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FROM PAPER-MILL TO PRESSROOM

ANCIENT PAPER-MAKING

The tools of the primitive paper-maker consisted of a pulp vat for the fiber-laden water, a frame, or mold across which was stretched a mesh of closely-spaced wires, and a removable frame known as the deckle; hence the term "deckle edged." The beating was done by iron shod hammers which were raised and released by cams on a shaft turned by water power: this machine called a stamper is shown in the foreground of this picture.

FROM
PAPER-MILL TO
PRESSROOM

By

WILLIAM BOND WHEELWRIGHT
Author of “How Paper is Made,” etc.

The Collegiate Press
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TO MY FATHER

George William Wheelwright

AND TO THE MEMORY OF HIS FATHER

WHO ENTERED THE PAPER BUSINESS IN 1834

THESE PAGES ARE

RESPECTFULLY INSCRIBED

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NOTE—*This book is printed on Wheelwright's "B.P.F." paper 25x38-70.*

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INTRODUCTION

In the following pages I have endeavored to present a treatise on paper free from confusing technicalities, yet sufficiently intimate to be of service alike to the manufacturer, the salesman, and the consumer of paper viewing the subject in a broad way from the paper mill to the pressroom. The manufacturer and the consumer may notice the omission of some details, as I have aimed to touch mainly on such points as are essential to a good understanding of the work-a-day problems of paper after it reaches the printer.

I am convinced that in many cases the problems of the pressroom are too slightly understood by the “paperman,” while the technicalities of paper-making are only too vaguely comprehended by the printer. I also feel that both should have at least an acquaintance with the history and progress of paper-making.

William Bond Wheelwright.

Appleton, Wisconsin,
January, 1920.

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CHAPTER ONE

THE TRADITION AND HISTORY OF PAPER-MAKING

It would be difficult to single out among the diversified objects of human investigation,” wrote John Murray in his remarks on “Modern Paper” (published in 1829), “a question more curious or interesting than the medium which bears the symbols that register the circumstances and events of past ages.... It is through such wonderful media that we are introduced into the multitudinous throng of a world’s tenantry, and from their inscription learn what they thought, and said and did.... In deciphering these transcriptions of ideas and memorials of humanity we virtually converse with minds long since numbered with those who people the world of spirits; and even the mummy from his cerements in his sycamore coffin, recovered from the vaults of eternal pyramids, talks with us by virtue of the roll of papyrus which he holds in his hand.”

From this substance of Egyptian origin is derived the name of its modern successor—paper. Paper, which in convenience and varied utility is as much in advance of its forerunner as papyrus was in advance of brick, stone, lead, copper, brass, leaves, bark, wood and skins, the successive media for the transcription of human thought.

The exact date of the origin of paper-making has probably yet to be discovered, though the researches of Dr. Aurel Stein and others have traced its antiquity back into the second century, B. C. (see Encyclopædia Britannica).

According to R. W. Sindall (“The Manufacture of Paper,” 1908), the earliest reference to the manufacture of paper is to be found in the Chinese Encyclopædia, wherein it is stated that Ts’ai-Lun, a native of Kuei-yang, entered the service of the Emperor Ho-Ti in A. D. 75, and, devoting his leisure hours to study, suggested the use of silk and ink as a substitute for the bamboo tablet and stylus. Subsequently he succeeded in making paper [2] from bark, tow, old linen and fish-nets (A. D. 105).

The art thus originated and nurtured by the Chinese remained to be transmitted to Europe by the Arabs after their conquest of Samarkand in A. D. 751.

The first centers of the industry founded in the eleventh century were in Spain, at Toledo, Valencia and Xativa. From Spain the craftsmen migrated to Sicily, Italy, France and the Netherlands.

A mill was established at Hainault, France, as early as 1190.

The oldest-known document on cotton paper is a deed of King Roger of Sicily, dated 1102. It is probable that the famous mills of Fabriano sprang from Sicilian sources; their establishment was followed in 1360 by a mill in Padua, and later in Treviso, Bologna, Palma, Milan and Venice, while the first paper-mill of Germany was that of Ulman Stromer at Mainz in 1320.

A most interesting account of this period of paper-making is given as follows by Harold Bayley in his volume, “A New Light on the Renaissance:”

“In the Dark Ages there existed in the south of France a premature civilization far in advance of that of the rest of Europe. Among the arts and industries that flourished in Provençe and the surrounding districts, paper-making was one of the foremost. Not only was this district the cradle of European paper-making, but for many centuries it remained the center of this industry.

“The freedom and prosperity of Provençe attracted large numbers of persecuted Jews and heretics, who took refuge there, and by their industry and intellect augmented the power and influence of the country. So deeply, indeed, did heresy enter into the politics of Provençe, that in 1209 the Church of Rome considered it necessary to launch a crusade against the infected district.

“During a period of twenty years the heretical inhabitants were either extirpated or driven into perpetual [3] exile. Those who escaped carried with them a passionate affection for their destroyed fatherland, and an undying hatred against the tyranny of the Church of Rome.

“It will be shown that from the appearance of the first water-mark in 1282 these mysterious marks are, speaking broadly, the traditional emblems of Provençe.

“From the fact that fundamentally the same designs were employed all over Europe, we can deduce the inference that Provençal refugees carried their art throughout Europe, just in the same way as at a later period and under somewhat similar circumstances Huguenots carried new industries into strange countries. It will also be shown that the same code which unlocks many of the obscurities of paper-marks elucidates the problems of printers’ marks, and evidence will be brought forward that paper-makers and printers were originally in close touch with each other, held similar views, and were associated in identical aims.”

Gradually the secrets of the craft pursued their northward trail into the Netherlands. Saardam, in the Duchy of Holland, became in the eighteenth century an important center, employing, it is said, one thousand persons.

In England, which for many years imported all its paper, the first mill was erected about 1498, as is attested by an entry for that year in the privy-purse expenses of King Henry VII. Further corroboration is also to be found in the following quaint verse from Wynken de Worde’s edition of “De Proprietatibus Rerum”:

And John Tate the younger Joye mote he broke,
Which late hathe in England doo make this paper thynne
That now in our Englyshe this book is written inne.

England, however, achieved no reputation for fine papers until the establishment of the famous James Whatman, in 1760.

In the meantime, the trade had taken root in our own country when, in 1690, William Rittenhouse started [4] the first American mill on the Wissahickon river at Roxborough, near Philadelphia, and thirty years later New

England’s first mill was established by David Hinchman at Milton, Massachusetts.

The migratory characteristics of the trade were made possible by the simplicity of the machinery which was required in these times. Pictures of early mills depict a mortar and pestle in which to macerate the rags to pulp, a small vat for the paper stuff, a mold on which the paper was formed, and a screw press with which to squeeze out the water from the new-formed sheets.

Mechanical improvements came with painful slowness, and no doubt each small advance was a jealously guarded secret.

The mortar and pestle were succeeded by a machine mechanically imitating the handwork of beating the rags to pulp. This was called a stamper. The old mortar remained, but the beating was done by iron-shod hammers, which were raised and released by cams on a shaft turned by water-power. Note the stamper in the foreground of the picture of Ancient Paper-making on page II.

The Dutch improved upon this device by the invention of the Holland beating engine about 1770, which in its essentials is practically the same thing to-day on a much larger scale.

Until the year 1798 there had been no further advance in mechanical inventions for paper-making, but let us pause a moment for a consideration of the paper itself.

The early raw material consisted solely of cotton and linen rags, and there was very little variety of output. Until 1750 all the paper was made on molds, the seats of which were made by fine parallel wires supported by heavier wires, which ran at right angles to them. Consequently all the paper was what is called “laid.” In 1750, at the instance of the famous Printer Baskerville, a mold was made with a woven-wire seat, and the first “wove” [5]
paper was used in his famous Edition of Virgil.

The characteristics of the earlier paper are well summed up by Mr. De Vinne in an article on woodcut printing which appeared in Volume XIX, No. 6, of *Scribner’s Magazine*, a reading of which impresses one with the limitations of ancient paper-making as contrasted with the complexity of modern paper-making, and all the study which its variations impose upon the modern printer who seeks proficiency.

“Much of the paper made in the sixteenth century,” he says, “was unsuitable for woodcuts. By far the larger portion was made of linen stock, hard and rough as to surface, laid, or showing the marks of the wires upon which the pulp had been crushed, or ragged edges, unsized and very sensitive to dampness, uneven in thickness, usually thin in the center and thick at the edges.…

“The paper selected was, in most cases, too rough and hard to be forcibly impressed against the delicate lines of fine woodcuts. It was the usage everywhere to soften the paper by a careful dampening.

“When the paper was sized it was more weakened by this dampening, which really lightened the labor of the pressman. But unsized paper was only about half the price of sized, and the inducement to use it was great. The unsized paper was dampened with difficulty, it greedily sucked up water, and when fully wet became flabby and unmanageable. Under searching pressure of the woolen blanket which was always put between the paper to be printed and the printing surface, this flabby paper was forced around the finer lines of the cut, making them much thicker than was intended.”

Let those whose shallowness leads them to regard modern paper-making as an abortion of a once noble art take thought!

The transition from the old ways of paper-making to modern processes was sudden. The century which gave [6]
them to us stands out in radiance against the dark ages of heavy toil at the vat and press.

First came the mechanic whose genius caused tons to be produced in the time that pounds were made of yore. Next came the chemist who developed unthought-of raw materials to supply the ever-growing demands of “papivorous” civilization, until it has been said with so much truth that ours is the paper age.

In 1798 an obscure French workman, Louis Robert, of Essonne, announced that he “had discovered a way to make, with one man, and without fire, by means of machines, sheets of paper of a very large size, even twelve feet wide and fifty feet long.”

Times were hard on the continent, yet the Government of France, recognizing the importance of the invention, awarded Robert eight thousand francs and a patent for fifteen years. Furthermore, permission was given to carry over the small working model to England, with the hope of interesting British capital.

A successful attempt to make paper on Robert’s machine having been made in the mill of François Didot, in France, Leger Didot purchased the patent and, accompanied by an Englishman of the appropriate name of John Gamble, proceeded to England and employed Mr. Bryan Donkin to construct a machine.

Being in need of funds, they interested two wealthy London stationers, Messrs. Henry and Sealy Fourdrinier, in their proposition, and in 1804 the first successful machine was started at Frogmore. Much credit is due Mr. Donkin, by whose ingenuity the mechanical difficulties were mastered, but the Fourdriniers, for whom the machine was named, are no less entitled to the honor, as their persistent faith in the machine finally led them into bankruptcy.

After having expended sixty thousand pounds and being reduced to penury, they finally petitioned
Parliament for compensation for their losses. Their labors were fortunately appreciated, and a sum of seven [7]
thousand pounds was voted them.

Surely all these early pioneers deserve a place in the hall of fame beside that of Gutenberg.

In 1812 the type of machine known as “cylinder” was invented by John Dickinson, whose name is still associated with paper-making, and so different is the machine in principle that Dickinson’s name should also be placed alongside of Robert’s as a benefactor to mankind. Neither of these machines had any means for drying paper, consequently their production was decidedly limited. This lack was supplied by the invention of driers by T. B. Crompton in 1821, who later took out a patent for slitter-knives. Suction boxes were contributed by the ingenuity of M. Canson, a Frenchman, in 1826. John Wilks, an Englishman, produced the first dandy roll in 1830, while Thomas Barratt conceived the idea of making water-marks by means of this roll.

And so, one after another, various useful additions came into existence, until we have the modern paper-machine, which differs mainly in width, length and productive power from the machines of the thirties.

In the meantime, researches for new paper-making materials had been in progress. As early as 1719, Reamur, observing how wasps made their nests from wood, threw out the hint to paper-makers, but for over a century there was no important result.

In 1727, Dr. Brueckmann, a German naturalist, published a work on stones, four copies of which are said to have been printed on paper made with asbestos.

In 1751 M. Guettard in France published his experiments and showed samples of paper made from bark, leaves and wood; while in 1765 Jacob Christian Schaffers, of Ratisbon, published a volume, a copy of which exists in the Smithsonian Library, upon the different sorts of paper he could make without rags.[A]

[A] A copy of the second edition of this work is in the Library of the University of Michigan at Ann Arbor.

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Matthias Koops in 1801 printed some account of his patents for utilizing waste papers, straw and wood. This volume, printed on straw paper, with one signature on paper claimed to be made of wood, is well worth reading, and is to be found both in the Boston Public Library and in the Harvard College Library, and quite likely elsewhere.

These experiments are only interesting as forerunners. In their own time they came to naught. Not until 1840 was ground wood-pulp invented by Keller.

The production of cellulose from straw and esparto by the soda process was discovered by Routledge, an Englishman, in 1860, while the first patents for making wood soda pulp were those of Watt and Burgess in 1854.

To an American belongs the credit for the important invention of the sulphite process, Benjamin C. Tilghmann, of Manayunk, Pennsylvania, having taken out the first patents in 1866.

Although excellent fiber was obtained, the engineering difficulties proved so serious that experiments were temporarily abandoned in the United States. But the process was afterward put upon a successful commercial basis by Fry and Ekman, at Berzwik, Sweden, in 1870. Americans soon took up the problem with renewed energy, and the late Charles S. Wheelwright, of Providence, Rhode Island, after a visit to Sweden in 1882 on which he obtained the rights to the Ekman patents, introduced the process at the plant of the Richmond Paper Company, in Providence, and while a commercial success was not realized, it was an important step in the development of the industry, and not many years passed before the United States gained a leading position in the production of wood-pulps.[B]

[B] See Little & Griffin, “The Chemistry of Paper-making.”

Thus in less than ninety years, from Robert’s invention of 1798 to the early eighties, the world witnessed a complete revolution of the paper industry, which had struggled along in the same old rut for some two thousand years.

To-day the United States leads the world in the production of paper. According to the census of 1909, we 9
produced 4,216,708 tons, valued at $232,741,049, an amount which exceeds in tonnage the combined production of England, Germany, France, Austria and Italy.

Well may we be proud of this great industry, which after all is largely the reflection of a nation’s intelligence and culture, and commercial activity.

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CHAPTER TWO

RAW MATERIALS

Paper has been defined as “an aqueous deposit of cellulose,” and while this is incomplete as a catalogue of the materials composing a sheet of modern paper, it is an excellent epitome of the foundation of paper-making. Minute cellulose fibers, derivatives of various raw materials, are deposited upon a wire cloth by the passage of a volume of water in which they have been suspended. The pulpy film thus formed becomes a sheet of paper, after the expulsion and evaporation of the water which served as a medium for their deposit.

The minute fibers composing this hypothetical sheet of paper may have been isolated from one of several sources of raw materials in present commercial use, or the sheet may be composed of a mixture of different fibers, all more or less pure cellulose, in accordance with the preliminary treatment each has undergone.

The principal sources from which American paper fibers are derived are cotton and linen rags, hemp, jute, wood, straw; and waste papers.

Previous to the year 1840, the sources were limited to rags. These are almost wholly composed of pure cellulose fibers, which give up their non-cellulose concomitants with slight resistance. The more severe chemical treatments necessary for the isolation of cellulose fibers, from wood, for example, half of which is non-cellulose in structure, were unknown to early paper-makers, and only became possible after the discovery of bleaching-powder by Tennant, and the manufacture of soda by Le Blanc.

Although experiments in search of suitable substitutes for rags began to be made in the eighteenth century, it was Keller’s invention of ground wood in 1840, Routledge’s work on esparto grass and wood with a soda 11
process in 1854, and our own fellow countryman Tilghmann’s patent of the sulphite process in 1866, from which we may date the beginnings of the now extensive use of materials other than cotton and linen wastes.

The accompanying table, taken from the United States Statistics of Manufacture for 1909, gives an illuminating indication of the rapid growth of our paper industry, and also shows the remarkable increase in the use of wood celluloses.

Note.—Statistics are taken from U.S. Reports for 1909. Subsequent reports are obtainable from the Director of the Census, Washington, D.C.

It may be observed that the percentage of increase in the use of wood-pulp of all kinds for the decade 1899–1909 was 111.6, and of rags, 50. Approximately four and one-quarter millions tons of paper were produced in 1909, for which the fibers used figured in the following proportions:

	Per Cent.
Wood-pulp	61.6
Old and waste papers	21.4
Rags	7.8
Straw	6.6
Manila (rope)	2.6

Of the total amount of wood fibers, the various proportions were approximately as follows:

	Per Cent.
Ground wood	47
Sulphite pulp	42
Soda pulp	11

A further investigation as to the species of woods used shows that, while spruce is still the most important, contributing nearly 60 per cent, other woods are being increasingly used.

Another noteworthy fact is the mighty increase in imports of wood-pulps, which jumped from 33,319 tons in 1899 to 307,122 tons in 1909, an amount equal to 12 per cent of all that is used in the United States.

