **10** for a 3D printing system. An example double vane **14** may have a z-profile. The z-profile may comprise two parallel outer sections **31**. Both outer section **31** may be connected to a central double vane section **32** via an elbow **33** as shown in FIG. 3. In some examples, the elbow **33** may be a longitudinal bending edge. In one example, the longitudinal bending edge may be a rounded edge. In another example, the longitudinal bending edge may be a sharp edge transition between the outer double vane sections **31** and the central double vane section **32**.

(29) In one example, the z-profile may be arranged such that the predetermined dose of build material may be enclosed between the spreading plane **13** and one outer double vane section **31** when the double vane **14** is rotated into the trimming position. In the trimming position, the elbow **33** approaches the spreading plane **13**. In one example, the elbow **33** may come close to the spreading plane **13** from below in the trimming position. In another example, the elbow may connect the spreading plane **13** in the trimming position. In yet another example, the elbow **33** may align with the spreading plane **13** in the trimming position.

(30) In some examples, the predetermined dose of build material sets boundary conditions for configuring the bending angle of the elbow **33** and, in dependence of the angle, for the length of the outer section **31** in the trimming position. In another example, the predetermined dose of build material sets boundary conditions for configuring the length of the outer section **31**, and in dependence of the outer section, for the bending angle of the elbow **33** in the trimming position. The resulting z-shape may determine the distance between the rotation axis **15** and the spreading plane **13**. In another example, the distance between the rotation axis **15** and the spreading plane **13** may determine the z-shape of the double vane **14** under consideration the predetermined dose of build material.

(31) FIG. 3a schematically presents the controller **9** of the build material supply unit **10** which controls rotation of the double vane **14** by a driving system **34**. The controller **9** may control rotation speed of the double vane **14**. The controller **9** may control the angular position of the double vane **14** in the trimming and the supplying position. The controller **9** may further synchronize the movement of the recoater **16** and the rotation of the double vane **14**.

(32) FIG. 4 shows a perspective view of an example of a build material supply unit **10** for a 3D printing system. In one example, the double vane **14** is mounted with its rotation axis **15** below the spreading plane **13**. The distance between the rotation axis **15** of the double vane **14** to the build material supply opening **12** may be designed such that in the trimming position, the bending edge **33** of the double vane approaches the spreading plane **13** and prevents build material of the enclosed predetermined dose of build material to be moved by the recoater to the other vane **20**. The recoater **16** may be arranged to move across the build material supply opening **12**. The deflectors **21** may redirect the falling excess build material towards the lateral ends of the tray **11** such that the build material supply unit **10** supplies the predetermined dose of build material uniformly along the spreading plane **13**.

(33) FIG. 5 shows a side view of an example of a build material supply unit **10** for a 3D printing system. In some examples, the build material supply unit **10** may comprise a thermal blanket **52**.

The thermal blanket **52** may surround the tray **11** to control the temperature of the build material which is accumulated in the tray **11**. In some examples, the thermal blanket **52** may preheat the build material which may cause the build material to become stickier or more cohesive. In some examples, preheating the build material may cause the build material to form a semi-hard cake once supplied to the spreading plane **13**.

(34) In some examples, the build material supply unit **10** may comprise a build material inlet **53**. The build material inlet **53** may be coupled to a build material feeder **51**, wherein the build material feeder **51** may feed build material through the build material inlet **53** into the tray **11**. The build material feeder **51** may feed build material from a build material storage of the 3D printing system through the build material inlet **53** into the tray **11**. In one example, the build material inlet **53** may be located at the bottom of the tray **11** opposite the build material supply opening **12**. In some examples, the build material inlet **53** is located centrally along the rotation axis **15** of the double vane **14**. The amount of build material fed by the build material feeder **51** in one cycle may be synchronized to correspond to the predetermined dose of build material supplied to the spreading plane **13** in one cycle.

(35) In one example, the build material supply unit **10** may comprise a plurality of material inlets **53**. In some examples, the deflectors **21** of the double vane **14** may be arranged to the configurations of the build material inlet **53** in the tray **11** such that the deflectors **21** distribute build material uniformly along the tray **11**. In one example the tray **11** may comprise two build material inlets **53** which divide the tray **11** into two sections. The deflectors **21** of the double vane **14** corresponding to the first section may be inclined towards the build material inlet **53** of the first section whereas the deflectors **21** of the double vane **14** corresponding to the second section may be inclined to the build material inlet of the second section respectively.

