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(72) Inventors:
• **PEREZ GELLIDA, Francisco Javier**
1260 Nyon (CH)
• **MEYER, Raphael**
1040 St-Barthélemy (CH)

(71) Applicant: **BOBST MEX SA**
1031 Mex (CH)

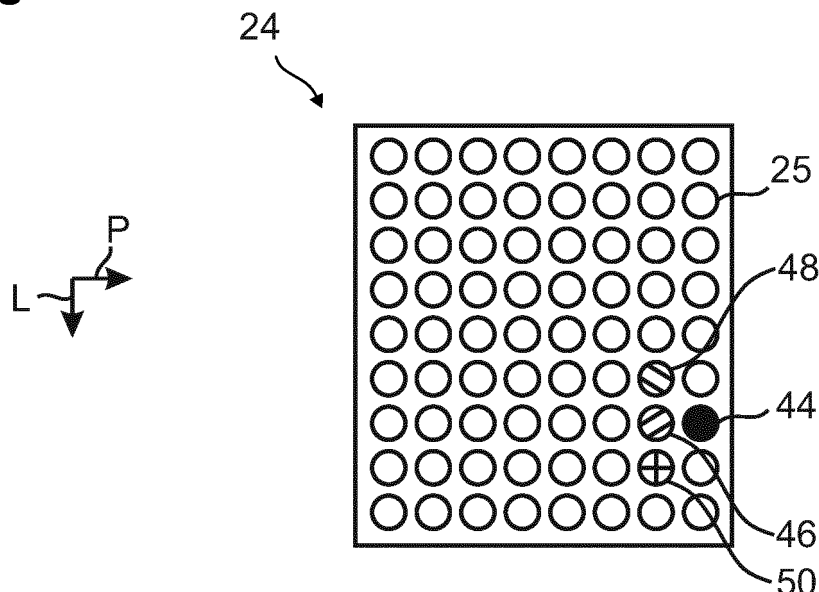
(74) Representative: **Wagner, Sigrid**
Bobst Mex SA
P.O. Box
1001 Lausanne (CH)

(54) **METHOD FOR CONTROLLING A PRINTING DEVICE AND PRINTING DEVICE**

(57) A method for controlling a printing device (10) comprising a printhead (20) with a plurality of nozzles (25) along a printing direction of the printhead (20) and a plurality of nozzles (25) along a lateral direction of the printhead (20) being perpendicular to the printing direction. The method comprises the following steps: Detecting a defective nozzle and a pixel position associated to the defective nozzle along the lateral direction of the printhead. Then, a target color associated to the defective nozzle is determined and one or more substitute inks are

ejected from a multitude of compensating nozzles to form substitute ink dots, wherein the substitute ink dots are of a substitute color or add up to a substitute color. The multitude of compensating nozzles comprises a first compensating nozzle associated to the same pixel position along the lateral direction of the printhead (20) as the defective nozzle and a second and third compensating nozzle associated to a pixel position adjacent to the pixel position of the first compensating nozzle at opposite sides along the lateral direction of the printhead (20).

Fig. 2



Description

[0001] The invention relates to a method for controlling a printing device comprising a printhead with a plurality of nozzles and a printing machine.

[0002] In digital inkjet printing, ink is dosed on a substrate by means of a multitude of nozzles from a printhead of the respective printing device, thereby forming ink dots or pixels on the substrate. The type of ink dots as well as their size and distribution on the substrate result in a color impression being perceived by a human eye.

[0003] However, individual nozzles of the printhead can become inoperable during operation of the printing machine, e.g. by becoming deviated, lost, clogged, crooked or split. In this case, no or at least only insufficient amounts of ink can be dosed anymore by the printhead at the position of the substrate associated to the defective nozzle, resulting in reduced printing quality. E.g., the affected area of the substrate is perceived as having an uneven color appearance.

[0004] One possibility to avoid this problem is to provide a redundancy nozzle for each of the nozzles in the printhead. Said redundancy nozzle can continue dosing the same ink in case a nozzle becomes defective. However, keeping a high number of redundant nozzles result in larger and more expensive printheads, which is not desirable for many applications.

[0005] Another possibility is to compensate for a defective nozzle by nozzles arranged adjacent to the defective one. E.g., in case a defective nozzle is detected, the adjacent nozzles can provide an increased amount of ink next to the parts of the substrate the defective nozzle would have printed upon. The idea behind this solution is that the additional amount of ink spreads into the missing area left on the substrate, thereby eventually filling up the gap. However, the extent any ink spreads on a substrate is highly dependent on the interaction of the substrate with the respective ink, especially based on the surface tension of the ink on the substrate. In some cases, the additional ink does not spread at all but coalesce right on the edges of the empty area, actually resulting in even worse printing results by pronouncing the empty areas of the substrate.

