Wide Print-Head with High-Stiffness and Control Method of Drive

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Abstract

Recently, the market of inkjet printers has accomplished dramatic growth by means of high-speed and high-quality imaging technologies.

GelSprinter Aficio GX series are the latest type of inkjet printers to create business documents on plain papers in high-speed and high-quality as well as duplex printing, which had been considered as very difficult to be achieved.

Which have overcome the above difficulties are the newly developed Inkjet technologies;

(1)Pigment ink with high viscosity and penetration improves image quality on plain papers. (To be described in another paper.)

(2)Newly developed print-head of 1.27 inch width enables high-speed printing and supports two-bit control with Modulated Dot Technology.

We developed wide Print-head with high stiffness and control method of drive in order to eject new pigment ink droplet stably.

In this paper, we show the structure of wide Print-head with high stiffness and describe the control method of drive.

***Figure 2**. The appearance of GelSprinter Wide Head*

Introduction

The authors have developed GelSprinter Wide Head. GelSprinter Wide Head is developed to eject GelSprinter Pigment Ink with high viscosity and penetration. It needs high drive energy to eject high viscosity ink. In order to eject GelSprinter Pigment Ink effectively and stably, we have developed GelSprinter Wide Head.

***Figure 1**. The appearance of GelSprinter Aficio G (above) and GX series (below)*

GelSprinter Wide Head with high-stiffness

GelSprinter Wide Head comprises a base unit, a piezoelectric actuator unit, a vibration plate, an ink chamber plate and a nozzle plate. The piezoelectric actuators deform to pressurize the ink chambers. The ink chambers communicate with the nozzles respectively. The channel structure of GelSprinter Wide Head is shown in Figure 3.

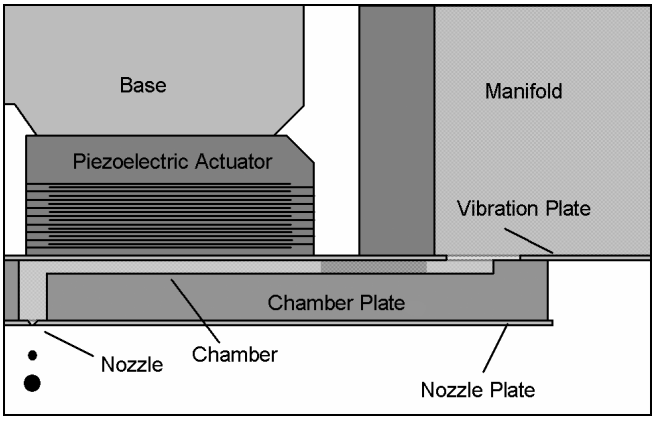

***Figure 3**. The channel structure of GelSprinter Wide Head*

The width of GelSprinter Wide Head is 1.27 inch. The resolution of GelSprinter Wide Head is 300 dpi because of two nozzle lines which comprise each 192 nozzles with resolution of 150dpi. GelSprinter Wide Head enables ink to be distributed to large area per scanning, so it is possible to achieve high-speed printing. The nozzles of GelSprinter Wide Head are shown in Figure 4.

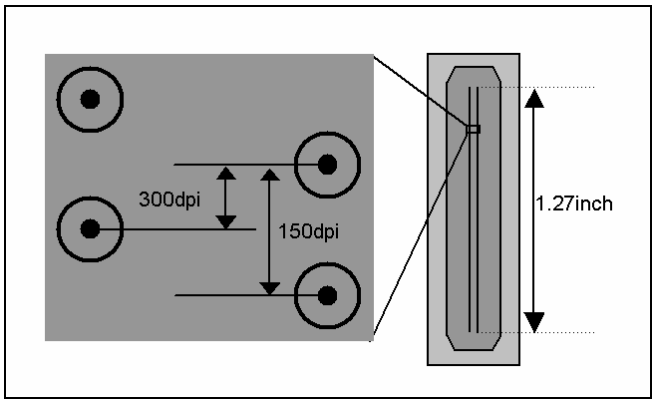

***Figure 4**. Nozzle of GelSprinter Wide Head*

As mentioned above, the piezoelectric actuators deform to pressurize the ink chamber. The piezoelectric actuators comprise accumulated piezoelectric layers. GelSprinter Wide Head eject ink droplets by using a displacement in the d33 direction.

