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(54) Title: PRINTING APPARATUS AND PRINT MASK GENERATION

(57) Abstract: A printing apparatus comprises a print head to print an image by scanning the print head across a print medium in a first direction and in a second direction, the second direction being opposite to the first direction. The print head includes an array of nozzles, the array comprising a first group of nozzles and a second group of nozzles which are arranged along the length of the array of nozzles. A controller controls the print head to eject print agent from a first number of nozzles of the first group of nozzles when scanning the print head in the first direction and from a first number of nozzles of the second group of nozzles when scanning the print head in the second direction; and further to eject print agent from a second number of nozzles of the first group of nozzles when scanning the print head in the second direction wherein the second number of nozzles is greater than one and less than the first number of nozzles of the first group of nozzles.



Printing Apparatus and Print Mask Generation

BACKGROUND

[001] An inkjet printing apparatus performs printing by ejecting a print agent, e.g. in the form of an ink droplet, onto a printing medium from nozzles of a print head. A print head may have a plurality of ink ejection nozzles and corresponding ink channels arranged in an array on the nozzle plate. The inkjet printing apparatus prints images sequentially on a print medium by scanning the print head across a print zone and transporting the print medium through the print zone, below the print head, in a direction perpendicular to the scanning direction. Printing can be performed in both scanning directions.

SHORT DESCRIPTION OF DRAWINGS

[002] Different examples are described with reference to the drawings.

Fig. 1a shows a schematic view of part of an inkjet printing apparatus, according to an example;

Fig. 1b shows a schematic view of part of an inkjet printing apparatus, according to another example;

Fig. 2 shows a schematic view of a nozzle plate of a print head, according to an example;

Fig. 3 shows a schematic view of a nozzle plate of a print head, according to another example;

Fig. 4a shows a schematic sectional view through ink ejection ports of the print head for illustrating ink droplet generation, according to an example;

Fig. 4b shows a schematic sectional view through ink ejection ports of the print head for illustrating ink droplet generation, according to another example;

Fig. 5a shows a schematic representation of ink droplets deposited by even-numbered nozzles and odd-numbered nozzles, according to an example;

Fig. 5b shows a schematic representation of ink droplets deposited by even-numbered nozzles and odd-numbered nozzles, according to another example;

Fig. 6 shows a diagram of color gamut for a masking strategy according to an example;

Fig. 7 shows a flow diagram of a method of controlling a printer according to an example; and

Fig. 8 shows a flow diagram of a method of generating a print mask according to an example.

DETAILED DESCRIPTION

[003] Fig. 1a shows a schematic overview of part of a printing apparatus 100 according to an example. The printing apparatus comprises at least one print head 10 which is supported for scanning across a print zone, in the first scanning direction and in the second scanning direction, opposite to the first scanning direction. The printing apparatus further comprises a controller 12 controlling the print head to eject a print agent. The printer may be a 2-D inkjet printer or a 3-D printer that prints on a bed of build material.

[004] Fig. 1b shows a schematic view of part of an inkjet printing apparatus 100 according to a more detailed example. The printer comprises a print media transport portion 110 and a print head scanning portion 120. The print media transport portion 110 comprises a platen 112 for supporting a print medium 130, the platen 112 schematically represented by a number of rollers, a platen motor 114, a position controller 116, and a memory 118. The position controller 116 is coupled to the platen motor 114 for driving the motor and hence the platen 112 to incrementally transport the print medium 130 through a print zone. The print head scanning portion 120 comprises a print head carriage 122 which is movable to slide along a carriage support rod 124 and which is driven by a carriage motor 126. The carriage 122 is coupled to a drop firing controller 128.

[005] The carriage 122 may carry a number of cartridges 132, 134 having print heads for scanning the print heads across the print medium 130 when it is transported through the print zone. The print heads may be multi-color ink to print heads, such as print heads having a number of reservoirs or being connected to a number of reservoirs for feeding and ejecting black ink, magenta ink, cyan ink and yellow ink. During scanning, the drop firing controller 128 drives the print heads to eject ink droplets or droplets of another printing agent to form a desired pattern or image on the medium 130. The drop firing controller 128 may apply a print

masking scheme to enable certain selected nozzles during each scan across the print medium 130, and disable non-selected nozzles.

[006] Print heads include nozzle plates wherein examples of different nozzle plates are shown in Fig. 2 and 3. A nozzle plate includes a plurality of orifices or nozzles each of which is coupled to a drop generator via an associated channel. In the example of Fig. 2, a nozzle plate 20 is shown having an array of nozzles N1, N2, N3, N4, N5, N6, ... which are arranged in two parallel columns 22, 24 along the length of the nozzle plate 20. Column 22 can be considered to be a left-hand column (as seen in the bottom view of the nozzle plate of Fig. 2) and includes odd-numbered nozzles N1, N3, N5, ..., and column 24 can be considered to be right-hand column (as seen in the bottom view of the nozzle plate of Fig. 2) and includes even-numbered nozzles N2, N4, N6, ... Further, in this example, column 22 can be considered to form a first group of nozzles and column 24 can be considered to form a second group of nozzles.

[007] Fig. 3 shows another example of a nozzle plate 30 from the bottom view thereof. In the example of Fig. 3, the nozzle plate 30 comprises a plurality of nozzles, numbered from 1 to 52, which are arranged in two symmetric arrays 32, 34 along the length of the nozzle plate 20. Array 32 can be considered to be a left-hand array (as seen in the bottom view of the nozzle plate of Fig. 3) and includes odd-numbered nozzles N1, N3, N5, ..., N51, and array 34 can be considered to be a right-hand array (as seen in the bottom view of the nozzle plate of Fig. 3) and includes even-numbered nozzles N2, N4, N6, ..., N52. Further, in this example, array 32 can be considered to form a first group of nozzles and array 34 can be considered to form a second group of nozzles.

[008] In another example, not shown in the drawings, even-numbered nozzles and odd-numbered nozzles may be arranged in an interleaving manner within the same column. Further, nozzle groups can be defined based on other criteria than odd and even-numbers or their location, such as right and left.

