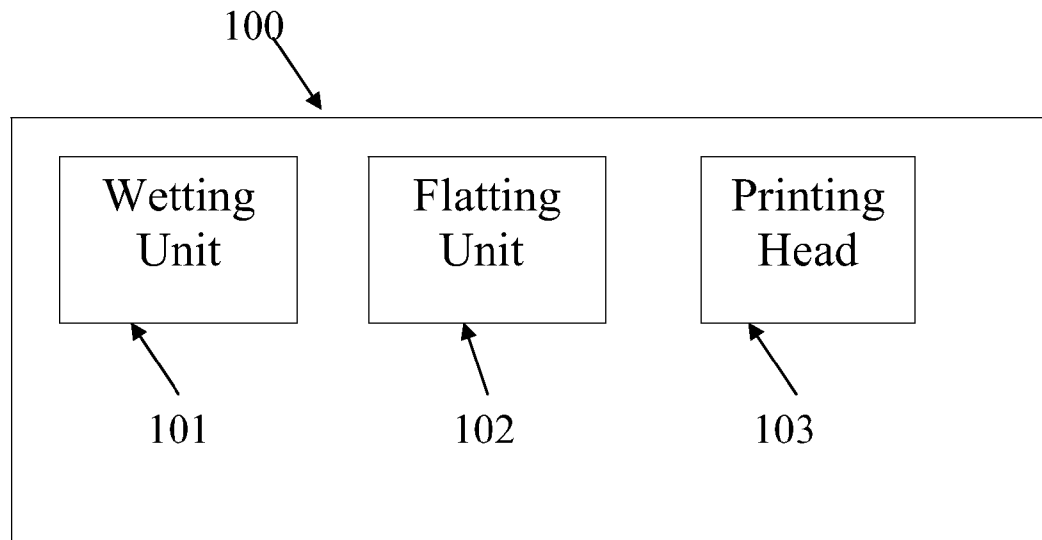




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(19) **United States**(12) **Patent Application Publication**
KAPLAN et al.(10) **Pub. No.: US 2011/0032319 A1**(43) **Pub. Date: Feb. 10, 2011**(54) **DIGITAL PRINTING DEVICE WITH
IMPROVED PRE-PRINTING TEXTILE
SURFACE TREATMENT**(75) Inventors: **Asaf KAPLAN**, Moshav Ein-Sarid
(IL); **Eli KEDAR**, Beit-Dagan (IL);
Uri DUSHY, Moshav Ein-Sarid
(IL); **Jacob MOZEL**, Kfar-Saba
(IL)Correspondence Address:
MARTIN D. MOYNIHAN d/b/a PRTSI, INC.
P.O. BOX 16446
ARLINGTON, VA 22215 (US)(73) Assignee: **Kornit Digital Technologies Ltd.**,
Rosh HaAyin (IL)(21) Appl. No.: **12/853,361**(22) Filed: **Aug. 10, 2010****Related U.S. Application Data**(60) Provisional application No. 61/245,333, filed on Sep.
24, 2009, provisional application No. 61/272,436,
filed on Sep. 24, 2009, provisional application No.
61/232,494, filed on Aug. 10, 2009.**Publication Classification**(51) **Int. Cl.**
B41J 2/01 (2006.01)(52) **U.S. Cl.** **347/101**(57) **ABSTRACT**

A digital printing machine prints textiles. The machine comprises a wetting unit for wetting fabric to be printed prior to printing, a printing head for printing on said fabric and a flattening unit located between the wetting unit and the printing head for exerting pressure on the fabric to flatten outwardly extending fibers of the fabric after wetting and before printing. The flattening provides a smoothed surface for digital printing.



