MECHANICAL GHOSTING ON WEB OFFSET PRESSES

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ABSTRACT

During printing on web offset presses and particularly with a blanket to blanket configuration, coated grades are sometimes disturbed by a dot distortion. Halftone dots in some areas, on one side, have a lower dot gain due to an image on the opposite side. This phenomenon is a "mechanical ghosting" and has not been described previously.

We have tested a number of coated grades, different web offset presses and printing conditions to try to solve this problem.

Results to be developed are :

- A higher coverage on top is able to influence a lower coverage on bottom.
- The loss in print density increases with running time, and reaches an equilibrium. After cleaning the blanket, the normal situation is recovered.
- Some coated papers are more sensitive than others in relation to their ability to adhere to the top blanket and to their sensitivity to react with fountain solution.
- The variation of ink formulation affects this behavior.

Analysis of this phenomenon reveals a microscopic build-up on the blanket between printing dots where ghosting appears. In these areas, due to a strong adhesion between the web and the top blanket a CD elongation of the sheet occurs. On the released area on the bottom blanket, an overflow of fountain solution gives a deposit between dots, corresponding to the ghosting area. In these areas dot gain returns to the original gain of the plate.

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INTRODUCTION

Lithography printing with web offset presses and sheet-fed offset is sometimes affected by special defects called ghosting.

On sheet-fed offset ghosting mainly occurs after printing when sheet are stacked together. Distillates from vegetable drying oils are able to give yellow marks on white coatings after storage, called chemical ghosting or yellowing. The same distillates can also be the cause of gloss ghosting between two inks films stacked together.

Mechanical ghosting on sheet-fed offset is caused by ink rolls, and dampening rolls and appears as a loss in optical density on solids or on a printed screen.

On web offset, we have found a new mechanical ghosting which has not been previously described by WILLIAMS (1988) and BUREAU (1985). It is a ghosting from one side to the other which gives a loss in optical density which increases versus running time. This is exaltly the opposite effect of print through which gives an increase in O.D. but does not change with running time.

Design of the equipment, papers and ink composition, ink coverage affect ghosting. From the results of our trials, we try to explain the causes of this phenomenon.

This is a case where a build up on the blanket is able to reduce the dot gain in the ghosting area.

A. EVIDENCE OF MECHANICAL GHOSTING ON WEB-OFFSET

Mechanical ghosting appears only on blanket-to-blanket web-offset presses with coated papers of basis weight between 45 and 120 g/m2.

The defect always occurs with a 20 - 80 % halftone screen print on the lower blanket (bottom). In the affected area, the print from the top side can be seen on the reverse side. This effect is more evident with solids printed areas on the top side. It is not a print through phenomenon because the shape of the top print which appears on the bottom side is affected by a drop in optical density (O.D.) rather than an increase.

Fig. 1 shows an industrial example of mechanical ghosting. We can see in reversed negative the text of the top side.

Fig. 2 is an example of a test print, where the D of Douai from the top side is seen in reversed negative in the 50 % halftone of the bottom.

An investigation of the printed area in Fig. 2 with an image analyser shows a dot gain of 19 % from the 50 % theoretical screen, i.e. a 69 % print of the bottom side outside of the ghosting area. However the dots in the affected area are smaller and the coverage, 49 %, is nearly equal to the original screen. Mechanical ghosting is in fact a localized loss in dot area. This effect is illustrated in Fig. 3. The drop in O.D. which accompanies the dot shrinkage can be used to follow ghosting evolution.

Figure 4 shows the surface of the bottom blanket ; ghosting in this case is caused by a 50 % magenta screen on the top which affects the 50 % magenta screen on the bottom. In the reference area (photo A), the edges of dots are just touching, and the deposits appear as diamond-shaped spaces between them. In the ghosting area (photo B), the area of the deposits is increased and the dots are clearly separated. Photo C shows a hard deposit on the borderline between the halftone screen area and the non-print area ; a microscopic deposit also covers the remaining non print area. This microscopic deposit on the blanket between dots is the cause of dot size reduction. After cleaning the blanket, normal dot size is recovered.

The X-ray analysis shown in Fig. 5 of the deposits between dots in reference area A from Fig. 4 shows that these deposit have a similar chemical composition to those between the dots in ghosting areas. The mineral content of the deposit is similar to that of the paper combined with components of ink and blanket ; Si and Al show the presence of clay, Ca the presence of calcium carbonate, and S has come from the rubber blanket and ink.

These two examples illustrate the simplest cases, i.e. a text in solid print on the top side which affects the halftone on the bottom side of a one color press ; this is called direct ghosting. On multicolor presses, backtrap, as well as direct ghosting, can occur.

B. MEASUREMENT OF THE MECHANICAL GHOSTING

In all cases, when ghosting appears, a drop in O.D. is obtained with increased running time. Fig. 3 has shown that this O.D. loss is caused by a dot loss.

It is possible to quantify this phenomenon by following the dot loss over time with an image analyser (see Fig. 3).

However, a more practical and rapid technique is the measurement of the increase over time of the difference between the O.D. from reference area and ghosting area i.e. Δ O.D.

$$\Delta \text{O.D.} = \text{O.D. ref.} - \text{O.D. ghost.}$$

Where

Δ O.D. is the drop in Optical Density

O.D. ref. is the Optical Density in reference area

O.D. ghos. is the Optical Density in ghosting area.

Table 1 shows the correlation between image analysis and the Δ O.D. calculation.

Ghosting can be detected by eye when the drop in O.D. is greater than 0.05. However with LWC, ghosting can be masked by print-through from the other side ; normally the print-through from the top gives an increase in O.D. on the bottom of 0.03 to 0.07. Fig. 1 has shown an example of the print through with the reverse black letters "parfum" clearly seen on the right arm of the women.

EXPERIMENTAL RESULTS

A. EFFECT OF EQUIPMENT DESIGN

Mechanical ghosting can be seen on most types of blanket-to-blanket presses. The affected halftone is always on the blanket of the end-nip (Fig. 6). Ghosting has never been observed on presses with both blankets in the same vertical axes.