[009] In the examples described, the nozzle plate comprises even-numbered nozzles and odd-numbered nozzles. More generally speaking, the nozzle plate may comprise different groups of nozzles. A print head manufacturing process may cause different groups of nozzles to have different geometries. For example, even-numbered nozzles and odd-numbered nozzles

and their associated channels may have opposite inclinations relative to the nozzle plate. In another example, right-hand nozzles and left-hand nozzles in a nozzle array may have opposite inclinations, too. This may cause a variation in artifacts when printing with nozzles of the first group and the nozzles of the second group in the forward and backward directions.

[0010] An ink droplet ejected from the print head may include a main droplet and a small droplet separated out of the main droplet which form a large dot and a small dot, respectively, when landing on the print medium. This phenomenon can be described as “spray” and the small dot can be referred to as “satellite”. Satellites may degrade print quality. More specifically, during ink ejection, the main droplet may be generated to have a tail portion at its rear end (in the scanning direction) caused by a tension between the main droplet and an ink meniscus in the nozzle. The tail portion is separated from the main droplet and forms the satellite (e.g., small droplet). In other words, the surface tension pulls the small droplet backward in an ejection direction. Accordingly, the ejection speed of the small droplet is slower than that of the main droplet. If the opening surface of the nozzle is parallel to the print medium, the relationship between the landing positions of the main droplet and the small droplet will be different but the distance between the two droplets will be constant or approximately constant at a constant scanning speed, in both print head scanning directions. If, however, the nozzles are designed to be inclined relative to the opening surface, the ejection direction of the small droplet would be changed and the distance between the two droplets will vary depending on the scanning direction. This is explained with reference to Fig. 4a and 4b.

[0011] Figures 4a and 4b schematically show sectional views through a print head 40, illustrating two nozzle openings and associated channels, referred to herein as nozzles 42 and 44. Nozzle 42 can be considered to belong to a first group of odd-numbered nozzles, and nozzle 44 can be considered to belong to a second group of even-numbered nozzles. As shown in the drawings, nozzles 42 and 44 have opposite inclinations relative to the plane of a nozzle plate 46 and relative to a print medium 48. Figures 4a and 4b also illustrate ink drops 52, 54 which are just about to leave the nozzles 42, 44 at their openings at the nozzle plate 46, and additionally illustrate the flight paths and ejection speeds V_D and V_S of a main droplet (arrow V_D) and its satellite (arrow V_S) for the theoretical case of a static print head 40. Ejection speed of the main droplet is higher than of the satellite, as illustrated by the length of the arrows. Because the print head 40 is scanning across the print medium 48, in the case of

Fig. 4a from left to right, and in the case of Fig. 4b from right to left, depending on the scanning speed of the print head and the ejection directions and ejection speeds of the main droplet 56 and its satellite 58, different patterns may be generated on the print medium 48. In one scenario, the main droplet 56 and its satellite 58 ejected from the first nozzle 42 will be deposited on the print medium 48 at the same or at almost the same position, whereas the main droplet 56 and its satellite 58 ejected from the second nozzle 44 will be deposited spaced from each other, when scanning in a first direction, e.g. from left to right, as shown in Fig. 4a; in another scenario, the main droplet 56 and its satellite 58 ejected from the second nozzle 44 will be deposited on the print medium 48 at the same or at almost the same position, whereas the main droplet 56 and its satellite 58 ejected from the first nozzle 42 will be deposited spaced from each other, when scanning in a second direction, e.g. from right to left, as shown in Fig. 4b.

[0012] Other print heads may have other types of nozzle geometry variations, such as nozzles inclined in the opposite directions to those shown in figures 4a and 4b, or nozzle size and/or shape variations.

[0013] In some printer configurations, redundancy is provided by allowing two nozzles to print the same pixel. This can be achieved by enabling all nozzles while scanning in both directions, i.e. from left to right and from right to left. This explained with reference to Fig. 5a.

[0014] In Fig. 5a, black dots represent a main droplet 150, 151 and its satellite 152, 153 generated by an odd-numbered nozzle, and white dots represent a main droplet 154, 155 and its satellite 156, 157 generated by an even-numbered nozzle, wherein the scanning direction is represented by arrows 160, 162. The left-hand column illustrates the droplet/satellite pairs generated when scanning in the first direction 160, e.g. from left to right, and the right-hand column illustrates the droplet/satellite pairs generated when scanning in the second direction 162, e.g. from right to left. If all nozzles are enabled in either scanning direction, 50% of the nozzles will eject ink droplets including spray where a satellite of a main droplet is deposited on the print medium at a substantial offset from the position of the main droplet. Satellites degrade printing quality. If satellites should be avoided altogether, it could be considered to apply a masking scheme where only odd-numbered nozzles are enabled in the first scanning direction 160, e.g. from left to right, and only even-numbered nozzles are

enabled when scanning in the second direction 162, e.g. from right to left, as illustrated by the arrows in Fig. 5a. As a consequence, in a strict odd/even masking strategy, only 50% of all nozzles would be used for printing in one direction. Whereas this would reduce undesired artifacts generated by spray, it would reduce the total amount of ink ejected to 50% and also may reduce the printing speed and color gamut.

[0015] In an example, the printing apparatus and method apply a masking scheme which allows ejecting a print agent from the first number of the first group of nozzles when scanning the print head in the first direction and from the first number of the second group of nozzles when scanning the print head in the second direction, and which additionally allows ejecting the print agent from a second number of the first group of nozzles when scanning the print head in the second direction and/or from a second number of the second group of nozzles when scanning the print head in the first direction. The first number may include all of the nozzles of the first group and the second group of nozzles, respectively. The second number may include at least one nozzle and less than the first number of nozzles of the respective group of nozzles. For ease of reference, in the following description, the second number of nozzles also is referred to as a “subset”.

[0016] In an example, whereas the first group of nozzles may produce satellites, these satellites will be deposited on the print medium at the same or almost the same position as their main droplets when scanning in the first direction. Similarly, whereas the second group of nozzles also may produce satellites, these satellites will be deposited on the print medium at the same or almost the same position as their main droplet when scanning in the second direction. On the other hand, the satellites produced by the first group of nozzles may be deposited on the print medium at a noticeable offset from the main droplet when scanning in the second direction; and the satellites produced by the second group of nozzles may be deposited on the print medium at a noticeable offset from their main droplet when scanning in the first direction.