[0006] EP 0 983 885 A2 discloses a method for operating an ink jet printer in which an inoperative black printing element is substituted for by printing with a plurality of non-black color printing elements at the pixel locations on which the black printing element would have been printed upon.

[0007] However, the quality of the printing results achievable by this method depends strongly on the accuracy of delivering the alternative inks on the exact same locations on the substrate the defective nozzle would have been printed upon. In case of high-resolution and high-throughput printing, this accuracy cannot be achieved in a reliable manner or only by using very expensive equipment. Additionally, the achievable color match between the color obtained by the non-black color printing elements and actual black still depends on the spreading behavior of the alternative inks on the substrate, i.e. on the individual surface tension of each of the non-black inks used for compensation.

[0008] In view of the above, it is an object of the invention to provide a printing machine and a method for controlling a printing machine which provides good and reliable printing results even in case of one or more defective printing nozzles. Preferably, the printing machine should be simple and cheap.

[0009] The object of the invention is solved by a method for controlling a printing device comprising a printhead with a plurality of nozzles along a printing direction of the printhead and a plurality of nozzles along a lateral direction of the printhead being perpendicular to the printing direction. The method comprises the following steps: Detecting a defective nozzle and a pixel position associated to the defective nozzle along the lateral direction of the printhead (i.e. perpendicular to substrate's running direction). Then, a target color associated to the defective nozzle is determined and one or more substitute inks are ejected from a multitude of compensating nozzles to form substitute ink dots, wherein the substitute ink dots are of a substitute color or add up to a substitute color. The multitude of compensating nozzles comprises a first compensating nozzle associated to the same pixel position along the lateral direction of the printhead as the defective nozzle and a second and third compensating nozzle associated to a pixel position adjacent to the pixel position of the first compensating nozzle at opposite sides along the lateral direction of the printhead.

[0010] The invention is based on the idea to use a multitude of compensating nozzles arranged at different but adjacent positions along the lateral direction of the printhead. In this way, a higher tolerance in positioning the compensating nozzles during ejection of the one or more substitute ink is achieved, while at the same time ensuring a high printing quality.

[0011] Further, even in case the one or more substitute ink ejected from the compensating nozzles exhibits only a low amount of ink spreading on a substrate printed upon, the visual perception of the area the substitute ink dots are printed upon is smooth because of the larger area the substitute ink is provided on compared to merely using a single compensating nozzle as known in the art.

[0012] The compensating nozzles and the defective nozzle are members of the plurality of nozzles of the printhead.

[0013] The plurality of nozzles of the printhead can be an array of nozzles. In such an array, several nozzles associated to the same ink are arranged next to each other along the printing direction of the printhead forming a nozzle line. Along the lateral direction of the printhead, more than one nozzle line is arranged next to each other, each nozzle line preferably being associated to another ink. Such an array of nozzles allows for printing a multitude of inks on a substrate within a single pass of the printhead.

[0014] The term "pixel position" denotes an area on a substrate the printhead prints upon with a nozzle of the printhead associated to this pixel position. Generally, this area on the substrate is not completely filled with the respective ink, but with one or more dots formed by the ink on the substrate.

[0015] The substrate preferably is paper, cardboard, plastic, films or foil.

[0016] Here and in the following the expressions "ink color", "color of the ink", "ink of color" and similar denote the color impression as perceived by the human eye when the respective ink is provided on the substrate.

[0017] For increasing the number of possible ink mixtures and therefore for being able to use a wider spectrum of possible substitute colors, the printhead can have nozzles associated to five or more base colors, preferably nozzles associated to six to eight base colors.

[0018] E.g., the base colors can comprise at least one further base color other than cyan, magenta, yellow and black, i.e. at least one further base color other than used in conventional CMYK printing.

[0019] Preferably, the base colors comprise or consist of cyan, magenta, yellow, black, orange, violet and white, i.e. preferably the printing device can print colors in the so-called CMYKOV+W color space.

[0020] In one variant, the target color is black. Being able to substitute a defective nozzle being responsible for printing black color is especially important, as the printing quality perceived by the human eye can diminish strongly in case parts of a printed motif is missing black. Therefore, it is especially desirable to compensate for missing black ink dots.

[0021] For reliably finding the optimum color match between the substitute color and the target color, the substitute color can be determined as being the color of ink dots achievable by the one or more substitute inks with a minimum distance to the target color in the CIELAB space.