B. THE EFFECTS OF INK COVERAGE UPON DIRECT AND BACKTRAP GHOSTING

With test prints, we can compare the effects of solids and halftones on the top side upon the halftone on the bottom side. Two separate trials with different ink sequences have been performed. These sequences are unusual because they employ two black inks. The first sequence was on both sides black (B1), black (B2), cyan (C3), magenta (M4) ; the sequence of the second trial was B1, M2, B3, M4. Inks for the two trials were provided by different suppliers. The normal design of the four color rotary press was chosen

The first trial was performed with four different papers and test prints mainly obtained from rectangles 3 x 5 cm on both sides. These rectangles are 50 % screens and solids of each color and combinations of colors. During this first trial ink film thickness was run on a high level and dot gain was large.

The second trial was performed only with only two papers with tests prints as rectangles 3 x 13 cm of 25 %, 50 %, 75 %

screens and solids on both sides. Ink film thickness was normal, and dot gain was lower than the first trial.

From these two trials ghosting was found to increase with increasing difference in coverage between the two sides. Two kinds of ghosting were identified, direct ghosting and backtrap ghosting.

Table 2 presents defects which occur with the second trial.

Direct ghosting affects paper A with the first color unit and paper C with the second color.

Backtrap ghosting affects paper A and C with black as a first color on the magenta second color.

We can see that a solid top print causes more defects on the bottom side of the two papers (A and C) than does a fifty percent top halftone. It follows that a 50 % top halftone causes more defects upon a 20 % bottom halftone than upon a 50 % bottom halftone. Ghosting is increased by a difference in coverage between the two sides.

Table 3 shows examples of the effects of direct, backtrap and additive (direct + backtrap) ghosting. We can see that paper type has an effect upon the ΔO.D. Papers A and B gives the same results with direct ghosting. Paper B appears to be more sensitive to backtrap ghosting, while paper A is more sensitive to additive ghosting.

C. <u>DOT LOSS VERSUS RUNNING TIME AND EFFECT OF DOT GAIN</u>

Fig. 7 illustrates ΔO.D. which occurs as the number of copies increases. This case is a strong backtrap ghosting from screens C3 on M4 where the print through on top and bottom are clearly seen.

Fig. 8 is a plot of ΔO.D. versus no. of copies showing the slope of the line as ghosting first begins to appear.

Fig. 9 shows two kinds of direct ghosting and the drop in O.D. versus running time. With a 20 % halftone of black no. 1 on the bottom side, the drop in O.D. is stabilized at 0.06 (a dot loss of nearly 6 %). Therefore, the theoretical 20 % coverage of the plate results in a 20 % coverage of the paper ; the usual offset dot gain has been eliminated. The other line shows a 50 % bottom halftone of M2 affected by the M2 on the top side. Printing was not continued for a sufficient time to observe the ΔO.D. stabilization, but it is expected that this would occur between 0.20 and 0.25 ΔO.D.. At this O.D. usual dot gain would be eliminated and the theoretical 50 % screen would result in 50 % coverage. As illustrated previously by Fig. 3, ghosting had indeed caused the coverage to return to 49 %, close to its theoretical value of 50 %.

So we can expect, that the higher the dot gain, the higher the direct or the backtrap ghosting after a long running time. A comparison of ΔO.D. from Figs. 8 and 9 illustrates this point, with the ΔO.D. from trial one 2 to 3 times higher than for trial 2.

This difference in slope versus running time comes mainly from the dot gain which was different for the two trials.

D. PRINTING FORM ORIENTATION AND LOCATION ON THE BLANKET

Ghosting is also influenced by the print pattern, i.e. the location of the print on the blanket, as well as the orientation of the top print in relation to the bottom.

Fig. 10 describes the effect of print location on the blanket. ΔO.D. is lower at the leading edge of the plate and is slightly higher at the image end.

In Fig. 11, we can see that the area covered by ghosting is greater at the image end. We can also see that in this case the direct ghosting is greater than the backtrap ghosting.

All cases of ghosting which have been studied are summarized in Table 4. Even when the paper is very sensitive to ghosting in machine direction, and all ten possibilities of ghosting are obtained (paper A), ghosting does not occur in cross direction.

The maximum ghosting effect is obtained when the long edge of the top print is oriented in machine direction. When the same screens (rectangle 13 x 3 cm) are printed on the top with the long edge in cross direction ghosting is less significient.

E. INK FORMULATIONS

The rate of change of ΔO.D. due to ghosting is not the same for all types of inks. This is illustrated in Fig. 12 where for one type of paper, plots of ΔO.D. versus number of copies for different inks have different slopes. The two black inks cause a higher degree of ghosting than the 2 magenta inks. In addition, ink composition appears to affect the amount of ghosting, since B1 and M2, with a higher proportion of mineral oil, produce more ghosting than B3 and M4. One would expect that ink tack would be an important factor but Fig.13 shows that there is no correlation between ink tack and ghosting.

F. PAPER FORMULATIONS

Tables 2 and 4 have shown that paper composition has a large effect upon mechanical ghosting (second trial papers A and C).

Table 5 lists the properties of the four different papers which were tested during the two trials. Papers A and B are from the same supplier and are therefore similar in composition but have different porosities. Paper C and D are from an other supplier and are quite different in porosity from A and B.

Ghosting results for these papers are presented in Table 6 (first trial).

There are 4 possibilities of direct ghosting with solid on a halftone and also four possibilities with halftone on halftone.

Paper B is the most sensitive to ghosting and after only 500 copies, shows seven direct ghostings from the eight possibilities. Paper A reveals the same ghosting but after 3,000 copies.

Papers C and D are very similar to each other and show their maximum effect with the third color, a solid cyan on a halftone cyan. They are significantly less sensitive to ghosting than papers A and B. But if we consider paper A and C and the second trial with the data shown in Table 4, paper C is less sensitive to direct ghosting. Paper C is nevertheless more sensitive to backtrap ghosting. Fig. 14 shows the different slopes obtained with these two papers A and C. After 10,000 copies paper C gives a Δ O.D. of 0.08 against 0.02 for paper A with the same ink.

