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(54) **Curing method for inkjet printing apparatus**

(57) A curing method in UV-curable inkjet printing uses a combination of a partial curing followed by a final curing step. The printing is organized in a first set of printing passes during which partial curing takes place, followed by a second set of passes during which no partial curing takes place. The method apparently suppresses gloss banding artifacts.

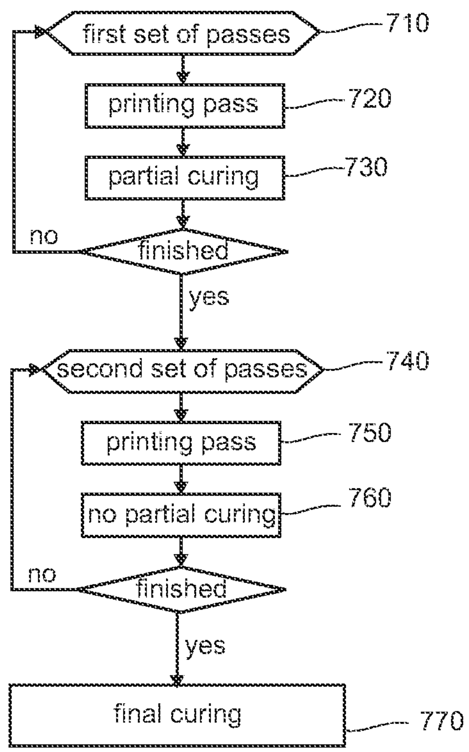


Figure 7

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## Description

### FIELD OF THE INVENTION

**[0001]** The invention relates to a curing method for an inkjet printing apparatus. The curing method includes partial and final curing steps.

### BACKGROUND ART

**[0002]** Patent application PCT/WO 2004002746 A (INCA DIGITAL PRINTERS LTD) published on 8 January 2004 discloses partial and final curing of ink droplets deposited by inkjet printing.

**[0003]** In this patent application, curable ink is deposited in a plurality of passes. Immediately after the deposition of ink in a particular pass, the ink is partially cured by a "partial cure lamp" (34 in Figure 2 of this patent application).

**[0004]** When all ink has been jetted for a particular area of the printing surface, and all this ink has been partially cured, that particular area passes under a "final cure lamp" (36 in Figure 2 of this patent application) that effectuates a final curing of the deposited ink.

**[0005]** Said application only discloses unidirectional printing. Patent application EP 06122346 (AGFA-GEVAERT N.V.) filed on 16 October 2006 teaches bidirectional printing of a curable ink.

**[0006]** Gloss banding refers to bands having different diffuse or specular reflection and that are correlated with the different printing passes of a print head during printing.

**[0007]** We have found that prior art curing techniques result in a gloss banding problem - both if unidirectional and bidirectional printing are used.

### SUMMARY OF THE INVENTION

**[0008]** The problem of gloss banding is solved by a method and a system having the specific features set out in claim 1 and the other independent and dependent claims of the current application.

**[0009]** We have observed that the invention apparently results in a more even gloss level of a print and that the overall gloss level is apparently increased.

**[0010]** According to the present invention and referring to Figure 7, printing of an image is organized in two sets 710, 740 of printing passes.

**[0011]** In a first set 710 of printing passes, a printing pass 720 is followed by a partial curing step 730 during which the printed ink can partially solidify.

**[0012]** In a second set 740 of printing passes, a printing pass 750 is specifically not followed by a partial curing step.

**[0013]** When all printing passes are finished, the printed image is subject to a final curing step 770.

**[0014]** Preferably, the positions of the pixels printed in said first and said second set of passes are mutually interstitial.

**[0015]** Preferably the multiple passes comprise interlacing to increase the printing resolution in slow scan orientation.

**[0016]** Preferably the multiple passes comprise shingling to reduce correlated image quality artifacts, such as streaking and banding parallel to a fast scan orientation.

**[0017]** Preferably, the inks are UV-curable inks and curing is established by means of UV-curing lamps.

**[0018]** Preferably, the positions of the pixels printed in said first set of print passes have a diagonal orientation with regard to a fast and a slow scan orientation of a printer.

### BRIEF DESCRIPTION OF FIGURES IN DRAWINGS

**[0019]** Figure 1 shows a printing system comprising three stations that can be used to carry out a method according to the current invention.

**[0020]** Figure 2 shows a print head assembly comprising four print heads and two partial cure lamps that can be used to carry out a method according to the current invention.

**[0021]** Figure 3 shows a multiple print head configuration comprising two print heads printing with the same ink.

**[0022]** Figure 4 is used to explain how in a preferred embodiment of the current invention printing with multiple passes can reduce correlated image quality artifacts.

**[0023]** Figure 5A to 5D show a preferred embodiment of printing mutually interstitial images using multiple printing passes such as streaking and banding.

**[0024]** Figure 6 further explains a preferred embodiment of using multiple printing passes.

**[0025]** Figure 7 shows the steps of a method according to a preferred embodiment of the current invention.

### TERMINOLOGY

<u>printing</u>

**[0026]** The method according to the current invention is mainly directed towards the use in dot matrix printers and specifically drop-on-demand inkjet printers, but it is not limited thereto. The term printing as used in the invention refers to the process of creating a structured pattern of ink markings on a substrate to render an original image, for example an image of a document. Non-impact printing methods are preferred but the present invention is not limited thereto.

**[0027]** Referring to Figure 1, printing an image of a document in a station 120 (Figure 1) can be achieved by moving a marking element 123 mounted on a shuttle 122 relative to a substrate 121 and selectively marking the substrate in response to pixel values of a digital image of said document.

**[0028]** For this purpose, the shuttle 122 is designed to move along a fast scan orientation 124, 125 and a slow scan orientation 128, 129.

**[0029]** To improve printing performance, a printing system may not comprise one single marking element but a plurality of marking elements - for example arranged in an array - that can be operated in parallel and that together make up a print head.

**[0030]** Referring to Figure 3, printing performance may be improved even more by operating multiple print heads 301, 302 in parallel.

<u>substrate</u>

**[0031]** The substrate on which is printed could be paper, but it could also be textile, a synthetic foil or a metal plate. It can be made available in sheets or on a web.