[0022] For this purpose, the substitute color can be determined as being the color which has the smallest Euclidian distance to the target color in the CIELAB space and which is achievable by ink dots of the one or more substitute inks associated to the compensating nozzles.

[0023] E.g., the distance can be calculated as the ΔE value, as defined in DIN EN ISO 11664-4 using the formula

$$\Delta E = \sqrt{(L_s^* - L_t^*)^2 + (a_s^* - a_t^*)^2 + (b_s^* - b_t^*)^2}.$$

as the distance between the substitute color $C_s(L^*a^*b^*)$ and the target color $C_t(L^*a^*b^*)$ with L^* being the perceptual lightness and a^* and b^* defining the plane describing the unique colors of human vision, i.e. red, green, blue and yellow, as defined by the CIELAB space.

[0024] Hence, a value of $\Delta E = 0$ means that the distance in coordinate space between the substitute color and the target color is zero, implying that the substitute color is the target color.

[0025] In one variant, all of the compensating nozzles eject the same substitute ink. With other words, only a single substitute ink is used for producing the substitute color.

[0026] E.g., if black is the target color, only a violet substitute ink is ejected by the compensating nozzles. Though the achievable color accuracy, i.e. the achievable match between target color and substitute color, can be limited when only a single substitute ink is used, this variant provides an especially easy choice between the available substitute colors. Further, in some cases the use of a single substitute ink even results in a better color match than trying to form a substitute color from a multitude of substitute inks, especially in case the different substitute inks show considerable differences in surface tension and therefore ink spreading on the substrate.

[0027] In another variant, more than one substitute ink is ejected from the compensating nozzles, wherein the difference of the surface tension of the substitute inks on a substrate printed upon is below a pre-set threshold value.

[0028] The use of more than one substitute ink makes available a large color space from which the substitute color can be chosen. Further, by choosing the substitute inks in a way to ensure that the difference between their respective surface tension is below the pre-set threshold value, it can be prevented that the substitute inks spread differently on the substrate. Thus, an even distribution of the substitute inks and therefore of the substitute color is achievable, providing even better and more consistent printing results.

[0029] A defective nozzle can be detected by measuring the optical density at the pixel position associated to the respective nozzle. The optical density is the negative decadic logarithm of the transmission rate, i.e. of the ratio of the transmitted to the incident radiant flux received by a material, multiplied by 100 %.

[0030] E.g., a given nozzle can be identified as being a defective nozzle if the optical density at the pixel position associated to said nozzle is below a certain pre-set threshold. The pre-set threshold can be 90 % or less.

[0031] A pixel can have a size of 25 μm or less along the lateral direction of the printhead, preferably of 21 μm or less. Such a pixel size especially occurs in high-resolution printing, e.g. for printing with a resolution of 1200 dpi.

[0032] When printing with such a resolution, it is especially demanding to precisely control the location the one or more substitute ink is ejected onto. Therefore, it is especially advantageous to use the first, second and third compensating nozzle for providing the one or more substitute inks to minimize the effect of small deviations during ink application on

the overall printing quality.

[0033] For informing a user of the printing device that one or more substitute inks are used in the printing process, a warning message can be shown on a display in case a defective nozzle is detected.

[0034] The warning message especially includes an information on the target color and the substitute color.

[0035] Also, the display can be a touch-sensitive display which the user of the printing device can interact with to operate the printing device. E.g., the user can choose a different substitute color other than the one automatically found by the printing device or stop the printing job, if necessary.

[0036] The object of the invention is further solved by a printing device comprising a printhead with a plurality of nozzles along a printing direction of the printhead and a plurality of nozzles along a lateral direction of the printhead being perpendicular to the printing direction, the printing device being adapted to apply the method as described above.

[0037] The features and advantages described for the method of controlling a printing device also apply for the printing device according to the invention and vice versa.

[0038] The printing device is preferably a high-throughput printing machine for professional applications. E.g., the printing machine is used in the large-scale production of printed paper or cardboard, plastic, films, packaging materials or labels.

[0039] Preferably, the printing device comprises a control unit with a color computing module, the control unit being adapted to determine the substitute color and to control the operation of the plurality of nozzles in the printhead. Accordingly, the substitute color can be determined automatically by the color computing module, thereby ensuring an interruption-free operation of the printing device.

