Formation and Evaluation of Images Obtained by the Toner Jet Printing Technology(III)

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Abstract

There are various non-impact printing methods used in a printers in general use. Each method has its advantage and disadvantage in terms of equipment cost price, quality, reliability, speed and equipment size, etc. We have investigated an imaging method by using Toner Jet in which a visible direct image is obtained using an electrostatic field to make the toner sticking to the paper. Images obtained from the Toner Jet Printer (TJP) are of equal quality to those obtained by electrophotographic method. In this paper, we confirmed that the Toner JET method will be an effective new electrical applied method.

1. Introduction

Recording methods currently in use can largely be classified as optical, thermal, ink based, ion based or mechanical. Printers which are typical of those which use these various methods include laser printers, thermal printers, inkjet printers, wire dot printers, in flow printers,[1] each of which has its own strengths and weakness in terms of price, quality, reliability and speed.[2] Toner Jet is a registered trademark owned by Array Printers AB; Sweden.

Various improved and novel printing methods have been devised over the years to satisfy these demands more fully, but no completely ideal printing method has yet appeared.

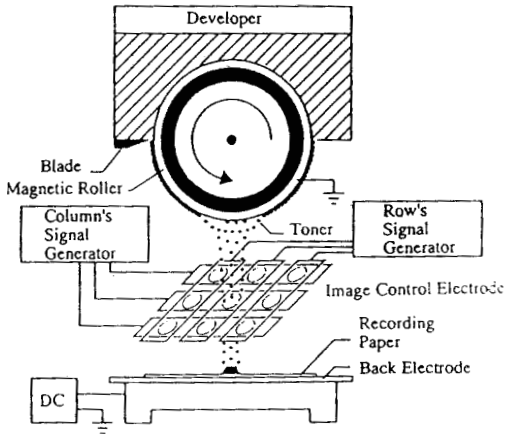

Figure 1. The basic mechanism of toner jet printer.

We have therefore been investigating a net process know as Toner Jet in which a visible image is formed by using static electricity to make the toner stick to the surface of the paper.

A Toner Jet printer was used in this study in which we evaluated dot images of 8 lines by 48 columns and symbols and letters formed by partial printing of dots along such lines and columns and in which we investigated whether this could be a viable printing method in the future.

2. The Printer Mechanism and How it Works

Figure 1 shows the basic mechanism of a toner jet printer. The developing units is at the top, the rear electrodes are at the bottom and there is a mesh-shaped control in between. In this study there was a control electrode and flexible printed circuit (F.P.C.) on the control electrode.

Recording principle have changed by a now applied method. Figure 2 illustrates the principles by which the Toner Jet printer makes recordings. The developer unit conveys the toner uniformly, the control electrode comprises two layers for lines and columns and produces an electrical filed when signal voltage is applied to the two layers Further, a high-voltage D.C. current is applied to the rear electrode.

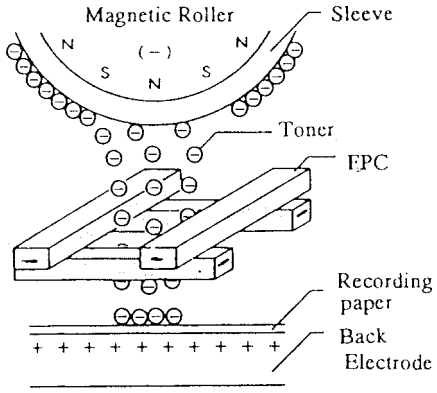

Figure 2. The recording Process of TJP.

The condition of the Toner Jet Printing is as follows; the flexible printed circuit (F.P.C.) on the control electrode is not applied voltage but positive field on the back electrode attracts the toner due to coulomb force from which holds the negative charged toners on the magnetic roller.

Conversely, the condition of the toner background printing is as follows; the flexible printed circuit (F.P.C.) on the control electrode is applied negative voltage and the toner is attracted, does not pass through the control electrode due to the repulsive force and does not adhere to the recording medium. The Toner Jet conditions appear to be as shown in Table 1.

Table 1. The Toner Jet conditions and unjet conditions

Column's Direction	0	—	0	—
Row's Direction	0	0	—	—
Jet State of Toner Particles	O	×	×	×

3. Experimental Device and Experimental Materials

(1) Experimental Equipment

- Toner Jet Printer, Made by company A
- Photoelectric pixel evaluator (Model IT3), Tokyo Denshi Kogyo Co., Ltd.
- Fixing unit, Made by company A
- Oscilloscope, Kikusui Denshi Co., Ltd.
- High-voltage voltmeter (0 to 10 kV) Kikusui Denshi Co., Ltd.
- Surface electrometer, TREK Japan
- Digital multimeter, Takeda Riken Co., Ltd.