(36) The build material may be fed through the build material inlet **53** into the tray **11** by a feeder **51**. In another example, the feeder **51** may comprise a pneumatic conveyance system. In another example, the feeder **51** may comprise an auger. In yet another example, the feeder **51** may comprise an Archimedes screw.

(37) Before the build material unit **10** may be operated in steady state, it may undergo an initialization. During initialization, the double vane **14** may rotate some full turns to uniformly distribute build material within the tray **11** while the recoater **16** is on hold. In steady state, the build material supply unit **10** may supply the predetermined dose of build material for building one layer of a 3D object uniformly along the spreading plane **13**. The build material feeder **51** may be synchronized to feed the predetermined dose of build material into the tray **11** such that the build material level in the tray **11** is maintained at steady state.

(38) In some examples, the configuration of the deflectors **21** may determine the speed at which build material is distributed along the tray **11**. In one example, the length of the deflectors **21** may determine the distance the build material travels along the tray **11** during rotation. In another example, the size of the deflectors **21**, the angle the deflectors **21** are tilted with regards to the rotation axis as well as the distance between deflectors **21** may determine the amount of powder that is redirected towards the longitudinal ends of the tray **11** during rotation. In some examples, the deflectors may be arranged to meet the build material characteristics.

(39) In some examples, the sense of orientation of the deflectors **21** is modified to the build material inlet **53**. In an example, where build material is supplied over the length of the tray **11**, the deflectors may not be inclined but still arranged on the double vane to comb through the build material to avoid conglomerating of build material. In another example, where build material is supplied over the length of the tray **11**, the double vane **14** may not comprise deflectors **21**. In an example of a central build material inlet, the deflectors may be oriented symmetrically with respect to the build material inlet. In some examples, stickier powder may require enhanced height of deflectors for distribution to counteract fins that may otherwise occur when sticky powder hits deflectors.

(40) FIG. 5 further shows an example predetermined dose of build material **54** being supplied at the build material supply opening **11** of the build material supply unit **10**. The predetermined dose of build material **54** will be spread into the spreading plane **13** by the recoater **16** which moves over the build material supply unit **10**.

(41) In some examples, the build material supply unit **10** may further comprise a collecting unit **55**. The collecting unit **55** may be positioned at least at one longitudinal end of the tray **11** and arranged to collect excess build material. In some example, the collecting unit **55** may be a removable storage. In some examples, the build material collected in the collecting unit **55** may be processed for reuse. The build material unit **10** may be arranged to minimize build material that is collected in the collecting unit **55**.

(42) An example build material supply unit **10** may also comprise a controller **9**. The controller **9** may be programmed to measure the amount of build material loaded on the front side **17** of one vane **19**. The amount of build material loaded on the front side **17** of one vane **19** may be measure for example by measuring the torque applied to the double vane **14**. In some examples, the torque to be applied to the double vane **14** may be measured using pulse-width modulation. In some examples, this measurement indicates the level of build material in the tray **11**. In another example, the level of build material in the tray **11** may be measured using laser measurement. The amount of build material supplied by the build material feeder **51** may be controlled closed-loop as a response of the measured level of build material in the tray **11**.

(43) An example build material supply unit **10** may comprise a driving system **34** to rotate the double vane **14**. In one example, the driving system **34** may comprise a motor and the controller **9**. The controller **9** may further comprise an encoder to control the rotation angle of the double vane **14**. The driving system **34** may also comprise a gearbox to increase torque applied to the rotating axis **15**. The driving system **34** may also comprise a coupling that enables dislodging the double vane **14** from the tray **11** for maintenance and cleaning. In some examples, the build material supply unit **10** may further comprise a locking system arranged at the opposite side of the driving system to preload the double vane against the driving system axial datum.

(44) In an example of the build material supply unit **10** the controller **9** may actuate the driving system **34**. In an example, the controller **9** may also measure the level of build material in the tray **11**.