[0040] Further advantages and features will become apparent from the following description of the invention and from the appended Figures which show non-limiting exemplary embodiments of the invention and in which:

- Fig. 1 shows a schematic representation of a printing device according to the invention;
- Fig. 2 shows a schematic bottom view of a sub-module of a printhead of the printing device of Fig. 1;
- Fig. 3 shows a schematic top view of a printed area as received from the printing device according to Fig. 1 if a nozzle of the printhead of Fig. 2 is defective;
- Fig. 4 shows the printed area of Fig. 3 as obtained in a first embodiment of a method for controlling the printing device of Fig. 1;
- Fig. 5 shows the printed area of Fig. 4 as obtained in a second embodiment of the method;
- Fig. 6 shows the printed area of Fig. 4 as obtained in a third embodiment of the method; and
- Fig. 7 shows a block diagram of the method for controlling the printing device of Fig. 1.

[0041] Fig. 1 shows a printing device 10 comprising a housing 12 and an ink supply module 14 and a printing module 16 contained in the housing 12.

[0042] The ink supply module 14 comprises a multitude of ink reservoirs 18, wherein each of the ink reservoirs 18 comprises ink of a different base color.

[0043] Preferably, the ink reservoirs 18 provide inks of the base colors cyan, magenta, yellow, black, orange, violet and white.

[0044] As the skilled person will appreciate, the printing device 10 could of course use different base colors than the ones recited above and less or more than eight ink reservoirs 18. Also, more than one of the ink reservoirs 18 can comprise ink of the same base color.

[0045] The ink supply module 14 is fluidically connected to a printhead 20 of the printing module 16 via an ink supply line 22 such that ink from each of the ink reservoirs 18 can be provided from the ink supply module 14 to the printhead 20.

[0046] As shown in Fig. 1, the printhead 20 comprises a multitude of sub-modules 24 arranged next to each other along a printing direction P of the printhead 20. Each of the sub-modules 24 comprises a multitude of nozzles 25 for ejecting ink provided from the ink supply module 14 (see Fig. 2).

[0047] E.g., each of the sub-modules 24 can be or comprise a printhead of the type "Samba®" available from the company Fujifilm.

[0048] As the skilled person will appreciate, the ink supply module 14, the ink supply line 22 and/or the printhead 20 can comprise any kind of suitable valves and/or distribution system for distributing any of the inks to an associated nozzle 25 of the printhead 20.

[0049] Coming back to Fig. 1, the printing module 16 comprises an unwinding roll 26 onto which a substrate 28 to be

printed upon can be provided by a (not shown) user of the printing device 10.

[0050] The substrate 28 is transported, as indicated by arrows in Fig. 1, by a series of rolls 30 to a rewinding roll 32 which is used to collect the printed substrate, thereby passing the printhead 20 along the printing direction P.

[0051] Further, the printing module 16 comprises a preparation module 34, which prepares the substrates prior to printing, e.g. by heating the substrate to a processing temperature, and an after-printing module 36.

[0052] The after-printing module 36 can be used for drying the printed substrate 28 but can also have additional functionality like measuring the optical density of the printed substrate 28.

[0053] Further, the printing device 10 has a display 38 which in the shown embodiment is a touch-sensitive display functioning as a human-machine-interface of the printing device 10 to the user.

[0054] The display 38 is connected to a control unit 40 which is used to control the operation of the printing device 10.

[0055] Accordingly, the control unit 40 can be connected in a signal-transmitting manner to one, more than one or all components of the printing device 10.

[0056] Further, the control unit 40 comprises a color computing module 42 whose function will be explained in more detail below.

[0057] In Fig. 2, one of the sub-modules 24 of the printhead 20 is shown in more detail.

[0058] The sub-module 24 comprises a multitude of nozzles 25 which are arranged in a regular pattern along the printing direction P and along a lateral direction L being perpendicular to the printing direction P. With other words, the nozzles 25 are an array of nozzles.

[0059] In said array, the nozzles 25 being arranged at the same position along the printing direction P are associated to the same ink, while the nozzle 25 being arranged at different positions along the printing direction P but at the same position along the lateral direction L are associated to different inks.

[0060] In the following, a method for controlling the printing device 10 according to the invention is described.

[0061] During operation of the printing device 10, a nozzle 25 of the printhead 20 can become damaged, e.g. by becoming deviated, lost, clogged, crooked or split. With other words, said nozzle becomes a defective nozzle 44. This defect results in a situation as schematically indicated in Fig. 3, which shows a schematic top view of a printed area of the substrate 28.

[0062] In Fig. 3, a total of nine pixel positions 1 to 9 along the lateral direction L of the printhead 20 is shown, with the defective nozzle being the one which is associated to pixel position 7.

[0063] Each pixel position has a size along the lateral direction L of 25 μm or less, preferably of 21 μm or less.

