#2938 THE INSTITUTE OF PAPER CHEMISTRY
(Web Offset Printing Press Evaluation)
Project Reports

PROJECT REPORT FORM

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COOPERATOR Institute of Paper Chemistry
REPORT NO. 4
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Editorial

PRESS EVALUATION OF OFFSET PAPERS

EVALUATION OF INFRARED STRIP HEATERS FOR DRYING HEATSET INKS

INTRODUCTION

The Didde-Glaser Apollo web press is used at The Institute of Paper Chemistry for press evaluation of offset printing papers. Evaluations have been largely confined to uncoated papers which do not require heatset inks or drying ovens. It would be desirable to extend evaluation capabilities to coated papers that are dried with heat. The drying unit which is needed for this purpose should not only be capable of drying inks but should detect the unfavorable effects of heat drying, such as blistering and surface roughening on papers which are prone to exhibit such difficulties. For use in these evaluations the dryer should be operative with black on each side of the paper web. Drying of colored inks is not essential in these tests although it might be desirable on some occasions.

Through the courtesy of Mr. John A. Ruce of Research Incorporated, two 10-inch quartz tube strip heaters with water-cooled reflectors and a phaser for control of these heaters were obtained on 90-day loan with the understanding that results of drying experiments would be made available to Research Incorporated.

SUMMARY

The Research Incorporated strip heaters are effective means of heating the paper web in a small space. Two of the heaters (one on each side of a web which was printed on both sides) provided barely adequate drying of the ink at the minimum press speed of 100 ft./minute. It was necessary to provide a long web lead to allow the ink solvent to evaporate from the heated ink and the web to cool before sheeting and stacking. It was not possible to blister the paper under these conditions, but the paper used was not particularly prone to blistering. Some roughening of the surface did occur.

One-side heating with the heaters parallel to the web direction to provide 0.3 seconds in the heating zone resulted in excessive heating as judged by scorching of the paper. Failure to achieve blistering under these conditions was probably because printing (and heating) was on only one side of the web.

Measurements made with Thermopaper indicate that the temperature reached during the approximately 0.05 seconds in which the paper is in the heated zone (heater in cross-machine direction) is less than that at which blistering is encountered in the blister tester. Tests of papers using the strip heaters in the blister tester showed that about the same blistering behavior was achieved in 0.3-0.4 seconds as in 0.9 seconds with the regular blister tester heaters.

The rapid response of the heaters when they are turned on and the rapid dissipation of heat by water cooling when they are turned off are attractive features of the strip heaters. It is possible to shut down the press without the danger of fire from accumulated heat in the drier section.

CONCLUSIONS

Two strip heaters are not quite adequate for the type of ink-drying unit needed for testing of coated papers on the Apollo press. It is expected that four heaters will be adequate for at least the minimum press speed of 100 ft./minute.

It should not be assumed without further study that four heaters will permit drying of colored inks. This is not a serious requirement in our own work but it would be wise to run tests with yellow and red inks, which have relatively little absorption of longwave visible light, when more heaters have been installed.

EXPERIMENTAL DETAILS

A 60-pound coated web offset was used in all the press experiments. The ink was a black heatset offset ink from Inmont. Press speed was 100 ft./minute, which is the minimum press speed. In the first three experiments the heaters were installed in the space between the two printing units. The first printing unit was used and the web was passed through the second printing unit (no ink) and then directly into the sheeter and stacker with the normal web lead. Two Research Inc. 5305-1CB strip heaters with 2000T3/CL/HT quartz lamps were controlled with a phaser operated at 240 volts input.

Experiment 1

The heaters were placed in apposition (one on each side of the web in cross-machine direction). On the basis of the $1\frac{1}{2}$ inch width of the strip heater, this provides 0.075 seconds in the heating zone. The ink could be rather easily smeared but did not offset in the stack.

Experiment 2

Experiment 2 was like experiment 1 except that the two heaters were both side by side in the cross-machine direction on the printed side. This provides 0.15 seconds in the heating zone. The ink could be smeared rather easily but was dry enough to prevent offsetting in the stack.

Experiment 3

In order to provide greater time in the heating zone, the two heaters were placed side by side in the web direction. Because of the 10-inch heated length of the lamps, this provides 0.5 seconds in the heating zone for the central 3-inch strip of the web. Under these conditions the ink in the central strip was dry and the paper was scorched along the center where the heat patterns of the two lamps overlapped. The scorching was particularly noticeable on the back of the web opposite printed areas. The paper did not blister.

Experiment 4

In all of the above experiments the second printing unit and the sheeting unit became warm from the hot paper and it would not have been wise to run for any extended period. Consequently the heaters were placed after the second printing unit and an extended lead of about 16 feet was employed following the heaters to permit the web to cool before it entered the sheeting unit. The turnover unit was placed between the printing units and both printing units were used to permit printing on both sides of the web. The heaters were placed in apposition--one on each side of the web--to permit simultaneous heating of the two printed sides of the web. Under these conditions at full power to the heaters the web was substantially dry and cool when it reached the stack. There was some roughening of the printed surfaces because of the

high rate of heating but there was no blistering. More heating capacity would be required to reach a blistering condition and more heaters at lower temperature would be required to reach a satisfactory drying condition without surface roughening.

Experiment 5

In previous ink blistering studies by Wink, Hackley and Tyler (Tappi 50, no. 7:102A-108A. July 1967), Thermopaper was used to estimate the paper temperature reached in the blister tester. It is recognized that this is at best an estimate because of differences in absorption of radiant energy and differences in heat capacity between the Thermopaper and the printed paper under test. However, use of Thermopaper with the strip heaters did permit a comparison of these heaters with the blister tester and, therefore, with accumulated experience with the instrument. Windows were cut in a web of printing paper and patches of printing papers were taped over these windows so they would be heated from both sides. This web was then wound up and then passed through the press (without printing). The positions of the strip heaters were as in Experiment 4. Under these conditions a temperature of 400°F. (204.4°C.) was registered. Wink, et al found only one paper that blistered at a power input corresponding to this temperature on the blister tester.

The temperature indicated by the Thermopaper depended on the method of mounting. When placed on the carrier web without cutting the window, only one side was directly exposed to the strip heaters and the temperature indicated was only 240°F. (115.6°C.).

Experiment 6

The strip heaters were mounted on the blister tester in order to permit longer heating times at the slower paper speed. The paper samples were in the heated zone between the two strip heaters for between 0.3 and 0.4 seconds. In comparison when the blister tester is used normally with its two stove elements, the sample is heated for 0.9 seconds which corresponds to the heating time in some commercial ink driers. The samples were heated to the point of failure with each heating method and the end points (KW in the case of the normal blister tester and amperes in the case of the strip heaters) are shown in Table I.

An offset oil ink was used instead of a heatset ink in the test with the blister tester. This has been standard practice with blister experiments because of the experimental difficulties in working with the less stable heatset inks. The test strips were printed simultaneously on both sides using the IGT printability tester immediately before testing.

TABLE I

COMPARISON OF STRIP HEATERS WITH HEATING ELEMENTS OF THE BLISTER TESTER

Paper	Basis Weight, lb./ream [a]	Normal Blister Test [b]			Strip Heater Blister Test [c]		
		KW	Blistered	Scorched	Amps	Blistered	Scorched
1	50	2.96	Yes	No	13.5	No	Yes
2	60	1.68	Yes	No	11.5	Yes	No
3	80	1.59	Yes	No	11.5	Yes	No
4	45	3.26	No	Yes	17.0	Yes	Yes
5 [d]	60	3.26	No	Yes	17.0	No	Yes

[a] Pounds per 3300 sq. ft.

[b] Exposure 0.9 seconds between electric stove elements

[c] Exposure between 0.3 and 0.4 seconds between strip heaters

[d] This was the paper used in Experiments 1 - 5.

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Editorial

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PRESS EVALUATION OF OFFSET PAPERS

OBJECTIVE MEASUREMENT OF PRINT

QUALITY CHANGE DURING PRESS RUN

SUMMARY

A study has been made of objective measurement of change in printing quality occurring during runs on the Apollo offset press. Changes in tone scale were minor except for the two runs in which ink level was lowest and continued to fall during the run. Ink level decreased during all runs and this was responsible for lower contrast at the end of the run. There was some tendency for the solid to become lighter than the 90% tone, but this must be checked on runs in which ink level is kept as constant as possible.

The differential densitometer has been used to detect the increase in print unevenness during the run. The product of the standard deviation in R_S/R_L and the average reflectance $\bar{R}$ was shown to increase generally during the run. Exceptions to this tendency were few considering the great change in ink level during the run, the size of the small aperture, and the limited number of points (100) used for statistical analysis. It is recommended that this method be tentatively adopted to follow the decrease in quality caused by accumulation of paper debris.

INTRODUCTION

The accumulation of paper debris on blankets and other parts of offset presses is generally objectionable but there is little information available to indicate the degree to which such accumulations impair printing quality. In studies of offset printing papers it is desirable to know not only the nature and amount of accumulated paper debris but also its effect upon printing quality. This applies to the present offset newsprint linting study (Project 2949), to group projects on coating piling and dusting that are being considered, and to evaluations of offset papers for individual members.

Subjective examination of prints from the beginning and end of test runs suggests that lint may adversely affect tone scale by destroying or even reversing the distinction between solids and deep halftones. It also appears to cause unevenness of solids and deep tones. The present study is concerned with the objective measurement of these characteristics. The prints used were made for another purpose under Project 2949. They were made without adjustment during the run of the ink supply and represent duplicate runs with high ink-high water; low ink-high water; high ink-low water; and low ink-low water.

Change in Tone Scale

Reflection density measurements were made on the magenta ink prints from the start, the center and end of the 2500-sheet run using the Welch Densichron with green filter. The measurements were made in the central portion of the test image to avoid the variation in ink thickness which was evident at the edges of the image. Six measurements were made from the same selected areas of each tone, and three measurements were made from the solid areas. The average density values are shown in Table I. The values for the 50% tone are

TABLE I

AVERAGE DENSITY OF PRINT

Low water - Low ink

Tone Density	Run 15 Start	Run 15 Center[a]	Run 15 End[b]	Run 22 Start	Run 22 Center[a]	Run 22 End[b]
Solid	.2563	.1170	.0883	.3487	.2797	.2620
90	.2387	.0925	.1042	.3395	.2527	.2433
70	.2165	.1082	.1107	.2703	.1952	.1952
50	.1817	.0998	.0880	.2408	.1558	.1648
20	.0538	.0335	.0305	.0672	.0335	.0410

High water - High ink

	Run 18			Run 19		
Solid	.873	.760	.717	.903	.757	.740
90	.882	.742	.716	.917	.758	.755
70	.798	.6650	.6692	.843	.678	.655
50	.6683	.5492	.5442	.755	.559	.553
20	.1737	.1537	.1562	.1903	.1475	.1582

High water - Low ink

	Run 16			Run 21		
Solid	.2403	.0917	.0920	.5617	.2630	.2447
90	.2202	.1063	.0962	.5338	.2267	.2267
70	.1902	.0937	.0980	.4482	.2095	.1968
50	.1525	.0775	.0797	.3423	.1640	.1512
20	.0300	.0188	.0258	.0940	.0335	.0195