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	1909	1904	1899
MATERIALS			
Total cost	$165,442,341	$111,251,478	$70,530,236
Pulpwood, cost	$33,772,475	$20,800,871	$9,837,516
Wood pulp, purchased:			
Tons	1,241,914	877,702	644,006
Cost	$43,861,357	$27,633,164	$18,369,464
Ground—			
Tons	452,849	317,286	261,962
Cost	$9,487,508	$5,754,259	$4,361,211
Soda fiber—			
Tons	154,626	120,978	94,042
Cost	$6,862,864	$5,047,105	$3,430,809

Sulphite fiber—			
Tons	626,029	433,160	273,194
Cost	$27,184,726	$16,567,122	$10,112,189
Other chemical fiber—			
Tons	8,410	6,278	14,808
Cost	$326,259	$264,678	$465,255
Rags, including cotton, flax waste and sweepings:			
Tons	357,470	294,552	234,514
Cost	$10,721,559	$8,864,607	$6,595,427
Old and waste paper:			
Tons	983,882	588,543	356,193
Cost	$13,691,120	$7,430,335	$4,869,409
Manila stock, including jute bagging, rope, waste, threads, etc.:			
Tons	117,080	107,029	99,301
Cost	$3,560,033	$2,502,332	$2,437,256
Straw:			
Tons	303,137	304,585	367,305
Cost	$1,460,282	$1,502,886	$1,395,659
All other materials cost	$58,375,515	$42,517,283	$27,025,505
PRODUCTS			
Total value	$267,656,964	$188,715,189	$127,326,162
Newspaper:			
In rolls for printing—			
Tons	1,091,017	840,802	454,572
Value	$42,807,064	$32,783,308	$15,754,992
In sheets for printing—			
Tons	84,537	72,020	114,640
Value	$4,048,496	$3,143,152	$4,336,882
Book paper:			
Book—			
Tons	575,616	434,500	282,093
Value	$42,846,674	$31,156,728	$19,466,804
Coated—			
Tons	95,213	(2)	(2)
Value	$9,413,961	(2)	(2)
Plate, lithograph, map, woodcut, etc.—			
Tons	6,498	19,837	22,366
Value	$555,352	$1,458,343	$2,018,958
Cover—			
Tons	17,578	22,150	18,749
Value	$1,982,853	$2,023,986	$1,665,376
Cardboard, bristol board, card middles, tickets, etc.—			
Tons	51,449	39,060	28,494
Value	$3,352,151	$2,764,444	$1,719,813
Fine paper:			
Writing—			
Tons	169,125	131,934	90,204
Value	$24,966,102	$19,321,045	$12,222,870
All other—			
Tons	29,088	14,898	22,503

Value	$4,110,536	$2,928,125	$3,673,104
Wrapping paper:			
Manila (rope, jute, tag, etc.)—			
Tons	73,731	86,826	89,419
Value	$6,989,436	$6,136,080	$5,929,764
Heavy (mill wrappers, etc.)—			
Tons	108,561	96,992	82,875
Value	$4,380,794	$4,035,588	$4,143,240
Straw—			
Tons	32,988	54,232	91,794
Value	$870,419	$1,389,348	$2,027,518
Bogus or wood manila, all grades—			
Tons	367,932	228,371	203,826
Value	$19,777,707	$10,099,772	$9,148,677
All other—			
Tons	179,855	177,870	67,338
Value	$10,202,035	$8,774,804	$3,293,174
Boards:			
Wood pulp—			
Tons	71,036	60,863	44,187
Value	$2,639,496	$2,347,250	$1,406,130
Straw—			
Tons	171,789	167,278	157,534
Value	$3,750,851	$4,367,560	$3,187,342
News—			
Tons	74,606	38,560	32,119
Value	$2,215,469	$1,174,216	$930,531
All other—			
Tons	514,208	253,950	131,777
Value	$17,539,768	$9,070,531	$4,829,316
Other paper products:			
Tissues—			
Tons	77,745	43,925	28,406
Value	$8,553,654	$5,056,438	$3,486,652
Blotting—			
Tons	9,577	8,702	4,351
Value	$1,186,180	$1,046,790	$580,750
Building roofing, asbestos, and sheathing—			
Tons	225,824	145,024	96,915
Value	$9,251,368	$4,845,628	$3,025,967
Hanging—			
Tons	92,158	62,606	54,330
Value	$4,431,514	$3,013,464	$2,265,345
Miscellaneous—			
Tons	96,577	106,296	49,101
Value	$6,869,169	$6,729,820	$2,795,841
Wood pulp made for sale or for consumption in mills other than where produced:			
Ground—			
Tons	310,747	273,400	280,052
Value	$5,649,466	$4,323,495	$4,433,699
Soda fiber—			
Tons	155,844	130,366	99,014
Value	$6,572,152	$5,159,615	$3,612,602
Sulphite fiber—			
Tons	444,255	376,940	271,585

Value	$17,955,748	$13,661,464	$10,451,400
All other products, value	$4,738,549	$1,924,195	$919,415
WOOD PULP			
Quantity produced (including that used in mills where manufactured), total tons	2,495,523	1,921,768	179,535
Ground, tons	1,179,266	968,976	586,374
Soda fiber, tons	298,626	196,770	177,124
Sulphite fiber, tons	1,017,631	756,022	416,037
EQUIPMENT			
Paper machines:			
Total number	1,480	1,369	1,232
Capacity, yearly, tons	5,293,397	3,857,903	2,782,219
Fourdrinier—			
Number	804	752	663
Capacity per 24 hours, tons	10,508	8,569	(3)
Cylinder—			
Number	676	617	569
Capacity per 24 hours, tons	6,316	4,740	(3)
Pulp:			
Grinders, number	1,435	1,362	1,168
Digesters, total number	542	517	426
Sulphite fiber, number	348	309	(2)
Soda fiber, number	194	208	(2)
Capacity, yearly, tons of pulp	3,405,621	2,644,753	1,536,431
Ground, tons	1,809,685	1,515,088	(2)
Sulphite, tons	1,250,983	885,092	(2)
Soda, tons	344,953	244,573	(2)

Table from United States Statistics of Manufacture for 1909, Showing Rapid Growth of Paper Industry.

The comparative statement follows:

Kind of Wood.	Quantity, in Cords, of Pulpwood Consumed			
	1911	1910	1909	1908
Total	4,328,052	4,094,306	4,001,607	3,346,953
Spruce, domestic	1,612,355	1,473,542	1,653,249	1,487,356
Spruce, imported	903,375	902,407	768,332	672,483
Hemlock	616,663	610,478	559,657	569,173
Poplar, domestic	333,929	315,717	302,876	279,564
Poplar,				

imported	34,295	45,359	25,622	22,653
Balsam fir	191,779	132,362	(1) 95,366	(1) 45,309
Pine	124,019	105,882	90,885	84,189
Beech	44,320	44,265	31,390	(2)
Maple	36,979	42,621	(2)	(2)
White fir	36,493	30,845	37,176	(2)
Cottonwood	25,043	31,099	36,898	45,679
All other	88,268	97,092	151,179	140,547
Slabwood, etc,	280,534	262,637	248,977	(3)

[1] Balsam.

[2] Included in “All other.”

[3] Included with other wood by species.

The high point of importation of chemical wood-pulp was reached in 1914, when approximately 3,600,000 tons came in from Europe and 92,000 from Canada. In January 1916 owing to the war, imports for the month from Europe dropped from an average of 30,694 tons to 12,985 tons, while Canadian pulp increased from an average of 7,654 to an actual importation for the month of 28,833 tons.

Although the use of wood now so heavily overshadows that of rags that it almost seems as though the latter 16
were being slowly abandoned, this is of course only relatively true, their consumption being actually greater than ever. The mere cost of the rags in 1909 was slightly in excess of the total value of all paper products recorded in the United States Census for 1850, a circumstance which leads us to wonder at the timely discoveries which made wood cellulose available.

It is evident, however, that to some extent paper history is already beginning to repeat itself. The visible supplies of wood are markedly less, as evidenced by their increasing costs, and we are forced to a much more active attitude than one of mere speculation as to what new sources may become available to supply our demand for paper, which has lately been increasing in the value of the annual products by almost 11 per cent.

In the decade from 1899 to 1909 shown by government statistics, book-paper advanced 104 per cent in quantity, but 120 per cent in value; writing-paper, 88 per cent in quantity, but 104 per cent in value; wrapping-paper, 43 per cent in quantity and 72 per cent in value. It is true that rising wages account in part for these changes in value, but above and behind all this stands the inexorable law of supply and demand.

The discrepancies between the percentages of increase in production and value serve to emphasize the increasing difficulties in obtaining raw material. That sprucewood is being consumed in this country faster than it is grown, is indicated by the recourse to less-favored species, as well as by the steadily increasing imports, both of pulpwood and wood-pulp. This situation emphasises the great importance of conserving waste papers, in spite of the fact that 21.4 per cent of the fiber used in 1909 in the United States were derived from waste papers. Vast quantities may readily be saved which now go to waste, as was definitely proved by England’s 17
experience during the war, when the imports of pulp were shut off and immediate substitutes had to be found.

This is a matter demanding the attention not only of printers, but of municipalities and nations. It offers an immediate source of relief from the drain on our forests and is hence a most practical form of conservation. Furthermore as demonstrated by the city of Cleveland the revenue from collecting waste papers assists substantially in offsetting the cost of the collection of municipal wastes.

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CHAPTER THREE

FUTURE FIBER POSSIBILITIES

The United States Department of Agriculture, in August, 1911, issued a treatise on “Crop Plants for Paper-Making,” in which the author, Charles J. Brand, concluded: “There is some skepticism as to the failure of pulpwood supplies, but this is certainly poorly grounded.

“During 1909 the quantity of spruce used was less by 40,000 cords than in 1907, but the cost was $2,000,000 greater. Present efforts in connection with reforestation of spruce and poplar are not extensive enough to produce any noteworthy effect upon the available supply within a generation.

“At the present rate of increase in consumption, it will require between 15,000,000 and 20,000,000 cords of wood for pulp and paper fiber in 1950. It will certainly be impossible to furnish this from the forests. If every acre cut over each year were reforested, it would be twenty-five or thirty years, or possibly even longer, before the trees could obtain sufficient size to warrant cutting. The forests can not recover from overdrafts continually being made on them. Hence it is only a question of a limited number of years until paper fiber must be grown as a crop, as are practically all other plants materials entering into the economy of man. While the conservation of only a few of the by-products of the farms yielding paper fiber can be accomplished profitably in the near future, and only a few of the plants promise to be money-makers immediately if grown solely for paper production, it seems very probable that raw products, now scarcely considered, may in a few years play an important part in the paper and pulp industry.”

Two lines of research are now being followed by the United States Government. The Forest Products Laboratory of the Forest Service is investigating a large number of coniferous and broad-leaved trees, which 19
have not hitherto been used in paper-making. These sources are likely to be the first which manufactures will turn to, as the processes involved are such as they are already familiar with, and the apparatus with which they are supplied is suitable.

The second line of research is being followed by the Bureau of Plant Industry, assisted by the Bureau of Chemistry, and is concerned with plants other than trees. Private investigations are also being carried on.

The following five requirements are given by the Bureau of Plant Industry, Circular No. 82, as to the availability of crop plants:

1. They must exist in large quantities.
2. They must be available throughout the year.
3. They must yield a relatively high percentage of cellulose.
4. The fiber cells or cellulose, must be of a highly resistant character, and must have length, strength and good felting qualities.
5. And must be of such a nature that the cost of obtaining the fiber will not be prohibitive.

Fibers complying with these conditions will come into commercial use whenever the increasing costs of wood-pulp reach a figure approximately equal to cost of producing cellulose from any other available source. Up to the present time this has not been brought about, but the steady increase in the cost of wood-pulp is approaching a level with which crop pulps may soon compete.

A synopsis of the fibers described in the circular referred to is given below.

Corn Stalks.—On account of the enormous supply, corn stalks were first taken up by the Bureau. The yield of stalks per acre is conservatively estimated at one ton, and the annual product is placed as at least 100,000,000 tons, of which not over one-third is believed to be utilized by the farmers. Three products have been derived from the stalks:

1. Long fiber suitable for paper-making, composing 12 to 18 per cent of the bone-dry weight. 20
2. Pith pulp, suitable for paper specialties, equal to 15 to 30 per cent bone-dry weight.
3. Corn-stalk extract, obtained by lixivaition, and of value as a cattle food, a ton of stalks yielding 200 to 300 pounds of soluble solids.

It would require an immense area to supply a mill of moderate capacity, and the question of whether the derivatives of corn stalks could be sufficiently valuable to overcome the costs of harvesting and hauling, has never been answered by any experiment on a commercial scale.

Broom Corn.—Broom corn contains a higher percentage of fibers than corn stalks. In laboratory and semi-commercial tests, fiber yields of 32 to 40 per cent have been obtained with a comparatively low consumption of chemicals. The Bureau claims that results “indicate that this material is suitable for immediate use in paper-making on the basis of quality of fiber produced and yield of fiber secured.” It is estimated that 450,000 tons is the approximate annual crop. Food extracts may also be obtained as well as the fiber.

Rice Straw.—The Chinese and Japanese have for years used rice straw in paper-making, and it is regarded by the Government investigators as one of the most promising crop materials, the annual crop approximating 1,500,000 tons.

Cotton-hull Fiber.—The lint adhering to the cotton hulls, after the long fiber has been removed, may be conserved as a by-product of the cotton-seed oil industry, and this fiber may be reckoned among the possibilities. Cotton stalks also have been the subject of experiment. The yield per acre, however, is not estimated at above 1,000 pounds, so that immense tracts would have to be covered in accumulating any considerable supply, and after the cotton crop has all been picked, negro help is very difficult to obtain.

BAGASSE.—Bagasse, or the refuse sugar-cane, is given rather scant consideration in the Government report. 21 Its individual fibers are short, and the percentage of pith is large. Several small plants have had discouraging experiences in attempting to put this material to commercial use. Nevertheless, recent experiments carried on in the interests of the United Fruit Company, under the Simmons patents, point to a promising result. Under this process the cane is not treated in the usual manner of crushing for the extraction of sugar. Instead, it is shredded, dried, and the pith separated from the fiber. The product is then shipped in bales to refineries, where the sugar is extracted.

This method is said to achieve an almost complete extraction of the sugar, whereas the old method of crushing loses about twenty per cent of the sugar and injures the fibers. The Simmons process does no damage to the fibers, which though short, possess excellent felting properties. The pith, being cellulose of a non-fibrous structure, has a value for other industries than paper-making.

FLAX STRAW.—There is an abundant annual crop of flax straw. The average yield per acre is about one ton, and the total annual production about 3,000,000 tons. In the opinion of the Government investigators, it is a "most promising" material.

There are practical pulp men who deprecate the findings of the Bureau of Plant Industry. Martin L. Griffin, chemist to the Oxford Paper Company, of Rumford, Maine, in an article appearing in Volume XI, No. 2, of *Paper* for March, 1913, makes the following statement:

"There is a popular view, which has been erroneously fostered by the Government, that there are exhaustless resources of waste fiber in our country, suitable for paper, and a substitute for wood. I once thought so myself. It is very natural to think that the discarded stalks of sugar-cane, corn, cotton, rice, flax, and other plants, which mature annually, would prove an abundant substitute for wood.

"These have all been exploited for twenty-five years to my personal knowledge, with no visible results. A 22 plant has one function to perform—it is to flower, fruit or make stalk. Its other functions are subordinate and produce only by-products. The stalk is the main product of the forest tree. No other fibrous material is so rich in cellulose; no other which lends itself so easily to paper-mill processing. It has no seasons of harvest; does not require curing; does not easily decay; requires no packing, and may be stored best in the rivers. All these waste stalks are pithy, bulky and perishable, and would require much labor to gather, pack and ship. These are but a few reasons why we may expect no practical results from this source. Wood fills a place no other material can. There is no substitute for it."

In this argument Mr. Griffin ignores the fact that esparto grass is a crop which gives a yield of cellulose practically equal to wood, and of equal, if not superior, quality. Although it is not available for American mills, it is worth citing in contradiction to the flat statement that "there is no substitute for wood." Furthermore, there is no evidence that the American crops furnish an inferior fiber, though the cellulose yield is less. It is quite possible that the low cellulose yield may be compensated for through the production of by-products along with the paper-making material. Hitherto, however, this low yield and other considerations, as expense of harvesting and packing, have been the factors which have retarded their development, but the increasing scarcity of wood, and its consequent advance in cost, is hastening the day when crop plants will become not only valuable, but necessary adjuncts to the paper industry.

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RAGROOM, PIONEER MILL, CRANE & CO.

The two girls in the foreground are sorting shirt cuttings. Those beyond are cutting them into suitable sizes preparatory to boiling.

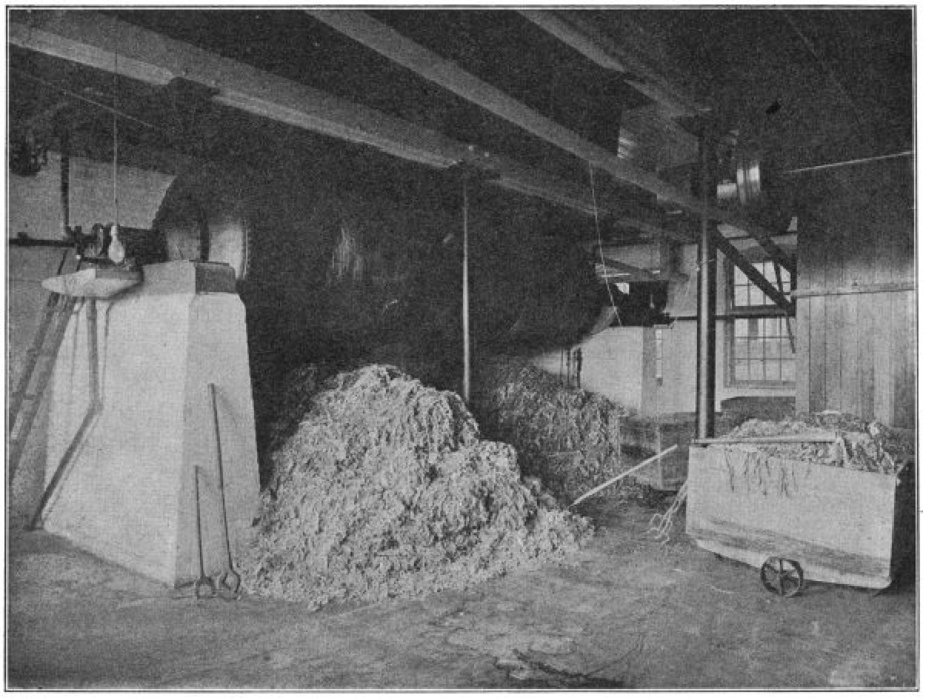
CHAPTER FOUR

THE CONSTITUENTS OF PAPER

The technique of paper-making varies greatly in accordance with each particular product. In fact, so wide is the range of paper products, that the different branches of paper-making severally require knowledge so special that an artisan in one branch might be as useless in another as if it were an entirely different industry. The coating of paper, for example, is an absolutely different trade from that of paper-making.

This remarkable diversification is entirely the development of a century, and principally the evolution of the past forty years consequent to the discovery of wood cellulose. To-day the products of the paper-mill are no longer confined to the use of pen or press. We ride on car wheels made in part of paper; sit in paper-seated chairs; drink from paper cups; eat from paper plates; use paper napkins; wrap our food in parchment paper; sheath our buildings with paper without, and wall paper or wall board within; keep out the rain with roofing paper if we please. Our shoes, even, contain a paper part, said to be more durable than leather. Millions of packages, mailing-tubes and boxes are made of paper. It is even spun into a kind of yarn and woven into imitation cloth, while a surprising imitation silk necktie is produced from wood-pulp. In electrical engineering, paper as an insulator is almost indispensable.

