Study on paper releasing phenomena in offset printing by acoustic approach

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Abstract: It is generally said that the periodical sound from offset printing press during printing is generated when paper is released from blanket. In this study the paper release phenomena were analized by focusing on paper releasing sound. A device detecting the images printed at B/I nip(nip between blanket cylinder and impression cylinder) was developed and was combined with acoustic measurement. The images printed at B/I nip at the moment when paper releasing sound was generated were measured. And ℓ_1, the paper length held by blanket after passing B/I nip was obtained. The results suggested that the paper releasing sound was generated at the moment when ℓ_1 changed. The relationships between printing patterns and paper releasing sound were studied by using simplified test charts. Only 1mm width of non-image strip arranged perpendicular to printing direction or only 30% change in image area rate in a chart could cause paper releasing sound. The change in paper's tension near B/I nip could be detected by the combination of acoustic measurement and simplified printing patterns. It was also found that the ℓ_1 deviated considerably, when the printing speed and tack value of inks varied even within ordinary printing conditions.

Introduction

As the printing speeds of presses increase, the exact information of the paper's behavior especially at the nip of blanket cylinder become very important. The releasing facility of paper from blanket, namely, the paper releasing property is regarded as one of the important factorts for the existence of printing efficiency and quality. If this releasing property is poor, it causes the degradation of print quality and loss of efficiency. It is said that operators usually evaluate this releasing property by sound level during printing, basing on their experiences.

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Experimental

1. Experiment 1

1.1 Acoustic measurement

A narrow directional microphone was set toward B/I nip of printing press from delivery side. The sound generated from nip was processed by digital oscillograph (see Fig.1).

1.2 Test conditions

The following materials and printing conditions were applied. The sound from press was measured under the condition of optimum ink supply. Both sounds at idle running of press and at printing with only fountain solution (in other words, printing without inking) were also measured.

1)Test chart: Cromalin offset com guide
2)Printing press: Sheedfed press (26 inches)
3)Paper: Double side art coated, 70.5kg
4)Printing speed: 10000sph(Sheets/hour)
5)Ink: Process ink magenta
6)Pressure between plate and blanket: 0.10mm
7)Pressure between blanket and impression: 0.15mm
8)Optimum solid density: 1.3-1.4 (Cosar 61J)

2. Experiment 2

The microphone was set toward B/I nip from two directions to check where the sound was generated from during constant printing. One was from delivery side and another was from feeder side(shown in Fig.2). Test conditions were the same as 1.2.

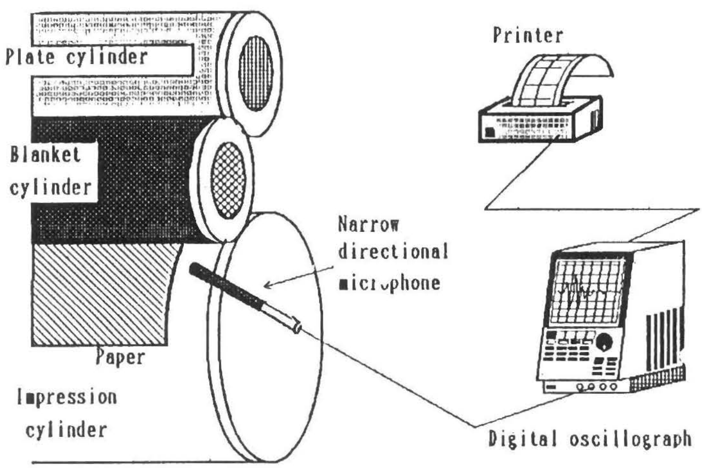

Fig. 1 Measuring system

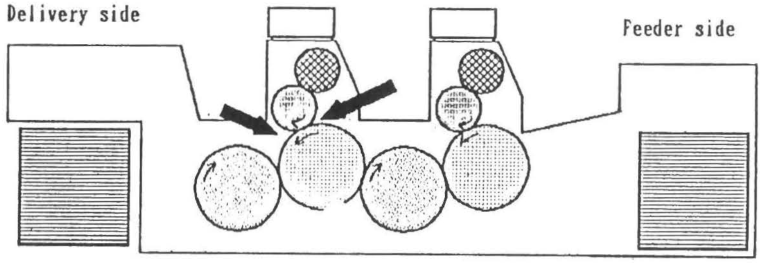

Fig. 2 The position of microphone

3. Experiment 3

3.1 Measurement

A stay was fixed at the side of blanket cylinder's bearer. A photointerrupter was set as the stay went through its slit(shown in Fig.3). The output signal from photointerrupter was processed by the digital oscillograph by way of amplifier. And the output of a narrow directional microphone was also processed by the digital oscillograph at the same time. Therefore both outputs could be evaluated synchronously.

