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Pore removal from screen devices to increase flow uniformity

Abstract

According to examples, an apparatus may include a processor that may access information about a screen device having pores, in which the screen device is to be employed to filter liquid from a slurry composed of the liquid and material elements to form a part from the material elements. The processor may also access information about a main body, in which the main body is to support the screen device during formation of the part and has a plurality of openings that are larger than the pores in the screen device. The processor may identify, based on relative locations of the pores and the openings, pores that are to be removed from the screen device to increase uniformity of liquid flow through the pores across the screen device and may modify the accessed information about the screen device to remove the identified pores from the screen device.

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Background/Summary

BACKGROUND

(1) Various types of products may be fabricated from a pulp of material. Particularly, a pulp molding die that includes a main body and a wire mesh may be immersed in the pulp of material and the material in the pulp may form into the shape of the main body and the wire mesh. The main body and the wire mesh may have a desired shape of the product to be formed and may thus have a complex shape in some instances. The main body and the wire mesh may include numerous pores for liquid passage, in which the pores in the wire mesh may be significantly smaller than the pores in the main body. During formation of the product, a vacuum force may be applied through the pulp molding die which may cause the material in the pulp to be sucked onto the wire mesh and form into a shape that matches the shape of the pulp molding die. The material may be removed from the wire mesh and may be solidified to have the desired shape.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) Features of the present disclosure are illustrated by way of example and not limited in the following figure(s), in which like numerals indicate like elements, in which:

(2) FIG. **1** shows a block diagram of an example apparatus that may identify pores that are to be removed from a screen device to increase uniformity of liquid flow through the pores across the screen device;

(3) FIG. **2**A shows a cross-sectional side view of an example pulp molding die in which the example screen device discussed with respect to FIG. **1** may be implemented.

(4) FIG. **2**B shows an enlarged view of a section of the pulp molding die shown in FIG. **1**;

(5) FIG. **2**C shows a view similar to FIG. **2**B, with some pores and pillars removed;

(6) FIG. **3** shows an example 3D fabrication system that may be employed to fabricate the screen device depicted in FIGS. **2**A-**2**C;

(7) FIGS. **4** and **5**A-**5**B, respectively, show flow diagrams of example methods for identifying pores that are to be removed from a screen device to increase uniformity of liquid flow through the pores across the screen device; and

(8) FIG. **6** shows a block diagram of a computer-readable medium that may have stored thereon computer-readable instructions for identifying pores and pillars that are to be removed from a screen device to increase uniformity of liquid flow through the pores across the screen device.

DETAILED DESCRIPTION

(9) For simplicity and illustrative purposes, the present disclosure is described by referring mainly to examples. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present disclosure. It will be readily apparent however, that the present disclosure may be practiced without limitation to these specific details. In other instances, some methods and structures have not been described in detail so as not to unnecessarily obscure the present disclosure.

(10) Throughout the present disclosure, the terms “a” and “an” are intended to denote at least one of a particular element. As used herein, the term “includes” means includes but not limited to, the term “including” means including but not limited to. The term “based on” means based at least in part on.

(11) Disclosed herein are apparatuses, methods, and computer-readable media, in which a processor may identify pores that are to be removed from a screen device, which may be part of a pulp molding die (or equivalently, a mold tool set), to increase uniformity of liquid flow through the pores across the screen device. The processor may also modify information about the screen device to remove the identified pores from the screen device in the modified information. In some examples, the processor may also identify pillars that may form channels between the screen device and a main body (e.g., a mold) that are to be removed or removed. The pillars may be part of the screen device and may thus be removed or moved from the screen device. In any regard, the processor may identify the pillars that are to be removed or moved to further increase uniformity of liquid flow through the pores across the screen device.

(12) Through implementation of the features of the present disclosure, the pores in a 3D fabricated screen device may be designed to enable parts formed on the screen device to be fabricated in an efficient manner. For instance, by increasing (or in some instances, maximizing) uniformity of liquid flow through the pores across the screen device, the uniformity of the rates at which sections of a part may be formed from material elements across the screen device may be increased (or in some instances, maximized). As a result, the part may not have sections that are built up more slowly, which may require that additional time be taken to build up those sections. Instead, the uniform build-up of the sections of the part may enable the part to be formed at an increased efficiency level, e.g., at a minimized length of time, with a minimized amount of material elements, or the like.

(13) Reference is first made to FIGS. **1** and **2**A-**2**C. FIG. **1** shows a block diagram of an example apparatus **100** that may identify pores **204** that are to be removed from a screen device **202** to increase uniformity of liquid flow through the pores **204** across the screen device **202**. FIG. **2**A shows a cross-sectional side view of an example pulp molding die **200** in which the example screen device **202** discussed with respect to FIG. **1** may be implemented. FIG. **2**B shows an enlarged view of a section of the pulp molding die **200** shown in FIG. **1** and FIG. **2**C shows a view similar to FIG. **2**B, with some pores **204** and pillars **206** removed. It should be understood that the example apparatus **100** depicted in FIG. **1** and/or the example pulp molding die **200** depicted in FIGS. **2**A-**2**C may include additional features and that some of the features described herein may be removed and/or modified without departing from the scopes of the apparatus **100** and/or the pulp molding die **200**.