All these paper commodities, and more, too numerous to mention, require special machinery and treatment. To give an exhaustive treatment of the subject would require volumes, but for the purpose of this book we are principally concerned with printing and writing papers.



BOILER ROOM, CRANE & CO.

The contents of the rotary boiler have been emptied upon the floor. The next step is to wash and bleach.

Broadly speaking, there are five steps in the manufacture of paper:

1. The isolation of the paper-making fiber from the raw material.
2. The conversion of the fiber into pulp.
3. The beating and refining of the fiber, and the admixture of non-fibrous components.
4. The manufacture of the mixture into paper.
5. The finishing of the paper and its preparation for the market.

Cotton and linen rags, hemp, woods and plants each require their peculiar treatments. Cotton and linen, being the original paper-making fibers, will be considered first.

RAG STOCK.

Rag papers may be made from all sorts and conditions of rags, so the fineness of the finished product depends upon the newness and quality of the rags. New white cuttings from textile factories are the best, as their strength is unimpaired by previous use, and they may be prepared for manufacture with a minimum use of chemicals.

From this high standard, rags are graded down in accordance with their color, cleanliness and condition. The first sortings are made by stock-dealers, and the paper-maker orders whatever grades are suitable to his purpose. After their receipt at the mill, the bales of rags are opened, dusted by machine and distributed to girls, who sort them, open up the seams so as to release hidden dirt, remove buttons and other foreign material.

In the making of the highest grades, the new white rags are cut by hand into small pieces of uniform size, but ordinarily they are fed into a mechanical rag cutter. After this they are passed through a dusting machine to rid them as far as possible from dirt and foreign matter, which might otherwise appear as specks in the paper.

Boiling.—Dyes and greasy matters are associated with the fibers, and in order to obtain the pure cellulose fiber the rags are cooked, under steam pressure, in rotary boilers with alkali. This saponifies and dissolves the non-cellulose compounds, and the soda in combination with these soluble materials is subsequently washed out. 27
The amount of steam pressure, the quantity of chemicals, and the duration of the cooking, are subject to variation under different conditions. At the conclusion of the process the manholes in the boilers are opened, and the contents are deposited on the floor, later to be transferred to the washer room.

Washing.—A washing engine consists of an oval tub about four feet high. It is divided longitudinally by a partition or "mid-feather," with a passage left at either end for the circulation of the stock. On one side is located a large roll, having a continuous parallel series of knives horizontally inserted in its surface. The floor of the engine slopes gently to a point under the roll, where a bed plate is set. Behind the roll is a raised partition or dam, over which the stock is thrown as it passes between the beater roll and the bed plate. This is known as the "back-fall," and assists in the circulation. The roll may be raised or lowered over the bed plate, and by this means the breaking of the stock is regulated.

Affixed to the tub are one or more washing cylinders, so arranged that they may be lowered into the stock. These are constructed in such a way that during the process of washing the water passes through their wire-covered surfaces and is drained into the hollow axle of the roll by an interior arrangement, called buckets. The axle, being open at one end, permits the wash water to escape.

At first the engine is partly filled with water, then the rags are gradually thrown in until the tub is full. The revolving roll keeps the mass in circulation, while the rags are broken and shredded as they pass beneath it. A continuous stream of fresh water runs into the tub, and in running out through the revolving washer drums carries off the dirt, but the fibers themselves can not pass through the wire coverings, so remain until cleansed.
Necessarily the water used must be free from sediment or mineral impurities, such as iron, otherwise it would 28
fill the stock with specks. Therefore, a filter plant is usually maintained.

Bleaching.—After the washing has been completed the drums are raised clear of the stock and bleaching liquor is introduced. This is an important step, and if not carefully managed may impair the stock. For instance, if bleaching is carried on at too high a temperature, the white color obtained will not be permanent, and discoloration will occur after the paper is made. Much of the paper, which at first displays a brilliant white color, will afterward take on a yellowish tinge, especially if it is exposed to light. A comparison between the century-old hand-made papers and modern "fine writings," makes the old papers appear a "natural" shade, but place both for a few hours in the sunlight and often the modern paper will fade, whereas the old sun-bleached papers remain unaltered. The high artificial bleaching does not insure permanent results.

After the bleach liquor has been thoroughly mixed in, the stock is discharged into drainers and allowed to stand for a week or more, until no traces of chlorine remain. In this state the pulp is known as "half-stock."

The treatment of hemp is so similar to that of rags that a description here of the process is superfluous.

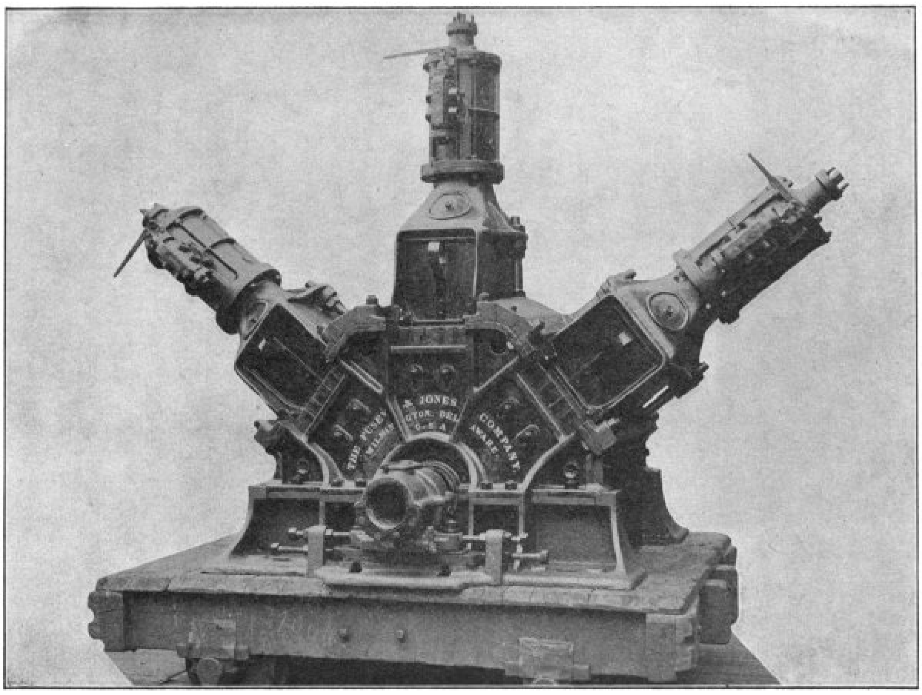
WOOD-PULPS.

Wood-pulps are of two classes, mechanical and chemical. In the lay mind there often appears to be some confusion between the two, leading to an unreasonable prejudice against papers made from either class. The fact is so generally known that news-print, one of the cheapest grades of paper, is made from wood, that the partially informed person is prone to think that all wood papers are of low quality, whereas paper of permanence and excellent quality may be made from the high grades of wood cellulose chemically prepared.

Ground Wood.—The mechanical, or ground wood, as its name implies, is made by grinding logs from which 29
the bark has been removed. The logs are shipped, or floated from the lumber camps to the mills, where they are cut to convenient length and the bark is removed. Next they are taken to the grinders. One type of grinder consists of a vertical grindstone encased in an iron jacket. There are three pockets over its circumference into which the logs are placed. They are held by hydraulic pressure against the revolving stone, over which flows a stream of water, and are rapidly reduced to fibers. These fibers are carried by the flowing water into a chamber below the grinders, passing through a screen which catches the coarser bits, the fibers of suitable size thus being separated from the rest. This pulp is still not sufficiently fine or uniform, so it is pumped into screens and forced through the finely perforated plates. The fibers are carried through with a large quantity of water, and are formed into thick sheets by means of a so-called "wet machine."

Wet Machine.—The wet machine consists of a vat, in which a partially submerged hollow drum rotates. The surface is covered by a wire cloth, and the hollow axle of the drum acts as a drain for the fiber-laden water, which, in passing through the drum, deposits a film of fibers upon the revolving surface. This soft pulp film, continuously forming, is removed from the top of the drum by an endless felt running tangent to it, and held in close contact with it by a couch roll, the pressure of which causes the web of pulp to adhere to the felt.

The felt passes between two squeeze rolls, and the pulp adhering to the upper roll is wound up until a certain number of layers have accumulated, when it is cut across by a knife and removed as a thick sheet.



WOOD GRINDER

The sheets, folded to a convenient size, separated by alternate pieces of sacking, are put in a hydraulic press and squeezed to remove the water. The pulp is taken from the press about fifty per cent moist; the sheets are 31
separated from the sacking and are now ready for use or for shipment. It is also quite customary to ship the pulp without having pressed it. In this case it contains about 70% water, due allowance for which is made in billing.

This pulp contains practically all the constituents of the original wood, has little strength, inferior felting properties, and is not of permanent character. Its utility results largely from its cheapness. When made into paper with a suitable admixture of sulphite pulp, for strength’s sake, it proves to be admirably adapted for the fast-running newspaper presses, as ink dries upon it almost instantly.

It is also used in the making of boxboards, cheap cardboards, pie plates, wall papers, etc. It should, however, be strictly excluded from all papers of more than ephemeral purposes, because of its lack of permanence. The appearance of a paper containing much ground wood is inferior, as the color is poor and small shives of wood may be discerned on the surface. An easy and reliable way to ascertain the presence of ground wood is to moisten the paper with a drop of strong nitric acid, which develops a dark-brown stain if ground wood is present. Another good test is phloroglucine, which turns ground wood to a bright carmine shade. The quantity of ground wood is roughly indicated by the intensity of the stain.

BLEACHED GROUND WOOD

A quality of pulp intermediate between chemically produced wood cellulose and ground wood is obtained by bleaching an especially finely ground quality of pulp wood. This product is excellent as a filler for medium grades of paper, as it is opaque—fine, and of fair color. Nevertheless, it is open to the same criticism as other ground wood as to permanence, though in a less degree.

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CHAPTER FIVE

THE CONSTITUENTS OF PAPER—*Continued*

Chemical Wood-pulps.—Chemical wood-pulps are obtained by a variety of processes, all of which have as their object the isolation of the pure cellulose fiber by the dissolution of non-cellulose components. The same principles are applied to the treatment of esparto straw or other plants. The character of the pulp depends not only upon the nature of the wood, but also upon the solvents used and the duration and severity of the cooking.

The preparatory steps to any process by which chemical wood-pulp is made are identical with the preparation of trees for ground wood, only after the logs have been “barked,” they are reduced to chips by a mechanical “chipper.” The ordinary practice in America is to sort out any knotty or imperfect logs as they pass on a conveyor from the “barker,” and if the log it too faulty it is discarded. As it is desirable to have a uniform size of chips, the chips are passed through a screen for this purpose.

The chips are stored in bins convenient to the digesters. The digesters are of two types, rotary and stationary. The rotary type is horizontal and the stationary is vertical.

After the digester has been loaded with chips, the chemicals are introduced and the “cook” is carried on by means of high steam pressure. The strength of the chemicals, pressure of steam, and duration of cooking, are the principal factors in determining the result from any particular wood. Slow cooking at low temperatures yields the best results.

WET MACHINES WHERE THE PULP IS CUT OFF IN SHEETS, THE BROWN CO.

To the right are the hydraulic presses for removing moisture from the pulp. The pulp is shipped about seventy per cent moist.

Soda Pulp.—Soda pulp takes its name from the caustic soda which is used as a solvent. Rotary digesters are employed in its manufacture. The principal wood used for making soda pulp is poplar, though chestnut and aspen are also used. Soda pulp is soft in texture and of no great strength, but in combination with harder stocks 34
it lends mellowness to the sheet. It is almost one-third cheaper than bleached sulphite pulp, quotations for February, 1915, being $2.20 to $2.35 per hundredweight, whereas bleached sulphite was quoted at $2.80 to $2.95 per hundredweight. The prices since the war have risen over 100% and were quoted in September 1919 at $4.75 to $5.00 and $5.75 to $6.25, respectively. One reason for the difference in price between soda and sulphite pulps, is that the soda is recovered from the spent liquor, whereas in the sulphite process the liquors go to waste.

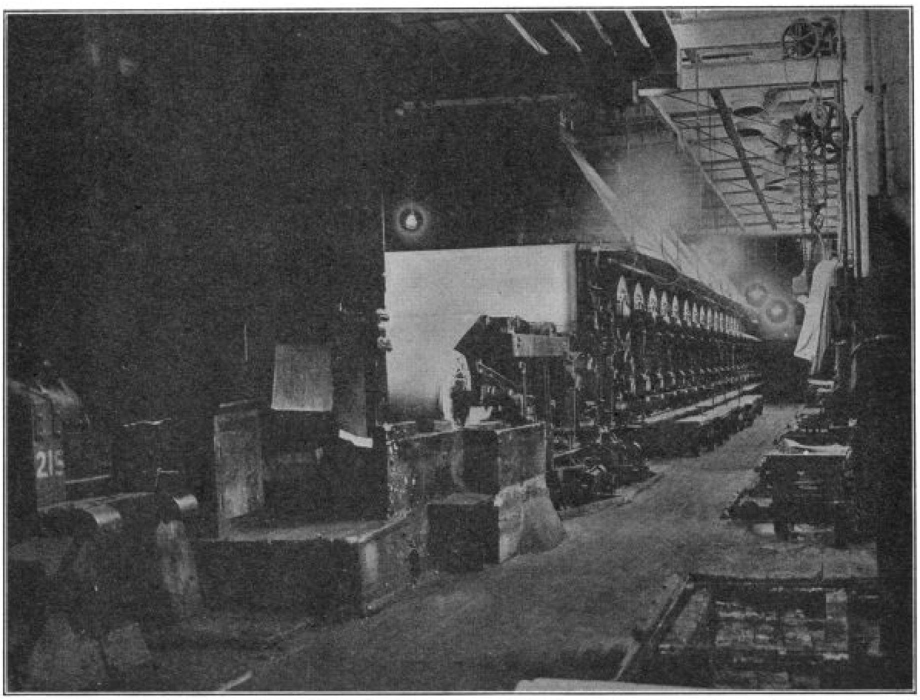
Sulphate Pulp.—The solvent used in making sulphate pulp is a mixture of caustic soda, sulphide of soda and sulphate of soda. Sprucewood, largely, is used and the pulp produced is exceedingly strong. Unbleached sulphate pulp is used, notably, in the making of Kraft wrapping-paper. The soda is recovered from the spent liquors.

Sulphite Pulp.—Sulphite pulp is produced by the use of bisulphite of lime; this, being acid, necessitates a special brick lining in the digesters, which are of the vertical type. Sprucewood is the best raw material and yields a strong, fairly long fiber, capable of being bleached to a good white color.

Mitscherlich Pulp.—A special method for making sulphite pulp was invented in Germany by Professor

Mitscherlich. It varies from the ordinary process in that the cook is continued over four times as long under lower steam pressure, and yields a fiber of greater strength.

The steps subsequent to cooking chemical pulps of all kinds are similar. After emptying the digesters, the soft, discolored mass of fibers is washed and bleached. The yield of cellulose fiber is close to fifty per cent of the air-dry weight of the wood. The shives and undigested particles are removed by screening, and the pulp is either run out like ground wood on wet machines, or made up into rolls, or sheets, on a paper-machine. The soda pulp is shipped in rolls and the sulphite in sheets, as this is the most favorable form in which to handle them at the paper-mill. If the pulp is to be used on the premises, it is made up into laps on the wet machine and is not artificially dried. The so-called “air dry” pulp contains about 10% moisture, and pulp containing not over this amount of moisture is billed at its actual weight. 36



CYLINDER MACHINE FOR DRYING PULP, THE BROWN CO.

The web of pulp is shown as it passes from the cylinder mold over the couch roll toward the driers.

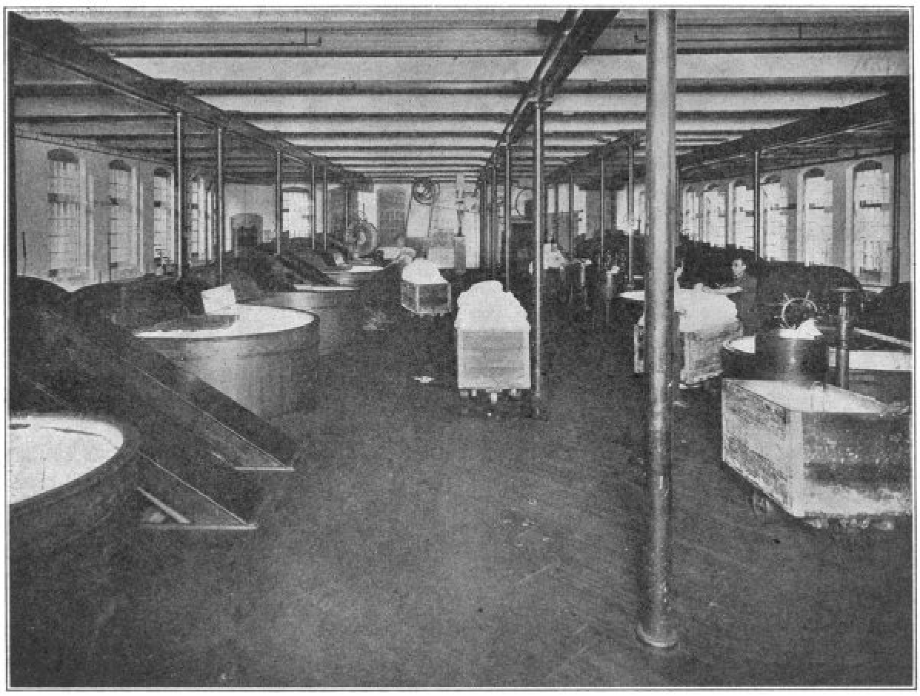
Esparto and Straw.—Esparto pulp is made by the soda process from a grass obtained in the circum-Mediterranean countries, and is used most extensively in England and somewhat on the Continent, but freights have been prohibitive for American manufacturers.

Straw pulp is similarly made, and while occasionally used on medium grades of writing-papers, its principal use in this country is for strawboard and cheap wrappings. It is expensive to reduce to a clean, bleached pulp on account of its knots, and the large quantities of silicious matter it contains.