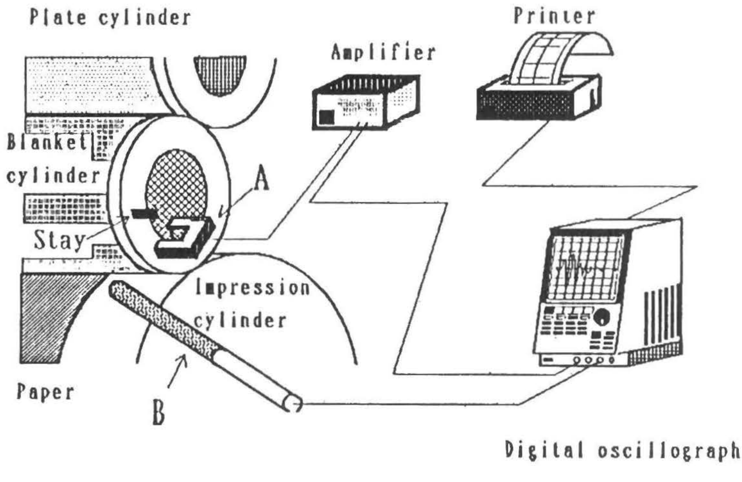

Fig. 3 Acoustic measurment and position sensing.
A : Photointerrupter
B : Narrow directional microphone

3.1.1 Relationship between the position of photointerrupter and B/I nip

The relationship between the position where the stay went through the photointerrupter and the position of B/I nip was measured by following procedures.

1)Supply ink on the whole surface of plate and transfer it to blanket. Then separate blanket cylinder from impression cylinder.
2)Revolve the blanket cylinder and stop it to correspond the stay position with the center of photointerrupter's slit.
3)Bring the blanket cylinder into contact with impression cylinder, and then transfer the nip image to paper. This condition is illustrated in (1) of Fig.4, where A shows the position when the stay is in the slit of photointerruper, B shows the B/I nip, and C shows head or gripper side of paper.
4)Pick up printed paper and then measure the length between center of nip image and C. This length is shown as La.

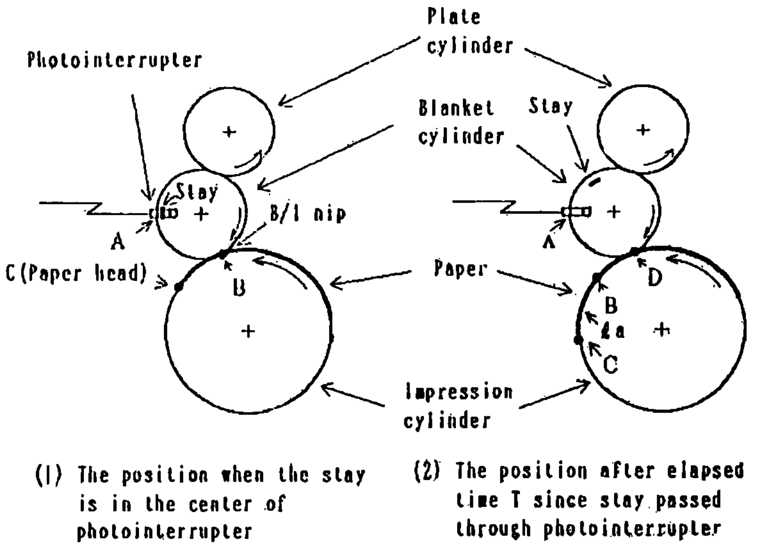

Fig.4 The position relationship between photointerrupter and paper

ℓa : Paper length between B and C

$t \times u$: Paper length between B and D

ℓt : Paper length between C and D($\ell a + (t \times u)$)

3.1.2 The paper position and the generation timing of releasing sound

The stay fixed at the side of blanket cylinder went across the slit of photointerrupter on each revolution. When the stay crossed the slit, voltage of output from photointerrupter changed. Therefore the period between first voltage change to next voltage change was the time Tr required for one revolution. The printing speed U (π d/Tr) could be obtained from this Tr and d, the diameter of blanket cylinder. As both outputs from photointerrupter and microphone were processed synchronously, the lap time T when the paper releasing sound generated after the stay passed photointerrupter's slit, could be obtained to compare both outputs.

D is defined as the paper position of T elapsed after passing B/I nip. The paper moving distance from B/I nip can be obtained by the maltiplication of printing speed U and elapsed time T (shown in Fig.4-(2)). The paper length Lt, the distance from C to D after elapsed time T, is shown as La + BD. What image was printed in B/I nip at the moment when the releasing sound is generated can be detected by comparing the printed sheet and this Lt,

3.1.3 Test chart

By using test chart A shown in Fig. 5 the acoustic measurement was carried out under the printing condition shown in 1.2.