(14) The apparatus **100** may be a computing system such as a server, a laptop computer, a tablet computer, a desktop computer, or the like. As shown, the apparatus **100** may include a processor **102**, which may be a semiconductor-based microprocessor, a central processing unit (CPU), an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), and/or other suitable hardware device. The apparatus **100** may also include a memory **110** that may have stored thereon machine-readable instructions (which may also be termed computer-readable instructions) that the processor **102** may execute. The memory **110** may be an electronic, magnetic, optical, or other physical storage device that contains or stores executable instructions. The memory **110** may be, for example, Random-Access memory (RAM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), a storage device, an optical disc, and the like. The memory **110**, which may also be referred to as a computer readable storage medium, may be a non-transitory machine-readable storage medium, where the term “non-transitory” does not encompass transitory propagating signals.

(15) Although the apparatus **100** is depicted as having a single processor **102**, it should be understood that the apparatus **100** may include additional processors and/or cores without departing

from a scope of the apparatus **100**. In this regard, references to a single processor **102** as well as to a single memory **110** may be understood to additionally or alternatively pertain to multiple processors **102** and multiple memories **110**. In addition, or alternatively, the processor **102** and the memory **110** may be integrated into a single component, e.g., an integrated circuit on which both the processor **102** and the memory **110** may be provided.

(16) As shown in FIG. **1**, the memory **110** may have stored thereon machine-readable instructions **112-118** that the processor **102** may execute. Although the instructions **112-118** are described herein as being stored on the memory **110** and may thus include a set of machine-readable instructions, the apparatus **100** may include hardware logic blocks that may perform functions similar to the instructions **112-118**. For instance, the processor **102** may include hardware components that may execute the instructions **112-118**. In other examples, the apparatus **100** may include a combination of instructions and hardware logic blocks to implement or execute functions corresponding to the instructions **112-118**. In any of these examples, the processor **102** may implement the hardware logic blocks and/or execute the instructions **112-118**. As discussed herein, the apparatus **100** may also include additional instructions and/or hardware logic blocks such that the processor **102** may execute operations in addition to or in place of those discussed above with respect to FIG. **1**.

(17) The processor **102** may execute the instructions **112** to access information about a screen device **202** having pores **204**. The processor **102** may access the information via input from a user, from a data store, via a network, and/or the like. The information about the screen device **202** may include information such as the dimensions of the screen device **202**, the shape of the screen device **202**, the locations of the pores **204** within the screen device **202**, the orientations (e.g., the normals) of the pores **204**, the material or materials from which the screen device **202** is to be fabricated, and/or the like. In some examples, the information about the screen device **202** may include information that may be used to fabricate the screen device **202** using, for instance, a 3D fabrication system. According to examples, the information about the screen device **202** may be included as comma separated values, in a tabular format, or the like. In addition or alternatively, the information about the screen device **202** may be included as a digital model of the screen device **202**.

(18) In the examples discussed herein, the screen device **202** may be employed to filter liquid from a slurry **220** composed of the liquid and material elements **224** to form a part from the material elements **224**. The liquid may be water or another type of suitable liquid in which material elements **224**, which may be pulp material, e.g., paper, wood, fiber crops, bamboo, or the like, may be mixed into a slurry **220**. The material elements **224** may be, for instance, fibers of the pulp material.

(19) In addition to the pores **204**, the screen device **202** may include pillars **206** that may extend below the screen device **202** to support the screen device **202** on a main body **210** such that a channel **208** may be formed between the screen device **202** and the main body **210**. In other examples, the pillars **206** may be formed on the main body **210** instead of or in addition to the screen device **202**.

(20) The processor **102** may execute the instructions **114** to access information about a main body **210** (which may equivalently be referenced as a mold) having openings **214**. As shown in FIG. **2**A, the openings **214** may be formed between or within a solid portion **212** of the main body **210**. The processor **102** may access the information about the main body **210** in any of the manners similar to those discussed above with respect to the information about the screen device **202**. According to examples, the information about the main body **210** may be included as comma separated values, in a tabular format, or the like. In addition or alternatively, the information about the main body **210** may be included as a digital model of the main body **210**.

(21) As shown in FIG. **2**A, the main body **210** may support the screen device **202** during formation of the part. The main body **210** may also be formed to have a relatively larger thickness than the