G. SOLVING INDUSTRIAL PROBLEMS

Fig. 15 illustrates various methods which can be employed to reduce mechanical ghosting in an industrial situation. The figure shows that a bottom print of a blue sky has been profoundly affected by the "blue cushions" and the "black sofa" from the top print after 6,000 copies. Simply cleaning the bottom blanket return the quality of the bottom print to its original level.

If 2 % of a tack reducer is added to the cyan ink on the top only, the binding forces of the two sides of the paper are equalized against the two blankets. After an additional 18,000 copies following the cleaning, the blue sky print is still marked by the black backtrap but the direct ghosting from the modified cyan has not reappeared. A reduction in ghosting can also be achieved by the addition of a "non build-up" additive to the fountain solution. This decreases the slope of the line of Δ O.D. versus time, which increases the number of copies that can be printed before ghosting occurs.

H. DISCUSSION OF RESULTS

Ghosting appears only when there is a contact time between the sheet and the blanket after the nip, such as occurs when the two blankets are not in the same vertical plane. Normal press design gives a possibility of ghosting on the bottom side only.

SORENSEN (1983) has shown that the adhesion forces between blanket and paper increase with decreasing paper porosity, but there is no correlation with ink tack. This apparently anomalous behavior to produce ghosting may be due to other interactions between paper and ink.

Modern inks which are rich in mineral oils are more sensitive to ghosting than formulations with vegetable drying oils. We think that mineral oils are able to increase the adhesion of the sheet to the top blanket because they penetrate into the sheet more rapidly than vegetable drying oils.

Differences in the pigment content of a coating, for example clay or calcium carbonate, show a different behavior toward absorption of these oils.

Adhesion on the top blanket gives an elongation of the sheet in the cross direction. This elongation of the sheet acts as a "funnel" on the bottom blanket to collect the fountain solution flowing around the image.

This overflow of fountain solution is clearly identified by specific marks on the ghosting area. In this ghosting area fountain solution is the cause of the deposit between dots which increases with running time. The ghosting patterns are shown in Fig. 16.

CONCLUSION

Mechanical ghosting on web-offset is a system problem where the rotary press design, inks, fountain solution, paper and printing configuration are involved.

The normal design of a blanket to blanket rotary-press gives ghosting on the bottom side. Ghosting is a reverse image which comes from the top side and appears as a dot loss on a screen print.

Higher ink coverage on top than bottom gives a strong adhesion of the web to the top blanket, which causes a CD elongation allowing a localized fountain solution overflow on the bottom blanket. During the contact time between the nip and the release of the web, a microscopic build-up is deposited between dots on ghosting areas. These deposits increase versus running time and give a loss in O.D. until an equilibrium is achieved. At the equilibrium normal dot gain between the plate and the sheet is eliminated. The higher the dot gain the higher the possibility of ghosting.

Coated grades with high smoothness and low porosities are able to give a strong adhesion on the top blanket. Pigments from paper coatings have different capacities to absorb ink vehicules and to promote adhesion. Some papers are more sensitive to direct ghosting while others are more sensitive to backtrap ghosting.

There is no correlation between ink tack and ghosting. Ink composition is nevertheless a factor affecting ghosting ; ink formulations containing mineral oils appear to be more sensitive than vegetable drying oils.

Some remedies for mechanical ghosting have been tried with success. With the addition of a tack reducer in the ink on top side, ghosting does not reappear after cleaning the bottom blanket. Non build-up additives in fountain solution can also be helpful in the prevention of ghosting. Reduction of dot gain by modification of the printing system can also reduce mechanical ghosting.

ACKNOWLEDGEMENT

The authors would like to thank Ms. Cheryl Bizub, Guest Researcher at CTP, for her linguistic revision and suggestions for presentation of this manuscript.

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LEGENDS OF FIGURES

Fig. 1 : An industrial example of mechanical ghosting. The reduction in optical density can be seen in the reversed letters and outside the square in the illustration on the right, corresponding to the white square and the black letters on the left.

Fig. 2 : Mechanical ghosting with a four color test print. The defect occurs on the bottom side print, only in the halftone dot area to the right and not in the solid block print at the left.

Fig. 3 : Enlargement of defective area from Fig. 2. Mechanical ghosting has reduced coverage from 69 % to 49 %.

Fig. 4 : Electron micrographs of bottom blanket, 50 % magenta screen as second color (M2), paper C. The surface area of deposits between dots increases with increased ghosting.

Fig. 5 : X ray analysis of printing materials and build up between dots.

Fig. 6 : Three blanket-to-blanket press designs. The most common appears in the center. Web direction is always from left to right. Location of ghosting is indicated by the arrows.

Fig. 7 : Increase in ghosting on the bottom side versus no. of copies, first trial, paper C (Variations in O.D. on the top are due to print through).

Fig. 8 : ΔO.D. of bottom print in ghosting area versus no. of copies for a 50 % top halftone upon a 50 % bottom halftone (C3 upon M4, first trial, paper C).

Fig. 9 : ΔO.D. of bottom prints versus no. of copies, illustrating a rapid stabilization for a large difference between top and bottom coverage. Stabilization has not yet occurred for the situation where top and bottom coverage is the same (paper C, second trial).

Fig. 10 : ΔO.D. of bottom print versus no. of copies for different locations on the plate (second trial, paper C, B1 50 % top on M2 50 % bottom).

Fig. 11 : Increase in surface covered by ghosting from image start to image end for direct and backtrap ghosting (second trial, paper C).

Fig. 12 : ΔO.D. from direct ghosting for paper A with the four inks (second trial, 50 % top on 50 % bottom).

Fig. 13 : Ink tack for the four second trial inks.

Fig. 14 : Difference in behavior for backtrap ghosting with papers A and C (second trial, B1 50 % top on M2 50 % bottom).

Fig. 15 : Industrial results for ghosting elimination. On the right, after modification of the cyan, direct ghosting has not reappeared (color seq. B, C, M, Y).

Fig. 16 : Patterns of ghosting caused by different top printing orientations. The solid lines indicate orientation of the top print and dotted lines the orientation of the bottom print. Water flow, indicated by the arrows, is believed to cause ghosting.

