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(71) Applicant: **Hewlett-Packard Company**
3000 Hanover Street
Palo Alto California 94304(US)

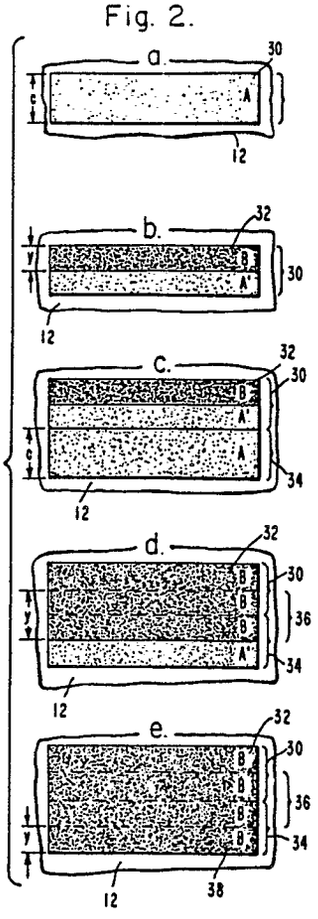
(72) Inventor: **Bergstedt, Donald B.**
3429 Vista de la Cresta
Escondido California 92025(US)

(74) Representative: **Colgan, Stephen James et al**
CARPMAELS & RANSFORD 43 Bloomsbury Square
London WC1A 2RA.(GB)

(54) Method of printing dot-on-dot graphics area-fill using an ink jet device.

(57) Perceived quality of printing dot-on-dot graphics area fill using an ink-jet device is improved by printing rows (30, 32, 34, 36, 38) of alternating colors, with each row offset from the preceeding row by a predetermined amount. In this manner, banding (22, 22′), which is perceived with prior art printing methods, is substantially reduced.

Fig. 2.



EP 0 300 595 A1

METHOD OF IMPROVING DOT-ON-DOT GRAPHICS AREA-FILL USING AN INK-JET DEVICE

TECHNICAL FIELD

The present invention relates to ink-jet devices for printing colors on a print medium, and, more particularly, to a method of improving the perceived quality of color graphics thereon.

BACKGROUND ART

Ink-jet devices fire droplets of ink toward a printing medium, such as paper or mylar. Typical ink-jet printheads comprise at least one group of nozzles, called a primitive, through which the droplets of ink are fired. For full color printing, three primitives are employed, with the nozzles of each fluidically connected to a reservoir of a different color ink (cyan, yellow, magenta). The firing, or propelling of ink droplets, may be done by piezoelectric means or by resistive heating (thermal).

In green, red and blue solid area-fill, the colors are generated by placing one dot of a first color on top of another dot of a second color, which produces the desired third color (e.g., yellow on cyan creates green).

In the normal printing mode, the dots are put down on each other in the same pass of the printhead across the medium. When printing a block of area-fill, bands occur between swaths of print rows, due to absorption of the first color printed on the medium, which may be a specially coated paper used for color ink-jet printing. The banding tends to reduce the perceived quality of the output.

Accordingly, a method of producing a substantially uniform block of color, without the perceived banding or at least with reduced perceived banding is desired.

DISCLOSURE OF INVENTION

In accordance with the invention, a method of forming dot-on-dot graphics area-fill with reduced perceived banding is provided. The method comprises overlapping a portion of one print row with a portion of another print row.

More specifically, the method of the invention comprises:

(1) printing a first row of a first color;

(2) printing a second row of a second color offset from the first row by a predetermined amount; and

(3) printing subsequent rows of alternating first and second colors offset from preceeding rows by the predetermined amount, until the entire area is filled.

The offset printing may be done by moving either the print medium or the printhead relative to the other. Also, primitives on the printhead may be staggered to achieve the desired effect.

By overlapping, or interleaving, swaths of the individual colors, the bands present in the conventional print mode are eliminated. This results in improved print quality and homogeneity of graphics output.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1a-d are top plan view of printing two colors to achieve a third color, employing a conventional print mode used in the prior art; and

FIGS. 2a-e are top plan views of printing two colors to achieve a third color in accordance with the invention.