Low water - High ink

	Run 17			Run 20		
Solid	.890	.720	.720	.953	.773	.750
90	.867	.727	.724	.942	.757	.802
70	.787	.638	.659	.867	.6658	.6725
50	.652	.5292	.5508	.732	.5297	.5833
20	.1713	.1333	.1425	.2022	.1478	.1392

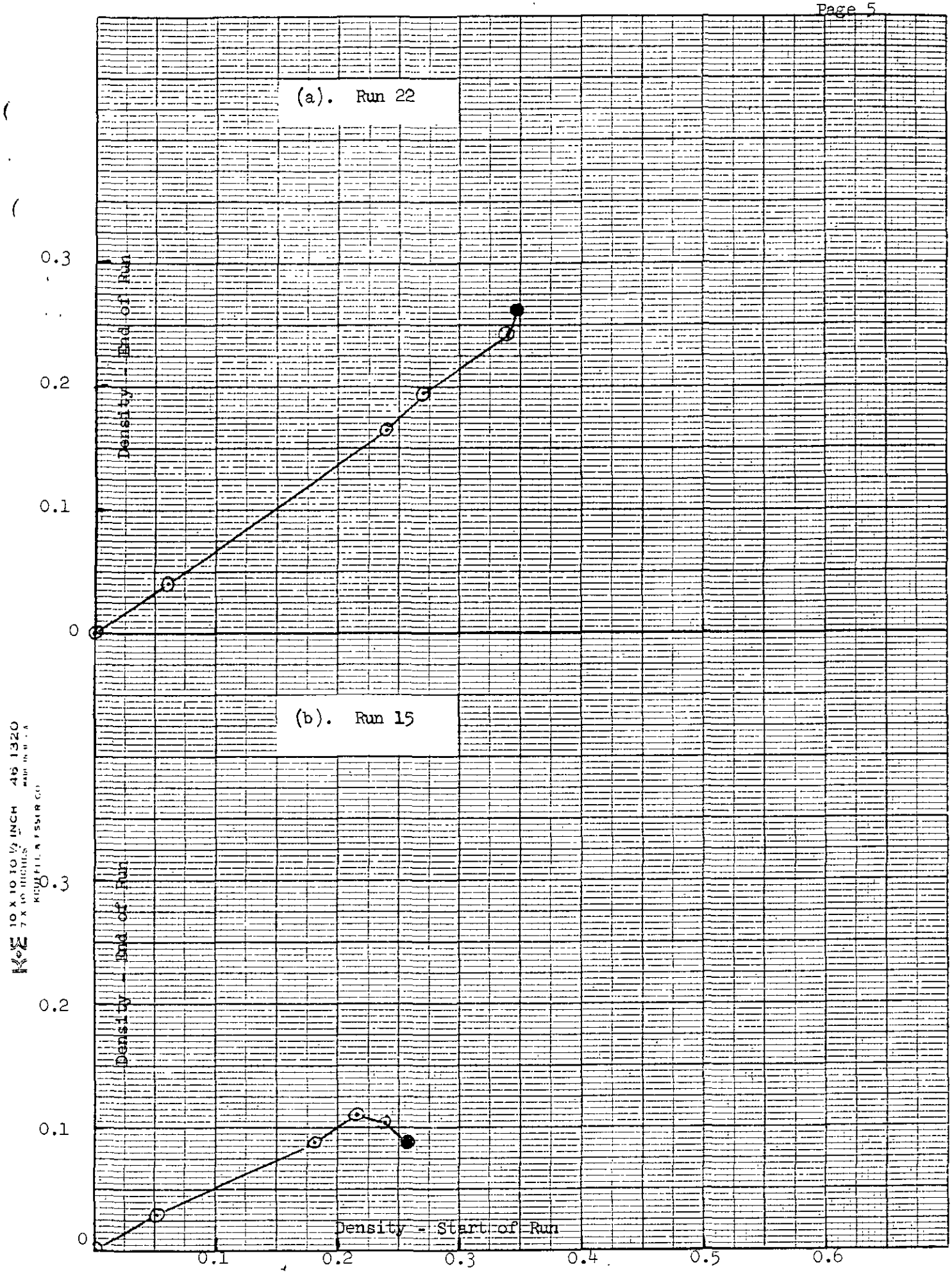
[a] At approximately 1,250 impressions

[b] At approximately 2,500 impressions

considered less reliable because a ghost appears one ink roll circumference from the gap and this passes through the central 50% tone. Figures 1 - 4 show plots of the end-of-run density versus the density at the start of the run for each of the ink and water conditions. In these plots the solid is shown as a closed circle and the halftone tones as open circles. It is obvious that the contrast decreases in all cases due to the decreasing supply of ink. Run 15 (Fig. 1b) and Run 16 (Fig. 3b) are both abnormal in that the maximum density at the end of the run occurred in the 70% tint. These two runs had the lowest amount of ink at start and it decreased considerably during the run. It should be noted that companion runs 22 and 21 did not show this behavior, but in these cases ink level was somewhat higher. It was not unusual to find the 90% tone more dense than the solid at the end of the runs and, to some degree, this supports an earlier subjective judgment made on other runs that--as lint accumulates--the sclid becomes lighter than the 90% tone. It must be admitted, however, that this reversal was found in some cases at the start of the run.

Change in Evenness of the Prints

Karttunen (1) has used the coefficient of variation, $s'/\bar{R}$, where s' is the standard deviation of small spot reflectance and $\bar{R}$ is the mean reflectance, as a measure of print unevenness. Nordman (2) prefers $s'/\bar{R} \log \bar{R}$ because the sensitivity of the eye to unevenness is dependent upon the reflectance level of the tone. In the present work the purpose is detection of the unevenness of ink distribution in the same tone caused by accumulation of lint rather than visual unevenness, so the log $\bar{R}$ is not necessary. The differential densitometer gives a plot of R_S/R_L, where R_S is the small spot reflectance and R_L is the average reflectance of the surrounding large spot. If R_L is constant, it becomes equal to $\bar{R}$ and the standard deviation s of R_S/R_L becomes equal to the coefficient of


(a). Run 22
Density - End of Run
0.3
0.2
0.1
0
(b). Run 15
Density - End of Run
0.3
0.2
0.1
0
Density - Start of Run
0.1
0.2
0.3
0.4
0.5
0.6