The ink chambers of GelSprinter Wide Head are composed of a Si ink chamber plate with MEMS technology. The ink chambers of our former inkjet head are composed of a resin ink chamber plate. This change of material achieves high-stiffness and high precision of an ink chamber plate.

A nozzle plate , an ink chamber plate and a vibration plate compose the ink chambers and are manufactured in inside order. A nozzle plate and a vibration plate are manufactured by Ni electroforming.

GelSprinter Wide Head composed of above-mentioned materials achieves high-stiffness. In addition to this point, a resonant period of GelSprinter Wide Head is shortened by about a half as our former inkjet head. By increasing pressure of the ink chambers and shortening a resonant period of ink chamber, GelSprinter Wide Head can eject GelSprinter Pigment Ink with high drive frequency stably.

Control method of drive

In order to eject GelSprinter Ink droplets stably, it needs the suitable control method of drive for the structure of GelSprinter Wide Head. Our control method of drive is called as M-Dot; Modulated Dot Technology.

M-Dot uses high linear response of the piezoelectric actuators. The suitable drive signal can change the size of ink droplets, so we achieve both of high-speed and high-quality printing.

Figure 5 indicates meniscus condition while ejecting ink droplet. At first, the ink meniscus is kept inside the nozzle shown in (1).

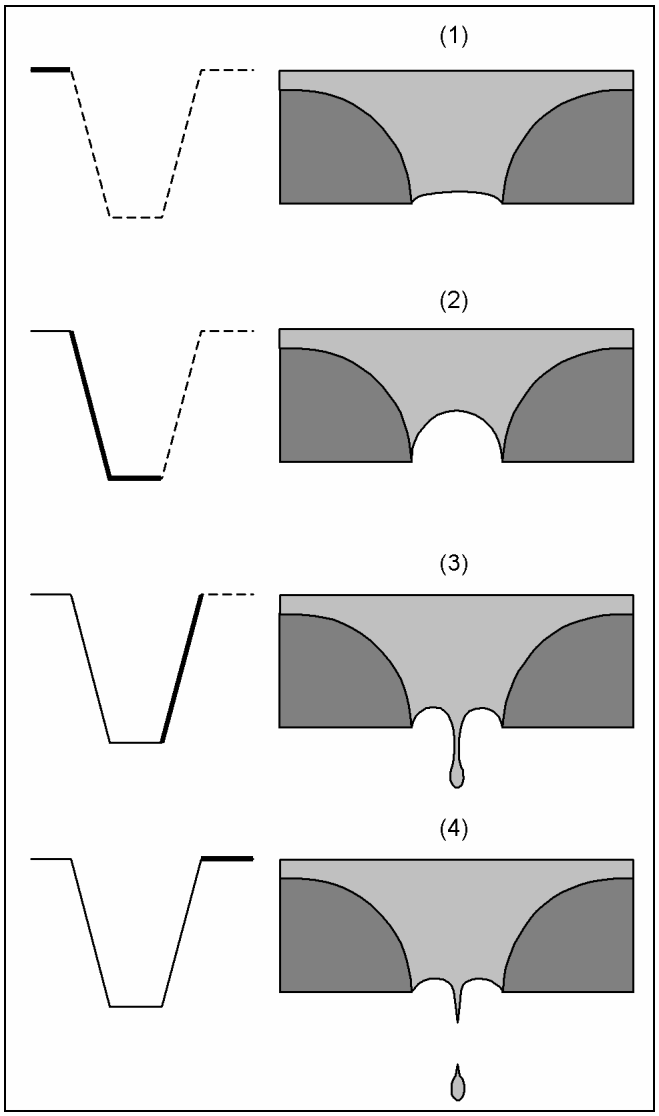

***Figure 5**. Drive Signal and Position of ink meniscus*

Secondly, the ink chamber expands and ink meniscus is pulled into the nozzle shown in (2). Thirdly, the ink chamber constricts and ink meniscus is pushed out from the nozzle shown in (3). Finally, ink droplet is ejected shown in (4). This is the fundamental control method of drive. Drive Signal to eject plural size of ink droplets is a combination of such a drive signal.

The velocity and volume of ink droplets depend on the voltage and time of electric discharge, the time of electric hold, and the voltage and time of electric charge. For example, the bigger the voltage of electric discharge and electric charge is, the faster the velocity of ink droplets is.

Figure 6 indicates pattern of drive signal and the size of ink droplets accordingly. Small ink droplet is ejected by single drive signal pulse, and large ink droplet is ejected by four drive signal pulses. The size of ink droplets depends on the choice of drive signal pulses.