(45) FIG. 6 shows how the controller **9** controls example positions of the double vane **14** and the recoater **16** during one cycle. In some examples, one cycle may correspond to a half turn of the double vane **14**. FIG. 6a shows a state of the build material supply unit **10** after initialization. During initialization, the controller **9** may rotate the double vane **14** a predetermined number of full turns to uniformly distribute the build material within the tray **11** while halting the recoater **16**. The predetermined number of full turns may depend on the arrangement of the deflectors **21** on the double vane **14**. In an example, the deflectors **21** may be spaced apart and inclined with respect to the rotation axis **15** such that the build material reaches the next adjacent deflector in outwardly longitudinal direction during a half turn. The number of full turns during initialization may correspond to at least one quarter of the total number of deflectors **21**.

(46) As the build material has been distributed uniformly along the longitudinal axis of the tray **11** the double vane is ready for operation. The controller **9** controls the build material feeder **51** to supply the predetermined dose of build material through the build material inlet to the tray **11** from a build material storage in each cycle. Upon rotation, the double vane **14** may be controlled by the controller **9** to load a portion of build material on the convex front side **17** of one vane **19**, while the recoater **16** may be controlled by the controller **9** to move from the build platform towards the tray **11** as shown in FIG. 6b. In one example position of the double vane **14**, the controller **9** may further rotate the double vane may until one elbow **33** of the vane aligns with the spreading plane **13** as shown FIG. 6c. In this position, the vane encloses the predetermined dose of build material to be fed to the spreading plane **13** between its convex front side **17**, the spreading plane **13** and the inner

side section of the tray **11** below the spreading plane **13**. In this trimming position, the controller **9** may halt double vane **14** until excess build material has been trimmed and the controller **9** may have moved recoater **16** across the tray.

(47) The controller **9** may continue to move the recoater towards a direction away from the build platform thereby trimming excess build material. The recoater **16** relocates excess build material such that it is accumulated on the rear side **18** of the other vane as shown in FIG. **6d**. The rear side of the other vane **20** catches the excess build material. Free fall of the excess build material into the tray **11** and related airborne build material is thus avoided.

(48) FIG. **6e** shows the controller **9** to further rotate the double vane **14** until the outer section of the one vane **19** aligns with the spreading plane **13** and the predetermined dose of build material is lifted to the spreading plane **13**. The controller then moves the recoater **16** in a opposite direction towards the build platform and which spreads the predetermined dose of build material into the spreading plane **13** as shown in FIG. **6f**. Upon further rotating the double vane **14** by the controller **9**, excess build material is lowered into the tray **11** by the other vane **20**. In some examples, the predetermined dose of build material may be slightly modified in that the controller **9** halts the double vane **14** at different angles in the trimming and supplying position.

(49) The controller **9** may synchronize the movement of the recoater **16** and the rotation of the double vane **14** may such that the recoater **16** does not interfere with the double vane **14**. Also, the height of the double vane **14** may be arranged such that outer sections **31** and the elbows **33** do not interfere with the recoater **16**.

(50) FIG. **7** shows a method **70** performed by the controller **9** to control rotation of the double vane **14** and movement of the recoater **16** for supplying build material from the tray **11** of the build material supply unit **10** to the spreading plane **13** in a 3D printing system. In block **71**, the controller **9** rotates the double vane **14** in a trimming position. Upon rotation by the controller **9**, the double vane **14** lifts build material with the front side **17** of one vane **19** from the tray **11** into the trimming position where a predetermined dose of build material is enclosed between the front side **17** of the one vane **19** and the spreading plane **13**.

(51) In block **72** the controller **9** controls the recoater **16** to trim excess build material loaded on the front side **17** of the one vane **19**. The controller **9** moves the recoater **16** for this in the spreading plane **13** from the front side **17** of the one vane **19** to the rear side **18** of the other vane **20**. The method **70** further comprises accumulating excess build material that has been trimmed by the recoater **16** on the rear side **18** of the other vane **20** of the double vane **14** in block **73**. The method **70** comprises the controller **9** to further rotate the double vane **14** thereby lowering the build material which has been accumulated on the rear side **18** of the other vane **20** into the tray **11** in block **74**.