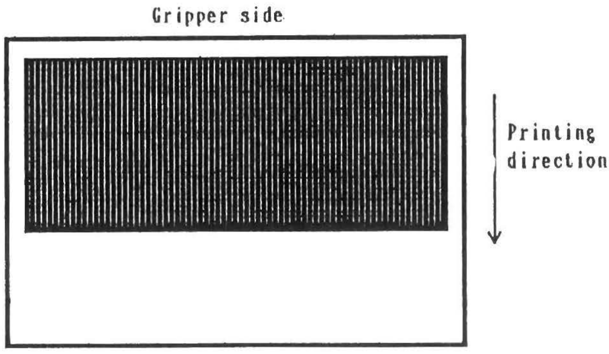

Fig.5 Test chart A

4. Experiment 4

Test chart B shown in Fig. 6 was designed to study the relationship between the width of non-image area and paper releasing sound. The chart B consisted of five solid strips. These strips were arrange perpendicular to printing direction in the way that widths of non-image area between strips became 1, 3, 6 and 10mm. The acoustic measurement was carried out by using chart B under the printing condition shown in 1.2.

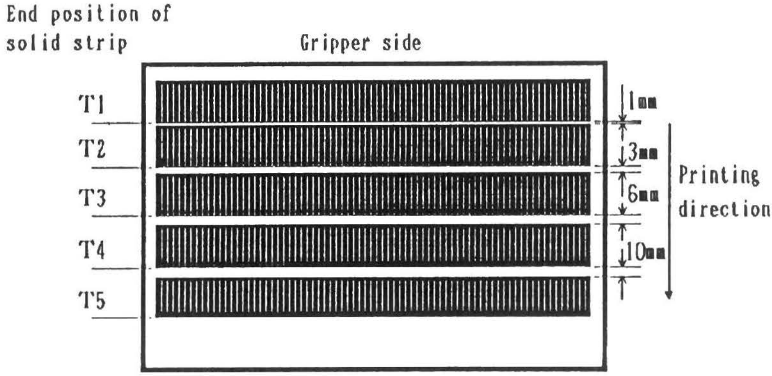

Fig.6 Test chart B

5. Experiment 5

Three test charts(chart A1, A2 and A3) replacing solid image (chart A) with screen images were designed. Their screen percentages were shown in Table 1. The acoustic measurements under the several inking conditions were carried out. The inking conditions were controlled by optical density of printed images, and the conditions are also shown in Table 1.

Table 1 Inking conditions

Test chart	Image area rate of plate	Print density (-)
A	100 % Solid	1.50~1.55
		1.35~1.40
		1.10~1.15
		0.90~0.95
		0.75~0.80
		0.65~0.70

Test chart	Image area rate of plate	Print density (-)
A－1	78 % 150 lpi	0.90~0.95
		0.75~0.80
		0.65~0.70
		0.60~0.65
A－2	60 % 150 lpi	0.50~0.55
		0.40~0.45
A－3	38 % 150 lpi	0.30~0.35

6. Experiment 6

Test chart C shown in Fig.7 was designed to study the effect of changing in image area rate. It had four non-image strips in solid image area, and these non-image strips were arranged perpendicular to printing direction in the way that their widths corresponded to 100, 70, 50 and 30% of solid image area's width. The acoustic measurement was carried out by using chart C under the printing condition shown in 1.2.

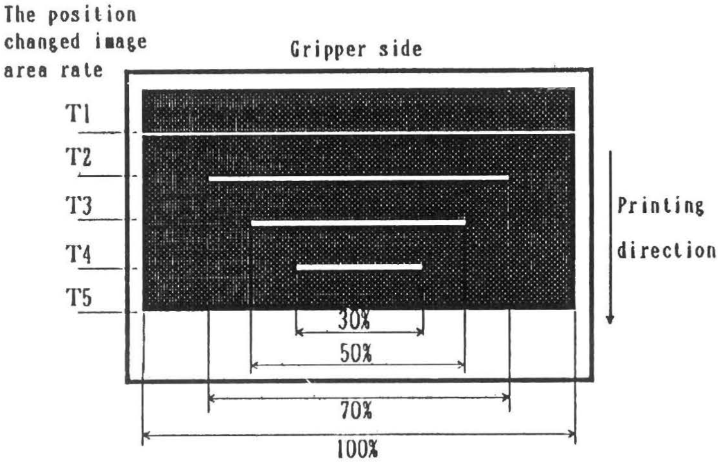

Fig.7 Test chart C

7. Experiment 7

Test chart D was designed by arranging 50mm width of seven solid strips in a right angle to printing direction. The layout of the chart D is shown in Fig.8. The acoustic measurement was carried out by this chart under the printing condition shown in 1.2. Further tests were carried out by using this chart under following conditions to evaluate the influence of printing speed and tack value of test ink.