screen device **202** and may be substantially more rigid than the screen device **202**. The main body **210** may thus provide structural support for the screen device **202**. The solid portions **212** of the main body **210** may be formed of a substantially rigid material, such as a metal, a plastic, a ceramic, and/or the like. In addition, the openings **214** may be formed between or within the solid portions **212** through any suitable fabrication technique. For instance, the openings **214** may be formed through a 3D fabrication process, drilling, through use of a mold, and/or the like. In any of these examples, the openings **214** may extend from one side of the main body **210** to an opposite side of the main body **210**. In some examples, the main body **210** and the screen device **202** may be formed together during a 3D fabrication process.
(22) According to examples, and as shown in FIGS. **2**A-**2**C, the openings **214** in the main body **210** may have circular cross-sections that may be relatively larger in diameter than the pores **204** in the screen device **202**. In other examples, the openings **214** may have other shapes, such as rectangular, oval, triangular, etc., shapes. In operation, a vacuum pressure may be applied from a side of the main body **210** opposite the screen device **202** when the pulp molding die **200** is immersed in a pulp or slurry **220** containing a material. As liquid in the pulp or slurry **220** flows through the pores **204** in the screen device **202** and the openings **214** in the main body **210** as denoted by the arrows **222**, the material elements **224** in the pulp or slurry **220** may be compressed onto the screen device **202** and may take the shape of the screen device **202**. Particularly, the material elements **224** may form into a part on the screen device **202** as the liquid is drawn from the slurry **220** and the remaining material elements **224** are dried.
(23) In some examples, as the pores **204** in the screen device **202** may not exactly line up with the openings **214** in the main body **210**, the screen device **202** and/or the main body **210** may include channels **208**, e.g., formed by the pillars **206**, that may enable the flow of liquid between sections of the screen device **202** and the main body **210** that may be in contact with each other. The channels **208** may thus enable pressure to be applied through a larger number of the pores **204** and thus cause liquid to flow through the larger number of the pores **204**.
(24) In some instances, liquid may flow more rapidly through the pores **204**, e.g., pore **204***a*, that are positioned within the circumferences of the openings **214** projected from the main body toward the screen device **202** than the pores that are outside of the projected circumferences, e.g., pore **204***c*. This may occur as there are fewer obstructions between the pore **204***a* and the opening **214** than there are between the pore **204***c* and the opening **214**. As a result, when vacuum pressure is applied, the material elements **224** may gather more rapidly over the pores **204** that are positioned in-line with the openings **214** than the pores **204** that are not positioned in-line with the openings **214**. This difference in the rates at which the material elements **224** gather may result in some sections of the part to reach intended thicknesses more quickly than other sections of the part. This difference in the rates may also cause a relatively long length of time for the sections of the part to be formed above the pores **204** that are not in-line with the openings **214**.
(25) As disclosed herein, some of the pores **204** may be removed from the screen device **202** to increase uniformity of liquid flow through the pores **204** across the screen device **202**. Through increase of the uniformity of liquid flow through the pores **204**, the rates at which the material elements **224** may be collected together across the screen device **202** may be more uniform. As a result, the length of time in forming a part on the screen device **202** having intended thicknesses may be reduced and/or optimized. In this regard, the processor **102** may execute the instructions **116** to identify pores **204** that are to be removed. Particularly, the processor **102** may apply a set of rules to identify which of the pores **204** that are to be removed and which of the pores **204** are to be maintained.
(26) As discussed above, the processor **102** may have accessed information that may include the identification of the locations of the pores **204** in the screen device **202** and the locations of the openings **214** in the main body **210**. According to examples, the processor **102** may identify the pores **204** that are to be removed from the screen device **202** based on relative locations of the

pores **204** in the screen device **202** with respect to circumferences of the openings **214** projected from the main body **210** toward the screen device **202** when the screen device **202** is positioned on the main body **210**, for instance, as shown in FIG. **2**A.

(27) By way of a particular non-limiting example, the processor **102** may determine that a pore **204** is to be removed from the screen device **202** based on an entire perimeter of the pore **204** being within the projected circumference of an opening **214** of the main body **210**. As shown in FIG. **2**B, pore **204***a* may match this example. As another non-limiting example, the processor **102** may determine that a pore **204** is to be removed from the screen device **202** based on a center of the pore **204** overlapping a portion of the projected circumference of an opening **214** of the main body **210**. As shown in FIG. **2**B, pore **204***b* may match this example. As a further non-limiting example, the processor **102** may determine that a pore **204** is to be removed from the screen device **202** based on a center of the pore **204** being outside of the projected circumference of an opening **214** of the main body **210**, while a portion of the pore **204** is within the projected circumference of the opening **214**. As a yet further non-limiting example, the processor **102** may determine that a pore **204** is to be removed from the screen device **202** based on an entire perimeter of the pore **204** being outside of the projected circumference of an opening **214** of the main body **210**. In this example, the processor **102** may determine that the pore **204** is to be removed based on the perimeter of the pore **204** being within a certain distance to the projected circumference of the opening **214**.

(28) In other examples, however, the processor **102** may determine that a pore **204** that is not completely within the projected circumference of an opening **214** is not to be removed. In yet other examples, the processor **102** may make pore removal determinations based on other criteria, such as, for instance, a density of pores **204** within a given location, sizes of the pores **204**, flow characteristics of liquid through the pores **204**, and/or the like. In a particular example, the processor **102** may maintain some of the pores that are positioned entirely within the projected circumference of the opening **214** while removing some or all of the pores **204** that are adjacent to the maintained pores **204**.

(29) The processor **102** may determine which of the rules to follow in determining which pores **204** to remove based on any of a number of manners. For instance, the processor **102** may apply a first rule to remove some of the pores **204** and a screen device **202** with the removed pores **204** may be fabricated. A test may be performed on the screen device **202** to determine the flow properties of the liquid through screen device **202**. This process may be repeated for a number of different pore removal configurations to determine the pore removal configuration that may result in the highest level of liquid flow uniformity across the screen device **202**. In some examples, the tests may be performed empirically on fabricated screen devices **202**, while in other examples, the tests may be performed through use of modeling techniques, such as through implementation of computational fluid dynamics modeling.

