The values are the mean of six curves, each paper being bent once in each direction.

From the load/elongation curves (Instron), it was also apparent that the first bend produces the greatest changes in the paper properties. Practically, this would infer that bending the paper beforehand would produce the major changes in the paper before printing commenced. Subsequent printing operations might therefore give rise to less running or printing direction registration difficulties.

Effect of bending on viscosity velocity product (VVP) required to produce pick

These tests were carried out on an IGT printability tester, using the letterpress technique at a spring tension of 35 kg. We concluded from the tests that—

1. The VVP for the unbent paper is always higher than that for the bent paper.
2. The VVP for the unbent paper in the machine-direction was always higher than in the cross-direction. This was earlier reported by Hsu.[14]
3. After bending, the VVP in the machine-direction was higher than in the cross-direction, but the percentage reductions in the VVP for machine-direction bending of heavyweight papers was greater than the percentage reductions for cross-direction bending. The reverse was true for lightweight papers.
4. In all cases except two, the VVP after bending was higher on the inside of the bend than on the outside.

Effect of bending on oil penetration rate

The paper oil penetration index is the value K in the expression $V_t = K\sqrt{\gamma t/\eta}$ and is effectively a measure of the volume of oil penetrating the paper in a given time, the unit chosen here was 25 sec. We determined K from graphs of the volume of oil penetrating unit area of paper against the square root of the time, using the IGT penetration volumeter.[15] High values of K mean high rates of oil penetration. Our results for three coated papers (Table 4) indicate greater collapse of the sheet when bent in the cross-direction than in the machine-direction. Any increase in oil penetration rate of the paper after bending at the first printing would increase the tack of the ink via vehicle absorption and would thereby enhance the likelihood of picking or wet pick.

Effect of bending on surface smoothness, air permeability and compressibility ratio

We measured changes in smoothness with the Bendtsen tester and found less effect with coated than with uncoated papers and larger effects with heavyweight than with lightweight papers. For air permeability changes measured with the Bendtsen tester, we found more effect on coated papers, suggesting that coating fractures on bending. Both these effects would assist cavitation in later printings. Compressibility ratio is the ratio of the air flow at pressures of 1 kg/cm² and 5 kg/cm². This ratio increased with bending for both coated and uncoated papers, more

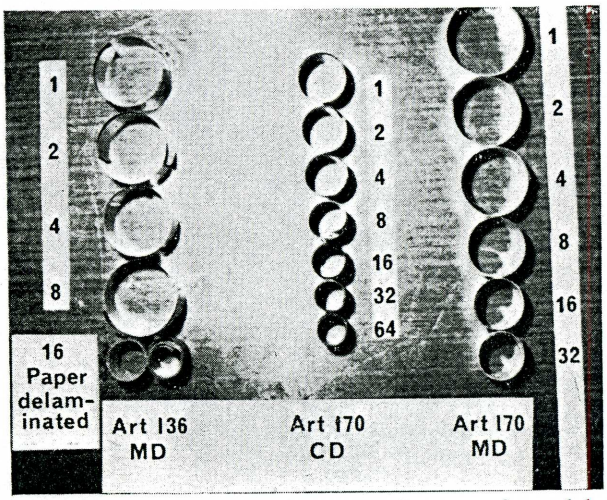

Fig. 10—Paper cylinder of various diameters formed by varying the number of bends

TABLE 4—PAPER OIL PENETRATION INDICES (K) FOR BENT AND UNBENT PAPERS

Art paper substance	$K \times 10^5$	*Art paper substance*	$K \times 10^5$	*Art paper substance*	$K \times 10^5$
170 g/m²	2	136 g/m²	2.6	102 g/m²	2.4
170 g/m², (bent in machine-direction)	6.5	136 g/m² (bent in machine-direction)	7.1	102 g/m² (bent in machine-direction)	4.9
170 g/m² (bent in cross-direction)	9.8	136 g/m² (bent in cross-direction)	11.3	102 g/m² (bent in cross-direction)	5.5

TABLE 5—PAPER CYLINDER DIAMETERS DUE TO CURL FOR VARIOUS NUMBERS OF BENDS

No. of double bends	*Cylinder diameter in mm for 170 g/m² art paper, cross-direction*	*Cylinder diameter in mm for 170 g/m² art paper, machine-direction*	*Cylinder diameter in mm (after 2 h) for 170 g/m² art paper, machine-direction*
0	—	—	—
1	32	57	48
2	30	48	40
4	28	45	39
8	27	40	34
16	26	35	29
32	22	31	27
64	21	31	26