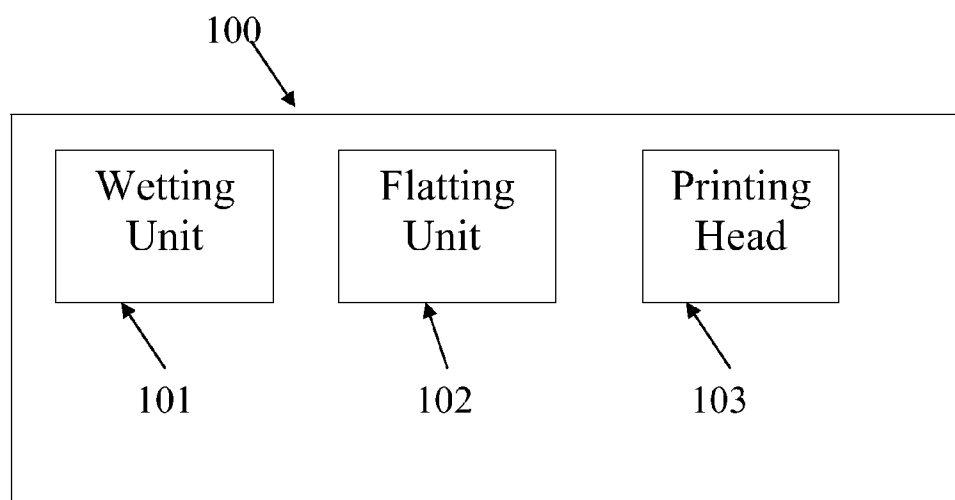


FIG. 1

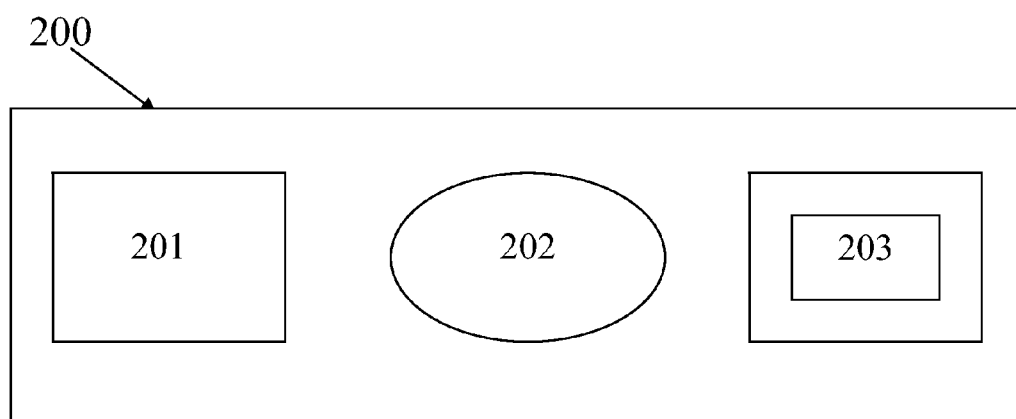


FIG. 2a

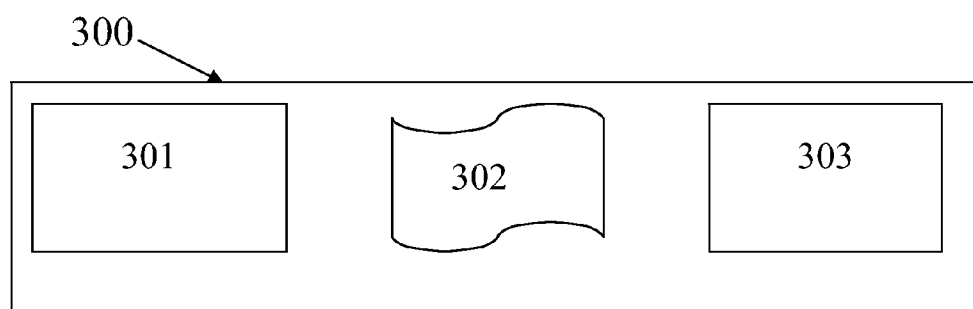
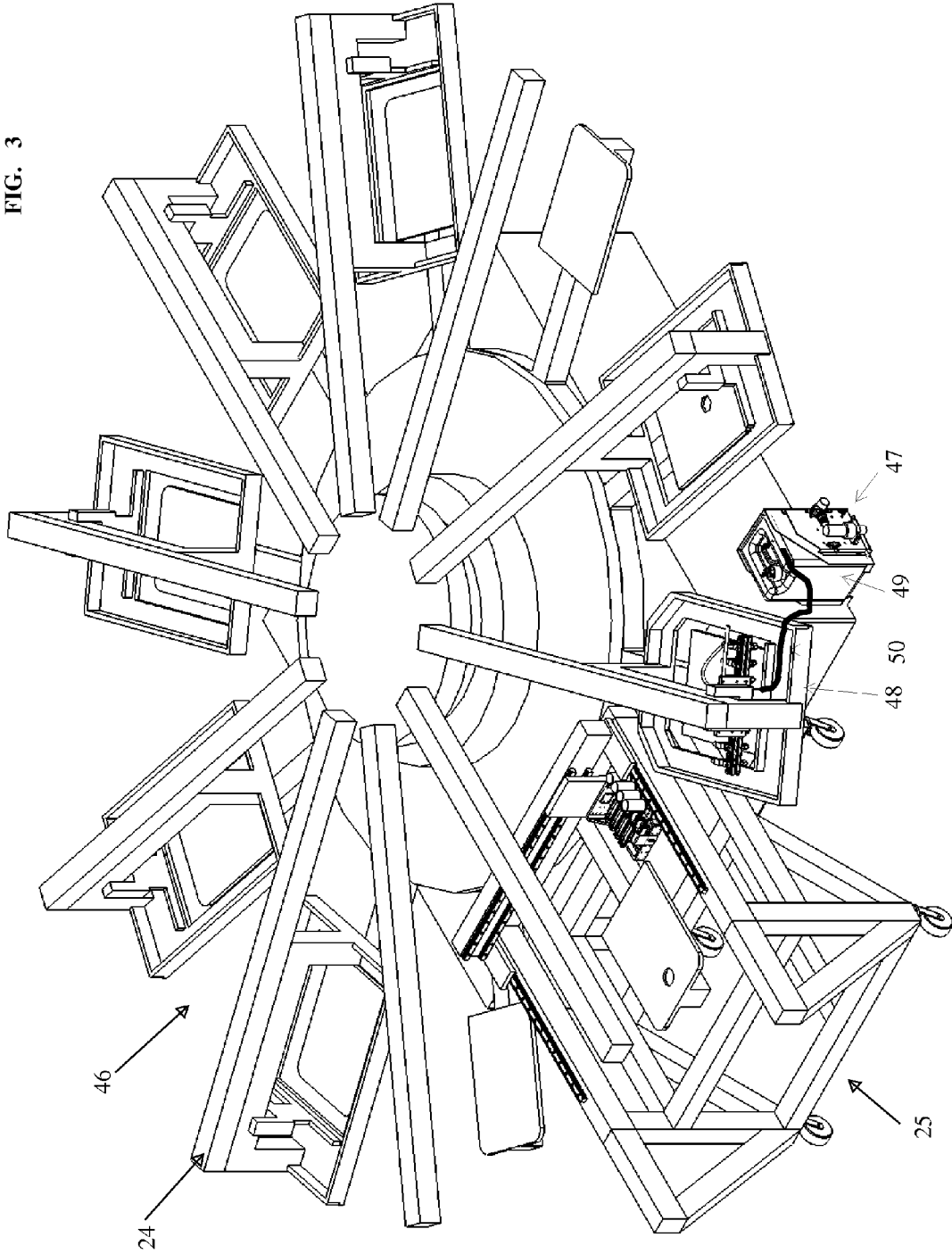
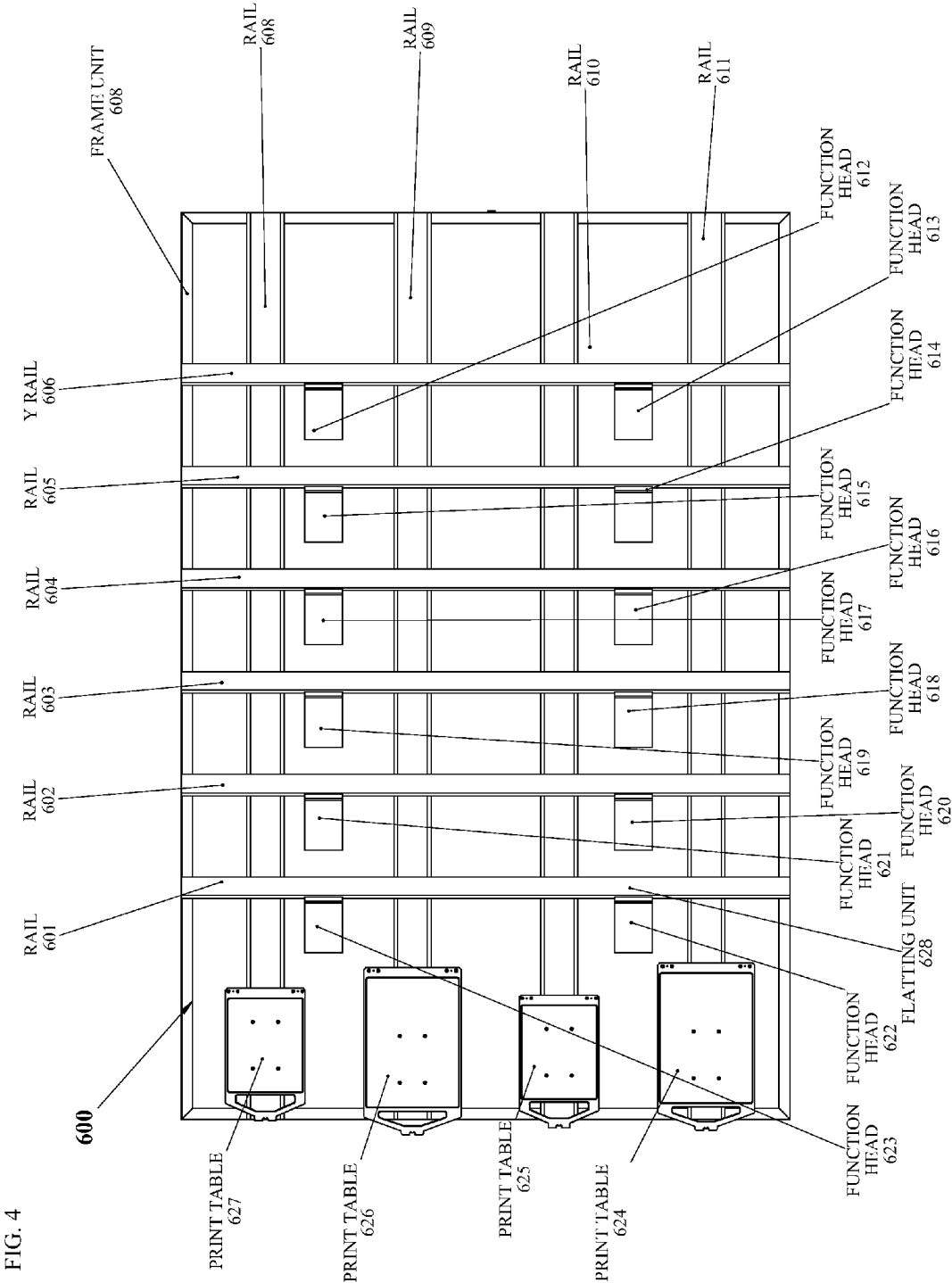


