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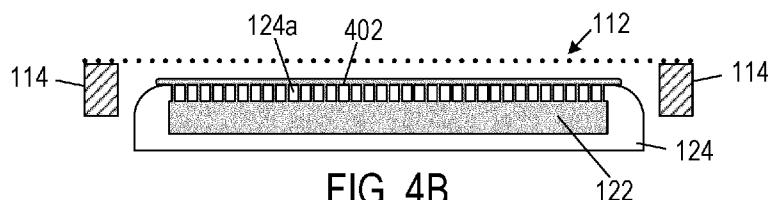


FIG. 4B

(57) Abstract: A direct to mesh (DtM) screen printer for creating a screen stencil is provided. The DtM screen printer includes a fixture to hold a frame, which holds a pre-stretched mesh in place during application of a jettable emulsion, a platen having a cavity and an array of holes in a top surface of the platen and is located against one side of the pre-stretched mesh, a printer carriage supporting a print head for printing the jettable emulsion on a side of the pre-stretched mesh opposite the platen, and release fluid dispensed from the array holes between the mesh and the platen, the release fluid enabling the jettable emulsion to encapsulate strands of the mesh.



PROCESS AND DIRECT TO MESH SCREEN PRINTER FOR STENCIL CREATION

BACKGROUND

5 [0001] Screen printing is a printing technique whereby a mesh is used to transfer ink onto a substrate, except in areas made impermeable to the ink by a screen printing stencil, also called a blocking stencil. A blade or squeegee is moved across the screen to fill the open mesh apertures with ink, and a reverse stroke then causes the screen to touch the substrate momentarily along a line of contact. This
10 causes the ink to wet the substrate and be pulled out of the mesh apertures as the screen springs back after the blade has passed.

[0002] The creation of a screen printing stencil is a tedious, labor-intensive job. It is one that requires many process steps, chemical products, lots of water, and is largely manual. It is the least automated part of the current screen printing
15 business.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] Features of examples of the present disclosure will become apparent by reference to the following detailed description and drawings, in which like
20 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.

[0004] FIG. 1A illustrates a direct to mesh screen printer, according to
25 an example of the present disclosure.

[0005] FIG. 1B illustrates a general formal of an oxirane compound.

[0006] FIG. 2A illustrates top plan view of a platen, a frame, and a
fixture.

[0007] FIGS. 2B-2C illustrate cross-sectional views of the platen, frame,
30 and fixture shown in FIG. 2A.

[0008] FIG. 3 shows a top plan view of platen and top and bottom plates
of the platen.

[0009] FIGS. 4A-4H depict elements of processes in screen printing, using a direct to mesh screen printer.

[0010] Figures 5A-5F show plan views of depositing and curing a jettable emulsion to create an example stencil of a bus.

5 [0011] Figures 6A-6F show plan views of depositing and curing a jettable emulsion to create an example stencil of a bus.

[0012] FIG. 7 shows a cross-sectional view of capillary behavior of a release fluid to aid with encapsulation of strands (or threads) of a mesh by the emulsion.

10 [0013] FIG. 8 shows a release fluid control system, according to an example of the present disclosure.

[0014] FIG. 9 shows a release fluid control system, according to an example of the present disclosure.

15 [0015] FIG. 10 shows a release fluid control system, according to an example of the present disclosure.

[0016] FIG. 11 is a flow chart illustrating a process of screen printing, according to an example of the present disclosure.

DETAILED DESCRIPTION

20 [0017] There are several examples of previous solutions for directly coating a mesh to form a stencil for screen printing. These are now described.

Mesh Preparation and Coating:

25 [0018] Direct application of emulsion: this is done either with a machine or by hand. Both sides of the screen must be coated with the emulsion to ensure proper coverage. The machine or automated version is strictly a machine replacing a human. The machine is much more accurate at applying precise amounts of the emulsion and getting even coverage. The machine generally has less waste.

30 [0019] Capillary films: These are films that are pre-coated with an emulsion. The mesh is oversaturated with water and the film (emulsion side down) is placed against the supersaturated mesh. The capillary action draws the emulsion into the mesh. This gives a more precise coating of the emulsion, both in thickness and in cover. Once the emulsion has diffused into the mesh, the film is peeled off.

[0020] Once the screen mesh is emulsified it must be dried. Once dry, it is ready for the image transfer or making of the stencil. As the emulsion dries, it contracts and conforms to the mesh causing a rough, uneven surface. (This rough surface causes an accelerated aging of the squeegee during the printing process.)

5 [0021] Most emulsions today are activated by ultra-violet (UV) radiation (i.e., UV-activated) but may also be visible-light activated. Once coated, the stencils must be protected from any exposure to light (even normal visible light has enough UV to start the curing process). Hereinafter, it is assumed that the emulsion is UV-activated/cured.

10 [0022] Film Positive Ink: A totally black, UV absorbent layer is printed onto a clear sheet of plastic. The printing is done normally by laser or inkjet printers with special film positive inks (film positive ink means a high opacity black ink that completely blocks all visible and UV light). The film is then attached to the pre-coated mesh and exposed to UV light. The attachment is usually by a removable tape (such
15 as masking tape). Once exposed, the film is removed and the uncured emulsion is washed off.

[0023] However, this approach is very labor intensive at all stages, and it is not possible to automate many steps. In addition, it is prone to error, such as during mounting the film, using the correct film, adjusting the final stencil before print.
20 Lots of chemicals and washing, as well as lots of consumables (inks, films), are required.

[0024] Thermal Screen: In this method, the mesh is pre-coated with a thermally-activated emulsion. Typically, the mesh (without a frame) is put into a thermal printer, where the emulsion is directly cured/activated. Once completed, the
25 un-exposed emulsion is washed off, the stencil is mounted on a frame, and printed.

[0025] However, this approach suffers from limited mesh counts. Also, the emulsions are typically not as robust. The pre-treated mesh is expensive. The stencil alignment is more intensive. Finally, the stencil can be damaged while it is being
30 mounted.

Computer to Screen (CtS):

[0026] CtS – Printed: In this method, the image is directly printed onto the emulsified screen with a high-opacity black ink. This is similar to Film Positive Inks without the film. All of the processes are the same.

5 [0027] However, these machines require a high-opacity ink, which is more expensive than regular inkjet inks.

[0028] CtS – Wax: This method is a close relative of CtS – Printed, but uses wax to block the UV light. All else is the same.

[0029] However, due to the use of melted wax, these machines can be temperamental. Further, they require that the wax be heated to apply it to the mesh.

10 [0030] CtS – Direct Exposure: This technology directly exposes the emulsion using a UV laser.

[0031] However, the machines used in this technology are typically very expensive. Further, the process does not work as well on coarse grade mesh. Finally, UV lasers are still very expensive when they need replacing.

15 [0032] Each of the above methods require some post-processing/follow-up. Except for Thermal Activated and CtS Direct Exposure, all stencils must be exposed after the image blocking is applied (either films or CtS Printed and Wax). This process takes, for example, at least about 1 to 2 minutes per screen with an intense developer.

20 [0033] All screens must have the excess emulsion washed off. Care must be taken so that the emulsion does not get into the drainage system. Screens must be thoroughly dried after washing.

[0034] For the Film and Thermal Activated methods, the finished stencil must be fine adjusted when placed on the carousel to ensure proper registration.

25 Current Disclosure:

[0035] It is clear from the foregoing description of the current technology that a simpler approach that uses fewer chemicals and less water would be desirable.

30 [0036] FIG. 1A depicts a block diagram of the direct to mesh (DtM) printer 100. The DtM printer 100 includes a mesh support system 110 that includes the pre-stretched mesh 112 held in place by the frame 114. The frame 114 is in turn held by the fixture 116. The fixture 116 securely and firmly holds the frame 114 with the pre-stretched mesh 112 in place during the application of the jettable emulsion.

[0037] As used herein, the mesh 112 is made of connected strands of textiles, strand, metal, or other flexible/ductile materials, here, woven in a crisscross pattern. The material comprising the mesh may be any of a number of textiles including silks; polyesters; metals, such as stainless steel; plastics, such as polypropylene, polyethylene, nylon, polyvinyl chloride (PVC) or polytetrafluoroethylene (PTFE); or strandglass. The diameter of the strands may be any diameter common in screen printing, and the mesh size may also be any size common in screen printing. Coarser mesh is typically woven with larger diameter (gauge) strands, which requires a thicker application of the emulsion.

[0038] The DtM printer 100 further includes a platen support system 120, including a release fluid 122 held against the underside of the pre-stretched mesh 112 by a platen 124. The platen 124 provides a smooth flat surface for the release fluid 122 to be held firmly and evenly against the bottom of the pre-stretched mesh 112. The platen 124 includes a surface that is perforate with holes, is smooth, and is resistant to dents and cracks. The platen 124 includes a cavity for storing the release fluid 122 that is forced through the holes to coat the surface of the platen 124 located beneath the mesh. The platen 124 may also act to dissipate energy from a UV curing source 208 (not shown in FIG. 1A but shown in FIG. 2D).

[0039] The platen 124 maintains the level of the release fluid 122 below and in contact with the mesh 112. The array of holes in the perforated top surface ensures that the mesh 112 is evenly coated by the release fluid 122. A release fluid control system is used to control penetration of the release fluid 122 into the mesh 122 and may be used to maintain an essentially constant release fluid moisture level of the mesh 112 throughout printing of the emulsion onto the mesh.

[0040] The release fluid 122 may be applied onto the mesh 112 once the mesh 112 is in position over the platen 124 prior to the application of the jettable emulsion. For example, a release fluid control system 126 controls the level of the release fluid 122 injected from the cavity onto the surface of the platen 124. In particular, the release fluid control system 126 controls the level of the release fluid disposed on the surface of the platen 124 such that the meniscus of the release fluid and the capillary action of the release fluid enable the emulsion to wrap around the threads in the mesh.

[0041] The release fluid 122 inhibits dot-gain, which is the effect of a printed fluid spreading into a print medium, by not reacting with the curing emulsion. Dot-gain need only be inhibited for a short period, as curing of the emulsion occurs quickly after the emulsion fluid is jetted on to the mesh 112.

5 [0042] Finally, the DtM printer 100 includes an inkjet printer 130 that includes a print head 132 mounted on a printer carriage 134. The print head 132 prints the jettable emulsion on the side of the pre-stretched mesh 112 opposite to that of the platen 124. The printer carriage 134 is a high-precision printer carriage, accurate in both the X and Y Cartesian directions to support accurate droplet placement over one
10 or more passes while building up the jettable emulsion. Indeed, the emulsion can be “built up” to accommodate a wide range of mesh gauges, from very fine to super coarse. The layering can be used to maintain high resolution as it builds up the emulsion.

[0043] The print head 132 may be an inkjet print head, such as thermal inkjet,
15 piezoelectric inkjet, drop-on-demand inkjet, or other suitable jetting printhead capable of jetting fluids, including the jettable emulsion disclosed herein.

[0044] The screen mesh 112, which may be of any type, is stretched onto the frame 114. The frame 114 is put into the inkjet printer 130 with the release fluid 122 which has been dispensed onto a surface of the platen 124 below the mesh
20 112. The jettable emulsion is then applied by the inkjet printer 130 to the masking areas and substantially simultaneously exposed with high intensity UV lamps or other suitable UV source, such as UV-light emitting diodes (LEDs). The wavelength of the UV lamp (or LED) may be tuned to the reaction range of the jettable emulsion for optimal performance. For the jettable emulsion disclosed herein, the emulsion reacts
25 at a wavelength of 395 nanometers (nm). Other jettable emulsions may have other reaction wavelengths, including lower than 395 nm. For coarse mesh, the application may be a multi-pass operation in order to build up the necessary emulsion thickness. By “coarse mesh” is meant mesh having a loose weave, and thus having larger gaps between the strands than a fine mesh screen. Mesh counts are given as either tpi
30 (threads per inch) or T (threads per centimeter). For example, 335tpi (130T) mesh count is considered to be fine mesh, while 110tpi (43T) mesh count is considered to be a coarse mesh, where mesh count is the number of thread crossings per square inch. 110tpi (43T) is most commonly used for general textile printing.

[0045] The Direct to Mesh process disclosed herein is made possible with the recent development of low viscosity jettable emulsions. By “low viscosity” is meant a range from about 4 centipoises (cP) to about 15 cP (about 4 millipascal second to about 15 millipascal second). These jettable emulsions are used to create an embossing effect with UV printers onto a wide variety of materials. These new jettable emulsions are also more elastic, so they can be used more readily as a replacement for previous emulsions. Any color can be used for the jettable emulsion, including transparent or clear, although light cyan, light magenta, or purple may be used to provide a slight contrast in order to verify the stencil.