1)Printing speed: 7000, 10000 and 12000 sph
2)Tack value of inks:ink L: 7.0~7.5, ink M: 9.0~9.5 and ink Y: 10.0~10.5

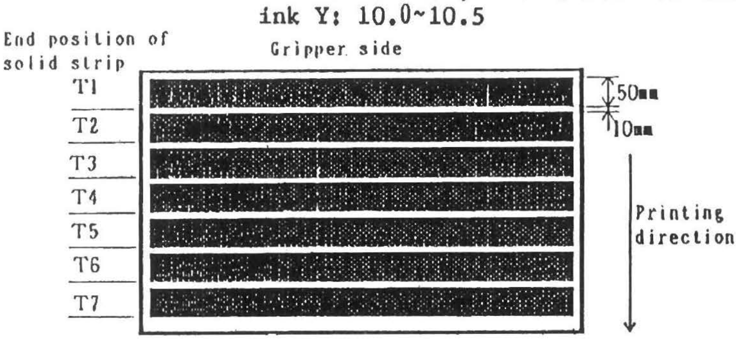

Fig.8 Test chart D

Results and Discussions

1. Acoustic output during printing

The sounds during idle running of press, during printing only supplying fountain solution, in other words, printing without ink and during printing of test chart are shown in Fig.9. The noise level of acoustic output during the printing without ink is slightly larger than the level during idle running, but the acoustic outputs during printing of Cromalin offset com guide is definitely much stronger than others and generated periodically. It shows that high intensive periodical sound isgenerated when ink exists.

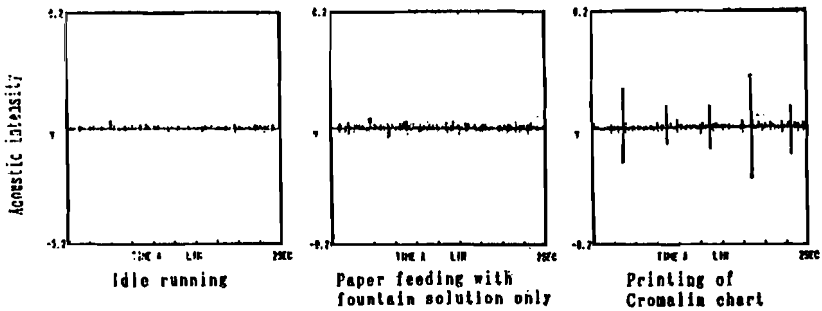

Fig.9 Comparison of acoustic output

The volume of the sounds coming out from the microphones which were fixed toward B/I nip, one at delivery side and the other at feeder side are shown in Fig.10. The intensity of periodical sound from delivery side is much stronger than that from feeder side. The periodical sound is generated from the delivery side around B/I nip, in other words, from paper's outlet of B/I nip. The results show that this periodical sound attributable to the paper releasing sound.

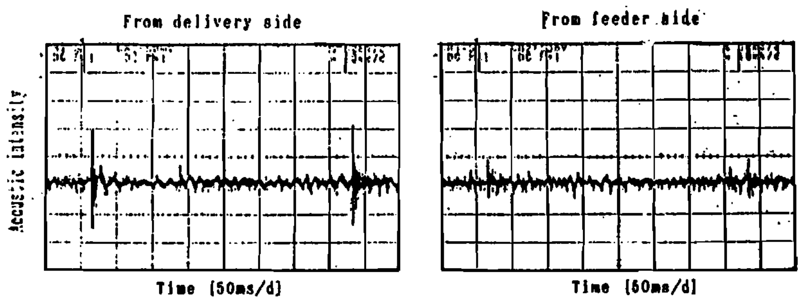

Fig.10 Comparison of positions of microphone put toward B/I nip

2. The time when the periodical sound is generated

One of the results from experiment 3 by test chart A is shown in Fig.11. The channel 1 shows the output of photointerrupter, while the channel 2 shows the acoustic output from microphone. The time when the stay went through the slit of photointerrupter can be recognized from peak output of channel 1. Peripheral speed of blanket can be calculated from the lap time between one peak and the one next. The output of Fig.11 is enlarged and Tc, the time of the end of image area printed at B/I nip is added. The results are shown in Fig.12. The lap time until the paper releasing sound is genelated after the stay goes through the photointerrupter is defined as Td. Paper releasing sound is generated after Td-Tc, the time elapsed since the end of image passed B/I nip. The moving length of paper after the end of image passed B/I nip until paper releasing sound is generated is defined ℓ_1. ℓ_1 can be expressed as (Td-Tc)x U. Under this test condition, ℓ_1 iresults in 18mm.