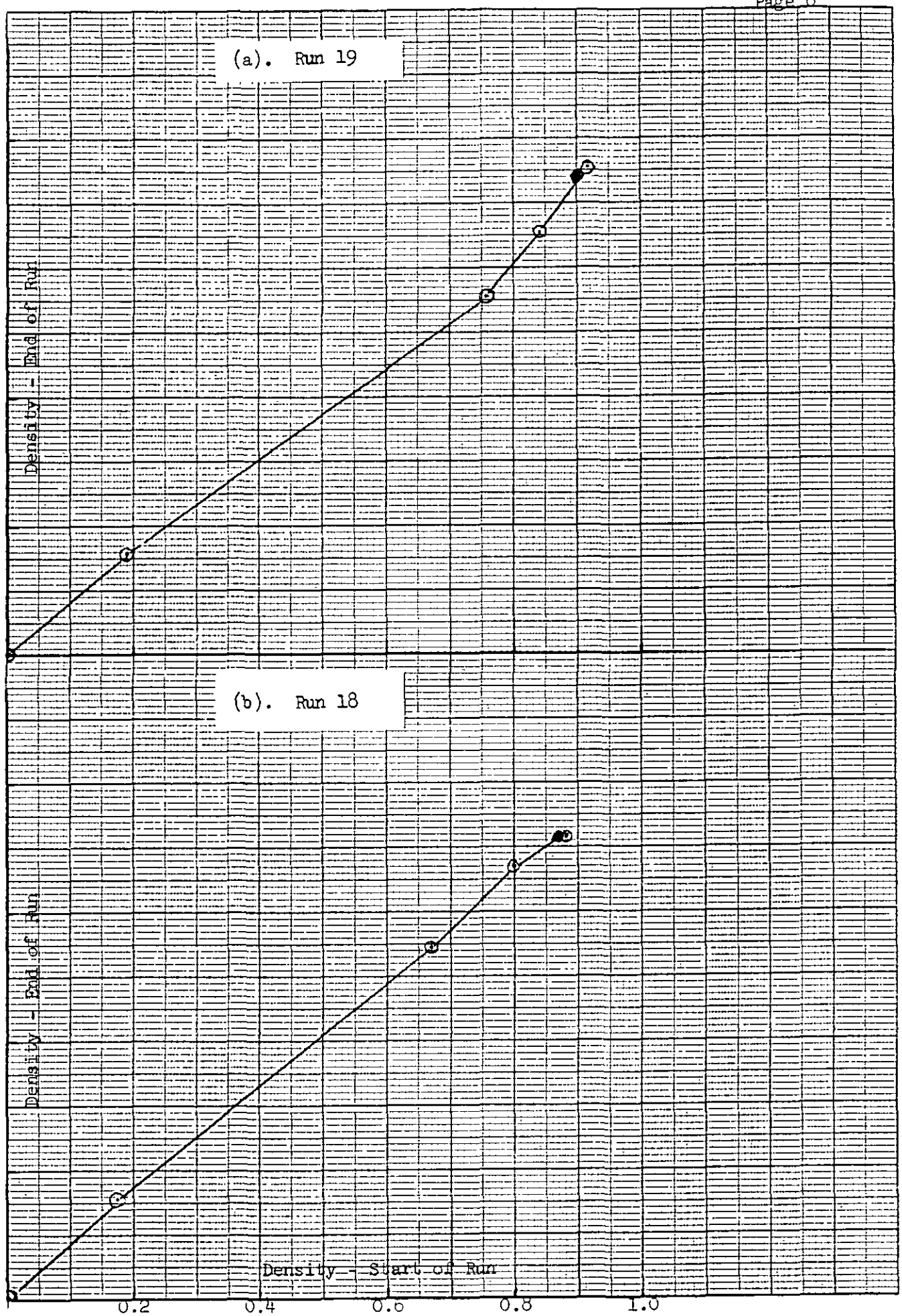


Figure 2. Tone Scale Change. High ink - high water

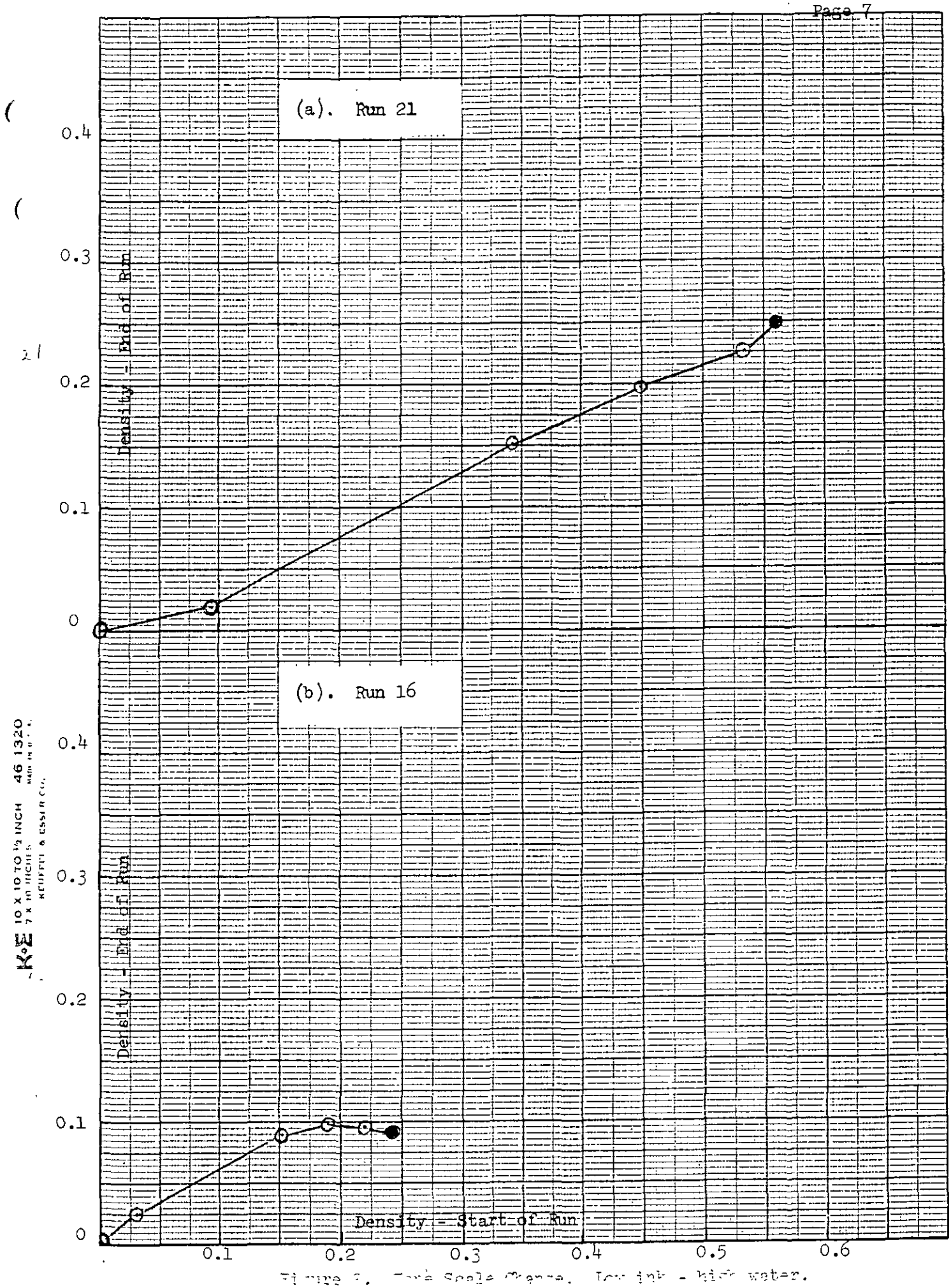
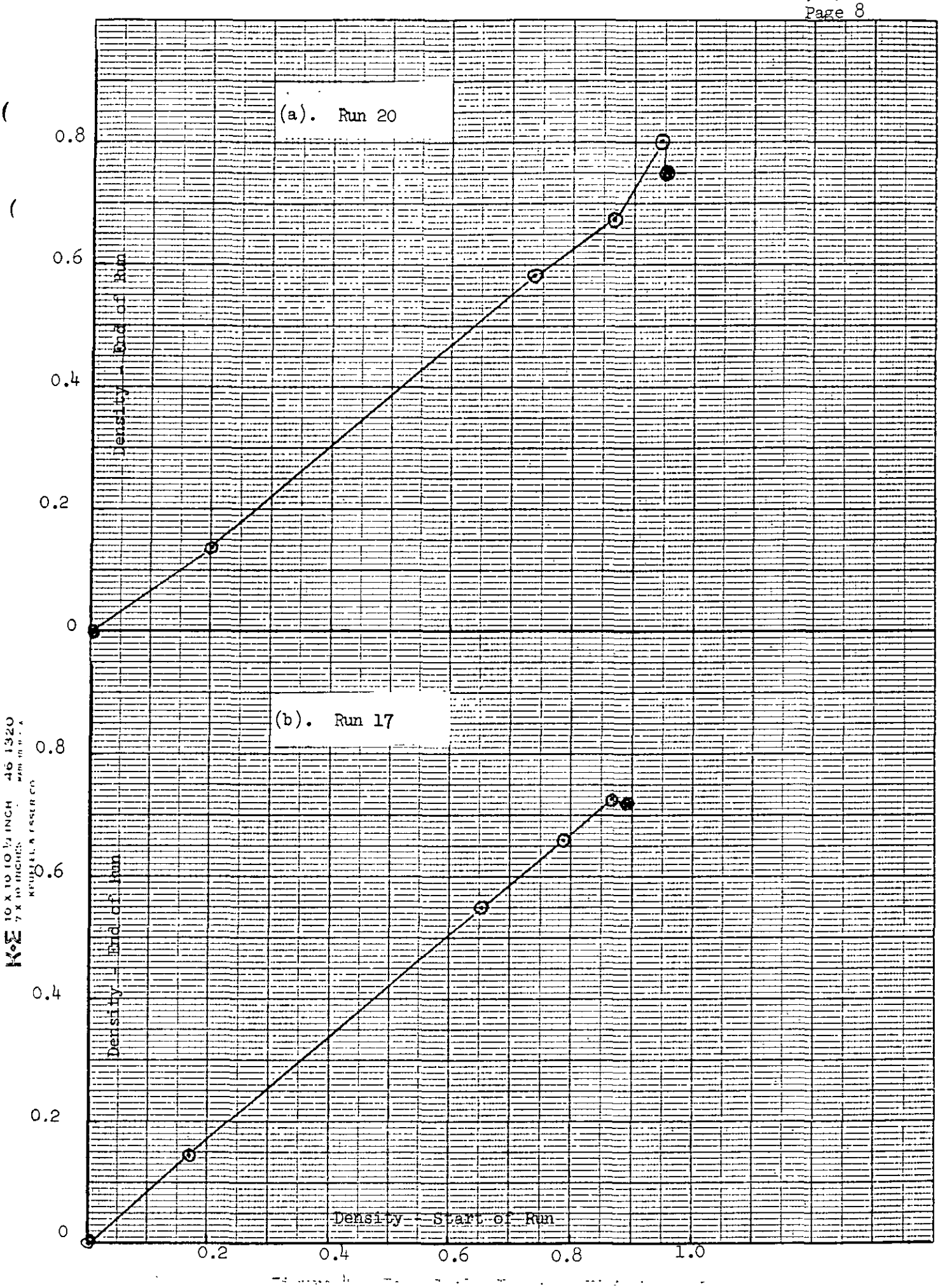


Figure 5. Tank Scale Models. Low ink - high water.


(a). Run 20
Density - End of Run
0
0.2
0.4
0.6
0.8
(b). Run 17
Density - End of Run
0
0.2
0.4
0.6
0.8
Density - Start of Run
0.2
0.4
0.6
0.8
1.0

variation $s'/\bar{R}$ of Karttunen. Therefore $\underline{s}$ should be a satisfactory measure of unevenness of printing provided $\bar{R}$ remains constant. In a press run, however, the ink level may change. Even though this may not change the way the available ink is distributed over the paper, it will affect the contrast between inked and uninked areas and therefore the ability of either the eye or an instrument to detect changes in ink distribution. A decrease in ink supply will therefore decrease both the range and standard deviation of R_S/R_L. For present purposes where the ink level may change somewhat during the run, it seems preferable to use the quantity $s\bar{R}$, where $\bar{R}$ is determined with an instrument of large aperture, as a measure of unevenness of ink transfer. Of course it is probable that ink level may have some direct effect upon distribution of ink on the sheet; therefore it is desirable to hold ink level as constant as possible.

A square aperture which isolated an eight-dot area of the 120-line print was installed in the differential densitometer. Differential densitometer traces were prepared from the prints taken at the start, center, and end of Runs 15, 17 and 18 of Project 2949. A green filter was used to provide maximum contrast for the magenta ink. A grid was laid over the trace and R_S/R_L values were read from the plot at 100 equally-spaced intervals. An existing computer program was used to calculate the standard deviation, range, skewness, 95% confidence limits of the mean and a 15-cell histogram. Certain of those statistics are recorded in Table II. In keeping with the above reasoning, the product of the average reflectance and the standard deviation shows a general tendency to increase during the run while the standard deviation alone appears to change erratically. In general, changes in range tend to parallel changes in standard deviation so the product of range and average reflectance could also be used. However, range would be much more sensitive to single large deviations in reflectance and therefore would be less reliable. There seems to be no pattern to the changes in skewness.

TABLE II

OPTICAL EVENNESS OF PRINTS [a]

		Average Reflectance	Standard Deviation	Range	Skewness	Ave. Reflectance x Standard Deviation
Run 15						
Solid	S[b]	0.554	0.0531	0.232	-0.165	0.0294
Solid	C	0.764	0.0608	0.327	0.214	0.0474
Solid	E	0.816	0.0497	0.277	-0.570	0.0405
90% Tone	S	0.577	0.0580	0.347	0.512	0.0334
90% Tone	C	0.808	0.0526	0.235	0.153	0.0425
90% Tone	E	0.787	0.0458	0.196	0.227	0.0362
70% Tone	S	0.607	0.0587	0.318	0.163	0.0356
70% Tone	C	0.779	0.0517	0.254	-0.397	0.0403
70% Tone	E	0.775	0.0631	0.332	0.775	0.0490
50% Tone	S	0.658	0.0633	0.400	0.279	0.0416
50% Tone	C	0.795	0.0494	0.274	-0.140	0.0392
50% Tone	E	0.817	0.049	0.250	0.136	0.0401
20% Tone	S	0.882	0.0453	0.240	-0.126	0.0396
20% Tone	C	0.926	0.047	0.240	-0.371	0.0436
20% Tone	E	0.932	0.0415	0.207	-0.318	0.0387
Run 18						
Solid	S	0.134	0.0693	0.321	-0.261	0.0093
Solid	C	0.174	0.0730	0.341	0.239	0.0127
Solid	E	0.192	0.0744	0.374	-0.157	0.0143
90% Tone	S	0.131	0.0664	0.349	0.197	0.0087
90% Tone	C	0.181	0.066	0.370	-0.189	0.0121
90% Tone	E	0.192	0.078	0.446	0.900	0.0150
70% Tone	S	0.159	0.072	0.352	-0.885	0.0114
70% Tone	C	0.221	0.067	0.338	0.174	0.0150
70% Tone	E	0.214	0.0642	0.324	0.424	0.0137
Run 17						
Solid	S	0.128	0.0846	0.392	0.3370	0.0108
Solid	C	0.191	0.0632	0.335	-0.027	0.0121
Solid	E	0.191	0.0713	0.331	0.002	0.0136
90% Tone	S	0.136	0.0772	0.435	0.218	0.0105
90% Tone	C	0.187	0.0822	0.453	0.593	0.0154
90% Tone	E	0.189	0.0627	0.301	0.184	0.0119
70% Tone	S	0.163	0.0833	0.466	0.064	0.0136
70% Tone	C	0.230	0.0674	0.294	0.584	0.0155
70% Tone	E	0.219	0.0899	0.454	0.421	0.0196

[a] Based on 100 evenly spaced values of R_S/R_L

[b] S = start of run; C = center of run; E = end of run (2500 impressions)

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2. Makkonen, T. and Nordman, L. Paperi Puu 50, no. 9:509-16 (Sept. 1968).

Nordman, L. and Makkonen, T. Studies of print-through by means of unevenness measurements. In Proceedings of the 10th Conference of International Association of Research Institutes for the Graphic Arts Industry, Vienna 1969. To be published, Pergamon Press.

