

History of Paper and Technology
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AN INVESTIGATION OF LINTING AND FLUFFING
OF OFFSET NEWSPRINT

Project 2949

Report One

A Progress Report

to

MEMBERS OF GROUP PROJECT 2949

December 10, 1971

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

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Bowaters Southern Paper Corp.

International Paper Company

Southwest Forest Industries, Inc.

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THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

AN INVESTIGATION OF LINTING AND FLUFFING
OF OFFSET NEWSPRINT

SUMMARY

In order to provide reproducible test methods for linting potential of papers it was necessary to determine and to develop a means of controlling those press variables which contributed to linting severity. Conclusions drawn from these studies are as follows: Lint accumulation increases with printing speed. Simultaneous low levels of printing ink and water aggravate linting significantly. Blanket age, plate age, and steel vs. blanket impression cylinders do not significantly affect linting under the conditions studied. The forementioned studies were limited to press operating variables and do not include evaluation of various printing raw materials, viz., various ink or dampening solution compositions, plate or blanket surfaces, etc., since the prime concern was the development of standard reproducible conditions under which a variety of newsprints could be evaluated relative to linting potential. Standard press operating conditions for future evaluations in this program are outlined in this report.

A printing test pattern incorporating 120 line halftones of 20, 50, 70, and 90% printing area, separated by one-fourth inch solid lines was adopted. The total ink demand per plate revolution is essentially constant across the press but the order of halftone tints is reversed in the central region from that at the edges. The design is shown to be useful in the determination of lint buildup on the blanket and on the plate relative to halftone area value.

The principal quantitative test for lint severity is based upon a procedure published by F. P. Hughes (1). However, the test has been substantially

modified since it was shown the procedure, as reported to be practiced currently, degrades the physical character of lint significantly as revealed by microscopic studies. Since lint characterization is expected to be a prime source of information concerning the character and properties of the fibers involved in linting in later studies, modification of the procedure was imperative. The modified procedure is shown to significantly reduce, if not essentially eliminate, structural degradation of the accumulated lint.

Hughes method quantitatively evaluated only blanket lint; however, procedures developed here have extended gravimetric analyses to include lint accumulated in a substantial part of the ink train as well. It has been shown that total lint, calculated by addition of ink train lint to blanket lint, has better reproducibility in replicated trials than blanket lint alone.

Contact photos of the wax containing the blanket lint as obtained under the gravimetric procedure are prepared. These photos have proven to be a practical means for correlating lint buildup on the blanket with halftone area value and image geometry and with paper print degradation. While it is shown that print quality decreases as lint accumulates during the run, the 50 and 70% tones, which usually accumulate the greatest amount of lint on the blanket, do not necessarily show the greatest print degradation. The most readily discerned, and, therefore, objectionable print defects were decided print discontinuities or "hickies" in the solids and dark halftones. Such discontinuities are most obvious in these darker printing tones. It was observed that these defects, when they were present at the end of the run, frequently could be traced to lint on the plate rather than the blanket.

INTRODUCTION

This project was established to effectively study press conditions and newsprint paper properties which affect the severity of linting of this grade of paper when printed by the offset method. The program is divided into five parts as follows:

1. A screening evaluation of press variables which affect linting and the development of a number of tests which would evaluate this linting qualitatively and quantitatively.
2. Comparison of cooperator's newsprints for linting severity by methods developed in Part 1.
3. Evaluation of newsprint sheet properties to determine which may correlate with linting potential.
4. Develop laboratory tests requiring small amounts of paper which will predict linting potential.
5. Consider the development of an on-machine test which will predict linting potential.

To initiate this phase of study, the Institute purchased a Didde-Glaser Apollo Web Offset Duplicator. An Institutional project was also initiated to provide press operators with an opportunity to become familiar with the press and develop a feel for evaluating linting potential by tests known to be practiced currently. Those procedures which have proven useful to evaluation of linting potential are, however, completely covered in this report as well as those procedures developed directly for this program.

This report summarizes the findings under Part 1 of the program and outlines tests presently adopted for future studies. Based upon these results, studies

relative to Part 2 of the program — the comparison of linting severity of several commercial newsprints — have been initiated and will be covered in a separate progress report to be prepared soon.

DEVELOPMENT OF QUANTITATIVE LINTING TESTS

PRELIMINARY EXPERIMENTS BASED ON HUGHES METHOD

The principal quantitative test for linting severity was based initially upon a procedure published by F. P. Hughes (1). According to the published procedure blankets are removed from the press and coated with molten beeswax to take up the lint. The cooled wax is stripped from the blanket carrying with it the lint and residual ink. Isolation of the lint is achieved by dissolving the wax in hot turpentine and filtering the mixture through a clean preweighed glass crucible. The lint in the crucible is treated with Senefix (a proprietary acid sold by Sefelder Co.) to decompose and remove the ink pigment, after which the lint was washed, dried, and weighed. Since publication it is understood that, in some laboratories, the turpentine and Senefix steps have been combined for more effective removal of wax and ink. The ink utilized on the press was reported to be a normal process red ink, similar in composition to the ink currently utilized at the Institute for these studies.

Initial trials utilizing the technique combining the turpentine and Senefix in a single step produced lint unsuitable for lint characterization. Limited microscopic studies of the isolated lint suggested severe chemical burn occurred with possible loss of structural characteristics. A loss of weight may also occur but this was not determined independently. It is known, however, that weight of lint recovered increased essentially twofold as improvements in the

isolation procedure progressed. Part of the increase may be due to changes in press operating conditions but this should not account for the total increase.

To confirm the potential of fiber degradation, a newsprint stock was subjected to the isolation treatment. Examination of the photomicrographs of Fig. 1 (approximately 8X) show considerable degradation of the treated fibers as compared to the untreated fibers. No like photographs are available showing the character of the lint after isolation by the modified method now practiced at the Institute; but, microscopic studies have shown the degradation is substantially reduced if not essentially eliminated.

Trials were then undertaken according to Hughes original published method. However, difficulties were encountered early due to reprecipitation of the wax during filtration when turpentine was utilized as the sole solvent. Use of benzene instead of turpentine alleviated this difficulty. Senefix treatment of the isolated lint containing ink pigment in the crucible also did not yield a suitable clean lint for microscopic studies. Furthermore, chemical degradation of the lint continued to occur although not as seriously as in the combined procedure. Senefix is believed to be an acidified alcohol mixture but the actual composition is not known. Decolorizing agents of known composition were therefore sought which would have limited effect on cellulose and lignin when properly utilized. Decomposition of the pigment (the lead lake of eosin) was accomplished with 1% nitric acid which converted the lead to readily water-soluble lead nitrate. This was followed by 1% sodium hydroxide to convert the eosin to its water-soluble sodium salt.