The condition around B/I nip at the moment when paper releasing sound is generated is illustrated in Fig.13. At the time when image area is printed, paper is held by blanket in the length of ℓ_1 mm after passing B/I nip and then releases from blanket's surface constantly. This releasing position is indicated in Fig.13 as E. The end of image area goes away from B/I nip, and gets near to the releasing position E. At the moment when the end of image area is released from position E, ℓ_1, the paper length held changes because the cohesion strength in image area (inked area) is different from that in non-image area. It shows that the paper releasing sound is generated when ℓ_1 varies.

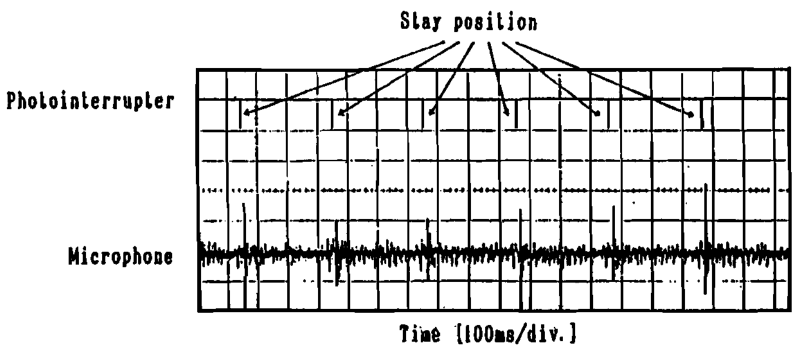

Fig.11 Output by test chart A

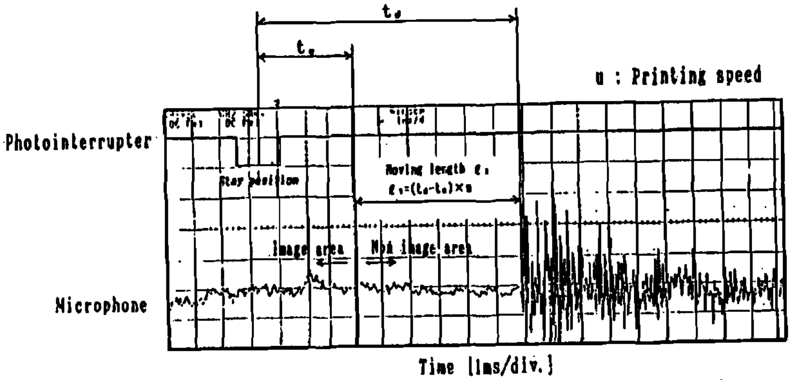

Fig.12 Paper releasing sound and its generation timing (enlonged figure of Fig.11)

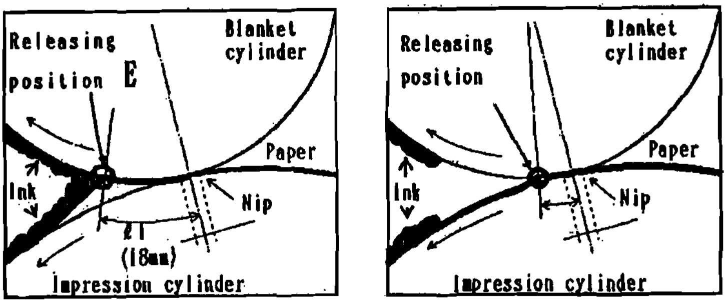

Fig.13 Paper releasing position on blanket

3.The paper releasing sound and printed images

Output by test chart B is shown in Fig.14. The test chart B was prepared by arranging five solid strips at a right angle direction in the way that widths of non-image area between strips became 1, 3, 6 and 10mm (see Fig.6). Five acoustic peaks are observed at each revolution, same with the numbers of solid strips. Therefore it shows that the paper releasing sound is generated if 1mm width of non-image strip exists. The end position of each strip were expressed as T1, T2, T3, T4 and T5 from gripper side, and ℓ_1 at each position was measured (see Fig.15). ℓ_1 at T5 is longer than the others.