<u>ink</u>

**[0032]** An ink is a substance that is selectively deposited by a printing device on the substrate to render an image.

**[0033]** The ink could be a pigmented or dyed colorant but it could also be wax, a water repellent substance, an adhesive, or a polymer that is printable.

**[0034]** Usually ink is not a pure compound, but a complex mixture comprising several components such as dyes, pigments, surfactants, binders, fillers, solvents, water, and dispersants - each component serving a specific function.

<u>partial and final curing</u>

**[0035]** A curable ink shall refer to an ink that undergoes a phase change under the influence of an external energy source that is specifically used for this purpose. The external energy source could for example be an IR light or a UV light source.

**[0036]** An ink that is printed on a substrate and that is not cured can exhibit coalescence. Coalescence is a physical process in which ink markings on a substrate that physically connect start to fuse. This is sometimes referred to as "bleeding."

**[0037]** An ink can be partially cured or completely cured.

**[0038]** A partially cured ink printed on a substrate has been solidified to the point that it does not coalesce anymore, but still requires additional curing to obtain a rub resistance that is needed for the intended application of a the printed product.

**[0039]** A completely cured ink on a printed substrate is sufficiently solidified so that it has a rub resistance that is sufficient for the intended application of the printed product.

<u>interstitial printing - interlacing shingling</u>

**[0040]** The application EP 06122346.7 filed on 16 October 2006 by the same applicant as the current invention teaches a method in which pixels having positions on a given row or column in an image are printed in multiple printing passes.

**[0041]** Printing in multiple passes enables to achieve at least two objectives.

**[0042]** A first objective is to increase the resolution of a printer with regard to the intrinsic resolution of the print heads in a slow scan orientation.

**[0043]** Referring to Figure 2, the intrinsic resolution of a print head 204 in a slow scan orientation 128, 129 is defined by the nozzle pitch 221. By printing in two passes, whereby the print head in a second pass is shifted over half the nozzle pitch 221 (or a multiple thereof) in a slow scan orientation 128, 129, it is possible to double the print resolution along this orientation 128, 129. This technique to increase the printing resolution in a slow scan orientation by a multiple factor is sometimes referred to as "interlacing."

**[0044]** An "interlacing factor" designates an integer multiple factor by which the resolution in a slow scan orientation is increased by using interlaced multiple pass printing.

**[0045]** A second objective of printing in multiple passes is to suppress artifacts that are correlated with individual nozzles of a print head.

**[0046]** Differences in jetting characteristics between individual nozzles can result in streaking or banding artifacts.

**[0047]** Referring to Figure 4, a solution to this problem consists of printing the pixels on a line 410 parallel to a fast scan orientation 124, 125 alternately by two nozzles 420 and 421. This has the effect that the correlated artifacts caused by each individual nozzle 420, 421 are averaged out and become less noticeable.

**[0048]** Practically the method is realized by:

- printing in a first pass a first one 440 out of two pixels 440, 441 on a line 410 parallel to a fast scan orientation 124, 125 by a print head 401,
- shifting said print head 401 over a distance 430, and
- printing in a second pass a second one 441 out of two pixels 440, 441 on the same line 410.

**[0049]** The same principle is easily extended to average out correlated artifacts between more than two different two nozzles, for example between four nozzles.

**[0050]** The just described technique for reducing correlated image quality artifacts is sometimes referred to as "shingling."

**[0051]** A "shingling factor" indicates the number of different nozzles that are used to print the pixels on a given line in a fast scan orientation. In the example shown in Figure 4, a shingling factor equals two.

**[0052]** Technically both interlacing and shingling are realized by separating an image that is to be printed in mutually interstitial images, and printing these mutually interstitial images in different passes, whereby the print head is moved in directions 128, 128 between the different printing passes.

DETAILED DESCRIPTION OF THE CURRENT INVENTION

description of a system

**[0053]** Figure 1 shows a system 100 that can be used for carrying out a method according to the current invention.

**[0054]** The system comprises a first station 110, a second station 120, and a third station 130.

**[0055]** A first station 110 holds a stack of unprinted substrate 111.

**[0056]** In a first step, a sheet 111 of the unprinted substrate is moved by a first substrate transport mechanism (not shown in Figure 1) from the first station 110 in a direction 140 to the second station 120.

**[0057]** In a next step, an image is printed with ink on the sheet in station 120. During this step, the ink on the printed sheet 121 is also partially cured.

**[0058]** The printing of the image is achieved by means of multiple inkjet print heads 123 that are part of a print head assembly 123 mounted on a shuttle 122 that moves bidirectionally along a fast scan orientation 124 and 125.

**[0059]** Because the size of a print head 126, 127 is generally less than the size of a sheet 121, the shuttle with the print head assembly can also move along a slow scan orientation 128, 129 so that the whole area of a sheet 121 can be printed on. This also enables to print an image in multiple printing passes using interlacing and shingling.

**[0060]** The partial curing is preferably achieved by means of partial curing lamps 126, 127 that are preferably also mounted on shuttle 122.

**[0061]** In a third step, the printed sheet 121 is moved by a second substrate transport mechanism (not shown in Figure 1) in a direction 141 to the third station 130. In this third station 130, the ink on the substrate undergoes a final curing step.

**[0062]** The final curing is achieved by means of final curing lamps 133,134 mounted on a shuttle 132 that moves bidirectionally in the directions 140 and 141.

**[0063]** Optionally, the printed and cured sheet is moved in a fourth step from the third station 130 to a fourth station (not shown on Figure 1) where it is stacked.

**[0064]** A printing system that is used for the current invention also comprises a printer controller to control the different sensors and actuators of the system and a raster image processor to calculate a digital image having pixels of a document that is to be printed.

**[0065]** These peripheral components are not elaborated here, as they are known to a person skilled in the art.

print head and print head assembly

**[0066]** Figure 2 shows a preferred embodiment of a print head assembly wherein the numbers 201 to 204 each correspond with individual print heads printing cyan (C), magenta (M), yellow (Y) and black (K) inks and wherein the numbers 126 and 127 correspond with partial curing lamps.

**[0067]** In the embodiment shown in Figure 2, an individual print head 201 has an array comprising two rows 260, 261 of inkjet nozzles. The electronic drivers of the nozzles are preferably adapted so that the droplets ejected by nozzles on rows 260, 261 land on the same line parallel to a slow scan orientation 128, 129 on the substrate. The distance between two adjacent nozzles measured along a slow scan orientation 128, 129 corresponds with a nozzle pitch 221.