[0017] An example of a masking scheme is illustrated with reference to Fig. 5b. Fig. 5b illustrates, on the left-hand side, an example of printing artifacts generated by a nozzle array, including odd-numbered nozzles and even-numbered nozzles, when scanning in one direction (from left to right in this example); and on the right-hand side, an example of printing artifacts generated by the same nozzle array when scanning in the opposite direction. A printing

“artifact”, in this example, comprises a main droplet 150, 151, 154, or 155 and its satellite 152, 153, 156, or 157 ejected from a nozzle, wherein the satellite may be deposited at the same or approximately same position as its main droplet or it may be deposited offset therefrom, depending on the orientation of the nozzle and the scanning direction.

[0018] In the example illustrated in Fig. 5b, odd-numbered nozzles represent nozzles of a first group and even-numbered nozzles represent nozzles of a second group, the two groups having different nozzle geometries, such as opposite nozzle inclinations, as illustrated in Fig. 4a and 4b. In the example of the masking scheme illustrated in Fig. 5b, when scanning in a first direction, e.g. from left to right, all nozzles of the first group, e.g. all odd-numbered nozzles, are enabled; and when scanning in a second opposite direction, all nozzles of the second group, e.g. all even-numbered nozzles, are enabled. This is illustrated by the solid arrows 160, 162. Additionally, a subset of the even-numbered nozzles is enabled when scanning in the first direction and a subset of the odd-numbered nozzles is enabled when scanning in the second (opposite) direction. This is illustrated by the dashed arrows 164, 166. The subset includes at least one nozzle and less than all nozzles of the respective group. In the schematic example of Fig. 5b, the subset includes 10% of the nozzles of the respective group; more specifically, one out of five nozzles, without any limitation thereto. In other examples, the subset may include from 5% to 50% of the nozzles of the respective group, e.g. 5%, 10%, 20%, 30%, 40%, or 50%, or any value there between.

[0019] Enabling a subset of the nozzles of the group of nozzles which, in a particular scanning direction, generate satellites having an offset from their main droplet (in the following, for ease of reference, these nozzles sometimes are referred to as “unfavorable” nozzles), can provide a good compromise between a reduction of spray and the deposition of a sufficient amount of ink to obtain a good image quality. By enabling less than all “unfavorable” nozzles in a particular scanning direction, the amount of spray can be controlled and is reduced when compared to a masking scheme which enables all nozzles in both scanning directions. By enabling some of the “unfavorable” nozzles in a particular scanning direction, the overall amount of ink deposited can be increased, resulting in an improved color gamut.

[0020] In one example, a balance between the reduction of spray and obtaining high color gamut, in a high-pass quality print mode, such as a 10 pass mode or higher, applying a

maximum ink firing frequency of about 9 kHz, is obtained by a masking scheme where 90% of the nozzles of a particular group are used for printing in only one direction e.g. using odd-numbered nozzles in the first direction and even-numbered nozzles in the second direction, and 10% of the nozzles of each group are used for printing in both directions. In total, 20% of all nozzles are used for printing in the “unfavorable” direction. In this example, the print mode is controlled so that enabling only nozzles of a particular group in one scanning direction would allow depositing 3.2 drops per pixel. Accordingly, enabling an extra 20% of the nozzles for printing in the “unfavorable” scanning direction allows firing 0.8 additional drops per pixel so that a total of 4 drops per pixel can be deposited in one scan, without an increase of firing frequency or the number of passes per pixel. Depositing four drops per pixel allows depositing one drop of each color from a four color print head, including a black ink drop, a magenta ink drop, a cyan ink drop and a yellow ink drop. Whereas “unfavorable” nozzles generate a certain amount of spray, this can be taken into account in view of the improved color gamut.

[0021] One example of a print mask for a 12 pass print mode is further illustrated below. Table I shows each pass and the percentage of odd-numbered nozzles and even-numbered nozzles which are fired in the respective pass:

Pass	1	2	3	4	5	6	7	8	9	10	11	12
Odd nozzles	100%	10%	100%	10%	100%	10%	100%	10%	100%	10%	100%	10%
Even nozzles	10%	100%	10%	100%	10%	100%	10%	100%	10%	100%	10%	100%

Table I

[0022] This means that

100% of the odd-numbered nozzles will fire in forward passes (passes 1, 3, 5, 7, 9, 11), considered as Nozzle group A;

10 % of even-numbered nozzles will fire in forward passes (passes 1, 3, 5, 7, 9, 11), considered as Nozzle group B;

100% of the even-numbered nozzles will fire in reverse passes (passes 2, 4, 6, 8, 10, 12), considered as Nozzle group C; and

10% of the odd-numbered nozzles will fire in reverse passes (passes 2, 4, 6, 8, 10, 12), considered as Nozzle group D.

[0023] Accordingly, in this example of a 12 pass print mode, nozzle groups A and C fire in their desired direction and they can fire overall of 3.2 drops per pixel (for a given carriage speed and mask size, and for a given firing frequency not exceeding a firing frequency limit of 9KHz). The nozzles groups B and D (that also fire in their not desired direction, or also fire in the “unfavorable” direction) will give an extra capacity to fire more drops per pixel. For example, 20% of nozzles of a whole print head having 5120 nozzles will allow for 1024 extra nozzles to fire. In this example, the nozzles are selected for firing to obtain equal or approximately equal usage of the nozzles of the first group of nozzles and the second group of nozzles

[0024] The print mask does not have to follow the same pattern in each pass but patterns can be varied. For example, nozzle groups B and D can be used according to a ramp shape to be used more in the middle passes and less in the first and last passes of a multi-pass print mode, e.g. a 12 pass print mode. This can be considered as progressive masking and helps smooth learning image quality. An example of a weighted mask is shown in table II below:

Pass	1	2	3	4	5	6	7	8	9	10	11	12
Odd nozzles	100%	10%	100%	20%	100%	30%	100%	30%	100%	20%	100%	10%
Even nozzles	10%	100%	20%	100%	30%	100%	30%	100%	20%	100%	10%	100%

Table II

[0025] In this example, the number of nozzles which are used in the “unfavorable” scanning direction varies between 10% and 30% and is higher in the middle passes then in the first and last passes in a 12 pass print mode. In average, 20% of the “unfavorable” nozzles in each group of odd-numbered nozzles and even-numbered nozzles are used.