TABLE N° 1

DIFFERENCES IN COVERED AREA BY IMAGE ANALYSIS AND CORRESPONDING VARIATIONS IN OPTICAL DENSITY

- Printing seq. : B1 + B2 + C3 + M4 (first trial)
- 50 % screen C3 / 50 % screen M4
- Paper C

NO OF PRINTS (Thou)	1	3	6	9	12
Δ AREA %	2.6	8.2	16.7	19.0	22.7
Δ O.D.	0.03	0.07	0.13	0.20	0.22

TABLE N° 2

INFLUENCE OF INK COVERAGE UPON GHOSTING

- Printing seq. : B1 + M2 + B3 + M4 (second trial)
- S = Solid, H 50 = 50 % screen, H 20 = 20 % screen
- A = ghosting visible on paper A, C visible on paper C

	TOP → ↓	H50	H50	S
BOTTOM → ↓		H20	H50	H50
B1	B1	A		
M2	B1	A		A C
M2	M2	C	C	C

TABLE N° 3

O.D. FOR DIRECT BACKTRAP AND ADDITIVE GHOSTING

- Printing seq. . B1 + B2 + C3 + M4 (first trial)
- H = 50 % screen   S = Solid

TOP	BACK TRAP	B1.H		B1.H	B1.S		B1.S
	DIRECT		B2.H	B2.H		B2.S	B2.S
BOTTOM B2.H	PAPER A	0.04	0.10	0.12	0.13	0.12	0.13
	PAPER B	0.10	0.07	0.10	0.16	0.12	0.02

TABLE N° 4

TOP PRINTING ORIENTATION INFLUENCE ON GHOSTING

- Printing seq. : B1 + M2 + B3 + M4 (second trial)
- ⊥ and // refer to the orientation of the long edge at a rectangular 50 % screen
- A = ghosting visible on paper A ; C for paper C
- * Direct ghosting

	TOP ↓→	TOP ⊥	TOP //
BOTTOM ↓→		BOTTOM //	BOTTOM ⊥
B1	* B1		A
M2	B1		A C
	* M2	C	A C
B3	B1		A
	M2		A
	* B3		A
M4	B1		A
	M2		A
	B3		A
	* M4		A

TABLE N° 5

PAPERS PROPERTIES

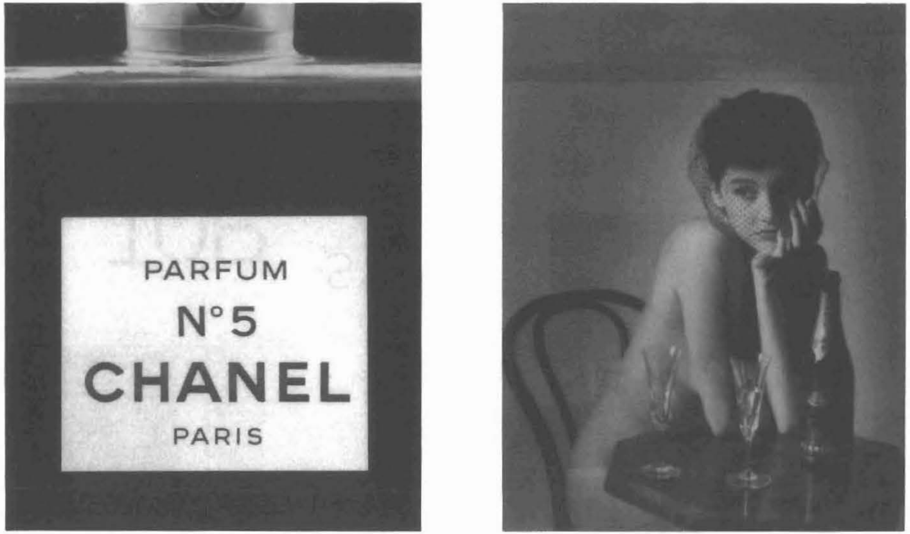
LWC REF.		A	B	C	D
WEIGHT, g/M2		52	54	65	63
THICKNESS, µM		55	52	60	58
SMOOTHNESS	TOP	420	1070	1575	990
BEKK, s	BOTTOM	550	1200	1560	1130
PERMEABILITE BEKK S/100 mL		170	300	730	840

TABLE N° 6

GHOSTING FROM FOUR DIFFERENT PAPERS

- Printing seq. : B1 + B2 + C3 + M4 (first trial)
- S = Solid, H = 50 % screen
- * direct ghosting

BOTTOM	TOP	RUNTIME TO APPEARANCE IN THOUSANDS			
		A	B	C	D
B1.H	* B1.S	3	0.5	9	5
	* B1.H	3	0.5		
B2.H	B1.S	3	0.5		
	B1.H	4	0.5		
	* B2.S	3	0.5		
	* B2.H	3	1		
C3.H	B1.S	MIXED WITH GHOSTING B2.S/C3.H			
	B1.H	3	0.5	1.5	2
	B2.S	1	0.5		
	B2.H		0.5		
	* C3.S	1	0.5	1.5	3
	* C3.H	2	0.5	2	5
M4.H	B1.S	3	0.5	3	2
	B1.H		0.5	8	4
	B2.S	3	0.5	8	4
	B2.H				
	C3.S	3	0.5	11	5
	C3.H	3	0.5	4	2
	* M4.S	3	0.5		
	* M4.H				