[0046] An example of a jettable emulsion that may be suitably employed in the process disclosed herein is a UV-activated acrylate monomer with elastomeric qualities after curing. The jettable emulsions are specialty embossing “varnish” polymers that quickly cure into both highly durable / resistant layers that quickly build up on the substrate. The cured polymer is also durable and flexible/elastic (if it were rigid, it would crack easily under use and render the stencil useless).

[0047] The release fluid 122 provides a smooth, non-reactive printing surface under the mesh 112. Dot gain occurs when a jetted droplet (or a dot of emulsion) expands or spreads out horizontally before exposure to the UV light source (i.e., UV curing described below). This is particularly important when a half tone is employed, i.e., less than the entire space in the mesh is filled with emulsion. Dot gain expands the surface area of the emulsion applied to the mesh 112 beyond the intended surface area. The release fluid 122 is formulated as described below to limit dot gain of the printed emulsion and to enable encapsulation of the strands of the mesh 112.

[0048] The release fluid 122 is formulated to limit the dot gain, facilitate wet emulsion encasement of strands of the mesh 112 strands, and is non-reactive with the curing emulsion so that the release fluid 122 does not lift or separate the emulsion from the mesh 112. In other words, the release fluid 122 prevents the emulsion from overspreading after application and does not react with the emulsion to create other compounds or dissolve the emulsion. The release fluid 122 is composed of water 128 and a wetting agent 130. The water 128 is desalinated water or condensate water with an electrical conductance less than about 30 μ S (microsiemens). In other words, the water 128, prior to combining with the wetting agent 130 is substantially free of

minerals and salts. The release fluid 122 can be produced by adding the wetting agent 130 to the water 128. The wetting agent 130 causes the wet emulsion to encapsulate the strands or threads of the mesh 112 prior to exposure to the UV light.

[0049] In one implementation, the wetting agent 130 is composed of 2,4,7,9-Tetramethyl-5-decyne 4,7-diol (“tetramethyldec”). In another implementation, the wetting agent 130 is composed of tetramethyldec combined with alcohol and/or an oxirane compound. For example, the wetting agent 130 can be tetramethyldec alone, tetramethyldec combined with alcohol, tetramethyldec combined with an oxirane compound, or a combination of tetramethyldec, alcohol, and an oxirane compound.

[0050] The alcohol of the wetting agent 130 can be methanol, ethanol, propanol, butanol, or pentanol, which include isomers of propanol, butanol, or pentanol. For example, the propanol can be 1-propanol and 2-propanol (isopropanol). The butanol can be 1-butanol, 2-butanol, tert-butanol, and isobutanol. The pentanol can be 1-pentanol, 2-pentanol, 3-pentanol, 2-methyl-1-butanol, 3-methyl-1-butanol, 2-methyl-2-butanol, 2-methyl-3-butanol, and 2,2-dimethylpropanol. The alcohol of the wetting agent 130 can be composed of a combination of different alcohols. For example, the alcohol of the wetting agent 130 can be composed of propanol and butanol. Alternatively, the alcohol of the wetting agent 130 can be composed of a combination of ethanol, propanol, and butanol. Alternatively, the alcohol of the wetting agent 130 can be composed of a combination of methanol, ethanol, propanol, and pentanol.

[0051] The oxirane (i.e., epoxide) compound of the wetting agent 130 can be ethylene oxide (C_2H_4O) or another oxirane compound. Oxirane compounds are composed a three-membered ring consisting of one oxygen atom bonded to two carbon atoms that form the functional group of the oxirane compounds. The two carbon atoms of the functional group can be bonded groups of atoms that represent the rest of compound. Figure 1B shows the functional group of a general oxirane compound, where R1, R2, R3, and R4 represent groups of atoms bonded to carbon atoms of the functional group. For example, with ethylene oxide (C_2H_4O) R1, R2, R3, and R4 represent four hydrogen atoms. Alternatively, R1, R2, and R3 can represent three hydrogen atoms and R4 can represent a hydrocarbon chain. Alternatively, R1, R2, and R3 can represent different substituents bonded to the carbon atoms of the functional group.

[0052] In another implementation, the wetting agent 130 is an alcohol-free compound. For example, the wetting agent can be Hydropalat® WE 3650, which is a low foaming wetting agent that contains a fatty alcohol alkoxylate substituent. The ratio of the wetting agent WE 3650 to water 128 in liters ranges from about 1/400 to about 3/2000. For example, about 20 – 30 mL of the wetting agent WE 3650 is added to about 20 L of water 128.

[0053] In another implementation, the wetting agent 130 is a polysiloxane or a polydimethylsiloxane. Examples of polysiloxanes include BYK-347, BYK-333, BYK-375, BYK-346, and BYK-345. The co-solvent dipropylene glycol monomethylether can be used with the polysiloxane BYK-345. The ratio of the wetting agent 130 to water 128 in liters ranges from about 1/4000 to 1/200. For example, about 5 – 10 mL of the wetting agent BYK-346 is added to about 20 L of water 128.

[0054] Note that the jettable emulsion may also include the wetting agent 130 as an additive to increase encapsulation of the strands. In one implementation, the jettable emulsion and the release fluid 122 contain the same wetting agent 130. For example, the wetting agent 130 can be added to the release fluid 122 and to the emulsion in approximately equal amounts.

[0055] In most preparations in the current art, the emulsion can be quite rough; this is often caused by conformance of the emulsion to the mesh during the drying process. This rough emulsion surface can wear away at the squeegee, requiring resurfacing or replacing of the squeegee blade. In the Direct to Mesh process, however, when the jettable emulsion is built up in the mesh, the release fluid 122 ensures encapsulation of the mesh strands see, for example, FIG. 7 and the associated discussion below.

[0056] Since the emulsion applied to the mesh 112 is only in a blocking area, there is essentially little risk of over-shoot or over-exposure from reflection of the UV light into masked areas. This provides a much smoother, cleaner image. (These over-shoot and over-exposure areas can create spots or drops inside the image, especially around the edges. These are the “inverse” of pin holes.)

[0057] Examples of platens are depicted in FIGS. 2A-3.

[0058] In FIG. 2A, a platen 124 is disposed on a fixture 116 and is surrounded by a frame 114. The fixture 114 may include clamps (not shown) that hold the frame 114 and the platen 124 in place during printing. Dashed lines 202 and 204

identify internal walls that separate four internal cavities 206-209 of the platen 124. In general, the walls, such as walls 202 and 204, are for controlling the flow of the release fluid inside of the platen 124. FIG. 2B shows a cross-sectional view of the platen 124, fixture 116, and frame 114 in the direction indicated by line A-A. The cross-sectional view reveals the cavities 206 and 207 separated by a wall 204. The cross-sectional view also shows that the top surface 210 of the platen 124 is perforated with holes 212 that lead to the cavities 206 and 207. Inserts may be added to the cavities to reduce the volumes of the cavities and aid in even distribution of the release fluid within each cavity. FIG. 2C shows a cross-sectional view of the platen 124, fixture 116, and frame 114 in the direction indicated by line A-A with inserts 214 and 216 located within the internal cavities 206 and 207, respectively. The inserts 214 and 216 may be made of non-woven cloth (such as Pelon®), open core foam, plastic, or wood. The inserts 214 and 216 reduce the release fluid volume and to equalize the fluid pressure in the cavity. In other implementations, the platen 124 has fewer than four interval cavities. For example, the platen 124 may have one interval cavity.

[0059] Each cavity of the platen 124 has an input port and may have an output port. In certain implementations, the platen 124 may have only input ports and no outputs. Output ports may be included to control the flow of the release fluid and drain the release fluid when the platen 124 is no longer in use. When output ports are not included, the input ports are bi-directional in order to quickly lower the release fluid level. The platen 124 also comprises a top plate and a bottom plate.

[0060] In FIG. 3, the platen 124 is separated into a top plate 302 and a bottom plate 304. FIG. 3 shows the input ports 306a-306d located along the long sides of the bottom plate 304 and the output ports 308a-308d located along the short sides of the bottom plate 304. Directional arrows 310a-310d represent the inflow of the release fluid into the cavities 206-209 through the input ports 306a-306d. Directional arrows 312a-312d shows the outflow of the release fluid from the cavities 206-209 through the output ports 308a-308d. Magnified view 314 shows the input port 306c located in the long side of the bottom plate 304. In other implementations, the output ports may be located along the long sides of the bottom plate 304 and the input ports may be located along the short sides of the bottom plate 304. In still other implementations, the input ports 306a-306d and/or the output ports 308a-308d may be located in the underside of the bottom plate 304. Magnified view 316 shows an

example of the input port 306c located underneath the cavity 208 of the bottom plate 304.

[0061] Input and output ports may be barbed fittings made of metal or plastic. For example, a straight, barbed fittings may be used for the input and output ports located along the long and short sides, or edges, of the bottom plate 304. Alternatively, barbed L-shaped fittings may be use for underside mounts.

[0062] It should be noted that the bottom plate 304 is not limited to four cavities. In other implementations, the bottom plate 304 may be includes a single cavity with multiple input and output ports (e.g., the walls 202 and 204 may be omitted). In other implementations, the bottom plate 304 may have two cavities, each cavity having at least one input port and at least one output port. In still other implementations, the bottom plate 204 may have six or more cavities, each cavity having at least one input port and at least one output port.

[0063] In FIG. 3, the top plate 302 is perforated with an array of holes that extend the thickness of the top plate. Magnified view 318 shows the top surface of the top plate 302. Holes 212 located in the top plate 302 allow for passage of the release fluid. The top plate 302 of the platen 124 provides a smooth, hard flat surface. When release fluid is dispensed into the cavities 206-209 and emerges through the array of holes 212, the distribution of holes 212 in the top plate 302 allows the release fluid to evenly coat the top surface of platen 124 and gently pushes mesh 112 taut to ensure an even, flat surface upon which to apply the emulsion. By “smooth” is meant that the surface of the plate 302 is a polished/glossy or frosted/matte as long as the surface is regular.

[0064] Example steps of the Direct to Mesh (DtM) process using the platen 124 are depicted in FIGS. 4A-4H, which include cross-sectional views of the DtM apparatus and the platen 124.

[0065] In FIG. 4A, frame 114 surrounds platen 124. The fixture 116 for supporting the frame 114 is omitted in this figure and in FIGS. 4B-4H. The frame fixture 116 is similar to what is currently used in the art. The release fluid 122 fills the cavities of the platen 124 and emerges through the holes 212 to form a release fluid layer 402 on a top surface 124a of the platen 124. Examples of release fluid control systems for dispensing the release fluid into the cavities of the platen 124 and onto the top surface 124a of the platen 124 are described below with reference to FIGS. 6 and 7.

[0066] In FIG. 4B, mesh 112 is placed over the top of the frame 114. The platen 124 is located below the mesh 112 with a thin, even release fluid layer 402 of the release fluid 122 supported on surface 124a of platen 124. In some embodiments, the thickness of the release fluid 122 is about 20 micrometers (μm), but in any event less than the gauge of the mesh and is within $\pm 0.5 \mu\text{m}$ planarity. The release fluid 122 backs up the mesh 112 to provide good coverage of the jettable emulsion, as it is applied. The release fluid 122 is formulated to avoid adherence of the jettable emulsion to the platen 124. The formulation of the release fluid 122 prevents the emulsion from bonding, reacting, or otherwise sticking to the platen 124. In some cases, the emulsion may react with the release fluid 122, but that interaction/reaction typically may not allow any adhesion to the platen 124. If the adhesion to the platen 124 is greater than the adhesion to the mesh 112, then the emulsion may de-bond / delaminate from the mesh. This may cause pin holes or bare patches. In the worst case, it could cause the mesh to be damaged or to tear.

[0067] In FIG. 4C, the platen 124 with the release fluid layer 402 is moved up to the mesh 112, tightening the mesh 112 and pressing the underside of mesh 112 into the release fluid layer 402. This provides a smooth, tensioned, level surface to print the emulsion on. The movement of the platen 124 is indicated by arrows 404. Alternatively, frame 114 with the mesh 112 attached may be moved downward with the underside of the mesh 112 pressed into the release fluid layer 402.

[0068] In FIG. 4D, the print head 132, which is translatable by the printer carriage 134 (not shown in FIG. 4D, but shown in FIG. 1A) prints (i.e., deposits the jettable emulsion) the blocking image, or stencil, 406 directly onto the mesh 112, where the blocking image is the reverse, or negative, of the actual image that is to be printed, or screened, onto a suitable print medium. The print head 132 moves laterally in a direction indicated by arrow 408 to form a screen stencil 406 on the mesh 112. The print head 132 dispenses the UV-curable jettable emulsion described above. While the print head 132 deposits the jettable emulsion in the first direction 408, the UV source 410 may be turned "on" or "off." In the example of Figure 4D, the UV source 410 is turned "off." In another implementation where the UV source 410 precedes the print head 132, the UV source 410 may be left "on" while the print head 132 trails behind the UV source 410 to deposit the jettable emulsion.