(30) In some examples, the processor **102** may determine whether removal of a pore **204** from the screen device **202** causes a shortest distance between nearest neighboring pores **204** of the removed pore **204** to exceed a predefined distance threshold. In some instances in which the gap between pores **204** is relatively large, the lack of liquid flow at an area of the gap on the screen device **202** may result in material elements **224** failing to collect on the area. As a result, a thinner section of material elements **224** may form on the area, and may thus require a greater length of time for the material elements **224** to form into the part.

(31) In order to prevent the thinner sections from forming on the screen device **202**, the processor **102** may determine whether removal of the pore **204** may cause a gap in the pores **204** that may be sufficiently large to cause an area of smaller thickness material elements **224** to form on the screen device **202**. The predefined distance threshold may be based upon, for instance, sizes of the material elements **224**, the concentration of material elements **224** in the slurry **220**, the amount of vacuum pressure applied through the screen device **202**, and/or the like. In addition, the predefined distance threshold may be determined through physical testing, modeling, and/or the like.

(32) In any regard, based on a determination that removal of the pore **204** causes a shortest distance between nearest neighboring pores **204** of the removed pore **204** to exceed the predefined distance threshold, the processor **102** may maintain the pore **204** in the screen device **202**.
(33) According to examples, the processor **102** may access information about the pillars **206** that may provide a channel **208** between the screen device **202** and the main body **210**. The processor **102** may access the information about the pillars **206** from the information about the screen device **202**. That is, for instance, the pillars **206** may be part of the screen device **202** and the information about the screen device **202** may include information about the pillars **206**. In other examples, the pillars **206** may be part of the main body **210** and the information about the main body **210** may include information about the pillars **206**. In yet other examples, the information about the pillars **206** may be separate from both the information about the screen device **202** and the main body **210**.
(34) In any regard, the processor **102** may identify, from the accessed information about the pillars **206**, pillars **206** that are to be removed or moved from their stated locations. The identification of which pillars **206** to remove or move may be made to increase uniformity of liquid flow **222** through the pores **204** across the screen device **202**. That is, some of the pillars **206** may be positioned at locations at which the pillars **206** may restrict the flow of the liquid in the channel **208** as compared with other locations and removal of those pillars **206** may increase the liquid flow **222** at those locations. Additionally or alternatively, the channel **208** may include locations where the liquid flow **222** is higher than other locations and movement of the pillars **206** from the lower flow locations to the higher flow locations may result in the flow at the locations being more uniform with respect to each other. A result of the more uniform liquid flow **222** through the locations of the channel **208** may be that liquid flow **222** through the pores **204** near those locations may also be more uniform.
(35) The processor **102** may determine which of the pillars **206** to remove or move through implementation of empirical testing and/or computer modeling. For instance, liquid flow **222** characteristics through the channel **208** resulting from removal or movement of some of the pillars **206** may be determined and a determination may be made as to the uniformity of liquid flow **222** through the pores **204** across the screen device **202**. Additional liquid flow **222** characteristics through the channel **208** resulting from the removal or movement of others of the pillars **206** may be determined and determinations may be made as to the uniformity of liquid flow **222** through the pores **204** across the screen device **202**. Moreover, a determination may be made as to which removal and/or movement of the pillars **206** resulted in the greatest increase in the uniformity of liquid flow **222** through the pores **204** across the screen device **202**. The processor **102** may remove and/or move those pillars **206**.
(36) By way of particular non-limiting example, the processor **102** may remove all of the pillars **206** that extend directly above an opening **214**. In addition, or alternatively, the processor **102** may remove a certain number of the pillars **206** and may arrange the remaining pillars **206** to be equidistant from each other.
(37) According to examples, the processor **102** may determine whether removal or movement of a pillar **206** causes a shortest distance between nearest neighboring pillars **206** of the removed or moved pillar **206** to exceed a predefined span threshold. In some instances in which the span of the screen device **202** between pores **204** is relatively large, the screen device **202** may be bowed toward the main body **210** at the span, which may restrict liquid flow **222** at that section. This may result in a greater deviation in liquid flow at that section as compared with other locations in the channel **208**.
(38) In order to prevent spans of the screen device **202** between the pillars **206** from bowing to an extent that may affect liquid flow **222** through the channel **208**, the processor **102** may determine whether removal or movement of the pillar **206** may cause a span to be sufficiently large to cause the span to bow beyond some predefined level. The predefined span threshold may be based upon, for instance, the thickness of the screen device **202**, the material or materials from which the screen

device **202** is fabricated, the amount of vacuum pressure applied through the screen device **202**, and/or the like. In addition, the predefined span threshold may be determined through physical testing, modeling, and/or the like.

(39) In any regard, based on a determination that removal or movement of the pillar **206** causes a shortest distance between nearest neighboring pillars **206** of the removed or moved pillar **206** to exceed the predefined span threshold, the processor **102** may maintain the pillar **206**.

(40) According to examples, the processor **102** may identify the pores **204** to be removed and the pillars **206** to be removed or moved concurrently with each other. That is, for instance, the processor **102** may identify combinations of pores **204** and the pillars **206** that may be removed to increase (and/or maximize) uniformity of liquid flow **222** through the pores **204** across the screen device **202**. The processor **102** may identify the combination of pores **204** and pillars **206** to remove through empirical testing and/or modeling of different combinations of pore **204** and pillar **206** removals.