FIG. 2b





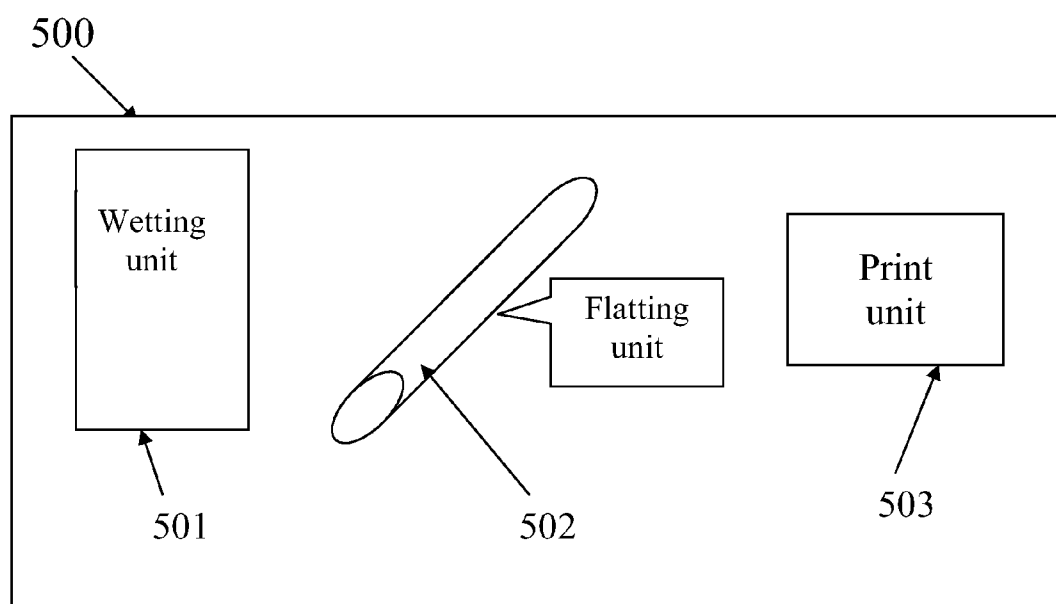


FIG. 5

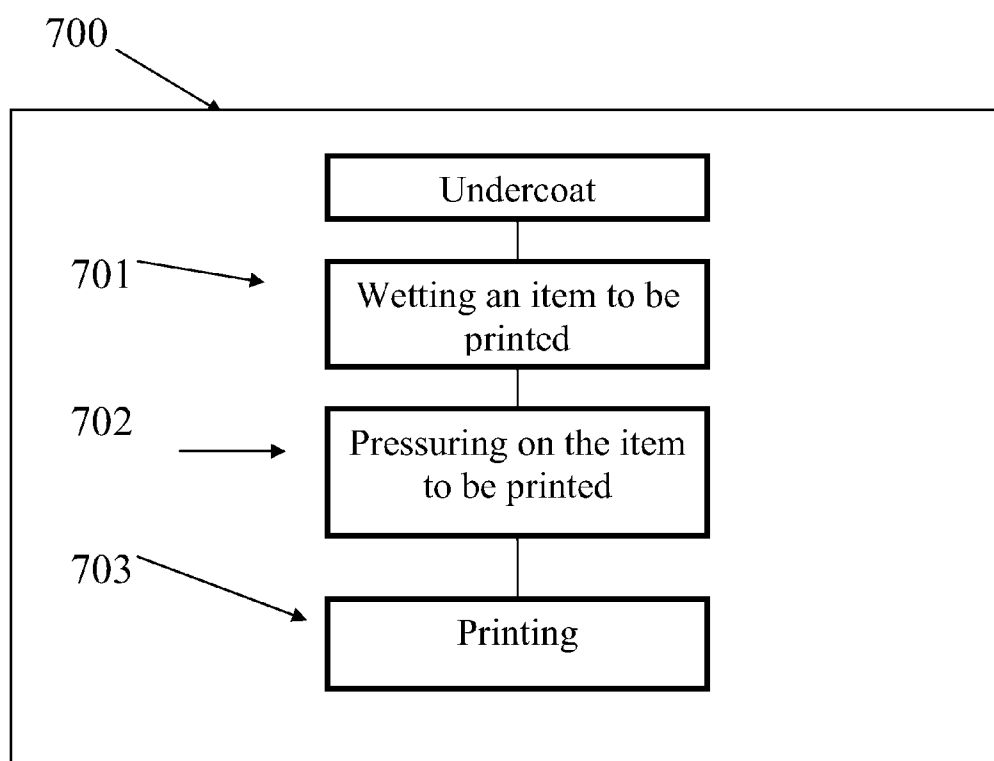