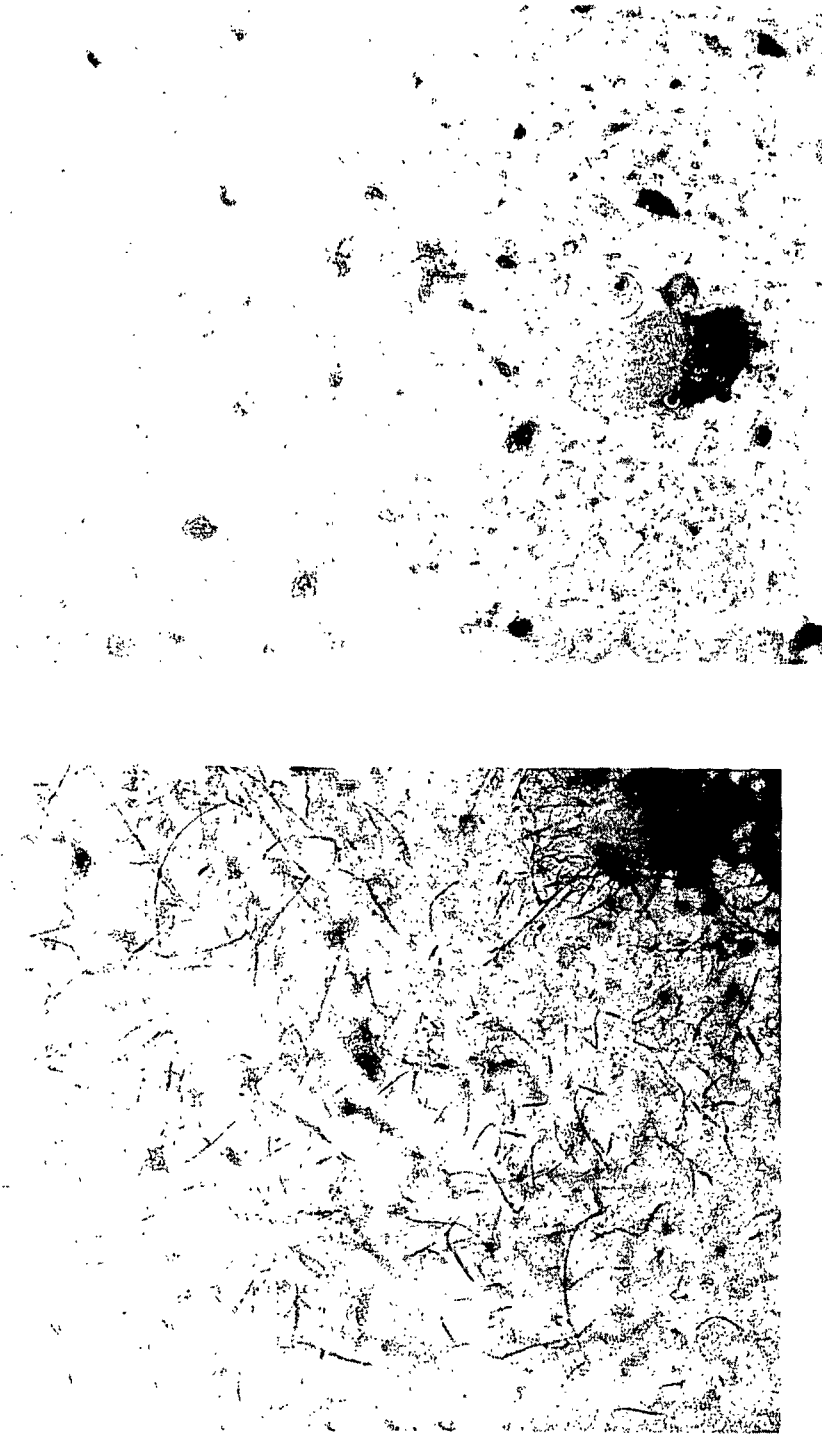


Figure 1. Left, Untreated Fibers; Right, Fibers After Combined Turpentine-Senefix Treatment. Approximately 8X

DETERMINATION OF LINT IN THE INK DISTRIBUTION
SYSTEM OF THE PRESS

Hughes method of lint isolation quantitatively determined only the lint deposited on the blanket. Although this may be the most important part of the lint, only part of the total lint supplied by the paper is deposited. Most of the remainder accumulates in the inking system where it may eventually degrade printing quality. Under other printing conditions, a larger part of the total lint might deposit on the blanket. Therefore, it would be desirable to determine total lint as well as blanket lint.

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 that most of the lint, ink, etc., accumulated in this tray. Therefore, 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 (supplied by Lithocraft Products, Inc.) was 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 the printing plate. The method of gravimetric isolation of the lint follows the general procedure outlined for isolation of blanket lint.

GRAVIMETRIC METHOD OF LINT ISOLATION NOW IN STANDARD USE

The following is a condensed outline of procedures utilized to recover the lint from the blanket. Detailed discussions of each phase, as deemed necessary, follow the outline.

1. The linted blanket is taped to cork-surfaced plywood board on which the lint recovery area has been outlined relative

to the design. Lint recovery area, based upon the present plate design is 480 cm.² (20 x 24 cm.). The actual recovery area, which is marked on Fig. 2, is bounded by tape.

2. Molten white beeswax (90-100°C.) is applied to the blanket with a 3-inch paint brush. Either white or yellow beeswax is satisfactory for lint collection, but white wax facilitates preparation of photographic contact prints of the lint-bearing wax sheet. Four coats of wax are applied, one from each direction in turn, starting from the unnumbered toward the numbered side of the design.
3. The waxed blanket is allowed to cool at room temperature for 5 minutes and the wax containing lint is peeled from the blanket. Excess wax and tape are removed from around the recovery area.
4. Contact photos of the wax containing lint may be prepared at this time if desired as described later in this section.
5. The wax containing lint is folded onto itself, placed in a clean 600-ml. beaker and 250 ml. of benzene is added. The mixture is heated in a hot water bath 10 min. (final temperature of the mixture reaches approximately 70°C.).
6. The mixture is filtered through cleaned preweighed coarse fritted glass crucibles (reported pore size 40-60 μ m.) under vacuum. Filter apparatus consists of a 1-liter filter flask equipped with a funnel and Bailey crucible holder.