**[0068]** According to a preferred embodiment of the current invention, the ink is a UV curable ink, i.e. it solidifies under the influence of a UV radiation source. The solidification is preferably caused by a polymerization process that is initiated by the exposure to the UV radiation source.

**[0069]** According to a preferred embodiment of the current invention, the addressable grid of pixels is not a traditional rectangular grid of addressable pixels, but rather a checkerboard type of addressable grid.

**[0070]** This is exemplified by Figure 5D in the current application, where the pixels having positions 501, 502, 503 and 503 form a checkerboard pattern.

**[0071]** According a preferred embodiment of the current invention and referring to Figures 5A to 5D of the current application, an image that is to be printed is separated into four mutually interstitial images that are printed in separate passes. A method for separating an image into mutually interstitial images is explained by means of Figure 10 in the application EP05104466.7 filed on 5 May 2005 by the same applicant as the current invention.

**[0072]** A first pass (Figure 5A) is followed by a second pass (Figure 5B) and results in the printing of ink at the positions of the pixels 501, 502 that are laid out on diagonal lines with regard to the fast and slow scan orientation of the printer.

**[0073]** These first and second passes form a first set of passes.

**[0074]** According to a preferred embodiment of the current invention, the printed ink at the positions of the pixels 501 and 502 in said first set of passes receives a partial curing.

**[0075]** A third and a fourth pass further fill in ink at the positions of the pixels 503, 504.

**[0076]** These third and fourth passes form a second set of printing passes.

**[0077]** According to a preferred embodiment of the current invention, the ink printed at the positions of the pixels 503, 504 in said second set of passes receives no partial curing.

**[0078]** In a next step, the ink of the completely printed image receives a final curing.

**[0079]** The printing of the four passes can also be explained in more detail by means of Figure 6.

**[0080]** The directions 124, 125 correspond with a fast scan orientation and the directions 128, 129 with a slow scan orientation.

**[0081]** Print head 600 has a nozzle pitch 640 and a length 642 of ten times the nozzle pitch. Printing resolution is doubled by using interlacing having an interlacing factor of two, so that the distance 641 between two printed lines is half the nozzle pitch 640.

**[0082]** The printing is organized in print cycles, each print cycle comprising two sets of two printing passes.

**[0083]** At the beginning of a first print cycle, print head 600 is at a first starting position 601 along the slow scan orientation 128, 129. During the first printing pass, the print head 600 moves in a fast scan direction 124 and prints ink at pixels having positions indicated by a "1" on Figure 6.

**[0084]** According to said preferred embodiment, the ink printed at pixels having positions indicated by "1" receives a partial curing step from lamp 126 (Figure 1) during the first pass.

**[0085]** Before starting a second printing pass, print head 600 is shifted over a distance 630 - of for example half a nozzle pitch - from the first position 601 to a second position 602 in the slow scan direction 129. During the second printing pass, the print head 600 moves in a fast scan direction 125 and prints ink at pixels having positions indicated by a "2" on Figure 6.

**[0086]** According to said preferred embodiment, the ink printed at pixels having positions indicated by "2" receives a partial curing step from lamp 127 (Figure 1) during the second pass. Because the lamp 127 produces a diffuse radiation, the printed ink at pixels having positions indicated by "1" also receives a second partial curing step.

**[0087]** Optionally <u>both</u> the lamps 126 and 127 are used for partial curing during the first and second printing passes.

**[0088]** The first and the second printing pass together form a first set of printing passes that include a partial curing step.

**[0089]** Before starting a third printing pass, print head 600 is shifted over a distance 631 - of for example two and half times a nozzle pitch 640 - from the second position 602 to a third position 603 in a slow scan direction 128. During the third printing pass, the print head 600 moves again in a fast scan direction 124 and prints ink at pixels having positions indicated by a "3" on Figure 6.

**[0090]** According to said preferred embodiment, the printed ink at pixels having positions indicated by "3" specifically does <u>not</u> receive a partial curing step from either lamp 126 or 127 (Figure 1) during the third pass.

**[0091]** Before starting a fourth printing pass, print head 600 is shifted over a distance 632 - of for example half a nozzle pitch 640 - from the third position 603 to a fourth position 604 in a slow scan direction 129. During the fourth printing pass, the print head 600 moves in a fast scan direction 125 and prints ink at pixels having positions indicated by a "4" on Figure 6.

**[0092]** According to said preferred embodiment, also the printed ink at pixels having positions indicated by "4" specifically does <u>not</u> receive a partial curing step from either lamp 126 or 127 (Figure 1) during the fourth pass.

**[0093]** The third and fourth printing passes together form a second set of printing passes that include no partial curing step.

**[0094]** After a first cycle of first four passes, print head 600 is shifted over a distance 633 - of for example twelve and half times a nozzle pitch - from the fourth to a fifth position in a slow scan direction 129. This fifth position is the starting position for a second cycle of four passes and that works in the same way as the first cycle of four passes.

**[0095]** The cycles continue until the whole page is printed.

**[0096]** After a last cycle, the ink on the printed sheet receives a final curing.

**[0097]** This is realized in a third station 130 (Figure 1) by moving the two lamps 133, 134 mounted on a shuttle 132 bidirectionally over the printed sheet 131 in the directions 140, 141.

**[0098]** The shifting distances 630, 631, 632 and 633 are preferably selected taking into account specific constraints.

**[0099]** According to a preferred embodiment, a first constraint is that the first two positions 601 and 602 address lines that are relatively interlaced.

**[0100]** This constraint has the effect that after the first two passes a set of pixels has been addressed that are contiguously oriented along diagonal lines as indicated by 610 in Figure 6.

**[0101]** A similar constraint to achieve a similar effect is that the positions 603 and 604 also preferably address lines that are relatively interlaced.

**[0102]** According to the same preferred embodiment, the shifts 630, 631, 632 and 633 are selected so that after each print cycle the position 605 of print head 600 is exactly the print head length plus one nozzle pitch located from the position 601 of print head 600 in a previous print cycle.