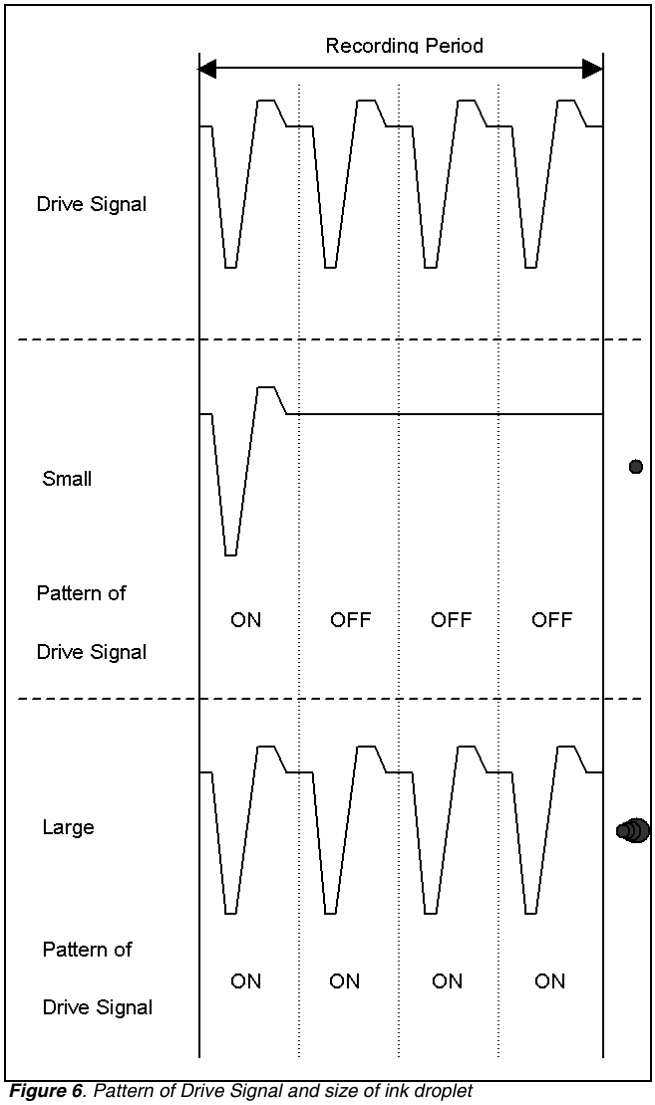

***Figure 6**. Pattern of Drive Signal and size of ink droplet*

As for large ink droplet in Figure 6, four ink droplets by four drive signal pulses are merged before ink droplets reach the paper. Therefore four ink droplets can be put on the paper as a circle in shape.

Figure 7 indicates condition of ink droplet merged. Condition of ink droplet merged is observed by CCD camera.

In GelSprinter Aficio G series, GelSprinter Wide Head eject ink droplets stably by reducing vibration of the ink meniscus after ejecting. The condition of ink meniscus before next ejecting is kept stable by controlling drive signal actively. The timing of active controlled drive signal depends on a resonant period of the ink chamber. The comparison of position of ink meniscus is shown in Figure 8. One used active controlled drive signal, and the other didn't.

By above-mentioned M-Dot, GelSprinter Wide Head can eject ink droplets with maximum 50kHz. GelSprinter Wide Head can eject two and more kinds of ink droplet size; maximum size is 36pl droplets composed by four ink droplets and minimum size is 5pl composed by one ink droplet.