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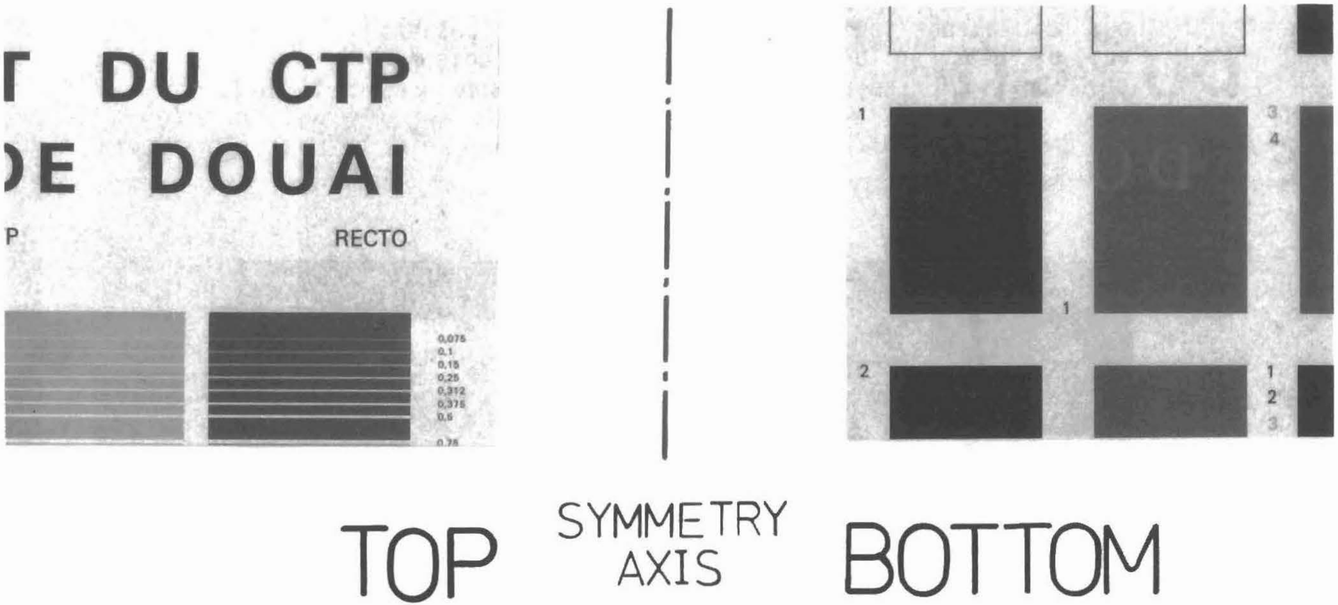

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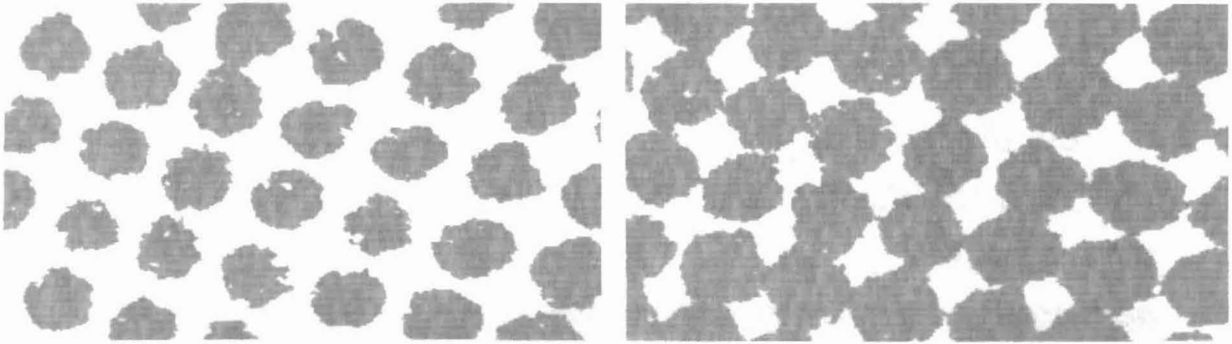

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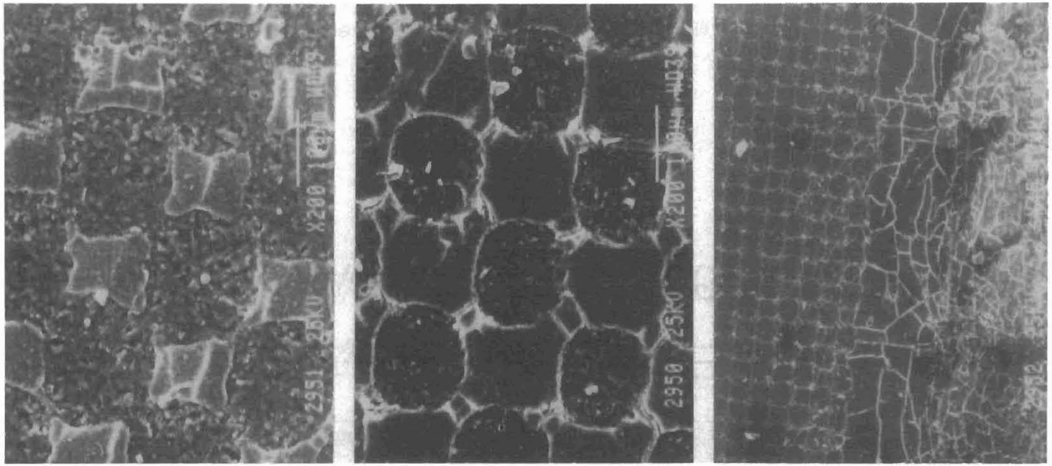
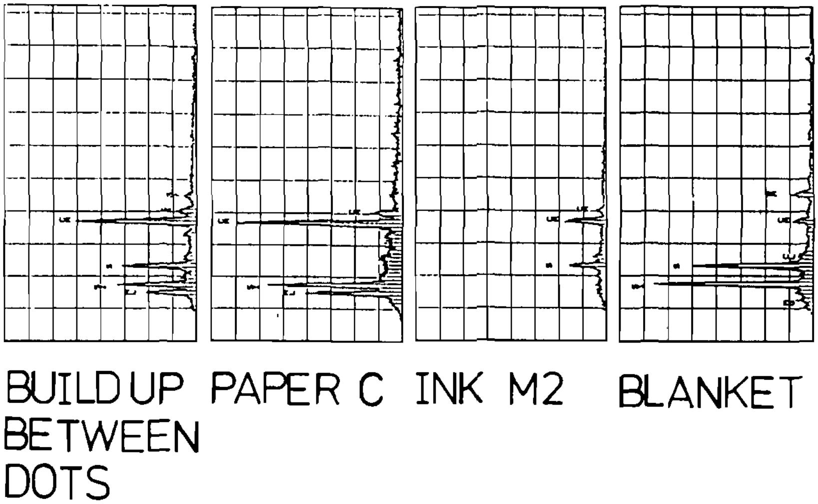


A REFERENCE AREA

B GHOSTING AREA

C BORDERLINE BETWEEN SCREEN & NON-PRINT AREA

Fig. 4 : Electron micrographs of bottom blanket, 50 % magenta screen as second color (M2), paper C. The surface area of deposits between dots increases with increased ghosting.