(41) The processor **102** may execute the instructions **118** to modify the accessed information about the screen device **202** to remove the identified pores **204** from the screen device **202**. For instance, the processor **102** may modify or update the information about the screen device **202** to remove the identified pores **204** identified in the accessed information. As such, when the screen device **202** is fabricated using the information about the screen device **202**, the removed pores **204** may not be formed in the screen device **202**. In examples in which the information about the screen device **202** is included as comma separated values, the processor **102** may delete the entries corresponding to the removed pores **204** from the comma separated values.

(42) The processor **102** may also modify the accessed information about the pillars **206** to remove or move the identified pillars **206**. For instance, the processor **102** may modify or update the information about the pillars **206** to remove or move the pillars **206** identified in the accessed information. As such, when the screen device **202** is fabricated using the information about the screen device **202**, the removed pillars **206** may not be formed in the screen device **202** and the moved pillars **206** may be formed at the moved positions on the screen device **202**. In examples in which the information about the pillars **206** is included as comma separated values, the processor **102** may delete the entries corresponding to the removed pillars **206** from the comma separated values and may add entries corresponding to the moved pillars **206** in the comma separated values.

(43) An example of the screen device **202** with some of the pores **204** and some of the pillars **206** removed is depicted in FIG. **2**C. As shown in FIG. **2**C, the liquid flow **222** may differ from the liquid flow **222** depicted in FIG. **2**B. Particularly, for instance, the liquid flow **222** through the pores **204** in FIG. **2**C may be more uniform across the screen device **202**.

(44) According to examples, the processor **102** may cause a three-dimensional (3D) fabrication system to fabricate the screen device **202** according to the information about the screen device **202**. In some examples, the processor **102** may also cause the 3D fabrication system **300** to fabricate the main body **210** to have openings **214** according to the information about the main body **210**. An example of a suitable 3D fabrication system **300** that may be employed to fabricate the screen device **202**, and in some examples, the main body **210**, is depicted in FIG. **3**. It should be understood that the example 3D fabrication system **300** depicted in FIG. **3** may include additional features and that some of the features described herein may be removed and/or modified without departing from the scope of the 3D fabrication system **300**.

(45) The build material particles **302** may be formed into a build material layer **304** on a build platform **306** during fabrication of the screen device **202**, and in some examples, the main body **210**. The build material particles **302** may include any suitable material for use in forming 3D objects, for instance, a polymer, a plastic, a ceramic, a nylon, a metal, combinations thereof, or the like, and may be in the form of a powder or a powder-like material. As shown, the 3D fabrication system **300** may include a recoater **308**, which may spread, spray, or otherwise form the build material particles **302** into a build material layer **304** as the recoater **308** is moved across the build

platform **306** as indicated by the arrow **310**. According to examples, the build platform **306** may provide a build area for the build material particles **302** to be spread into successive layers **304** of build material particles **302**. The build platform **306** may be movable in a direction away from the recoater **308** during formation of successive build material layers **304**.
(46) According to examples, the 3D fabrication system **300** may include decks **312**, **314** from which build material particles **302** may be supplied for formation into build material layers **304**. For instance, the deck **312** may supply an amount of build material particles **302** on top of the deck **312** that the recoater **308** may push over the build platform **306** as the recoater **308** is moved across the build platform **306** as denoted by the arrow **310** to form a build material layer **304** on the build platform **306** or on a previously formed build material layer **304**.
(47) As shown, the processor **102** may control operations of the recoater **308**. In other examples, however, the 3D fabrication system **300** may include a separate controller (not shown) that may control operations of the recoater **308** in which the processor **102** may communicate with the controller. The processor **102** and/or the controller **320** may control other components of the 3D fabrication system **300**. For instance, the 3D fabrication system **300** may include fabrication components **330** and the memory **110** may have instructions that the processor **102** or controller may execute to control the fabrication components **330**. Particularly, the processor **102** or controller may control the fabrication components **330** to cause the build material particles **302** at selected locations of the build material layer **304** to be bound and/or fused together to form the pillars **206** of the screen device **202** in the build material layer **304**.
(48) The fabrication components **330** may include an agent delivery device that the processor **102** may control to selectively deliver an agent onto the build material layer **304**. For instance, the processor **102** may control the agent delivery device to deliver a fusing agent onto the selected locations of the build material layer **304** that are to be bound/fused together to form the pillars **206**. By way of particular example, the agent delivery device may be a printhead having a plurality of nozzles in which droplet ejectors, e.g., resistors, piezoelectric actuators, and/or the like, may be provided to eject droplets of an agent through the nozzles.
(49) According to examples, the agent may be a fusing and/or a binding agent to selectively bind and/or solidify the build material particles **302** on which the agent has been deposited. In particular examples, the agent may be a chemical binder, a thermally curable binder, and/or the like. In other particular examples, the agent may be a fusing agent that may increase the absorption of energy to selectively fuse the build material particles **302** upon which the agent has been deposited. The fabrication components **330** may also include another agent delivery device that the processor **102** may control to selectively deliver another type of agent onto the build material layer **304**. The other type of agent may be a detailing agent, which may inhibit or prevent fusing of build material particles **302** upon which the detailing agent has been deposited, for example by modifying the effect of a fusing agent.
(50) The fabrication components **330** may also include an energy source that may apply energy, e.g., warming energy, onto the build material layer **304**, for instance, to warm the build material particles **302** in the build material layer **304** to an intended temperature. The energy source may output energy, e.g., in the form of light and/or heat and may be supported on a carriage, which may be movable across the build platform **306**. As such, for instance, the energy source may output energy onto the build material layer **304** as the carriage is moved across the build platform **306** to cause the build material particles **302** upon which the fusing agent has been deposited to melt and subsequently fuse together. In other examples, the screen device **202** may be formed through implementation of another fabrication technique. For instance, the screen device **202** may be formed through selective laser ablation, selective laser melting, stereolithography, fused deposition modeling, and/or the like.
(51) Reference is now made to FIGS. **4** and **5**A-**5**B, which respectively depict flow diagrams of example methods **400**, **500** for identifying pores **204** that are to be removed from a screen device

