New Technologies for Image Stability and Reliability Used in the RICOH Production Printer

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Abstract

RICOH Pro C900 is the first full-color printer for the production printing market for RICOH. In this market, it is very important to secure stable image quality and high reliability. This product newly introduced two technologies to achieve these key factors. The former is the new control algorithm to stabilize the image quality. A Charging bias, an exposure power and a development bias are controlled according to this algorithm. This brought the superior image stability in any image patterns. The latter is the design of the high durability and long lifetime. After several improvements and optimizations the lifetime of the developer was lengthened 6 times, the OPC was lengthened 3～4times and the photoconductor drum cleaning unit was lengthened 2 times compared with the conventional one.

1. Introduction

In recent years, in the commercial and office market, as the print type is getting full of variety and the number of same image print is getting lessening, the demand for POD (Print on demand) is expanding so that you can print adequate number of print whenever you need at low cost. It is getting more important to deal with these jobs in a short time. Also it is getting more concerned with more appealing print which can print variable data such as leaflets or direct mails. We have developed new high-speed print engine RICOH Pro C900 featuring stable image quality and high reliability although it is more compact and lighter than the conventional production printers.

We will introduce the technologies about stable image quality and high reliability equipped to the RICOH Pro C900.

2. Product outline

Fig.1 is the layout and the Table.1 is the specification of RICOH Pro C900.

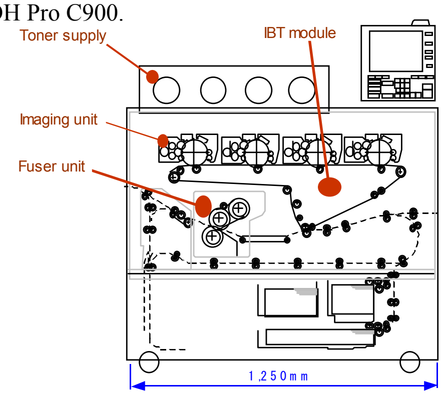

Fig.1 Engine Layout.

Table.1 Specifications.

Term	Specifications
Configuration	Console
Printing Process	Laser Electrostatic Transfer System；4-drum Tandem Engine
Printing Speed per Min.	Full Color：90 ppm（A4_LEF），50 ppm（A3）
	Black & White：90 ppm（A4_LEF），50 ppm（A3）
First Print Speed	Full Color：Less than 13.5 seconds
	Black & White：Less than 13.5 seconds
Resolution	1,200 dpi × 1,200 dpi
Tones Reproducibility	256 tones
Zoom	25% ～ 400%
Paper Sizes	Standard Tray：A5_SEF ～ 12×18 inch（305×457 mm）
	LCT：A5_SEF ～ 13×19.2 inch（330.2×487.7 mm）
Maximum Image Area	320×480 mm
Paper Weights	Standard Tray：60 ～ 220 g/m^2
	LCT：60 ～ 300 g/m^2
Paper Capacity	Standard：2,200 sheets×1 + 550 sheets×1
	Maximum：12,100 sheets（A3LCT×2 + Bypass tray）
Duplexing	Standard
Power Source	200 V，30 A，50/60 Hz
Power Consumption	Less than 5,500 W with LCT & Finisher
Warm-Up Time	Less than 420 seconds
Dimensions	1,250×1,100×1,450 mm（Main unit），3,083×1,100×1,450 mm（+ A3LCT & Finisher）
Weight	700 kg （Main unit）

3. Technology for Stable Image Quality

3-1. Stable image density

The electrophotographic printers usually have difficulty to stabilize the image density. To stabilize the image density, we developed a new developing system that can reduce the deviation of toner concentration along the axial direction of development roller. This system can improve the uniformity of toner concentrationand improve toner dispersion. This technology has much improved the stability of image density in a page as well as the stability of image density through pages compared with conventional printers.

3-2. High and stable image quality

In the production market, there are so many kinds of image patterns from low coverage image like direct mails to high coverage image like leaflets, posters and graphic arts. It becomes also very important to keep middle tone really stable because a little difference in the middle tone could cause conspicuous different image. RICOH Pro C900 aimed at stable image quality and fine reproduction not depending on image patterns, print volume, environmental conditions and time passing.