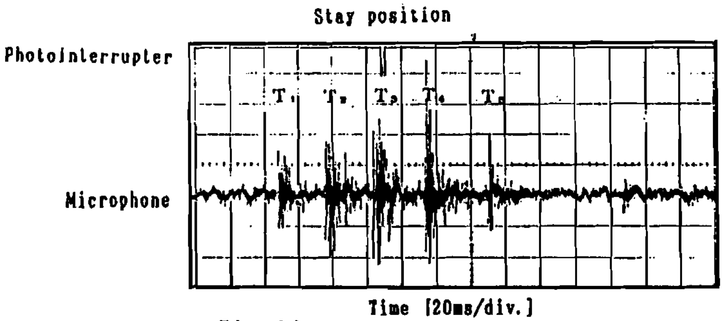

Fig. 14 Output by test chart B

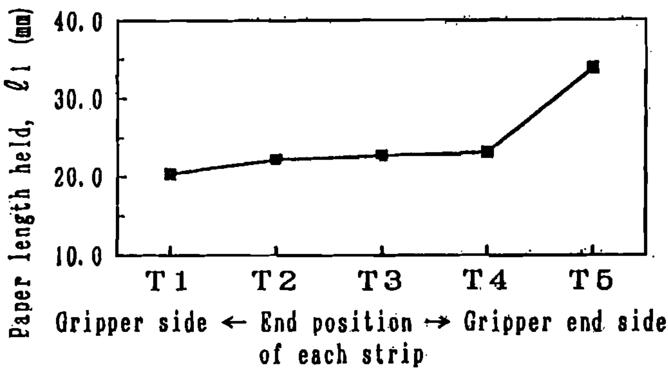

Fig. 15 End position of each strip and its ℓ1 by test chart B

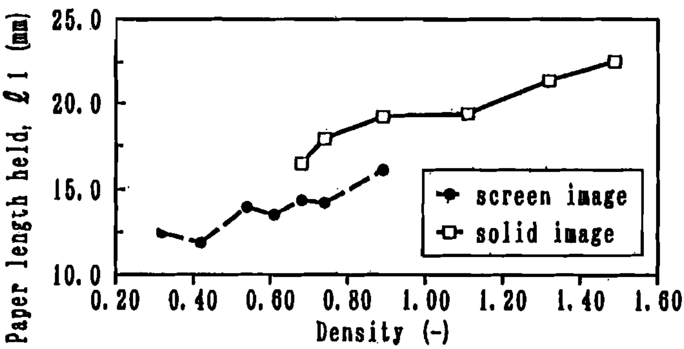

Fig. 16 The relationship between optical density and ℓ1

By screen charts (A1, A2 and A3) and solid chart A ℓ_1 was measured under several inking conditions, which are shown in Table 1. The relationships between optical density of printed image and ℓ_1 are shown in Fig.16. As the density decreases, in other words, the amount of ink transferred to paper decreases, the cohesion strength between paper and blanket decreases and ℓ_1, the paper length held becomes shorter as the result. The ℓ_1 from screen charts is shorter than that from solid chart, when compared in the range of density between 0.7 and 0.9. This is attributable to the difference of ink emulsification relating ink separation strength (screen printing requires more fountain solution) and morphology of printed ink relating optical gain and cohesion area.

ℓ_1 was measured by using test chart C (Fig.7) prepared by arranging non-image strips at a right angle to printing direction in the way that their widths corresponded to 100, 70, 50 and 30% of solid image's width. The result is shown in Fig.17. There are five acoustic peaks corresponding to the number of non-image strips. It shows that 30% change in image area rate causes paper releasing sound. The positions of image area rates changing are expressed as T1, T2, T3, T4 and T5 from gripper side. ℓ_1 measured at each position is shown in Fig.18. ℓ_1 at T5 position is much longer than those of others, and this tendency is the same with the result shown in Fig.15.