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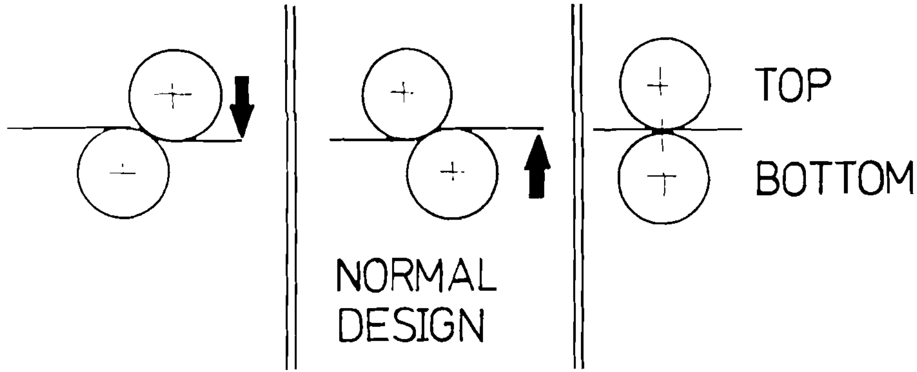

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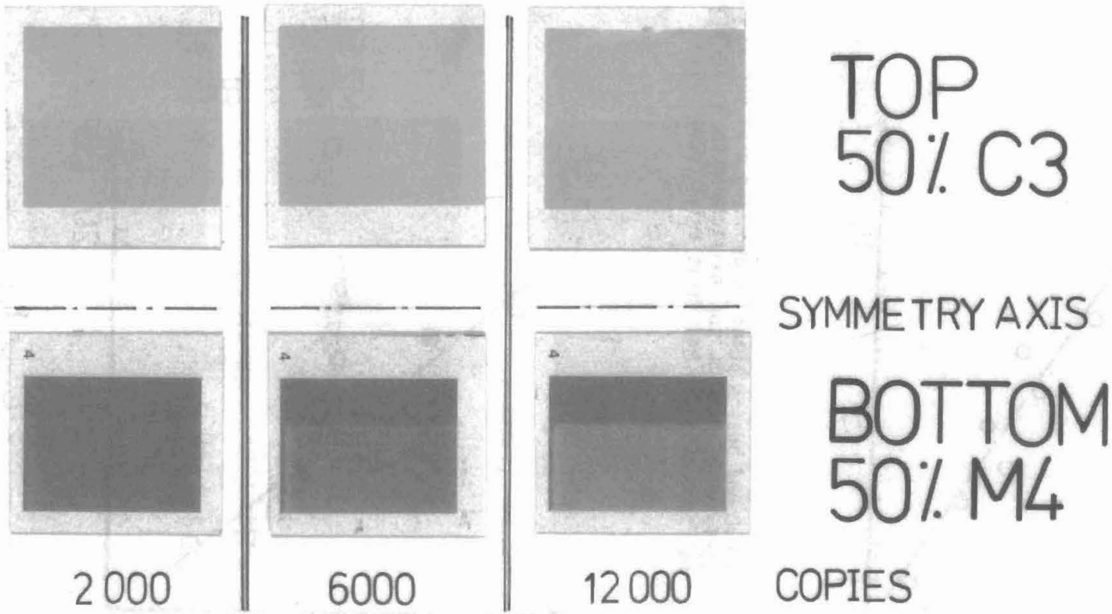

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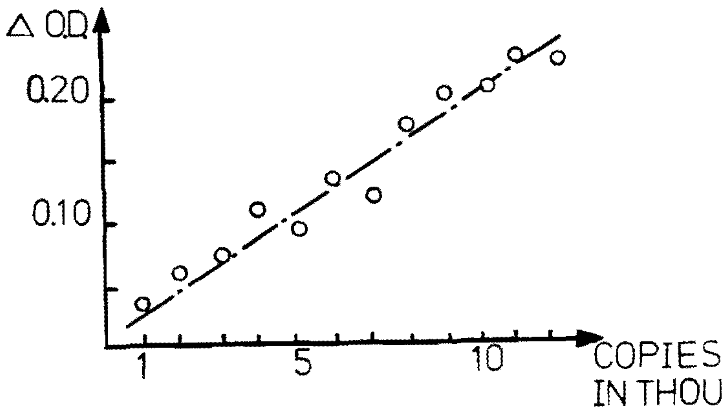

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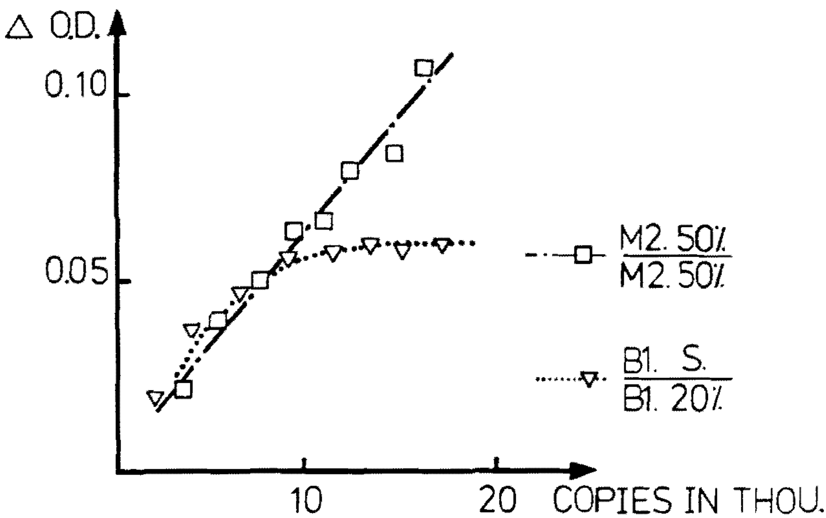