[0064] While for pixel positions 1 to 6 and 8 to 9 a target color, e.g. black, can be printed upon the substrate 28 by the printhead 20, this is not possible anymore at pixel position 7. Therefore, the overall printing quality of the printed substrate 28 is deteriorated, as there is no homogenous distribution of ink over the full course of the substrate 28.

[0065] Though in Fig. 3 to 6 continuous areas are used to indicate an area with ink printed on the substrate 28, the skilled person will appreciate that typically only ink dots are provided in the respective area on the substrate 28, while a human will perceive such an area filled with ink dots as being continuously colored.

[0066] In the method according to the invention, first, the defective nozzle 44 and the pixel position associated to the defective nozzle 44 is detected (see step S1 in Fig. 7).

[0067] Said detection can be made by the user of the printing device 10 when checking the printed substrate collected on the rewinding roll 32.

[0068] More preferably, the detection is automatically done by the printing device 10, e.g. by measuring the optical density of the printed substrate by the after-printing module 36.

[0069] In case the optical density is below a pre-set threshold, e.g. below 90 %, the corresponding nozzle 25 is termed to be a defective nozzle 44.

[0070] The pre-set threshold can be stored within the control unit 40 and can be adjustable by the user via the touch-sensitive display 38.

[0071] After the defective nozzle 44 has been detected, a target color associated to the defective nozzle 44 is determined (see step S2 in Fig. 7). As explained above in relation to Fig. 3, in the shown embodiment the substrate shall be printed black, i.e. the target color is black.

[0072] For determining the target color, the control unit 40 can take into account information about the current print job of the printing device 10.

[0073] Further, the pixel position of the defective nozzle 44 is used to determine a first compensating nozzle 46 having the same pixel position along the lateral direction L of the printhead 20, i.e. in the shown embodiment a nozzle 25 which is also associated to pixel position 7 as shown in Fig. 2.

[0074] Said first compensating nozzle 46 can be a further nozzle 25 within the same sub-module 24 of the printhead 20 or can be a nozzle 25 of another sub-module 24 (see Fig. 1).

[0075] Additionally, a second compensating nozzle 48 and a third compensating nozzle 50 are determined, wherein the second and third compensating nozzles 48 and 50, respectively, are associated to a pixel position adjacent to the pixel position of the first compensating nozzle 46 at opposite sides along the lateral direction of the printhead 20.

[0076] With other words, in the shown embodiment, the second compensating nozzle 48 is associated to pixel position 6 while the third compensating nozzle 50 is associated to pixel position 8.

[0077] Analogously to the first compensating nozzle 46, the second and third compensating nozzles 48 and 50, respectively, can be a nozzle 25 within the same sub-module 24 of the printhead 20 as the defective nozzle 44 or can be a nozzle 25 of another sub-module 24 (see Fig. 1).

[0078] The first, second and third compensating nozzle 46, 48 and 50, respectively, are then used for ejecting one or more substitute inks to form ink dots on the substrate 28, wherein the substitute ink dots are of a substitute color or add up to a substitute color (see step S3 of Fig. 2).

[0079] The substitute color is determined within the control unit 40, especially in the color computing module 42.

[0080] E.g., the substitute color is determined as being the color of ink dots achievable by the one or more substitute inks having a minimum distance to the target color in the CIELAB space, said minimum distance being calculated as being the Euclidian distance in the CIELAB space between the substitute color and the target color.

[0081] In Fig. 4, a first alternative for compensating for the defective nozzle 25 associated to pixel position 7 is shown.

[0082] In the first alternative, all of the compensating nozzles, i.e. the first, second and third compensating nozzle 46, 48 and 50, respectively, eject the same substitute ink as indicated by diagonal lines in Fig. 4, thereby forming a continuous strip of the same substitute color along pixel positions 6 to 8.

[0083] This alternative is especially suitable, if one of the base colors provided in the ink reservoirs 18 closely matches the target color.

[0084] E.g., in case the target color is black and one of the ink reservoirs comprises violet ink, this ink can be used as the unique substitute ink.

[0085] This embodiment also corresponds to the choice of first, second and third compensating nozzle 46, 48 and 50, respectively, as shown in Fig. 2, wherein each of said compensating nozzle 46, 48 and 50 are associated to the same position along the printing direction of the printhead 20 and thereby to the same ink provided from the ink supply module 14 (see Fig. 1).

[0086] In Fig. 5, a second alternative for compensating for the defective nozzle 44 associated to pixel position 7 is shown.

[0087] In the second alternative, two different substitute inks are applied on the substrate 28 in a checkerboard pattern along pixel positions 6 to 8. In Fig. 5, a first substitute ink is indicated with diagonal lines and a second substitute ink is indicated with lines along the printing direction P.