[0026] In an example, where an image was printed according to the above masking scheme, shown in table I, the color gamut achieved by an ink volume of 3.2 drops per pixel was compared to the color gamut achieved by an ink volume of 4.0 drops per pixel. This comparison is shown in Fig. 6. Fig. 6 illustrates the color gamut difference between strict odd/even masking strategy and a masking strategy which allows for using a certain percentage of nozzles in the “unfavorable” scanning direction. Fig. 6 shows from top to bottom, and a-b diagram, an L-a diagram, and an L-b diagram. In the diagrams of Fig. 6, the color gamut achieved by 3.2 drops per pixel (strict odd/even masking city) is shown in gray lines and the

color gamut achieved by 4.0 drops per pixel (modified masking strategy) is shown in black lines. The comparison shows that 3.2 drops per pixel achieve 79% of the color gamut of 4.0 drops per pixel. Further, the pantone coverage of 3.2 drops per pixel is 67% whereas the pantone coverage of 4.0 drops per pixel is 73%.

[0027] In examples of this masking scheme, the first subset may comprise different ones of the first group of nozzles in different scans of the print head in the second direction, and the second subset may comprise different ones of the second group of nozzles in different scans of the print head in the first direction. The nozzles of the first subset and the nozzles of the second subset may be selected in respective scans of the print head in the second direction and in the first direction to obtain equal or approximately equal usage of the nozzles of the first group of nozzles and the second group of nozzles. For example, the nozzles of the first subset and the nozzles of the second subset can be selected in a randomized manner from the first group of nozzles and the second group of nozzles in respective scans of the print head in the second direction and in the first direction.

[0028] Fig. 7 shows a flow diagram of a method of controlling a printer according to an example; and Fig. 8 shows a flow diagram of a method of generating a print mask according to an example.

[0029] Fig. 7 illustrates an example of a method of controlling a printer, the printer having a print head including an array of nozzles, the array comprising a first group of nozzles and a second group of nozzles which are arranged along the length of the array of nozzles, wherein nozzles of the first group and nozzles of the second group generate ink drop and spray of different geometries. The method comprises controlling 72 the print head to scan across a print medium in a first direction and allowing 74 a print agent to be ejected from any one of the first group of nozzles and from a subset of the second group of nozzles when scanning the print head in the first direction. The method further comprises controlling 76 the print head to scan across the print medium in a second direction, the second direction being opposite to the first direction, and allowing 78 the print agent to be ejected from any one of the second group of nozzles and from a subset of the first group of nozzles when scanning the print head in the second direction. Each subset may include at least one nozzle and less than all nozzles of the respective group of nozzles.

[0030] Fig. 8 illustrates an example of generating a print mask for incremental printing of an image, the printing using image-forming elements in an array, the image-forming elements including odd-numbered elements and even-numbered elements in the array. The method comprises generating 82 a first print mask to be used for printing in a first direction, the first print mask enabling all odd-numbered image-forming elements and a subset of the even-numbered image-forming elements, and generating 84 a second print mask to be used for printing in a second direction, opposite to the first direction, the second print mask enabling all even-numbered image-forming elements and a subset of the odd-numbered image-forming elements. Each subset may include at least one image-forming element and less than all odd-numbered or even-numbered image-forming elements.

[0031] The masking scheme provides a good compromise between printing quality, printing speed and color gamut. In one example, the masking scheme can be based on an even/odd masking strategy, where all odd-numbered nozzles are enabled in a first direction and all even-numbered nozzles are enabled in a second direction. To improve color quality, additionally, a subset of the even-nozzles can be enabled in the first direction and a subset of the odd-numbered nozzles can be enabled in the second direction. The subset can be selected in such a way that artifacts caused by spray are still acceptable and color gamut is improved when compared to a strict odd/even masking strategy. For example, in each scan, 20% of the “unfavorable” nozzles can be enabled. The “unfavorable” nozzles can be selected randomly or in such a way to obtain equal or almost equal usage of the nozzles across multiple scans.

Claims

1. A printing apparatus comprising:

a print head to print an image by scanning the print head across a print medium in a first direction and in a second direction, the second direction being opposite to the first direction, the print head including an array of nozzles, the array comprising a first group of nozzles and a second group of nozzles arranged along the length of the array of nozzles; and

a controller to:

eject print agent from a first number of nozzles of the first group of nozzles when scanning the print head in the first direction and from a first number of nozzles of the second group of nozzles when scanning the print head in the second direction; and

eject print agent from a second number of nozzles of the first group of nozzles when scanning the print head in the second direction, wherein the second number of nozzles is greater than one and less than the first number of nozzles of the first group of nozzles.

2. The printing apparatus of claim 1, wherein the controller is further to eject print agent from a second number of nozzles of the second group of nozzles when scanning the print head in the first direction, wherein the second number of nozzles is greater than one and less than the first number of nozzles of the second group of nozzles
3. The printing apparatus of claim 1, wherein the nozzles of the first group and nozzles of the second group have different geometries.
4. The printing apparatus of claim 3, wherein
the first group of nozzles is a group of odd-numbered nozzles and the second group of nozzles is a group of even-numbered nozzles on a print head to die; or
the first group of nozzles is a group of left side nozzles and the second group of nozzles is a group of right side nozzles on a print head to die.