Fig. 2 shows flow of image density control. The target of γ is controlled depends on image ratio, print volume, environment and the change of carrier charge ability. These systems make image quality stable when the image patterns, print volume and other characteristics change.

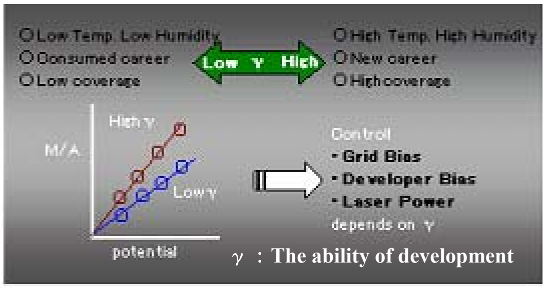

Fig.2 Flow of image density control.

Also, Both LD power control considering the photoconductor sensitivity (Fig.3) and the background potential control considering the potential depth of the latent image (Fig.4) can make line quality and middle tone image stable whenever the photoconductor sensitivity or potential depth change. As an example of achievements for high line image quality, Table 2 shows the good results of barcode image grade (barcode symbol length: 58.7mm).

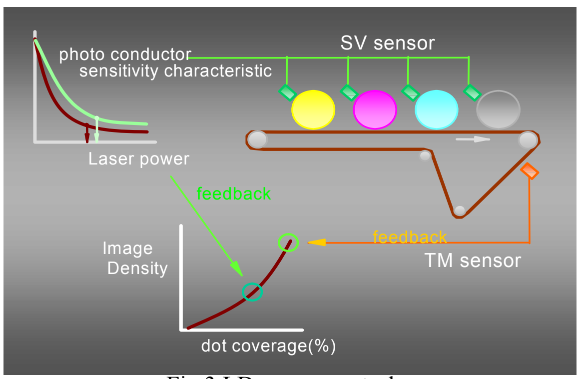

Fig.3 LD power control.

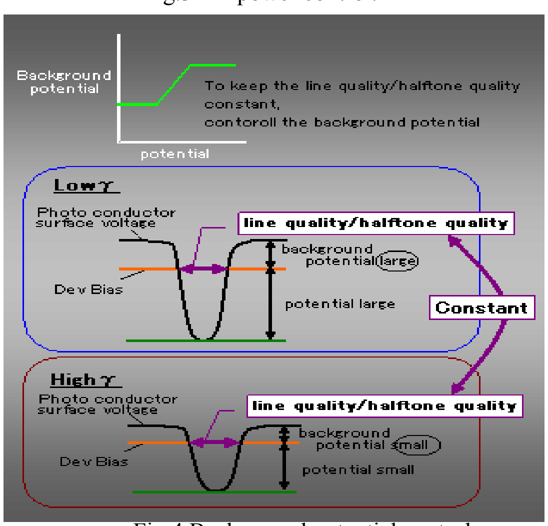

Fig.4 Background potential control.

Table.2 Evaluation result of Barcode.

Direction	Reduction	Symbol Grade
Land	0	B (3.0)
	1	B (3.0)
	2	B (3.1)
Port	0	B (3.0)
	1	A (3.5)
	2	A (3.7)

Barcode made by BarStarPro V1.2 (Ainix Inc.)

4. Technology for High durability / Long Lifetime

In order to reduce downtime, cost per page (CPP) and service cost, it is necessary to improve the lifetime of the supplies and the key parts of the machine. We introduce several technologies including improvement of lifetime regarding developer, development unit, photoconductor and photoconductor unit, which have large impact to them.

4-1. Improvements of developer durability

In order to improve the lifetime of developer, we have adopted pre-mix developer system and reduced the developer stress exhaustively.