Waste Papers.—The next largest source of paper-making fibers to wood is the waste paper, such as old books, magazines, newspapers, binders’ waste, paper shavings and miscellaneous waste. This stock is collected by regular packers, sorted, and sold by grade to the mills.

The poorest grade consists of a mixture of miscellaneous papers of all colors and description. It is only used in the production of boxboards, sheathing paper, and other coarse varieties, and without undergoing any preliminary treatment it is shoveled right into the beaters.

A higher grade consists only of mixed papers, printed or unprinted. Next is a grade containing no ground wood or colored papers, and above this are graded old ledger and writing papers.



THE BEATER-ROOM, CRANE & CO.

The beater at the far end of the room is equipped with a washing drum. This drum is lowered into the tub during the process of washing.

Paper trimmings are divided into four classes, white and mixed, soft and hard “shavings,” and are especially available, as they may be used after sorting and dusting without undergoing further treatment, but it is customary to macerate them in some sort of a pulper before placing with other stock in the beaters. The printed 38 waste must be boiled in a solution of soda ash. This makes the ink removable. After about six hours’ boiling, the stock is transferred to washers and treated like rags. The ink and dirt having first been removed, bleaching solution is introduced, and finally the stock is let down into drainers. In some mills the draining is omitted, the excess bleach is washed out and an antichlor added; then the stock is pumped over to a beating engine to be mixed with the other ingredients preparatory to manufacture. This process is less thorough, and there is more danger of getting residues of bleach into the paper, as it is rather a nice matter to exactly neutralize the bleach in the washer, and the maintenance of a uniform color is endangered.

Printers, or others, who accumulate large quantities of waste papers, will find that it pays to keep the various grades in separate receptacles, as a better price may be obtained for it in this way. Furthermore, by means of a baling press, the papers may be set aside in compact bales, which occupy less room and are not so great a fire risk as loose accumulations. The fact that 21.4 per cent of the paper-making fibers, according to United States Census Report, 1909, are derived from waste papers, indicates their importance as raw materials, while their use lessens the drain upon our forests.

THE NON-FIBROUS CONSTITUENTS OF PAPER.

The non-fibrous constituents of paper are the mineral fillers, the ingredients for sizing, and the coloring pigments and dyes. Mineral fillers should not be regarded as adulterants. They are used, not as a means for adding weight, but for the sake of certain effects which are requisite in many papers. No filler is used on good writings or ledgers, as the printing requirements do not call for a closely filled surface or a mellow texture.

In book papers a varying percentage of clay is used, as it improves the printing quality by filling up the 39 interstices between the fibers and increases opacity. Papers for half-tone printing require more filling, in order to have smooth, level surfaces.

There are several kinds of filler in common use. The most common is China clay, of which the cleanest and finest grades are obtained principally in England. No equally good deposit has yet been successfully developed in this country. Clay is a product of the natural disintegration of feldspar. It is soft, plastic, and non-crystalline.

Agalite and talc, which are silicates of magnesia, are also used. They are cheaper and less desirable, both on account of color and their crystalline nature, which is more or less damaging to cutter knives and printing-plates. These fillers are used widely in the cheaper book-papers, and can often be detected by holding a sheet against the light, as the little, translucent crystalline particles then appear like pinholes.

Sulphate of lime, commercially known under such names as gypsum, pearl hardening, satinite, etc., is a white, crystalline substance. This is used to some extent in paper-making, but principally as a coating.

Barium sulphate, prepared chemically, and known as blanc fixe, is used largely for coating papers because of its brilliancy and purity of color.

Sizing Materials.—Starch was one of the earliest materials used for sizing paper, and is used considerably in addition to other materials, as it adds a hard, tinny character desired by the trade on certain grades. Silicate of soda is also used to impart similar characteristics.

Gelatine, or animal size, is obtained by boiling down suitable animal tissues. As a sizing agent, it is applied after the paper is made by passing the web of paper through a vat containing the hot liquid size.

Casein, which is sometimes used as sizing, is more important in its functions as an adhesive for the making 40
of coated paper. It is prepared by treating skim milk with weak acid.

Rosin size, the most widely used size, is produced from rosin by cooking with soda ash, which produces a soft soap. The soap when mixed with water by agitation assumes a milky appearance. In this condition it is poured into the beater after all other ingredients have entered, and is precipitated by the addition of alum as a resinate of alumina.

Impurities in Paper.—Impurities, either chemical or physical, are sometimes found in paper, owing to lax methods or inferior materials.

Free acid occasionally occurs, and in some cases would be very deleterious. In papers that are to be bronzed, for example, this acid would tarnish the bronze. Needle papers, and paper for wrapping steelware, must be acid-free, otherwise they will cause rusting. The presence of free acid may only be determined by an analyst.

Sulphur, which may give rise to the formation of sulphuretted hydrogen, exists sometimes as an impurity in paper. It causes a brownish halo to appear around printed letters, because of its action on printing-ink. It would also cause oxidization of jewelry, mounted upon cardboard containing sulphur residues.

Free chlorine, or chlorine compounds, the result of inadequate draining of the stock, may cause final disintegration in the paper. It is the duty of manufacturers to guard against this and the other deficiencies noted.

Mineral impurities in paper are not uncommon. Minute particles of iron worn off the machinery, or getting into the stock in the shape of wire stitching, can often be discovered by the use of a magnet test. In photographic papers this must positively be excluded, but in most papers, if the particles do not show as specks, and are not large enough to make trouble for the printer, they are not a serious menace.

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CHAPTER SIX

PAPER-MAKING

We have now reviewed the various steps preparatory to the process of beating, and this process is perhaps the most important of all. The output of a mill depends, first, upon the quality of stock which is furnished to the beaters, and secondly, on the way the stock is handled in the beaters. A formula, better known as a “furnish,” is prepared by the superintendent and given to the beater engineer. This tells him exactly how to blend his raw materials. Very few papers are made from one kind of material alone, most papers being a mixture of different fibers, with the addition of mineral filler, sizing and coloring. All the ingredients are put together into the beating engine with a large volume of water similar to a washer, minus the washing drums.

BEATING.

The process is called beating because it has displaced the original method of maceration by mallets and later by the machine described in Chapter I as a “stamper.”

The ultimate characteristics of the paper are dependent upon the handling of the beater roll and the character of the knives. For example, a blotting-paper is made by a quick beating with sharp knives. This cuts the fibers clean and short and leaves them in a most absorptive condition. The very same fibers, treated with dull knives and slowly beaten, would have an entirely different character. Their ends would be teased out and ragged, and in the process of manufacture they would part very slowly from the water absorbed. The paper produced would have the characteristics of a writing-paper, hard and strong. This instance will afford some idea of the wide variation in results which may be brought about by varying the treatment in the beaters. So 42
important is this step in manufacturing that it has been said with a good deal of truth that “the paper is made in the beaters.”

After the process has been continued a sufficient length of time, the stuff is emptied into a chest called the “Jordan chest,” because it acts as a reservoir for another type of refining engine known as the “Jordan.” This engine is conical in shape and the inside is lined with knives. A cone-shaped plug, also shod with knives, fits into this shell, and by the turn of a screw may either be moved in or out, thus varying the space between the two sets of knives. By this adjustment the refining of the pulp which flows through the engine is regulated.

The stock passes through one or more of these “Jordans” into the machine chest. Thence it is pumped to a level higher than the machine, and flows through “sand settlers” to a screen. The “sand settler” is a long, open trough containing a series of baffle boards which collect any sediment, preventing it from getting into the paper.

Screens are of various types, the main feature consisting of bronze plates pierced with fine slots through which the fibers are forced. The object is to give uniformity to the stock which reaches the machine, and to exclude any knots of stock, strings or foreign substances.

The width of the slots is varied to suit different stocks—some slots being as fine as 10/1000 of an inch.

We have now described the process of paper-making up to the point where the stuff is formed into paper, and must pause for a description of the paper-machine itself.

PAPER-MACHINE.

The paper-machine may be considered in three parts: The wet end where the paper is formed and pressed, the middle, where it is dried, and the dry end, where it is calendered, slit and wound.

There are two distinct types of wet ends—the Fourdrinier and the cylinder. Both are mechanical 43
reproductions in continuous process of the steps taken in the ancient hand methods, a brief consideration of which impresses clearly on one’s mind the rationale of the machine.

HAND PROCESS.

The tools of the primitive paper-maker consisted of a pulp vat for the fiber-laden water, a frame, or mold, across which was stretched a mesh of closely woven wire, and a removable frame, known as the deckle, which fitted around the edge of the mold to keep the moist pulp from overflowing and to help regulate the thickness of the paper.

Grasping the mold by two opposite sides, the vatman submerged the mold in the water; then raised it out, holding it level. By this means a film of pulp was caught up, being deposited on the bottom of the mold by the passage of the water in which the fibers had been suspended. A lateral shaking motion served to knit the fibers together, and to deposit them as evenly formed as possible all over the mold. As the water drained through, the film of pulp solidified. Then the deckle frame was removed, and there, on the top of the mold, was a sheet of moist pulp. The edges of this sheet would be thin and feather-like as a result of the pulp leaking under the deckle. Hence the term deckle edge.

It required a great deal of skill to remove this film, while preserving it intact. This was accomplished by inverting the mold and pressing the sheet upon a moist felt cloth. If the act was skilfully performed, the mold could be lifted away from the sheet, leaving it unbroken upon the felt. Then it was covered by a second piece of felt and the process was repeated until a small pile had accumulated.

The pile was removed to a screw press, wherein as much water as possible was squeezed out of the paper. Cellulose fibers have a strong affinity for water, however, and it is said that under any pressure which such a pile could withstand, without becoming crushed and gruelly, the paper would retain water equal to one-half its 44
weight. Hence, the last vestiges of moisture, excepting of course that amount normally retained by air-dried paper, had to be removed by evaporation. In the old days, this was accomplished by hanging the sheets over poles to dry.

After that, if the paper required sizing, the sheets were dipped one by one into a pot of animal size, then dried once more. Lastly they were finished to the desired surface by being placed between smooth plates and pressed.

FIBER CHARACTERISTICS.

A few moments' consideration of the changes which the fibers undergo from their condition of isolation as they exist mixed in the vat, to their status as components of a sheet of paper, will help to make clear much that seems obscure about the behavior of a sheet of finished paper, as well as to explain the reason for the different processes executed on the paper-machine.

The fiber is a hollow, collapsed tube, the ends bruised and frayed by the treatment in the beating and refining engines. Absorptive in nature to a marked degree, it swells with the water it takes up and is limp and flaccid. As the mold is raised horizontally out of the vat in the process of forming sheets, all the fibers which had been suspended in the water which passed through the meshes of the mold are caught like so many fish in a net, and lie spread in a limp, impressionable mass over the surface of the mold until they are transferred by the "coucher man" to the felt. Little alteration can take place in the general position of the fibers after they have been "couched," consequently the formation of the sheet is the most important stage of the process. As the water is pressed out, each fiber contracts to some extent, and, from a consistency like gruel, the formed sheet passes to a more stable state, wherein it can be gently handled without disintegrating.

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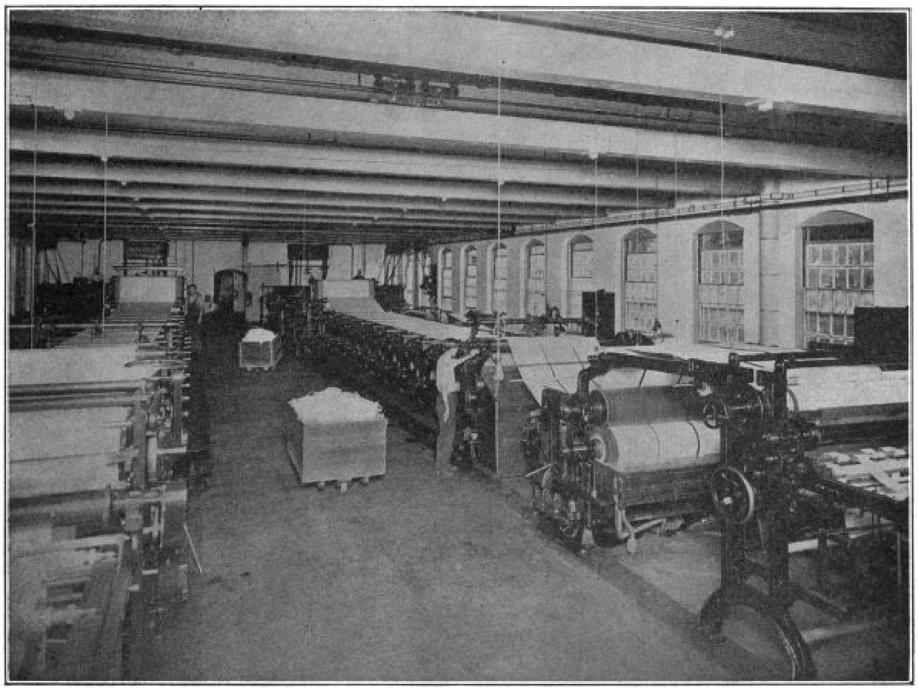


FOURDRINIER MACHINES, CRANE & CO.

A good view of the surface-sizing vat is obtained in the machine on the right hand. The paper is being slit just before its introduction into the vat.

As the drying proceeds there is a marked shrinkage in the dimensions of the sheet, caused by the shrinking 46
of each individual fiber, until the fibers are thoroughly set, enmeshed one with the other.

The addition of size glazes over each fiber and makes it less susceptible to moisture. The addition of clay permeates the structure, filling up the interstices. Up to a certain point the clay does not materially weaken the structure, as a certain percentage of empty air space would exist without it. Beyond that point the clay will fill places that conceivably would be filled by fibers, and having no adhesive strength, the structure of a sheet overloaded with clay is weakened in proportion to its overload.

While the fibers are more or less moist, they are susceptible to alteration in structure, and may in this state be flattened by calendering to a smooth surface, and the presence of clay helps to fill in the microscopic valleys between the fibers so that the surface becomes level to human vision.

THE FOURDRINIER

Now to return to a sketch of the wet ends of paper-machines. The Fourdrinier part consists of a head box, which resembles the case of an upright piano. Where the keyboard might be, is a broad portal for the passage of a stream of pulp, the width of the machine, onto a horizontal, endless wire belt. This wire belt is suspended in a frame some thirty feet long and held taut by being stretched over a number of rolls. The large roll near the head box is known as the breast roll. The still larger roll at the other extreme of the frame is called the lower couch roll, on top of which is a felt-jacketed couch roll. The wire is kept level by a transverse series of "table rolls" closely set, and the under part of the wire is held down by stretch rolls. Directly under the top part, and continuing from the breast roll for about two-thirds the length of the frame, is a shallow tray called a "save-all," as it catches all the drippings which contain filler, and some fine fibers which are returned to the screens by 47
stuff-pumps, maintaining a continuous circulation so that nothing goes to waste. Into this save-all water may be admitted to regulate the consistency of the stuff.

Near the couch roll the wire passes over two or three suction boxes, and on top of the wire, between the suction boxes, turns a wire-covered roll called a "dandy."

On either side of the machine is a frame which may be contracted or expanded. It carries a series of pulleys over which run rubber deckle straps, the under parts of which rest on the wire and keep the wet pulp within bounds. By this means the width of the web of paper is regulated. As a little pulp leaks under these straps machine-made paper has deckle edges on both sides of the web. Artificial deckle edges may also be produced by squirting a fine stream of water upon the web near the couch roll, but it is not possible to produce this effect across the web. Except on special papers the deckle edges are trimmed off by slitters at the end of the machine.

Near the flow box, running at right angles across the machine, are two so-called "slices" about eight inches apart. These may be adjusted at various heights from the wire, in order to regulate the thickness of the paper. Their most important function is to make the thickness uniform from one side to the other of the sheet, and to create a pond which assists in forming the paper.

The frame of the Fourdrinier has a joint near the first suction box, and a mechanical arrangement called a "shake" is located near the head box to impart a lateral shaking motion to the frame while the wire runs straight ahead, thus imitating the shaking of the hand mold.

Beyond the couch roll is a series of press rolls, between which run endless felts to carry the soft, moist paper.

Then follows a large series of steam-heated cylinders. Next a stack of iron calender rolls, and a set of reels. As soon as one reel is full a new reel is started and the paper from the first reel is slit by rotary slitters and 48
made up into rolls of the desired widths on the winder.

PAPER IN PROCESS

It is an almost dramatic moment when the machine is ready to start. The machine tender opens the valves which admit the stuff from the flow box and a stream spreads out onto the wire. At a given signal the back tender starts the wire, and the endless white stream moves smartly forward. Then ensues the mechanical imitation of making paper by hand, only instead of forming sheet by sheet, the formation is a continuous process in the web. The shake of the machine mixes the position of the fibers in the "pond" behind the slices; the water runs like a downpour of rain through the moving wire into the save-all, leaving behind its burden of fiber, or "stuff," as the mixture is at that stage called, in a white film.

The suction boxes accelerate the expulsion of water, and the dandy roll closes the fibers together as the film passes beneath it. Then the web is carried between the couch rolls, when the water fairly pours out in the squeeze. As the top roll is felt-jacketed, the film sometimes sticks to it, as a slight suction is created in the pores of the felt. The back tender stands by with a hose to wash down the paper if it starts to adhere to the jacket. The paper is prevented from completely going around this top roll by a guard board which is fixed across the top. Many machines are now equipped with a "suction couch roll," which does away with the need for a top roll, as the water is sucked, instead of pressed, out of the paper.

At a given signal the back tender starts one edge of the film forward, by a skilful slap of the hand, which picks up the edge of the film and transfers it to the felt carrier between the press rolls. The remainder of the web is made to follow the lead of the first section, till finally the full width is transferred to the first felt, which 49
carries it through the first series of press rolls.

An arrangement similar to the guard board, called a "doctor," runs across the top press roll, so that the paper may be allowed to roll up if desired, while the machine tender regulates the flow of water until the consistency of the stuff is right. The doctor also keeps the press roll clean. Quite often the long end of paper first started at the couch roll is passed right along from the first felt to the second, carried through the second set of press rolls, and the third, if three there be, to the steam driers, and thence over the entire battery of driers, through the calenders onto the reel.