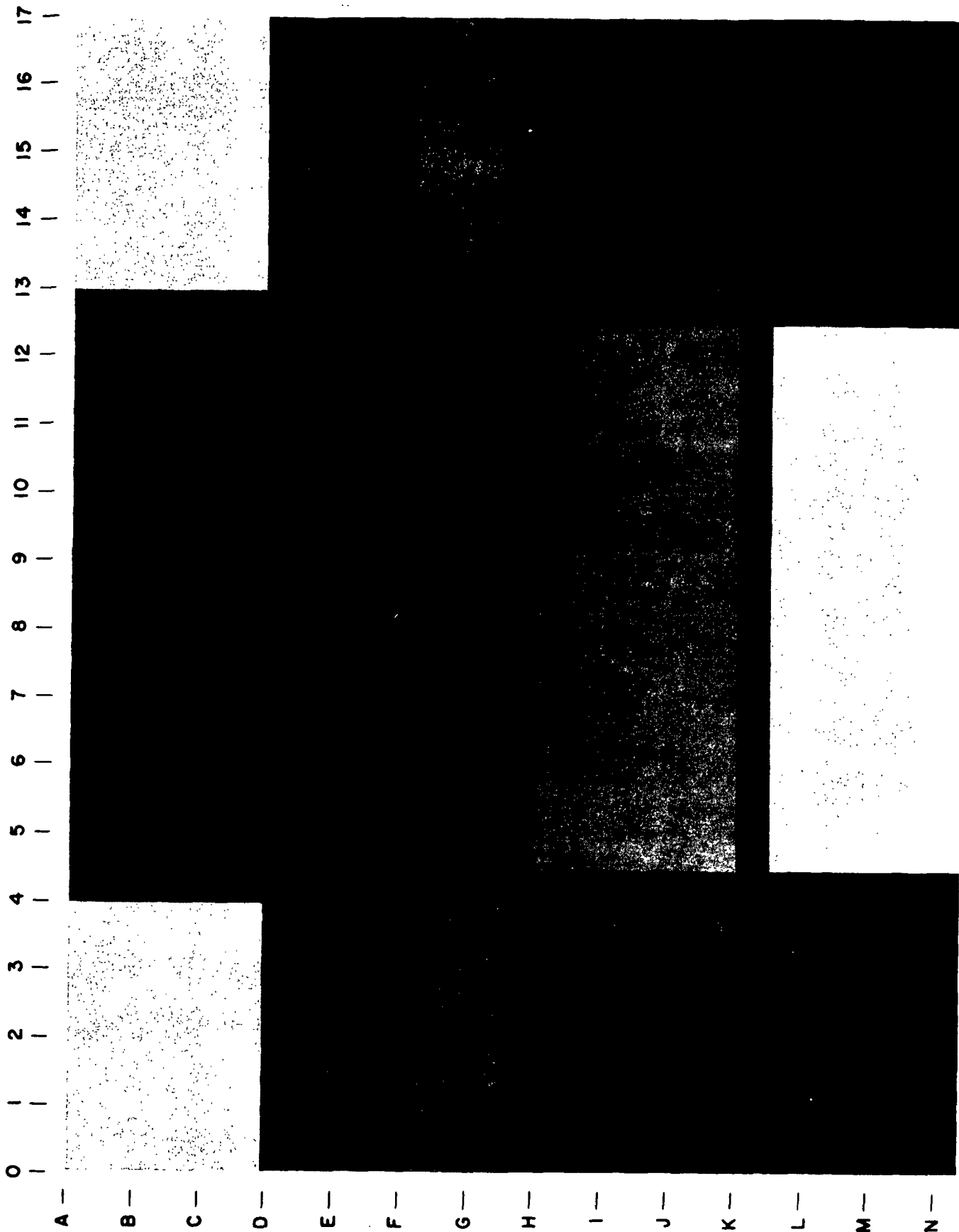


Figure 2. Test Plate Design. Dotted Lines Indicate Area of Blanket from Which Lint is Collected

7. The isolated lint is washed with 200 ml. of hot benzene and 60 ml. of ethanol. The material now in the flask is transferred to a suitable container for safe processing of the flammable wastes as will be reviewed later.
8. The lint is washed with approximately 60 ml. of water.
9. The ink pigments are destroyed by treating the lint sequentially with 30 ml. 1% nitric acid, 30 ml. of water, 30 ml. of 1% sodium hydroxide, and 30 ml. of water. This sequence is repeated once and the sample is finally washed with an additional 30 ml. of water.
10. The lint in the crucible is dried 2 hr. at 105°C., cooled and weighed, after which the lint is removed from the crucible and retained for subsequent examination.

Lint from the ink train is isolated by dilution of the material collected from the washup tray with 250 ml. of benzene. The diluted material is heated and filtered as in Step 5 and processed according to the subsequent steps of the above procedure.

The entire lint isolation operation is carried out under suitable ventilation in an approved hood due to the variety of Class One solvents involved.

Lint isolated from the blanket resembles the original newsprint in color. Lint isolated from the ink train retains a pink or light magenta coloration.

Molten wax applied to the blanket should not be quickly cooled since it fails to pick up all the lint. Cork backing was shown to temper the cooling process appropriately. Continued application of heat to the molten wax after coating the blanket, on the other hand, will cause the wax to flow, disturbing the lint distribution on the blanket. In addition, the wax tends to infiltrate the pores of the blanket, and pick upon separation occurs. The waxed blanket is allowed to cool at room temperature for approximately 5 min. during which time the wax will appear to proceed from a milky translucent state to a more uniform, less translucent state.

Separation of the wax from the blanket is accomplished 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. The blanket should be just warm to the touch. Changes in wax translucency, however, are the best indication of ideal cooling time.

The wax containing lint is placed upon a clean surface lint side up. Tape and excess wax are removed by bending at the tape-wax junction, leaving the wax area to be studied intact and essentially without distortion. Thickness of wax within the recovery area ranges from 0.02 to 0.03 in. and approximately 25-30 g. of wax is contained within the area.

Immediate removal of the lint from the blanket is desirable because drying of the ink, after a period of time, will cause wax pick with potential incomplete removal of the lint from the blanket. It is also desirable to clean and appropriately store the lint-free blankets as soon as possible for future use to avoid possible setting of residuals in the pores of the blanket, thus successively modifying its printing properties.

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

Coarse fritted glass crucibles (pore size 40-60 μm .) are utilized for filtration procedures. Results indicated no variation in fiber retention in changing from medium (10-15 μm , pore size) to coarse crucibles. Therefore, coarse crucibles became standard.

Fritted glass crucibles are cleaned utilizing concentrated sulfuric acid and potassium dichromate. Crucibles are placed in small beakers. Each crucible is filled with concentrated 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.

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 normal solvent disposal pit since it solidifies 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:

A suitable hood was constructed and connected to the regular laboratory system. The exhaust rate is between 1000 and 2000 c.f.m.

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

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.

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

PREPARATION OF CONTACT PHOTOGRAPHS OF WAX CONTAINING BLANKET LINT

The wax film is placed with the lint side in contact with the surface of a photographic emulsion and exposure is made through the wax in a contact printer. A Wratten filter G in combination with a green sensitive film (3M Line Ortho PL5) provides the best contrast because of the preferential absorption of green light by the magenta ink. Eastman Ektaflo Developer No. 1 is used for development of the image.

It was found that the linted wax may be contact photographed immediately after preparation without loss of lint or undue tackiness of wax or ink interfering with photographic procedures or subsequent gravimetric lint results, providing no undue pressure is applied.