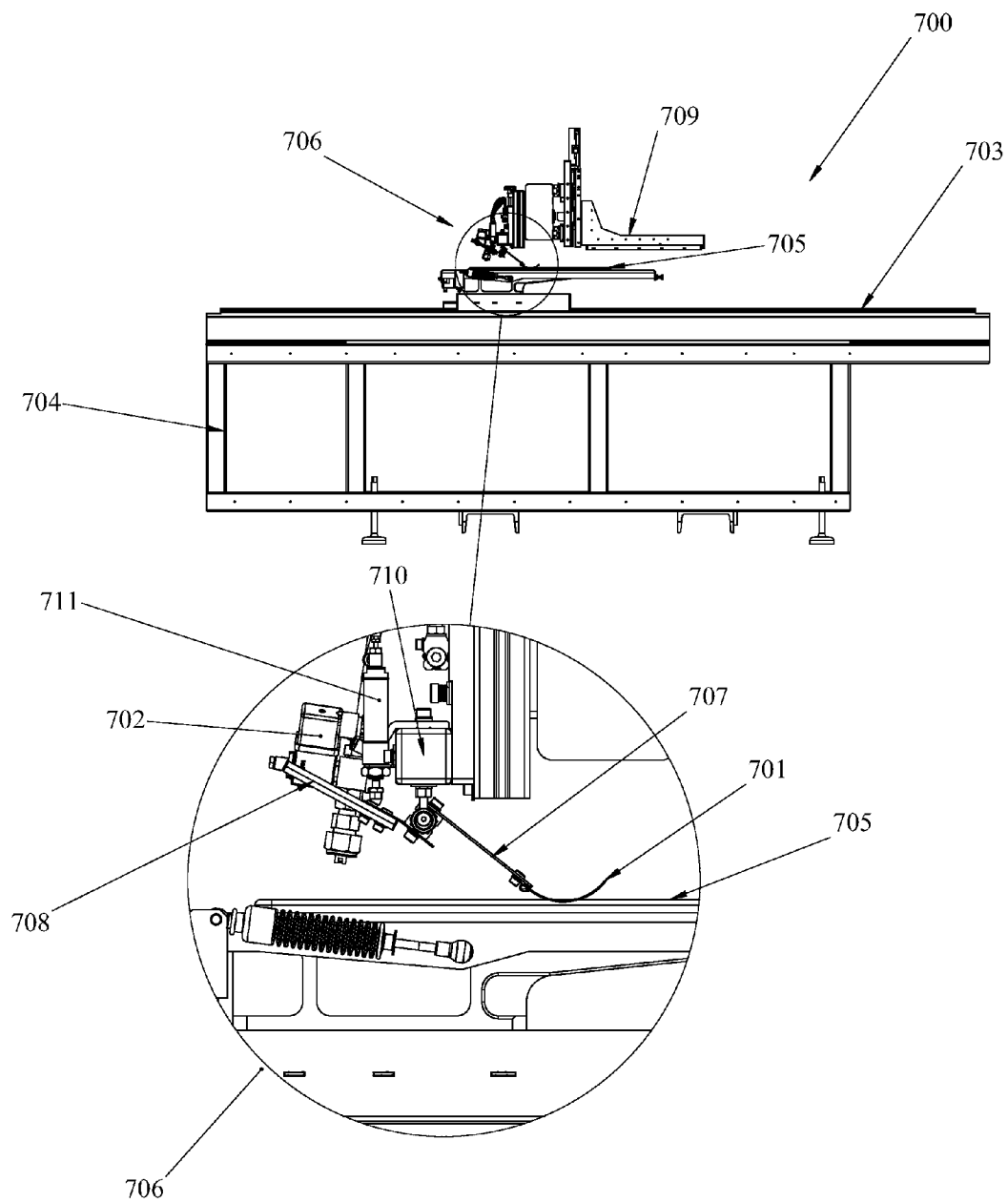
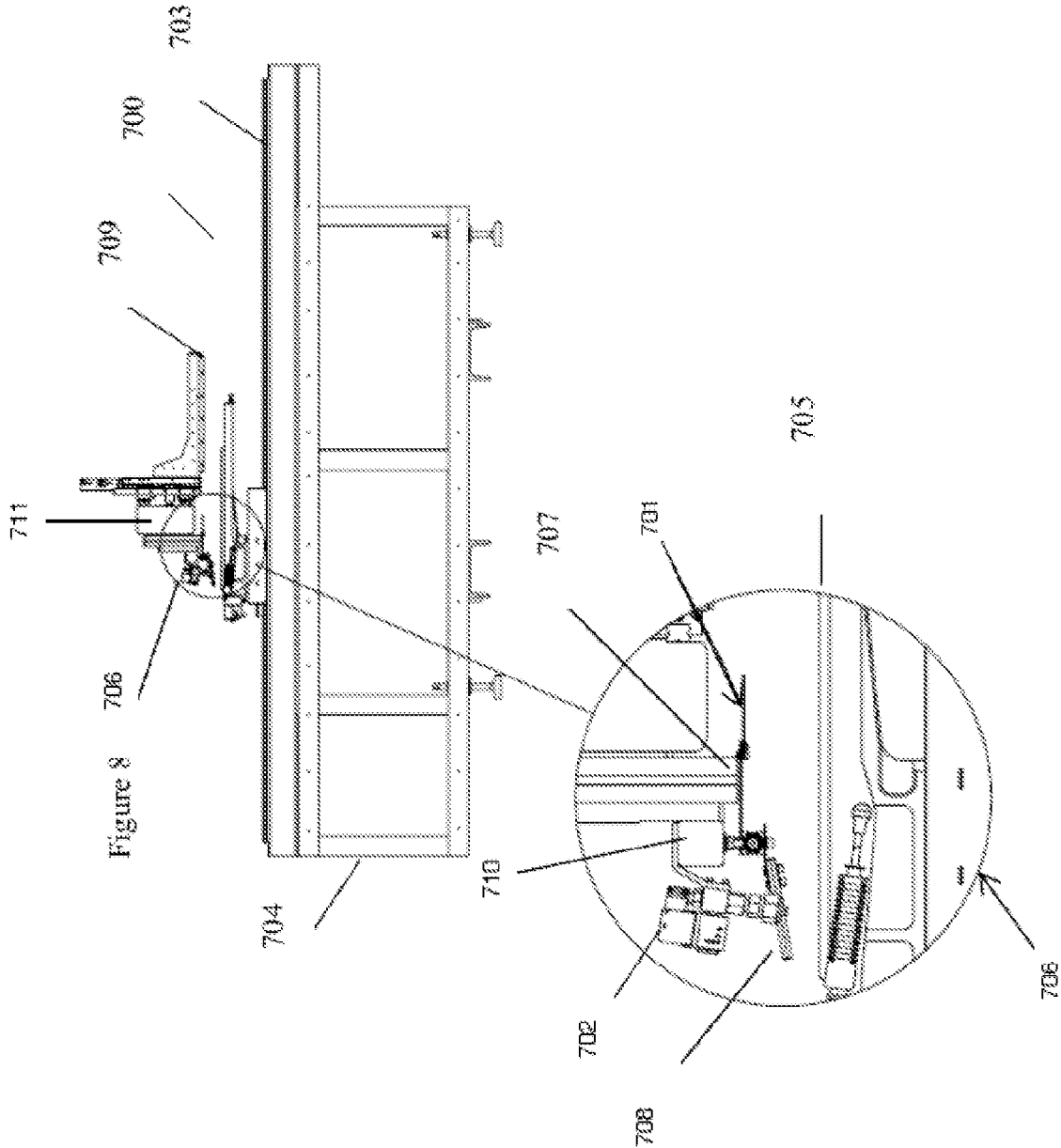
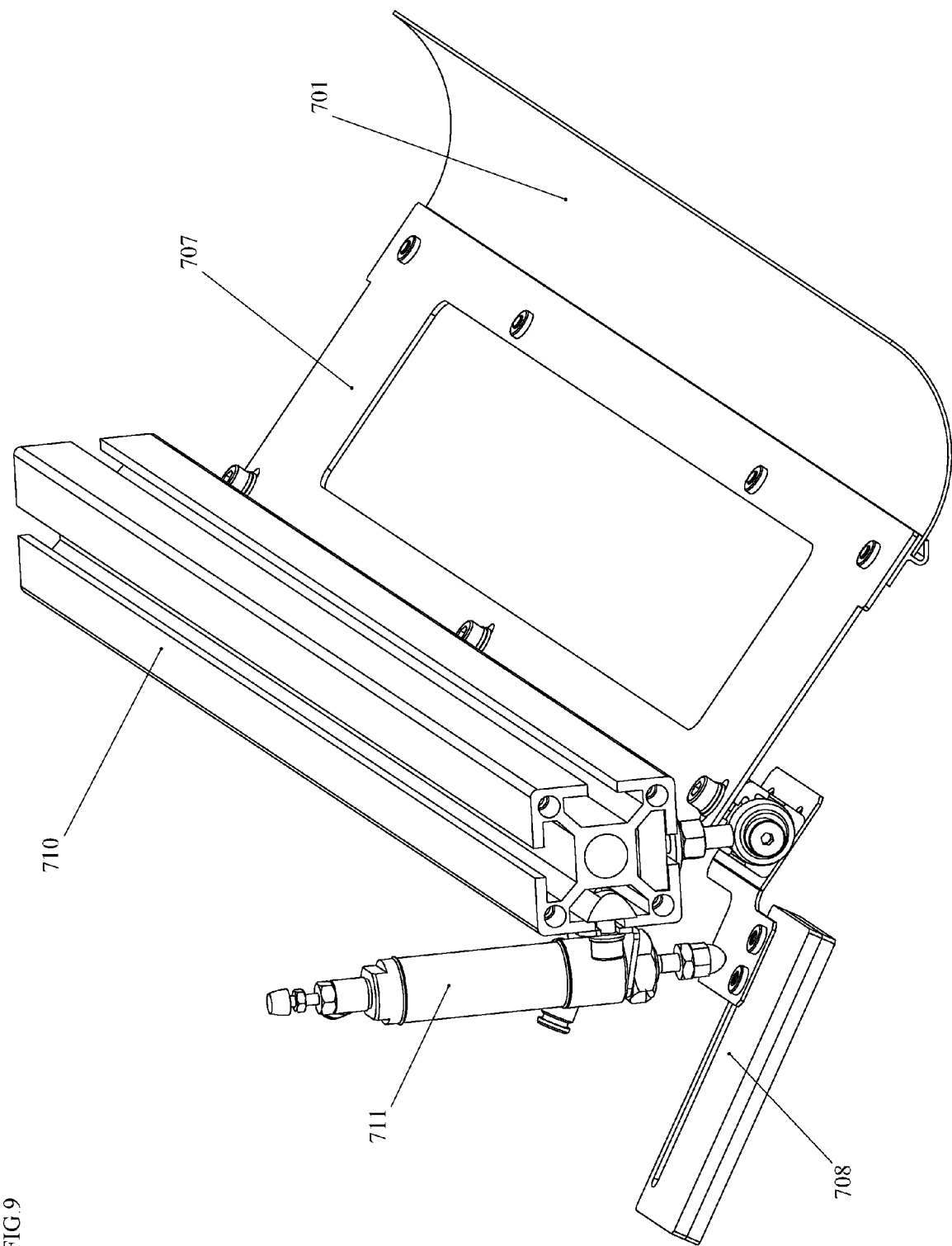