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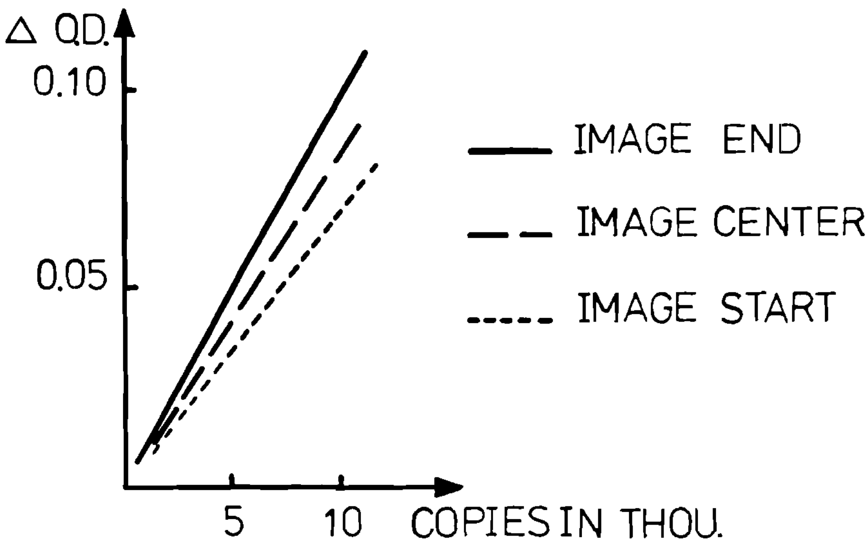

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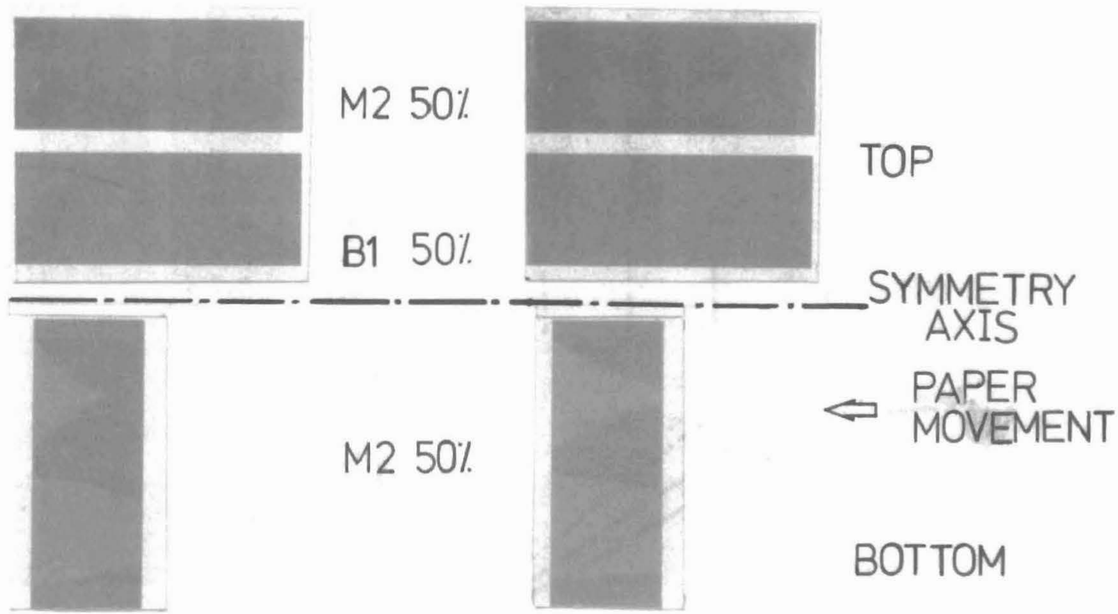

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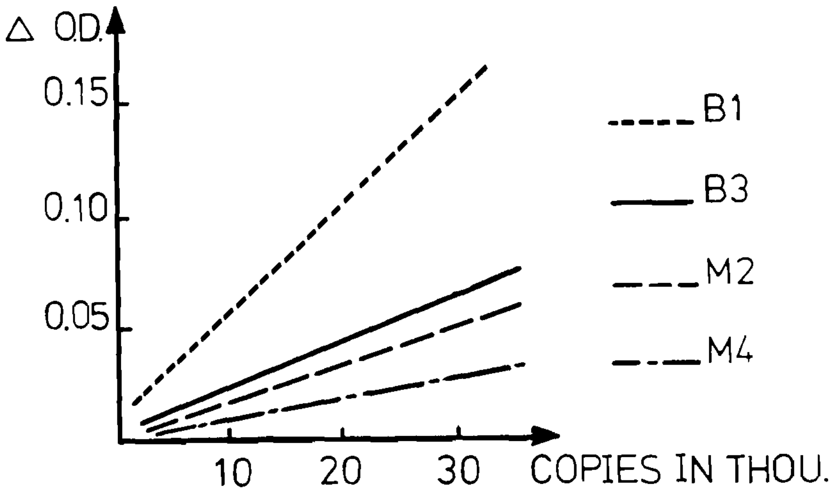

Fig. 12 : ΔO.D. from direct ghosting for paper A with the four inks (second trial, 50 % top on 50 % bottom).

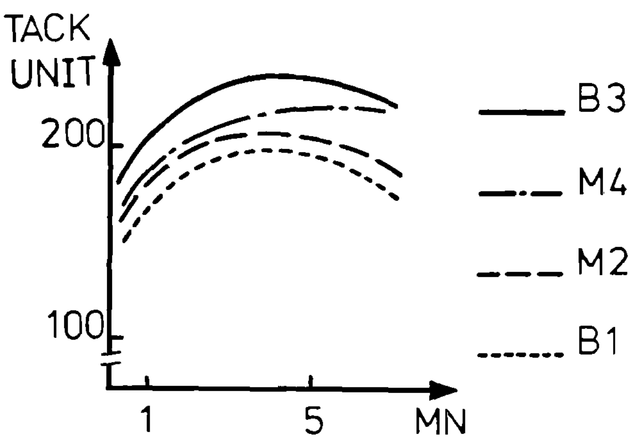

Fig. 13 : Ink tack for the four second trial inks.