PRINTING EQUIPMENT AND MATERIALS

DESCRIPTION OF THE PRESS

The press used for the printing studies is a Didde-Glaser Apollo web offset duplicator. It is equipped with two printing units whereby images of one or two colors can be printed on one side of the web, or, by the use of a turnover attachment, a single color can be printed on each side of the web. The impression cylinders normally supplied with the press are of steel. In order to better simulate the impression nip of a blanket-to-blanket perfecting press, a special blanket covered impression cylinder has been installed on the second printing unit. It is recognized that the simulation of the blanket-to-blanket press is imperfect in that no ink is applied to the impression blanket. The blanket impression cylinder has been used in all one-color printing evaluations except when comparison to the rigid steel impression cylinder has been specifically desired.

Other general specifications of the press are as follows:

Maximum roll width, 13-1/2 inches

Minimum roll width, 5 inches

Sheet cutoff size, 8-1/2 inches

Maximum printing area, 8-3/16 by 13-1/4 inches

Plate size, 9-3/8 by 13-3/8 inches

Maximum web speed, 295 ft./min.

Minimum web speed, about 100 ft./min.

Roll core diameter, 3 inches

Maximum roll diameter, 32 inches

Runnable paper weights, 46 to 181 g./m.²

Figure 3 is a diagram of the two web leads used for lint testing with steel and blanket-covered impression cylinders. It will be noted that the sheet is cut after printing and the product is accumulated in a stacker.

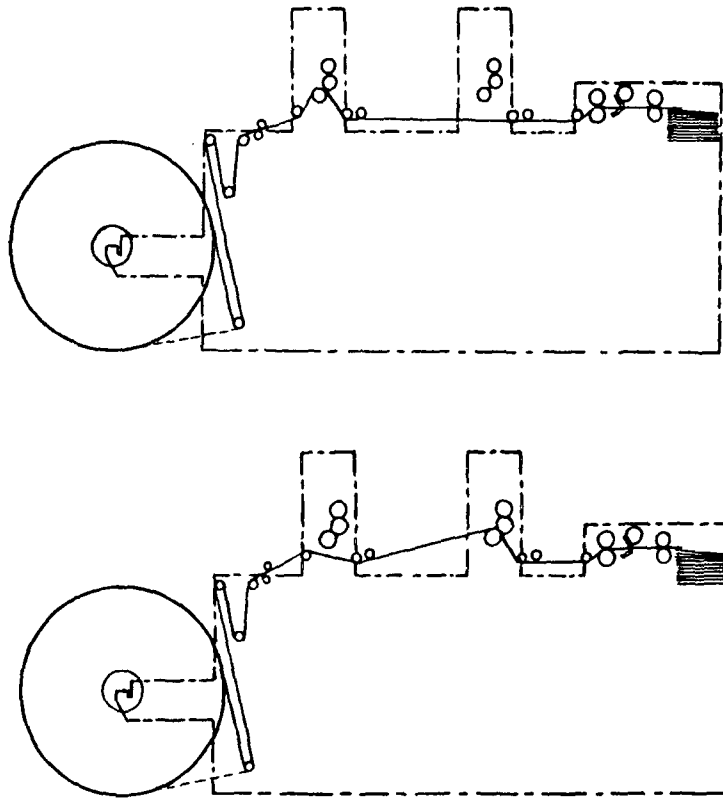
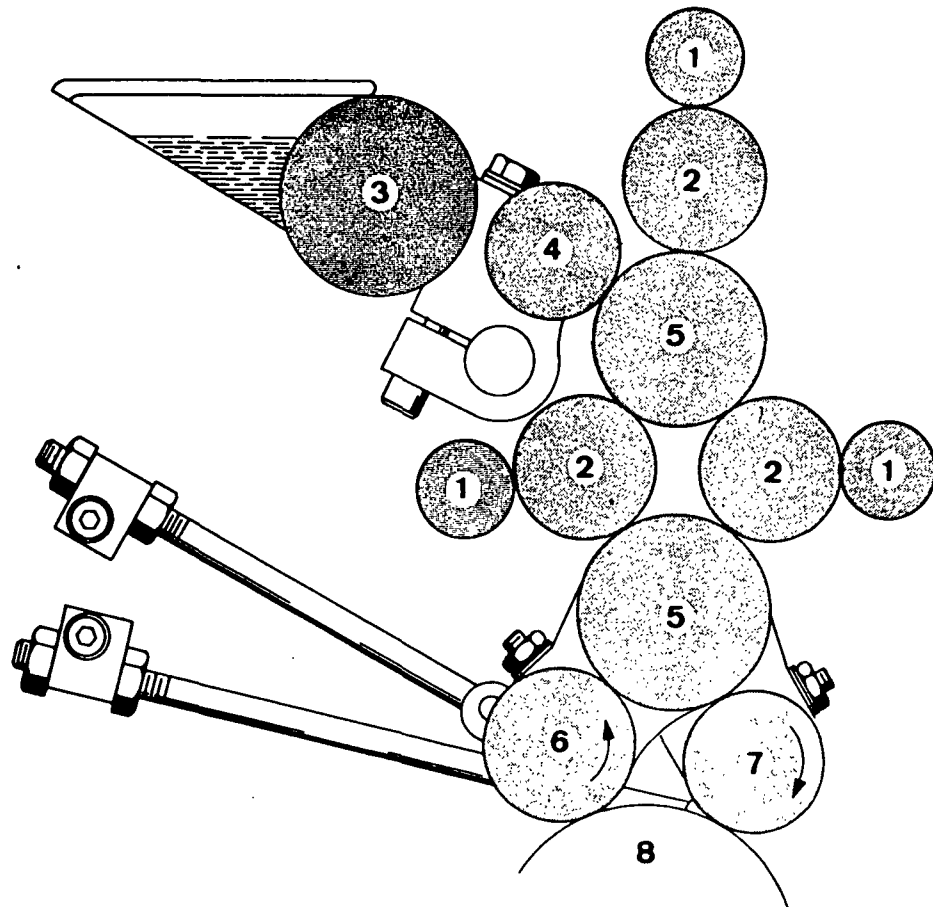


Figure 3. Web Lead Used in Linting Tests. Upper Diagram Uses Steel Impression Cylinder; Lower Diagram Uses Blanket-Covered Impression Cylinder

The ink fountain is equipped with self-sealing Neoprene end inserts which permit interchangeability of fountain blades. Action of the ink fountain roll is governed by an infinitely variable one-way clutch drive. This drive, together with 19 fountain keys, regulate the ink distribution and flow. An ink ductor, three sets of distribution rolls, two vibrators, and two form rolls complete the ink train. A diagram of the ink distribution system is shown in Fig. 4.



- | | |
|------------------------|------------------------|
| 1. Metal Rider Roller | 5. Vibrator Roller |
| 2. Distributor Roller | 6. Form Roller (Large) |
| 3. Ink Fountain Roller | 7. Form Roller (Small) |
| 4. Ink Ductor Roller | 8. Plate Cylinder |

Figure 4. Apollo Press Inking Train

The dampening water system consists of a fountain roller, water ductor, water vibrator, and water form roller. A second form roller may be added if desired. The water fountain roller is driven by a variable speed motor, the speed of which controls the amount of water ultimately transferred to the plate.