(2) Experimental Materials

- Mono component developer (insulating magnetic toner), Made by company A

4. Experimental Method

Setting the Effective Range is Table 2.

The multiparameter Table 2, a combination of parameters depends on jet condition and image production. As many number of combinative parameter, the new electric applied method is fixed for minimum 0.25 V in VPW, VTW (recording voltage) and maximum -400 V of recording voltage. The parameter of the above mentioned shows Table 3.

Table 2. Effective values for each parameters

Item				Set value(min–max)
Type of Toner				Mono Component Toner
Round Per Minute Drive Motor (rpm)				0 ~ 90
Magnet Angle (°)				0
Principal Electrode Magnetic Intensity (GAUSS)				500
D	ROLL-FPC		(mm)	0.00 ~ 0.70
	FPC-Back Electrode		(mm)	0.40 ~ 0.50
	Printed Time Per Column		(sec)	0.21/0.19 ~ 2/2
V	C	VPB	(V)	0 ~ 200
		VPW	(V)	0 ~ 400
	L	VTB	(V)	0 ~ 200
		VTW	(V)	0 ~ 400
Back Electrode			(KV)	0.8 ~ 1.8

Table 3. The standard values for each parameter

Item				Set value
Type of Toner				One Component Toner
Round Per Minute Drive Motor (rpm)				60
Magnet Angle (°)				0
Principal Electrode Magnetic Intensity (GAUSS)				500
Printed Time Per Column (sec)				0.16
V	C	VPB	(V)	0.25
		VPW	(V)	400
	L	VTB	(V)	0.25
		VTW	(V)	400

Relation the rotation of Magnetic roller and the diameter of dot show on Table 4. The rotative number of magnetic roller is fixed. Relation the recording time and the diameter of dot show on Table 5. The recording time is fixed on 0.15 sec per a column.

The distance of between magnetic roller ~ F.P.C.. and F.P.C. ~ back electrode are a range of setting effective value and extruded in the random for six-position.

Table 4. The rotation of magnetic roller and the diameter of dot

ϕ 1: diameter of horizontal direction
ϕ 2: diameter of vertical direction
ϕ 3: average of ϕ 1 and ϕ 2

No.	Rotation (rpm)	ϕ 1 (μm)	ϕ 2 (μm)	ϕ 3 (μm)
1	30	235.8	251.5	243.7
2	50	345.9	345.9	345.9
3	70	424.5	424.5	424.5
4	90	550.2	565.9	558.1

Table 5. The recording time and the diameter of dot

ϕ 1: diameter of horizontal direction
ϕ 2: diameter of vertical direction
ϕ 3: average of ϕ 1 and ϕ 2

No.	Recording time (μs)	ϕ 1 (μm)	ϕ 2 (μm)	ϕ 3 (μm)
1	108	345.9	345.9	345.9
2	324	408.7	393.0	400.9
3	540	424.5	471.6	448.1
4	756	503.1	518.8	511.0

In much the same way, back voltage extrude in the random for six-position and the back of the random position shows on Tables 6 and 7.

Table 6. Back electrode voltage of any position

No.	1	2	3	4	5	6
Back Electrode Voltage (kV)	0.8	1.0	1.2	1.4	1.6	1.8

Experiment

A line gap controlled recording is used in accordance with setting Tables 3, 6 and 7.

Table 7. Parameter table of any position.

No.	L1	L2	No.	L1	L2
1		0.00	19		0.00
2		0.14	20		0.14
3	0.00	0.28	21	0.90	0.28
4		0.42	22		0.42
5		0.56	23		0.56
6		0.70	24		0.70
7		0.00	25		0.00
8		0.14	26		0.14
9	0.30	0.28	27	1.20	0.28
10		0.42	28		0.42
11		0.56	29		0.56
12		0.70	30		0.70
13		0.00	31		0.00
14		0.14	32		0.14
15	0.60	0.28	33	1.50	0.28
16		0.42	34		0.42
17		0.56	35		0.56
18		0.70	36		0.70

L1: Distance from F.P.C. to back electrode (mm),
L2: Distance from magnetic roller to F.P.C. (mm)

5. Evaluation Method

The recording results are measured by the imaging evaluated device and compared evaluate for relation imaging production for distant and most suitable parameter.

