Development of "Jet Press 720S" Digital Inkjet Press

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Abstract

FUJIFILM released a new sheet-fed inkjet printer in 2014—Jet Press 720S. Based on the previous Jet Press 720 model revealed in 2008, the Jet Press 720S has been developed with improved functions. We adopted the PZT sputtering process in the printhead for good uniformity among jets, new printhead maintenance technology for nozzles with fewer defects, and a simplified replacement process for defective printhead modules. These technological advancements have resulted in improved printing productivity. In addition, full-size variable printing was introduced to diversify the available printing services.

1. Introduction

At Drupa 2008, FUJIFILM exhibited the technology of the Jet Press 720, a high-speed, high-resolution sheet-fed inkjet printer that enabled small-lot commercial printing. Later, the printer was launched onto the market.[1)] The company then developed the successor model, Jet Press 720S, and started its mass production in 2014, having established a good reputation with it. This paper describes the functions incorporated into the Jet Press 720S improving on its predecessor by achieving stable printing quality, increase in productivity via downtime reduction, and full variable-data printing.

2. Outline of the Jet Press 720S

2.1 Outline of the system

The Jet Press 720S incorporates the following technologies that are inherited from and improve upon its predecessor, Jet Press 720.

i. High-density droplet jetting enabled by the high-durability MEMS printhead
ii. Printhead maintenance function to sustain high-resolution printing
iii. High-speed cohesion technology to achieve high color reproducibility
iv. Water-based ink drying
v. High-precision scanning with an inline scanner
vi. Image processing technology
vii. Full variable-data printing (optional)

With those technologies, the printer has acquired a versatility that conventional offset printers lack and is now highly regarded as an innovative printer that meets a variety of needs such as small-lot printing and quick delivery.

The following are the system specifications of the Jet Press 720S. The appearance is shown in Fig. 1.

Resolution:	**1,200 dpi × 1,200 dpi**
Colors:	**CMYK (four-color) water-based pigment ink**
Paper supply method:	**Sheet-fed**
Maximum paper size:	**B2 (750 × 532 mm)**
Paper thickness:	**0.105 to 0.34 mm**
Maximum printing speed:	**2,700 sheets/hour**
Equipment dimensions:	**8,019 mmW × 2,653 mmD × 2,050 mmH**
Weight:	**14 t**

2.2 Outline of the high-precision MEMS printhead

To ensure high-precision color registration, the Jet Press 720S deploys a four-color compact piezo-based printhead with a resolution of 1,200 dpi and a width of 720 mm in one printing cylinder (Fig. 2). That realizes printing productivity of a maximum of 2,700 sheets per hour in single-pass printing.

Fig. 1 View of Jet Press 720S

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The printhead employs 1,200-dpi head modules consisting of 2,048 nozzles. By forming print bars, each consisting of 17 modules aligned with a high precision of a few micrometers, it achieves a wide printing width.

The printhead is built with submicron-level, high precision and density via the microelectromechanical systems (MEMS) process, using silicon for the part from the ink channel to the nozzles. It is capable of jetting ink with a minimum droplet volume of 2.0 pL at 100 kHz and draws images by combining three different sizes of droplets, small, medium and large.

Figs. 2 and 3 show the appearance of the printhead module manufactured by FUJIFILM Dimatix, Inc. and that of a print bar implemented with high precision, respectively.

3. Technologies incorporated into the Jet Press 720S

The technologies to be incorporated into the Jet Press 720S were reviewed system-wide before implementation. Thus, new technologies, not only inherited from but also improvements on those of the Jet Press 720, were introduced into the printer. The following are the details of those technologies.

Fig. 2 Inkjet print engine and printhead module

Fig. 3 Print bar

3.1 Printhead-related technology

By improving printhead durability and preventing deterioration in printing performance, it has become possible to reduce non-printing time and thereby increase actual productivity in printing.[2] Specifically, the following improvements were made: (1) increase in the number of sustainable printing operations by making the piezoelectric actuator into a thin film via sputtering; (2) nozzle surface wiping with a web (cleaning cloth); (3) prevention of ink adhesion to the nozzle surface with divided dummy jetting; (4) prevention of nozzle degradation caused by drying; and (5) addition of the printhead module replacement function.