PRINTING PLATES AND TEST IMAGE

3M Type R printing plates have been used in all of the experiments described in this report. The manufacturer's recommendations have been followed with respect to exposure and development of the images. The test printing image which has been used in all of these experiments is illustrated in Fig. 2. The design consists of halftone tints of 20, 50, 70, and 90% printing areas separated by one-quarter inch solid lines. All of the halftones are at 120 lines per inch. The order of the four halftones is reversed in the central portion of the plate from that at the two edges. Therefore, differences due to the order of printing light and dark tones should be detectable. However, the constant halftone area in the printing direction across the full width permits uniform setting of the ink fountain across the image area. The one-quarter inch solid borders are included to determine whether there is any preferential plugging of the tones adjacent to solids on either the leading or trailing side. The size of the central halftone area is sufficient for subjective grading of the prints for uniformity or smoothness of tone by either subjective or instrumental methods. The image to the border of the halftones is 6-11/16 by 8-1/2 inches. The numbers are included along one margin and letters along an adjacent side in order to aid in graphically locating areas of interest within the test image.

PRINTING INK

The isolation of lint in pure condition requires that the ink pigment be either soluble or subject to decomposition to soluble products. In keeping with the Hughes procedure, a process red or magenta ink pigmented with "Phloxine Toner" (a lead lake of eosin) has been used. The particular ink is IPI offset news ink 66NK4780. It is manufactured from a flushed color in linseed oil by subsequent dilution with linseed and mineral oils to a given tack.

OTHER MATERIALS

Mercury two-ply hard blankets have been used in all of the experiments. In most cases it has been possible to use blankets that are known to come from the same lot. In view of the possible deterioration of blankets with extended use, a record is kept of the use of each blanket.

The water fountain solution is prepared from gum arabic and 3M fountain solution concentrate. The final composition contains 40 ml. of gum arabic concentrate per gallon of water and is adjusted to pH 4.5 with the concentrate.

A Molleton cover is used on the water-ductor of the moistening system and a 3M dampening sleeve No. 13014 is used on the water form roller.

Two newsprints which we will designate as Papers E and G furnished by The Cooperators were used in the experiments described in this report. Two thirty-inch rolls of each paper were furnished and these were slit into 10-inch rolls by a local converter. Six press rolls were obtained from each 30-inch roll. These are identified in this report by codes in which the first character is the letter E or G designating the paper, the second is the digit 1 or 2 indicating whether the press roll came from master roll

1 or 2, the third is the letter F, C, or B indicating whether the press roll came from the front, center, or back of the master roll and the fourth the digit 1 or 2 indicating whether the roll was the first or second, i.e., from nearer the outside or core of the master roll.

THE EFFECTS OF PRINTING AND PAPER VARIABLES ON LINTING

INITIAL SCREENING EXPERIMENTS

The initial experiments were designed to find the effect of the steel versus rubber blanket impression cylinder, the effect of the speed, and the effect of either of the two papers tested. In all cases the press run was 2500 impressions. The experimental conditions and the results are both shown in Table I.

From these data it can be seen that increased press speeds resulted in increased linting (compare Runs 1, 2, and 3 with Runs 4A, 5, and 6; and Runs 9, 10, and 11 with 12A, 13A, and 14A).

Paper G appeared to be somewhat superior to Paper E in that less lint accumulated. The differences between the blanket and steel impression cylinder appear to be unimportant (compare Runs 1, 2, and 3 with Run 8 and Runs 4A, 5, and 6 with Run 7).

In general, it was observed that, among replicate runs, individual values for both blanket lint and ink-train lint deviate more widely from their average value than do values for total lint. The reasons for the difference in distribution of total lint between blanket and ink-train are not known. However, these observations strongly suggest that the evaluation of blanket lint only is not a satisfactory measurement of total lint which, under some printing

TABLE I
EFFECT OF IMPRESSION SURFACE, PRESS SPEED AND PAPER ON LINTING TENDENCY

Run No.	Paper Code	Impression Cylinder	Press Speed, i.p.b.	Lint Recovered, g.		Average Lint Recovered, g.		Average Deviation, g		Remarks		
				Blanket	Ink Train	Blanket	Ink Train	Blanket	Ink Train		Total	Total
1	G1C1	Blanket	12,500	0.1302	0.0868	0.1324	0.0895	0.2220	1.13	13.63	6.12	Run temporarily interrupted at 800 impressions for delivery jam
2	G1C1	Blanket	12,500	0.1344	0.1080							
3	G1C1	Blanket	12,500	0.1327	0.0739							
4 ^c	G1C1	Blanket	25,000	0.1415	0.1793							
4A	G1C1	Blanket	25,000	0.2123	0.0984							
5	G1C1	Blanket	25,000	0.1732	0.0996							
6	G1C1	Blanket	25,000	0.1813	0.0966							
7	G1B1	Steel	25,000	0.1595								New molleton covers and 3M paper sleeve
8	G1B1	Steel	12,500	0.1361	0.0933							
9	E1F1	Blanket	12,500	0.1162	0.1980							
10	E1F1	Blanket	12,500	0.1322	0.1554							
11	E1F1	Blanket	12,500	0.1679	0.0916							
12 ^e	E1F1	Blanket	25,000	0.2294 ^d	0.0578							
13 ^e	E1F1	Blanket	25,000	--	0.1041 ^c							
14 ^e	E1F1	Blanket	25,000	0.1563	0.1789							
12A	E1C1	Blanket	25,000	0.2090	0.1651							
13A	E1C1	Blanket	25,000	0.2146	0.1591							
14A	E1C1	Blanket	25,000	0.2071	0.1020							
						0.1928	0.1183	0.3112	18.98	51.22	7.71	
						0.1387	0.1483	0.2871	13.98	25.48	6.40	
						0.2102	0.1420	0.3523	1.37	18.80	8.17	

^a Actual lint recovered after 2500 impressions.

^b Average deviation from average value.

^c Sample not used in calculation of average. Figure in parentheses would be average if sample is included.

^d Sample lost.

^e Runs 12, 13, and 14 were rerun as 12A, 13A, and 14A because the plate was unintentionally reversed, the paper from near the core caused interruptions due to jamming (Run 13 and 14) and the decurl bar was used on the reverse side (Run 14).

conditions, may accumulate on the blanket and affect printing behavior. The results reported in Table I indicate that total lint may sometimes differentiate between papers which deposit substantially equivalent blanket lint.