6. Test Results and Discussion

Figure 3 shows that relation between diameter of dot and the rotation number of magnetic roller. Figure 4 shows that relation between diameter of dot and recording time.

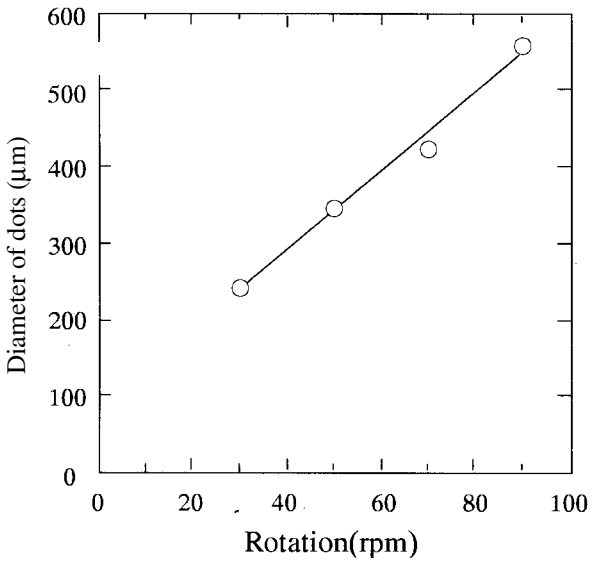

Figure 3. Relation the diameter of dot's and rotation (rpm).

Figure 5 shows that relation between the recording density and distance from magnetic roller to F.P.C. (L_1 = 0.6mm). Figure 6 shows between the non-recording density (fog) and distance from magnetic roller to F.P.C. (L_1 = 0.6mm).

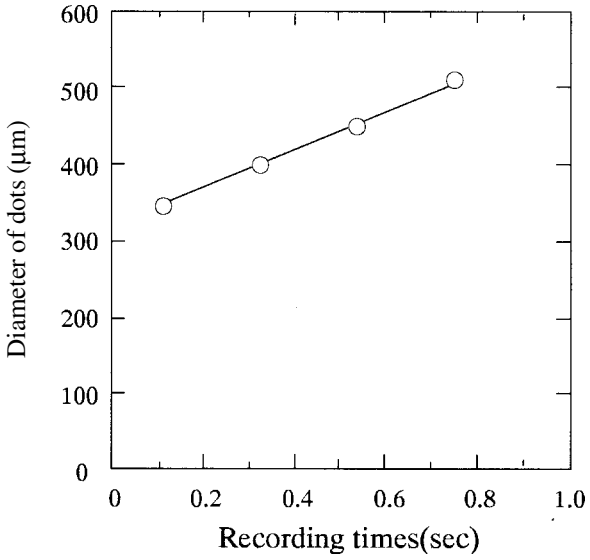

Figure 4. Relation the diameter of dot's and the recording times.

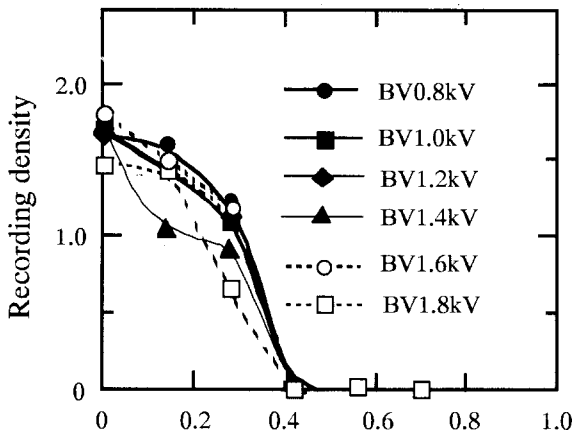

Figure 5. Relation the recording density and the distance from the magnetic roller to F.P.C. (mm).

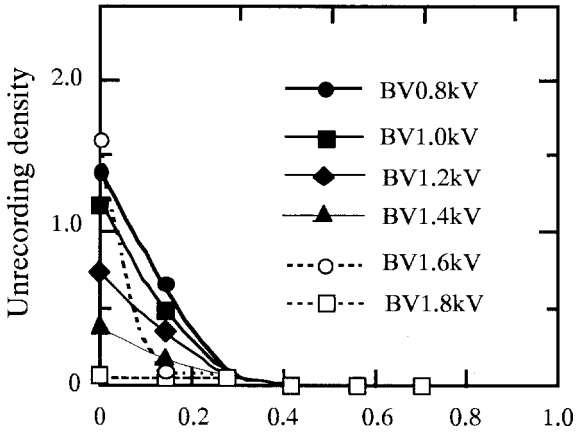

Figure 6. Relation the unrecording density (fog) and the distance from the magnetic roller to F.P.C. (mm).