[0088] The first and second substitute inks are selected such that the difference of the difference of their respective surface tension on the substrate 28 is below a pre-set threshold value. This ensures that both of the substitute inks exhibits a comparable extent of ink spreading, providing a homogenous substitute color.

[0089] E.g., in case the target color is black, the first substitute ink is cyan and the second substitute ink is magenta.

[0090] For the second alternative, preferably at least two compensating nozzles per associated pixel position are used, i.e. there are at least two first compensating nozzles 46 associated to the same pixel position as the defective nozzle 44, at least two second compensating nozzles 48 and at least two third compensating nozzles 50 associated to pixel positions adjacent to the pixel position of the defective nozzle 44.

[0091] In Fig. 6 a third alternative for compensating for the defective nozzle 44 associated to pixel position 7 is shown.

[0092] In the third alternative, three different substitute inks are applied on the substrate 28 in a three-color checkerboard pattern along pixel positions 6 to 8. In Fig. 6, a first substitute ink is indicated with diagonal lines pointing to the left-hand side, a second substitute ink is indicated with lines along the printing direction P and a third substitute ink is indicated with diagonal lines pointing to the right-hand side.

[0093] Analogously to the second alternative, the multitude of substitute inks are selected such that the differences of their respective surface tensions on the substrate 28 are below a pre-set threshold value.

[0094] E.g., in case the target color is black, the first substitute ink is cyan, the second substitute ink is magenta and the third substitute ink is yellow.

[0095] For the third alternative, preferably at least three compensating nozzles per associated pixel position are used, i.e. there are at least three first compensating nozzles 46 associated to the same pixel position as the defective nozzle 44, at least three second compensating nozzles 48 and at least three third compensating nozzles 50 associated to pixel positions adjacent to the pixel position of the defective nozzle 44.

[0096] The method for controlling the printing device 10 according to the invention allows to compensate for defective nozzles of the printhead 20 in an easy, reliable and automated manner.

Claims

1. A method for controlling a printing device (10) comprising a printhead (20) with a plurality of nozzles (25) along a printing direction of the printhead (20) and a plurality of nozzles (25) along a lateral direction of the printhead (20) being perpendicular to the printing direction, the method comprising:

- detecting a defective nozzle (44) and a pixel position (1-9) associated to the defective nozzle (44) along the lateral direction of the printhead (20),
 - determining a target color associated to the defective nozzle (44),
 - ejecting one or more substitute inks from a multitude of compensating nozzles (46, 48, 50) to form ink dots, wherein the ink dots are of a substitute color or add up to a substitute color, the multitude of compensating nozzles (46, 48, 50) comprising a first compensating nozzle (48) associated to the same pixel position along the lateral direction of the printhead (20) as the defective nozzle (44) and a second and third compensating nozzle (48, 50) associated to a pixel position adjacent to the pixel position of the first compensating nozzle (46) at opposite sides along the lateral direction of the printhead (20).

2. The method according to claim 1, the printhead (20) having nozzles (25) associated to inks of five or more base colors, preferably of six to eight base colors.

3. The method according to claim 1 or 2, wherein the target color is black.

4. The method according to any of the preceding claims, wherein the substitute color is determined as being the color of ink dots achievable by the one or more substitute inks with a minimum distance to the target color in the CIELAB space.

5. The method according to any of the preceding claims, wherein all of the compensating nozzles (46, 48, 50) eject the same ink.

6. The method according to any of claims 1 to 4, wherein more than one substitute ink is ejected from the compensating nozzles (46, 48, 50), and wherein the difference of the surface tension of the substitute inks on a substrate (28) printed upon is below a pre-set threshold value.

7. The method according to any of the preceding claims, wherein a defective nozzle (44) is detected by measuring the optical density at the pixel position associated to a nozzle (25).

8. The method according to any of the preceding claims, wherein a pixel has a size of 25 μm or less, preferably of 21 μm or less, along the lateral direction of the printhead (20).

9. The method according to any of the preceding claims, wherein a warning message is shown on a display (38) of the printing device (10) in case a defective nozzle (44) is detected, the warning message especially including an information on the target color and the substitute color.

10. A printing device comprising a printhead (20) with a plurality of nozzles (25) along a printing direction of the printhead (20) and a plurality of nozzles (25) along a lateral direction of the printhead (20) being perpendicular to the printing direction, being adapted to apply the method of any of claims 1 to 9.

11. The printing machine according to claim 10, wherein the printing device (10) comprises a control unit (40) with a color computing module (42), the control unit (40) being adapted to determine the substitute color and to control the operation of the plurality of nozzles (25) in the printhead (20).