From the press rolls it is led by the back tender, assisted by a third hand, and if all goes well the paper may be winding up on the reel inside of ten minutes.

But there is many a chance for mishaps before the wet end of the machine is adjusted and the heat in the driers is regulated to a nicety.

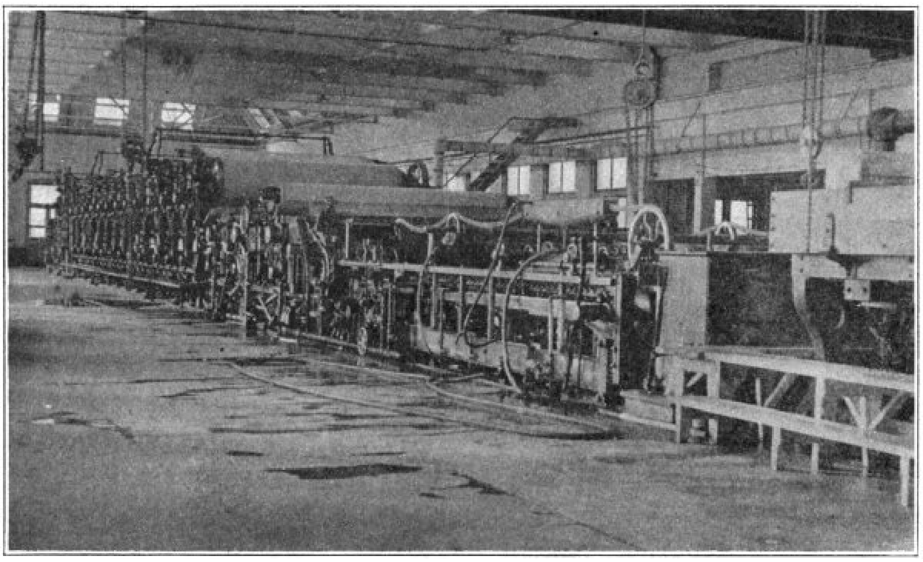
The weight of the paper depends upon the quantity of stuff let onto the machine, the dilution of the stock, and the speed at which the machine is run. Given a certain volume, the faster the wire runs the thinner the stuff is spread, and vice versa. Before things are settled down, considerable worthless paper may be turned off.

The width of the web is controlled by the distance between the deckle straps. These are adjustable, but an allowance of ten inches or so must be made for the shrinkage of the web in drying.

The preliminaries to a run of paper may be likened to the make-ready on a printing-press, though they do not, as a rule, last nearly so long. Yet this is the reason why small odd sizes and odd shades of paper are not popular with the manufacturer, unless he can get a sufficient extra price to compensate for the "make-ready" costs.

Water-marks.[C]—The water-mark in paper is effected by raised lines on the dandy roll. The design, being impressed in the moist web, displaces the fibers and leaves thin areas in the paper, which consequently show 50
when the sheet is held against the light, as they are more translucent than the adjoining areas.

[C] The study of ancient water-marks is quite fascinating in connection with early Printers' marks. See "A New Light on the Renaissance," by Harold Bailey.



FOURDRINIER MACHINE, S. D. WARREN & CO.

View showing the "Fourdrinier" part of a modern book paper-machine.

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CHAPTER SEVEN

PAPER-MAKING—*Continued*

Technique.—The importance of the formation of the sheet on the machine wire is the same as on the hand mold, as subsequent pressing and calendering can only modify faulty formation. The stuff should be uniform and even in texture. The press rolls must be ground with absolute accuracy, and slightly crowned to allow for their sagging. Otherwise water would be unevenly expelled from the web, possibly causing a damp streak throughout the entire run of paper, which would show in the finished product.

If a portion were pressed too hard it would contain less moisture as it reached the driers and become dry before adjacent sections. If the paper were calendered, the moister parts would take on a smoother surface than the drier parts.

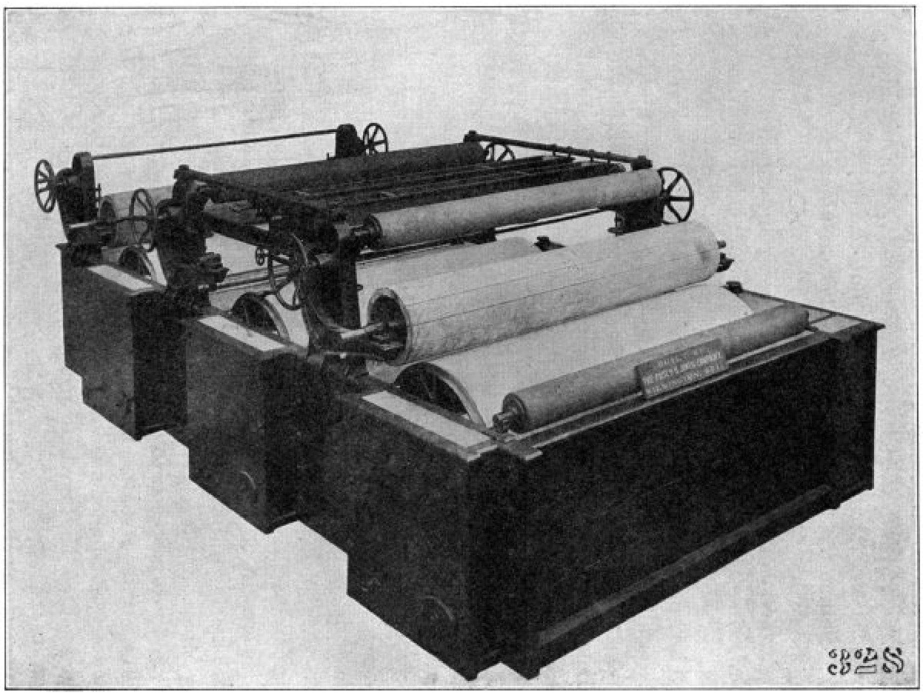
Another feature to be closely watched on particular papers is to eliminate, as far as possible, the impress of the weave of the wire cloth, which is left in the under side of the web. This can be accomplished to so fine a degree, by a skilful man, that the difference between the two sides of the paper is scarcely discernible. The fineness of weave of the one cloth also is an important bearing in securing an even sided sheet.

Thus we see that it is well-nigh impossible to reduce the making of paper to an exact science, and a reasonable variation must be expected, both in weight and finish. The successful management of a paper-machine depends, from start to finish, on careful, experienced judgment and alert attention. If the beater-man dilutes one batch of stuff more than another, the variation will show the minute the altered stuff appears on the machine, and only an immediate readjustment at the wet end can avoid considerable variation in the product. 52
Then, from end to end, the long machine must be watched carefully, so that the pressing, drying and calendering may all be kept uniform. A bungler should find no place in the machine-room, but it is desirable that consumers have sufficient appreciation of human limitations, as applied to paper-making, to admit proper allowances for normal variations.

Cylinder Machine.—The cylinder machine, invented by John Dickinson about ten years after the Fourdrinier, is much the same as the wet machine described in Chapter II, with the addition of press rolls, driers and calenders. The single-cylinder machine is used for making light-weight tissues and other thin papers. Cylinder vats can also be arranged in series, as on board machines, so that the webs formed on each cylinder can be combined. This is accomplished by an arrangement of felts which run tangent to the cylinders, picking off the formed paper automatically from each successive mold.

The felt runs between squeeze rolls, so that the various plies of paper are pressed together, forming a single thickness. Machines of this type can make very thick sheets, and are used for making bristol boards, blanks, boxboard, strawboard, etc.

The number and arrangement of driers on any machine depends on the product to be derived. Fast-running machines, such as the large news mills are equipped with, have necessarily a large number of driers, as they turn off fifty tons or so a day and require a great drying capacity. Slow running machines, such as are used in fine writing-paper mills, need a much smaller number, as the average fine writing-paper machine produces little over three or four tons a day.



CYLINDER VATS, MADE BY THE PUSEY & JONES CO.

The felts which convey the paper are omitted so as to get a clearer view of the molds.

Harper Machine.—There is a type of Fourdrinier called the Harper which differs from it in that it is turned end for end. A long felt carries the paper from the couch rolls back over the Fourdrinier part, delivering it to the first press. This is considered advantageous in making very light papers which otherwise are with difficulty led 54
from the couch to the press rolls and are apt to break down in the passage.

Yankee Machine.—There is even one type of machine known as the “Yankee” which has but one drier of very large diameter. This is used in making machine-glazed wrapping papers, which are very smooth on the side of the sheet which comes in contact with the drier and rough on the other side. The “wet” end of this machine is a Fourdrinier type.

The arrangement and number of smoothing and calender rolls is also dependent on the class of paper to be made. Most writing-paper machines have no calenders at all as the surface is obtained on special machinery such as platers and sheet calenders after the paper comes from the drying loft. One can easily appreciate that, while the general principles of all paper-making are identical, there is a call for a wide variety of arrangements, such as those cited, to meet the varying requirements of different classes of paper.

Surface Sizing.—Surface sizing, or animal sizing, necessitates a vat with squeeze rolls. The paper is first run over enough driers to dry it; then introduced into the vat of hot size. On the cheaper grades the size is dried on the machine by a special skeleton drying apparatus, but the better grades are cut off and piled up by the “lay-boy” at the end of the machine, then transferred to drying lofts and hung up over poles to dry. Hence the term “loft-dried.” Any special finish has then to be applied sheet by sheet.

Finishing Paper.—Finishing paper is accomplished either on the paper-machine itself, or after the paper is turned off on the machine it may be treated by special apparatus.

Wove and Laid Papers.—A so-called wove paper is made with a plain dandy, covered with fine wire cloth the same texture all over. Laid paper is really a water-marked paper, in which the whole surface is marked by a specially constructed dandy which imprints a mark in imitation of the early hand molds. There are heavy lines 55
running with the grain of the paper and lighter lines running across.

Antique.—An “antique” surface is obtained by skipping the calender rolls and leaving the paper rough as it comes off the felt to the driers. A medium finish is obtained by a slight calendering, while the highest machine finish, and the so-called English finish, is obtained by a heavy calendering.

Water Finish.—A common method of obtaining a high finish on heavy papers is by the use of “water doctors,” which keeps two or more of the calender rolls moist, dampening the paper while it is being calendered. The surface thus imparted is called a “water finish.”

SHEET CALENDERS

Fine writing-papers may be finished in a variety of ways. A plain, smoothed surface is obtained by passing the sheets, which are automatically fed, by a system of tapes, through calender stacks, called sheet calenders.

Plating.—Plating was first resorted to as a means of smoothing paper in the sheet, but when a linen, or pebbled, or any other special finish is desired, it is also accomplished in a plating machine. This consists of two heavy rolls. The sheets of paper, with a metal plate top and bottom, are passed through the rolls under heavy pressure. If a linen finish is desired, pieces of linen are placed between the plates on both sides of the sheets so that the linen texture is embossed into the paper. Similarly any other substance may be used for other effects.

Embossing.—Embossed papers are usually finished from the roll by running between iron rolls with embossing patterns engraved upon them. An extra strength is required of paper for this purpose, otherwise the pattern will cut through the sheet.

Supercalendering.—Supercalenders are machines, apart from the paper-machine itself, for making high-finished paper. The rolls vary in number. Each alternate roll is made of hard paper. In treating uncoated stock 56
there are also one or two steam boxes to moisten the paper before it is calendered. This softens the surface fibers, and they can then be rolled flatter and hence take a shinier surface. The alternate rolls in a stack for calendering coated papers are made of cotton, and no steam boxes can be used, because the moisture would injure the coating.

The paper is run through the calenders in the web. All smooth, or special, finishes are gained only at added cost. Where the process takes place on the machine, more breakage is occasioned and more paper has to be sorted out, as the hard-finishing accentuates spots in the paper, and little lumps of fibers, which would pass unnoticed in an uncalendered or antique paper, are squashed down and blackened by calendering. Hence the higher cost of such papers.

Supercalendering and plating bring into play different workman, so that the labor cost is increased, and any finishing, sheet by sheet, is necessarily slow and more costly than that accomplished in a continuous process from the roll.

Combining.—Many kinds of papers, as photo-mounts, double-thick covers and cardboards, are made by pasting two or more thicknesses together. This was formerly done in the sheet, but most of the pasting is now effected in the web. The papers are run over a paste roll, combined, and passed either through a drying chamber or over a battery of driers like those of the paper machine. The pasted paper is lastly made into rolls and taken to the finishing room to be sheeted.

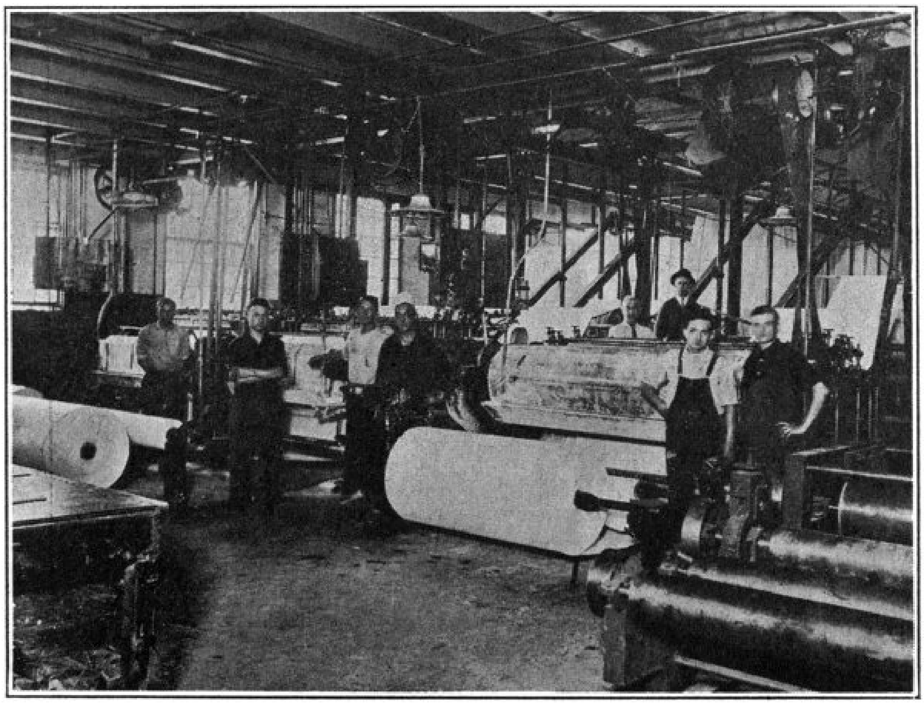
Coated Papers.—Coated papers are made by covering the surface of ordinary paper with a veneer of clay, mixed with some adhesive, as casein or glue, and suitably colored.

The process is done from the roll; the paper first goes through the machine where the liquid coating is brushed onto the surface, passing directly in automatically formed festoons through a long, heated room to dry, and finally is rewound. The rolls are then taken to the supercalender room and the paper is given the desired 57 finish.

Dull-finish coated papers require a special kind of coating and receive very light calendering after being coated.

High-finished coated papers of the best grades are double-coated and run several times through the calenders.

Another method of producing a high finish is known as “flinting.” In this process the paper is mechanically polished by smooth flint stones and gains a very high luster. Such papers are most widely used as box covering. A similar effect is obtained by friction calenders, which consist of two chilled iron rolls with an intermediate roll of hard paper. The top roll rotates at a higher speed than the others.



COATING ROOM, APPLETON COATED PAPER CO.

This view of the “wet end” of the coating machines shows the rolls going through the coating process, the web of paper traveling along the drying racks appears in the background.

The coating may be dyed to any color desired, so that coated and glazed papers are obtainable in a wide variety of shades. 59

FINISHING-ROOM, CRANE & CO.

The machine on the right is a plater.

Gummed Papers.—Gummed papers are made by passing the web through a machine, which coats it with glue, after which it passes over drying apparatus and is wound into rolls ready for finishing.

Gummed paper for labels is usually finished in sheets, while for sealing tape and box stays it is ordinarily made up into rolls.

Waxed Papers.—Waxed papers are made by applying a coating of parrafin. This renders the stock water proof, and it is used largely as a wrapper for food products.

Glassine Paper.—By a special treatment in the beaters and jordans cellulose fiber is so treated as to become hydrated. This hydration makes the paper produced grease proof, and by heavy supercalendering the character of the sheet is again greatly altered, it becoming almost perfectly transparent. In this state it makes a most attractive and hygiene wrapper.

CHAPTER EIGHT

THE PHYSICAL AND CHEMICAL ASPECTS OF PAPER

The size and weight of a sheet of paper of any given quality and finish are its most obvious features, and when we speak of the weight of a sheet of paper we refer not to the one sheet, but to the weight of one ream of similar sheets. Most papers are ordered on a basis of ream weight for a specified size, as, for example, 25 by 38, 50-pound. Blanks, cardboards and cover-papers, especially the first two, are more frequently ordered on a basis of bulk, as two-ply, three-ply, etc., and thick or double thick in the case of covers. The thinner covers are usually designated by their ream weight, though frequently quoted, as are the heavy-weight covers, the blanks and cardboards, in price by the hundred sheets.

The reason for this difference is probably that such stocks are sold in comparatively small lots, so that it is simpler to bill them in accordance with the number of sheets than to figure the weight of a small number of sheets and multiply by the pound price.

Another thing which facilitates the system is that these kinds of paper are carried in standard stock sizes, as the majority of orders are too small to be made in special sizes.

The relation between thickness and weight of a given paper is approximately a direct ratio. For example, given a sheet of machine finish 25 by 38, 50-pound, four sheets of which bulk .011 of an inch, the bulk of the same finish and quality, in 25 by 38, 60-pound, can be approximately ascertained by the equation 50 : .011 :: 60 : x, the answer of which is .0132.

The difference in bulk between two papers of the same weight depends on:

1. The finish. 61
2. The percentage of mineral filler.
3. The nature and treatment of the fiber.

For example, on a bulk of .015 of an inch to four sheets a supercalendered paper would weigh about 65 pounds, a high machine finish about 60 pounds, a text or medium finish about 50 pounds, an antique about 40 pounds. In other words, the density of any given piece of paper is proportionate to the amount of calendering it receives. Naturally, the antique paper, lightly pressed and uncalendered, is loose for texture and full of minute air pockets, so that it is light for bulk, while the supercalendered paper is squeezed to a hard, dense sheet containing little air space.