5. The printing apparatus of claim 1, wherein each second number of nozzles includes between 5% and 40% of the nozzles of the respective group of nozzles or 10% or about 10% of the nozzles of the respective group of nozzles.
6. The printing apparatus of claim 1, wherein the first group of nozzles is a group of odd-numbered nozzles and the second group of nozzles is a group of even-numbered nozzles on a print head to die; and
the even-numbered nozzles and the odd-numbered nozzles are arranged in an alternating manner in a single nozzle column or in two parallel nozzle columns where the even-numbered nozzles and the odd-numbered nozzles are offset in the length direction of the columns.
7. The printing apparatus of claim 1, wherein the print head comprises a nozzle plate and the first group of nozzles and the second group of nozzles are arranged along the nozzle plate wherein the nozzles of the first group and the nozzles of the second group are inclined in opposite directions relative to the plane of the nozzle plate.
8. A method of controlling a printer, the printer having a print head including an array of nozzles, the array comprising a first group of nozzles and a second group of nozzles arranged along the length of the array of nozzles, wherein nozzles of the first group and nozzles of the second group generate ink droplets of different geometries, the method comprising:
controlling the print head to scan across a print medium in a first direction and in a second direction, the second direction being opposite to the first direction, and
allowing a print agent to be ejected from a first number of nozzles of the first group of nozzles when scanning the print head in the first direction and from a first number of nozzles of the second group of nozzles when scanning the print head in the second direction, and
additionally allowing the print agent to be ejected from a second number of nozzles of the first group of nozzles when scanning the print head in the second direction, wherein the second number of nozzles is greater than one and less than the first number of nozzles of the first group of nozzles.

9. The method of claim 8, comprising:
allowing the print agent to be ejected from the second number of nozzles of the first group of nozzles when scanning the print head in the second direction and from a second number of nozzles of the second group of nozzles when scanning the print head in the first direction.
10. The method of claim 8, wherein each second number of nozzles includes between 5% and 40% of the nozzles of the respective group of nozzles.
11. The method of claim 8, wherein each second number of nozzles includes 10% or about 10% of the nozzles of the respective group of nozzles.
12. The method of claim 8, wherein the second number of nozzles of the first group comprises different ones of the first group of nozzles in different scans of the print head in the second direction, and the second number of nozzles of the second group comprises different ones of the second group of nozzles in different scans of the print head in the first direction.
13. The method of claim 12, wherein the nozzles of the second number of nozzles of the respective groups are selected in respective scans of the print head in the second direction and in the first direction to obtain equal or approximately equal usage of the nozzles of the first group of nozzles and the second group of nozzles.
14. The method of claim 13, wherein the nozzles of second number of nozzles of the respective groups are selected in a randomized manner from the first group of nozzles and the second group of nozzles in respective scans of the print head in the second direction and in the first direction.
15. A method of generating a print mask for incremental printing of an image, the printing using image-forming elements in an array, the image-forming elements including odd-numbered elements and even-numbered elements in the array; the method comprising: generating a first print mask to be used for printing in a first direction, the first print mask enabling the first number of the odd-numbered image-forming elements and a second number of the even-numbered image-forming elements, and

generating a second print mask to be used for printing in a second direction, opposite to the first direction, the second print mask enabling the first number of the even-numbered image-forming elements and a second number of the odd-numbered image-forming elements,

wherein each second number of image-forming elements is greater than one and less than the first number of image-forming elements.