**[0103]** In Figure 6, for example, the print head length equals ten times the nozzle pitch 640 and the sum of the distances 630, 631, 632 and 633 equals eleven times the nozzle pitch 640.

**[0104]** Yet another constraint is that preferably the print head positions 603 and 604 are far enough from the print head positions 601 and 602, to avoid that partial curing of ink at pixel positions "1" and "2" printed in a second cycle results in some partial curing of the pixels having positions "3" and "4" printed in a first cycle as a result of stray light from the partial cure lamps.

**[0105]** We have found that the above preferred embodiment solves the problem of gloss banding in a prior art technique that uses partial curing after each print step.

**[0106]** In a prior art technique, ink printed at pixels in a first pass of a cycle is four times partially cured, while ink printed at pixels in a fourth pass of the same cycle is only once partially cured. This difference in number of partial curing steps between different passes apparently results in a gloss of the final printed result that is correlated with the different printing passes and that has the effect of gloss banding.

**[0107]** By not applying a partial curing during a third and fourth printing step, the ink that is deposited during third and fourth printing passes is in exactly the same curing condition before it is subject to a final curing step. We have observed that this apparently results in a more even gloss level and an apparent reduction of the gloss banding problem.

**[0108]** One could wonder if it would not be advantageous to apply no partial curing at all - i.e. not even after the first and second printing passes - to obtain an even more even gloss level and even less gloss banding.

**[0109]** It was found, however, that this latter approach results in more coalescence, which is undesirable.

**[0110]** The partial curing of ink on pixels printed in a first set of passes has apparently the effect of forming a matrix of partially cured ink droplets that inhibit coalescence of ink droplets on pixels printed in a subsequent set of passes, even if the ink printed in the subsequent set of passes is not partially cured.

**[0111]** What this means is that applying a partial curing during a first set of printing passes but not during a second set of printing passes apparently enables to reduce gloss banding while at the same time it avoids coalescence.

<u>EXAMPLE</u>

**[0112]** An example of the current invention uses the following parameters:

<u>overall configuration</u>

**[0113]** The overall configuration is the one shown in Figure 1 and as previously explained.

<u>inkjet heads:</u>

**[0114]** Four inkjet print heads are used, printing with cyan 203, magenta 202, yellow 201 and black 204 inks, and relatively arranged on a print head assembly 122 as indicated in Figure 2.

**[0115]** Each head has 382 nozzles, arranged in two rows 260, 261 spaced at 70,6 micrometer (1/360 inch) in a staggered configuration. The nozzle pitch 221 is also equal to 70,6 micrometer (1/360 inch).

**[0116]** The shuttle speed in the fast scan orientation 124, 125 is approximately 1 m/sec and the firing speed of the inkjet heads is adjusted so that distance between two neighboring ink droplets printed in one pass on the substrate has a distance of 70,6 micrometer (1/360 inch).

<u>shingling and interlacing</u>

**[0117]** The interlacing factor is two, resulting in a printing resolution in the slow scan orientation 128, 129 of 283 pixels per cm (720 pixels per inch).

**[0118]** The shingling factor is also two, resulting in a printing resolution in the fast scan orientation 124, 125 of 283 pixels per cm (720 pixels per inch).

**[0119]** These shingling and interlacing factors result in four passes per print cycle.

<u>substrate</u>

**[0120]** The printing substrate is double-sided matte coated paper sheet, 150 g/m$^2$, having a size of 266 cm by 165 cm, aligned with its largest dimension in the fast scan orientation 124, 125 of the second station (Figure 1).

<u>ink</u>

**[0121]** The ink is the Anuvia UV-curable ink as manufactured and marketed in November 2006 by Agfa-Gevaert N.V. in Belgium.

<u>curing</u>

**[0122]** Partial curing is achieved by means of a pair of standard mercury arc tube lamps 126, 127 mounted on shuttle 122. A first lamp 126 is mounted on one side of print heads 123 and a second lamp 127 is mounted on the other side.

**[0123]** Each partial curing lamp is rated at an electrical power of 70W/cm. The distance between the heart of each tube lamp and the substrate is approximately 4 cm and each lamp is provided with a reflector/diffuser to reflect and diffuse the radiation in the direction of the substrate. The distances between the print heads and the lamps are indicated on Figure 2.

**[0124]** The lamps are operated in binary mode, i.e. the lamps can be switched off, or on in which latter case the lamps produce 100% of their rated power. Preferably, the lamps are switched off by means of a shutter that is controlled by means of a printer controller.

**[0125]** Partial curing takes place during the first set of two printing passes of a cycle, while no partial curing takes place during the second set of two printing passes of a cycle.

**[0126]** Final curing is achieved by means of a combination of a single standard mercury arc lamp 133 having an electrical power of 120 W/cm with a single iron doped mercury arc lamp 134 also having an electrical power of 120W/cm both mounted on shuttle 132. Both lamps have a reflector/diffuser. The lamps are mounted approximately 10 cm above the substrate and can be switched off or on to 100% of their nominal power. The shuttle 132 moves at approximately 30 cm/sec and curing takes place both during a first pass in a direction 140 and during a second pass in a direction 141.

<u>OTHER EMBODIMENTS</u>

**[0127]** The above embodiment is one example of a method and a system that solves the problem of gloss banding in the prior art, but many variations exist that use the same invention and achieve the same advantageous effects.

**[0128]** A first important variation relates to the actual printing order of the different passes. Referring to Figure 6, a print cycle as explained in a preferred embodiment consists of printing in order:

- FIRST CYCLE
  - o pixels "1" on even row numbers 0 to 20;
  - o pixels "2" on odd row numbers 1 to 21;
  - o pixels "3" on even row numbers 0 to 16;
  - o pixels "4" on odd row numbers 1 to 17;
- SECOND CYCLE
  - o pixels "1" on even row numbers 22 to 42;
  - o pixels "2" on odd row numbers 23 to 43;
  - o pixels "3" on even row numbers 18 to 38;
  - o pixels "4" on odd row numbers 19 to 39;
- THIRD CYCLE
  - o etc.