If the proportion of mineral filler is great, the weight will be still greater in proportion to the bulk, as the specific gravity of the mineral is greater than that of the fiber, and the fine particles tend to fill completely the small interstices between the fibers, so that the air space is reduced to a minimum. If, in addition, a surface coating is added, we get a paper with the highest possible percentage of filler, and consequently a glazed coated paper has less bulk in proportion to its weight than any other kind. Such paper contains from 30 to 40 percent of mineral.

The nature of the fiber brings about a difference, in that some fibers have thicker walls and smaller canals than others. The treatment causes a variation, in that a quick beating with sharp knives leaves the fibers more nearly in their original shape than a prolonged beating with dull knives, which breaks down the structure of the fibers and draws them out into minute fabrillæ.

The strength of a paper of given quality will also to a certain extent be proportionate to the duration of beating, as well as the amount of pressing and calendering received. The amount of sizing and the drying also affect its strength.

An antique paper, having large air spaces and loosely knit as it is, has not the tensile strength it would possess if pressed and calendered to a greater density.

The addition of loading adds to the weight without increasing the strength, as it has no binding properties. 62
Moreover, the bulk, in proportion to the weight, is lessened by the introduction of filler.

Consequently it is axiomatic, that of two given papers of equal weight, finish and quality of fiber, the one containing the less filler will be the stronger, as well as bulkier. The addition of filler, however, increases the opacity, gives mellowness, and improves the printing quality by equalizing the texture of the surface.

The addition of sizing tends to increase the strength of paper, owing to its adhesive properties, but if liberally used it detracts from the mellowness and gives the sheet a tinny "character."

The length of the fiber also affects the strength, as long fibers give greater strength and better folding quality than short. It is not possible to get as close formation with long as with short fibers.

Hence occasions frequently arise wherein customers ask for characteristics which are somewhat contradictory.

A desires a light, bulky paper with a high finish, but a bulky paper with high finish must, in the nature of things, be heavy.

B desires a very strong, thin, but opaque paper. It is obvious that the strength of a thin, opaque paper can be but a relative factor, while thinness and opacity are irreconcilable features.

C inquires for a closely formed sheet, with good folding qualities, but the first characteristic is only to be gained at the expense of the latter.

D wishes to print half-tones on an antique paper. In this case modern printing inventions have bridged over

some of the obstacles of the past, and the offset press and extra-deep engravings have brought this last requirement within the realms of possibility, but unless resort is had to these new methods, the requirements 63
again are irreconcilable to each other.

It is evident, however, that only through technical paper information can one solve such problems as necessitate a compromise capable of giving the maximum possible satisfaction.

The structure of paper, machine made, results in the greater proportion of the fibers in the formed sheet lying in the direction of the flow of the stuff. This determines what is called the "grain" of the paper. When paper is in the roll the grain of course is lengthwise of the web, but in the sheet the cutting and slitting may be arranged so as to leave the grain either lengthwise or crosswise of the sheet. This is an important consideration for a number of reasons.

In the first place, it is easier to tear the paper with the grain than across, as the fibers are parted rather than fractured in this way. This is a point which might be utilized by printers when printing detachable coupons.

Perhaps the most important consideration is the great difference in folding qualities. Many a paper will fold very nicely with the grain and crack badly if folded the other way.

Again, a great difference is noticeable in the flexibility of books, dependent largely on whether the grain runs parallel or at right angles to the binding. If flexibility is desired, the grain should run parallel to the back of the binding. Occasionally a wide-paged pamphlet, especially of light-weight paper, is improved by the rigidity to be gained from having the fibers run at right angles to the binding. It is also true that this increases the strength of the binding, as the sewing or wire stitching passes around more fibers than if the grain ran up and down the page.

Not infrequently does the middle signature of a pamphlet pull loose from the binding. Usually in such cases the paper is not strong anyway, but it could have had more resistance had the grain run at right angles to the binding.

The tensile strength of a strip of paper is greater with the grain, but its elasticity is greater across the grain. 64

A convenient way to ascertain the direction of the grain in papers that do not show it clearly by folding is to cut two narrow strips a few inches long, hold them by one end so that they coincide. When held horizontally, if the loose ends do not part, it indicates that the lower paper has its grain in the long dimension. If the lower paper has its grain crosswise, the loose end will sag away from the top strip, because, as above remarked, a paper is more flexible across the grain. This test may be applied either to sized or unsized papers.

Another test is to cut a small square and moisten one side; the paper will curl into a little cylinder and the grain runs parallel to the length of the cylinder. This test cannot be applied to an unsized paper.

This leads us to a consideration of the effects of moisture and humidity on paper.

It will be recalled from the chapter on Paper-Making (No. VI) how plastic paper is in its moist stage, and how tenacious of water are the cellulose fibers. It will also be recalled that there is considerable shrinkage across the web of the paper from the time it leaves the wire to the moment it is reeled. In fact, the very thing which makes paper-making a possibility is the shrinking of each individual fiber, occasioned by the expulsion and evaporation of the water, which has served as a carrier from the machine chest to the wet end of the machine.

This propensity of each individual fiber does not cease when the paper is made, but persists forever. A cellulose fiber will absorb moisture from the air in proportion to the relative humidity, just as the hair in a barometer is continually shrinking or expanding as the weather changes.

A definite percentage of moisture is normal to a cellulose fiber in proportion to the moisture in the air. The fiber swells as it absorbs, and shrinks as it gives off water.

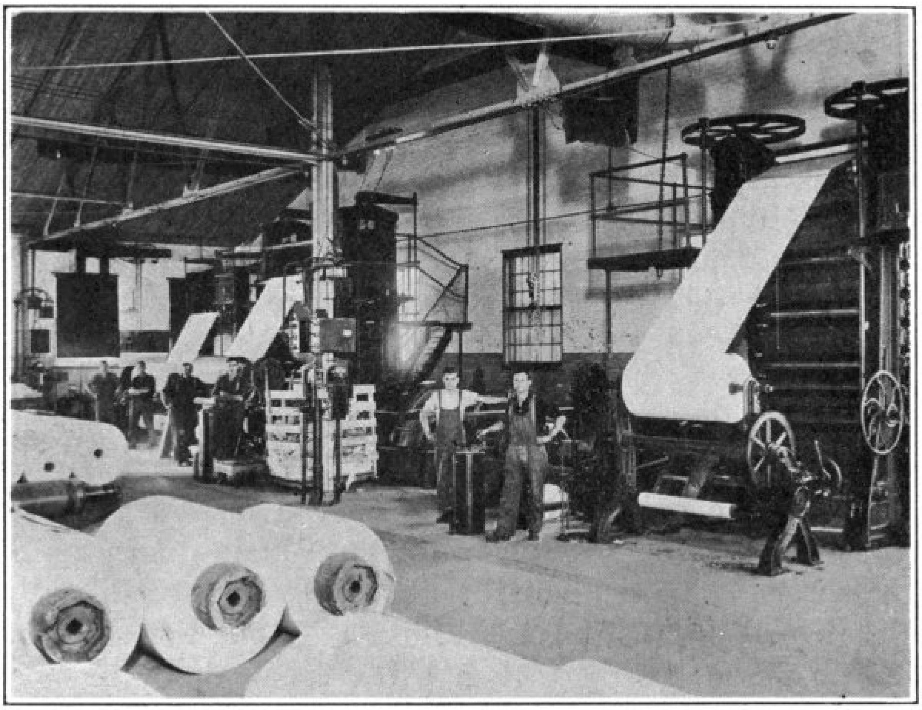
Herzberg gives as the results of investigation with a good writing-paper made of rags, sized with rosin, the 65
following report of the percentage of moisture retained under various degrees of relative humidity:

Relative humidity of the air, percentage	Moisture contained in the paper, percentage
100	21.5
90	13.5
80	8.9
70	8.4
60	6.5
50	5.6
40	3.4
30	2.3

In a sheet of paper, where thousands of fibers lie side by side, the combined expansion is distinctly noticeable in the changing dimensions of the sheet. This gives rise to difficulties in securing accurate register in color-printing, owing to atmospheric changes. The manufacturer may minimize this difficulty by a careful formation of the paper and the regulation of the drying, so as to turn out the paper as nearly as possible containing an average normal percentage of moisture.

The same conditions are responsible for wavy edges, which occur principally along the cross-grain dimension of the sheets. The ends of the fibers, being exposed, easily absorb moisture as paper lies in a pile, but the moisture seldom permeates more than a few inches into the pile. Therefore, the larger part of each sheet is unaffected, but the fibers exposed to the air expand when absorbing moisture increasing the area of the exposed end and, consequently, causing it to assume a wavy formation which is suggestive of a ruffle.

When feeding such sheets to a cylinder press, much trouble may arise if the waves occur along the "gripper edge," which is usually on the longer dimension of the sheet. In some instances the difficulty may be avoided by ordering paper with the grain running the long way of the sheet, which also offers another advantage in relation 66
to securing close register, namely this: the area of the sheet in square inches will increase least through atmospheric expansion which occurs across the grain if the cross-grain dimension is the lesser.



SUPERCALENDER STACKS, APPLETON COATED PAPER CO.

For a description of the Supercalendering process, see pages 55 and 56.

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CHAPTER NINE

APPRAISING AND TESTING PAPER

The appraisal of a specimen of paper differs from testing in that an appraisal comprehends the value of an object in relation to its usefulness and marketability, whereas testing is merely an arbitrary method of expressing the chemical or physical properties of the object. The knack of appraising can be acquired only through practical experience; and the ability to make tests is gained only by careful technical training.

In the majority of cases a satisfactory appraisal may be given without chemical or physical tests, but these are cases when the superficial characteristics, such as color, finish, feel, etc., are the prime qualifications, and such considerations as fiber contents, freedom from impurities, exact tensile strength etc., are of negligible importance.

Although experience, only, leads to the knack of appraising paper, certain points might be suggested with benefit to the beginner which would assist him to an earlier acquirement of the art.

Color.—Color being a purely relative term as applied to the variations in so-called “white” papers, it is necessary to make comparisons with accepted standards of the various grades in order to arrive at conclusions.

In common parlance, white papers may be described as natural, light natural, white, blue-white, pink-white. Natural papers are those in which a minimum of artificial coloring has been added, and the brilliancy of shade depends entirely upon the quality of the stock.

Almost all paper is colored to some degree while the stock is in the beater, and the minimum quantity of order of paper, which any mill will make on a special run is usually limited by the contents of one beater, and, on account of the time required to wash up, the cost of special colors is increased. Rose-pink and blue are the 68
colors used in modifying the natural color of any beater of pulp to produce a white paper. The so-called “white color” of the cheaper grades of papers is ordinarily gained by a comparatively heavy use of blue, and by comparison with a white paper of good quality the blueness is decidedly noticeable. In judging color, it is well not only to look at the surface, but also to examine the paper when held up against the light, making comparison with some acceptable standard, also noting the clearness of the stock, as indicated by the sharpness of definition of the shadows of the fingers which hold the sheet. This comparison is affected, of course, by the bulk of the paper, but two papers of about equal bulk may be fairly compared in this way. Any judgment as to shade is, in part, only a question of taste. Permanency of color may easily be determined by exposing a portion of a sheet to sunlight for a few hours and noting any alteration in color.

Formation.—While examining a paper for color and clearness, the formation of the sheet should also be observed. In general, a close, even formation is to be desired. Fibers of the same approximate length may be loosely or evenly formed, according to the skill of the machine-tender. The longer the fiber, the harder it is to get a close, even formation, and it should be remembered that these two qualifications are to a greater or less extent contradictory.

Finish.—Whatever the finish of paper, the two sides of an ideal sheet would look exactly the same. In most papers made on a Fourdrinier machine the impress of the wire is discernible, and there is a perceptible difference in texture between the “wire,” or bottom, side and the “felt,” or top, side, the one tending to reproduce the texture of the wire cloth, and the other the weave of the felts.

Some manufacturers have perfected their processes to a degree that renders these differences imperceptible. Papers made on cylinder machines of more than one vat are apt to be more even-sided, as the 69
contact with the wire of the molds is less protracted and there is considerable pressing of the web between two felts as it is carried along.

The evenness of the finish, and the fineness of texture over all parts of a sheet, may best be judged by holding it aslant to the light. This also discloses whether the paper is “fuzzy” or free from lint.

Fuzz, or hairiness, usually occurs on the wire side of the sheet. This is due partially to the stock, soda pulp being especially likely to fuzz. It is also due to overdrying, and sometimes to the action of the suction boxes, which if worked too hard cause the surface fibers to stand on end.

“Hairiness,” or fuzz is more apt to occur on antique and other light finishes, but calendering will not entirely overcome it, and such papers as would be fuzzy uncalendered, become fuzzy with handling.

In fact, the durability of the surface may well be tested by rubbing the paper between the fingers. In this way, too, one judges the “feel,” which of all qualities of paper is perhaps the most difficult to express, but usually described as hard, soft, mellow, harsh, rough, smooth.

In highly calendered papers, well closed and evenly finished, the light will be reflected uniformly, as from a well-polished table-top; but if the formation is “wild,” there will be a blotchy look as the small knots of unevenly distributed fibers cause thick and thin areas, and the thick ones get harder squeezing through the calender rolls and, consequently, a higher finish.

Another cause for unevenness in finish is a variation in the thickness of the paper as it is made on the machine. This unevenness runs lengthwise in streaks, and may originate on the wet end of the machine if the pulp is not deposited uniformly.

Again, the pressing may be faulty at the press rolls, causing a thin streak. Naturally, the thin part of the paper dries more readily than the thick, and as even surfacing depends partly upon even dissemination of 70
moisture in the sheet, a poorly pressed sheet would have a faulty finish. Dirty felts also cause uneven drying, as water can not be evenly squeezed through a felt the pores of which are partially choked. Lastly the unevenness may be caused by the calender rolls themselves being in poor condition.

It is easy to detect thin areas by examining paper in a pile, as a pile of papers of uniform thickness will be practically level on top.

Papers for half-tone printing, whether coated or uncoated, should be even in formation, thickness and surface, otherwise the printer's "make-ready," which is designed to offset inequalities in the plates, will be discounted by inequalities in the paper.

There are some special papers in which unevenness in formation and finish are intentional, on account of the unusual effects thus gained; and other papers, such as wrappings, where such niceties of the paper-makers' art are of little importance.

Opacity.—Opacity may easily be judged, although it is difficult to express it in any accurate terms, by placing the papers to be compared side by side over a printed page, the relative merits in this respect may be immediately perceived.

Sizing.—Sizing may be approximately judged by moistening the stock and noting the rapidity of the absorption, or tested by drawing lines with ink and watching to see if they spread afterward. Absorbency in blotting-papers may be measured by submerging two strips equally and noting how high the ink is drawn up into the strips. Such papers as are made without any sizing and are ordinarily called "water-leaf."

The sizing of coated papers should be neutral, but is frequently alkaline or acid, since alkali is used to neutralize the lactic acid of the casein. This may be detected by taste. The retention of a piece of coated paper in the mouth for a few minutes will reveal through the taste any tendency of the coating to sour. 71

Weight and Bulk.—Weight and bulk may be closely approximated by a practiced hand, but they must also be considered in relation to finish, as pointed out in the preceding chapter.

There are many convenient forms of micrometer gauges for measuring the thickness of paper and any one who has much to do with paper should be provided with one, as it is unsafe to depend entirely upon judgment when a thousandth part of an inch may account for ten pounds difference in the weight of a ream of paper or cause serious variations in the bulk of a book.

Quality and Strength.—Quality and strength may be approximately judged by tearing the paper in both directions of the grain and observing the fractured fibers, but these matters are to be more accurately estimated by mechanical and chemical tests.

It will be observed that cleanliness in paper, and most of the foregoing characteristics of paper, do not lend themselves to mechanical tests, but are properties which require the judgment of an expert.

Cardboards.—In judging thick papers, such as bristol boards, it is customary to see if they are snappy. An idea of their fibrous strength may be had by folding in various directions. Pasted cardboards may be distinguished from unpasted by burning, for if paste has been used the layers of paper will split apart as the paper burns. This burning will also give a slight idea of the amount of filler in the stock, as the ash will be greater as the filler is increased.

Paper-testing.—Tests applicable to paper may be divided into three classes—microscopical, physical and chemical.

The purpose of microscopical tests is to determine the kind and character of the fibers, and the proportion of each kind, also to assist in determining the nature of mineral filler and of impurities. It is also used in estimating 72 the percentages of the various kinds of fiber. Chemists are able to estimate this within five per cent. A minute sample of paper is prepared by boiling in a one per cent solution of sodium hydroxid, in order to remove everything from the fibers themselves. The resulting mite of pulp is placed on a slide with a dissecting needle, the excess moisture is removed and a stain is added. This stain gives different characteristic hues to the different kinds of fibers. The color and form of the fibers as observed through the microscope disclose their character to the trained eye.

By counting the different kinds of fibers under observation, the analyst estimates the proportions in which they existed in the sample of paper.

The physical tests are more familiar to most persons, and include (1) weight per ream, (2) thickness, (3) bursting strength, (4) tensile strength, (5) folding endurance, (6) absorption, (7) expansion.

1.—There are two kinds of paper-scales. The most common kind gives, directly, the ream weight from weighing a single sheet, and is of such convenience that almost all paper-users could well afford to have one.

Sensitive paper-scales for small samples, 4 by 4 inches in size, are of great assistance also, and should form part of the equipment of every paper-dealer.

2.—The thickness is determined by a micrometer gauge measuring to one-thousandth of an inch. In gauging thin papers it will prove more accurate to take four thicknesses, as the error in reading is thus quartered. The following table of bulks, which shows the number of pages per inch from a gauge of four sheets, will be found convenient:

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Thickness of four sheets in thousandths	Number of pages to one inch.
8	1,000
8½	941
9	889
9½	842
10	800
10½	762

11	727
11½	696
12	667
12½	640
13	615
13½	593
14	571
14½	552
15	533
15½	516
16	500
16½	485
17	471
17½	457
18	444
18½	432
19	421
19½	410
20	400
20½	390
21	381
21½	372
22	364
22½	356
23	348
23½	340
24	333
24½	326
25	320
25½	314
26	308
26½	302
27	296
27½	291
28	286
28½	281
29	276
29½	271
30	267
30½	262

3.—Bursting strength is determined by a variety of testing-machines, constructed so as to record the pressure per square inch which may be exerted before rupturing the paper.