[0069] The print head 132 and UV source 410 deposit and cure the jettable emulsion in a raster scan pattern above the mesh 122. When deposition of the jettable emulsion in the first direction 408 is complete along a path, the print head 132 is turned “off” to stop deposition of the jettable emulsion. While the print head 132 is turned off, the UV source 410 retravels behind the print head 132 along the same path previously traveled by the print head 132 and emits UV light that cures the previously wet jettted emulsion. In other words, the raster scanning techniques described below traverse each path of the raster scan twice. During the first traversal of a path, the jettable emulsion is applied to the mesh 112 as the print head 132 travels the path. Once the first traversal is complete, a second traversal of the path is performed with the print head 132 turned “off” (i.e., no deposition of the jettable emulsion) and the UV source 410 turned “on,” thereby illuminating the wet emulsion applied to the mesh 112 with UV light that cures the emulsion as the UV source 410 traverses the path.

[0070] In one implementation, the UV source 410 travels in the opposite direction along the same path previously traveled by the print head 132 to cure the jettable emulsion. In Figure 4E, the UV source 410 travels in the opposite direction indicated by arrow 414 across the same path previously traveled by the print head 132 during deposition of the jettable emulsion. While the UV source 410 travels in the direction 414, the UV light emitted from the UV source 410 cures the jettable emulsion that was previously deposited by the print head 132 along the path. This process is repeated for each path of the raster scan traveled by the print head 132, thereby creating the stencil 406.

[0071] Figure 4F shows a top view of the mesh 112 and paths of a raster scan traversed by the print head 132 and the UV source 410 to create a stencil as described above with reference to Figures 4D and 4E. Solid lines, such as line 416, represent placement of the printer carriage 134 and paths of a raster scan that are traversed by the print head 132 and the UV source 410. Note that return paths that reset the print head 132 and the UV source 410 to next path of the raster scan are omitted. Long dash arrows, such as long dash arrow 418, represent the process of depositing wet jettable emulsion along the paths with the print head 132 turned “on.” If the UV source 410 precedes the print head 132 while the print head 132 deposits the jettable emulsion along the path in the direction 418 the UV source may be turned “on” or “off.” If the UV source 410 trails behind the print head 132 while the print head

132 deposits the jettable emulsion along the path in the direction 418, the UV source is turned “off” to avoid immediate curing of the jettable emulsion. Short dash arrows, such as short dash arrow 420, represent curing the wet jettable emulsion by traversing the same paths in the opposite direction with the print head 132 turned “off” and the
5 UV source 410 turned “on.”

[0072] In another implementation, the UV source 410 cures the wet jettable emulsion by traveling the same path and in the same direction previously traveled by the print head 132. In Figure 4G, the jettable emulsion has been deposited on the mesh 122 with the UV source 410 turned “off” as described with reference to
10 Figure 4D. In this implementation, when the UV source 410 and the print head 132 reach the end of the path just traveled, the print head 132 is turned “off” and the UV source 410 and print head 132 are reset to the beginning of the path. The UV source 410 is turned “on” and the UV source 410 and print head 132 travel in the direction 408 across the same path previously traveled during deposition of the wet jettable
15 emulsion as described above with reference to Figure 4D. While the UV source 410 travels in the direction 408, the UV light emitted from the UV source 410 cures the jettable emulsion that was previously deposited by the print head 132, thereby creating the stencil 406.

[0073] Figure 4H shows a top view of the mesh 112 and paths of a raster scan traversed by the print head 132 and the UV source 410 in creating a stencil as
20 described above with reference to Figures 4D and 4G. Solid lines, such as line 416, represent placement of the printer carriage 134 and paths of a raster scan that are traversed by the print head 132 and the UV source 410. Note that return paths that reset the print head 132 and the UV source 410 to next path of the raster scan are
25 omitted. Long dash arrows, such as long dash arrow 418, represent the process of depositing wet jettable emulsion along a path with the print head 132 turned “on” and the UV source turned “off.” In this implementation, short dash arrows, such as short dash arrow 422, represent curing the wet jettable emulsion by resetting the UV source 410 and the print head 132 to traverse the same paths in the same directions
30 previously traversed by the print head 132 but with the print head 132 turned “off” and the UV source 410 turned “on.”

[0074] Figures 5A-5F show plan views of depositing and curing a jettable emulsion to create an example stencil of a bus as described above with

reference to Figures 4D-4F. In Figures 5A-5E, the print head 132 is represented by a square and the UV source 410 is represented by a circle. The printer carriage 134 that supports the print head 132 and the UV source 410 and directs the print head 132 and the UV source 410 to traverse the mesh 112 is not shown. The color black is used to identify when either the print head 132 or the UV source 410 is turned "on." The color white is used to identify when either the print head 132 or the UV source is turned "off." In Figure 5A, the print head 132 is turn "on" and the UV source 410 is turned "off." The print head 132 deposits (i.e., prints) the jettable emulsion 502 on the mesh 112 as the UV source 410 and the print head 132 traverses a first path in the direction 408. Wet jettable emulsion is represented by dark shaded area 502. In Figure 5B, the UV source 410 and the print head 132 have completed deposition of the wet jettable emulsion 502 on the mesh 112 along the first path. In this implementation, after completing deposition along the first path, the UV source 410 is turned "on" and the print head 132 is turned "off" to stop deposition of the jettable emulsion. In Figure 5C, the UV source 410 and the print head 132 reverse direction and travel back along the first path in the opposite direction 414. As the UV source 410 travels in the direction 414, UV light emitted from the UV source 410 cures the emulsion as represented by light shaded area 504. In Figure 5D, curing of the jettable emulsion 504 along the first path is finished when the UV source 410 reaches the end of the first path. In Figure 5E, the printer carriage 134 is moved 506 to a second path. The UV source 410 is turned "off." The print head 132 is turn "on" as the print head 132 and the UV source 410 to deposit wet jettable emulsion 508 along the second path. The process of depositing wet jettable emulsion along a path with the print head 132 turned "on" and the UV source turned "off" followed by traversing the same path in the opposite direction with the print head 132 turned "off" and the UV source 410 turned "on" to cure the jettable emulsion is repeated for each path, as described above with reference to Figure 4F, until formation of the stencil is completed. Figure 5F shows the finished stencil 510 of a bus.

[0075] Note that in Figures 5A-5F, because the UV source 410 precedes the print head 132, the UV source 410 may also be turned "on" during entire process of depositing the jettable emulsion onto the mesh 112. In another implementation, the UV source 410 is positioned to trail behind the print head 132 as the print head 132 deposits the jettable emulsion. In this implementation, the UV

source 410 would be turned “off” while the print head 132 deposits the jettable emulsion to avoid immediately curing of the jettable emulsion. The UV source 410 would be turn “on” when the UV source 410 and the print head 132 reach the end of the path and traverse the same path in the opposite direction.

5 [0076] Figures 6A-6F show plan views of depositing and curing a jettable emulsion to create an example stencil of a bus as described above with reference to Figures 4D, 4G, and 4H. In Figures 6A-6E, the print head 132 is represented by a square and the UV source 410 is represented by a circle. The printer carriage 134 that supports the print head 132 and the UV source 410 and directs the
10 print head 132 and the UV source 410 to traverse the mesh 112 is not shown. The color black is used to identify when either the print head 132 or the UV source 410 is turned “on.” The color white is used to identify when either the print head 132 or the UV source is turned “off.” In Figure 6A, the print head 132 is turn “on” and the UV source 410 is turned “off.” The print head 132 deposits (i.e., prints) the jettable
15 emulsion 602 on the mesh 112 as the UV source 410 and the print head 132 traverses a first path in the direction 408. Wet jettable emulsion is represented by dark shaded area 602. In Figure 6B, the UV source 410 and the print head 132 have completed deposition of the wet jettable emulsion 502 on the mesh 112 along the first path. In this implementation, after completing deposition along the first path, the print head 132
20 is turned “off” to stop deposition of the jettable emulsion and the print head 132 and the UV source 410 are returned to the starting point of the first path. In Figure 5C, the UV source 410 is turned “on” and the print head 132 and the UV source 410 travel along the first path in the same direction 408. As the UV source 410 travels in the direction 408, UV light emitted from the UV source 410 cures the emulsion as
25 represented by light shaded area 604. In Figure 6D, curing of the jettable emulsion 604 along the first path is finished when the UV source 410 reaches the end of the first path. In Figure 6E, the printer carriage 134 is moved 606 to a second path. The UV source 410 is turned “off.” The print head 132 is turn “on” to deposit wet jettable emulsion 608 along the second path. The process of depositing wet jettable emulsion
30 along a path with the print head 132 turned “on” and the UV source turned “off” followed by resetting the print head 132 and the UV source to the start of the path and traversing the path in the same direction with the print head 132 turned “off” and the UV source 410 turned “on” to cure the jettable emulsion is repeated for each path, as

described above with reference to Figure 4H, until formation of the stencil is completed. Figure 6F shows the finished stencil 610 of a bus.

[0077] The stencil 406 created as described above has the advantage of being ready for use immediately after creation. For example, the conventional practice is to degrease the mesh using conventional degreasing techniques before stencil creation. By contrast, the stencil 406 is created as described above without degreasing the mesh beforehand and the stencil 406 can be removed from the printer and used immediately without any further preparation or treatment. With thicker emulsion coverage (e.g. greater than 20% emulsion over mesh) post process curing may be used to complete curing of the stencil.

[0078] In typical stencil creation processes, the UV source is turned "on" and trails behind the print head as the print head applies the emulsion to the mesh 112. As a result, the emulsion is immediately illuminated by UV light, which often cures the emulsion before the emulsion has had an opportunity to encapsulate the strands of the mesh. By contrast, the release fluid 122 and/or emulsion deposition and delay before curing processes described herein (see discussion of Figures 4D-4F and Figures 4D, 4G, and 4G) enable the emulsion more time to achieve a greater encapsulation of the strands of the mesh 112 before the emulsion is cured by illumination, which is an advantage over typical deposition processes. Note that by delaying illumination of the wet emulsion until after the print head 132 has completed deposition of the emulsion along a path, as described above with reference to Figures 4D-4F and Figures 4D, 4G, and 4G, the wet emulsion is allowed more time to cover a larger surface area of the strands of the mesh 112 than the typical process of illuminating immediately after the emulsion is applied. The advantage of illuminating the wet emulsion with the UV light after the jettable emulsion has been allowed time to obtain greater surface area coverage of the strands of the mesh 112 is that the resulting stencil formed from processes described herein is better able to resist wear and tear from repeated use and last much longer than traditional stencils used in the same manner but created with traditional techniques in which deposition of the emulsion is immediately followed by curing.

[0079] The amount of surface area of the strands of the mesh 112 covered by the emulsion prior to curing is facilitated by the wetting agent 130. In other words, the wetting 130 helps the emulsion to cover a larger surface area of the strands

of the mesh 112 than typical stencil creation processes that omit a wetting agent. The following Table displays various examples of wetting agents, example wetting agent concentrations, and resulting emulsion thicknesses on mesh strands:

Wetting Agent	Concentration (ml/L)	Emulsion thickness on mesh strands (microns)
Hydropalat WE 3650	1.5	8
BYK-346	0.5	11
96% ethanol	1.5	11
Hydropalat WE 3120	1.5	11
Acetone	1.5	12
BYK-346	1.5	15
None	0	14

5

With the exception of BYK-346 at a concentration of about 1.5 ml/L and distilled water alone (i.e., no wetting agent), the wetting agents listed in the table produced full to nearly full encapsulation of the mesh strands. Although the thickness of the emulsion is greater for BYK-346 at a concentration of 1.5 ml/L and distilled water alone (i.e.,
 10 None), BYK-346 at a concentration of 1.5 ml/L and distilled water alone are ineffective at encapsulation of mesh strands (i.e., lower surface area coverage) and lower wear resistance than the other wetting agents listed in the table. In other words, the emulsions are thicker because the BYK-346 at a concentration of 1.5 ml/L and distilled water alone do little to facilitate emulsion encapsulation of the mesh 112 strands. By
 15 contrast, the other wetting agents listed in the table produced thinner emulsion thickness and greater surface area coverage of the mesh 112 strands, with WE 3650 producing the best strand encapsulation. It should be noted that the concentrations listed in the table are examples of concentrations that were tested to measure emulsion thickness on mesh strands and observe the amount of surface area covered
 20 by the emulsion. Note that implementations described herein are not limited to the concentrations listed in the table.