**[0129]** In an alternative embodiment, the order of the printing passes is changed so that all the pixels "1" and "2" are printed over the complete area of the page using partial curing, followed by printing all the pixels "3" and "4" over the area without partial curing. The printing order in that case would be:

- pixels "1" on even rows, complete page, partial curing
- pixels "2" on odd rows, complete page, partial curing
- pixels "3" on even rows, complete page, no partial curing
- pixels "4" on odd rows, complete page, no partial curing

**[0130]** This alternative embodiment achieves the same effect as the prior embodiment, i.e. that the pixels "1" and "2" are printed and receive partial curing, while the pixels "3" and "4" are printed and receive no partial curing.

**[0131]** To improve printing performance, an alternative print head assembly may comprise not one but a plurality of print heads that print in parallel with the same ink.

**[0132]** An example of such an arrangement is shown in Figure 3 and uses for a given ink two print heads. The two print heads are mounted so that their nozzles print on the same line. The distance 304 between the two print heads equals the length 303 of each print head. In yet another arrangement, the configuration as shown in Figure 3 is repeated so that sixteen print heads are mounted so that their nozzles print on the same line, with fifteen gaps in etween, each gap 304 between two print heads being equal to the length 303 of each print head.

**[0133]** The arrangement shown in Figure 3 results in a doubling of the number of printing passes per print cycle compared to the arrangement shown in Figure 2, which shows a page-wide print head. This is because additional print passes are needed to make up for the "missing nozzles" that exist between the two print heads 301, 302.

**[0134]** Another example of a variation of the current invention is to use the same lamps for partial and for final curing. In that case a controller is preferably capable to modulate the intensity of the lamps so that the intensity of the lamps is different for partial and for final curing. Alternatively, not the intensity of lamps is modulated to achieve this purpose, but the speed of the shuttle in the fast scan orientation.

**[0135]** The invention may be carried out using any combination of printing passes that comprises at least a first set comprising at least one printing pass and at least a second set also comprising at least one printing pass, wherein each printing pass of the first set is followed by a partial curing step whereas each printing pass of the second set is not followed by a partial curing step, as shown in Figure 7.

**[0136]** In a particular embodiment, one or more additional printing passes without partial curing are carried out before the first set of printing passes 710 shown in Figure 7.

**[0137]** Specifically mentioned is the case of a print head configuration as illustrated in Figure 3 and having sixteen print heads as discussed in connection with Figure 3, and that uses eight printing passes for each area of the substrate that has to be printed. According to one possible embodiment, a first set of printing passes during which partial curing takes place comprises the first two of these eight printing passes. According to another embodiment, said first set comprises four printing passes. According to yet another embodiment, said first set comprises six printing passes.

## Claims

1. A method for printing an image with a printer that uses a curable ink, the method comprising the steps of:

   - printing ink in response to values of first pixels of said image during a first set of printing passes;
   - partially curing the ink printed during said first set of printing passes;
   - printing ink in response to values of second pixels of said image during a second set of printing passes;
   - applying a final curing to the ink after said first and the second sets of printing passes;

   the method **characterized in that**:

   - there is no partial curing step of the ink printed during said second set of printing passes.

**2.** A method according to the previous claim, wherein said printer is an inkjet printer.

**3.** A method according to anyone of the previous claims wherein said ink is a UV-curable ink and wherein said curing comprises UV-curing.

**4.** A method according to anyone of the previous claims wherein said printing passes print pixels having mutually interstitial positions.

**5.** A method according to anyone of the previous claims wherein said pixels printed during said first and second sets of printing passes are laid out on diagonal lines with regard a slow and a fast scan orientations of the printer.

**6.** A method according to anyone of the previous claims, wherein said first set comprises two printing passes and said second set comprises two printing passes.

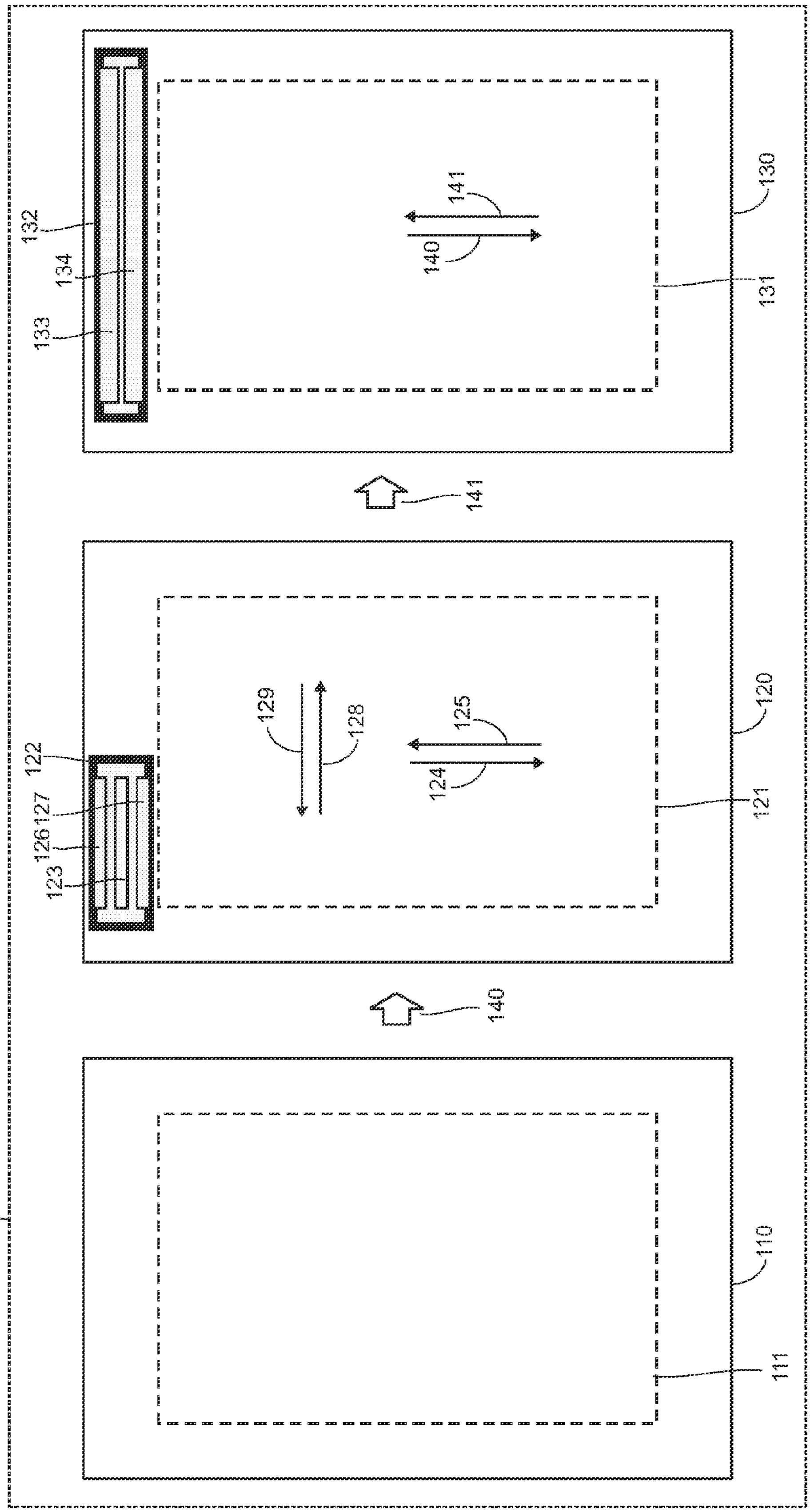
**7.** An inkjet printing system for printing with a UV-curable ink an image having pixels on a substrate, the system comprising:

- printing means for printing ink in response to values of pixels of said image in a set of printing passes;
- partial curing means for partially curing ink printed during a printing pass;
- controller means for controlling said partial curing means;
- final curing means for final curing the ink of a printed image; the system **characterized in that**:
- said controller means is set up to effectuate a partial curing during a first set of printing passes and not to effectuate a partial curing during a second set of printing passes.

**8.** A system according to the previous claim wherein said printing means is set up to print pixels having mutually interstitial positions during different passes.

**9.** A system according to anyone of the claims 7 to 8 wherein said first set comprises two printing passes and wherein said second set comprises two printing passes.

**10.** A system according to anyone of the claims 7 to 9 wherein said partial and said final curing means are identical.


100
110
111
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121
122
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140
141

Figure 1

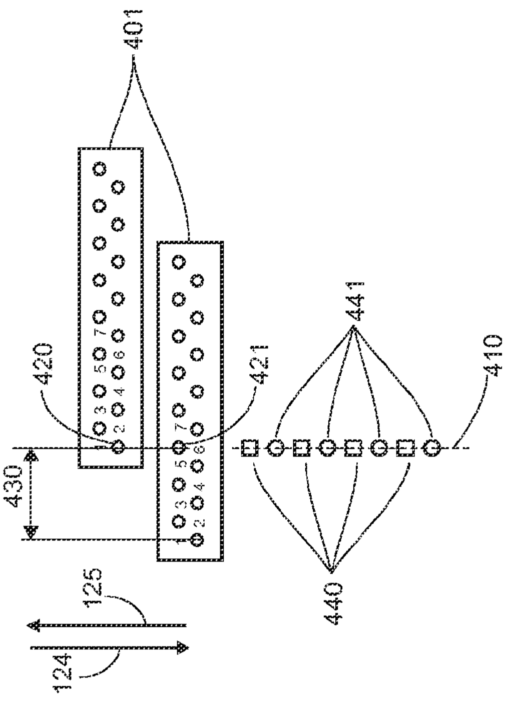



Figure 4

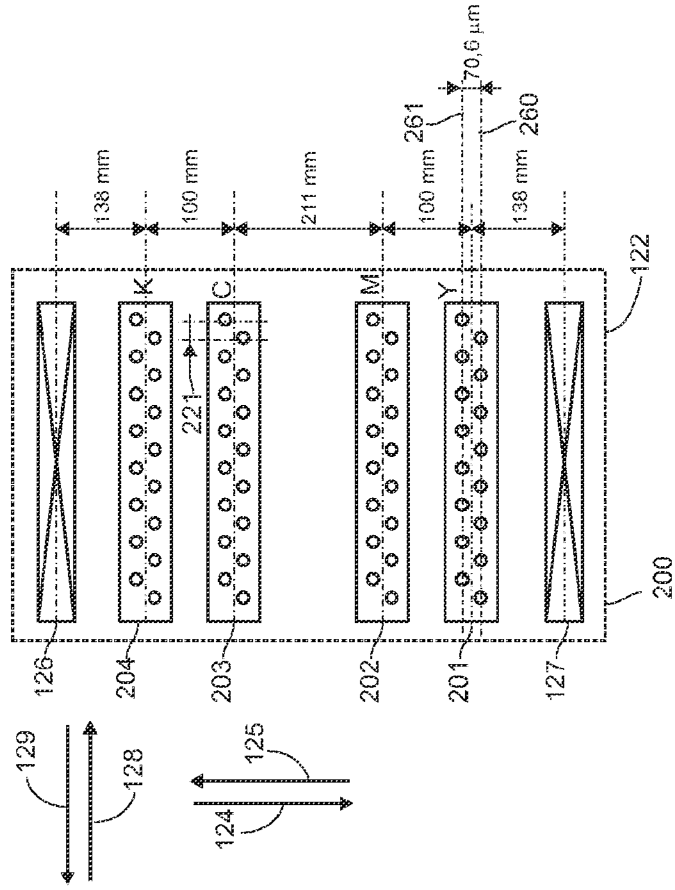



Figure 2

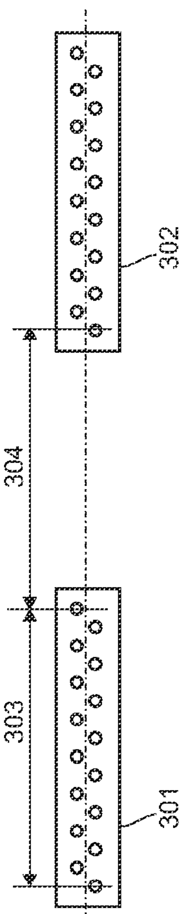



Figure 3

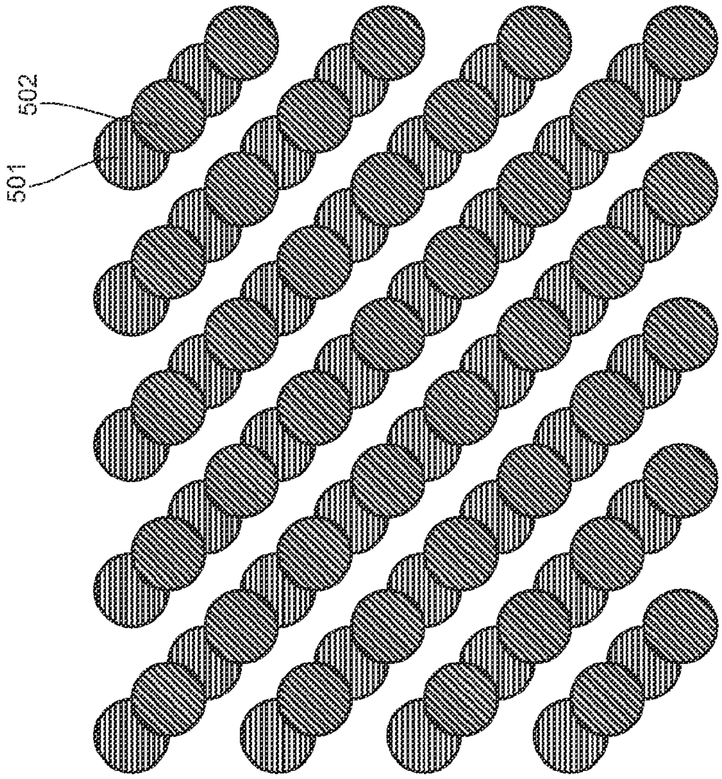



Figure 5B

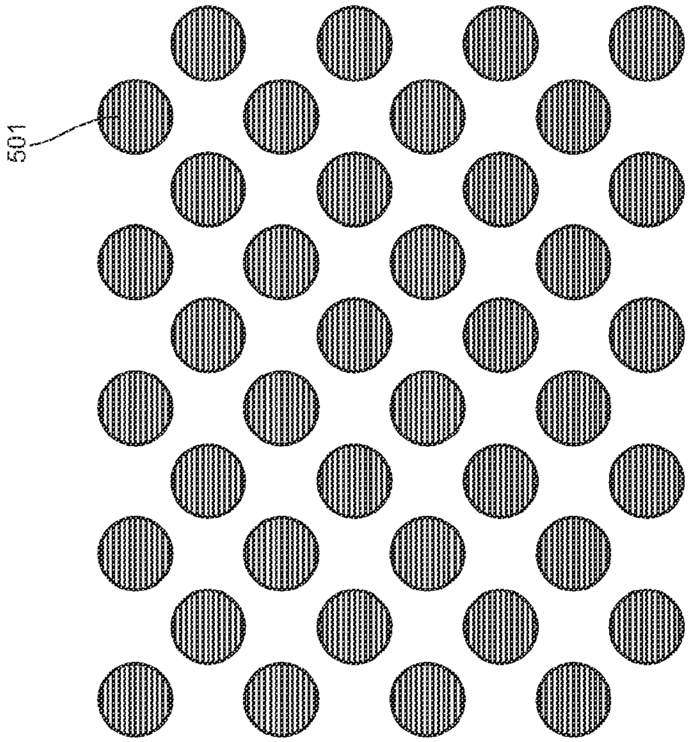



Figure 5A

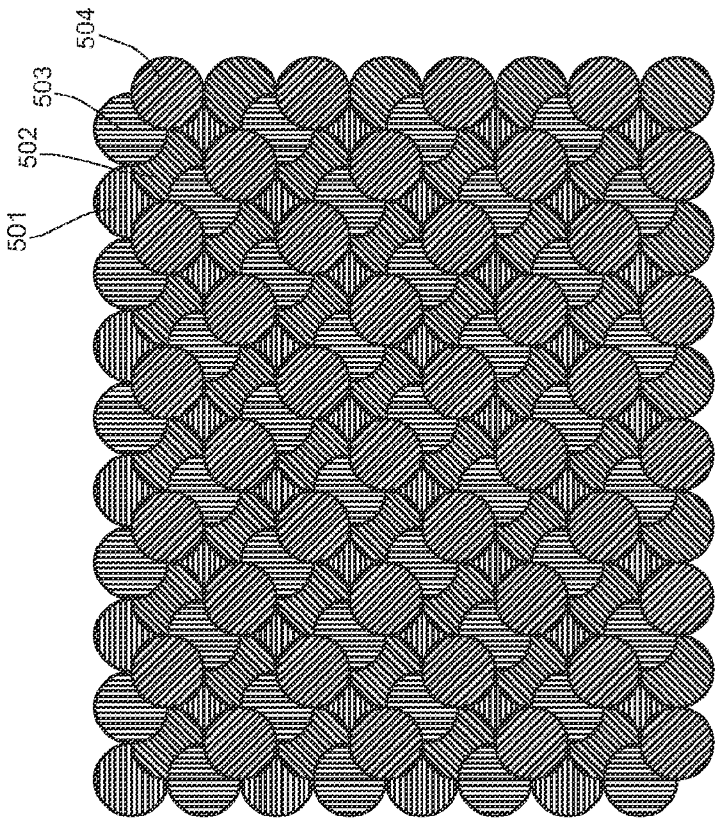



Figure 5D