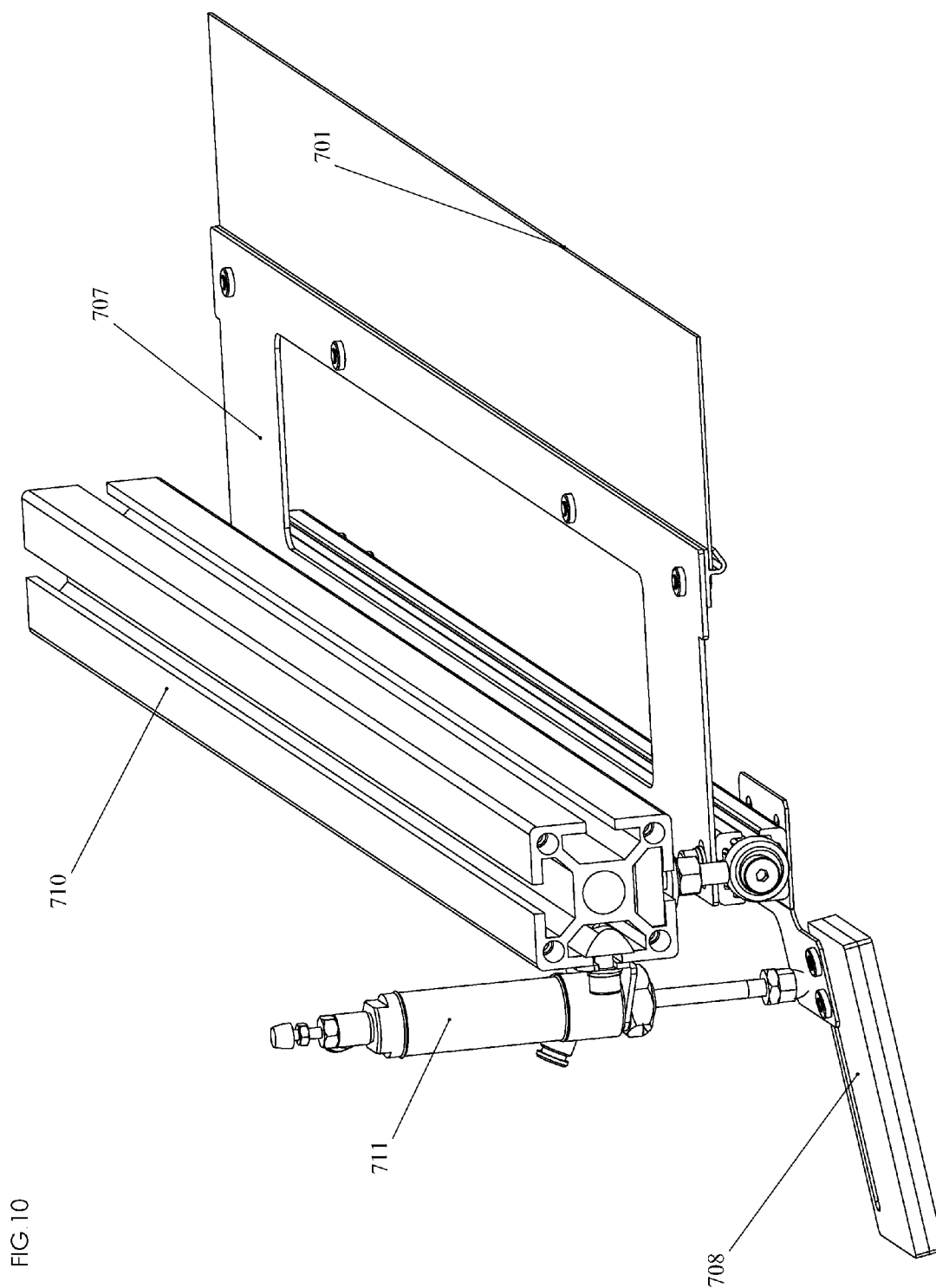
FIG. 6

FIG. 7









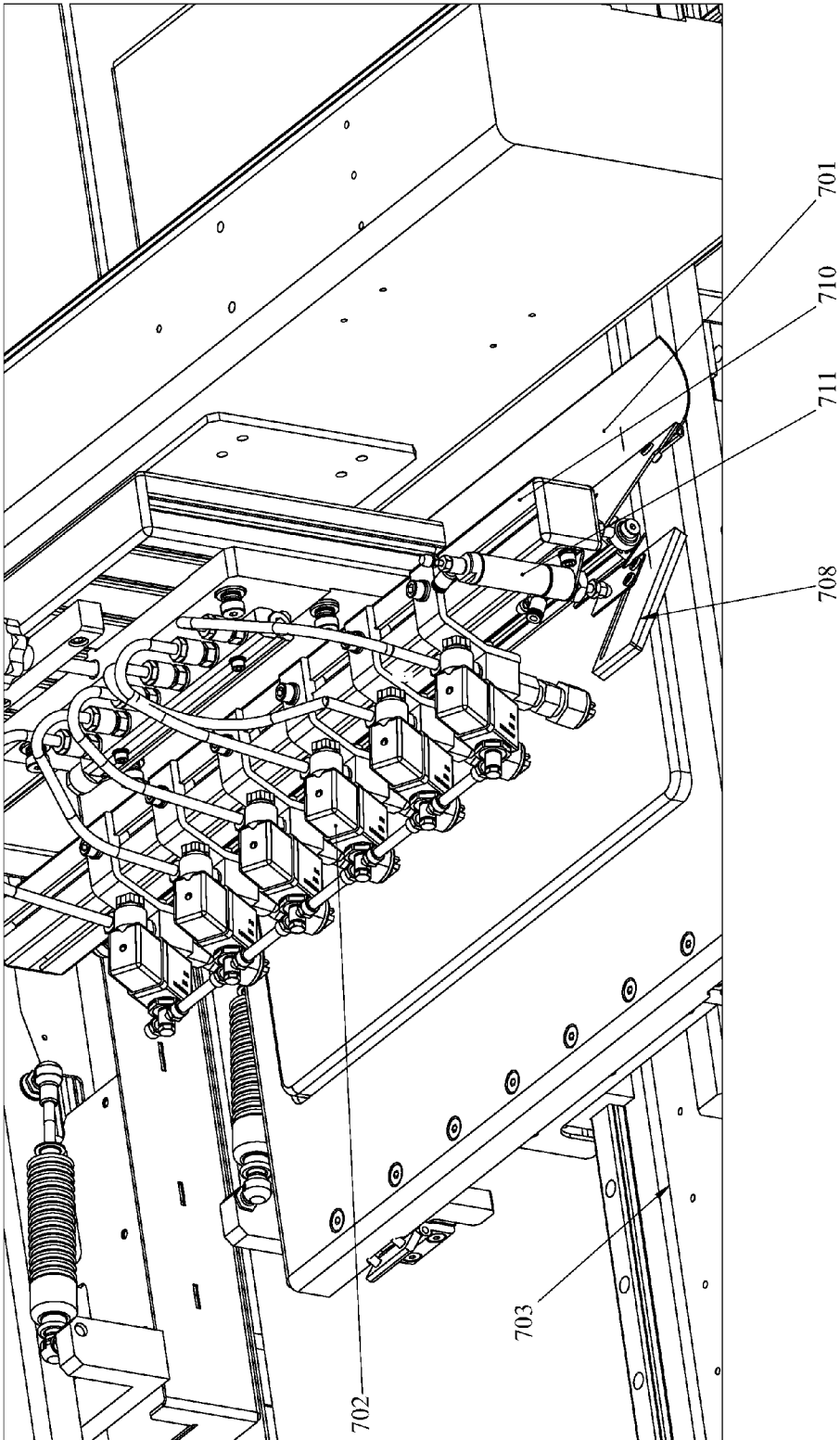


FIG. 11

DIGITAL PRINTING DEVICE WITH IMPROVED PRE-PRINTING TEXTILE SURFACE TREATMENT

RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 USC 119(e) of U.S. Provisional Patent Application Nos. 61/245,333 and 61/272,436, both filed on Sep. 24, 2009, and of 61/232,494 filed on Aug. 10, 2009. The contents of the above applications are hereby incorporated by reference as if fully set forth herein.

FIELD AND BACKGROUND OF THE INVENTION

[0002] The present invention relates to a digital printing device for printing and, more particularly, but not exclusively to a digital printing device for printing on textile surfaces, with pre-printing treatment to improve the textile as a printing surface.

[0003] Digital ink jet printing employs a printing head having several ink injectors, each injector applying one color, a controller for coordinating relative motion between the printing head and the printed substrate and for instructing the ink injectors when and where precisely to inject ink. To speed up the printing process, a digital printing system may comprise several printing heads working concurrently, wherein a printing head may comprise hundreds of injectors of the same color.

[0004] Digital printing on a textile is complicated as textile fabrics are notoriously difficult surfaces for printing. Until recently, screen-printing was the main way of printing on textiles, as the textile surface was considered unsuitable for inkjet printing. The fabrics, of which a garment is made of, are porous; furthermore, they are made of layers of threads and holes greater than one order of magnitude relative to the inkjet drops. This attribute of the fabric causes large-scale absorption of drops into the fabric body, especially in the case of dark fabrics, and thus requires relatively large amounts of ink, which eventually cause bleeding, smearing, padding and feathering of the fabric.

[0005] USA patent application 2005-0179708-A1 discloses a pre-printing assembly for wetting the substrate prior to printing. This wetting sub-system typically comprises an array of spraying nozzles that applies a wetting composition over the textile surface to be printed. This wetting composition interferes with the engagement of the ink with the material to be printed so as to limit the spread of the ink over, or within, the material.

[0006] The above is useful for printing over materials that usually cause the ink to smear and spread over the material, such as fibrous materials, porous materials and other ink absorbing materials, and materials having high surface tension with the ink liquid.