[0080] In some embodiments, a top surface of the top plate of the platen may be coated with a UV reflective material, such as a mirror, clear glass, or white

polyethylene or another material to create reflection of the UV light upward to the emulsion coating the underside of mesh 112.

[0081] The process is called Direct to Mesh (DtM) to distinguish it from CtS (computer to screen), which requires additional processing both before (i.e., application of the emulsion) and after (washing off the unexposed emulsion and ink). In the DtM process, typically no additional processing is performed before and after application of the jettable emulsion, thus simplifying creation of the stencil 406.

[0082] FIG. 7 shows a cross-sectional view of capillary behavior of the release fluid layer 402 to aid with encapsulation of the strands (or threads) of the mesh 112 by the emulsion. The release fluid 122 fills the cavities of the platen 124 and emerges through the holes 212 to form release fluid layer 402 on a top surface 124a of the platen 124. Magnified view 702 shows enlarged cross-sectional view of strands 704 of the mesh 112 and the release fluid layer 402 shown in FIG. 4C. The release fluid has a meniscus and exhibits capillary action that causes the release fluid to fill in spaces between strands of the mesh 112. The combination of meniscus and capillary action of the release fluid enables the release fluid to facilitate encapsulation of the strands 704 of the mesh 112 by the emulsion 708 during printing described above with reference to FIG. 4D. Magnified view 706 shows the strands 704 of the mesh 112 encapsulated by the emulsion 708 to form the stencil 406 shown in FIG. 5F and 6F.

[0083] Examples of release fluid control systems 126 are depicted in FIGS. 8, 9, and 10. The release fluid control systems are used to maintain the amount and level of the release fluid in the release fluid layer 402.

[0084] In FIG. 8, an example release fluid control system is connected to platen 124 and fixture 116. In this example, the release fluid control system includes a fluid level tank 802 and a fluid distribution system formed from a flexible hose 804 connected at one end to the base of the fluid level tank 802 and at the other end to a pipe or hose 806 that is in turn connected to the cavity 122 of the platen 124 (e.g., through the side or bottom of the platen 124 as described above with reference to FIG. 3). The fluid level tank 802, fluid distribution system, and cavity of the platen 124 contain the release fluid. The vertical position of the fluid level inlet tank 804 may be maintained and controlled with a mechanical lift 810. The mechanical lift 810 may be, for example, a ratchet jack or a screw jack. The level of the release fluid in the fluid level inlet tank 804 may be monitored with a measuring device 812, such as a linear

encoder, that includes a mark 814 corresponding to a desired level of the release fluid layer 402 as represented by dot-dashed line 808. The mechanical lift 810 may be used to raise or lower the fluid level inlet tank 804. Atmospheric pressure and gravity are relied on to ensure that the amount of release fluid dispensed to form the release fluid layer 402 corresponds to the level, or height, of the release fluid in the fluid level inlet tank 802. The amount of release fluid in the release fluid layer 402 is controlled by raising or lowering the fluid level inlet tank 802. When the level of the release fluid in the fluid level inlet tank 804 is raised above the mark 814, such as by raising the fluid level inlet tank 804 using the mechanical lift 810, atmospheric pressure and gravity force additional release fluid into the release fluid layer 402. Alternatively, when the level of the release fluid in the fluid level inlet tank 804 is lowered below the mark 814, such as by lowering the fluid level inlet tank 804 using the mechanical lift 810, atmospheric pressure and gravity force the release fluid back through the fluid distribution system to raise the level of the release fluid in the fluid level inlet tank 804, which decreases the amount of release fluid in the release fluid layer 402 or causes the release fluid layer 402 to disappear. Release fluid control system shown in FIG. 8 provides a position accuracy of less than about 1mm, such as 0.8mm.

[0085] In FIG. 9, an example release fluid control system is connected to platen 124 and fixture 116. In this example, the release fluid control system includes a release fluid reservoir 902, a fluid level inlet tank 904, a level sensor 906, and an evacuation pump 908. The release fluid reservoir 902 contains a volume of release fluid 122. The rate at which the release fluid fills the fluid level inlet tank 904 is controlled with a control valve 912. The release fluid control system also includes a fluid distribution system comprising a network of fluid connectors 914a-914d. The fluid connectors may be a combination of pumps, pipes and/or hoses. Directional arrows 916a-916d represent the directions the release fluid may flow within the network of fluid connectors. Connector 914a transmits release fluid from the fluid level tank 904 to cavities of the platen 124 (e.g., through the bottom or side of platen 124 as described above with reference to FIG. 3). Connector 914b carries release fluid from connector 914a to evacuation pump 908. Connector 914c carries release fluid from the evacuation pump 908 back to the release fluid reservoir 902. Connector 914d may be included to carry excess release fluid from the platen 124 back to the release fluid

reservoir 902. Alternatively, the connector 914d may be omitted and the release fluid is allowed to drain away.

[0086] The fluid level inlet tank 904 is stationary. The level sensor 906 measures the level of the release fluid in the fluid level inlet tank 904 to ensure the level corresponds to a desired amount of release fluid in the release fluid layer 402. The level sensor 906 may be an ultrasonic sensor or an ultrasonic distance measuring sensor. The level sensor 906 may be accurate to within about 0.1 mm. The fluid volume metering at control valve 912 and evacuation pump 908 are used in combination to rapidly control changes to the level of the release fluid in the fluid level inlet tank 904 and corresponding changes in the amount of release fluid in the release fluid layer 402. Atmospheric pressure and gravity ensure that the amount of release fluid dispensed onto the top surface of platen 124 to form the release fluid layer 402 corresponds to the level of the release fluid in the fluid level inlet tank 904 as represented by dot-dashed line 918. For example, if the level of the release fluid in the fluid level inlet tank 904 is raised above the top surface of the platen 124 by, for example, adding more release fluid into the fluid level inlet tank 904, atmospheric pressure and gravity will force additional release fluid into the release fluid layer 402. Alternatively, if the level of the release fluid in the fluid level inlet tank 904 is lowered below the top surface of the platen 124 by, for example, using the evacuation pump 908, atmospheric pressure and gravity will force release fluid back through the connector 914a to raise the level of the release fluid in the fluid level inlet tank 904, which decreases the amount of release fluid in the release fluid layer 402 or causes the release fluid layer 402 to disappear.

[0087] In FIG. 10, an example release fluid control system is connected to a platen 124 and fixture 116 and is similar to the release fluid control system in FIG. 9. In this example, the release fluid control system includes a release fluid reservoir 1002, a fluid level inlet tank 1004 located within an overflow tank 1006 (i.e., catch basin), a level sensor 1008, and an evacuation pump 1010. The release fluid control system also includes a fluid distribution system comprising a network of fluid connectors 1012a-1012d. The fluid connectors may be a combination of pumps, pipes and/or hoses. Directional arrows 1014a-1014d represent the directions the release fluid may flow within the network of fluid connectors. End of fluid connector 1012a passes through an opening in the base of the overflow tank 1006 and an opening in

the base of the fluid level inlet tank 1004. A sealing ring 1016a is located between the opening in the fluid level inlet tank 1004 and the connector 1012a to prevent release fluid 122 from leaking into the overflow tank 1006. A sealing ring 1016b is located between the connector 1012a and the opening in the overflow tank 1006 to prevent the release fluid 122 from leaking out of the overflow tank 1006. The end of connector 1012a located within the fluid level inlet tank 1004 may include openings or may be perforated to allow the free flow of release fluid. The fluid level inlet tank 1004 may be raised or lowered using a mechanical lift 1018, such as a linear encoder or a screw jack. The evacuation pump 1010 is used to ensure that the level of the release fluid 122 in the overflow tank 1006 is lower than the level of the release fluid 122 in the fluid level inlet tank 1004 by pumping release fluid back to the release fluid reservoir 1002. Release fluid 122 is added to the fluid level inlet tank 1004 via control valve 1020. Alternatively, the connector 1012d may be omitted and the release fluid is allowed to drain away.

[0088] The level sensor 1008 measures the position of the fluid level inlet tank 1004 to ensure the level corresponds to a desired amount of release fluid in the release fluid layer 402. Unlike the release fluid control system in FIG. 9, the amount of release fluid in release fluid layer 402 is controlled by raising or lowering the fluid level inlet tank 1004 such that any excess fluid overflows the sides of the fluid level inlet tank 1004 in the overflow tank 1006. When the fluid level inlet tank 1004 is raised so that the level of the release fluid is above the level of the top surface of the platen 124, atmospheric pressure and gravity force release fluid into the release fluid layer 402. Alternatively, when the fluid level inlet tank 1004 is lowered so that the level of the release fluid in the fluid level inlet tank 1004 is below the level of the top surface of the platen 124, atmospheric pressure and gravity force the release fluid back through fluid distribution system to raise the level of the release fluid in the fluid level inlet tank 1004, which decreases the amount of release fluid in the release fluid layer 402 or causes the release fluid layer 402 to disappear.

[0089] The level sensor 1008 and the mechanical lift 1018 may be connected to a computer system (not shown) that receives a feedback signal from level sensor 1008 regarding the level of the fluid level inlet tank 1004. The computer system may electronically control the mechanical lift 1018 to raise or lower the fluid level inlet tank 1004.

[0090] Note that the release fluid control system shown in FIG. 9 relies on high precision and accuracy in controlling the level of the release fluid in the fluid level inlet tank 1004 to maintain the level of the release fluid layer 402. By contrast, the release fluid control system shown in FIG. 10 relies on high precision and accuracy in positioning the fluid level inlet tank 1004 to maintain the level of the release fluid layer 402.

[0091] FIG. 11 is a flow chart of an example DtM process 1100, in accordance with the disclosure herein, for preparing a stencil for screen printing. In the DtM process 1100, the direct to mesh printer 100 is provided 1101. As noted above, the DtM printer 100 includes the fixture 116 to hold the frame 114, the frame holds the pre-stretched mesh 112 in place during application of the jettable emulsion. The platen 124 of the DtM printer 100 has at least one cavity to hold the release fluid 122 and allow the release fluid to be dispensed through an array of holes in the top surface of platen 124 to form release fluid layer 402 against one side of the pre-stretched mesh 112. Finally, the DtM printer 100 includes the printer carriage 134 supporting the print head 132 for printing the jettable emulsion on the side of the pre-stretched mesh 112 opposite the platen 124.

[0092] The DtM process 1100 continues with placing 1102 the frame 114 in the fixture 116. The fixture 116 is part of the DtM printer 100 and is adapted to receive a wide variety of frame 114 sizes. The fixture 116 accurately holds the frame 114 in place, so that the printer carriage 134 is accurately registered to the mesh 112.

[0093] The DtM process 1100 continues with dispensing 1103 the release fluid 122 into the cavity of the platen 124 such that the release fluid passes through the holes in the perforate top surface of platen to form a release fluid layer 406 on the top surface. This may be important for very large stencils or very high dot density, such as 5,000 DPI, where the release fluid 122 might be consumed in the printing process or have time to evaporate even with a good emulsifier.

[0094] The DTM process 1100 continues with placing 1104 the mesh 112 into contact with the release fluid 122 in order to apply to the release fluid to the underside of the mesh 112. The top surface of the platen 124 is positioned even with or above the top surface of the frame. For example, the top surface of the platen 124 may exert little to no pressure on the mesh.

[0095] The DtM process 1100 continues with applying 1105 the jettable emulsion to the mesh 112 opposite the platen 124 along paths of a raster scan described above with reference to Figures 4F and 4H. As noted above, the jettable emulsion is applied relative to the mesh 112 by means of the inkjet printer 130, in which the inkjet print head 132 is to jet the jettable emulsion.

[0096] The DtM process 1100 concludes with curing 1106 the jettable emulsion using UV light emitted from the UV source after completing deposition of jettable emulsion along each path of the raster scan. A UV light source may be used to cure the jettable emulsion, such as an LED or a halogen lamp.

[0097] At the conclusion of the DtM process 1100, the stencil is formed and cured and is ready to be used to screen print colors onto an appropriate print surface, such as clothing, for example. In particular, the jettable emulsion after curing forms the screen stencil, in which openings in the screen stencil are to be used to print an image on the print surface.

[0098] It is appreciated that, in the foregoing description, numerous specific details are set forth to provide a thorough understanding of the examples. However, it is appreciated that the examples may be practiced without limitation to these specific details. In other instances, well-known methods and structures may not be described in detail to avoid unnecessarily obscuring the description of the examples. Also, the examples may be used in combination with each other.

[0099] While a limited number of examples have been disclosed, it should be understood that there are numerous modifications and variations therefrom. For example, the "orientation" of the printer bed/table may be changed from horizontal to vertical, due to new high / ultra-high velocity print head technologies that may permit jetting onto a vertical surface.