PROJECT REPORT FORM

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FURTHER IMPROVEMENTS IN TECHNIQUES FOR THE ISOLATION AND CHARACTERIZATION OF LINT ACCUMULATED IN THE OFFSET PRESS

SUMMARY

Several of the procedures for the isolation of lint have been modified and several new techniques have been screened. This report summarizes the status of these procedures. Added or modified procedures include the following:

1. A standard printing design has been prepared which will be used in future studies.

2. Appropriate techniques have been devised to reproducibly retrieve lint from corresponding areas of the blankets based upon the above design.

3. Procedures for preparing contact prints of the lint bearing wax have been modified to utilize a series G Wratten filter and a green sensitive film to take advantage of the magenta ink's tendency to absorb green light and thereby produce greater contrast in the contact photos.

4. Ink removal from the isolated lint is now accomplished by a series of steps utilizing dilute nitric acid and sodium hydroxide. The procedure appears to essentially remove the ink without further chemical degradation of the fiber.

5. Attempts have been undertaken to recover and isolate the lint distributed in a substantial part of the ink train. Results indicate quantitative gravimetric analysis of this lint is feasible. However, quantitative values for the lint recovered have not been determined.

6. Control tests were undertaken to determine lint losses due to the isolation procedure.

7. Coarse fritted glass crucibles (pore size 40-60 microns) have been substituted for medium (pore size 10-15 microns) crucibles. Trials have shown lint recovery is comparable to that of the medium crucibles.

8. Procedures for cleaning used fritted glass crucibles are outlined.

9. Approved procedures for handling of flammable wastes (solvents, wax, and ink residuals) are outlined.

This report then serves merely as a subsequent status report concerning modification of procedures outlined in Report One and the additional screening of some further procedures.

EXPERIMENTAL PROCEDURES/DISCUSSION OF RESULTS

Standard Printing Design

A standard printing design was prepared consisting of half-tone tints of 20%, 50%, 70%, and 90% printing densities separated by solid lines. All tones were prepared from 120 line screen tints. Pattern is bordered by numbers on one side and letters on an adjacent side for graphic location of points of interest. A paper print of the design is attached showing the layout of the design. Areas represented by the respective tones are as follows:

Tone	Area, sq. in.
20%	11.595
50%	12.095
70%	12.095
90%	11.596
Solids	9.343
Numbers, letters*	0.194
Total	56.92

*Estimated area based upon the line weight of the letter and numbers.

It is hoped the design will serve to indicate relationships between lint aggregation and tone density and visual observation of defects in printing continuity due to linting. Layout of the design should serve to evaluate cross machine variations in printing and leading and trailing edge effects with both increasing and decreasing tone density as printing proceeds.

Standard Lint Recovery Area

Based upon the above design a standard lint recovery area was decided upon relative to the printing area. The area is 480 cm^2 (20 cm. x 24 cm.). Position of this recovery area is outlined on the attached print. To maintain this recovery area between blankets a standard waxing board was prepared as follows.

A suitable cork surface was taped to a particle board with masking tape. Lines were drawn on the cork surface outlining two adjacent sides of the print image and outlining the entire lint recovery area relative to these print image lines. For lint recovery the blanket is laid down upon the cork surface and squared relative to the print image area using an ordinary carpenters square. The blanket is taped to the surface with masking tape outlining the lint recovery area according to the lines on the cork base. Wax application and lint recovery then proceeds as outlined in Project Report One. Initial wax application proceeds from the unnumbered to the numbered side of the design since it is known some lint is dragged from the image area but is usually redeposited as soon as nonimage areas are encountered. The numbered side provides the greatest nonimage area as the recovery area is now outlined. Approximately 25 g. of wax is applied in the recovery area.

Preparation of Contact Prints of Linted Wax

The suggestion was made that contact photos of the wax-bearing lint would be enhanced in contrast if a green filter was utilized in preparation of the negatives along with a green sensitive photo emulsion since the magenta ink tends to absorb all green light while reflecting blue and red. Several trials were made utilizing a Wratten filter G with 3M Line

Ortho PL 5 film. Results indicated contrast was improved. A standard photographic method was chosen utilizing the contact printer in the IPC photography department. Standard exposure and development is as follows:

Variac setting	85%
Exposure time	0.4 sec.
Development	30 sec.

In addition, it was learned that wax-bearing lint may be contact photographed within one hour after preparation without undue tackiness of the ink or loss of lint interfering with the photographic procedures or subsequent isolation results. Of course, white bees wax (rather than yellow) has become standard for the isolation procedure since it is more suitable for the photographic procedures.

Modified Methods for Ink Removal from Isolated Lint

One of the remaining objections to the lint isolation technique was the use of Senefix to decolorize and remove the ink pigment. Senefix is a proprietary acid of unknown composition which appears to chemically degrade the fiber during ink removal. Since the pigment is known to be a lead lake of eosin, chemicals of known composition were sought which might produce soluble salts of the pigment components. On this basis trials were made utilizing dilute nitric acid anddilute sodium hydroxide. Findings indicate the pigment is destroyed presumably due to the formation of lead nitrate and the sodium salt of eosin both of which are water soluble. The following is an outline of the wax and ink solubilization procedure.

1. Fold the wax onto itself and place in a 600 ml. beaker.
2. Add 250 cc. benzene and steep in a hot water bath for 10 min.
3. Filter through a clean preweighed fritted glass crucible and wash with 200 cc. warm benzene.

4. Wash with 60 cc. alcohol followed by 60 cc. of water.

5. Treat material on crucible with 30 cc. 1% nitric acid, allow to stand 1 min. and filter. Wash with 30 cc. of water and filter. Treat with 30 cc. 1% sodium hydroxide and allow to stand 1 min.; filter. Wash with 30 cc. of water and filter. Repeat the procedure once and finally wash with 60 cc. of water. Gentle stirring may assist pigment removal if the amount of lint is large.

Subsequent oven drying of the lint and cursory microscopic examination of both press lint and fiber prepared by independent means and treated as above indicated little or no chemical degradation had occurred. Pigment color is essentially removed although a faint orange cast can sometimes be observed around the edges of the crucible. Color of deinked fiber after oven drying is that of normal groundwood. Three linted blankets were prepared under similar press conditions and the lint isolated and deinked under conditions similar to those outlined above. Results offered good precision between runs as below.

Run Number	Lint recovered, grams
1	0.1214
2	0.1235
3	0.1229
Average	0.1226 g.
average deviation, %	0.65

Recovery of Lint from Ink Train

An ink train cleaning tray is provided as an attachment to the Apollo press. During cleaning of the press train utilizing this attachment it was observed most of the lint, ink, etc. accumulated in this tray. Thus, it was decided to attempt to isolate this lint from the ink and other materials for gravimetric analysis and microscopic examination. Lithocraft Blanket Cleaner 200 (product of Lithocraft Products) is used to clean the

ink train. The cleaning method recovers foreign material from all parts of the ink train except the ink fountain, fountain roll, and ductor and the printing plate. The method of gravimetric isolation follows the procedure outlined for isolation of lint from the wax as discussed previously in this report beginning with step two, viz., 250 cc. of benzene is added to the material recovered from the ink train and steeped for 10 min. It was found the material could not be effectively filtered through medium pore size fritted glass crucibles apparently due to plugging of the fritted glass with substantial amounts of ink pigment. Attempts to solubilize and remove the ink pigment with nitric acid and sodium hydroxide intermittently during filtration did alleviate the problem to a slight degree, but insufficiently to warrant pursuing the technique. Therefore, coarse fritted glass crucibles were tried. It was found filtration would proceed at a reasonable rate and recovery of lint from the ink train for gravimetric was then feasible. The amount of lint recovered is not presently known nor can the completeness of lint recovery from the press be determined.

Independent Experiments to Determine Accuracy of Isolation Procedure

Since independent experiments for the determination of lint losses due to the isolation procedure covered in Report One were not entirely satisfactory and since recovery of lint from the ink train requires the use of coarse crucibles, it was decided to attempt further experiments to develop lint loss values. "Lint" was prepared by emerying the surface of Bowater's regular newsprint with 150 grit emery paper. Microscopic determinations indicated the fibrous materials produced should simulate material expected to be removed from the sheet during offset printing. Therefore six, approximately 3 g. samples of the material was oven dried

at 105°C. for two hours, weighed and subjected to the isolation treatment previously outlined. Three samples each were filtered through medium and coarse crucibles. The results are shown below.

FIBER LOSS ON ISOLATION

Weight o.d. Sample, g.	Weight o.d. Sample After Isolation	Crucible Size Used	Loss of Fiber, %
0.2804	0.2514	Medium	10.34
0.2852	0.2549	"	10.62
0.2935	0.2593	"	11.65
0.2817	0.2483	Coarse	11.85
0.2997	0.2720	"	9.24
0.2754	0.2486	"	9.73

	Average % loss	Average deviation, %
medium crucibles	10.87	4.8
coarse crucibles	10.27	10.3

Although the fiber loss due to isolation appears significant it is thought same is due to residual emery dust accumulated in the sample during preparation and not completely recovered during the isolation step. This would not only affect apparent fiber loss but precision of replicated results as well. Thus, again the method leaves the results in some doubt. The limited differences between results obtained with coarse versus medium crucibles seems insignificant, however. Therefore, a change to coarse crucibles for lint isolation will be made so lint may be recovered from the ink train and the blanket on a comparable basis.

Procedures for Cleaning Fritted Glass Crucibles

Fritted glass crucibles are cleaned utilizing conc. sulfuric acid and potassium dichromate. Crucibles are placed in small beakers. Each

crucible is filled with conc. sulfuric acid and a few crystals of potassium dichromate are added. A small amount of water is added to the beaker to the upper level of the fritted glass section of the crucible. The unit is allowed to stand in the hood overnight or until a green color is developed in the cleaning solution. The solution is discarded and the crucibles washed with water. If residual material remains the procedure is repeated. Acid cleaned crucibles are washed with water and alcohol and finally steeped a short time in benzene to remove any small amounts of wax or other organic residuals. Crucibles are again washed in alcohol and water and finally oven dried for two hours at 105°C., cooled and weighed. Weight losses to the order of 1 mg. are observed after each use apparently due to loss of fritted glass material. Thus, even though the loss is negligible it appears desirable to reweigh the crucibles after every cleaning to avoid the accumulation of significant errors with continued reuse.