[0007] US Provisional Patent Application by the present assignee, which is co-filed with the present application and titled "Inkjet compositions and processes for stretchable substrates" (Attorney Docket No. 45698), discloses multi-part ink compositions and a process for inkjet printing of color images on various stretchable substrates such as colored and absorptive or impregnable materials. The multi-part ink composition allows for immediate immobilization of the ink droplets on the surface of the substrate before curing and without pretreatment of the substrate. The process is characterized by

heightened efficiency in process time, ink and energy consumption, and yields textiles having stretchable yet durable, wash-fast and abrasion-fast high-resolution color images printed thereon.

[0008] In some cases, particularly when printing on a dark garment there is a need for printing a light background color before printing a colored image. In such a case, an opaque white layer is printed on the garment as an undercoat that covers exactly the dark surface under the printed image and does not extend beyond the area of the image to be printed by the color ink. The colored image is then digitally printed over the undercoat. The undercoat may also serve as white color or white highlight where needed.

[0009] Wetting may optionally be applied prior to printing of the colored image if performed on white or light colored fabric.

[0010] A fabric generally consists of fibers, which are woven together. The fibers of the weave tend to have smaller fibers extending outwardly from the fibers of the weave. In inkjet printing, drops of ink are jetted from printer nozzles to land at specific points on the fabric. However the outwardly extending fibers tend to intercept the drops along their paths so that drops do not reach their precise targets, or not in their entirety. The result is a blurring of the image.

[0011] As well as woven fabrics, non-woven fabrics such as felt also have hairs which stand out from the plane of the fabric and to which the same considerations apply.

SUMMARY OF THE INVENTION

[0012] The present embodiments thus provide a printing machine, which causes outwardly extending fibers to stick to the fabric before printing, and thereby provides a smoother plane for printing. A flattening unit presses on the fabric of an item to be printed to flatten the fibers of the fabric after wetting and before printing. Such an operation of flattening after wetting and before printing presses the extending fibers against the fabric and keeps the extending fibers adhering to the fabric during printing so that they no longer interfere with the paths of the ink drops. Thus, the thin fibers no longer stand out from the fabric or catch drops of ink on their way to the fabric. Such a process of pressing may also have the effect of eliminating the need for ironing the textile before printing.

[0013] According to embodiments of the present invention there is provided a digital printing machine for printing textiles, the textiles comprising fabric woven within a plane, the fabric comprising fibers extending outwardly from the plane, the machine comprising:

[0014] a. a wetting unit for wetting fabric to be printed prior to printing;

[0015] b. a printing head for printing on the fabric; and

[0016] c. a flattening unit for exerting pressure on the fabric to flatten the outwardly extending fibers to the fabric after wetting and before printing, thereby smoothing the fabric for printing.

[0017] In an embodiment, the flattening unit is located between the wetting unit and the printing head.

[0018] In an embodiment, the flattening unit causes the outwardly extending fibers to stick to the fabric.

[0019] Embodiments may comprise a printing table assembly for bringing the fabric to be printed under the flattening unit while the fabric is wet from the wetting unit, thereby causing the fibers to stick to the fabric.

[0020] An embodiment may comprise a controller for coordinating relative motion between the printing table-assembly and the flattening unit.

[0021] In an embodiment, the flattening unit comprises one member of a group consisting of a polymeric or metal curtain, a metal or polymeric roller, an Air knife, a Polymeric squeegee made of PVC, silicone, viton, polyurethane, neoprene or Natural rubber, a thin flexible metal squeegee or a brushing strip.

[0022] In an embodiment, the flattening unit is located on a side to be printed of the fabric.

[0023] In an embodiment, the flattening unit further comprising a pressure regulation mechanism for regulating flattening pressure applied to the fabric.

[0024] In an embodiment, the pressure regulation mechanism for the fabric is one member of a group consisting of a counter balance, adjustable mechanical spring and a pneumatic adjustable pressure unit.

[0025] In an embodiment, the fabric to be printed is a garment.

[0026] In an embodiment, the fabric is a one member of the group consisting of felt, leather, suede, fibrous materials, porous materials, materials having high surface tension with the ink liquid, weaves, weaves of natural fibers, weaves of synthetic fibers, weaves of natural and synthetic fibers, weaves comprising mixtures of natural and synthetic fibers, weaves comprising wool, cotton, linen or nylon.

[0027] In an embodiment, the printing head comprises a plurality of inkjet nozzles for performing digital printing; wherein the inkjet nozzles further comprise a drop-on-demand piezoelectric inkjet nozzle or a continuous piezoelectric inkjet nozzle.

[0028] In an embodiment, the printing machine is a carousel.

[0029] In an embodiment, the printing machine is a matrix.

[0030] An embodiment may comprise additional printing heads and/or additional flattening units and/or additional wetting units.

[0031] In an embodiment, the flattening unit is releasably tensioned to press on the table for the flattening.

[0032] According to a second aspect of the invention there is provided a method of digital printing on fabric; comprising:

[0033] a. wetting the fabric;

[0034] b. exerting flattening pressure on a surface to be printed of the fabric after the wetting; and

[0035] c. performing digital printing on the surface of the fabric after the exerting flattening pressure and whilst the fabric is still wet from the wetting.

[0036] In an embodiment, the exerting flattening pressure after the wetting is to an extent sufficient to cause outwardly extending fibers of the fabric to adhere back to the fabric, thereby to provide a smooth surface for printing.

[0037] In an embodiment, the printing is performed while the fibers continue to adhere to the fabric.

[0038] An embodiment may comprise adjusting the flattening pressure in accordance with a type of fabric being printed.

[0039] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. The materials, methods, and examples provided herein are illustrative only and not intended to be limiting.

[0040] The word “exemplary” is used herein to mean “serving as an example, instance or illustration”. Any embodiment described as “exemplary” is not necessarily to be construed as preferred or advantageous over other embodiments and/or to exclude the incorporation of features from other embodiments.

[0041] The word “optionally” is used herein to mean “is provided in some embodiments and not provided in other embodiments”. Any particular embodiment of the invention may include a plurality of “optional” features unless such features conflict.

[0042] Implementation of the method and/or system of embodiments of the invention can involve performing or completing selected tasks manually, automatically, or a combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] The invention is herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in order to provide what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

[0044] In the drawings:

[0045] FIG. 1 is a schematic diagram illustrating a digital printing machine with a wetting unit, a flattening unit and a printing head, according to a first embodiment of the present invention.

[0046] FIG. 2a is a schematic diagram of an exemplary printing machine with a roller-flattening unit according to a further embodiment of the present invention.

[0047] FIG. 2b is a schematic diagram of an exemplary printing machine with a curtain-flattening unit, according to a further embodiment of the present invention.

[0048] FIG. 3 is a schematic diagram of an exemplary carousel-printing machine using a flattening unit according to an embodiment of the present invention.

[0049] FIG. 4 is a schematic diagram of an exemplary matrix-printing machine using a flattening unit, according to an embodiment of the present invention.

[0050] FIG. 5 is a schematic diagram from the side, of a printing machine comprising a wetting unit, a roller type flattening unit and a printing unit.

[0051] FIG. 6 is a simplified flow chart describing an exemplary printing procedure for printing on a dark garment using a digital printing machine with a flattening unit according to an embodiment of the present invention.

[0052] FIG. 7 is a schematic side view of a digital printing machine comprising an exemplary flattening unit in operative state.

[0053] FIG. 8 is a schematic side view of an exemplary digital printing machine comprising an exemplary flattening unit in non-operating state.

[0054] FIG. 9 is a schematic view of an exemplary flattening unit in operative state.

[0055] FIG. 10 is a schematic view of an exemplary flattening unit in non-operative state.

[0056] FIG. 11 is a close up view of an exemplary digital printing machine comprising an exemplary flattening unit in operative state.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0057] The present embodiments thus provide a digital printing machine for textiles, that presses and flattens the face of the fabric to be printed after wetting and before printing, when the fabric is still wet from the wetting process. Pressing causes uniform spread of the wetting solution and the outwardly extending fibers of a textile fabric to adhere to the fabric through surface tension due to the wetting, which adhering lasts until printing. Pressing may be provided by a flattening unit. The flattening unit applies or exerts mechanical pressure on the fabric to flatten the fibers of the fabric after wetting and before printing. Adhering the fibers to the fabric at this stage may eliminate the need for ironing the textile before printing.