3.1.1 Sputter-deposited film for the piezoelectric actuator

A sputtered film with a high piezoelectric constant developed by FUJIFILM is used for the piezoelectric actuator of the Jet Press 720S (Fig. 4). Conventionally, a method has been used in which bulk PZT (lead zirconate titanate) is thinned via polishing. However, with our sputtering technology, it has become possible to streamline production processes, including polishing, and stabilize the ejection performance inside the module. In addition, sputtered PZT films do not use adhesives and are highly heat-resistant, which improves flexibility in high-temperature processes after film deposition and enables the stable formation of protective films with low moisture permeability on the surface. That prevents moisture penetration from affecting the life of the product. A rigorous endurance test, in which high-voltage pulses were applied 700 billion times experimentally in a high-humidity environment, achieved the excellent result that none of the 2,048 actuators failed at all and the displacement remained within 3%. The film thus contributes to increased durability of the actuators (Fig. 5).

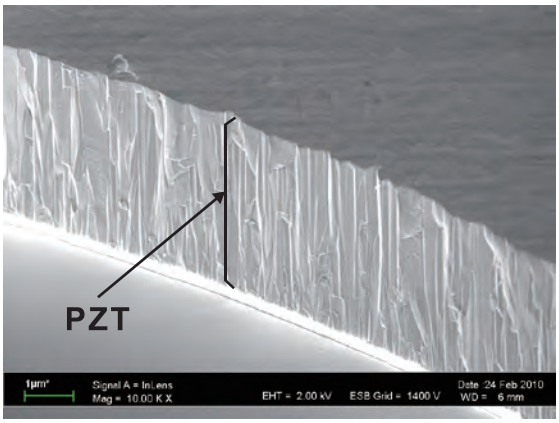


Fig. 4 SEM micrograph of sputtered PZT

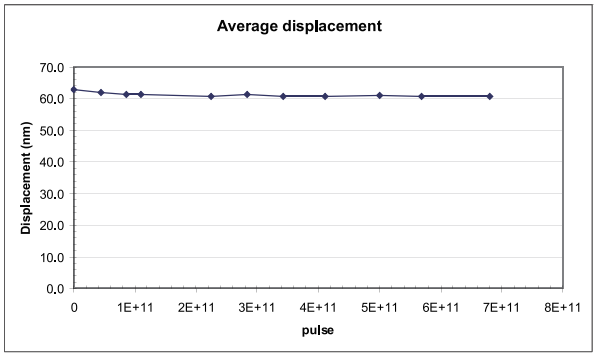


Fig. 5 Average displacement over time. Less time degradation of displacement occurs with recurring jetting pulses. Data points indicate when each jetting pulse occurred.

3.1.2 Nozzle surface wiping with a web

Long-term stable jetting of water-based pigment ink containing latex is difficult to achieve. To ensure high jetting precision, high water repellency must be maintained in the vicinity of the nozzles.

To that end, the printhead module is constructed with a high-durability, water-repellent fluorocarbon film on the nozzle surface and a structure that prevents the increase of ink viscosity near the nozzles by circulating ink inside the module (Fig. 6).

In addition, to ensure stable jetting of the printhead, a maintenance function is newly introduced in which a web wet with a nozzle cleaning solution wipes off water-based pigment ink containing latex that easily dries and adheres to the nozzle surface (Fig. 7). That mechanism keeps the nozzle surface always clean and maintains high jetting performance of the printhead.