Figure 7 shows that relation between diameter of dot and the distance from magnetic roller to F.P.C. (L_1 = 0.6mm case).

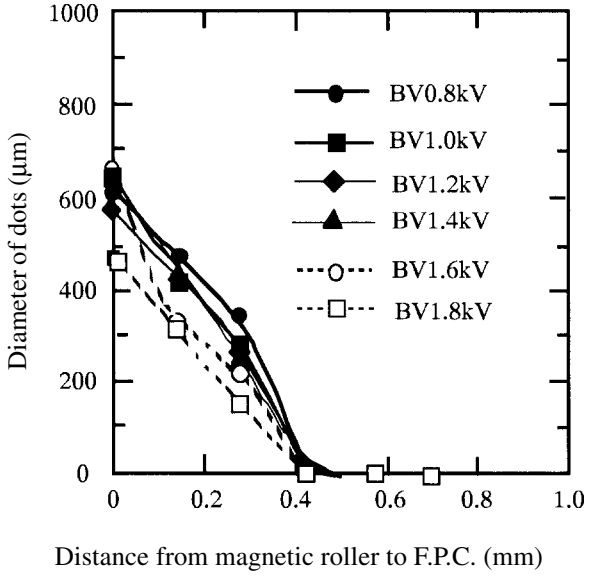

Figure 7. Relation the diameter of dot's and the distance from magnet roller to F.P.C.(mm).

Figure 8 shows the density distribution (B) and the density cross-section of an electrophotographic image (made by Company A) for comparison with the results of the tests.

In average density, electrophotographic type is 0.72 and TJP (Toner Jet Printing) type is 0.84. The density of TJP type were formed on more than electrophotographic type.

The trapezoid the density cross-section were idealized in much the same way as electrophotographic type. The form of dots were formed in round image in much the same ways as electrophotographic type. In the scattering of toners, the scattering of TJP can were largely found in human eye which vary with electrophotographic case. Figure 9 shows the dot's image of (B) and the density cross-section of TJP for comparison with the results of new system and old system.

In average density new system is 0.84 and old system is 0.55. This mentioned, the average density of new system is higher than old system.

In the density cross-section, old system is unhomogeneous density and waves is caused by the contour loses sharpness.

In new system, waves is sharpness. Also, the figure of dot's is in fowls and round.

In old system. to duplicated recording by double pattern can't possible but new system can be possible.

7. Conclusion

(1) The dot word printing with a Toner Jet printer gave images equivalent to an electrophotographic technique.
(2) In old system, to duplicated recording by double pattern isn't possible but new system can be possible.
(3) The new system recording is the effective method over a certain range of mechanically shattered toners.