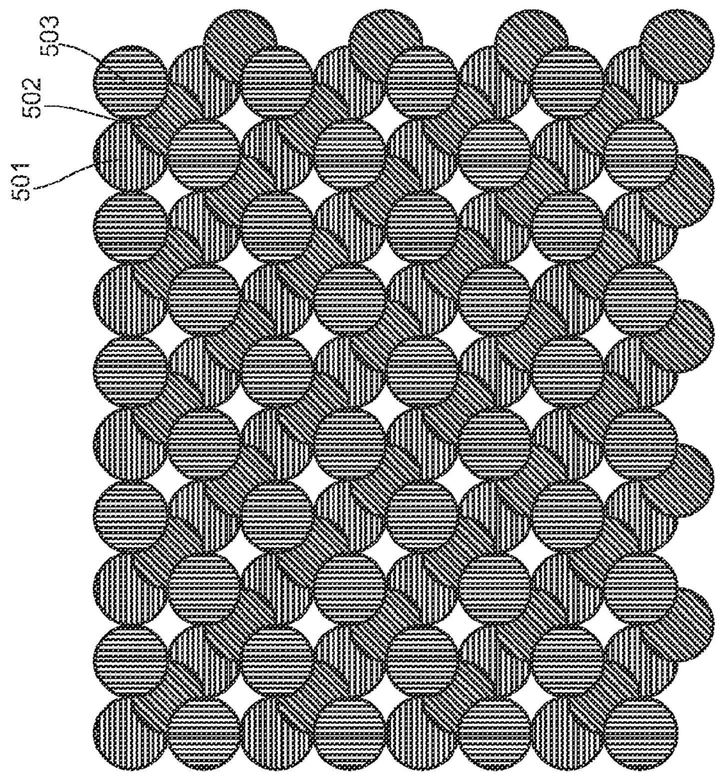
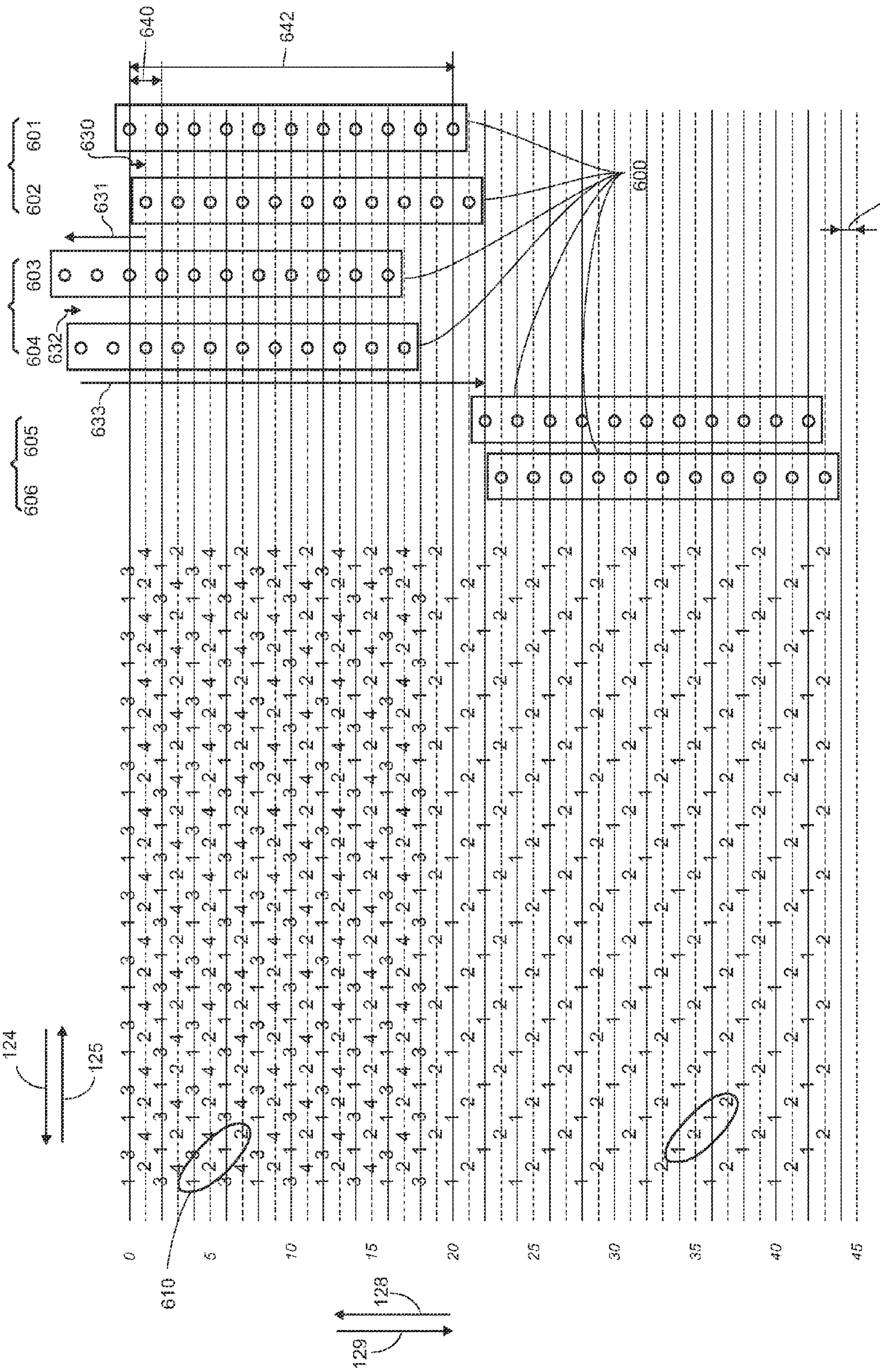



Figure 5C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15
20
25
30
35
40
45

Figure 6

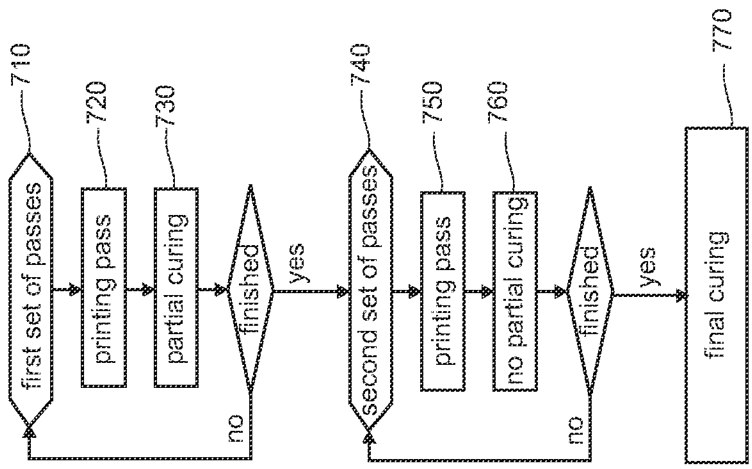
first set of passes
710
printing pass
720
partial curing
730
finished
yes
no
second set of passes
740
printing pass
750
no partial curing
760
finished
yes
no
final curing
770

Figure 7

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 06 12 5699

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| | | | B41J |

The present search report has been drawn up for all claims

3

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 23 May 2007 | Ziegler, Hans-Jürgen |

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