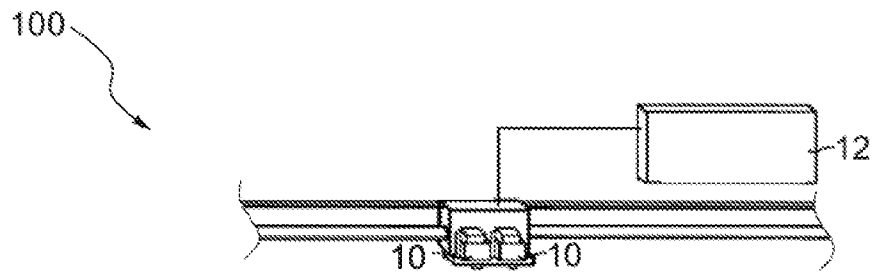


FIG. 1a

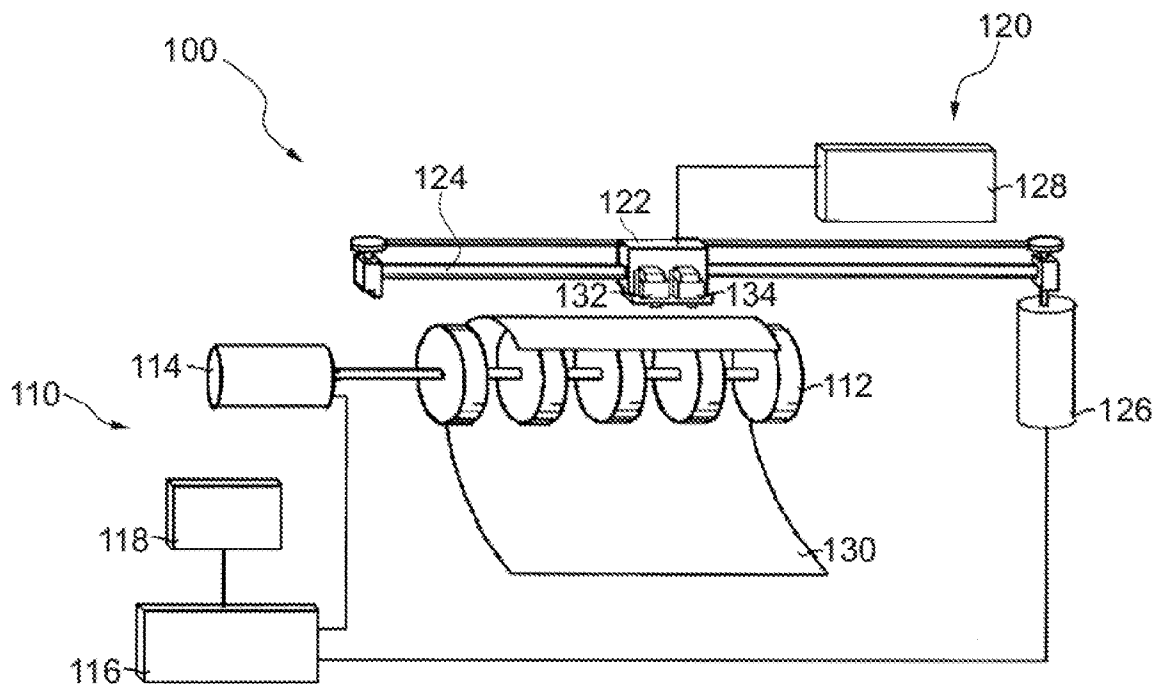


FIG. 1b

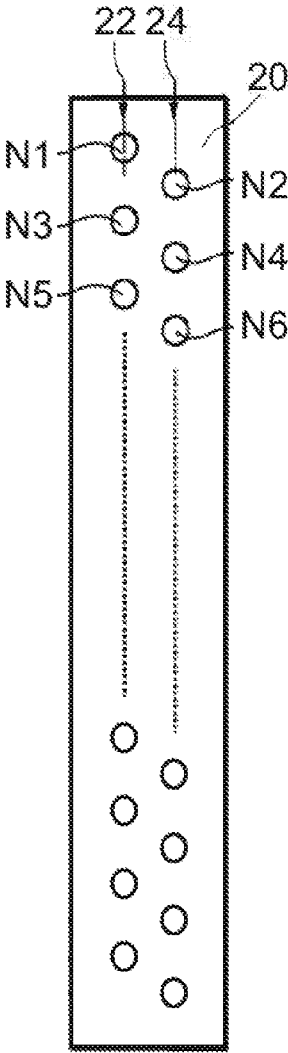


FIG.2

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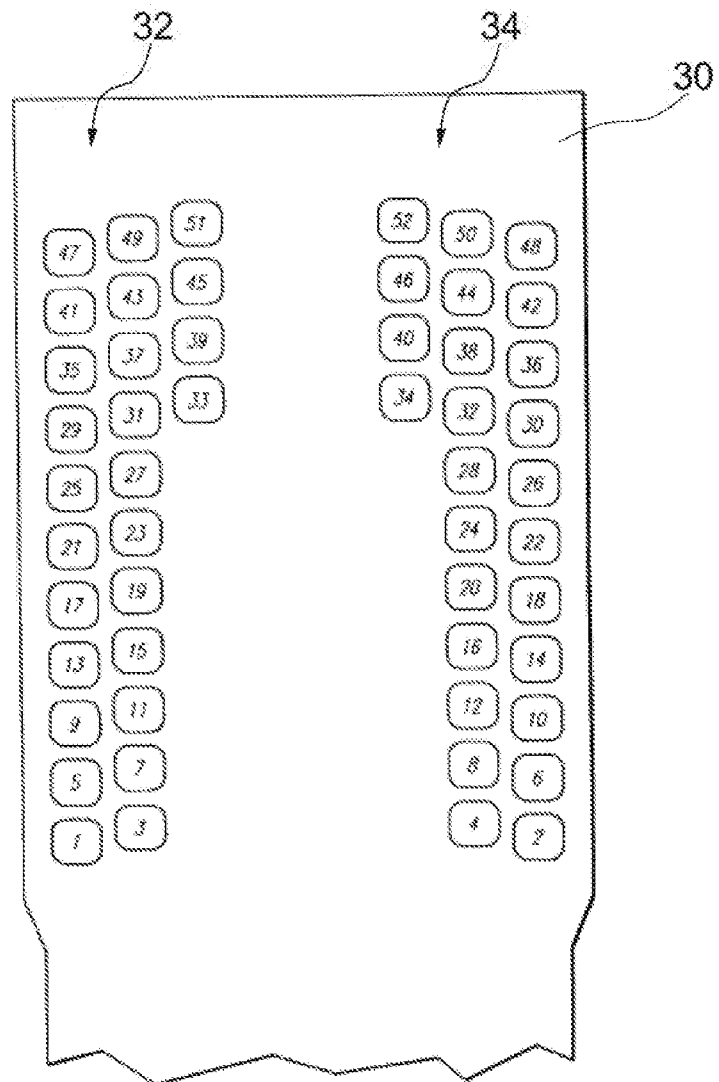