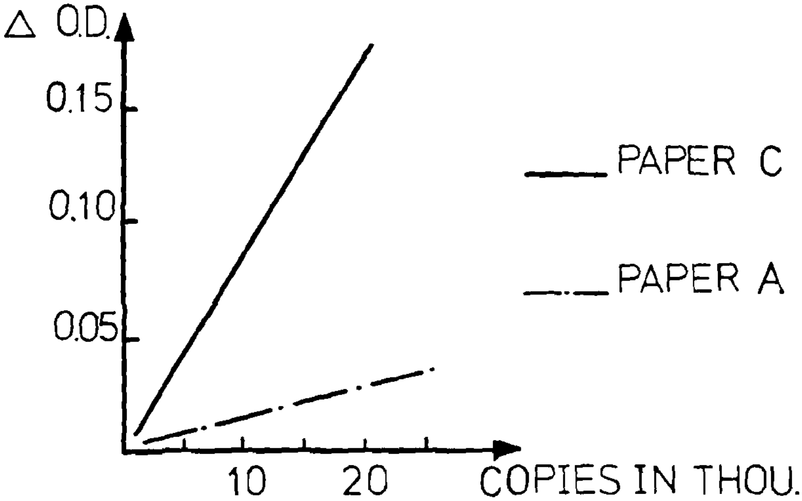

Fig. 14 : Difference in behavior for backtrap ghosting with papers A and C (second trial, B1 50 % top on M2 50 % bottom).

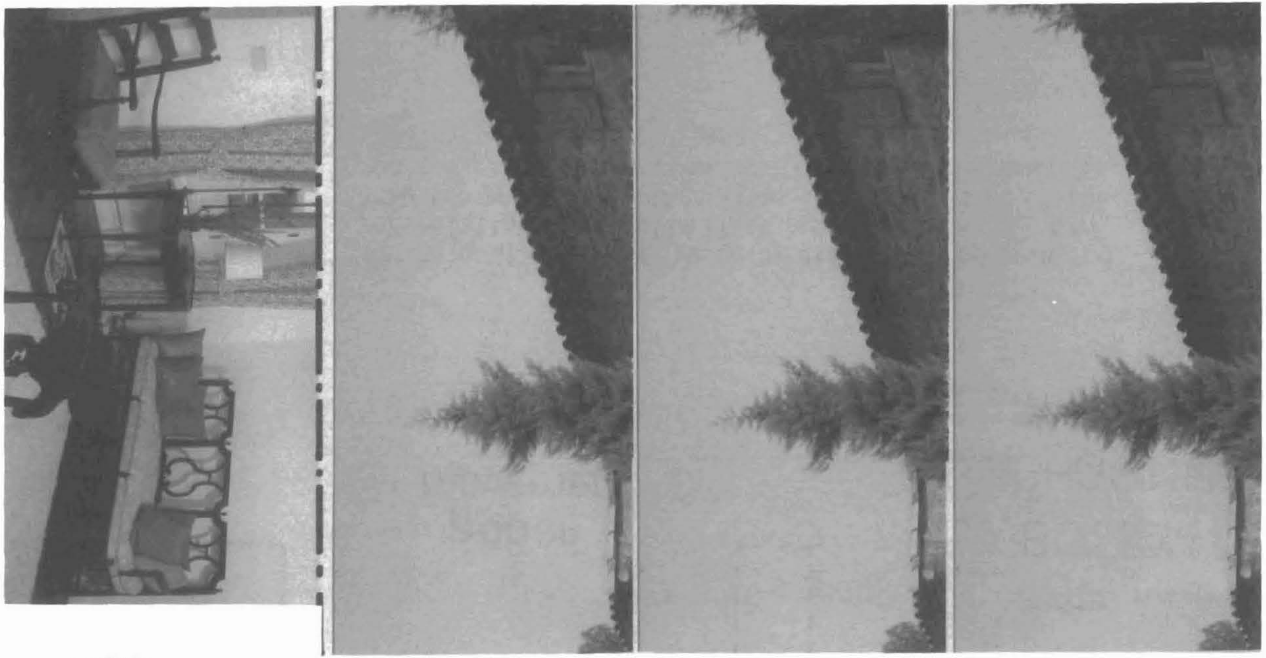

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Fig. 15 : Industrial results for ghosting elimination. On the right, after modification of the cyan, direct ghosting has not reappeared (color seq. B, C, M, Y).

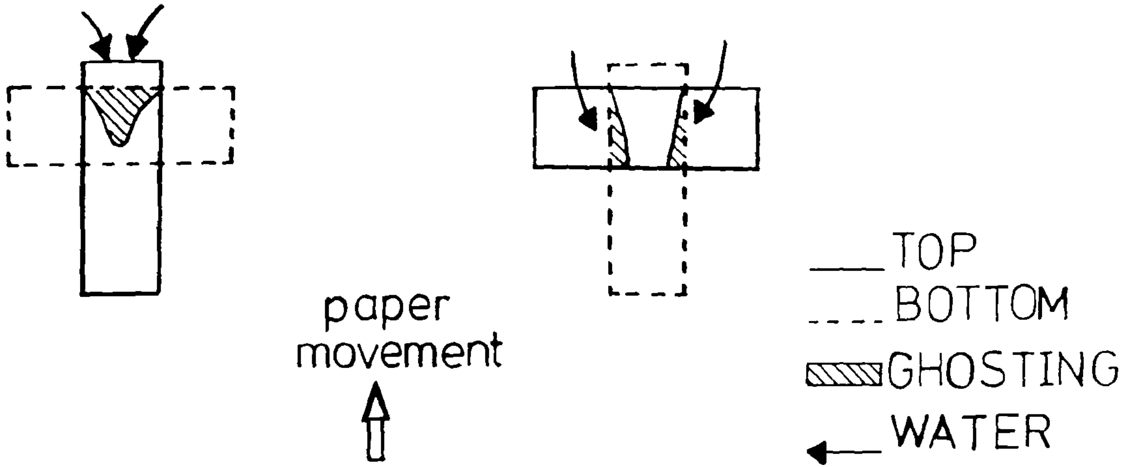

Fig. 16 : Patterns of ghosting caused by different top printing orientations. The solid lines indicate orientation of the top print and dotted lines the orientation of the bottom print. Water flow, indicated by the arrows, is believed to cause ghosting.