Fig. 1

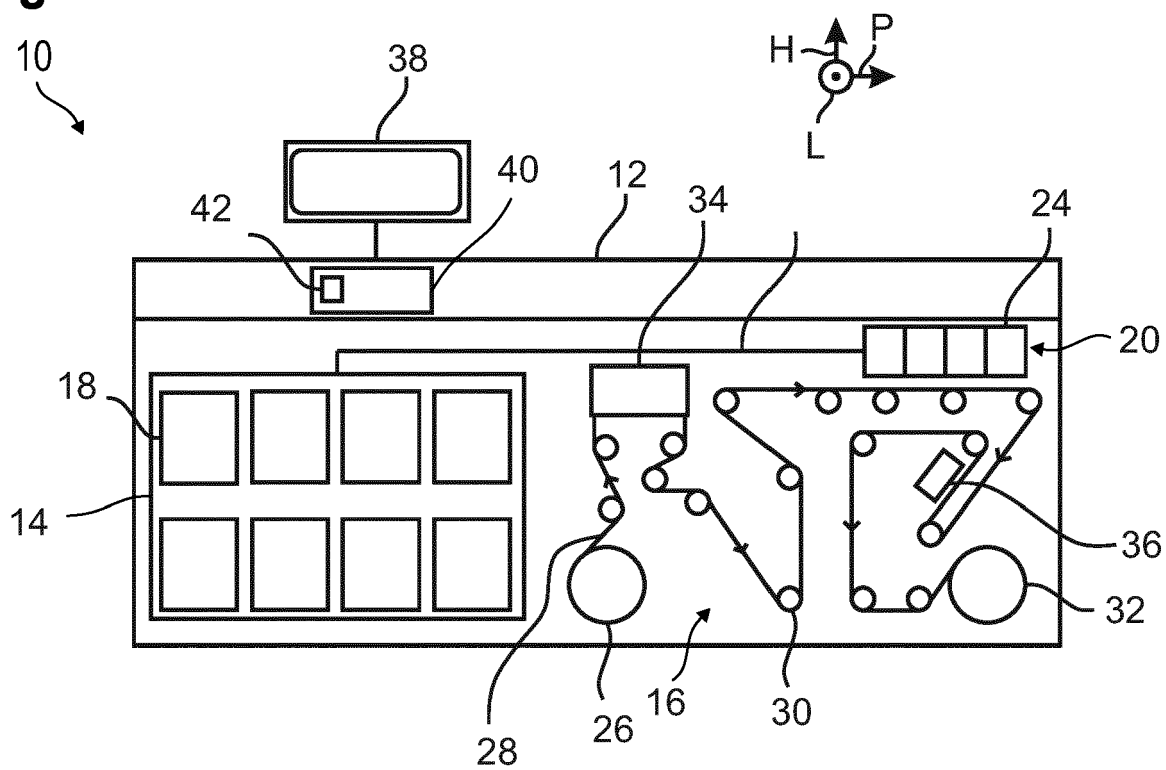


Fig. 2

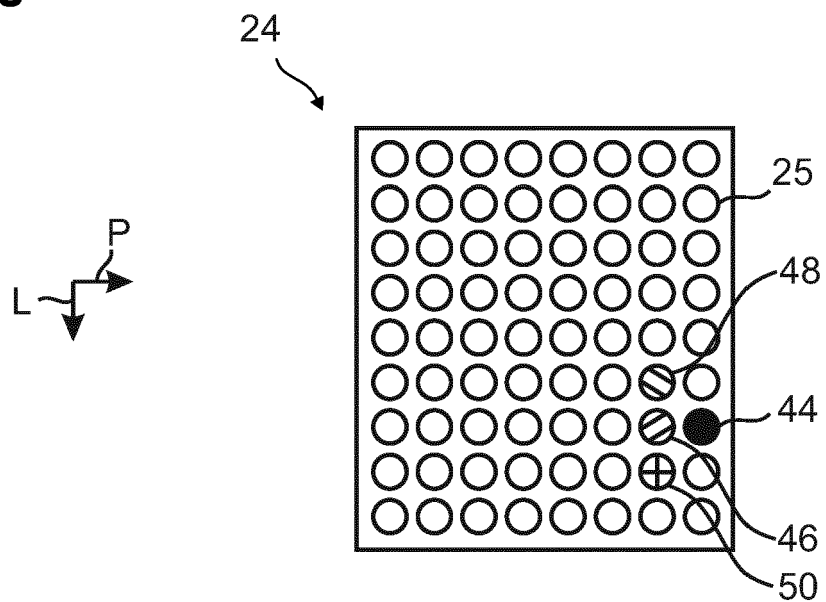


Fig. 3

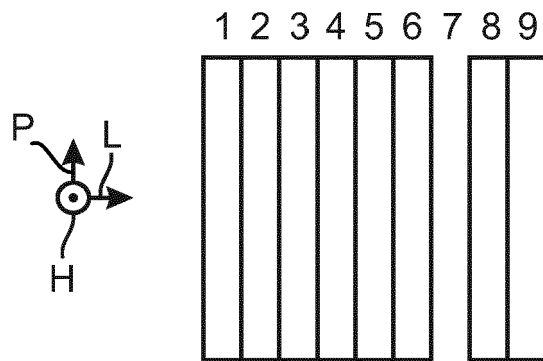


Fig. 4

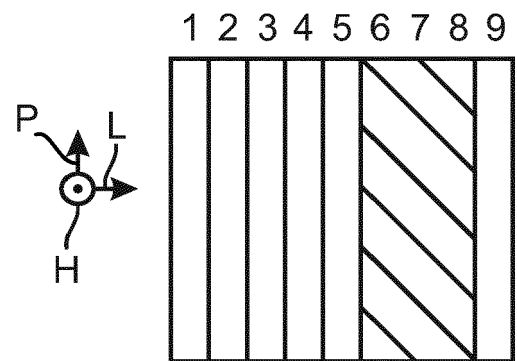


Fig. 5

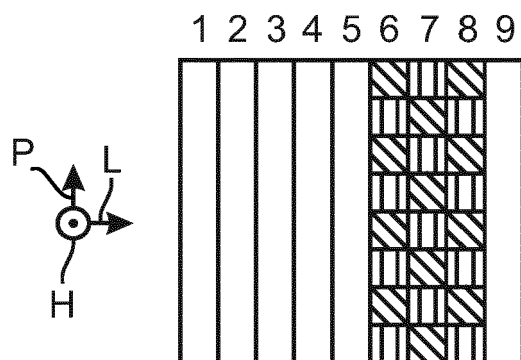


Fig. 6

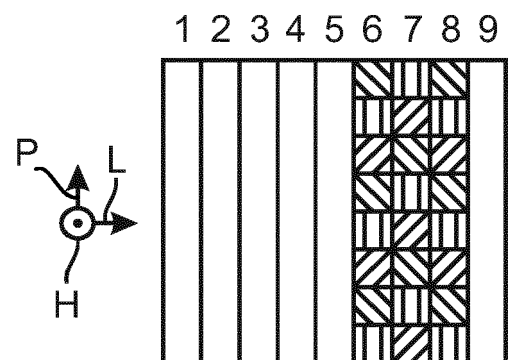