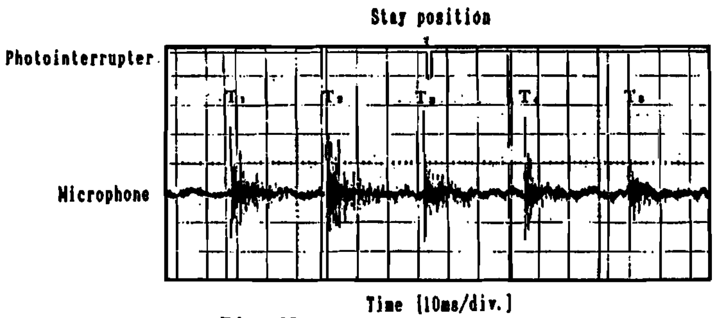

Fig.17 Output by test chart C

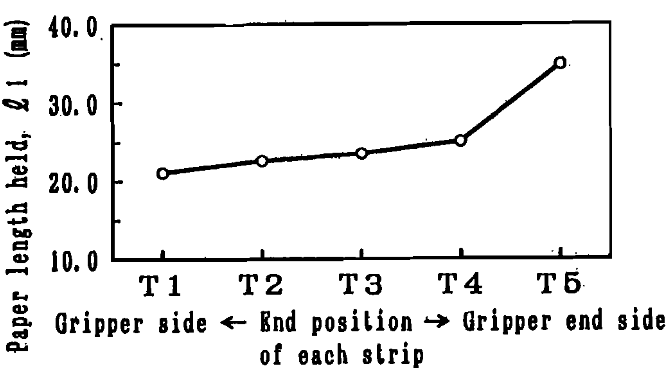

Fig.18 End position of each strip and its ℓ_1 by test chart C

4. The relationship between the paper length from paper head to B/I nip and ℓ_1

Measurement by using chart D (see Fig.8) was carried out to study the relationship between paper length from paper head to B/I nip and ℓ_1. End position of each solid strip in chart D is named as T1, T2, T3, T4, T5, T6 and T7 from gripper side. One of the outputs by chart D is shown in Fig.19. Seven acoustic peaks caused by each strip are observed. Each ℓ_1 and maximum acoustic intensity of each peak are measured. Maximum acoustic intensity is expressed as Φ_1, while the paper length from paper head to B/I nip is expressed as Lp. The relationships of Lp with ℓ_1 and Φ_1 are shown in Fig.20. ℓ_1 increases gradually as the paper head leaves B/I nip until Lp reaches about 270mm. When Lp exceeds about 270mm, ℓ_1 increases rapidly. As to the Φ_1, when Lp reaches about 270mm, Φ_1 shows maximum strength.

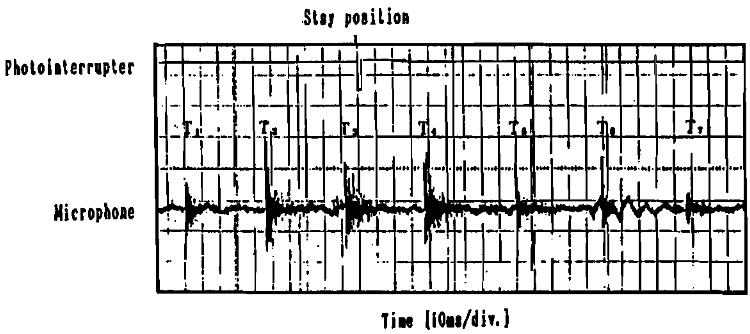

Fig. 19 Output by test chart D

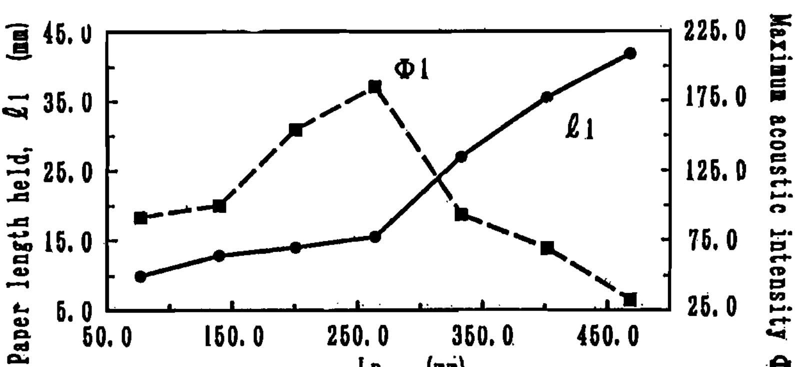

Fig. 20 The relationship amoung Lp, ℓ_1 and Φ_1

Lp : The paper length from paper head to B/I nip

The paper's flow in our press was investigated. The paper head was held by grippers installed in impression cylinder and then went through the B/I nip. At the moment when LP reached about 270mm, the paper head was held by transfer cylinder's grippers in stead of grippers of impression cylinders. This condition can be illustrated in Fig.21. It shows that the timing of gripper changing is corresponding to the timing when the ℓ_1 and Φ_1 change rapidly. These phenomena can be explained as follows. The head of sheet is held by the grippers of impression cylinder and goes through B/I nip. As the head of paper goes away from B/I nip, the tension of paper near B/I nip decreases and ℓ_1, the paper length held increases as the result. When the paper head goes away from B/I nip by 270mm, the paper head is then held by transfer cylinder's grippers. In this moment the paper's tension decreases rapidly and as the result ℓ_1 decreases suddenly. It shows that our measurement can detect the change of paper's tension around B/I nip during printing.