Disposal of Flammable Waste

One of the problems encountered in the lint isolation technique is the proper disposal of the waste flammables generated in the removal of the lint from the blanket and separation of the wax carrier. Under existing applicable ordinances the material could not be placed in the solvent disposal pit since it solidified on cooling or burned outside in such a manner as to produce obnoxious smoke, etc. The total volume of flammables involved in the processing of one blanket is about 750 cc. This consists of a mixture of benzene, alcohol, wax, and flammable ink residues. After review with members of the Operations Committee of the Institute it was agreed that the following method would be satisfactory and satisfy existing ordinances:

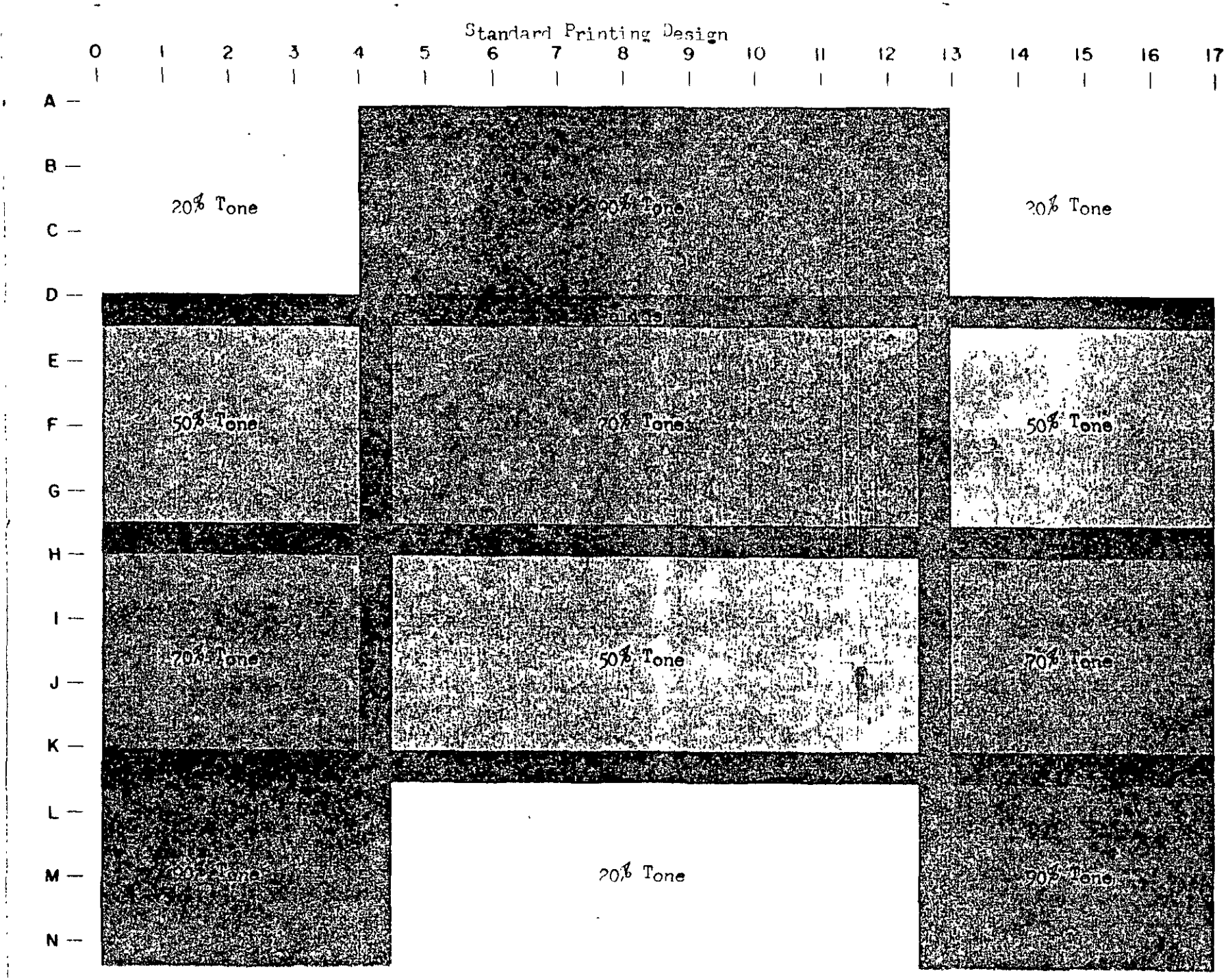
1. A suitable hood was constructed and connected to the Annex exhaust system. The exhaust rate is between 1000 and 2000 CFM.

2. A steam bath was installed in the hood in such a way that excess steam is allowed to escape along with the evaporated vapors.

3. The flammable materials are collected in a stainless steel container; placed in the steam bath and heated until all vapors that would be generated below the boiling point of water are released. This is done daily.

4. The molten wax is then transferred to a metal can, cooled to room temperature and disposed in the regular trash barrel.

Checks made on the vapor exhausted through the exhaust system were shown not to support combustion because of the excess steam present. Further checks of the solidified residue (after cooling) indicated the absence of flammable vapors. The proper handling and disposal of flammable liquids will have to be a matter to be considered in carrying out this method for lint isolation.


Standard Printing Design
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Wax Recovery Area

PROJECT REPORT FORM

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COOPERATOR The Institute of Paper Chemistry
REPORT NO. 1
DATE July 24, 1970
NOTE BOOK 2745
PAGE 1 TO 28
SIGNED Betty M. John
Betty M. John

Copies to: Central Records
R. M. Leekley
Betty John
Editorial

PRELIMINARY EVALUATION OF METHODS FOR ISOLATION AND/OR CHARACTERIZATION OF LINT ACCUMULATED ON THE OFFSET PRESS BLANKET DURING PRESS OPERATION

SUMMARY

The initial goal of this program was to develop skill in press operation and to screen techniques and tests which would permit isolation and/or characterization of the lint debris which accumulated on the offset blanket. This report covers a screening of a number of techniques, with particular emphasis upon a method reported by Hughes (Tappi Vol. 49, No. 10:46-8A) as practiced by Kimberly-Clark Corporation (memo to Files dated April 27, 1970). When problems were encountered in testing procedure, action was taken to modify procedures accordingly. New suggestions for screening examinations or photographic recording of results were incorporated and modified at will. Thus this report serves to summarize the status of these procedures along with conclusions drawn as a result of the screening. No attempt is made to correlate results with press operation since continuous modification of procedures would not yield valid results.

It was found that Hughes' method of lint isolation as presently practiced by Kimberly-Clark is unsuitable for lint characterization. Severe chemical burn occurs to the fiber and potential loss of weight occurs as well; the latter was not determined independently since modification of the technique already seemed desirable. The method has been modified to some degree with the result that quantitative gravimetric determinations of the lint should not be significantly in error as determined by an independent experiment; however, degradation of the fiber structural form continues to occur to some degree.

Lint collected during these screening techniques was observed under a variety of conditions, including microscopic as well as cursory examination of the lint-containing blanket, the lint-containing wax after removal from the blanket, and after isolation from the wax. Photomacro- and -micrographs and contact prints of some of these observations are appended to the original of this report. Slides of some observations were also taken but do not contribute significantly to the evaluation of the samples; these will be retained temporarily. Photomicrographs and photomacrographs of pertinent samples and contact prints of the lint bearing wax prove to be most helpful in visually recording results obtained when pertinent.

From the observations made during these screening examinations, it is theorized that "shives: or "coarse fiber aggregates" rather than "fines" are the principal constituents causing lint on the blanket even though "fines" are observed upon isolation of the lint material. Assumptions are based upon the following:

1. The isolation treatment is proven to degrade the fiber form.

2. There is evidence of shives on the lint-containing blanket and the lint-bearing wax which do not appear in the isolated lint. However, simple observation of the blanket does not indicate shives to be exclusively present. Further, since lint appears to travel to the trailing edge of a given print tone area, shives can not be typically separated from aggregations of single fibers.

3. The fines which are recovered by the isolation techniques do not resemble the "fines" normally found in groundwood--either as pulp or in the analysis of groundwood-containing sheets.

4. In addition to "chemical" degradation of fiber form exhibited by the lint, there is evidence of a grinding or milling action which presumably has assisted in the reduction of fiber form and size after initial removal from the paper during printing. It is theorized that said action could result from combined paper, blanket, and plate action on the lint after removal from the sheet.

While the case for "shives" as the principal constituent of the lint initially removed from the newsprint is largely circumstantial to date, there is

reasonable evidence that the fibrous materials removed must be coarser than those observed upon isolation.

It has been observed thus far that essentially 100% of the lint isolated is groundwood. The fibrous material appears rich in ray cells and particularly ray cell aggregates, some of which still appear to adhere to small pieces of longitudinal tracheids. This type of "fine" again is not "normal" to groundwood pulp or paper, at least in the form exhibited, but likely could be easily generated from ray-containing shives by a milling action. Thus the observation provides further circumstantial evidence for a "shive" theory.

EXPERIMENTAL PROCEDURES

Lint-containing blankets were prepared on the Apollo Web-Offset Duplicator utilizing IPI offset Web Newsink 66NK4780 as supplied by Inmont (Neenah). The ink is reported to be a lead lake of eosin with linseed varnish and mineral oil vehicles. A range of press conditions--speed, water settings, etc.--were used. In all trials the number of impressions was held to 2,500 prior to blanket removal for lint isolation. Printing plate designs included the Appleton Coated Woodbine test design and the Newsletter for the 1970 Executives Conference. Blankets were all Mercury blankets, 2-ply, hard. A newsprint stock of unknown origin was used as the printing stock. These blankets served only to develop ideas and competence for characterization and isolation of lint and to evaluate same as potential qualitative and/or quantitative tests. Hence, due to continuous modification of techniques, no attempt is made to correlate observations with variations in press operation.

Details of Kimberly-Clark's application of Hughes' method for isolation of lint are outlined in my memo to Files dated April 27, 1970 and therefore not repeated here, but that technique formed the basis of our initial trials. Evaluation of the method proceeded in several areas simultaneously as follows:

1. Proper wax application to the blanket;
2. Proper wax and ink solubilization;
3. Observation and/or gravimetric determination of lint recovered.

In the interest of clarity, discussion of the procedures will be undertaken in the several headings listed above.

PROPER WAX APPLICATION

A quantity of both white and yellow beeswax was obtained for trial. The following is found to be the idealized wax application to date:

1. Melt the wax and hold at 90-100°C. on a steam bath for application.
2. Tape the blanket to a flat cork surface with masking tape, outlining the area of lint to be recovered with tape.
3. Apply the wax with a 3-inch paint brush to the blanket uniformly. Coat the blanket with four layers of wax. One coating layer is applied beginning from each side of the blanket.
4. Allow the blanket coated with wax to cool for 5 minutes at room temperature. Wax will appear to proceed from a milky translucent state to a more uniform, less translucent state.
5. Peel blanket from the wax carefully by holding the unit in a vertical position and rolling the blanket back and away from the wax, utilizing the masking tape edging as support for the wax.
6. Place the wax on a clean surface with the lint side up. Bend at masking tape-wax junction to remove tape and excess wax from the sample, leaving the wax area to be studied intact and essentially without distortion.

Precautions

1. The paint brush should be soft and pliable at time of application to avoid disturbing or redistributing the lint. A light touch, particularly on the initial coating, is most desirable to avoid lint redistribution in so far as possible.
2. Wax on blanket should not be supercooled or superheated after application. Forced cooling will result in failure of the wax to pick up all the lint. Forced heating will cause the wax to infiltrate the pores of the blanket, making the wax difficult to impossible to remove; lint redistribution will also occur. Supercooling and heating were attempted, with the results indicated. Cork backing serves to temper the cooling process appropriately.

3. Peeling operation should be as prescribed exercising extreme care to avoid any possible distortion of the wax-bearing lint. Blanket should be just warm to the touch. Changes in wax translucency, however, are the best indication of ideal cooling time.

4. Immediate cleansing of the blanket after removal from the press is desirable since drying of the ink, after a period of time, will cause wax pick and potential incomplete removal of the lint from the blanket.

Remarks

1. Observations of cleaned blankets, both visually and microscopically, indicate that lint is essentially completely removed in the print areas. Some nonink-bearing lint, in particular slitter dust, may not be completely removed if the area of lint is especially heavy. Apparently the ink is compatible with the wax and actually assists in lint removal.