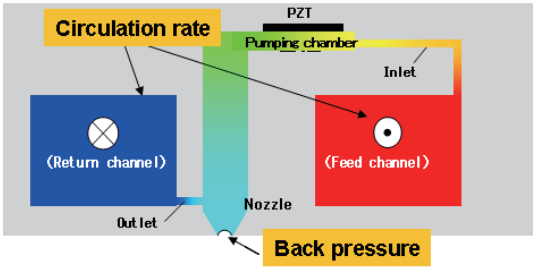


Fig. 6 Schematic of ink circulation in printhead module

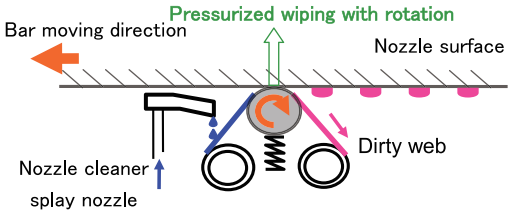


Fig. 7 Outline view of web wiping system

3.1.3 Divided dummy jetting

Before web wiping to ensure long-term stable jetting of water-based pigment ink containing latex, dummy jetting is carried out to eject ink that has its viscosity increased near the nozzles during print jobs. In addition to ink mist during print jobs, ink mist during the dummy jetting also adheres to the nozzle surface. Previously, it was therefore necessary to apply web wiping repeatedly to keep the nozzle surface clean.

However, the Jet Press 720S performs dummy jetting, dividing it into several operations with multiple dummy jetting nozzles, and thereby considerably decreases the amount of ink mist generated by crosstalk between nozzles and keeps the adhesion of ink mist to the nozzle surface to a minimum (Fig. 8). That keeps the wiping count and damage to the nozzle surface by wiping friction to a minimum, thus enabling the reduction of non-printing time.

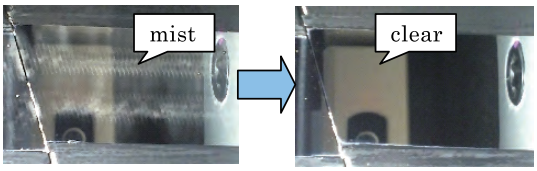


Fig. 8 With and without divided dummy jetting

3.1.4 Technology to prevent nozzle degradation caused by drying

To achieve high-speed ink cohesion and fixation to paper, the Jet Press series printers use water-based pigment ink containing latex, which is resistant to adhesion to the nozzle and re-dissolution after solidification compared with general water-based inkjet ink. The printers also employ a technology to prevent ink adhesion to the nozzle surface by optimizing the ink circulation pressure and nozzle surface pressure. Via the experimental optimization of individual pressures, it has become clear that the printers can prevent deterioration in jetting, due to adhesion caused by drying, by keeping a high ink circulation pressure and a high-precision, positive nozzle surface pressure. Reference values for typical pressures are given in Fig. 9. Under the conditions determined with this method, the drying deterioration rate slows six times compared with that under the standard initial conditions.

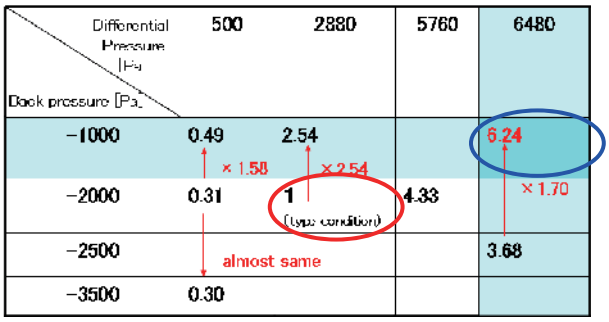


Fig. 9 Ink pressure control in printhead module

3.1.5 Printhead module replacement technology

With the above described technologies, sustainability in the printing performance of the printhead module has further improved from that of the Jet Press 720. However, easy maintenance of degraded printhead modules is also desirable. The Jet Press 720S has achieved significant improvement in maintenance performance and downtime reduction by introducing a module-by-module printhead replacement mechanism.

The Jet Press 720S allows users to replace printhead modules, to adjust the position of the replaced modules in the order of micrometers and to correct their properties in the course of its operation. Quick response to deterioration in printing performance has thus become possible.