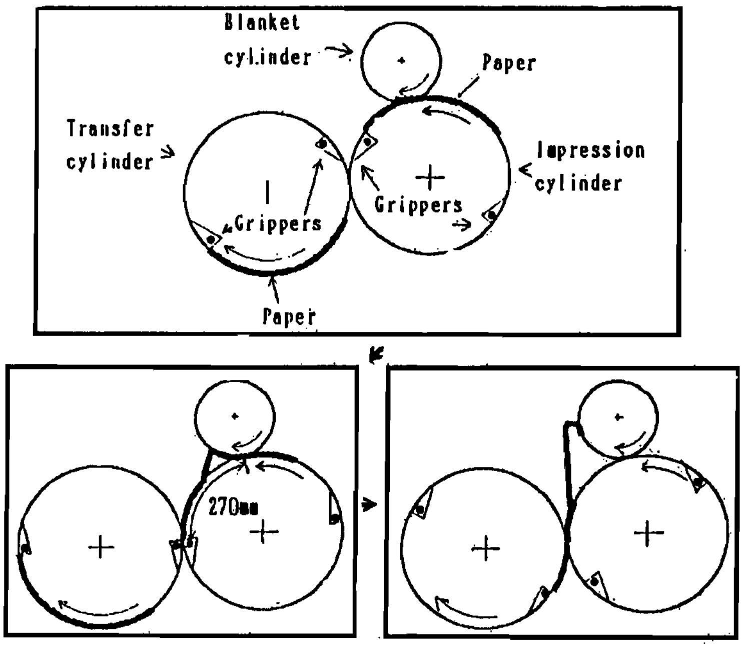

Fig.21 The timing of grippers' changing

5. The effect of printing speed and tack value of ink on ℓ_1

The relationship between printing speed and ℓ_1 is shown in Fig.22. ℓ_1 does not change too much in the range of speed between 10000sph and 12000sph. On the other hand when the printing speed is increased from 7000sph to 10000sph, ℓ_1 becomes much longer.

The effect of tack value of ink on ℓ_1 is shown in Fig.23. The tack values of test inks are within the range of ordinary use. ℓ_1 by ink Y which has highest tack value is almost the same as that by ink M which has medium tack value, while ℓ_1 by ink L which has lowest tack value is shorter than those by the others.

These results suggest that ℓ_1 deviates considerably even if the printing conditions (speed, tack value and so on) are changed within ordinary range.

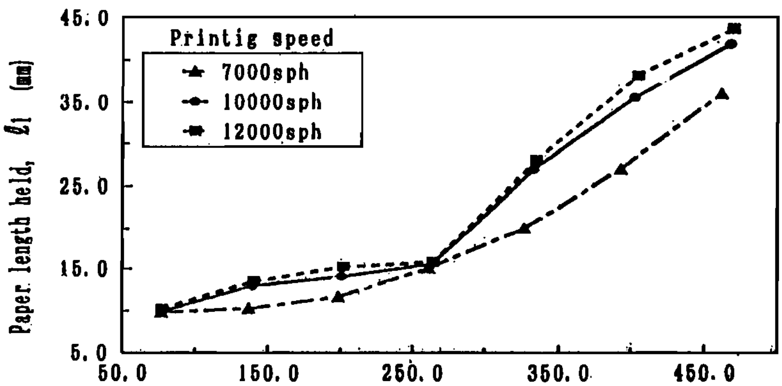

Fig. 22 The relationship between Lp and ℓ_1

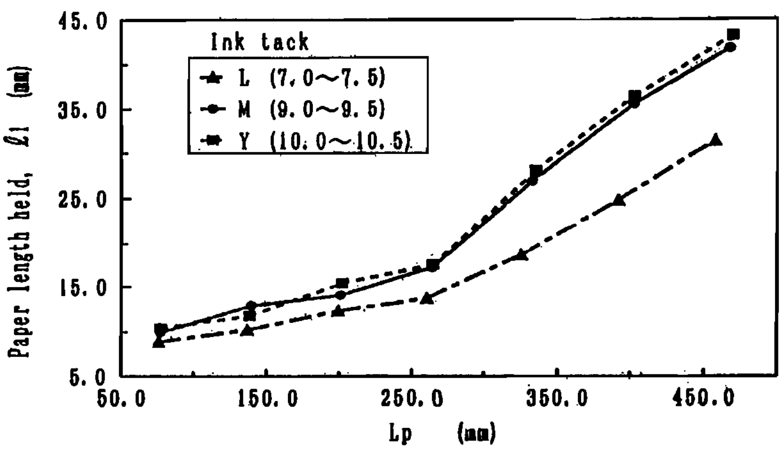

Fig. 23 The relationship between Lp and ℓ_1

Conclusions

The paper length held by blanket after passing through B/I nip during printing(which is expressed as ℓ_1) or paper releasing position, can be measured. The paper releasing sound is generated when ℓ_1 changes.

Even if 1mm width of non-image strip exists at a right angle to printing direction or 30% change of image area rate in printing direction exists in test chart, the ℓ_1 changes and the paper releasing sound is generated as the result. The ℓ_1 from screen charts is shorter than that from solid chart, when it is compared in the same optical density range. This is attributable to the difference of ink emulsification and morphology of printed ink between screen printing and solid printing.

It is found that the change in paper's tension of one sheet around B/I nip during printing can be detected by the combination of this measurement and printing patterns. It is also found that ℓ_1 deviates considerably, if the printing conditions(speeds, tack value and so on) are changed within ordinary range.