EFFECT OF AMOUNT OF WATER AND INK

It was anticipated that the ink-water balance might play an important part in the amount of lint recovered. Therefore, a statistical design was prepared to include a series of eight runs. Paper G was used for all the runs, but a roll change (from G2C1 to G2C2) was necessary after Run 20. Press speed was 18,000 impressions per hour (i.p.h.). Variable conditions included the amount of ink and dampening water applied during printing and the blankets used during the printing. Ink volume was adjusted by setting the clearance of the ink-blade keys to shim stock. Two widely different levels of ink flow were utilized. Two water levels were also used. The first, or low water volume was determined to be the minimum amount possible for operation without toning. A higher volume was then arbitrarily selected one press water setting above the minimum amount. Five runs were made per day, but the first of these was considered a seasoning run and, therefore, not included in the evaluation. A new printing plate was used each day. The seasoning run was undertaken because earlier studies suggested that changes in dampening roller absorbance do take place during the first run, presumably because of the drying of the rollers when the press is idle overnight or for a longer period of time.

The sequence of runs is indicated by the run numbers, but Table II groups replicated runs of like ink-water condition. A complete randomization is impractical with the limited number of runs so replicated ink-water balance runs were set up to utilize both a new and an old blanket to remove blanket age as a

TABLE II
EFFECT OF INK AND WATER AMOUNT ON LINTING TENDENCY

Run ^a No.	Ink Level	Water Level	Age of Blanket	Lint Recovered, g.					
				From Blanket		From Ink Train		Total	
				Indiv. Result	Paired Result, av.	Indiv. Result	Paired Result, av.	Indiv. Result	Paired Result, av.
15	Low	Low	New	0.1956	0.2143	0.0929	0.0633	0.2885	0.2775
22	Low	Low	Old	0.2329	0.2143	0.0336	0.0633	0.2665	0.2775
16	Low	High	Old	0.1501	0.1640	0.0505	0.0449	0.2006	0.2088
21	Low	High	New	0.1778	0.1640	0.0392	0.0449	0.2170	0.2088
17	High	Low	Old	0.1364	0.1247	0.0638	0.0682	0.2002	0.1929
20	High	Low	New	0.1129	0.1247	0.0726	0.0682	0.1855	0.1929
18	High	High	New	0.1060	0.1172	0.0828	0.0855	0.1888	0.2027
19	High	High	Old	0.1284	0.1172	0.0882	0.0855	0.2166	0.2027

^aAll paper was from the same machine position. Roll G2C1 was used on Runs 15-20 and Roll G2C2 on Runs 21-23.

possible variable. All blankets used were determined to be of the same lot. New blankets received a seasoning run prior to the study. The old blankets had been used for an indeterminate number of runs, but were still in excellent condition. Table II tabulates the actual lint recovered from each of the eight runs. Table III tabulates the analysis of variance calculated relative to blanket lint, ink-train lint and total lint recovered in terms of ink-water relationships. In addition, analysis of variance for the ink-water-blanket relationship is calculated relative to total lint recovered only.

Analysis of variance results relative to blanket lint recovered indicate that ink level is the only significant factor contributing to linting severity. Comparison of the calculated F ratio with the standard probability tables indicates differences encountered are likely to be real differences in excess of 99% of the time.

The analysis of variance for total lint recovered indicates a 95% expectancy that real differences in linting severity occur with changes in water level and ink-water balance as well as with changes in ink level.

The extended analysis of variance indicates that blanket age is not a factor contributing to linting in these experiments. However, since it is possible that with continued use the blankets will show some degradation which may change linting tendency, the total usage of all blankets is now being recorded.

Therefore, we can conclude: (1) Increasing ink volume on the press particularly at low water level reduces linting significantly. (2) Increasing water volume at low ink coverage also appears to reduce linting significantly,

TABLE III

ANALYSES OF VARIANCE

Effect of Ink and Water Amount on Linting Tendency

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio		
				Calculated	Tables ^a	
				95%	99%	
Analysis of Variance for Blanket Lint <u>vs.</u> Ink-Water Levels						
Ink level	0.00929	1	0.00929	23.23	7.71	21.20
Water level	0.00167	1	0.00167	4.18	7.71	
Interaction	0.00092	1	0.00092	2.30	7.71	
Residual	<u>0.00161</u>	<u>4</u>	0.00040			
Total	0.01349	<u>7</u>				
Analysis of Variance for Ink Train Lint <u>vs.</u> Ink-Water Levels						
Ink level	0.00104	1	0.00104	2.21	7.71	
Water level	0.00000	1	0.00000	--		
Interaction	0.00064	1	0.00064	1.36	7.71	
Residual	<u>0.00188</u>	<u>4</u>	0.00047			
Total	0.00356	<u>7</u>				
Analysis of Variance for Total Lint <u>vs.</u> Ink-Water Levels						
Ink level	0.00412	1	0.00412	19.61	7.71	21.20
Water level	0.00173	1	0.00173	8.23	7.71	21.20
Interaction	0.00308	1	0.00308	14.66	7.71	21.20
Residual	<u>0.00087</u>	<u>4</u>	0.00021			
Total	0.00980	<u>7</u>				
Analysis of Variance for Total Lint <u>vs.</u> Ink-Water-Blanket Conditions						
Ink level	0.00412	1	0.00412	412	161	4052
Water level	0.00172	1	0.00172	172	161	4052
Blanket age	0.00000	1	0.00000			
Ink-water interaction	0.00308	1	0.00308	308	161	4052
Blanket-ink interaction	0.00082	1	0.00082	82	161	
Blanket-water interaction	0.00006	1	0.00006	6	161	
Residual	<u>0.00001</u>	<u>1</u>	0.00001			
Total	0.00981	<u>7</u>				

^aSource of tables: Goulden, C. H. Methods of statistical analysis, 2nd ed. New York, Wiley & Sons, 1952.

but change in water level does not appear critical when ink level is high.

This is fortunate because ink level is much more easily controlled and monitored than water level.

EFFECT OF STRETCHING AND BENDING OF PAPER AND THE EFFECT OF MACHINE OR ANTIMACHINE PAPER DIRECTION

In an effort to conserve the cooperator's paper during preliminary experiments, an attempt was made to use a waste newsprint roll which had been subjected to tests on the web strainer. This roll was believed to be an offset grade of newsprint. This paper yielded a lint recovery exceeding three times that of other papers studied. Therefore, it was decided to undertake a limited study on the effect of bending and stretching of paper upon linting. Paper G2F1 was used in this study. The paper was treated on the web strainer at two levels of the strain, and with maximum and minimum bending around 8-inch rolls. The maximum bending used a web lead wrapping eleven rolls while the minimum bending utilized only six rolls. Since passing the web through the web strainer reverses the paper in the roll, it was thought wise to include an experiment comparing the linting when printing in the machine and antimachine directions. This was accomplished by rewinding part of a roll at minimum tension before printing. The results of lint testing on these papers are summarized in Table IV. The differences in amount of lint collected are comparable to the differences which have been previously noted between replicate runs on the same paper. Therefore, it must be concluded that for this particular paper, there is no significant difference between printing in machine and antimachine direction and that the amount of the strain and bending of the paper employed in these experiments does not significantly change the linting characteristics.