(52) In one example, the controller **9** controls the rotation speed of the double vane which corresponds to the lowering speed of lowering accumulated excess build material on the rear side **18** of the other vane **20** into the tray **11** to prevent free fall of excess build material into the tray **11**. The rear side **18** of the other vane **20** gently lowers excess build material into the tray which prevents build material becoming airborne within the build material supply unit **10**. In some examples, the development of airborne build material may cause malfunctioning of parts of the 3D printing system. In other examples, the development of airborne build material may reduce the life-time of parts of the 3D printing system.

(53) FIG. **8** shows a further example method **80** performed by the controller **9** to control rotation of the double vane **14** and movement of the recoater **16** for supplying build material from the tray **11** of the build material supply unit **10** to the spreading plane **13** in a 3D printing system. The controller **9** may rotate the double vane **14** such that excess build material accumulated on the rear side **18** of the other vane **20** is distributed over the length of the tray **11** by means of deflectors **21** provided on the double vane **14** in block **81**. In one example, blocks **74** and **81** are processed by the same rotation of the double vane **14**. The controller **9** may further lower the other vane **20** of the

double vane **14** by such that the excess build material is deflected by the deflectors and put into the tray. The deflectors may describe the movement of the excess build material.

(54) FIG. **9** shows an example method **90** performed by the controller **9** to control rotation of the double vane **14** and movement of the recoater **16** for supplying build material in a 3D printing system. In some examples, the method **90** may comprise collecting excess build material at the longitudinal end of the tray in block **91**. In some examples, excess build material may be processed for reuse.

(55) FIG. **10** also shows an example method **100** performed by the controller **9** to control rotation of the double vane **14** and movement of the recoater **16** for supplying build material in a 3D printing system. The controller **9** may rotate the double vane **14** a predetermined number of rotations to uniformly distribute the build material over the length of the tray **11**. The predetermined number of rotations may result from the arrangement of the deflectors **21** on the double vane **14**. The double vanes **21** may be spaced apart and inclined with respect to the rotation axis **15** such that build material reaches the next adjacent deflector in outwardly longitudinal direction during a half turn. The number of full turns during initialization may correspond to at least one quarter of the total number of deflectors **21**.

(56) FIG. **11** shows a further example method **110** performed by the controller **9** to control rotation of the double vane **14** and movement of the recoater **16** for supplying build material in a 3D printing system. In this method, the controller **9** may measure the amount of build material loaded on the front side **17** of one vane **19** and may adapt the feeding amount of build material a feeder feeds through a build material inlet into the tray **11** in response to the measured amount of build material in block **111**.

(57) While the method, apparatus and related aspects have been described with reference to certain examples, various modifications, changes, omissions, and substitutions can be made without departing from the spirit of the present disclosure. It is intended, therefore, that the method, apparatus and related aspects be limited by the scope of the following claims and their equivalents.

(58) It should be noted that the above-mentioned examples illustrate rather than limit what is described herein, and that those skilled in the art will be able to design many alternative implementations without departing from the scope of the appended claims. Features described in relation to one example may be combined with features of another example.

Claims

1. A build material supply unit for a 3D printing system, the build material supply unit comprising: a tray comprising a build material supply opening that defines a spreading plane in which a recoater of the 3D printing system spreads build material; and a double vane comprising a first vane and a second vane rotatably mounted inside the tray with a rotation axis extending along the tray below the spreading plane and with each vane having a convex front side and a rear side, wherein the first vane and the second vane each comprises a deflector on the rear side to distribute excess build material accumulated on the corresponding rear side over a length of the tray, and a controller, wherein the controller is to rotate the double vane; into a trimming position in which the front side of the first vane approaches the spreading plane such that a predetermined dose of build material loaded on the front side is enclosed between the front side of the first vane and the spreading plane and in which excess build material to be trimmed by the recoater in a first pass will be accumulated on the rear side of the second vane and lowered into the tray upon further rotation of the double vane; and into a supplying position in which the predetermined dose of build material is supplied with the front side of the first vane substantially in plane with the spreading plane to be spread by the recoater in a second pass over the spreading plane.