202 to increase uniformity of liquid flow through the pores **204** across the screen device **202**. It should be understood that the methods **400**, **500** depicted in FIGS. **4** and **5**A-**5**B may include additional operations and that some of the operations described therein may be removed and/or modified without departing from the scopes of the methods **400**, **500**. The descriptions of the methods **400**, **500** are also made with reference to the features depicted in FIGS. **1-3** for purposes of illustration. Particularly, the processor **102** may execute some or all of the operations included in the methods **400**, **500**.

(52) At block **402**, the processor **102** may access information about a screen device **202** having attributes that are to form matching attributes on a part, in which the part is to be formed from a slurry **220** composed of a liquid and material elements **224**. As discussed herein, the information about the screen device **202** may include information about pores **204** in the screen device **202**. At block **404**, the processor **102** may access information about a main body **210** having openings **214** that are larger than the pores **204** in the screen device **202**, in which the main body **210** is to support the screen device **202** during formation of the part. The information about the main body **210** may include about the openings **214**.

(53) At block **406**, the processor **102** may identify, based on the accessed information about the screen device **202** and the main body **210**, pores **204** in the screen device **202** that are to be removed to increase uniformity of liquid flow **222** through the pores **204** across the screen device **202**. In addition, at block **408**, the processor **102** may modify the accessed information about the screen device **202** to remove the identified pores **204** from the screen device **202**.

(54) Turning now to FIGS. **5**A and **5**B, at block **502**, the processor **102** may access information about pores **204** in a screen device **202** and openings **214** in a main body **210**. At block **504**, the processor **102** may determine relative locations of the pores **204** and the openings **214**. At block **506**, the processor **102** may identify a pore **204** that is to be removed from the screen device **202**, for instance, based on the relative locations of the pores **204** with respect to circumferences of the openings projected from the main body **210** toward the screen device **202** when the screen device **202** is positioned on the main body **210**.

(55) At block **508**, the processor **102** may determine whether removal of a pore **204** from the screen device **202** causes a shortest distance between nearest neighboring pores **204** of the removed pore **204** to exceed a predefined distance threshold. Based on a determination that removal of the pore **204** causes a shortest distance between nearest neighboring pores **204** of the removed pore **204** to exceed the predefined distance threshold, at block **510**, the processor **102** may maintain the pore **204** in the screen device **202**. In addition, the processor **102** may identify another pore **204** that is to be removed at block **506** and may repeat blocks **508-510**.

(56) However, at block **508**, based on a determination that removal of the pore **204** does not cause a shortest distance between nearest neighboring pores **204** of the removed pore **204** to exceed the predefined distance threshold, at block **512**, the processor **102** may modify the accessed information about the pores **204** in the screen device **202** to remove the pore **204**. In addition, at block **514**, the processor **102** may determine whether there is an additional pore **204** that is to be considered for removal. Based on a determination that there is an additional pore **204** that is to be removed, the processor **102** may identify the pore **204** at block **506** and may repeat blocks **506-514** until the processor **102** determines that there are no additional pores **204** for consideration for removal.

(57) Based, however, on a determination that there are no additional pores **204** for consideration for removal at block **514**, at block **516** (FIG. **5**B) the processor **102** may access information about pillars **206** that are to provide a channel **208** between the screen device **202** and the main body **210**. At block **518**, the processor **102** may identify, from the accessed information about the pillars **206**, a pillar **206** that is to be removed or moved to increase uniformity of liquid flow through the pores **204** across the screen device **202**. At block **520**, the processor may determine whether removal or movement of a pillar **206** causes a shortest distance between nearest neighboring pillars **206** of the

removed or moved pillar **206** to exceed a predefined span threshold. Based on a determination that removal of the pillar **206** causes a shortest distance between nearest neighboring pillars **206** of the removed or moved pillar **206** to exceed the predefined span threshold, at block **522**, the processor **102** may maintain the pillar **206**.

(58) However, based on a determination that removal of the pillar **206** does not cause the shortest distance between nearest neighboring pillars **206** of the removed or moved pillar **206** to exceed the predefined span threshold, at block **524**, the processor **102** may modify the accessed information about the pillars **206** to remove or move the pillars **206** identified to be removed or moved. In addition, at block **526**, the processor **102** may determine whether there is an additional pillar **206** that is to be considered for removal or movement. Based on a determination that there is an additional pillar **206** that is to be removed or moved, the processor **102** may identify the pillar **206** at block **518** and may repeat blocks **518-526** until the processor **102** determines that there are no additional pillars **206** for consideration for removal.