In a government bulletin, Report No. 89, United States Department of Agriculture, the following criticisms of this test are made: “This pressure is generally believed to represent the mean strength of the paper—that is, an average of the strength across and with the sheet. This is not true however, experience indicating that strength as thus determined more nearly agrees with the strength of the paper in the cross direction, with the minimum strength rather than with the average strength of the paper.

“Among other objections to testers of this type, is that to a certain extent the operator can influence the results at will, and even with the greatest care there is quite a wide difference between different tests of the 74
same paper.”

4.—Tensile strength is determined by clamping a strip of paper of standard dimensions in a machine which exerts a uniform tension until the strip breaks. The breaking strength is shown on the recorder, and the amount of stretch before breaking is also registered, thus indicating the elasticity of the paper. The best known instrument of this sort is the “Schöpper,” but the machine is very costly, hence is rarely found except in well-equipped laboratories.

5.—Folding endurance is determined on a machine which folds a strip of paper back and forth in a slot, the strip being clamped at either end to a spring device which maintains a uniform tension. The number of double folds which the strip withstands is automatically registered. This test is favorably regarded as an indicator of durability, but the apparatus is expensive and not easily available, hence this test fails of frequent use.

6.—The absorption tests are applied principally to blotting-paper, and consist in suspending equal widths of paper so their ends are submerged in a beaker of colored water. The height the water rises in a given time demonstrates the capillary attraction.

7.—Expansion is estimated by taking strips of uniform dimension, dipping in water and measuring the expansion.

Chemical tests are for the determination of (1) the percentage of mineral filler; (2) the percentage and nature of sizing materials; (3) qualitative test for starch, acid, sulphur, chlorine, glue, filler material, dyes, ground wood.

The amount of filler may be determined by incinerating a piece of paper of known weight. As the filler is non-combustible, the weight of the ash determines the percentage of filler, although allowance must be made for the amount of water of crystallization driven off from the mineral.

Tests for acids are important in papers used for mounting tarnishable substances, such as jewelry.

Tests for sulphur or chlorine are important in determining the chemical purity of the paper, since such 75
residues militate against the permanency of color and strength of paper.

The presence of ground wood is easily determined by a drop of either strong nitric acid, which turns the paper brown, or a drop of phloroglucine, which gives a reddish-brown tint from contact with ground wood. Aniline sulphate produces a yellow tinge.

The presence of starch may be ascertained by using a dilute solution of Iodine which leaves a black stain in contact with starch.

Note.—For more technical information see “Paper Technology” by R. W. Sindall.

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CHAPTER TEN

PRESSROOM DIFFICULTIES

Technical difficulties with paper in the pressroom arise from many sources. They may be conveniently classified into three groups: Difficulties for which the manufacturer is responsible; difficulties for which the printer is responsible, and difficulties due to atmospheric and other natural conditions not entirely within human control. Let us consider some of the first group.

Uniformity.—Probably the most frequent source of trouble is lack of uniformity, either in weight, thickness or finish. This is chargeable to carelessness on the part of the paper-machine tender. A run of paper which varies in weight will naturally vary in thickness, and, obviously, this could account for uneven color in presswork. These variations would not necessarily be accompanied by a variation in finish. To make paper uniform in all three respects necessitates, firstly, uniform consistency of the pulp—or “stuff,” as it is technically called—at the point where it flows onto the machine. A uniform volume of stuff and uniform speed of the machine are also demanded. The speed of the machine and the volume of stuff are quite readily controlled, but as the amount of water used by the beater-man in preparing the stuff is usually judged by the appearance of the pulp in the beater, there are always such variations as are peculiar to this human factor.

The difficulties of the machine-tender may often be traced to the beater-man, not only on account of the amount of water in the mixture, but also because of the irregularity in the length of fiber from one beaterful to another.

Assuming that the stuff is right and the formation on the machine is good, the pressing of the paper next demands close attention. It is obvious that any unevenness of pressure will result in the water being expelled 77 unevenly from the web of paper, with a consequent variation in thickness. In this case there would also be a damp streak in that part of the web where the pressing was too light.

The result is that such paper can not be dried evenly all the way across the machine because this damp streak will still have an excess of moisture after the adjacent areas of the web have become properly dried.

Finish.—In running through the calenders the damper portion will take a higher finish. It may even be so damp as to cause a blackening or crushing of the paper; whereas, if the moisture is sufficiently evaporated from this streak, the rest of the paper may be so dry that it will not finish smoothly enough.

On the other hand, there are cases where the pressing and drying may be perfectly uniform, but the whole web vacillates from being too dry to being too moist, while between times the manipulation is exactly right.

The result, obviously, will be a variation in finish over the whole width of the paper instead of over a portion. Moreover, too much drying makes the paper fuzzy and likely to become wavy, besides weakening the fibers.

Another result of uneven pressing is to make the paper thinner where the pressing is hardest. Such a defect is quite obvious in a pile of paper, as the top will not be as level as it would be in paper that is uniform in thickness throughout.

Assuming that the paper is perfect as it leaves the driers there is still a chance that one or more of the calender rolls may get out of true, especially when starting a run after they have been idle long enough to get cold. Under such conditions they often heat up and expand unevenly so that the pressure is harder in some sections than in others. The result is a thin streak in the paper. Whether the thinness be caused by poor pressing or calendering, it can easily be detected in a roll of paper, as the thin streak makes a soft spot in the roll which can quickly be located by tapping the roll all the way across. A muffled rather than a ringing sound 78 discloses soft places.

This defect, if bad, may cause considerable trouble on a web press, as no amount of manipulation will make the paper draw evenly as it runs into the press if the edge of the roll is slack.

Occasionally, segregated areas in paper are found to vary in finish, and when these do not run in continuous streaks they may often be caused by the felts which carry the paper through the press rolls having become clogged up in spots so that the water can not pass out evenly from the paper through the felt. This must be guarded against by occasionally stopping the machine and washing the felts, or changing them, as the occasion dictates.

Such damp spots in the paper crush in the calendering and make blackened areas in the paper. Uneven drying may also have been occasioned by slackness of the drier felt which holds the paper against the driers. In sheeting the cheaper grades of book paper it is customary to cut off from a number of rolls simultaneously, which often accounts for a variation in finish or bulk in sheets from the same case.

Of course, when any of these symptoms appear it is the duty of the men on the machines to correct them, and in the continuous course of paper-making it is inevitable that felts become filled up and require washing or changing, or that the variations of consistency in the stuff should call for some form of regulation. Stuff which runs too moist on the wire will often “crush” under the couch roll, producing a curdled appearance. Stuff run with insufficient water will not form evenly. The skilful machine-tender avoids these extremes.

Trade Customs.—In recognition of the many variable elements in paper-making, trade customs have been established, such as allowances for a normal variation in the weight of paper above or below the nominal ream-weight, and reasonable allowance should be made for normal variations in other characteristics.

Eternal vigilance and alert judgment are certainly required for setting high standards in the manufacture of 79 paper. It is a matter of common observation that mills using practically the same raw materials vary widely in their reputation for uniformity and excellence of product. The reason for this is to be found in the human element.

Calender Defects.—A number of difficulties may arise from much less excusable causes than those mentioned. For example, the paper sometimes may run slack through the calenders, with the result that it wrinkles and cuts in diagonal jags called “calender cuts.”

Sheets containing such defects sometimes elude the finishers, and on the printing-press such a sheet may crack and go around one of the ink rollers. On a web press the trouble from such a defect would be even worse, causing breaks and necessitating delays on the press. It is more difficult to exclude calender cuts from roll paper, as it is not always easy to see them in the fast-running paper, so that an occasional cut is not an unforgivable sin.

Among other defects arising on the calenders are little scarlike depressions in the paper, made by small scraps of paper which have become lodged on a calender roll and are embossed into the web at each revolution of the roll.

Holes, Dirt, Etc.—In very light papers, holes are sometimes found, the most likely cause of which may be picking under the dandy roll or grease spots on the wire cloth. Of less frequent difficulty are the so-called pinholes, caused by sand or grit, while slime spots, or spots caused by slight bundles of fibers, are also occasionally noticed.

Dirt and specks originate from careless handling of rags or paper stock, and are also derived from shives of undigested wood in the wood-pulp.

Streaks in the paper may originate from a crease in the wire, and mottled effects denote some fault in the handling of the paper in the wet stages of making.

Again there are times when sheets are not cut quite square, which is, of course, inexcusably careless. 80
Likewise, the packing of paper may be done in a careless manner, and cases too loosely packed, if set on end, often cause a wave in the paper, which sags in the case instead of remaining tight and flat. It is desirable that cases of paper be kept flat in storage and not set on end. Cases should be made from well-dried boards, and waterproof lining-paper should be used to exclude all dampness. When paper is finished in rolls it is fair to demand that the rolls should be wound evenly and hard, and all breaks should be carefully spliced and flagged.

Color.—The foregoing troubles are mechanical. Other difficulties may exist, even when the paper is handled well on the machine, owing to errors in composition. The color may vary, and the term “color” includes the various shades called white, as well as tints. Color is affected by water conditions. In the case of mills which depends upon river water, the water sometimes becomes so dirty that it severely handicaps the paper-maker, in spite of his filtering apparatus, and at such times it becomes difficult to get as bright and lively shades as under favorable conditions.

Dyestuffs do not always work uniformly, and, therefore, absolute matches of color from run to run are not to be expected. Shortcomings of this nature should be regarded with some lenience.

In this class of difficulties, discrepancies in sizing are the less pardonable and are more apt to be noticed when hard sizing is requisite, as in writing-paper or index bristol. In such cases a lack of sufficient sizing is an incurable fault, for which the manufacturer is responsible. There are occasions when excess of sizing would be troublesome—for example, in a smooth-finished book-paper it would be likely to cause offsetting, but this trouble may be alleviated by using less ink, or, if necessary, by slip-sheeting.

It would be difficult to catalogue all possible sources of trouble, but we have at least covered the principal 81
defects of uncoated papers.

Packing.—Occasionally troubles may be charged to faulty packing—cases too loosely packed when stood on end permit the paper to sag, thus causing a curling tendency at one end of the sheets.

The use of unseasoned case lumber or cases and inferior case lining give access to moisture, the effect of which is discussed herein at length.

The susceptibility of coating to picking may be determined by applying hot sealing wax. If the wax after cooling is pulled off with only the coating adhering it may be assumed that a “tacky” ink would work the same, whereas if the paper tears out with the wax—it proves conclusively that the coating is well sized.

Coated-paper Troubles.—Coated papers have their characteristic shortcomings. The picking of small particles of the coating is perhaps the most common fault, and is caused by insufficient adhesive elements in the coating mixture. Other troubles are traceable to some of the defects of the body stock. Irregularity of the finish is sure to come from faulty application of the coating or careless calendering. Grit or bubbles in the coating is likely to result in a porous surface. The sour odor of some coated papers is due to decomposing casein or glue.

Casein used as an adhesive in most coated papers is a product from skim milk. It contains lactic acid which must be neutralized in preparing the coating mixture. For this purpose an alkali such as soda or ammonia is used, and when properly handled the coating should be neutral. An alkaline coating will cause re-etching on lithographic plates or stones.

Starch coatings or combinations of starch and casein are cheaper than full casein and do not yield as high a finish and when improperly used have often been the cause of picking.

The Printer’s Responsibility.—The second group of difficulties, or those for which the printer is to blame, may 82
originate with the improper storage of the paper. As pointed out, the standing of cases on end is conducive to wavy paper. Dampness is a prime cause of trouble, as will be sufficiently shown later on, but it is elementary to say that paper should never be exposed to moisture.

Engravings.—The troubles of ignorant or inefficient pressmen and foremen are often laid to the paper, especially where half-tone printing is involved. In the first place, too little attention is given to securing proper originals for the half-tones. Retouching is omitted in a fit of false economy, for at this very stage of the game it was never truer that “An ounce of prevention is worth a pound of cure.” Too much care can hardly be given to securing good engravings.

Secondly, the selection of a proper half-tone screen is frequently overlooked. While no hard-and-fast rules may be set, the best one, when in doubt, is to include with the engraver's order a sample of the paper on which the cuts will be printed. He can judge, taking into consideration the subject and the stock, which screen is advisable. In general, it may be affirmed that 120 or 133 line screens are best for uncoated smoothly finished papers, and 150 or 175 line screens are most satisfactory for coated stock.

Inks.—Next comes the suitability of the ink, and there again the ink manufacturer's advice, always available, is often neglected; but experience proves that certain papers yield best results with certain inks. Such matters can only be determined by actual experience, but when in doubt consult the ink-man.

Make-ready.—Finally, the make-ready should be intelligently varied according to the subject and the paper. The best printers agree that different papers to some extent require individual treatment. A make-ready suitable for a coated paper is not necessarily equally satisfactory for an uncoated half-tone paper or even a dull-finished coated stock. But it is not within my province to go further than to emphasize these warnings. 83

Grain.—The question of the grain in paper is certainly, in many cases, within the control of the printer when ordering his paper, but its importance is very frequently overlooked. In machine-made papers there is a distinct grain that is caused because a majority of the fibers point in the direction that the stuff flows on the machine, just like logs floating in a river.

This grain direction is noticeable in folding, the crease being smoothest with the grain, because folding across the grain encounters the most resistance and breaks many of the fibers. This is especially noticeable in fairly heavy book-papers, in bristol boards and cover-stock, all of which should be scored for folding.

Cut cards, to have the maximum stiffness, should be so trimmed out of the sheet as to have the grain run in the long direction of the card.

Even in book-papers, where flexibility is desirable, it is necessary to have the grain run up and down the page. There are occasional cases when the grain is deliberately arranged to run across the page to acquire more rigidity. A wide page of light-weight paper might otherwise be too limp. Moreover, this arrangement makes for stronger bindings, as the stitches or wires pass around the bundles of fibers instead of cutting between them. The English books are mostly made up in this way, but they do not open so easily as when the grain runs parallel to the binding. Paper is materially weaker across the grain and can withstand only about half the tensile strain that it could bear with the grain, although crosswise it is more elastic.

There is one very serious objection to making books or catalogues "cross-grained." This is on account of the way fibers are affected by moisture. The cellulose fiber expands in diameter on absorbing moisture, for which it has a great affinity. Indeed, a cellulose fiber is only stable under uniform atmospheric conditions. The expansion 84 of each fiber in diameter makes paper expand much more across than with the grain. Obviously, the total expansion of a sheet equals the amount each fiber expands times the number of fibers that side by side go to make up the sheet.

When the glue is applied to a book in process of binding, it causes an expansion of all the moistened fibers.

If the grain runs parallel to the shelf-back no harm results, as the paper is free to expand toward the side margin, but if the grain is at right angles it usually makes a cockle in the binding because the moistened edges of the leaves expand while the dry portion beyond where the moisture penetrates retains its shape and resists the elongation of the wet edges. Consequently the expansion of the fibers expresses itself by cockling.

Register.—In all printing, when close register is necessary, the danger of poor register from the expansion of paper is minimized when the dimension across the grain is the shorter. Lithographers invariably prefer to have the grain run the long way of the sheet on this account. Moreover, they rack the paper before printing in order to get it thoroughly seasoned. To protect it from atmospheric changes that may occur during the printing process, they use slip-sheets of considerably larger dimensions, so that there is a generous margin of slip-sheet around each printed sheet, which helps to exclude the air from the edges of the printed paper.

Moisture in Paper.—It is true that some papers are more prone to expand than others, especially if they have been run too dry on the machine. Paper is not naturally bone-dry. Under average weather conditions, it contains six or seven per cent of moisture.[D] When in the making it is turned off far below its normal moistness, it seeks to obtain this moisture from the air at the first opportunity, and in acquiring it expansion takes place. Unless the 85 expansion pervades the entire sheet, wavy edges will result. Similarly when the air becomes dry exposed edges of paper give off some moisture and shrink accordingly leaving a boggy center to the sheets.

[D] See Herzberg table, page 64.

Seasoning.—This process of acquiring normal moisture is usually called "seasoning." As paper is probably never turned off at its full normal moisture, it is most desirable that it should be allowed time to season. It is not unusual to have people speak of new paper being too "green." This may not have been an uncommon condition of hand-made papers which were dried entirely naturally, but, so far as machine-dried paper is concerned, I doubt if it is ever too green, though it is frequently made too dry.

Conditions Beyond Absolute Control.—Believing it to be impracticable to leave the precise normal moisture in machine-made paper, I have deliberately refrained from classifying this difficulty with faults chargeable to manufacture, and the general recognition of this circumstance indicates the wisdom of ordering paper long enough in advance to permit of a period of seasoning. In fact, this phenomenon of expansion or contraction of cellulose fibers places difficulties originating from this source in the class of conditions beyond absolute human control, but a study and understanding of the subject will enable one to prevent, or at least to minimize, such troubles. It consequently becomes the business of the printer to inform himself as thoroughly as possible on the subject. Static electricity is an element beyond absolute control and the source of much trouble. Both phenomena could be controlled by proper atmospheric conditions in storage and press rooms, but it is an expensive matter to equip rooms and install the necessary apparatus. The amount of trouble arising from these elements is often sufficiently costly in time and material to warrant investigation as to the expense involved.

The least a printer can do is to maintain hygrometers in his pressroom so as to keep track of atmospheric 86
variations, and be guided accordingly.

STATIC ELECTRICITY IN PAPER

Among the “paper troubles” due to conditions for which neither the paper-maker nor the printer is responsible, none is more bothersome than the presence of static electricity in paper. These static charges, which are created by friction either in the making or handling of paper, develop magnetic propensities in the sheets, causing them to behave in ways which seem nothing but freakish until their nature is understood. Some sheets stick together as if they were glued, while others appear repellent to one another. Likewise, they may act in the same manner toward the fly-bars of the press. It is next to impossible to “feed” sheets so charged, and there is every likelihood of the ink from one sheet offsetting to another.

Every one familiar with the magnet knows that there are in magnetism two poles, the positive and the negative; that two substances of opposite polarity attract one another, but that substances of the same polarity repel each other. Static electricity—or frictional electricity, as it is also called—exists both in positive and negative charges, and sheets of paper containing static charges are governed accordingly.