BEST MODES FOR CARRYING OUT THE INVENTION

Referring now to the drawings wherein like numerals of reference designate like elements throughout, FIGS. 1a-d depict the sequence of events in filling in an area of a third color achieved by printing multiple rows of two colors. In the description which follows, the color green is achieved by printing alternating rows of cyan and yellow. However, it will be understood that other combinations suffer from the same effect to be described, and that such other combinations will also benefit from employing the method of invention.

FIG. 1a illustrates the printing of a first row 10 of a first color, here, cyan, on a print medium 12. Employing ink-jet technology, the row 10, and subsequent rows, are generated by firing all nozzles of a primitive on the printhead. As an example, a primitive may contain ten nozzles, although fewer or greater numbers of nozzles may be employed.

In FIG. 1b, a row 14 of a second color, here, yellow, is overlaid directly over the first row 10, either in the same pass across the medium 12 or

in a subsequent pass. However, the print medium 12 is saturated with the first color, so the second color tends to run off the first color, creating the third color in the central portion 16 and a border 18 of the second color.

In FIG. 1c, a second row 20 of the first color is printed, and its top edge is aligned substantially adjacent the bottom edge of the first row 10 of the first color. While that portion 22 of the border 18 overlaid by the second row 20 suffers from the saturation effects discussed in connection with FIG. 1a, it nevertheless is converted to the third color. However, whereas the central portion 16 comprises the second color on top of the first color, the border portion 22 comprises the first color on top of the second color. This distinction will be discussed shortly.

In FIG. 1d, another row 24 of the second color is overlaid directly over the second row 20. Again, due to saturation of the print medium, the third color is generated in the central portion 16′, and a border 18′ of the second color is formed, as in FIG. 1b.

It will be appreciated that printing of subsequent rows of the first color overlaid with rows of the second color generates two regions of a third color, namely a central portion 16 (and 16′, etc.) and a border portion 22 (and 22′, etc.). While both are of the same color, the former region is a third color of the case of the first color (due to the prior absorption of the first color therein), while the latter region is a third color of the cast of the second color (due to the prior absorption of the second color therein).

Thus, in the case of rows 10, 20 of cyan overlaid with rows 14, 24 of yellow, the central portions 16, 16′ are green with a bluish cast, while the border portions 22, 22′ are green with a yellowish cast. The resulting area-fill comprises large swaths of one shade of green separated by narrow bands of another shade of green. The distinct banding is considered objectionable.

In accordance with the invention, the perceived quality of the area fill is improved by overlapping, or interleaving, swaths of the individual colors. The preferred sequence of the overlapping is depicted in FIGS. 2a-e.

FIG. 2a shows a first row 30 of a first color, again, cyan, for example, printed on a medium 12. A complete first row is printed. Region "A" comprises the first color.

In FIG. 2b, only a portion of a second row 32 of a second color, again, yellow, for example, is printed, offset from the first row by a specific, predetermined amount. The portion (region "A") not printed by the second color relates to the amount of overlap, or offset, and here is one-half of a row. Thus, one-half row is initially printed, and the offset is one-half row, so that the second row 32 covers the top one-half of the printed portion of the first row 30. The row 32 creates the third color, again, green, for example, while the bottom half of the row 30 remains the first color. Region "B" is now the third color, while that portion of region "A" not printed on is denoted "A′".

In FIG. 2c, a third row 34 of the first color is printed adjacent the row 30, again, offset from the second row 32 by the predetermined amount, here, one half row. Thus, the top of row 34 butts against the bottom of row 30. Region "B", being unaffected in this step, remains the third color, region "A′", also unaffected, remains the first color, and region "A" is the newly-printed first color.

In FIG. 2d, a fourth row 36 of the second color is printed, offset from the third row 34 by the predetermined amount, again, one-half row. Region "B", being unaffected in this step, remains the third color, region "A′" and the upper portion of region "A" are now the third color, as denoted by "B", and the lower portion of region "A" not printed on is denoted "A′", the first color.

The method may be continued as many times as desired printing of rows of alternating first and second colors, until the area is filled. In order to terminate the last row of the area to provide only one color, only a portion of the last row is printed, and is the amount of offset, here, one-half of a row 38, as shown in FIG. 2e.