[0058] The principles and operation of an apparatus and method according to the present invention may be better understood with reference to the drawings and accompanying description.

[0059] Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

[0060] Reference is now made to FIG. 1 which is a schematic diagram illustrating a digital printing machine with a flattening unit according to embodiments of the present invention.

[0061] According to embodiments of the present invention, there is provided a digital printing machine 100 for printing textiles. The textiles may comprise garments or other textile items made of fabric woven within a plane, the fabric itself comprising fibers extending outwardly from the plain. The fabric may be based on any conventional or unconventional textile material. The fabric may for example comprise felt, leather, fibrous materials, porous materials, materials having high surface tension with the ink liquid, weaves of natural and synthetic fibers, weaves of mixtures of natural and synthetic fibers, natural fibers including wool, cotton, linen and synthetic fibers including nylon or suede. The fabric is essentially planar with smaller fibers, hairs, extending outwardly from the plane. The machine comprises a wetting unit 101 for wetting an item to be printed prior to printing. Wetting is performed for ink drop immobilization, thus limiting the penetration of the ink into the depth of the fabric, which may cause dull coloring of the garment, mixing of colors and blurring.

[0062] A printing head 103 prints on the item to be printed. A printing head comprises at least one inkjet nozzle (not shown). The printing head can be any conventional printing head, such as those marketed by Spectra, Inc., New Hampshire, USA, and others known in the industry.

[0063] When using conventional ink-jet type printing on textile without the use of the present embodiments, the outwardly extending fibers intercept the drops from the nozzle before they arrive at their intended destinations, as discussed above.

[0064] Pressing or flattening unit 102 may be located between wetting unit 101 and printing head 103, though other locations are possible. Pressing or flattening unit 102 exerts mechanical pressure on the item to be printed to flatten the outwardly extending fibers to the fabric after wetting and before printing. Flattening unit 102 may employ static pressure. Flattening unit 102 may be disengaged from the item to be printed (not shown) after flattening has been completed. The pressure of flattening unit 102 on the fabric, after wetting and before printing, causes the extending fibers or hairs to bend back towards the fabric before printing. The water from the wetting unit provides the fabric and the fibers with enough liquid to keep the outwardly extending fibers to temporarily remain stuck to the fabric. The fibers sticking to the fabric render the fabric as a smoother surface for printing without any interference of outwardly extending fibers.

[0065] Flattening unit 102 may be any construction that mechanically presses the fibers to the fabric as the fabric passes the unit. Flattening unit 102 may be implemented using for example a downwardly pressing curtain such as a PVC curtain, a mechanical roller such as a metal or polymeric roller, an Air knife, a squeegee, including for example a polymeric squeegee such as PVC or Natural or artificial rubber, silicon and, a thin flexible metal squeegee, a brushing strip and the like. Flattening unit 102 may replace the ironing unit (not shown), since there may be no need to iron the fabric. Flattening unit 102 may be adjusted before flattening for achieving a desired level of pressure. For example, different types of fabric or different levels of wetting may require different levels of pressure. Such pressure adjustment may be performed by using a counter balance (not shown), adjustable mechanical spring (not shown) or by pneumatic pressure adjustment (not shown).

[0066] The item to be printed (not shown) may be a garment or any other fabric, such as leather or suede.

[0067] Printing head 103 comprises an array of inkjet nozzles for performing digital printing. The inkjet nozzles may comprise a drop-on-demand piezoelectric inkjet nozzle or a continuous piezoelectric inkjet nozzle. Additional heads may provide post-printing and may comprise, a curing unit for curing ink, an ironing unit for ironing the item to be printed, or a heat press. The curing unit may be an infrared curing unit, a hot air blowing curing unit or a microwave-curing unit. Printing machine 100 may comprise an external head for stencil printing.

[0068] Printing machine 100 may comprise a printing table (not shown) for holding the items to be printed. Printing machine 100 may be a carousel, a matrix, or any other printing machine, as will be discussed in greater detail below.

[0069] Machine 100 may comprise additional printing heads and/or additional flattening units and/or additional wetting units.

[0070] Machine 100 may comprise a controller for coordinating relative motion between the table assembly (not shown) and the flattening unit 102.

[0071] FIG. 2a is a schematic diagram of an exemplary printing machine with a roller-flattening unit. Printing machine 200 comprises a wetting unit 201, a flattening unit 202, and a printing head 203. Flattening unit 202, according

to the exemplary diagram, is a roller, which is capable of exerting pressure on the item to be printed to flatten outwardly extending fibers to the fabric after wetting and before printing. In the exemplary diagram, the flattening unit is located before the printing head and after the wetting unit, though the units may be arranged in a different order.

[0072] FIG. 2b is a schematic diagram of an exemplary printing machine with a polymeric or metal curtain-flattening unit. Digital printing machine 300 comprises a wetting unit 301, a flattening unit 302 and a printing head 303. Flattening unit 302 comprises a polymeric, silicone, polyethylene or metal curtain, which mechanically pushes downward on passing fabrics, thus exerting mechanical pressure on the item to be printed to flatten outwardly extending fibers to the fabric after wetting and before printing. In the exemplary diagram, the flattening unit is located before the printing head and after the wetting unit, though the units may be arranged in a different order.

[0073] Reference is now made to FIG. 3, which is a schematic diagram of a carousel-printing machine 46 in which one of the stations 47 is a wetting and flattening unit which includes a flattening unit 50 according to an embodiment of the present invention. The garment printing apparatus 46 comprises other stations such as a stencil-printing station 24, and digital printing station 25. A combination of stencil printing and digital printing may be used for printing a background color on the garment before performing the digital printing.

[0074] The wetting apparatus, which is part of digital printing station 47, comprises a wetting unit 48 comprising sprinklers and a tank part 49. The wetting unit may spray a wetting and immobilizing solution onto the textile or garment.

[0075] In use, a garment is placed on one of a series of printing trays, which go around the carousel and stop at stations as needed. At each station, the printing trays go through the process being offered at that station. In the case of wetting and flattening unit 47, the garment undergoes wetting, and then is flattened using flattening unit 50 and then the tray is moved onwards to digital printing station 25 for printing while still wet and with the fibers still adhering.

[0076] In an embodiment, for each printed garment, the stencil printing, if executed, is executed first, flash cured if required (not shown), then the wetting, then the flattening and then the digital printing. The execution of the stencil printing is optional and may be used for printing background colors or standard images.

[0077] The digital printing can be performed at any application stage, while following the digital unit a flash cure unit may be used to dry the digitally printed image.

[0078] FIG. 4 is a schematic drawing of a matrix-printing machine using a flattening unit, according to an embodiment of the present invention

[0079] Matrix 600 is a matrix of printing stations set out in linear manner so that a garment is placed on a tray and passes down a row of stations to be treated with a series of pre-printing, printing and post-printing functions. The matrix 600 features rail 601 which bears function head 623 and function head 622, rail 602 which bears function head 621 and function head 620, rail 603 which bears function head 619 and function head 618, rail 604 which bears function head 617 and function head 616, rail 605 which bears function head 615 and function head 614 and rail 606 which bears function head 612 and function head 613. Matrix 600 also features rail 608 which bears printing table (tray) 627, rail 609 which

bears printing table (tray) 626, rail 610 which bears printing table (tray) 625, and rail 611 which bears printing table (tray) 624.

[0080] In the exemplary diagram, function head 622 is a wetting head and function head 620 is a printing head. Flattening unit 628 is located between wetting head 622 and printing head 620 underneath rail 601. In alternative embodiments, the units may be arranged in a different order.

[0081] Printing table 624, in the exemplary diagram, is first fed under wetting unit 622 for wetting the garment and then is fed under flattening unit 628 while the garment is still wet, thereby causing the fibers to stick due to surface tension. The table then passes to printing head 620, where digital printing takes place.

[0082] In the matrix, unit 622 could alternatively be a screen-printing station, in which case the wetting and digital printing units would be moved one station further along.

[0083] Reference is now made to FIG. 5, which is a schematic diagram showing a view from the side of a textile-printing machine according to the present embodiments. Printing machine 500 comprises a wetting unit 501, a roller type flattening unit 502, and a printing head 503. A garment first passes the wetting unit 501, then is pressed when wet by the roller type flattening unit 502 and finally is printed under the printing unit 503, while the area being printed is still wet from the wetting unit and the fibers around the textile material still adhere to the underlying fabric.