4-1-1. Pre-mix developer system

By the stress from development unit, under the condition of high toner use, the toner sticks to the surface of carrier, which is called “spent mode”. On the contrary under the condition of low toner use, the carrier get exhausted, which is called “scrape mode”. Generally Q/M tends to decline under the “spent mode” and Q/M tends to rise under the “scrape mode”. Pre-mix developer is the system that supplies a little amount of fresh carrier into the development unit while toner is supplied into the development unit. The overflowed developer is discharged out from development unit so that the amount of the developer maintain in the same level. Fig.5 shows the concept of the pre-mix developer system.

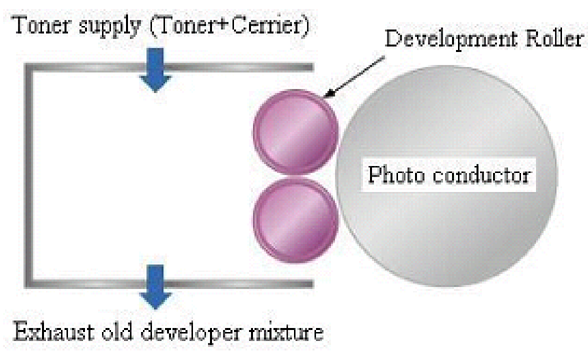

Fig.5 Pre-mix system.

Fig.6 shows the relationship between the amount of supplied carrier and the ability of static electrical charge. This graph shows the larger amount of carrier replacement becomes the more stable ability of static electrical charge. Finally the mixture rate has been designed in the optimum level considering both the stability and the cost.

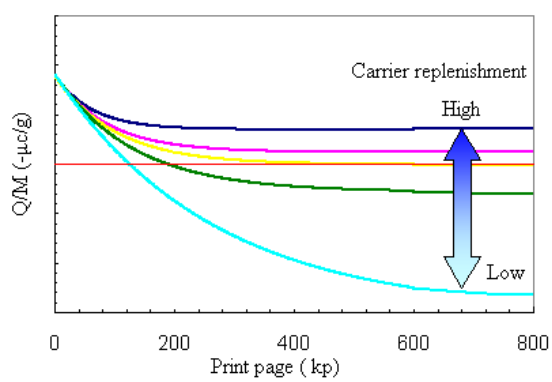

Fig.6 Time dependence of toner charge decay.

4-1-2. Low stress development

In order to achieve low stress development we have optimized the amount of developer adjusted by the doctor blade and the flow of developer behind the doctor blade by using numerical simulations (Fig.7).

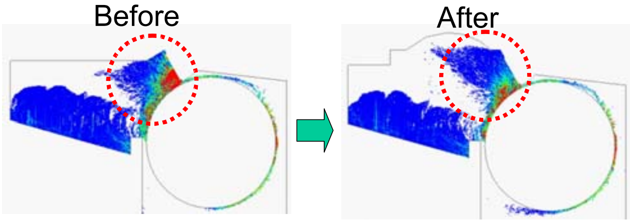

Fig.7 Simulation of developer flow at doctor blade.

The soft circulation by 3 axis screws also has contributed to the reduction of developer stress.

By above-mentioned pre-mix developer and low stress development unit, we have achieved much longer lifetime of the developer (six times longer than our conventional machines).

4-2. Improvements of development unit reliability

4-2-1. Development unit cooling

It is necessary to cool down the development unit and control the temperature so that high volume consecutive print can be done in the production market. The parts to be cooled are developer and bearings of mixing area. To cool the developer we arranged the ribs to the bottom of mixing area (Fig.8). And to cool the bearings of mixing area we blow there with air.

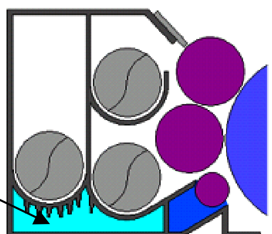

Fig.8 Cooling of Developer mixture.

4-2-2. Control of toner scattering

The preventive maintenance cycle of production printers, which are supposed to print a lot, has to be set long. At the same time service persons have to clean the inside of machine because of toner scattering from the development unit. Therefore Pro C900 controls the pressure inside development unit utilizing the pressure difference inside of it.

The development unit is divided into 3 areas, "supply area", "recovery area" and mixing area" respectively (Fig.9).