2. If subsequent isolation of the lint from the wax and ink can be upgraded sufficiently, it is the writer's opinion that this method of lint removal from the blanket meets the needs of the program.

3. However, if even limited redistribution of the lint is undesirable because direct visual correlation of lint on the wax with a printed sheet is intended or nonuniform coating of the wax interferes with the proper preparation of contact prints of the wax-bearing lint, metered thickness coatings of the molten wax may be attempted.

4. Thickness of the wax applied varies from 0.02 to 0.03 inch. Average weight of wax applied is 35 grams for a 9x11-inch area.

5. Both white and yellow wax are equally acceptable for application purposes; however, white wax appears more suitable for preparation of contact prints of the lint-bearing wax as will be discussed later.

PROPER WAX AND INK SOLUBILIZATION

Kimberly-Clark utilizes a combination of turpentine and Senefix (product of Sefelder Co.) to solubilize the wax and ink. The wax-bearing lint is steeped (approximately 90°C. on a steam bath) in the above for about two hours. Difficulties in filtration and damage to the fiber upon microscopic examination were found to occur; therefore a more suitable method was sought. Although results are not entirely satisfactory, the following method is the best devised to date:

1. Fold the wax unto itself and place in a 600 ml. beaker.

2. Add 250 cc. benzene (room temperature).

3. Steep 10 minutes in a hot water bath (approximately 180°F.). Final benzene temperature will approximate 70°C. Wax will be essentially solubilized within 5 minutes. Lint will appear as red floc.

4. Filter under vacuum through a preweighed fritted glass crucible, medium grade (reported pore size 10-15 microns); wash with warm benzene.

5. Treat lint in crucible with several applications of Senefix until color is removed or reduced to a pale tint. Approximately three applications are usually necessary.

6. Wash with ethanol and finally with water.

7. Dry to constant weight and determine amount of lint recovered.

Precautions:

1. Occasionally wax will precipitate out below the fritted glass due to vaporizing benzene from the wax; same can be controlled by reducing vacuum accordingly. If accumulations do occur, they can be removed by washing after filtration with benzene.

2. Ink removal is facilitated if isolation proceeds as soon after lint is accumulated on blanket as possible. Benzene is an excellent solvent and/or dispersant for the ink as received but does not appear to remove same from lint floc to any appreciable degree, particularly after drying.

Remarks:

1. Turpentine proved to be a poor solvent for the wax when it was observed that the wax would precipitate on even slight cooling and during filtration, which caused clogging of the filter. Therefore other solvents were tried. Comments are based upon the solubilization of 1 g. of wax in 50 cc. of solvent and tabulated below:

Solvent	Wax Solubility	
	Cold	Hot
Benzene	Estimate 80% dissolved	complete; will remain in solution upon cooling
Dichloromethane	Estimate 50% dissolved	complete; limited to moderate precipitation on cooling
Heptane	Similar to dichloromethane in all respects.	

Remarks (Continued)

Solvent	Wax Solubility	
	Cold	Hot
Ethanol	very limited	essentially complete; precipitates on cooling.
Turpentine	essentially nil	fair but incomplete
Dowanol DM (a glycol)	Essentially nil	limited
Ansul ether (a glycol)	essentially nil	limited
Senefix	essentially nil	essentially nil.

Based upon the above, benzene was chosen as the solvent for the wax since it was not expected to do further damage to the fiber.

2. Since Senefix is a proprietary acid of unknown composition, a substitute for it was also sought. Its composition is anticipated to be a strong acid in an alcohol, however. pH = 0.9. Its function is to decolorize and solubilize the ink pigment. Incidentally, benezene proves to be an excellent solvent and/or dispersant for the ink as received. However, it will not remove the pigment from the lint floc probably due to adsorption of the ink pigment on the floc. The ink pigment is reported to be a lead lake of eosin. Glacial acetic acid was found to essentially decolorize the pigment in the same manner as the Senefix; however, damage to the fiber continued to occur under the highly acidic conditions. After destruction of the ink, attempts were made to neutralize the acid with pyridine and ammonium hydroxide but fiber damage continued to occur. It would be desirable, however, to continue to search for a substitute for Senefix such that the components are of known composition and reagent quality and do not degrade the lint in any manner.

3. Recently it has been suggested that saturated aqueous solutions of sodium acetate may solubilize the pigment under essentially neutral conditions. Other suggestions include utilization of high molecular weight organic acids, e. g., lactic acid, dilute solutions of a strong acid, i.e. hydrochloric acid or complexing agents such as EDTA. None of the above have been attempted to date.

4. It is likely that drying (105°C. for approximately 2 hours) the isolated lint for gravimetric determination assists in fiber structural degradation under even mild residual acid or basic conditions; however, limited degradation has been shown to exist even before drying. Dessicant drying might be attempted to alleviate some of the problem.

Remarks (Continued):

5. Utilization of fritted glass crucibles is not entirely satisfactory since substantial cleaning is required for reuse, lint can not be completely recovered for subsequent examination and action of the fritted glass under vacuum could further serve to mechanically degrade fiber structure. Crucibles of two pore sizes were evaluated--fine (pore size 4-5.5 microns) and medium (pore size 10-15 microns). Filtration was not possible with the fine grade; however, part of the difficulty probably was related to the utilization of turpentine solvent at the time. Filters of medium pore size offer no difficulty and may be expected to recover all of the fiber since normal tracheid and ray thicknesses are in the range of 40-60 microns, well above the pore size of the filter. Thickness of the filter bed would further insure entrapment of the finest lint material.

6. MF millipore filters (mixed esters of cellulose; pore size = 5 microns) were tried as substitute filtration membranes with some degree of success. Initially the filtration was attempted by placing the millipore filter over the fritted glass filter. Under vacuum, however, the filter was drawn into the fritted glass surface and could not be subsequently removed. Some degree of success was attained in subsequent trials utilizing a perforated plate Buchner funnel as the filter holder. It was shown that the lint could be easily removed from the filter except in areas immediately above the perforations which caused indentation of the millipore filter under vacuum. If this technique is pursued further, it is suggested that a suitable filter holder should be procured, along with suitable Mitex (Teflon) filters which will withstand a greater range of solvents and elevated temperature drying for gravimetric analysis without degradation or weight loss.

7. In an independent experiment, paper from a recent issue of the Appleton Post Crescent was disintegrated in distilled water (utilizing a Brookfield mixer), reformed into a fibrous mat in a Buchner funnel, torn into small pieces, dried to constant weight, and subjected to the isolation treatment outlined previously. It was found that no weight loss occurred; in fact, an insignificant (less than 1%) weight gain was noted. On this basis, it is expected that gravimetric determinations of lint will be accurate. However, some fiber structural degradation did occur as noted microscopically and by cursory examination of the fibers after drying. By this technique, however, the fine fibrous floc similar to the lint product was not duplicated. Hence it is suggested that other methods of fiber preparation be used for further control testing. One possibility may be use of the Wiley mill to disintegrate a news sheet.

8. In brief, the modified isolation method appears to be suitable for gravimetric determinations of lint recovered from the blanket. However, since fiber structure continues to be degraded by this method, it is not a means of definitive determination of the structure of the fibrous material removed from the blanket.

9. Gravimetric determinations to date exhibited lint recoveries from

0.060 g. to 0.113 g., the latter determined after isolation by the modified method described earlier. Incidentally, an attempt was made to recover lint from the ink train on cleaning up. Preliminary results indicate relatively sizeable quantities of lint are recovered and, although groundwood is the principal constituent, fiber length appears slightly greater than shown on the blanket. It is suggested this testing be pursued and perfected as an adjunct to blanket lint examination.

MICROSCOPIC OBSERVATIONS AND PHOTOGRAPHIC TECHNIQUES

Initially the lint recovered after isolation by the K-C method was viewed microscopically. It was found that the material was very fine in character. A few measurements indicated the bulk of the material was less than 0.1 mm. long, probably in the range of 50 microns; little, if any, of the fiber approached 1 mm. or more in length. Photomicrographs I and II show the lint under varied degrees of magnification; however in the writer's opinion, these "fines" did not exhibit the normal structural configuration of fines found in groundwood pulp and/or paper.

Therefore the newsprint stock used on the press was analyzed independently before and after treatment by K-C's technique. Photomacrographs III and IV (approximately 8X) show these results. No. III is a slide of the stock before the isolation treatment; No. IV exhibits the stock after treatment.

Based upon these results, efforts were directed toward modifying the isolation procedures to eliminate further lint degradation after removal from the blanket. The modified technique described earlier has reduced the problem to some degree, but no method has been found which will eliminate further fiber degradation.

Photomicrographs V and VI show results obtained on the Post Crescent stock after treatment by the modified technique. Exhibits VII and VIII show the stock before treatment. Exhibits V and VII are at correspondingly identical magnifications as are VI and VIII. Figure VIII shows the fine hair-like fines in the background

as may be considered normal for groundwood fines in a paper. In addition, a portion of a large shive may be observed in the picture. The shive consists of at least two longitudinal tracheids with at least eight ray cells attached. Subsequent lint photomicrographs IX, X, and XI will show examples of fibrous remnants which may be shives degraded in structure.

Photomicrographs IX, X, and XI are of lint isolated by the modified treatment described previously. Some reduction of fiber damage is anticipated when No. IX is compared with No. I (lint isolated by the K-C method). Prints are at comparable magnifications. No. II (K-C method) and Nos. X and XI may also be correspondingly compared. Two good examples of fibrous remnants anticipated to have been shives originally are depicted in Exhibit XI. The first, in the center of the picture, is a remnant of one or two longitudinal tracheids with five or more ray cells attached. Ragged edges of the longitudinal tracheids are unusual, having the appearance of bring ground or milled from a larger fibrous unit. It is conceivable that a unit shive, such as shown in No. VIII, could take on this appearance with structural degradation either by press action or during the isolation procedure; however, press action seems more likely. Secondly, two attached longitudinal tracheid remnants may be observed in the first quadrant of the picture which also suggest a shive subsequently degraded by mechanical action. The above are intended to assist the reader in visualizing the results exhibited microscopically; however, many more photos would be necessary to exhibit all the features found and even these will not be equal substitutes for the careful evaluation of a number of slides. Based upon these observations, however, the "shive" theory of lint has been formulated. This theory is in direct opposition to the "fines" theory generally alluded to in the literature and by personal communications. Only one published article (CHemicals 26, May, 1970) found to date specifically suggests that shives are directly related to offset linting and dusting.

A number of photomacrographs (approximately 8X) of the linted blankets, cleaned blankets, linted wax and paper prints were also taken with low angle lighting. Numbers XII, XIII and XIV are pictures of the linted blanket, the linted wax, and a paper print retrieved near the end of the press run from which the blanket was taken, respectively. Lint buildup on the blanket (No. XII) can be observed at the outer edge of the print area as well as general overall linting. A sizeable number of potential shives may be noted as well as finer fibrous units. Number XIII indicates that these potential shives have been embedded in the wax preparatory to isolation. The isolated lint, however, has not shown fibrous units of comparable size. While it has been shown that isolation will degrade the fiber, the potential has also been established that press action could have mechanically degraded the fiber structure without necessarily displacing or separating all the remnants from each other. In any event, there is evidence that at least a number of shives are involved in the lint.