It will be appreciated that in the preferred embodiment, one color (the first color, here, cyan) is always overlaid by another color (the second color, here, yellow) so that the resulting third color is always of the same cast. Thus, the objectionable banding achieved with the prior art method is avoided.

The offsetting of one color relative to another color can be done using several methods. First, individual primitives on a single printhead containing separate colors can be physically offset relative to each other. Second, if the primary colors are contained in separate pens, the pens themselves can be offset relative to one another. Third, with a printhead having primitives not offset, or with a pen fixturing configuration not having the pens offset, less than the full number of nozzles in each primitive, or pen, can be used in order to allow for offsetting of the remaining nozzles.

The third method allows for offsetting without having to make a physical change to an existing pen or to the pen fixturing (in the case when each color is in a separate pen).

By physically offsetting the nozzles of one color relative to the nozzles of the other color using any of the methods stated previously, the two colors can be deposited during the same pass of the printhead across the medium. In FIG. 2, this

would be accomplished by depositing the rows 30 and 32 represented in FIGS. 2a and 2b in the same pass, as well as the rows 34 and 36 represented in FIGS. 2c and 2d during the same pass.

Two additional methods can be used to create the offset of the two colors. In the fourth method, the print medium 12 can be moved relative to the printhead. In the fifth method, the printhead can be moved relative to the print medium 12. These methods require that the medium or printhead, depending on which is being moved, move backward (opposite the direction of the progression of printing down the page) to allow for the offsetting of the second color relative to the first color. The printhead or medium must be then moved forward to deposit the first color on an unprinted section of medium again, then move backward to print the second color, and continue in this fashion until the area-fill block is complete. Thus, these methods require that one pass of the printhead across the medium be made for each primary color deposited.

The advantage of printing the first and second colors during the same pass of the printhead or printheads across the medium is that the time required to print a section of area-fill is approximately halved. However, with the offset configuration, the print quality is better when the section is printed in two pass modes rather then in a single pass mode. The reason for this is that one section of the third color is created by combining the first and second colors in the same pass, and another section is created by depositing the second color on top of the first color which was deposited in the previous pass of the printhead across the medium. The difference creates a variation in hue between the two sections, which is noticeable.

In the two-pass made, the second color is deposited on two sections of the first color. One section was deposited in the previous pass, and the other was put down three passes prior to the pass of the second color. The two sections of the first color are very similar, since both have had sufficient time to dry, and result in a uniform area of the third color.

The extent of offset may be varied. In the one-pass mode, maximum print quality is achieved at an offset of 100%, while slight improvement is made with slight amounts of offset of at least about 10%. In the two-pass mode, maximum print quality is achieved at an offset of 100% also, but major improvements are obtained with slight amounts of offset of at least about 10%.

INDUSTRIAL APPLICABILITY

The use of offset partial row printing in accordance with the invention is expected to find use in color ink-jet printers.

Thus, there has been disclosed a method of improving dot-on-dot graphics area fill using an ink-jet device. It will be clear to one of ordinary skill in the art that various changes and modifications of an obvious nature may be made, and all such changes and modifications are considered to fall within the scope of the invention as defined by the appended claims.

Claims

1. An improved method of generating dot-on-dot graphics area fill on a print medium (12) using an inkjet device, said device including at least one printhead having a set of primitives, each primitive comprising a plurality of nozzles fluidically connected to a reservoir of a given color, said method comprising:

(1) printing a first row (30) of a first color (c);

(2) printing a second row (32) of a second color (y) offset from said first row by a predetermined amount (A); and

(3) printing subsequent rows (34, 36) of alternating first and second colors offset from said preceding row by said predetermined amount, until said area is filled.

2. The method of Claim 1 wherein said predetermined amount comprises at least about 10% offset.

3. The method of Claim 2 wherein said predetermined amount comprises up to 100% offset.

4. The method of Claim 2 wherein said predetermined amount comprises one-half row.

5. The method of Claim 1 wherein said predetermined amount is attained by moving said medium with respect to said printhead.

6. The method of Claim 1 wherein said predetermined amount is attained by moving said printhead with respect to said medium.

7. The method of Claim 1 wherein said predetermined amount is attained by staggering said primitives with respect to each other.