CLAIMS

1. A direct to mesh screen printer for creating a screen stencil, including:
a frame to hold a pre-stretched mesh in place during application of a jettable
5 emulsion;
a fixture to hold the frame;
a release fluid composed of water and a wetting agent;
a platen having a cavity and perforated top surface, the cavity holds the release
fluid dispensed through holes in the top surface and form a release fluid layer against
10 one side of the pre-stretched mesh;
a release fluid control system for dispensing the release fluid into the cavity of
the platen and form the release fluid layer; and
a printer carriage supporting a print head for printing the jettable emulsion on a
side of the pre-stretched mesh opposite the platen.
15
2. The direct to mesh screen printer of claim 1, wherein the wetting agent comprises
tetramethyldec and one or more of an alcohol and an oxirane compound.
3. The direct to mesh screen printer of claim 1, wherein the wetting agent comprises
20 one of WE 3650, a polysiloxane, and a polydimethylsiloxane.
4. The direct to mesh screen printer of claim 1, wherein the water has a conductivity
of less than 30 μ S.
- 25 5. The direct to mesh screen printer of claim 1, wherein the release fluid has a pH in a
range of about 8-10.
6. The direct to mesh screen printer of claim 1, wherein the jettable emulsion contains
the wetting agent of the release fluid.
30
7. A process, including:
a direct to mesh screen printer, including a fixture to hold a frame, which holds
a pre-stretched mesh in place during application of a jettable emulsion, a platen having

a cavity and an array of holes in a top surface of the platen and is located against one side of the pre-stretched mesh, a printer carriage that supports a print head that dispenses the jettable emulsion on a side of the pre-stretched mesh opposite the platen and a UV source that emits UV light that cures the jettable emulsion;

5 placing the frame in the fixture;

dispensing a release fluid composed of water, a wetting agent, and a salt into the cavity of the platen such that the release fluid passes through the holes to form a release fluid layer on a top surface of the platen;

10 bringing the platen and the mesh together such that the release fluid in the release fluid layer wets the underside of the mesh; and

for each path in a raster scan of the mesh, using the print head to deposit the jettable emulsion on the mesh while traversing a path for a first time and, after the jettable emulsion has been deposited on the mesh along the path, using the UV source to cure the jettable emulsion while traversing the path a second time.

15

8. The process of claim 7, wherein using the print head to deposit the jettable emulsion on the mesh while traversing the path for a first time and using the UV source to cure the jettable emulsion while traversing the path a second time comprises:

20 using the print head to deposit the jettable emulsion on the mesh while traversing the path in a first direction; and

using the UV source to cure the jettable emulsion while traversing the path in the opposite direction.

25 9. The process of claim 7, wherein using the print head to deposit the jettable emulsion on the mesh while traversing the path for a first time and using the UV source to cure the jettable emulsion while traversing the path a second time comprises:

using the print head to deposit the jettable emulsion on the mesh while traversing the path in a first direction; and

30 using the UV source to cure the jettable emulsion while traversing the path in the first direction.

10. The process of claim 7, wherein using the print head to deposit the jettable emulsion on the mesh while traversing the path for the first time comprises the UV source is turned off to prevent emission of the UV light.
- 5 11. The process of claim 7, wherein using the UV source to cure the jettable emulsion while traversing the path a second time comprises the print head is turned off to avoid deposition of the jettable emulsion while the UV source emits the UV light.
12. The process of claim 7, wherein the wetting agent comprises tetramethyldec and
10 one or more of an alcohol and an oxirane compound.
13. The process of claim 7, wherein the wetting agent comprises one of WE 3650, a polysiloxane, and a polydimethylsiloxane.
- 15 14. The process of claim 7, wherein the water has a conductivity of less than 30 μ S.
15. The process of claim 7, wherein the release fluid has a pH in a range of about 8-10.
- 20 16. The process of claim 7, wherein the jettable emulsion after curing forms a screen stencil, in which openings in the screen stencil are to be used to form an image on a surface.
17. The process of claim 7, wherein the release fluid inhibits dot-gain while not
25 adhering to the jettable emulsion following its curing.
18. The process of claim 7, wherein the jettable emulsion is a UV-activated acrylate monomer with elastomeric qualities after curing.
- 30 19. The process of claim 7, wherein the jettable emulsion contains the wetting agent of the release fluid.