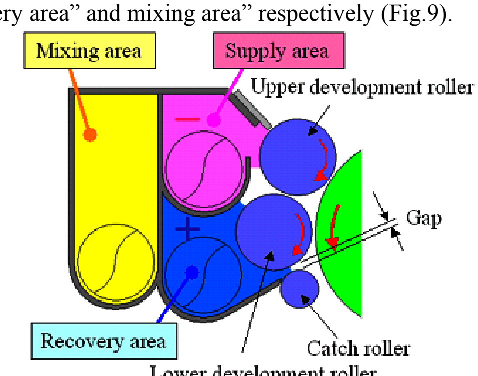

Fig.9 Pressure distribution of unit's inside.

Pressure in the "Supply area" becomes lower as the upper development roller supplies developer out to the photoconductor. On the other hand, in the "recovery area" pressure becomes higher as the lower development roller supplies developer into the "recovery area" (Fig.10).

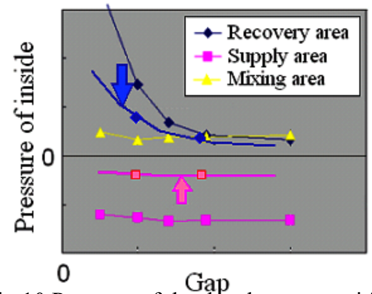

Fig.10 Pressure of the development unit's inside

In the "recovery area", when the gap between the lower development roller and the catch roller is wide, the positive pressure decrease and the floating toner from "recovery area" could scatter out from the development unit. On the other hand when the gap is too narrow the pressure rise and the toner scatter from the gap between the lower development roller and the catch roller.

We have optimized the gap and made the pressure of "recovery area" and "supply area" well-balanced so that it has made possible to prevent the toner scattering.

4-3. Improvements of OPC durability

Newly developed OPC consists of functionally separated layers on a large diameter (φ100) aluminum base is shown in Fig. 11. These layers consists of IL (Intermediate Layer) which improves electrostatic stability by improving the tolerability of the electric bias and preventing local leaks, and OL (Overcoat Layer) which adopts developed new materials and strike a good balance between the electric characteristics and the resistance to abrasion, in addition to CGL (Charge Generation Layer) and CTL (Charge Transport Layer) which is basic to a high sensitive OPC for a high speed machine. The combination of these layers achieves the balance of the mechanical resistance to abrasion and the electric stability, and eventually improves the durability of OPC (self conventional ratio: 3 to 5 times longer)

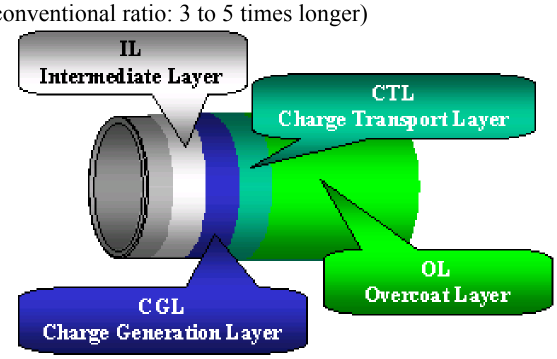

Fig.11 Structure of new OPC

4-3. Improvement of OPC cleaning unit durability by optimizing lubricant coating

RICOH has adopted lubricant coating system, which protects the surface of photoconductor by keeping the surface smooth and reduce the progress of abrasion. Fig.12 shows conventional photoconductor cleaning unit constitution. On the conventional cleaning unit, the cleaning brush has two functions, which are collecting untransferred toner and coating the lubricant to the photoconductor. The downstream cleaning blade also has the same two functions. However, the conventional cleaning system has serious problems. The cleaning brush collects not only untransferred toner but also applied lubricant. Furthermore, amount of the lubricant is affected by amount of untransferred tone. Consequently, the lifetime of the photoconductor and the cleaning system changes depend on the amount of untransferred toner (image area).

RICOH Pro C900 has adopted separated function lubricant coating system that has lubricant coating mechanism constituted from lubricant bar, coating brush and coating blade downstream to the toner cleaning brush and toner cleaning blade (Fig.13). Fig.14 shows the lubricant consumption and the coefficient of friction between new cleaning unit and old one. RICOH Pro C900 has improved the lubricant coating efficiency so that it has made possible to keep the coefficient of friction extremely low with a small amount of lubricant and made photoconductor cleaning unit lifetime twice longer than the conventional one.