(59) Based on a determination that there are no additional pillars **206** that are to be removed or moved, the processor **102** may end the method **500**. In some examples, however, at block **528**, the processor **102** may control fabrication components **330** to fabricate the screen device **202** with the removed pores **204** and the removed and/or moved pillars **206**.

(60) According to examples, instead of separately identifying and removing the pores **204** and the pillars **206**, the processor **102** may identify and remove pores **204** and pillars **206** concurrently with each other.

(61) Some or all of the operations set forth in the methods **400** and **500** may be contained as utilities, programs, or subprograms, in any desired computer accessible medium. In addition, the methods **400** and **500** may be embodied by computer programs, which may exist in a variety of forms. For example, the methods **400** and **500** may exist as machine-readable instructions, including source code, object code, executable code or other formats. Any of the above may be embodied on a non-transitory computer readable storage medium.

(62) Examples of non-transitory computer readable storage media include computer system RAM, ROM, EPROM, EEPROM, and magnetic or optical disks or tapes. It is therefore to be understood that any electronic device capable of executing the above-described functions may perform those functions enumerated above.

(63) Turning now to FIG. **6**, there is shown a block diagram of a computer-readable medium **600** that may have stored thereon computer-readable instructions for identifying pores **204** and pillars **206** that are to be removed from a screen device **202** to increase uniformity of liquid flow through the pores **204** across the screen device **202**. It should be understood that the computer-readable medium **600** depicted in FIG. **6** may include additional instructions and that some of the instructions described herein may be removed and/or modified without departing from the scope of the computer-readable medium **600** disclosed herein. The computer-readable medium **600** may be a non-transitory computer-readable medium, in which the term “non-transitory” does not encompass transitory propagating signals.

(64) The computer-readable medium **600** may have stored thereon machine-readable instructions **602-608** that a processor, such as the processor **102** depicted in FIG. **1**, may execute. The computer-readable medium **600** may be an electronic, magnetic, optical, or other physical storage device that contains or stores executable instructions. The computer-readable medium **600** may be, for example, Random Access memory (RAM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), a storage device, an optical disc, and the like.

(65) The processor may fetch, decode, and execute the instructions **602** to access information about a screen device **202** having pores **204** and pillars **206**, in which the screen device **202** is to be employed to filter liquid from a slurry **220** composed of the liquid and material elements **224** to form a part from the material elements **224**. The processor may fetch, decode, and execute the instructions **604** to access information about a main body **210**, in which the main body **210** is to

support the screen device **202** during formation of the part. The main body **210** may have a plurality of openings **214** that are larger than the pores **204** in the screen device **202**. The processor may fetch, decode, and execute the instructions **606** to identify, based on relative locations of the pores **204** and the openings **214**, pores **204** and pillars **206** that are to be removed from the screen device **202** to increase uniformity of liquid flow **222** through the pores **204** across the screen device **202**. In addition, the processor may fetch, decode, and execute the instructions **608** to modify the accessed information about the screen device **202** to remove the identified pores **204** and pillars **206** from the screen device **202**.

(66) The processor may also fetch, decode, and execute instructions to determine whether removal of a pore **204** from the screen device **202** causes a shortest distance between nearest neighboring pores **204** of the removed pore **204** to exceed a predefined distance threshold and, based on a determination that removal of the pore **204** causes a shortest distance between nearest neighboring pores **204** of the removed pore **204** to exceed the predefined distance threshold, maintain the pore **204** in the screen device **202**. The processor may further fetch, decode, and execute instructions to determine whether removal of a pillar **206** causes a shortest distance between nearest neighboring pillars **106** of the removed pillar **106** to exceed a predefined span threshold and based on a determination that removal of the pillar **206** causes a shortest distance between nearest neighboring pillars **206** of the removed pillar **206** to exceed the predefined span threshold, maintain the pillar **206**.

(67) Although described specifically throughout the entirety of the instant disclosure, representative examples of the present disclosure have utility over a wide range of applications, and the above discussion is not intended and should not be construed to be limiting, but is offered as an illustrative discussion of aspects of the disclosure.

(68) What has been described and illustrated herein is an example of the disclosure along with some of its variations. The terms, descriptions and figures used herein are set forth by way of illustration and are not meant as limitations. Many variations are possible within the scope of the disclosure, which is intended to be defined by the following claims—and their equivalents—in which all terms are meant in their broadest reasonable sense unless otherwise indicated.

Claims

1. An apparatus comprising: a processor; and a memory on which is stored instructions that when executed by the processor, cause the processor to: access information about a screen device having pores, wherein the screen device is to be employed to filter liquid from a slurry composed of the liquid and material elements to form a part from the material elements; access information about a main body, wherein the main body is to support the screen device during formation of the part and has a plurality of openings that are larger than the pores in the screen device; identify, based on relative locations of the pores and the openings, pores that are to be removed from the screen device to increase uniformity of liquid flow through the pores across the screen device; modify the accessed information about the screen device to remove the identified pores from the screen device in the modified information; and ultimately cause a 3D fabrication system to fabricate the screen device in accordance with the modified information.