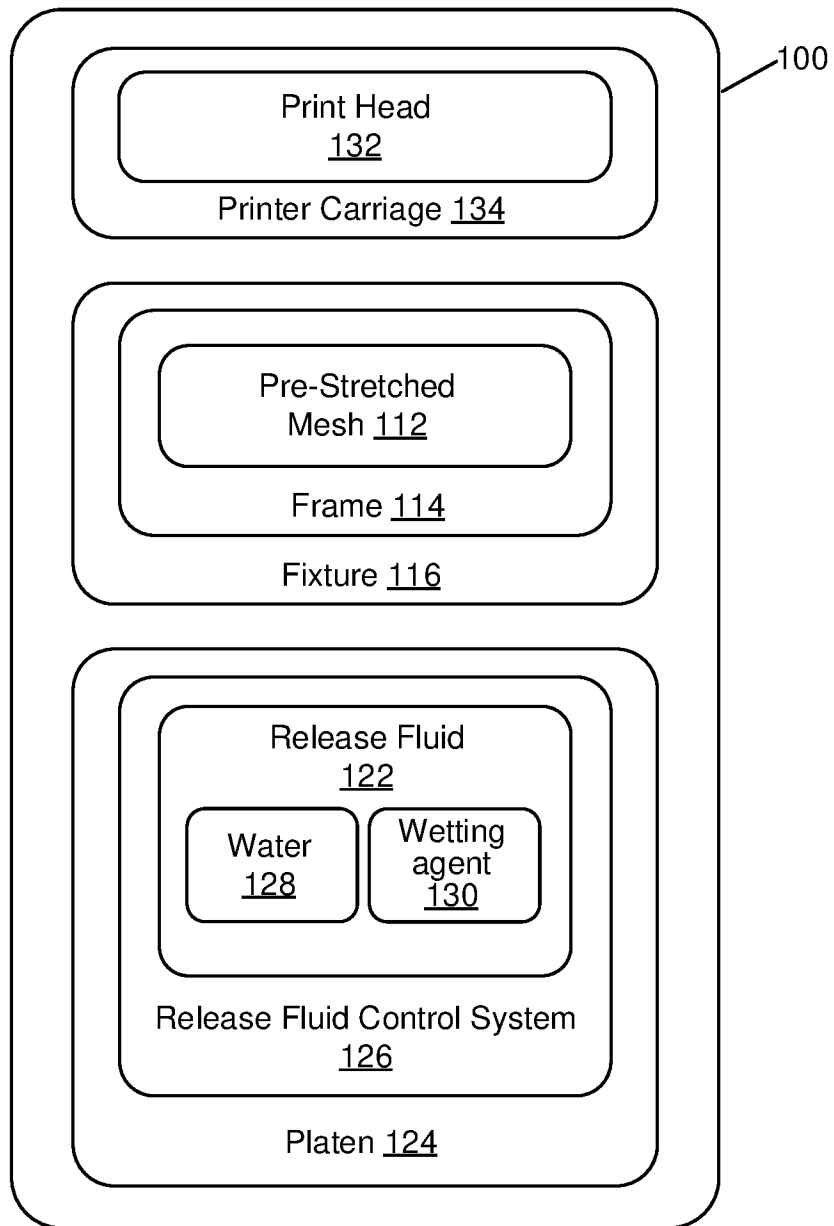


FIG. 1A

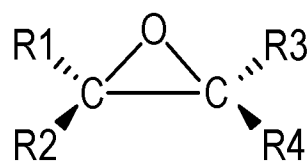


FIG. 1B

2/13

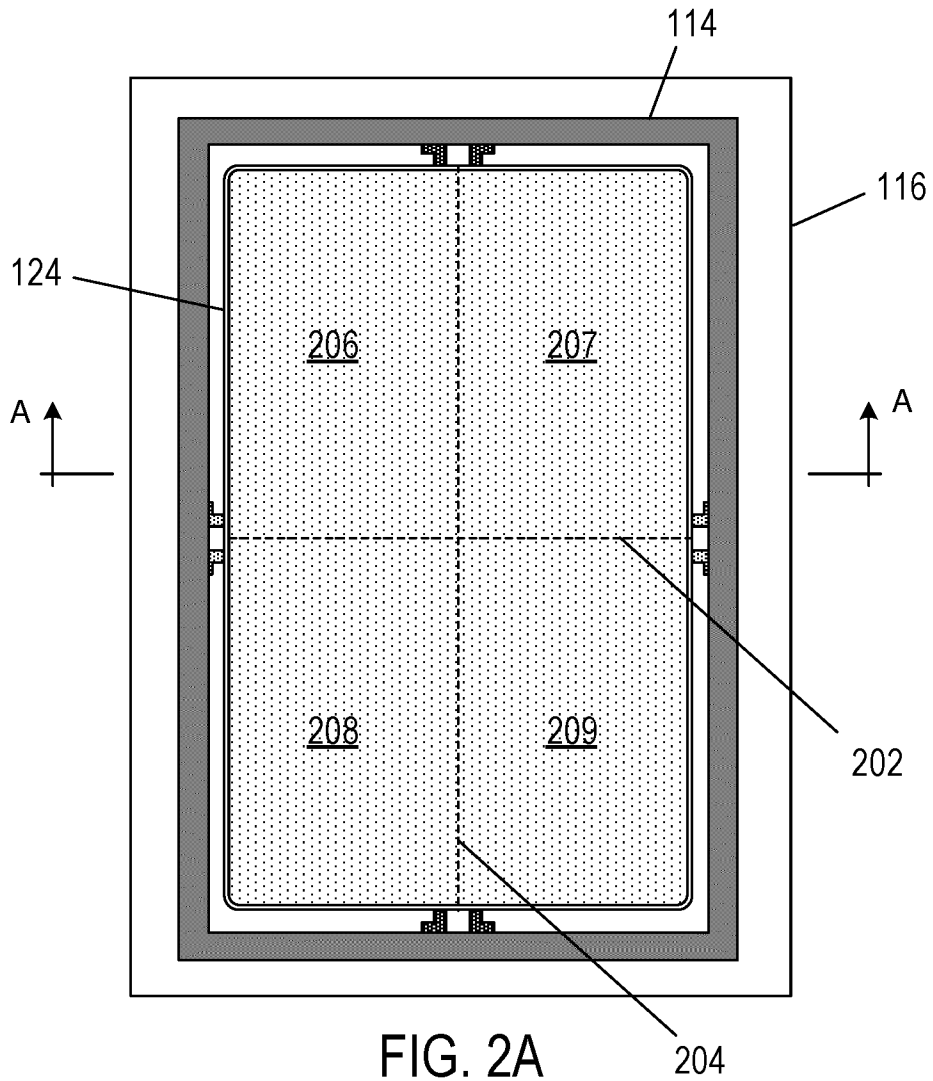


FIG. 2A

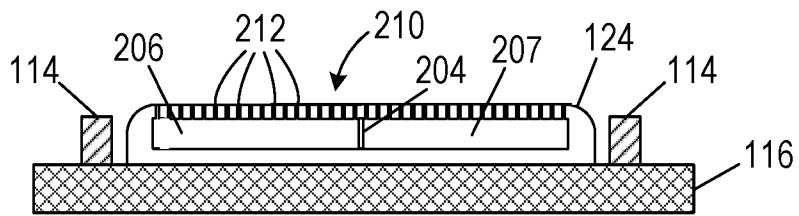


FIG. 2B

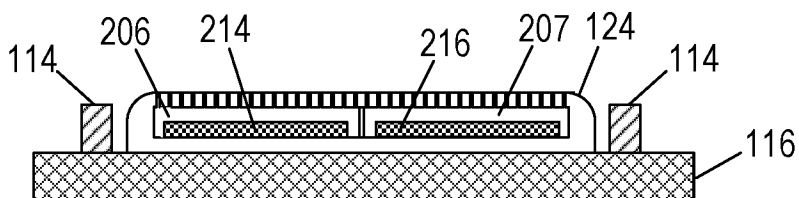


FIG. 2C

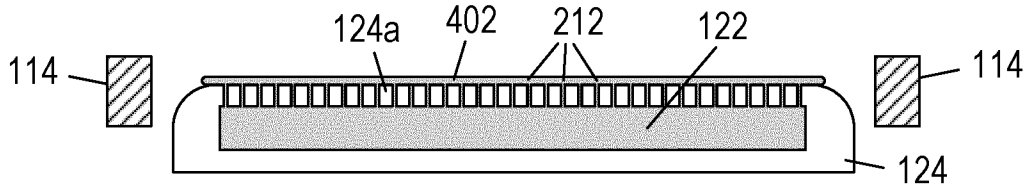


FIG. 4A

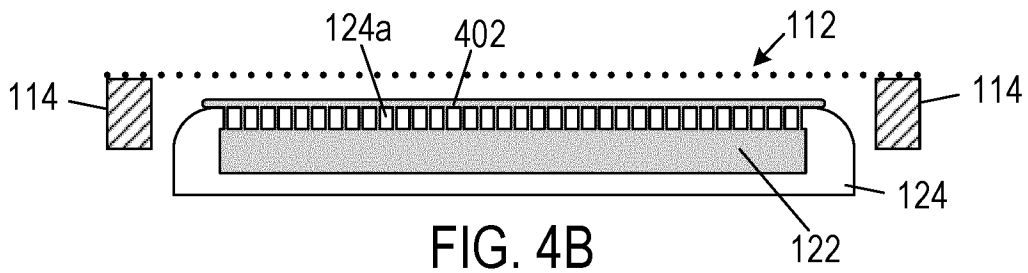


FIG. 4B

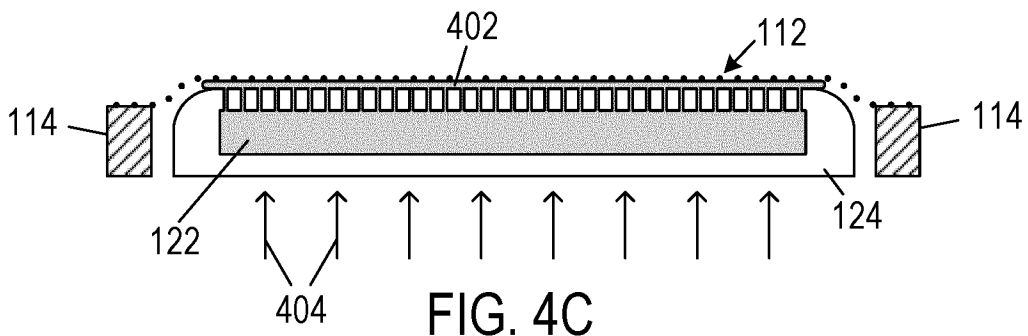
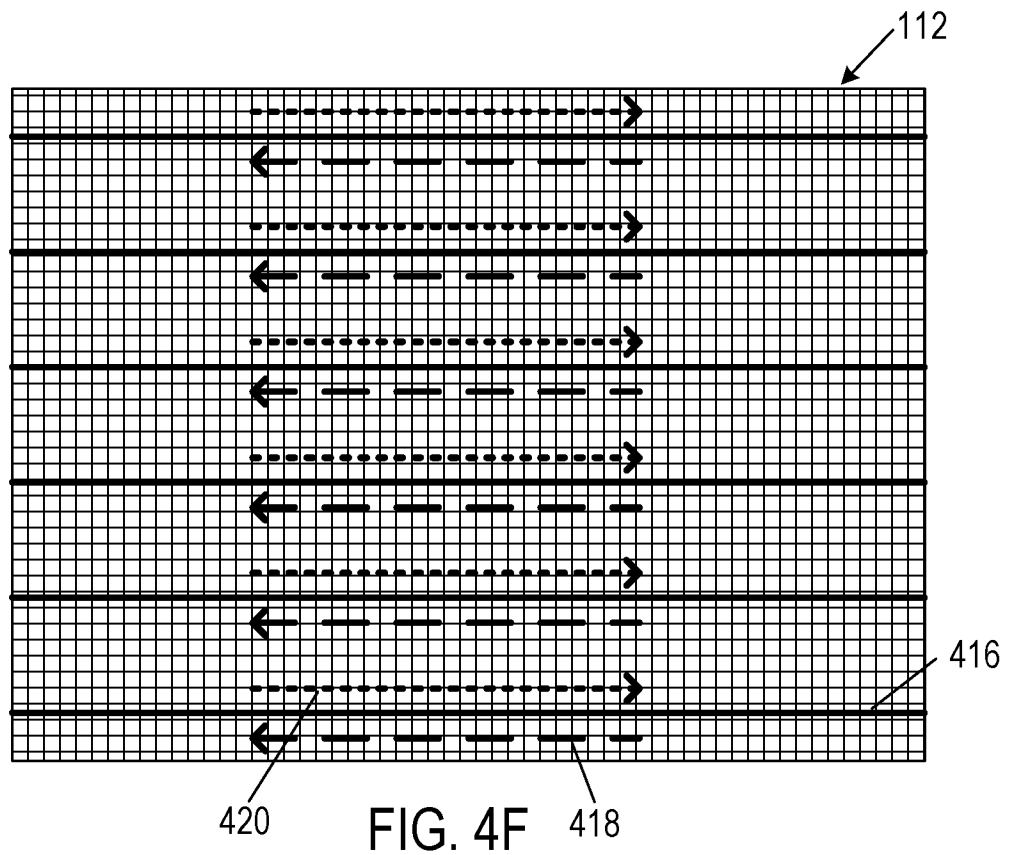
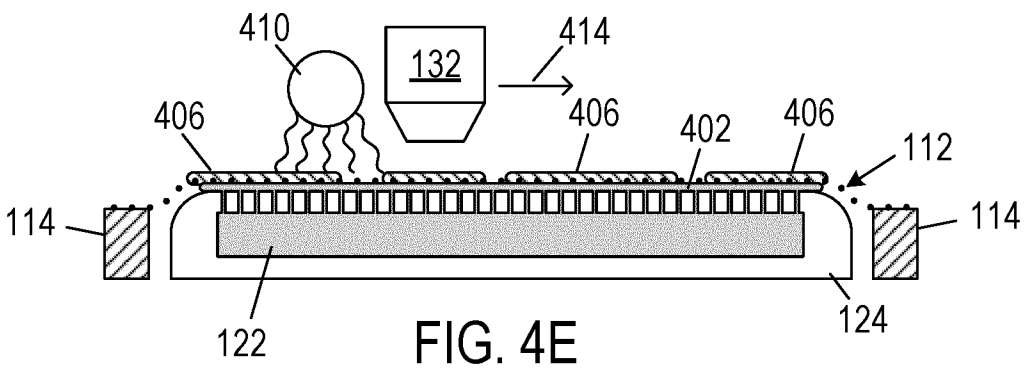
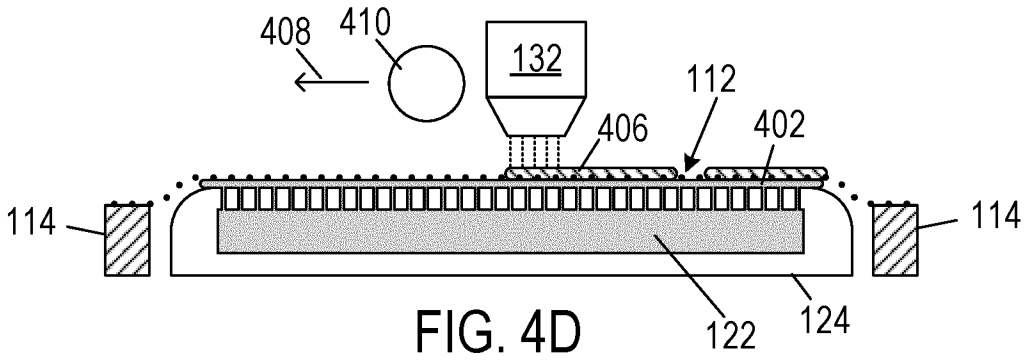