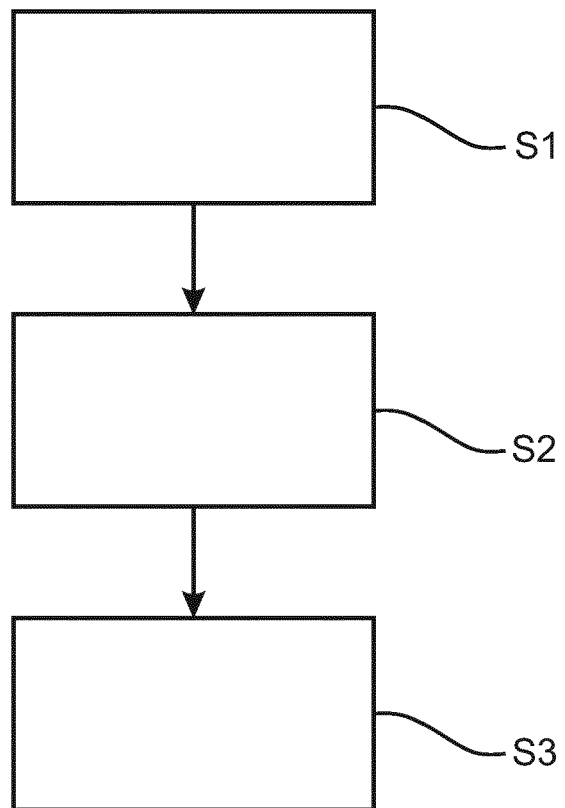


Fig. 7





EUROPEAN SEARCH REPORT

Application Number

EP 21 20 5874

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	* figures 1, 3C, 5 * * paragraph [0001] * * paragraph [0018] - paragraph [0023] * * paragraph [0012] *	2, 6, 9	
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