2. The apparatus of claim 1, wherein the instructions cause the processor to: identify the pores that are to be removed from the screen device based on relative locations of the pores in the screen device with respect to circumferences of the openings projected from the main body toward the screen device when the screen device is positioned on the main body.

3. The apparatus of claim 2, wherein the instructions cause the processor to: determine that a pore is to be removed from the screen device based on: an entire perimeter of the pore being within the projected circumference of an opening of the main body; a center of the pore overlapping a portion of the projected circumference of an opening of the main body; and/or a center of the pore being

outside of the projected circumference of an opening of the main body while portion of the pore is within the projected circumference of the opening.
4. The apparatus of claim 2, wherein the instructions cause the processor to: maintain pores that are positioned entirely within the projected circumferences of the opening while removing pores that are adjacent to the maintained pores.
5. The apparatus of claim 2, wherein the instructions cause the processor to: determine whether removal of a pore from the screen device causes a shortest distance between nearest neighboring pores of the removed pore to exceed a predefined distance threshold; and based on a determination that removal of the pore causes a shortest distance between nearest neighboring pores of the removed pore to exceed the predefined distance threshold, maintain the pore in the screen device.
6. The apparatus of claim 1, wherein the instructions cause the processor to: access information about pillars that are to provide a channel between the screen device and the main body; identify, from the accessed information about the pillars, pillars that are to be removed or moved to increase uniformity of liquid flow through the pores across the screen device; and modify the accessed information about the pillars to remove or move the pillars identified to be removed or moved.
7. The apparatus of claim 6, wherein the instructions cause the processor to: determine whether removal or movement of a pillar causes a shortest distance between nearest neighboring pillars of the removed or moved pillar to exceed a predefined span threshold; and based on a determination that removal or movement of the pillar causes a shortest distance between nearest neighboring pillars of the removed or moved pillar to exceed the predefined span threshold, maintain the pillar.
8. A method comprising: accessing, by a processor, information about a screen device having attributes that are to form matching attributes on a part, wherein the part is to be formed from a slurry composed of a liquid and material elements, the information about the screen device including information about pores in the screen device; accessing, by the processor, information about a main body having openings that are larger than the pores in the screen device, wherein the main body is to support the screen device during formation of the part; identifying, by the processor and based on the accessed information about the screen device and the main body, pores in the screen device that are to be removed to increase uniformity of liquid flow through the pores across the screen device; modifying, by the processor, the accessed information about the screen device to remove the identified pores from the screen device; and fabricating, by a 3D fabrication system, the screen device in accordance with the modified information.
9. The method of claim 8, further comprising identifying the pores that are to be removed from the screen device based on relative locations of the pores in the screen device with respect to circumferences of the openings projected from the main body toward the screen device when the screen device is positioned on the main body.
10. The method of claim 8, further comprising: determining whether removal of a pore from the screen device causes a shortest distance between nearest neighboring pores of the removed pore to exceed a predefined distance threshold; and based on a determination that removal of the pore causes a shortest distance between nearest neighboring pores of the removed pore to exceed the predefined distance threshold, maintaining the pore in the screen device.
11. The method of claim 8, further comprising: accessing information about pillars that are to provide a channel between the screen device and the main body; identifying, from the accessed information about the pillars, pillars that are to be removed or moved to increase uniformity of liquid flow through the pores across the screen device; and modifying the accessed information about the pillars to remove or move the pillars identified to be removed or moved.
12. The method of claim 11, further comprising: determining whether removal or movement of a pillar causes a shortest distance between nearest neighboring pillars of the removed or moved pillar to exceed a predefined span threshold; and based on a determination that removal of the pillar causes a shortest distance between nearest neighboring pillars of the removed or moved pillar to exceed the predefined span threshold, maintaining the pillar.

13. A non-transitory computer-readable medium on which is stored computer-readable instructions that when executed by a processor, cause the processor to: access information about a screen device having pores and pillars, wherein the screen device is to be employed to filter liquid from a slurry composed of the liquid and material elements to form a part from the material elements; access information about a main body, wherein the main body is to support the screen device during formation of the part and has a plurality of openings that are larger than the pores in the screen device; identify, based on relative locations of the pores and the openings, pores and pillars that are to be removed from the screen device to increase uniformity of liquid flow through the pores across the screen device; modify the accessed information about the screen device to remove the identified pores and pillars from the screen device; and ultimately cause a 3D fabrication system to fabricate the screen device in accordance with the modified information.

14. The non-transitory computer-readable medium of claim 13, wherein the instructions cause the processor to: determine whether removal of a pore from the screen device causes a shortest distance between nearest neighboring pores of the removed pore to exceed a predefined distance threshold; and based on a determination that removal of the pore causes a shortest distance between nearest neighboring pores of the removed pore to exceed the predefined distance threshold, maintain the pore in the screen device.

15. The non-transitory computer-readable medium of claim 13, wherein the instructions cause the processor to: determine whether removal of a pillar causes a shortest distance between nearest neighboring pillars of the removed pillar to exceed a predefined span threshold; and based on a determination that removal of the pillar causes a shortest distance between nearest neighboring pillars of the removed pillar to exceed the predefined span threshold, maintain the pillar.