Fig. 10 illustrates the outline of printhead module replacement.

3.2 High-speed ink cohesion technology

Among continuously incorporated basic technologies are preconditioning of paper and high-speed ink cohesion.

General inkjet printers are subject to bleeding of images with non-inkjet printer paper, such as that for offset printers, due to the expansion of dots. To realize high-quality, bleeding-free offset printing, the Jet Press 720/720S applies preconditioning solution to the paper before printing and thereby prevents bleeding. In that process, instantaneous ink cohesion takes place on the paper upon the reaction of the preconditioning solution with the ink, which maintains individual dot form without merging the neighboring dots (Fig. 11). As a result, a significant inkjet printing issue, bleeding, is solved and reduction in text reproducibility is prevented (Fig. 12).

High-speed ink cohesion has been realized by the development of our own pigment dispersant and latex. That same high-speed ink cohesion technology can also improve ink dot printing density, which may lead to the realization of wider-range color reproduction. The technology is thus one of our core inkjet printing technologies (Fig. 13).

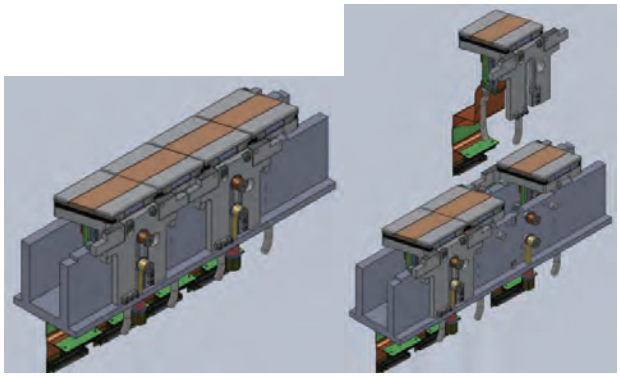
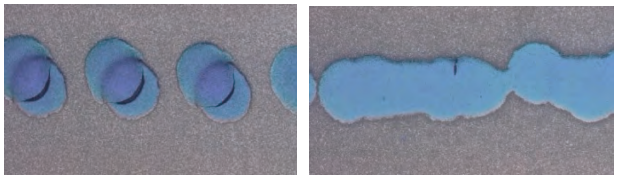


Fig. 10 Replaceable printhead module



With preconditioning　　Without preconditioning

Fig. 11 Ink-dot shapes with and without the preconditioning process

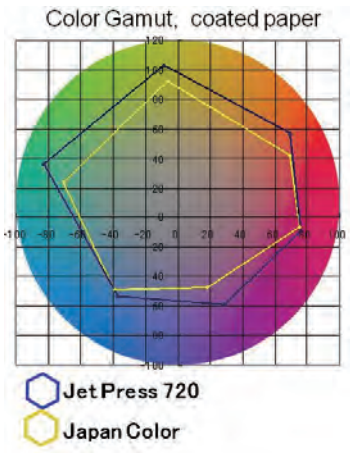


Fig. 13 Color gamut of Jet Press series and Japan color

3.3 Advanced image correction technology

The Jet Press 720S incorporates an inline scanner that allows instantaneous scanning of printed images and dedicated correction-purpose charts inside the equipment. Scanning just printed images directly after the printhead of the printing cylinder enables the prompt detection of changes in the printing condition and the correction of images. That keeps the number of lost printing sheets to the minimum if the drawing condition changes during printing.

With the image correction technology used in the Jet Press series, it is possible to correct white noise and irregular colors even when print nozzle jetting fails or is unstable. Without correction, any nozzles that do not eject ink produce white noise. In such cases, adjusting the intensity of drawing colors of the nozzles nearby can reduce the visibility of the noise (Fig. 14). Any large deviations detected in the ink jetting direction can also be corrected by disabling the relevant nozzles.