TABLE IV
EFFECT OF STRETCHING AND BENDING OF PAPER UPON LINTING TENDENCY

Run No.	Paper Strain, %	Paper Treatment Before Printing		Printing ^a Direction	Lint Recovered, g.	
		Bending	Tension, lb./in. Draw		Blanket	Ink Train Total
23	None	None	--	Machine	0.1598	0.1825
24	0.25	Minimum ^b	6.4	Antimachine	0.1773	0.2053
25	0.15	Maximum ^c	4.7	Antimachine	0.1722	0.1930
26	0.15	Minimum	4.6	Antimachine	0.1548	0.1791
27	None	None	--	Antimachine	0.1921	0.2157

^aThe true machine and antimachine directions are unknown because of the unknown number of times the paper was rewound prior to being received. The term "machine" direction is used for the printing direction from the 10-inch wide press rolls. Rolls rewound through the web strainer are reversed in direction and are then printed in the "antimachine" direction.

^bBending around 6 8-inch rolls.

^cBending around 11 8-inch rolls.

EFFECT OF THE DECURL BAR

The press came equipped with a square decurl bar which can be used between the unwind stand and the first printing unit to remove the curl resulting from the storage on the roll and to permit the delivery end of the press to operate without jam-up. In most cases, the decurl bar is not needed and is not used. However, experience has shown that with some papers, particularly when printing paper near the core and printing on the wire side of the sheet, it may be impossible to run without use of the decurl bar. It has been observed that when the square decurl bar is used, some paper debris is scraped from the paper and deposits on the bar. To avoid this treatment, a 1/2-inch round, rotating bar has been substituted for the square stationary bar that came with the press. It is used only when there is excessive curling in the sheet delivery which makes it impossible to run without the bar.

GENERAL OBSERVATIONS REGARDING PRINT QUALITY

Examination of prints taken periodically through the run established that print quality generally decreased during the run, and, therefore, can be assumed to parallel the gradual accumulation of lint. The most objectionable degradation was the accumulation of "hickies" in the solid and 90% tones, and a general loss in print smoothness. Comparison of prints from the end of the run with the photographic prints made of the wax taken from the blanket showed that there was little correspondence between the areas having the most lint and the areas showing the greatest effect on print quality. Lint tended to accumulate on the blanket in the midtone regions, but midtones and highlights continued to print with comparatively little difficulty, even when the ink must have been printed from the layer of lint rather than from the rubber blanket.

Attempts to relate a particular print defect to a particular bundle of lint or "hickie" on the blanket were generally unsuccessful. Obvious hickies or print defects in the 90% tone or in the solids could frequently be related to paper debris found on the plate, rather than on the blanket at the end of the run. Figures 5 and 6 in the Appendix show a print from the end of the run and a reproduction of the corresponding contact print of the lint-bearing wax.

STANDARD OPERATING PROCEDURES FOR COMPARISON OF
LINTING CHARACTERISTICS OF NEWSPRINTS

Based on the preliminary experiments described previously, the following test conditions have been selected for further linting tests.

PAPER

Paper for further work was obtained from the cooperators as 12-inch wide press rolls. It is believed that the cooperators can do a better slitting job with generation of less slitter dust than the local converter who does not ordinarily handle newsprint. The use of a 12-inch web instead of the 10-inch web used in the preliminary experiments places the slit edges further from the image area and reduces the possibility of including a significant amount of slitter dust with the lint.

PRINTING MATERIALS

No change has been made in ink, printing plate, test image, fountain solution or type of dampening roller covers from that described earlier. Mercury 2-ply hard blankets are used but these are coded and a record is kept of the particular blanket used on each run. This should permit detection of any long term change in amount of lint collected as a result of blanket deterioration.

PRESS OPERATION

A standard test run of 2500 impressions at 18,000 impressions per hour has been adopted. The second printing unit, employing the blanket-covered impression cylinder is used. The ink fountain blade keys are set with 0.007-inch shim stock between the doctor blade and fountain roll. All runs are made

with the same setting of the ink fountain roll speed control. The water fountain solution setting required to prevent toning is determined by a trial run. Each test run starts with clean plate, blanket and inking rolls. The ductor roll is allowed to oscillate through 16 cycles with the press operating at printing speed, off impression, the web stationary, the form rollers lifted from the plate, and the ink fountain roll speed control in the central position. The ductor control is then turned off and the fountain roll speed control advanced two divisions to the right which will be its position during running. The press is allowed to run until the ink is uniformly distributed on the inking rolls. The press is then shut down and the web engaged in the pull rolls at the cut-off unit. The water fountain roll motor is turned on and the press is then brought up to speed. Then, in rapid sequence, the fountain solution form roll is lowered onto the plate, the press is put on impression, the inking form rolls are lowered, the ink ductor is turned on, and the counter is started. By this procedure, the ink level on the prints is brought up to full strength almost immediately and effects upon linting due to changing ink level during the early part of the run are avoided.

Blanket lint and ink train lint are collected after each run and the lint is washed from the plate. The ink fountain is emptied and cleaned only once a day. A new plate is used each day. Up to five press runs are made in a day. It should be noted that more than 5 press runs could be made in a day. The present limit of five permits gravimetric isolation of blanket and ink-train lint on the same day as the press run.

SAMPLE PRINTS

Prints are retained at intervals of 100 prints as a means of determining when any particular change in print quality occurs. In addition, a group of samples are retained from the start, center (about 1250 impressions), and end (about 2500 impressions) for assessment of change in print quality and for inclusion in reports.

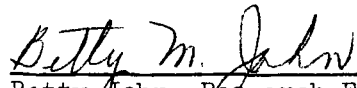
LINT DETERMINATION

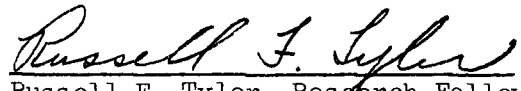
Blanket lint and ink train lint are both determined for each run by the methods described earlier in this report. Contact prints of the wax bearing lint from the blanket are made as a record of lint distribution.

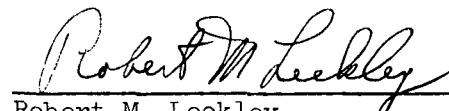
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APPENDIX