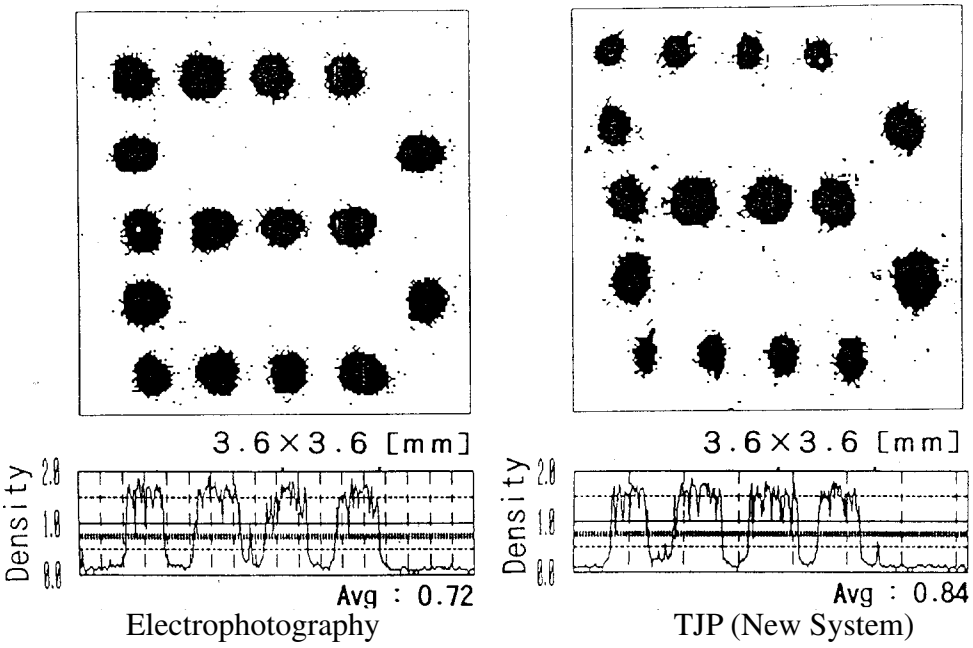

Figure 8. Dot Image [B] of Electrophotography and TJP.

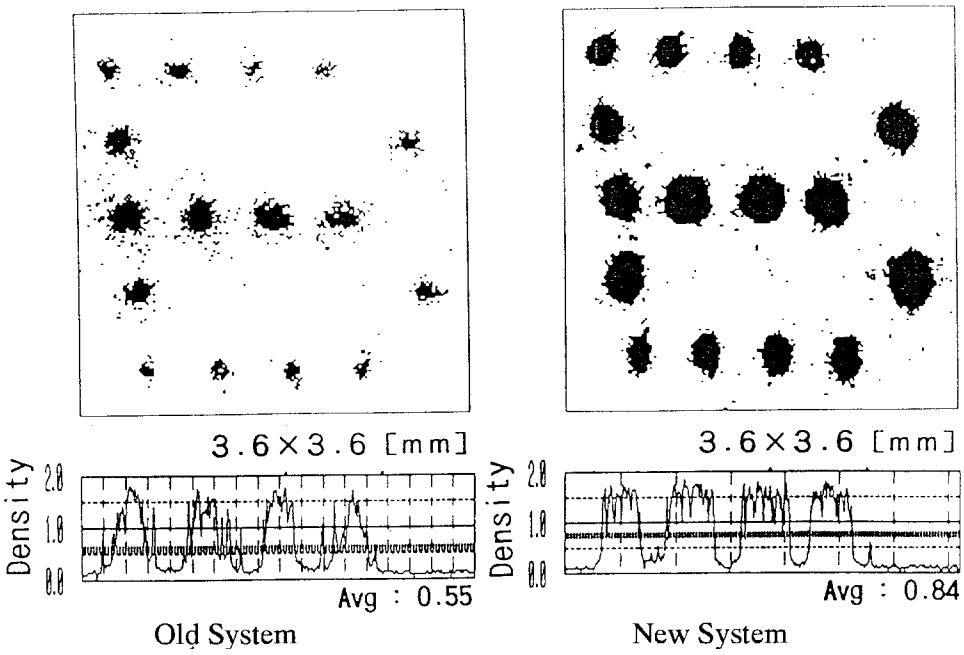

Figure 9. Dot Image [B] of TJP. (Old System and New System).

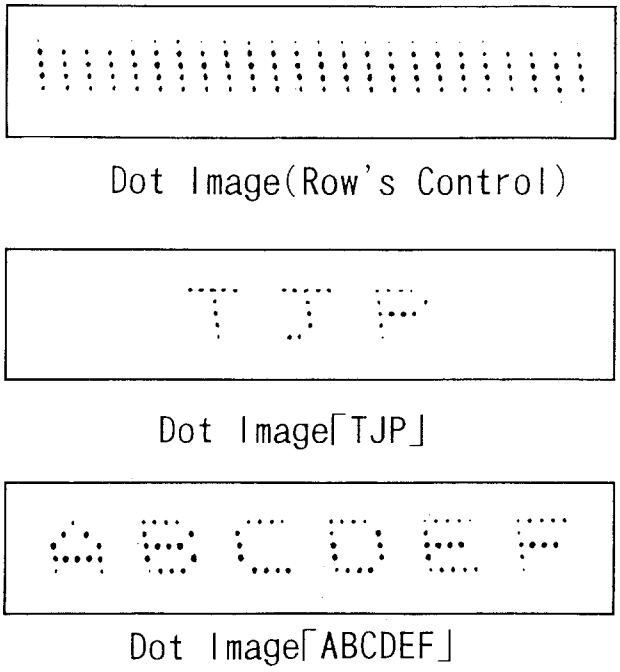

Figure 10. Image of TJP (New System)

Reference

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