With　　Without

Fig. 12 Letters printed with and without the preconditioning process

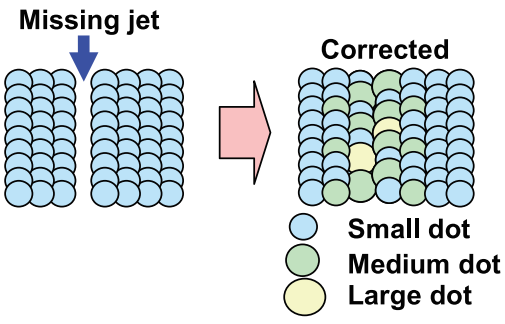


Fig. 14 Correction method for missing nozzle

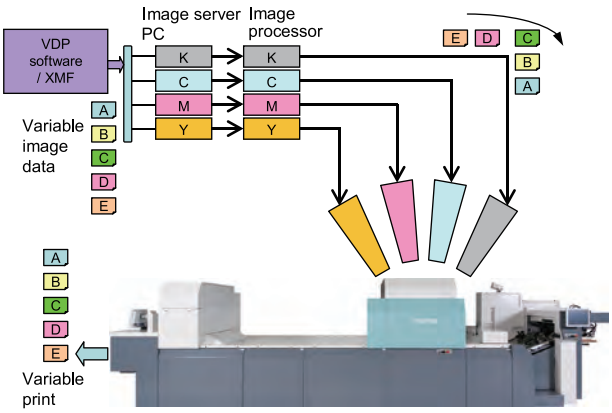


Fig. 15 Image data flow for variable printing

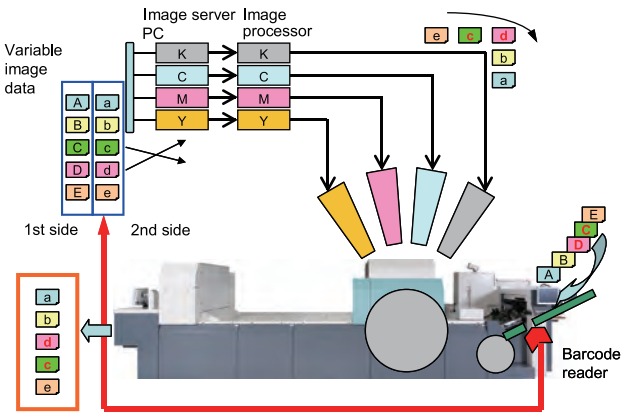


Fig. 16 Image data flow for reverse side variable printing

3.4 Variable-data printing

The Jet Press 720S has newly incorporated, as an option, the variable-data printing function, particular to digital printers, that can be set for each print image in a continuous print job. During variable-data printing, four-color, full-speed printing is still possible (Fig. 15).

In addition, in duplex printing, the Jet Press 720S performs real-time selection of images to be printed on the back print surface by printing a bar code on the front print surface of each sheet and later scanning the bar code with a dedicated reader at the feeder (Fig. 16).

Specifically, if image types A, B, C, D, E are printed in sequence on the front print surface but the sheet order is accidentally changed to A, B, D, C, E before the back surface is printed, the Jet Press 720S will detect it by scanning the bar codes and can still print the correct images on the back print surface of the corresponding sheets. In that way, the printer enables automatic correction of human errors and missing sheets during duplex variable-data printing.

Those functions are major advantages of digital printers that can be of significant appeal, meeting a variety of needs in printing.

4. Conclusion

The Jet Press 720S is an advanced version of the Jet Press series that has undergone innovative improvements on the basic technologies inherited from the preceding models. To create new areas for more diversified printing business in the future and thus vitalize the industry, we are going to continue to develop technologies that will widen the range of printing media, increase printing speeds and further improve print quality.

References

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2) Mita, T.; Nakazawa, Y.; Hishinuma, Y.; Shinada, H. Head Technology and Head Maintenance Technology for Sheet-Fed Inkjet Printer (Jet Press 720) - Effect of Heat Treatment of Carrier Beads. Imaging Conference JAPAN 2014 Fall Meeting. Kyoto, Nov. 21, 2014. The Imaging Society of Japan. 2014.

Trademarks