FIG. 4C



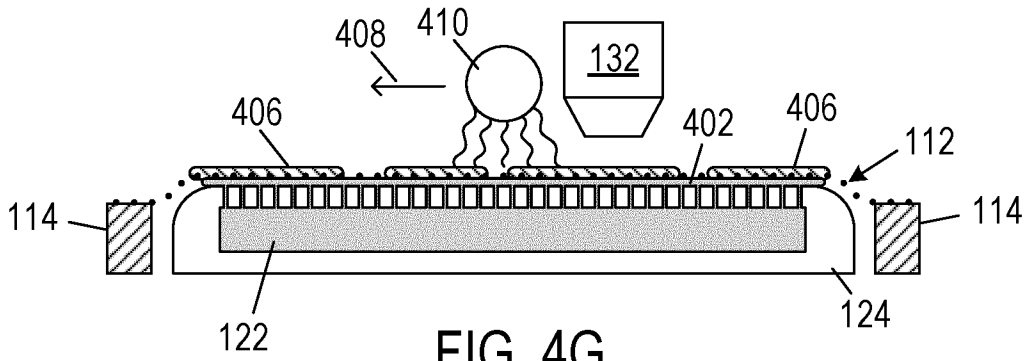


FIG. 4G

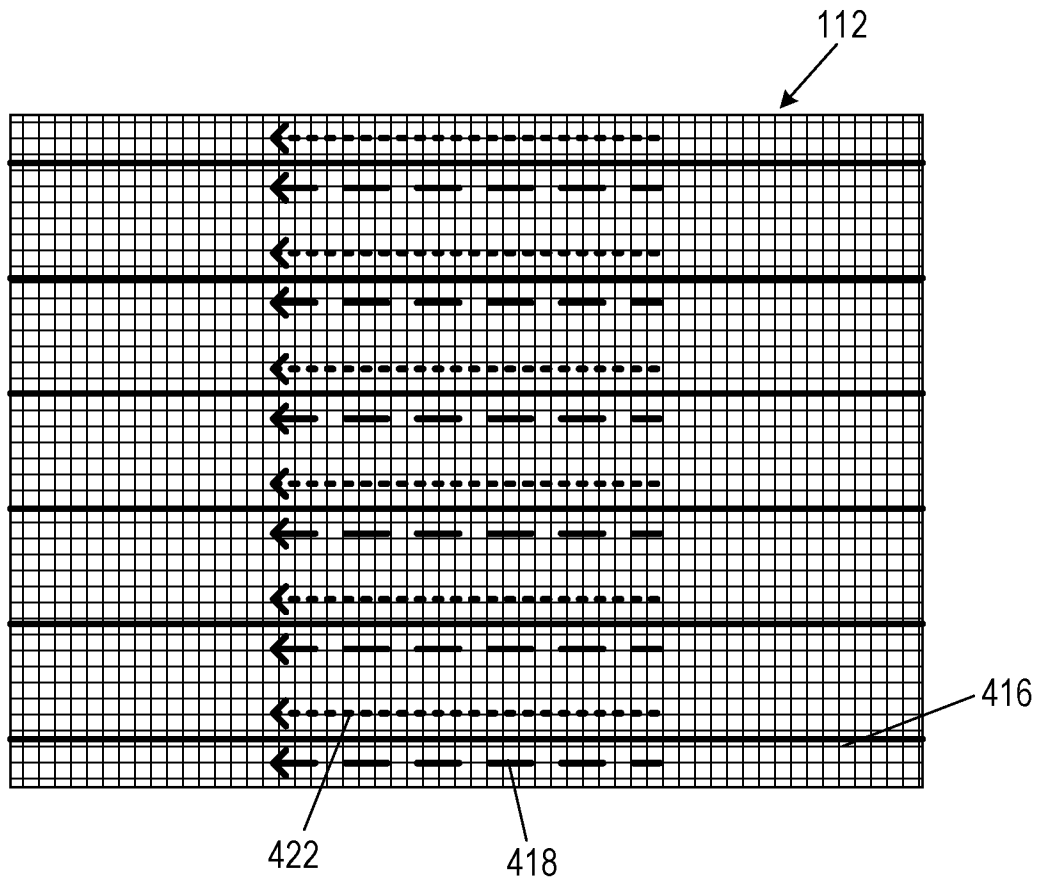


FIG. 4H

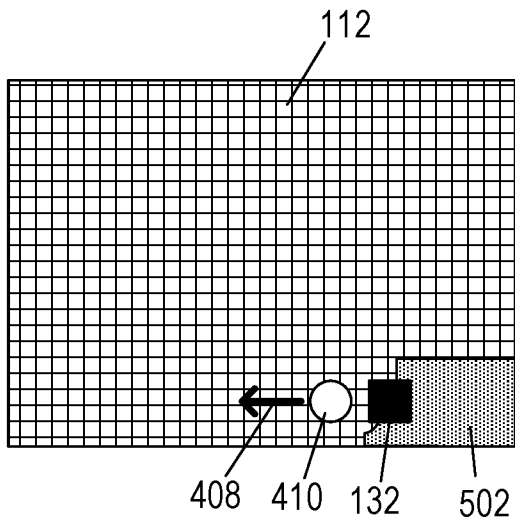


FIG. 5A

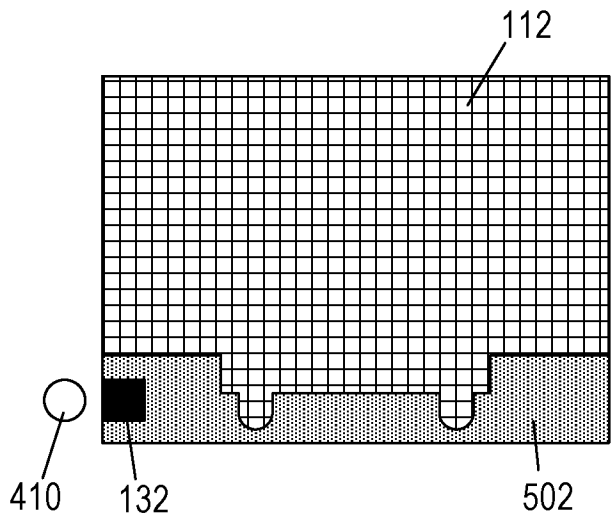


FIG. 5B

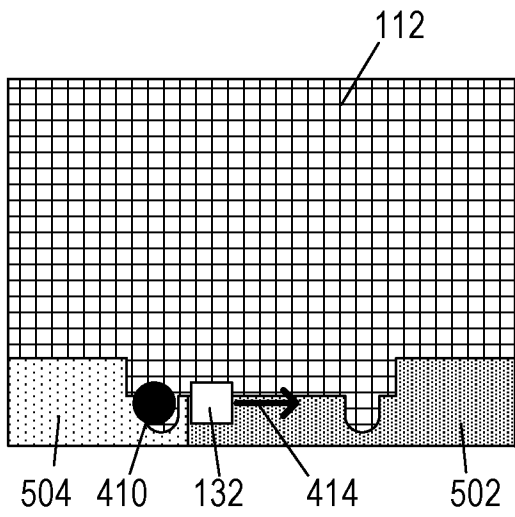


FIG. 5C

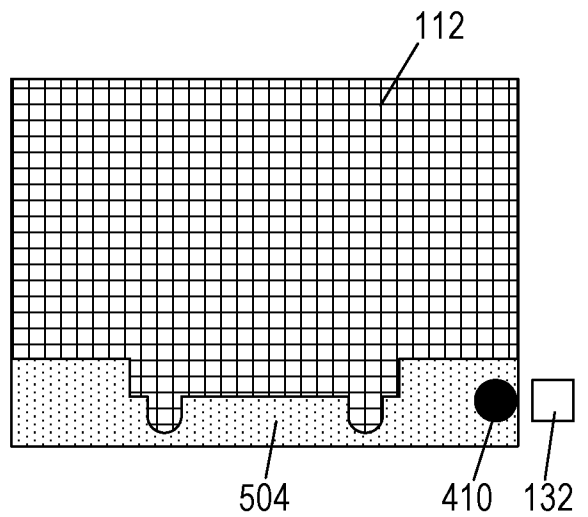


FIG. 5D

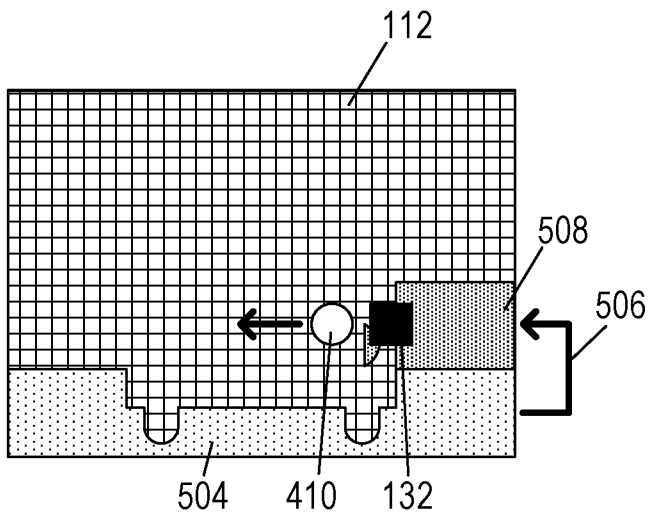


FIG. 5E

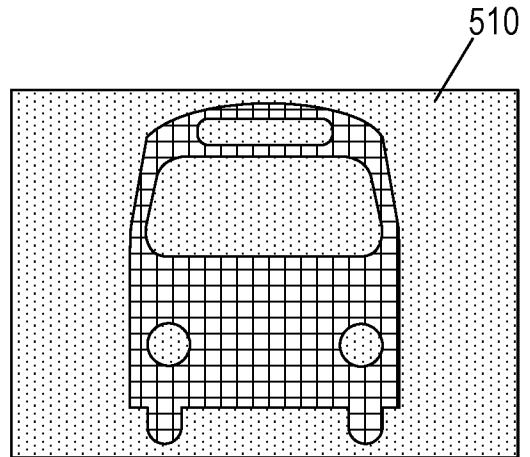


FIG. 5F

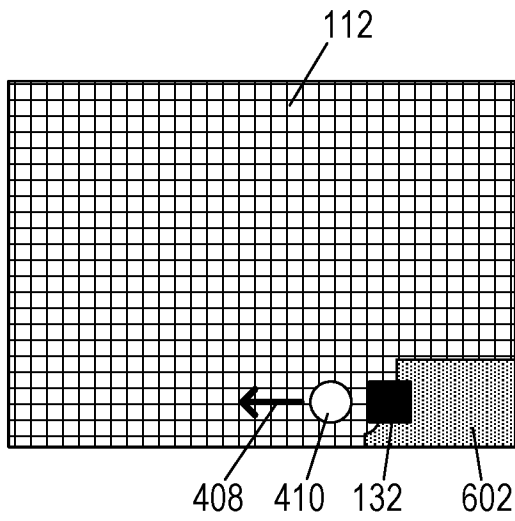


FIG. 6A

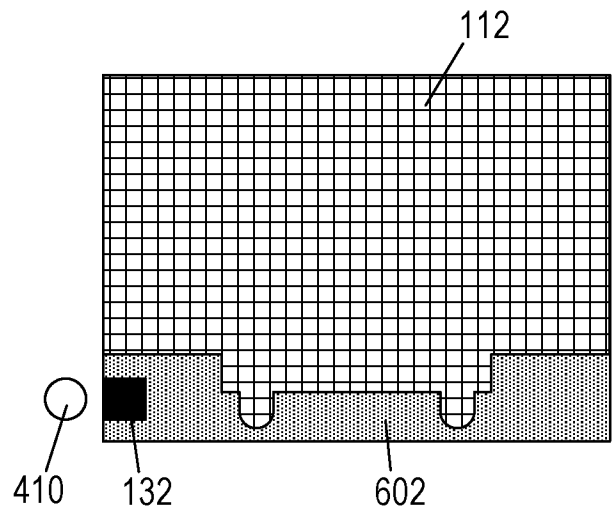


FIG. 6B

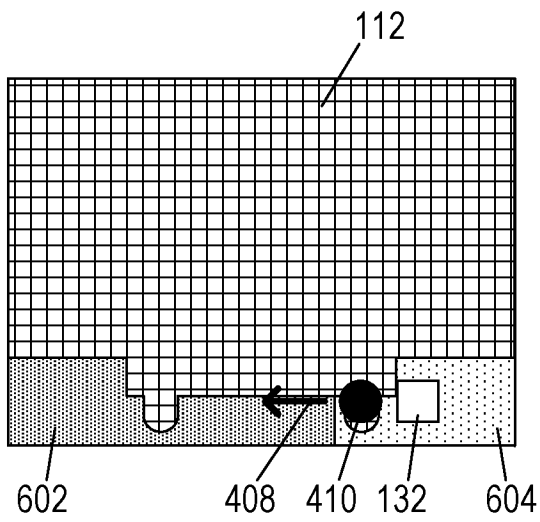


FIG. 6C

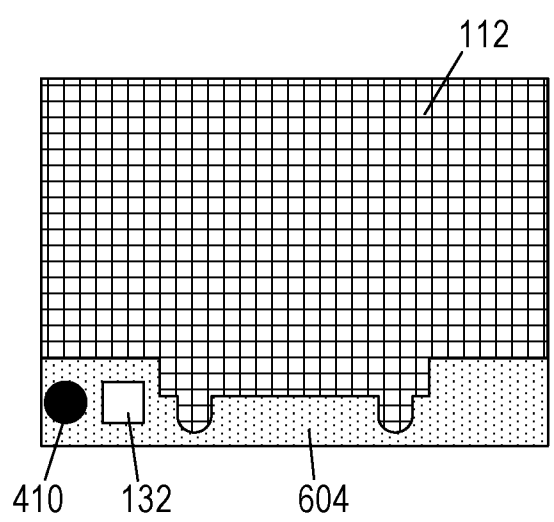


FIG. 6D

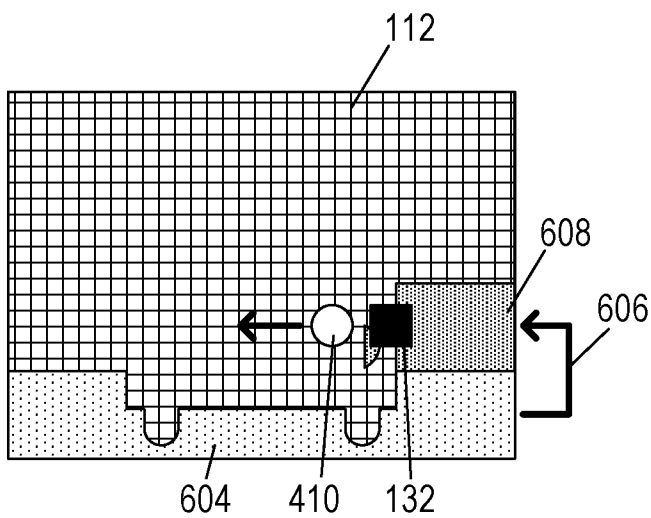


FIG. 6E

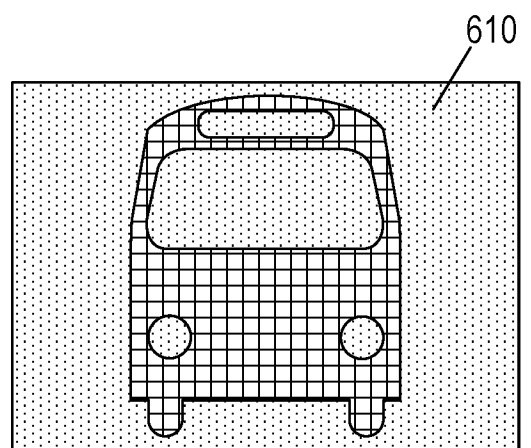


FIG. 6F

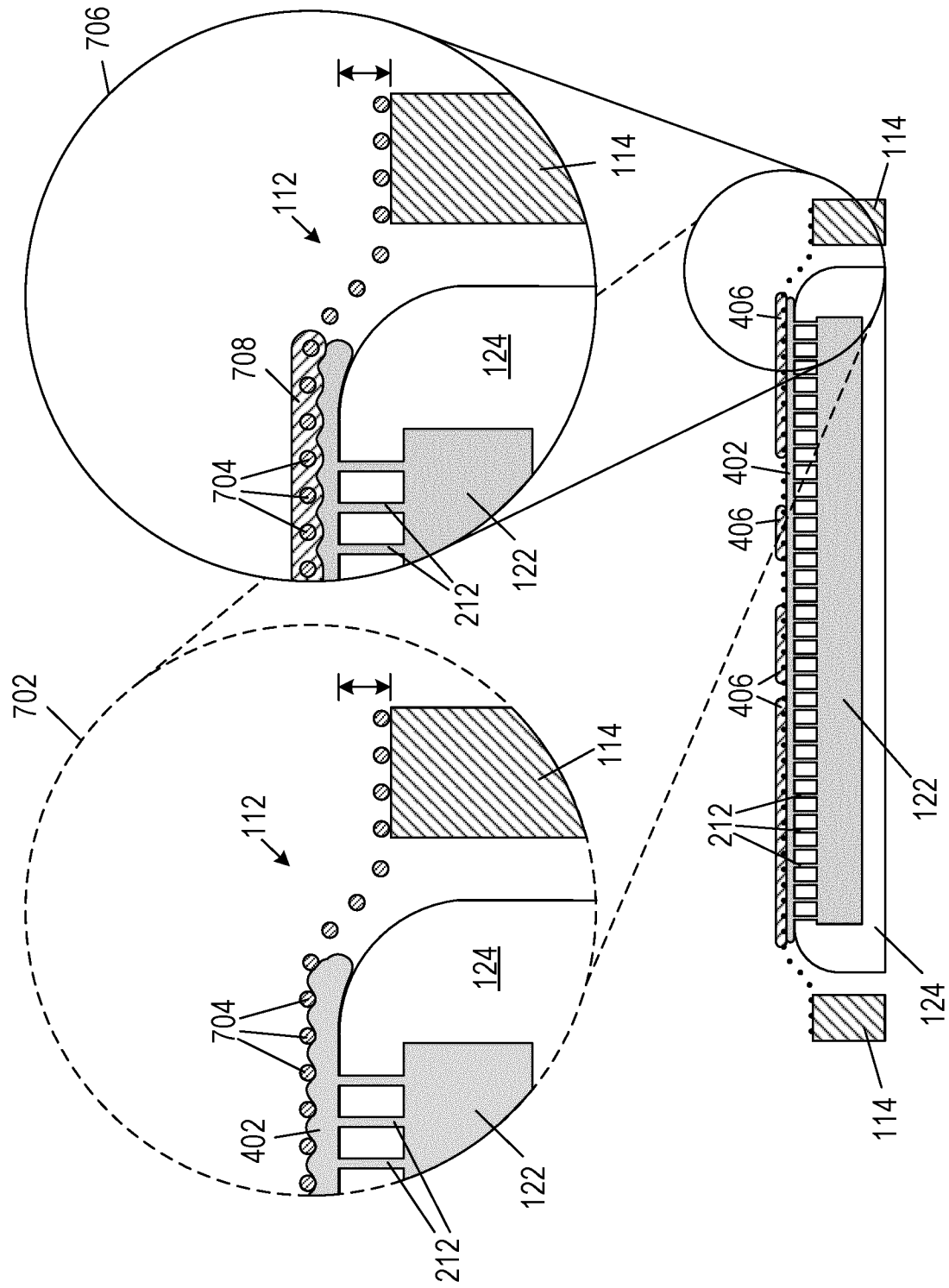


FIG. 7

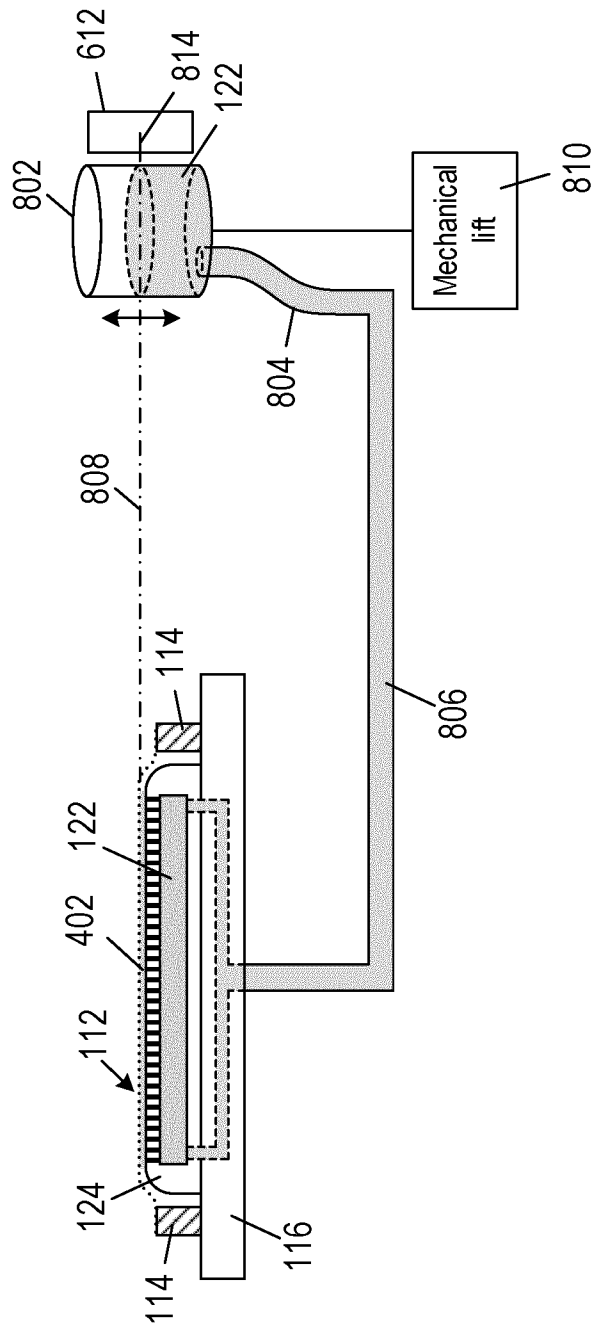


FIG. 8

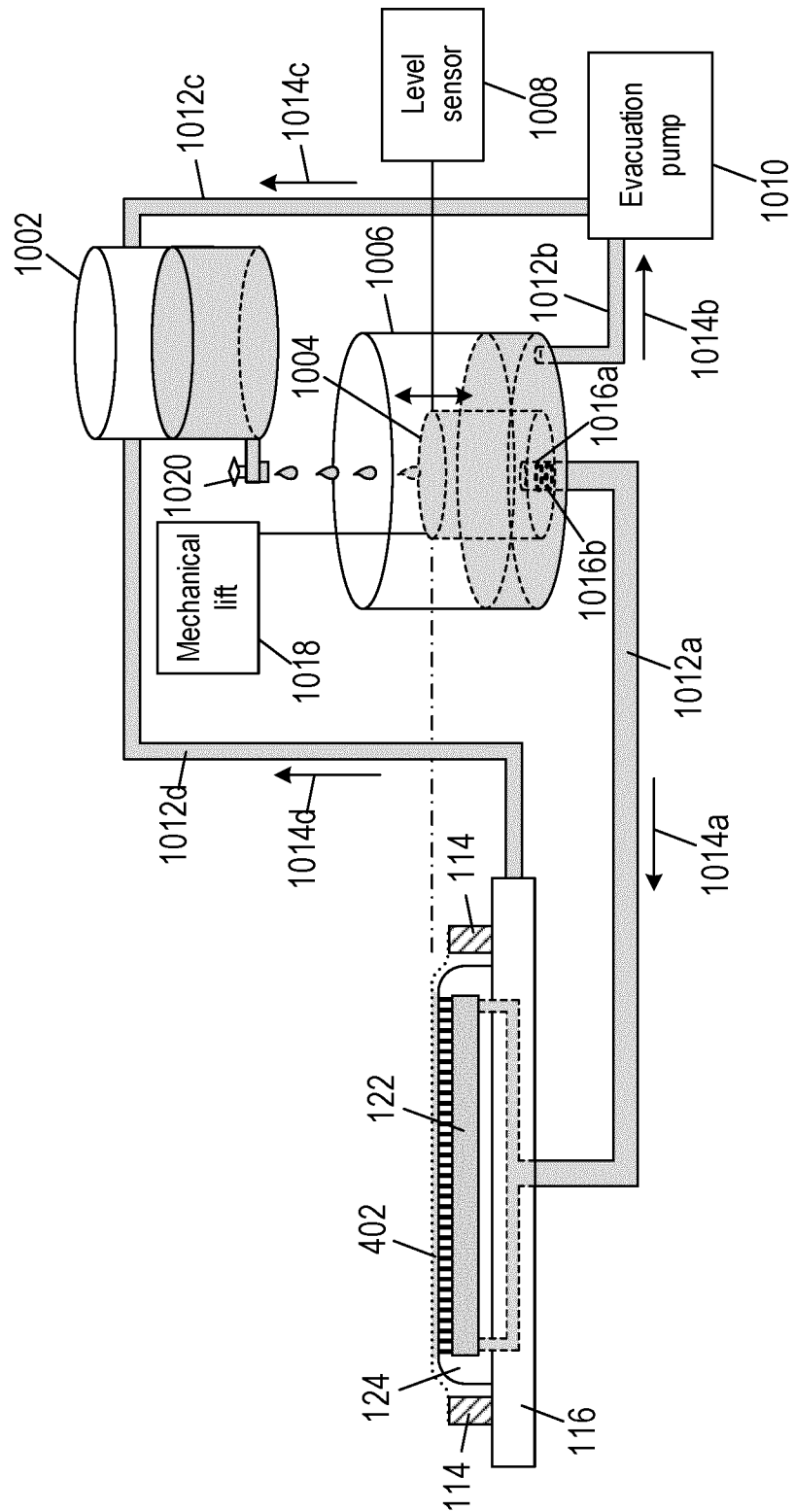


FIG. 10

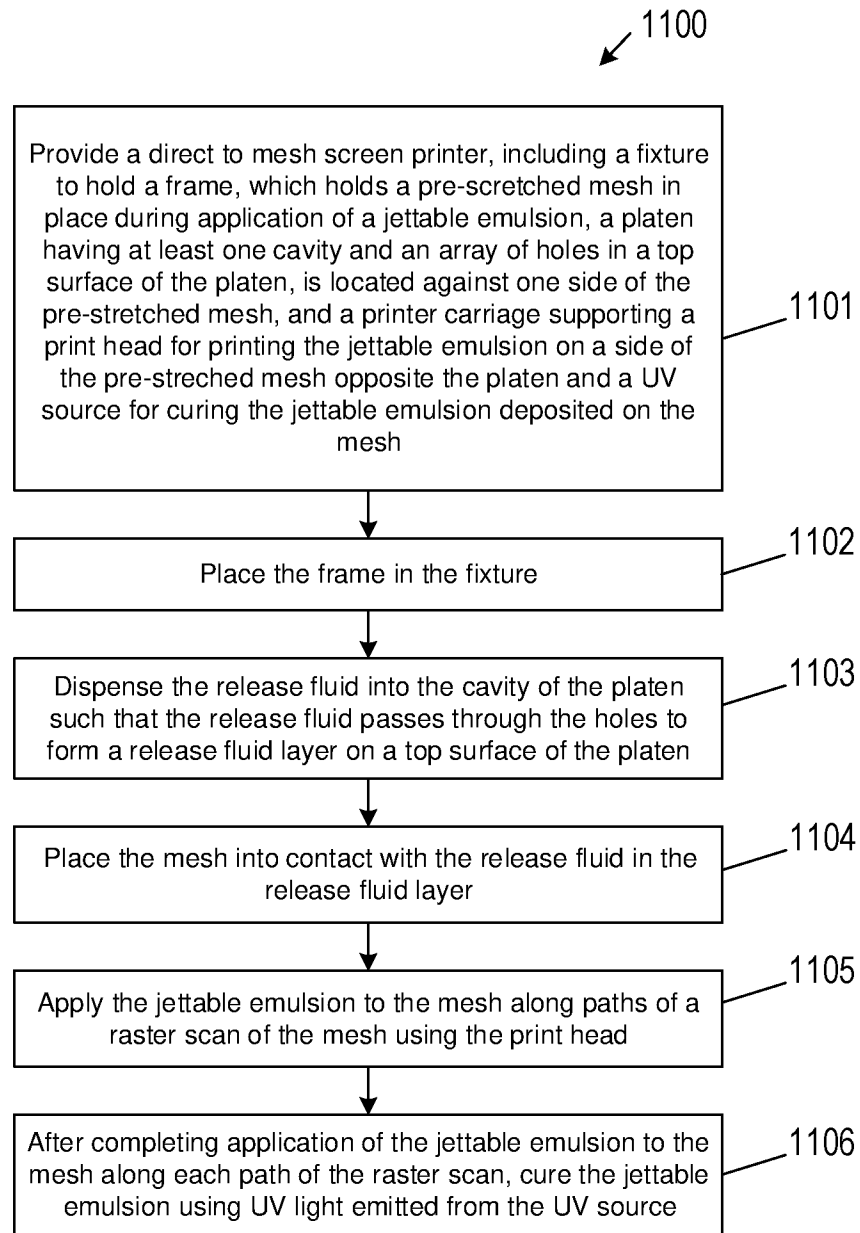


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/067736

A. CLASSIFICATION OF SUBJECT MATTER

INV. B41C1/14
ADD. B41J3/407 G03F7/12

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B41C G03F B41J

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2022/033702 A1 (DURALCHROME AG [CH]) 17 February 2022 (2022-02-17) the whole document especially the claims, paragraphs 46 and 47 and figures 4A-4E and the corresponding description of the figures -----	1-19
A	WO 2018/127288 A1 (DURALCHROME AG [CH]) 12 July 2018 (2018-07-12) the whole document especially the claims -----	1-19

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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Date of the actual completion of the international search

6 December 2023

Date of mailing of the international search report

18/12/2023

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Authorized officer

Vogel, Thomas

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2023/067736

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		WO 2018127288 A1	12-07-2018