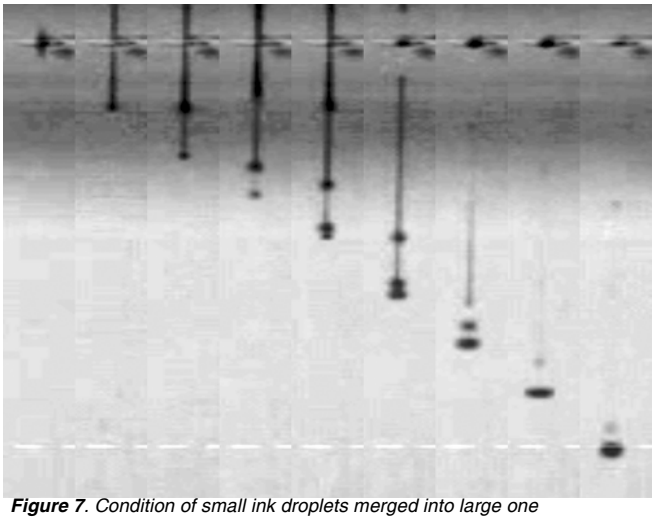

***Figure 7**. Condition of small ink droplets merged into large one*

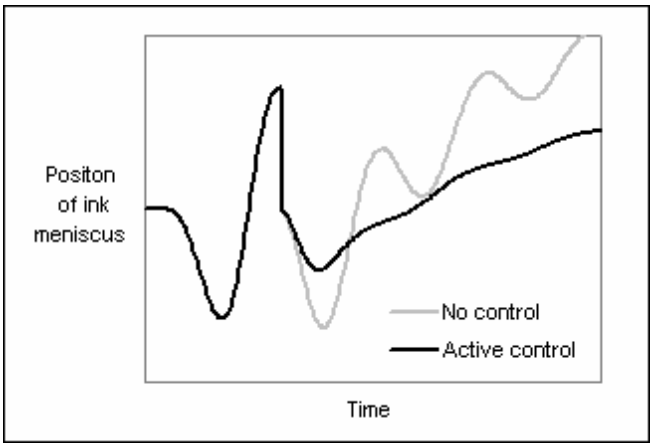

***Figure 8**. Comparison of Position of ink meniscus*

New GelSprinter Wide Head with high-stiffness

New GelSprinter GX Wide Head has achieved to eject ink droplets with higher frequency and eject smaller ink droplets than former GelSprinter G Wide Head. That is why New GelSprinter Wide Head have realized higher-speed and higher-quality printing.

The structure of New GelSprinter GX Wide Head is almost same as former GelSprinter G Wide Head. The change in the structure of head is to reduce the volume of the ink chambers and modify the structure of the ink chambers. This can shorten a resonant period of ink chamber by 2/3. Figure 9 shows the comparison of the position of ink meniscus.

As for control method of drive, New GelSprinter GX Wide Head has improved M-Dot. Former GelSprinter G Wide Head used active controlled drive signal for every ejecting, and achieved to eject ink droplets stably. However, New GelSprinter GX Wide

Head ejects ink droplets depending on the position of ink meniscus after ejecting former ink droplets. So, it is possible to shorten an interval of drive signal pulses.

By above-mentioned improved M-Dot, New GelSprinter GX Wide Head can eject ink droplets with maximum 50kHz. New GelSprinter GX Wide Head can eject two and more kinds of ink droplet size; maximum size is 36pl droplets composed by six ink droplets and minimum size is 2pl composed by one ink droplet. In comparison with volume of ejecting ink droplets per second, New GelSprinter Wide GX Head ejects about 1.4 times as much as former GelSprinter G Wide Head.

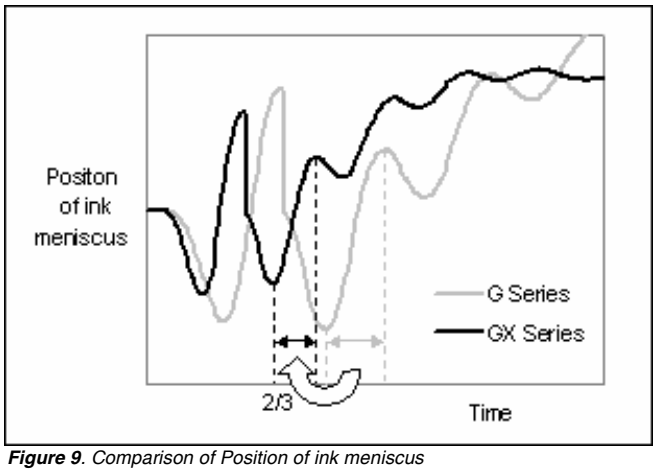

***Figure 9**. Comparison of Position of ink meniscus*

Conclusion

GelSprinter Wide Head can eject GelSprinter Pigment Ink effectively and stably because of high-stiffness and M-Dot. This is why GelSprinter Aficio G and GX series create printing in high-speed and high-quality.

References

[1] H. Noda, K. Ogata, T. Kamei, H. Eguchi, T. Kimura and Y. Ohta, "Japan Hardcopy", p85 (2004)

[2] Electronic Journal, "Inkjet Technology Outlook, 178 (2007).

Author Biography

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