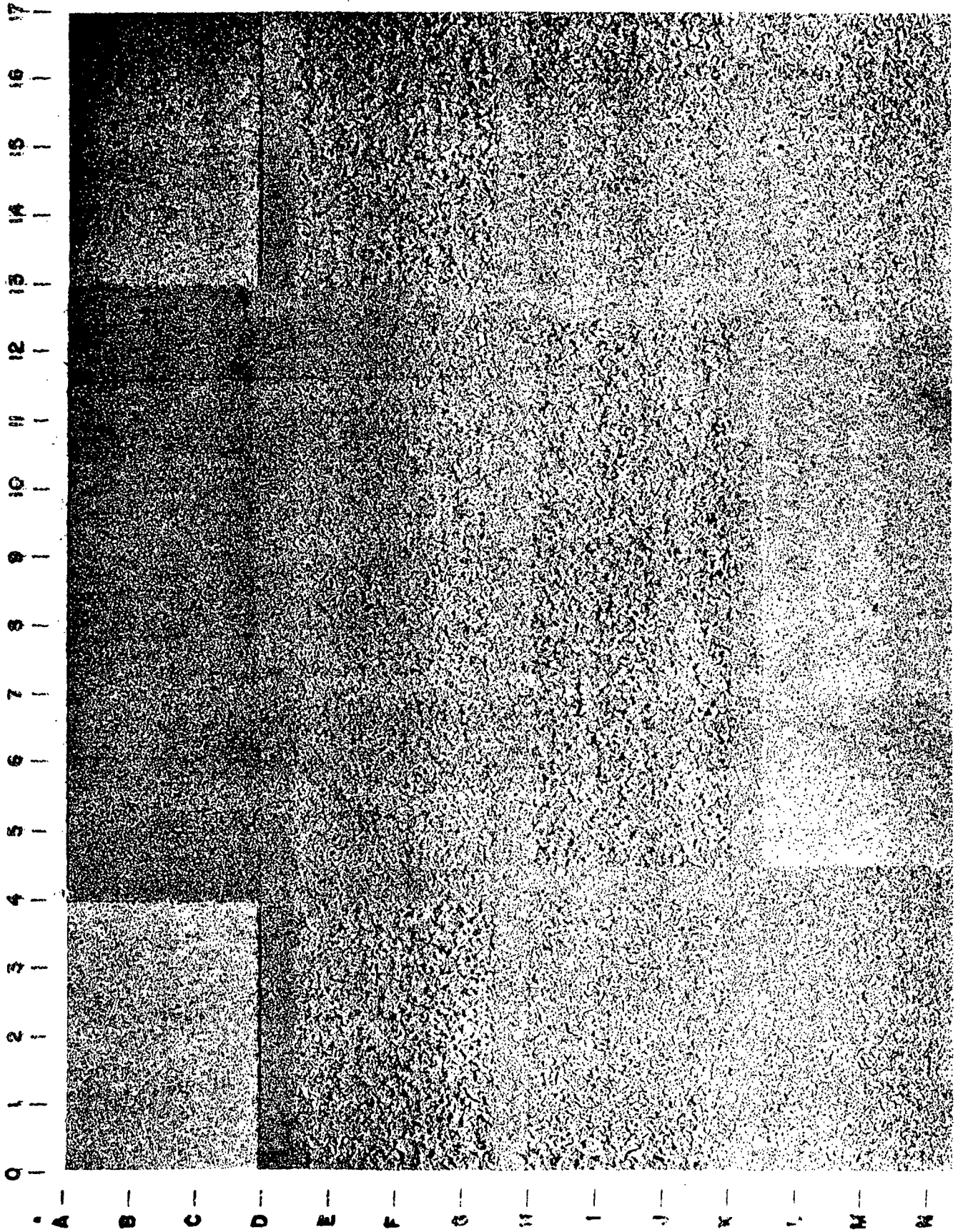


Figure 5. Contact Photograph of Lint Bearing Wax (Run 20)

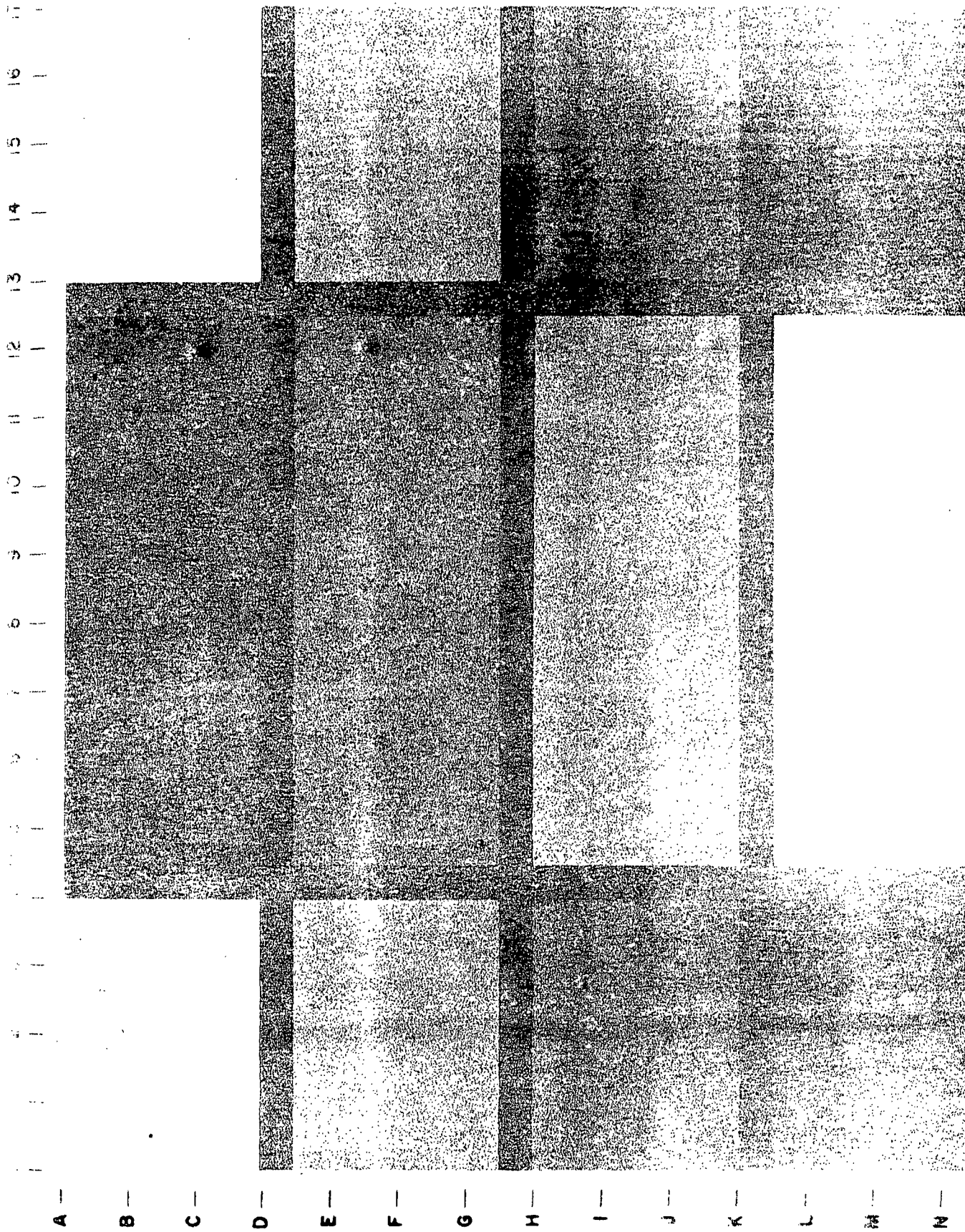


Figure 6. Print End of Run (Run 20)