8. The method of Claim 1 wherein said printing commences with printing said first row, followed by printing a portion of said second row, and terminates with printing a lower portion of the last row (38) coinciding with the amount of offset of the next to last row.

9. The method of Claim 8 wherein said printing commences with printing the bottom one-half of said first row and terminates with printing the upper one-half of said last row.

10. The method of Claim 1 wherein said rows of alternating first and second colors are printed in one pass of said at least one printhead across said print medium.

11. The method of Claim 1 wherein said rows of alternating first and second colors are printed in two passes of said at least one printhead.

12. An improved method of generating dot-on-dot graphics area fill on a print medium (12) using an inkjet device, said device including at least one printhead having a set of primitives, each primitive comprising a plurality of nozzles fluidically connected to a reservoir of a given color, said method comprising:

(1) printing a first row (30) of a first color (c);

(2) printing a second row (32) of a second color (y) offset from said first row by a predetermined amount comprising one half-row; and

(3) printing subsequent rows (34, 36) of alternating first and second colors offset from said preceding row by said predetermined amount, until said area is filled.

13. The method of Claim 12 wherein said predetermined amount is attained by moving said medium with respect to said printhead.

14. The method of Claim 12 wherein said predetermined amount is attained by moving said printhead with respect to said medium.

15. The method of Claim 12 wherein said printing commences with printing said first row, followed by printing one-half of said second row on the top half of said first row and terminates with printing the lower one-half of the last row (38).

16. The method of Claim 12 wherein said rows of alternating first and second colors are printed in one pass of said at least one printhead across said print medium.

17. The method of Claim 12 wherein said rows of alternating first and second colors are printed in two passes of said at least one printhead.

Fig. 1. (PRIOR ART)