Number XV is another photo of a linted blanket. Buildup is greater than in previous example and is shown to be just outside of the trailing edge of the print area.

Number XVI shows a wax cleaned blanket; little or no lint remains and pores of the blanket can be readily observed. It is known, however, that heavy aggregations of slitter dust will not be completely removed by the wax. Inked lint seems to be more readily embedded in the wax, and printed areas observed to date exhibit little or no residual lint after the wax treatment. Dark areas in the print show remains of ink in the areas originally showing sizeable lint buildup.

At present no theories are offered to explain the press actions which cause the lint to travel and aggregate along trailing edges of a given print tone area or its ultimate effect on print quality.

The above examples serve to establish that carefully prepared photomicro-

and -macrographs can be invaluable aids to a program of this nature and may be utilized as prima-facie evidence in the generation of further records for theories which may be developed. No attempt has been made to idealize photographic conditions for the recording of this data and it is expected that photos taken under more ideal circumstances will yield far more details than shown in these exhibits.

Several contact prints of the linted wax were also prepared. Numbers XVII and XVIII are contact prints of lint embedded in white wax at different exposures. General and detail linting character may be rather effectively noted and similar prints should find effective use in direct comparisons with the printed paper stock; however, careful control of both wax application and photographic techniques will be desirable. Some light scattering due to the wax is known to occur in the photographs. It is hoped that reflex copying techniques will alleviate this problem and provide greater detail in the negative, particularly regarding the finest lint particles. Kodagraph films are being procured to evaluate this possibility. Photographic exposure, of course, must be carefully controlled to capture the finest lint details. Critical observations of the linted wax and two negatives show no real or significant loss of lint during the photocopying step; therefore, it is not expected this procedure will invalidate subsequent gravimetric determinations. No attempt has been made to compare the photos with the printed stock to date but it is known that some distortion in the wax can occur upon separation from the blanket and some lint redistribution does occur upon waxing the blanket, so that point-to-point comparisons will not always be entirely accurate. General lint distribution, however, is essentially as it appeared on the blanket at the time of press removal.

The suggestion has been recently made that green exposure filters with green sensitive photographic films could improve the contrast of the prints since the magenta ink readily absorbs green light. Same would likely rule out Kodagraph

films which are sensitive to and utilized with yellow and orange filters. However, reflex copying has been achieved with Velox and Azo papers which should be more sensitive in the green region; they may also be tried. White wax has been found to lend itself to the photographic procedures more readily than the yellow because it had better light transmission properties as well as less tackiness under pressure. Assuming green sensitive filters and negatives are eventually utilized, a further preference for white rather than yellow wax will be established. Print XIX is of linted yellow wax; some sticking to the photograph was noted under pressure but lint did not appear to be lost from the wax.

The wax-bearing lint was held several days before the prints were made. It is not known if a problem would be encountered in taking contact prints of the freshly prepared lint-bearing wax while the ink remains tacky. Since it is known that a freshly prepared wax-lint combination lends itself more readily to lint isolation, same will have to be evaluated.

SUGGESTIONS FOR FUTURE WORK

Suggestions and possibilities for further improvement of the techniques have been included throughout this report. This section serves merely to list and summarize these suggestions.

1. Develop a more uniform method for applying the wax to the blanket which will essentially eliminate any potential lint redistribution as well. Suggested possibilities include metered thickness hot-melt applications which will likely require the construction and/or procurement of suitable equipment. Procedure is not deemed necessary unless point-to-point comparisons of the lint distribution with final printed sheets are required or nonuniform wax distribution interferes with subsequent photographic techniques.

2. Continue the search for ink decolorizing and destroying agents to replace Senefix and/or glacial acetic acid. Substitutes should be reagent grade chemicals of known composition and should exhibit little or no chemical or physical effect upon the lint fiber.

3. Evaluate the potential substitution of Millipore filters for isolation of the lint with the hope of:

   a. reducing fiber damage due to fritted glass action;

   b. providing better filter surfaces from which to recover completely the lint for microscopic examination; and

   c. eliminating the time consumed in cleaning crucibles for reuse.

   Procurement of suitable filters and a filter holder is necessary.

4. Develop a more suitable method for sheet disintegration by which fibers may be obtained for running controls for comparison with isolated lint.

5. Evaluate modifications suggested for preparation of contact prints of the wax-bearing lint, viz. utilization of green filters and green sensitive photo emulsions to increase contrast, and determine the potential of reflex copying.

There were other potential tests initially considered to be a part of this program, such as fiber length and coarseness determinations, which were not pursued since doubts had already arisen relative to potential degradation and modification of the fiber during the course of lint isolation and potentially as a result of press action which would make the data useless in predicting fiber form and character as it existed upon initial removal from the sheet. Should these problems be corrected, such determinations may well have real meaning.

Additionally a variety of theories and hypotheses concerning fiber properties, sheet formation and press operation which bear upon linting tendency in general beyond those already expressed have occurred to the author as a result of the work on this program. Upon reflection, however, it would seem that these would be better presented in a separate report or series of memoranda as future goals to be examined together with potential research techniques, where possible, to carry out the programs.

Attachments to File copy only: Nineteen exhibits.