[0084] FIG. 6 is a simplified flow chart illustrating an exemplary printing process for printing on a dark textile, using digital printing machine with a flattening unit according to the present embodiments.

[0085] As discussed above, when printing on a dark garment, a white undercoat may be printed on the garment prior to printing the image. In such a case, extensive wetting may be needed before printing the white undercoat. Thus, when printing an opaque layer, extensive wetting of the garment is performed before printing the white undercoat. Referring now to the drawing of FIG. 6, a process 700 of wetting, flattening and printing is shown which is suitable for dark colored backgrounds. In box 701, the garment is extensively wetted by a wetting unit in order to limit absorption of the ink by the fiber. In box 702, a flattening unit exerts pressure on the item to be printed in order to flatten outwardly extending fibers to the fabric after wetting and before printing. In box 703, the opaque undercoat is printed. In box 704, digital printing of the image on the wetted opaque layer is carried out by expelling drops of ink from nozzles of the printing head to desired points on the fabric, for example using the CMYK color system. Since the fibers of the fabric have been flattened and are clinging to the fabric surface, the fibers no longer intercept the ink drops and the drops thus land where intended on the fabric, leading to sharper printing.

[0086] FIG. 7 is a schematic side view showing in greater detail an exemplary digital printing machine comprising an exemplary flattening unit in operative state. Digital printing machine 700 comprises chassis 704, scan axis 703 and flattening assembly 706. Scan axis 703 comprises a rail which is placed on chassis 704 and provides the rail for bearing tray 705. Tray 705 is used for holding an item to be printed (not shown). The enlargement 706 shows in greater detail the assembly of the flattening unit. The exemplary flattening assembly comprises rigid arm 707 which applies a constant pressure in the on state, elastic flattening unit 701 which may be made of rubber, wetting unit 702, as counterweight 708,

which is here shown as a variable counterbalance to the weight applied by the rigid arm 707 to regulate the applied pressure, and the reversible attachment unit 711 that attaches or separates the flattening unit from the printing substrate.

[0087] Construction 710 holds the wetting spray units 702. Rigid arm 707 is attached to counterweight 708 which is here embodied as a variable counterbalance. Regulated counterbalance 708 imposes a required level of flattening pressure on flattening unit 701. Reversible attachment unit 711 comprises a piston that brings the flattening 701 squeegee into contact with the printing substrate and detaches it after flattening. Counterbalance 708 regulates the pressure on the flattening unit to press against tray 705 for flattening and detaches the flattening unit from tray 705 after flattening and before printing. Arm 707 of the flattening unit is hinged in order to allow pressure regulation unit 708 to regulate the weight applied to the garment. Attachment detachment unit 711 may transfer the pressure to the flattening unit when switched on. Adjusting the pressure on flattening unit 701 may be done for achieving a desired level of pressure. For example, different types of fabric or different levels of wetting may require different levels of pressure. Wetting unit 702 is used for wetting the item to be printed (not shown) before flattening. Wetting may be done, for example, by using water or acid solution optionally composed with wetting additive. Flattening unit 701 is shown in operative mode flattening the item to be printed (not shown) after wetting and before printing.

[0088] The item to be printed then passes under printing unit 709 to be printed while the fibers still adhere to the fabric.

[0089] FIG. 8 is a schematic side view of an exemplary digital printing machine comprising the exemplary flattening unit of FIG. 7 in non-operating state. FIG. 8 comprises the same units that are described in FIG. 7. By means of 711 piston the tension from counterweight 708 is released and flattening unit 701 and arm 707 are withdrawn from tray 705, and thus from the item to be printed (not shown). The garment etc is able to travel to the printing unit 709 to print on the item to be printed after wetting and flattening.

[0090] FIG. 9 is a view of an exemplary flattening unit in operative state. All units shown in FIG. 9 are shown and described in FIG. 7. Flattening unit 701 is operated by reversible attachment unit 711, for example a pneumatic piston (on/off) that either attaches or separates 701 flattening unit from the printed object, in order to press on the item to be printed with the desired flattening pressure and to release as required.

[0091] FIG. 10 is a schematic view of the exemplary flattening unit of FIG. 9 in non-operative state. All units shown in FIG. 10 are as shown and described in FIG. 9. Flattening unit 701 and arm 707 are horizontal to the tray (not shown) and are detached from the tray in order to enable the printing unit (not shown) to print on the item to be printed after wetting and flattening.

[0092] FIG. 11 is a close up view of the exemplary digital printing machine of FIGS. 9 and 10 comprising an exemplary flattening unit in operative state. Flattening unit 701 presses down on the item to be printed. FIG. 11 shows also sprinklers 702 being used for wetting before flattening.

[0093] It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the

invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub combination.

[0094] Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims. All publications, patents, and patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention.

What is claimed is:

1. A digital printing machine for printing textiles, the textiles comprising fabric woven within a plane, the fabric comprising fibers extending outwardly from said plane, the machine comprising:

- a. a wetting unit for wetting fabric to be printed prior to printing;
- b. a printing head for printing on said fabric; and
- c. a flattening unit for exerting pressure on said fabric to flatten said outwardly extending fibers to said fabric after wetting and before printing, thereby smoothing said fabric for printing.

2. The digital printing machine of claim 1; wherein said flattening unit is located between said wetting unit and said printing head.

3. The digital printing machine of claim 1; wherein said flattening unit causes said outwardly extending fibers to stick to said fabric.

4. The digital printing machine of claim 1, further comprising a printing table assembly for bringing said fabric to be printed under said flattening unit while said fabric is wet from said wetting unit, thereby causing the fibers to stick to the fabric.

5. The digital printing machine of claim 1, further comprising a controller for coordinating relative motion between said printing table-assembly and said flattening unit.

6. The digital printing machine of claim 1, wherein said flattening unit comprises one member of a group consisting of a polymeric or metal curtain, a metal or polymeric roller, an Air knife, a Polymeric squeegee made of PVC, silicone, viton, polyurethane, neoprene or Natural rubber, a thin flexible metal squeegee or a brushing strip.

7. The digital printing machine of claim 1, wherein said flattening unit is located on a side to be printed of said fabric.

8. The digital printing machine of claim 1, wherein said flattening unit further comprising a pressure regulation mechanism for regulating flattening pressure applied to said fabric.

9. The digital printing machine of claim 8, wherein said pressure regulation mechanism for said fabric is one member of a group consisting of a counter balance, adjustable mechanical spring and a pneumatic adjustable pressure unit.

10. The digital printing machine of claim 1, wherein said fabric to be printed is a garment.

11. The digital printing machine of claim **1**, wherein said fabric is a one member of the group consisting of felt, leather, suede, fibrous materials, porous materials, materials having high surface tension with the ink liquid, weaves, weaves of natural fibers, weaves of synthetic fibers, weaves of natural and synthetic fibers, weaves comprising mixtures of natural and synthetic fibers, weaves comprising wool, cotton, linen or nylon.

12. The digital printing machine of claim **1**, wherein said printing head comprises a plurality of inkjet nozzles for performing digital printing; wherein said inkjet nozzles further comprise a drop-on-demand piezoelectric inkjet nozzle or a continuous piezoelectric inkjet nozzle.

13. The printing machine of claim **1**, wherein said printing machine is a carousel.

14. The printing machine of claim **1**, wherein said printing machine is a matrix.

15. The printing machine of claim **1**, further comprising additional printing heads and/or additional flattening units and/or additional wetting units.

16. The printing machine of claim **4**, wherein said flattening unit is releasably tensioned to press on said table for said flattening.

17. A method of digital printing on fabric; comprising:

- a. wetting said fabric;
- b. exerting flattening pressure on a surface to be printed of said fabric after said wetting; and
- c. performing digital printing on said surface of said fabric after said exerting flattening pressure and whilst said fabric is still wet from said wetting.

18. The method of claim **17**, wherein said exerting flattening pressure after said wetting is to an extent sufficient to cause outwardly extending fibers of said fabric to adhere back to said fabric, thereby to provide a smooth surface for printing.

19. The method of claim **18**, wherein said printing is performed while said fibers continue to adhere to said fabric.

20. The method of claim **17**, further comprising adjusting said flattening pressure in accordance with a type of fabric being printed.

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