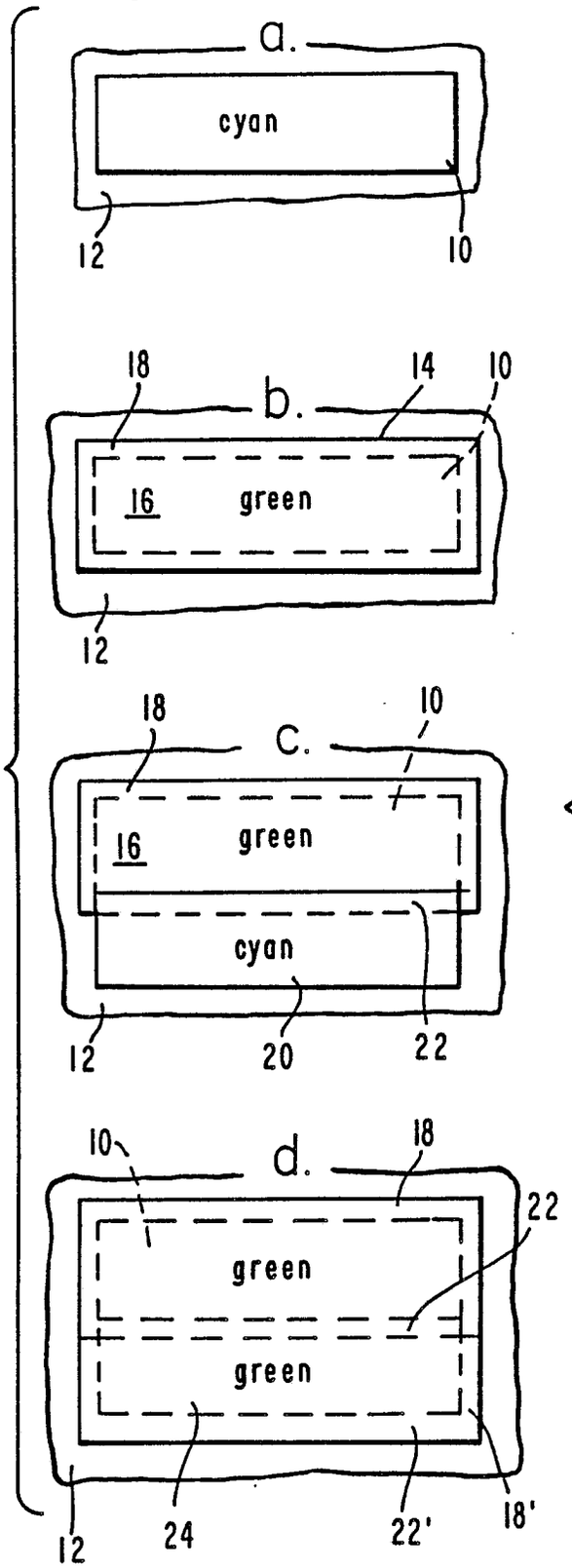
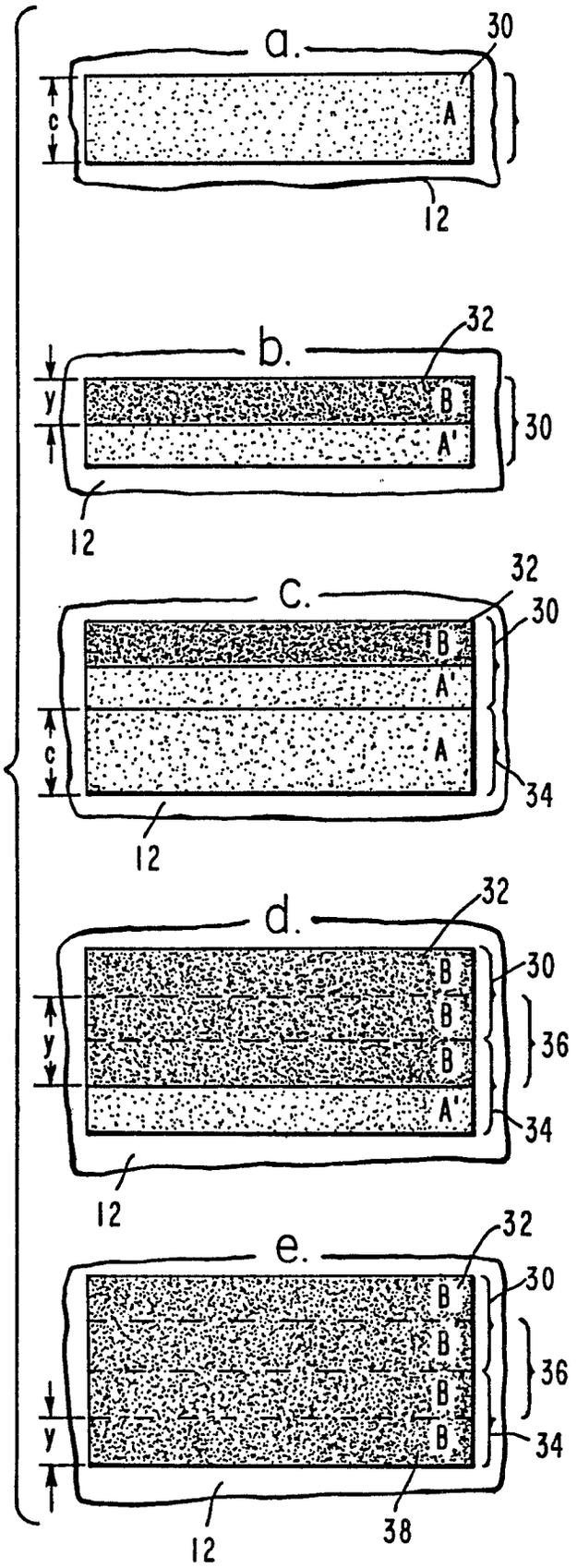


Fig. 2.



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EUROPEAN SEARCH REPORT

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 88304047.9

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
A	EP - B1 - 0 021 389 (SIEMENS) * Fig. 2; column 5, lines 17-44 * --	1,2,5, 11-13, 17	B 41 J 3/04 B 41 M 1/18 H 04 N 1/46
A	GB - A - 2 119 549 (PENTEL KABUSHIKI KAISHA) * Page 4, line 113 - page 5, line 6 * --	1,12	
A	EP - A2 - 0 170 136 (METROMEDIA) * Totality * --	1,12	
A	DE - A1 - 3 203 972 (FUJI PHOTO FILM) * Totality * ----	1,12	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 41 J
B 41 M
H 04 N
G 01 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	08-09-1988	WITTMANN

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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