FIGURE I

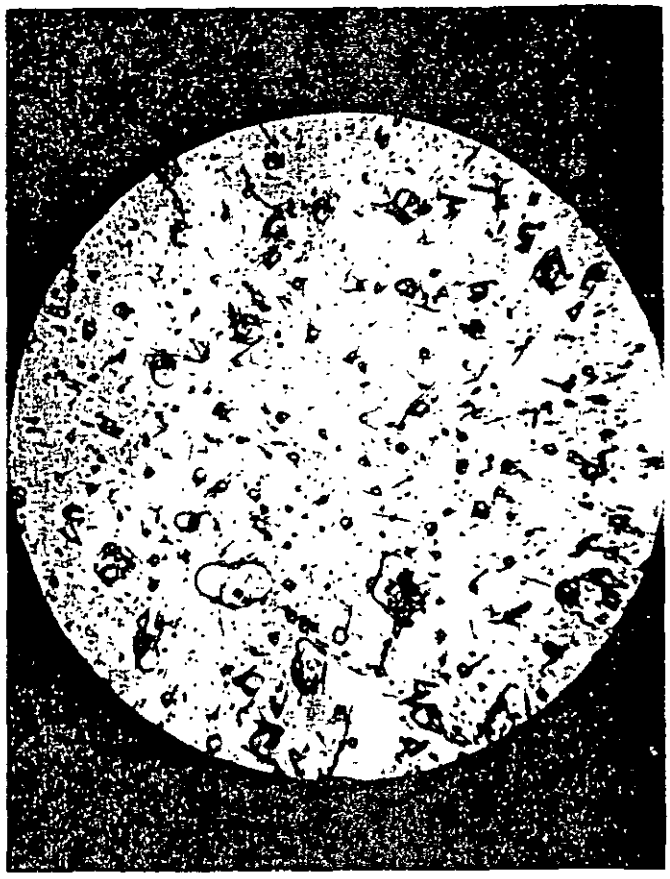


FIGURE II

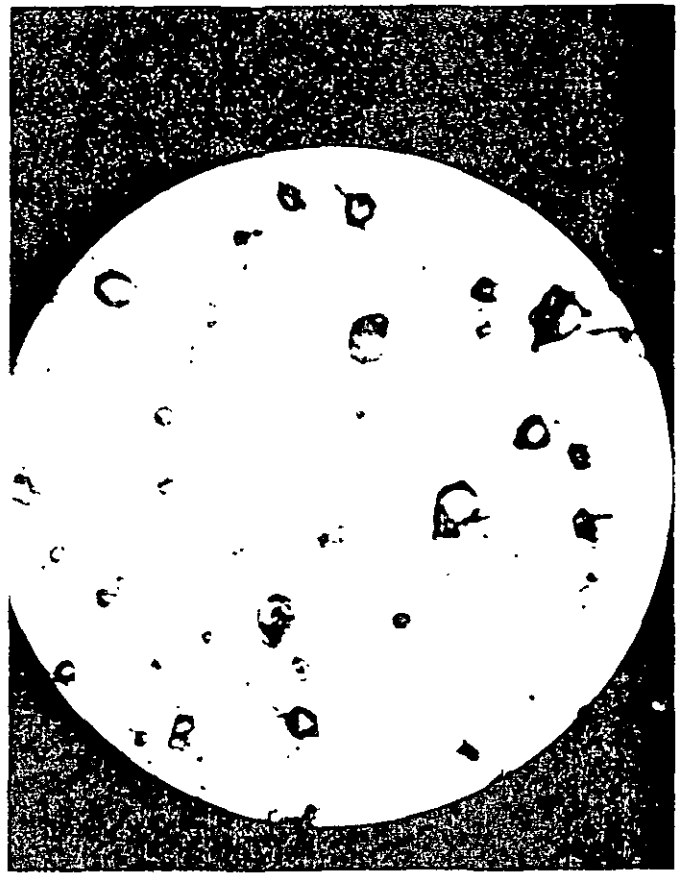


FIGURE II

FIGURE III

FIGURE I

FIGURE II

FIGURE VII

FIGURE VIII

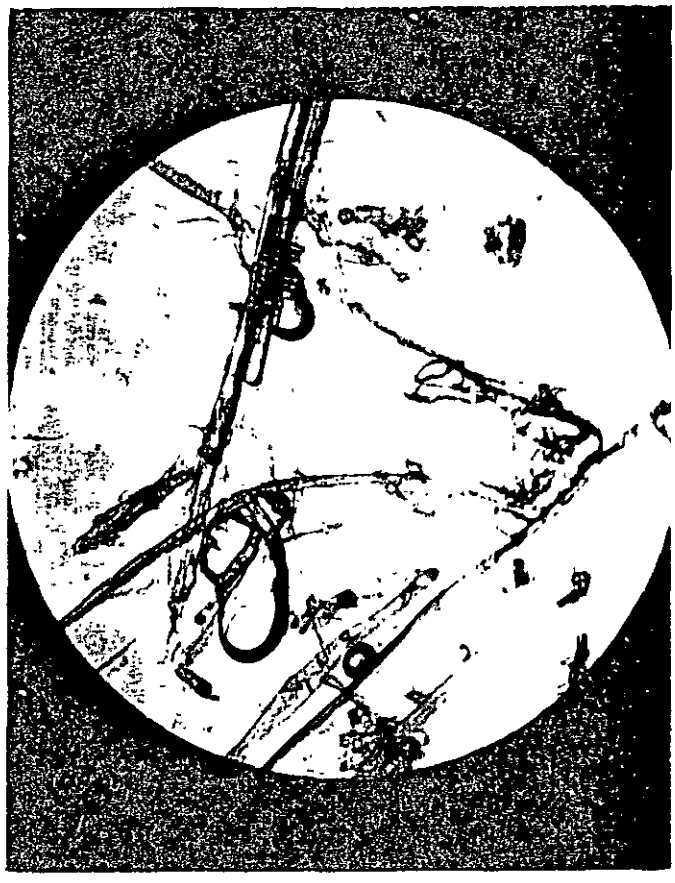


FIGURE IX

FIGURE X

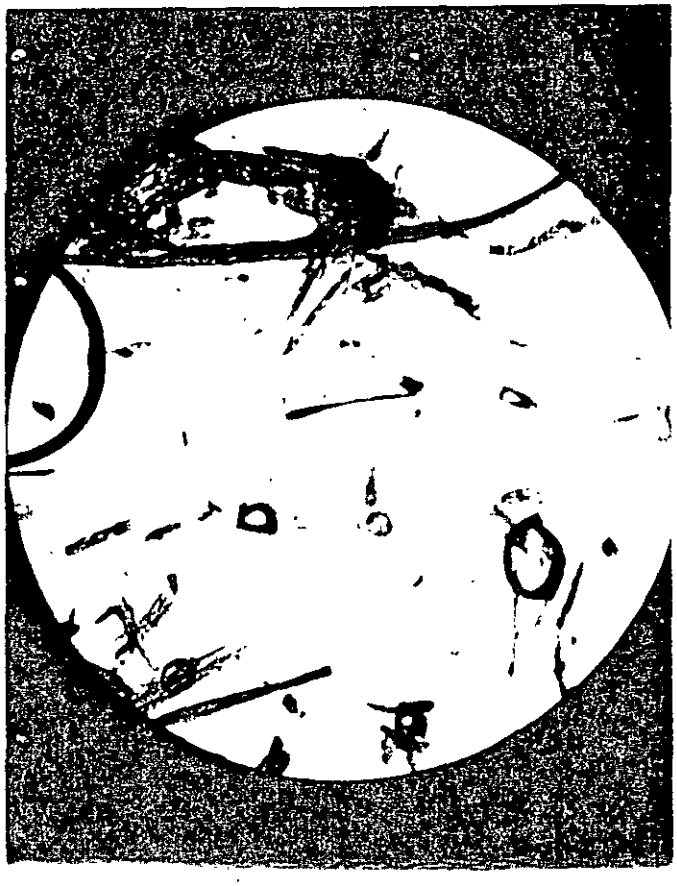
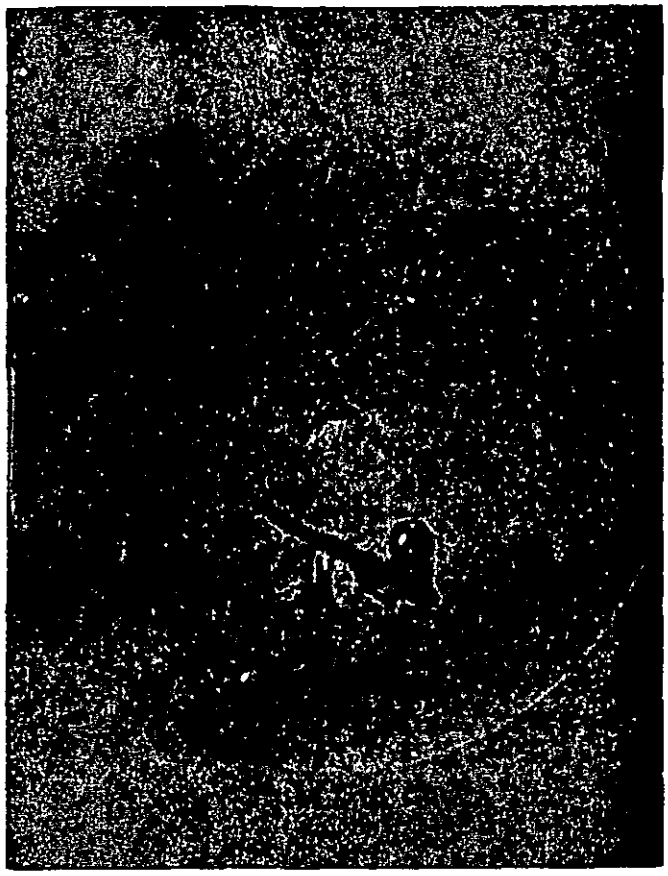
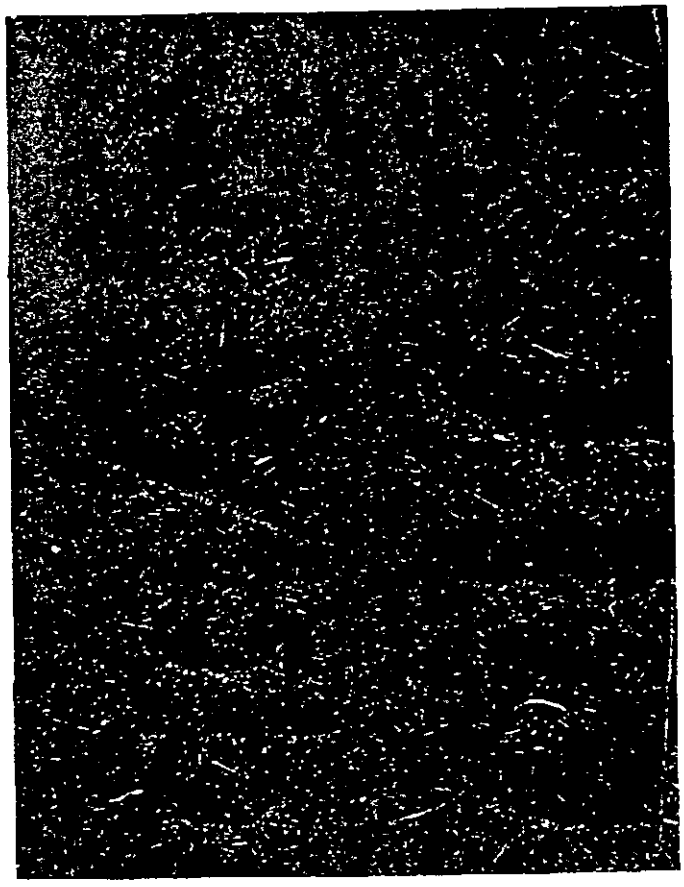


FIGURE II





Blanket FIGURE XII

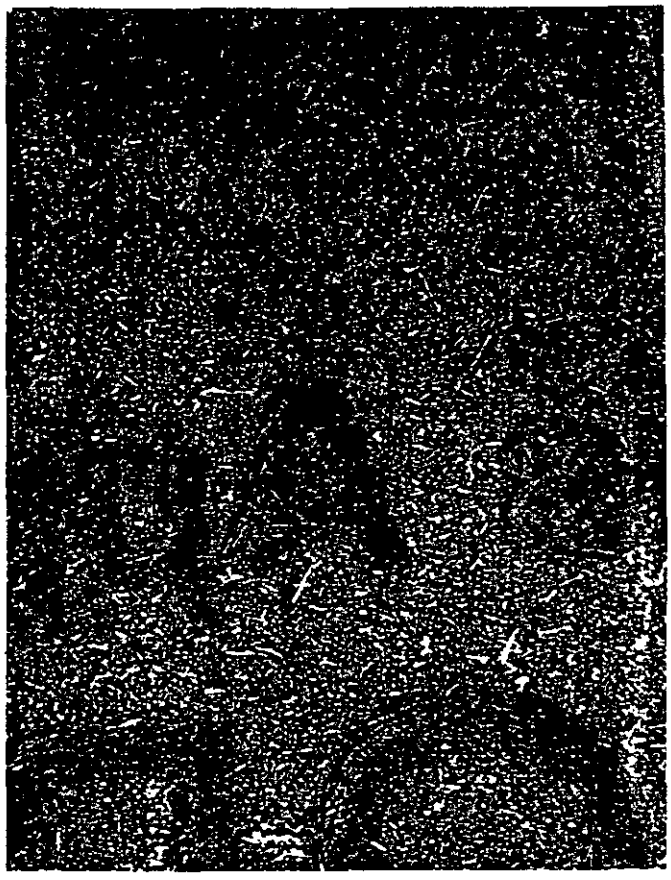
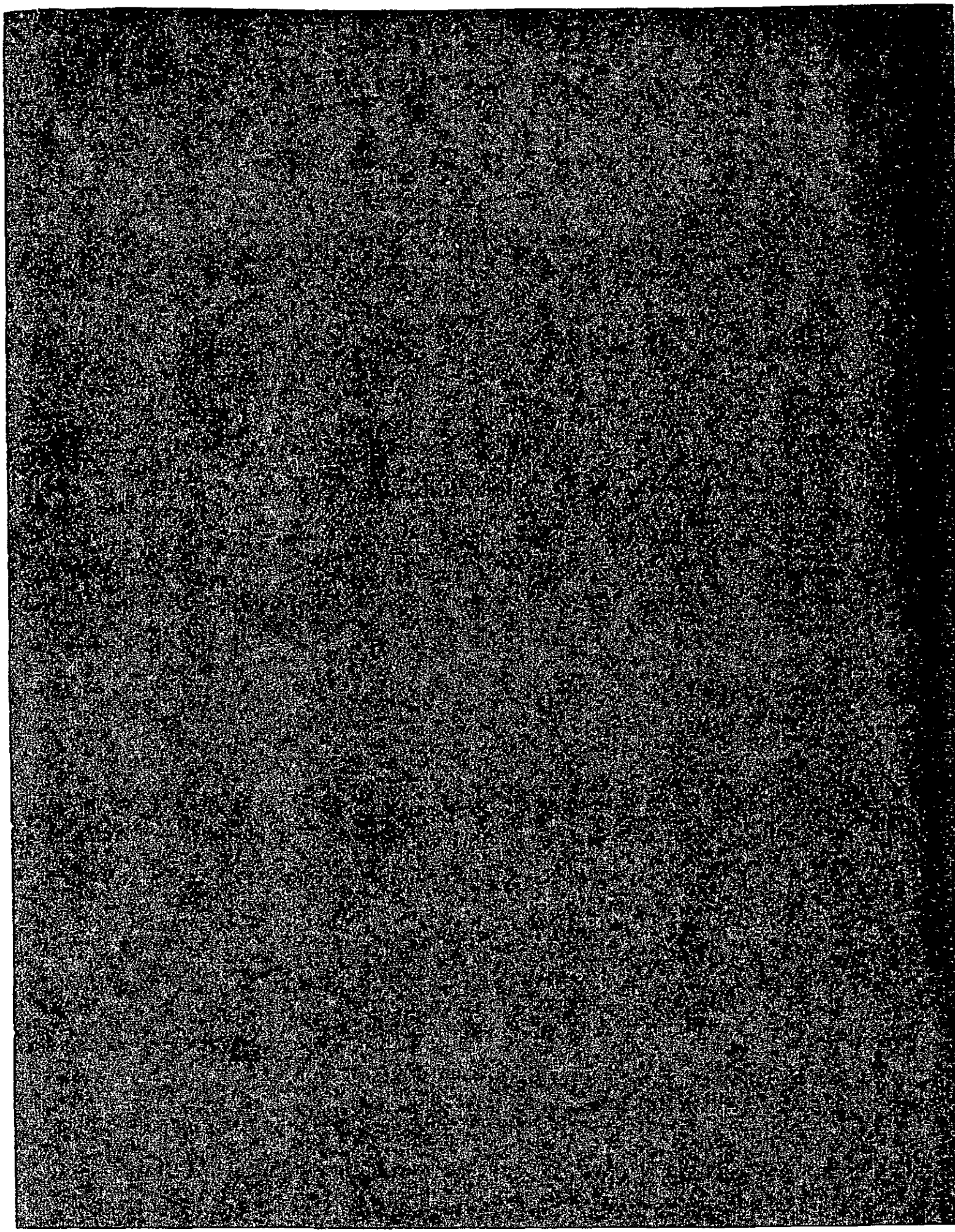


FIGURE II



Print No. XVII