2. The build material supply unit according to claim 1, wherein the deflectors distribute excess build material accumulated on the rear side of the second vane over a length of the tray during the

first pass of the recoater and rotation of the double vane.

3. The build material supply unit according to claim 1, wherein the double vane has a z-profile comprising two outer sections each being connected to a central double vane section via a corresponding elbow, wherein the z-profile is such that the predetermined dose of build material is enclosed between the spreading plane and a first outer section when the first outer section is rotated into the trimming position with the corresponding elbow connecting the first outer section to the central double vane section approaching the spreading plane.

4. The build material supply unit according to claim 3, wherein the deflectors are provided on the convex front side of each of the first vane and the second vane by extending from the rear side of the second vane and the first vane partly to the convex front side of the first vane and the second vane, respectively, wherein the deflectors are inclined with respect to the rotation axis of the double vane to distribute build material accumulated in the trimming position on the rear side of the first vane over a length of the tray upon trimming of excess build material and upon further rotation of the double vane.

5. The build material supply unit according to claim 4, wherein during an initialization phase the controller is to rotate the double vane for a predetermined number of turns to uniformly distribute the build material over the length of the tray, wherein the predetermined number depends on an arrangement of the deflectors on the double vane.

6. The build material supply unit according to claim 1, wherein the tray comprises a build material inlet coupled to a build material feeder to feed build material through the build material inlet into the tray.

7. The build material supply unit according to claim 1, wherein the controller is programmed to measure a torque employed to rotate the double vane, which indicates an amount of build material loaded on the front side of the first vane and to adapt a feeding amount of build material fed by a build material feeder in response to the measured amount of build material.

8. The build material supply unit according to claim 1, further comprising a collecting unit positioned at at least one longitudinal end of the tray to collect excess build material.

9. Method for supplying build material from a tray of a build material supply unit to a spreading plane in a 3D printing system, comprising of: rotating a double vane comprising a first vane and a second vane, which is rotatably mounted inside the tray with a rotation axis extending along the tray below the spreading plane and with each vane having a convex front side and a rear side, to lift build material with the front side of the first vane from the tray into a trimming position where a predetermined dose of build material is enclosed between the front side of the first vane and the spreading plane, trimming excess build material loaded on the front side of the first vane with a recoater which is moved in the spreading plane from the front side of the first vane to the rear side of the second vane, accumulating trimmed excess build material on the rear side of the second vane, further rotating the double vane into a supplying position in which the predetermined dose of build material is supplied to the spreading plane, distributing excess build material accumulated on the rear side of the second vane over a length of the tray by means of deflectors provided on the rear side of the first vane and the rear side of the second vane, spreading the predetermined dose of build material with the recoater over the spreading plane, and lowering the build material accumulated on the rear side of the second vane into the tray by further rotation of the double vane.

10. The method for supplying build material in a 3D printing system according to claim 9, wherein the deflectors distribute the excess build material accumulated on the rear side of the second vane over the length of the tray during a first pass of the recoater and rotation of the double vane.

11. The method for supplying build material in a 3D printing system according to claim 10, further comprising collecting excess build material at a longitudinal end of the tray.

12. The method according to claim 10, further comprising rotating the double vane for a predetermined number of turns during an initialization phase to uniformly distribute the build material over the length of the tray.

13. The method according to claim 10, further comprising: measuring an amount of build material loaded on the front side of the first vane; and adapting a feeding amount of build material fed by a build material feeder through a build material inlet into the tray in response to the measured amount of build material.

14. The double vane for a build material supply unit according to claim 1, wherein the double vane has a z-profile comprising two outer sections each being connected to a central double vane section via a corresponding elbow, wherein the z-profile is such that the predetermined dose of build material is enclosed between the spreading plane and an outer double vane section when the double vane is rotated into the trimming position with the corresponding elbow connecting the outer double vane section to the central double vane section approaching the spreading plane.

15. The double vane according to claim 14, further comprising the deflectors being on the convex front side of each of the first vane and the second vane by extending from the rear side of the second vane and the first vane partly to the convex front side of the first vane and the second vane, respectively, wherein the deflectors are inclined with respect to the rotation axis of the double vane.