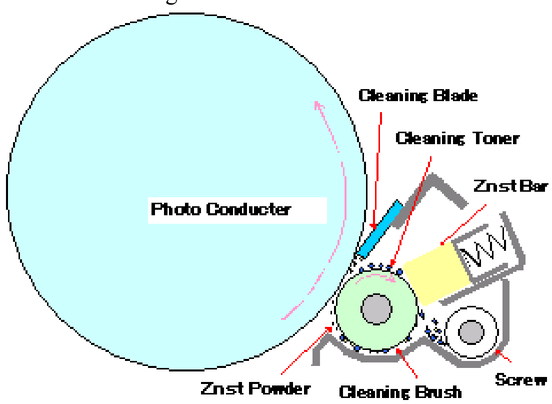

Fig.12 Function Collection Lubricant Applied System

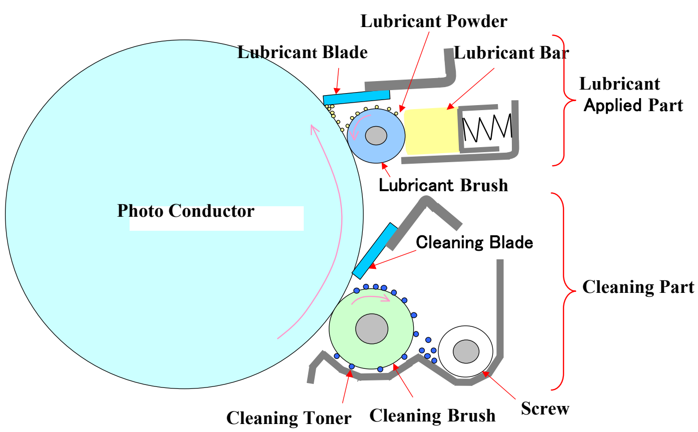

Fig.13 Pro C900 Type
(Function Separated Lubricant Applied System)

Furthermore Pro C900 has improved deflection of the amount of lubricant coating by making each spring (front and rear) independent for axis direction thrust force.

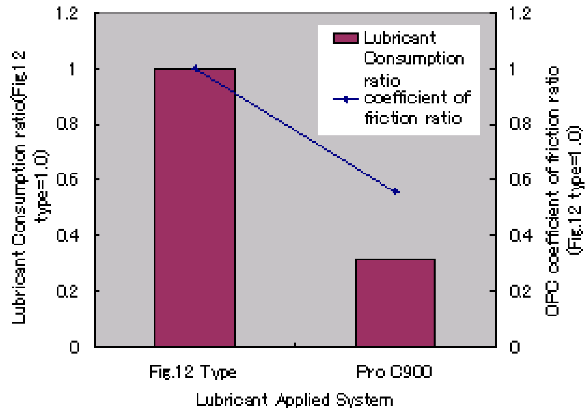

Fig.14 Lubricant Consumption, OPC coefficient of friction

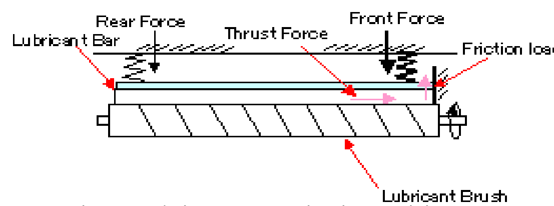

Fig.15 Lubricant Pressurization revision System

5. Conclusion

We introduced the some technologies about Pro C 900. With new developing system and γ control, we achieved the superior stable image in any patterns. And with new developing system, new OPC and new cleaning unit, we achieved long lifetime 2～6 times longer than the conventional printers.

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Author Biography

Toshihiro Sugiyama received his MD in materials science & chemical engineering from the University of Yokohama National University (1988). Since then he has worked in the Research and Technology Division at RICOH. His work has focused on the development of process of electro photographic printers.