FIG.3

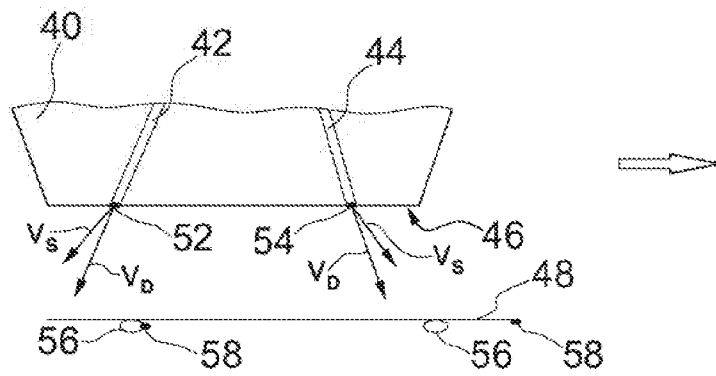


FIG. 4a

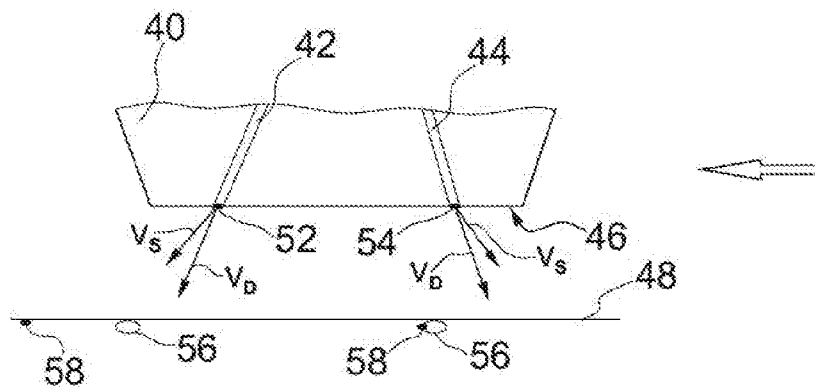


FIG. 4b

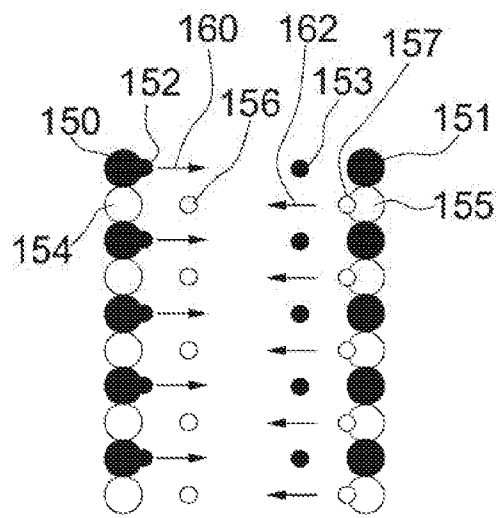


FIG.5a

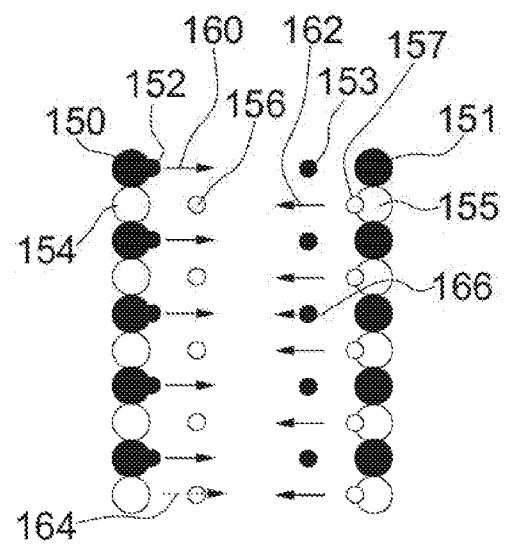


FIG.5b

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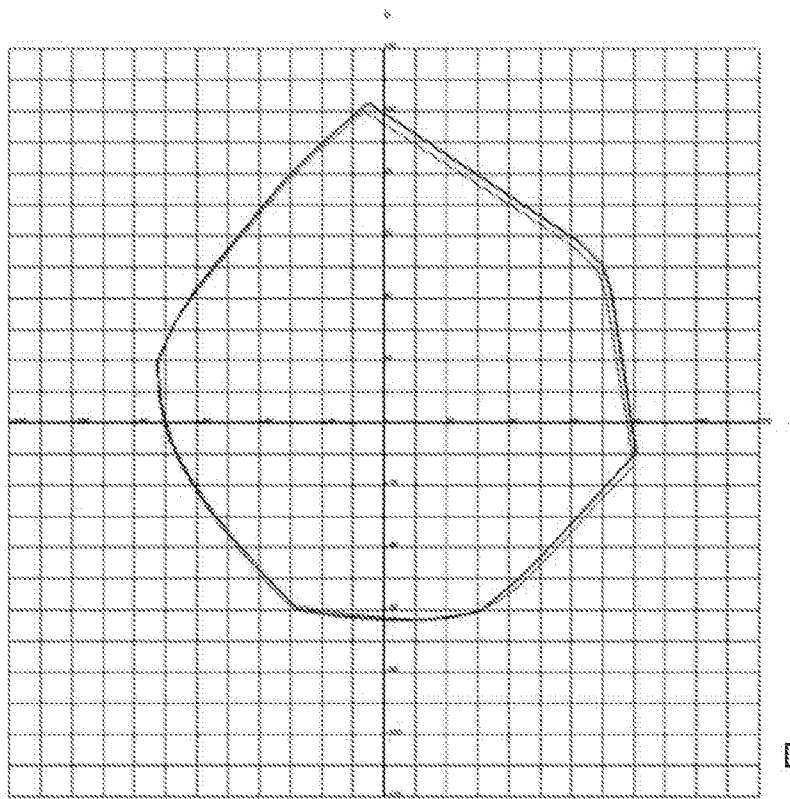


Diagram a-b

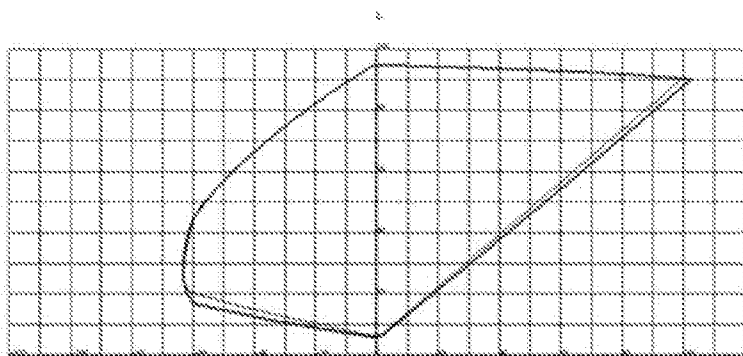


Diagram L-a

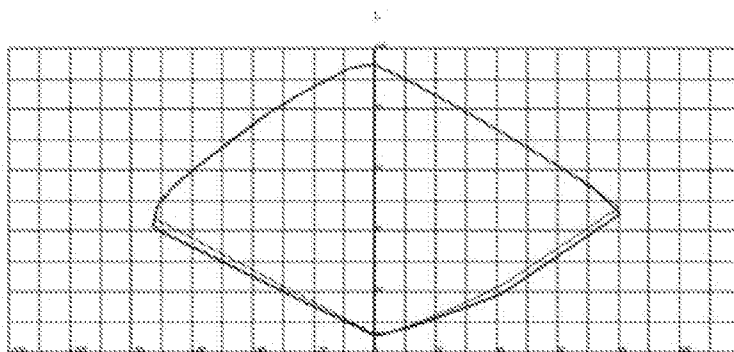


Diagram L-b

FIG. 6

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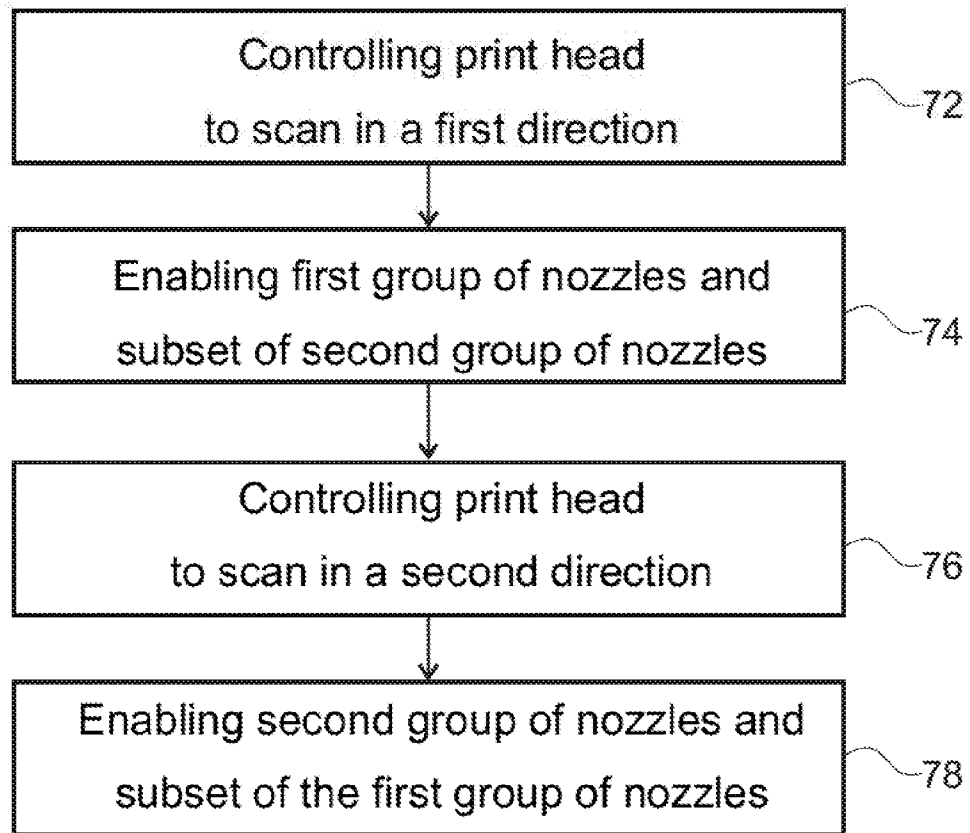


FIG.7

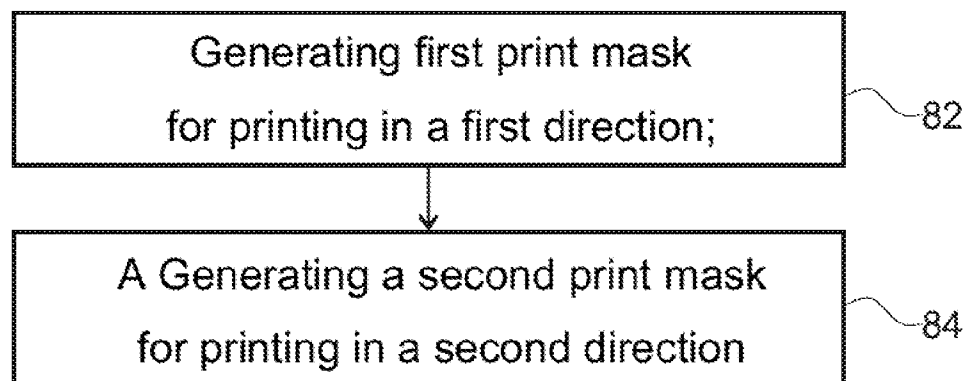


FIG.8

INTERNATIONAL SEARCH REPORT	International application No. PCT/US 2016/058779								
A. CLASSIFICATION OF SUBJECT MATTER G06F 3/12 (2006.01) B41J 29/38 (2006.01) B41J 2/005 (2006.01)									
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) G06F 3/00-3/12, B41J 29/00-29/38, 2/00-2/145									
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) PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, Information Retrieval System of FIPS									
C. DOCUMENTS CONSIDERED TO BE RELEVANT									
Category*	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; padding: 5px;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="width: 10%; padding: 5px;">Relevant to claim No.</th> </tr> <tr> <td style="padding: 5px;">X US 2009/0102875 A1 (CANON KABUSHIKI KAISHA) 23.04.2009, abstract, paragraphs [0010], [0013], [0018]-[0019], [0035], [0051], [0064]-[0066]</td> <td style="text-align: center; padding: 5px;">1-15</td> </tr> <tr> <td style="padding: 5px;">A US 2005/0052493 A1 (ANDRE VAN DOORN et al) 10.03.2005</td> <td style="text-align: center; padding: 5px;">1-15</td> </tr> <tr> <td style="padding: 5px;">A US 2010/0289843 A1 (CANON KABUSHIKI KAISHA) 18.11.2010</td> <td style="text-align: center; padding: 5px;">1-15</td> </tr> </table>	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X US 2009/0102875 A1 (CANON KABUSHIKI KAISHA) 23.04.2009, abstract, paragraphs [0010], [0013], [0018]-[0019], [0035], [0051], [0064]-[0066]	1-15	A US 2005/0052493 A1 (ANDRE VAN DOORN et al) 10.03.2005	1-15	A US 2010/0289843 A1 (CANON KABUSHIKI KAISHA) 18.11.2010	1-15
Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.								
X US 2009/0102875 A1 (CANON KABUSHIKI KAISHA) 23.04.2009, abstract, paragraphs [0010], [0013], [0018]-[0019], [0035], [0051], [0064]-[0066]	1-15								
A US 2005/0052493 A1 (ANDRE VAN DOORN et al) 10.03.2005	1-15								
A US 2010/0289843 A1 (CANON KABUSHIKI KAISHA) 18.11.2010	1-15								
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.									
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Date of the actual completion of the international search 09 June 2017 (09.06.2017)	Date of mailing of the international search report 27 July 2017 (27.07.2017)								
Name and mailing address of the ISA/RU: Federal Institute of Industrial Property, Berezhevskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	Authorized officer A. Tokarev Telephone No. (495) 531-64-81								