Paper, when dry, is an insulator to electricity, but when moist it becomes an excellent conductor. Consequently, too much drying in manufacture increases the likelihood of electrical troubles, because it makes the paper more retentive of electricity with which it may become charged.

Pure air is also an insulator of electricity, which finds its paths through the air by means of the dust particles in suspension. Moisture in the air forms a connection between the dust particles through which the electricity easily passes into the ground, but when the air is dry this medium is lacking, so that substances containing
static charges are deprived of these channels of conductivity. Cold air can not hold so much moisture as warm 87
air, so that its insulating properties are increased. It is, consequently, in cold weather when this sort of paper trouble is at its worst.

These facts suggest the first steps of prevention to take against static electricity. First keep the air in the pressroom warm, and, if necessary, increase its humidity. It is also advisable to keep the paper in a warm room, for it has often been noticed that paper coming cold into a pressroom gives much trouble.

The entire virtue of the so-called electric annihilators for moistening the tympan of a press comes from the moisture they contain. Ordinary glycerin, which is cheaper, will answer as well. These applications are undesirable because they cause the packing to swell, and, in consequence, detract from the adjustment of the overlays.

There is a simple and not very expensive device on the market called the Thompson electrical neutralizer that has been found helpful. It is provided with a tinsel cord such as is used in decorating Christmas trees. The cord is stretched across the press so that the sheets are brushed by it as they pass to the delivery board, and are thus offered a connection whereby the static charges may escape into the ground. A second device of merit consists in a gas pipe with flames at frequent intervals over which the printed sheets pass in close proximity on their way to the delivery board.

The most successful neutralizer with which the writer is personally familiar is the Chapman. By means of an alternating current of electricity, it supplies through a special apparatus alternating discharges of positive and negative electric currents against the sheets of paper as they are carried along the press. In the presence of such a current the charges on the paper become their own destroyers, as they draw out of the alternating current only the kind and quantity of electricity which is sufficient for their complete neutralization.

There have been quite a number of other inventions, an account of which the writer published in *The* 88
Printing Art, Vol. XIX, No. 1, March, 1912. All are based on one of the following principles:

1.—Making paper a conductor by moistening.

2.—Making the air a conductor by humidifying.

3.—Inducing static charges out of the paper by means of grounded wires or gas flames.

4.—Neutralizing the static charges in the sheet with charges of opposite polarity.

Another solution of this problem, as well as of the problem of expansion of paper and consequent poor register, could be reached by the construction of an insulated pressroom. The air for this room should be supplied through an apparatus in which it could be brought to any required degree of temperature and humidity. The paper would naturally have to undergo sufficient airing in such a room as to become acclimated. After that, if the conditions remained constant, there could be no difficulty in getting register, so far as the paper was concerned, and a proper amount of warmth and moisture would also dissipate all static electricity.

It is difficult to anticipate or to completely cover all conceivable paper troubles, and when some one which may not be diagnosed on the basis of the general principles enumerated, consultation with some paper expert should clearly be sought. The author will be glad to communicate on such subjects.

CHAPTER ELEVEN [89]

THE PAPER TRADE

The distribution of paper is cared for in part by direct sales from the mills to consumers, such as large publishers of newspapers, magazines, and books, and manufacturers of paper commodities, such as tags, boxes, stationery, toilet accessories etc.

The sale is also conducted to some extent by brokers, who operate principally in a few of the larger cities, especially those located within easy shipping distance from the mills, where the handicap of not carrying a large warehouse stock is at a minimum.

The broker carries no stock as a rule, with the exception of a supply for regular contracts. Occasionally the mills will carry a stock for the broker. A few firms specializing on contract business have made distinct successes in this branch of the paper business, but the broker is not an important figure in the paper trade, taking the country as a whole.

The most important distributing factor to the printing trade, is the paper merchant, who with his large purchasing power, accumulates ample and varied stocks, at minimum cost (having the advantage of carload prices and freight rates), and stands ready to distribute in large or small quantities, whatever is required. He also helps in a considerable measure to finance his trade by extending credit.

There is a distinct tendency toward “chain stores” one of the more prominent of which now comprises eight warehouses and seventeen branch offices, covering practically the entire country. These large factors frequently control the entire output of several mills, and sell to the smaller jobbers, as well as to the printers and consumers.

Statistics on distribution are apparently lacking, since the Government has never regularly compiled them, and the National Paper Trade Association, composed of paper merchants was unable to furnish any. The only [90] estimate the author has obtained, comes through the President of the American Paper & Pulp Association, (The Manufacturers’ Association), who wrote on Jan. 22nd, 1914—

THE PAPER TRADE

> “In writing paper I should estimate that 95 per cent is sold through the jobbers.
>
> In book paper I should say not over 33½ per cent is sold through jobbers.
>
> In news paper probably not over 10 per cent is sold through jobbers.
>
> In wrapping paper I should say about 95 per cent is sold through jobbers.
>
> In box boards probably not over 25 per cent is sold by jobbers.
>
> Tissue paper, perhaps 25 per cent is sold through jobbers.
>
> (The balance is sold direct to manufacturers who re-manufacture it, like toilet paper manufacturers).”

The indications therefore are, that the very large consumers of printing papers buy direct from the mills, as do many of the large manufacturers of commodities composed largely of paper.

The printers who in the aggregate consume large quantities of writing, catalog, and miscellaneous printing paper, but whose orders are composed principally of many small items, buy almost wholly from the paper jobbers. In localities far removed from the Mills, the jobber very naturally occupies a more conspicuous position than elsewhere, and his superior facilities for handling the business make him a stronger factor than in the markets adjacent to the mills, and enable him to handle much of the largest business to advantage.

In the *New England Letter* issued in January, 1913, by the First National Bank of Boston, the following interesting statement was made in regard to paper.

“The Paper trade is essentially a hand-to-mouth trade in all branches except the news print department. In [91] general, purchases are made only as required, and fluctuations in price effect but slightly the demand. In short, an analysis of the production of the Paper Mills of the country, taking into consideration stocks on hand, is specially significant as an index of current trade conditions.

The situation is shown by the following table which gives an idea of the paper output, the stocks on hand, and the number of days’ supply available for November, 1912.

Output and Stocks for November, 1912, of American Paper
(in tons)

	Normal Output per month Nov., 1912	Actual Output Nov., 1912	Stk. on hand Nov. 30, 1912	No. days supply on hand Output	
				Normal Basis	Actual Basis
All Grades	367,154	348,640	163,557	13	13
Newsprint	113,516	106,715	43,504	11½	12
Board Paper	83,174	78,243	11,249	4	4¼

Book Paper	63,474	62,134	31,200	15	15
Wrapping Paper	50,674	49,168	27,065	16	16½
Writing Paper	16,198	14,024	23,137	48	49
Coated Book Paper	10,868	9,922	10,750	30	32
Tissue Paper	5,642	5,455	2,187	11½	12

It is noticeable from this table what the merchants' service means to the Printer, for in the lines that are sold very largely, direct on making orders from the mill to the consumer, the number of days' supply on hand is small, whereas among the items most often used in the average print shop, anywhere from two to seven weeks' supply is carried in stock.

The Jobber unquestionably occupies a permanent and important position as the distributor of paper, not only because he affords a centralization of information and stocks, which is more economical than if every 92 manufacturer had to maintain separate channels of distribution, but also because he relieves the Printer of the necessity of tieing up a large amount of money in paper. In earlier times, when there were but few kinds and a small consumption of paper, the situation was very different, and there was no need for the middle man.

Today the elimination of the merchant would mean the elimination of the majority of Printers, for it is inconceivable that the printing industry, in which according to Government Statistics, 86% of the establishments do a yearly business of less than $20,000, and 52% less than $5000, could finance itself without the aid of well organized Jobbing Houses.

Certainly the Printers are in the total, large and important from the merchants' viewpoint, but there exists a strong inter-dependence, which both should realize and recognize, as a most natural basis for coöperation, in the expansion and increase of the demand for printing.

MERCHANDISING

Having considered the channels of trade we come to the methods of merchandising.

Mills that sell their products direct to consumers necessarily maintain a sales organization at their main offices, and as circumstances may require local representatives, in the larger markets, such as New York and Chicago, these men keep in personal touch with the customers, furnishing samples, making contracts, following up shipments and adjusting claims. Knowing the possible customers, this direct method suffices without any accessory effort, such as advertising.

Their business is as a rule, strictly a wholesale proposition. It happens in some instances that the same mills which sell some classes of paper direct, manufacture other grades for distribution through the dealer. While other mills rely entirely upon the merchant for their distribution.

Formerly the paper re-sold by the merchant, was with few exceptions handled under the private brand of the 93 merchant. A grade of paper so handled would be called by as many different names as there were merchants selling it.

Frequently the manufacturer conceded the exclusive sale in given territory to one merchant, but in other cases the same paper has been handled by two or more merchants in the same City, sold under different names, but not invariably at the same price. Such a condition is not unusual, even today, but it obviously works to perpetuate the "Caveat emptor" theory, which standard advertised brands in all branches of merchandising is steadily eliminating.

Paper sold in this way is usually advertised at the entire expense of the jobber. If the grade is a stock article it is listed in the price book and shown in the sample set.

The competition between merchants has extended to their methods of sampling, and no important dealer today is without a well arranged Catalog and price list, giving complete data as to the standard sizes, weights, and grades, etc., and also substantial sample cabinets, which are distributed to paper buyers.

A comparatively recent development in the paper business, is the exploitation of "mill brands." That is to say, a mill manufactures and stocks in the most merchantable sizes, a grade of paper. This is marked with the mill brand. Agencies are established as far as possible with a desirable chain of paper merchants, usually restricted to one for each City. The mill prepares sample books at its own expense, which are either mailed direct or divided among the appointed agents for distribution. The agent lists the paper in his price lists, and gives his salesmen the necessary information about it.

This represents the simplest form of merchandising mill brands. It has been elaborated however, until most mills with connections of this sort, do more or less advertising to assist in creating a demand for their brands. They can afford to do this on a scale which would not be warrantable for the individual dealer with a more 94 restricted market. Hence it has come about that many handsome specimen books, far more elaborate than any the merchants had usually issued, have been put out by the mills.

It is generally admitted that the influence on printing has been good, and an appreciation and demand for better printing, especially on the part of advertisers, has resulted.

A few mills have carried their campaigns beyond the field of direct advertising, which includes the mailing of samples and printed circulars, and the dissemination of printed samples in trade journals, such as *The Printing Art Suggestion Book*, *The Pacific Printer & Publisher*, or the direct mailing of folders or specimen books.

They also take advertising space in the *Printing Art*, *Inland Printer*, *The American Printer* and other printing trade journals. Outside of these has come the use of such class magazines as *System*, *Printers' Ink* and *Advertising & Selling*, and some have even extended their appropriations to include national magazines, notably *The Saturday Evening Post*. In one campaign a Chicago newspaper was among the media selected; but the use of newspapers for paper publicity is practically nil.

General Magazine advertising of paper has been principally devoted to writing paper. This is natural, since of all paper products this commodity has the largest number of buyers, and the matter of taste is not so overshadowed by technical considerations, as in the case of printing papers.

The specifications for general printing, involve more knowledge of printing processes than most people possess, hence the final decision rests in a majority of cases on the printer's judgment, so that logically the printer is the most necessary individual to convert.

Although there has been a marked increase of late in the exploitation of mill brands, there is no indication of
the disappearance of jobbers' brands. A consumer today may fill nearly every requirement at will from either 95
class, and this condition will probably continue indefinitely, although the tide seems to be setting for the moment toward the mill brands.

This condition is not confined to the paper trade, and is probably due largely to the aggressive advertising of manufacturers. Such promotion work is still in its infancy, and a continuation of a growing demand for mill brands may safely be predicted for sometime to come.

TRADE ASSOCIATIONS

There are two principal trade associations in the paper business, one composed of manufacturers and the other of jobbers.

The American Paper & Pulp Association, composed entirely of manufacturers was organized in 1877. Its purposes were described by its President at the Annual Meeting of 1914, as "entirely educational." It collects and distributes statistics of production, and consumption, among its members, aims to develop cost systems, agrees upon trades customs, and seeks to bring about uniformity in these respects. Technical education has been the subject of much study by the Association, and it is hoped will lead to the establishment of trade schools.

A labor bureau is maintained, which helps manufacturers to find help, and laborers to secure work.

The Association is separated into divisions; News, Wrapping, Boards, Tissue, and Writing. A Book division was formerly included, but the manufacturers of book paper recently formed a separate organization solely concerned with their special branch of the industry.

The Association has also played a prominent part in representing the industry in tariff matters. The membership represented in 1915—246 mills.

The National Paper Trade Association was organized in 1903. Membership consists of jobbers and includes
the following subsidiary associations; Baltimore & Southern Association, Central States Paper Dealers' 96
Association, Empire State Association, New England Paper Jobbers' Association, Northwestern Paper Dealers' Association, Pacific Coast Paper Association, Paper Association of Philadelphia, Paper Association of New York City, Western Paper Dealers' Association. The total membership in 1916 was 236.

The work of the Association has included credit organization for the exchange of information as to credits; the study and installation of cost systems; consideration of the relations between jobbers and manufacturers.

There are a number of standing committees which have special details assigned to them. They make regular reports at the annual meeting.

The existence of both associations is of distinct benefit to their members, and to the trade in general. The establishment of standard trade customs throughout the country facilitates the conduct of business upon an equitable basis. Copies of these rules are to be found in the price list of most paper jobbers, and as they are subject to occasional changes it seems inadvisable to reprint them here.

A third organization known as the Paper Makers Advertising Club, consisting of 15 Mills, was organized in 1914. Its purpose is to develop the growth of printing by disseminating information about the purpose and uses and planning of "direct-by-mail" advertising. Its membership is open to any paper mill which sells its product in whole or in part under its own brands.

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CHAPTER TWELVE

IMPORTANCE OF A KNOWLEDGE OF PRINTING

The study of printing should be more general in all our schools—but not as it is taught so often—by teachers incompetent to glimpse and grasp its widest possibilities—to make it live and thrill with all its latent power.

If its mechanical aspects are over emphasized it must fail to appeal to intellectual scholars, since it cannot sufficiently stir their imaginations to command interest.

The printing and publishing industry stands among the six largest from the point of view of annual value in dollars—in this country—and has, of course, boundless possibilities for good and evil. Nothing is more essential to civilization intellectually or commercially, than printing.

The allied industries are also relatively important. The United States produces more paper than any other five nations combined and hence offers countless opportunities for a good livlihood in this line.

Six hundred million dollars and more are annually expended for advertising in the United States and advertising invariably involves printing of some sort.

Aside from the positions that require a knowledge of printing more or less complete, such as proofreading, publishing, librarians’ work, etc., there are jobs connected with the paper industry where this knowledge, which as a matter of fact is rarely found, would prove of great advantage.

It is evident, moreover, that some practical knowledge of printing may prove useful if not essential for practically all men who engage in commerce or manufacturing. They are all buyers of printing, and it is a difficult commodity to purchase intelligently.

For authors or editors a knowledge of typesetting is very valuable. They should know the mechanics of it, for “author’s corrections” are the bugaboo of most printers and the cause of much unnecessary expense and 98
misunderstanding about the cost of printing, because the inexperienced author seldom realizes that the change of a word may involve the resetting of an entire paragraph.

When we have agreed that a grounding in printing is desirable for prospective authors and business men, we have included a high proportion of our population. Even professional men will find it beneficial, though possibly not in proportion to the time required for its mastery.

From a purely educational point of view, I can emphatically state from personal experience, that nothing ever helped me more in acquiring concentration of mind than typesetting.

There is a wholesome discipline in the performances involved in products of the press. Nor should the aesthetic aspect be ignored. It seems a pity that cultured persons should be so generally ignorant of what constitutes good printing.

The same people who would not wish to admit that they could not recognize a Sheraton chair, or a Rubens painting, have no sense of omission from their educations because of their inability intelligently to appreciate a beautiful example of printing, as mere printing. A collection of well-printed books is an indulgence within the reach of modest incomes and the source of much satisfaction.

Considering that Printing is the “Art preservative of all arts” does it not seem like a subject which should be generally touched upon, at least collaterally, in every institution of higher education?

To sum up a bit: Printing is an industry of basic importance to civilization. It means, therefore, the livlihood directly or indirectly of many persons. The opportunities open to young men well equipped with a knowledge of printing are numerous, and the young man so prepared has an advantage over his competitors.

So much for the commercial aspect.

Aesthetically, printing has risen in the past, and does still, occasionally rise to high levels. Its 99
encouragement as an art should come from the better educated people, as well as from the hard headed business men, who, by producing beautiful catalogs, have actually done much to encourage and bring in an age of better printing.

Educationally, I would like my own children to undergo this training which possesses so much that is fascinating, but is at once exacting and disciplinary to the mind, the eye and the hand.

There is no escape from the consequences of one’s work. It remains proved in black and white, or even in many colors, as a credit or otherwise to one’s imagination, conception and workmanship. It is my conviction that there are large educational advantages in the study of Printing if it be taught by trained enthusiasts in a way to make it live and vibrate with all its far-reaching and inexhaustible power.

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Transcriber's Notes

Punctuation, hyphenation, and spelling were made consistent when a predominant preference was found in this book.

Discovered typographical errors were corrected. The non-trivial ones are noted below.

Ambiguous hyphens at the ends of lines were retained.

Index not checked for proper alphabetization or correct page references.

"livelihood" was consistently spelled as "livlihood"; not changed here.

Copyright page: The spelling of the author's name has been changed from "Wheelright" to "Wheelwright" to match the spelling used throughout the rest of the book and the cover.

Page 11: The "Note" originally was at the bottom of the first page of the chapter.

Page 15: The attribution at the end of the long table originally was printed at the bottom of each of the pages containing that table.

Page 59: "parrafin" was printed that way.

Page 81: "may be charged to" was misprinted as "changed".

Page 81: "case lining give access to moisture" was misprinted as "case linning five access to moisture".

Page 85: "when the air becomes dry exposed edges" was misprinted as "when the air becomes due exposed edges".

Page 91: No closing quotation mark for the paragraph beginning, "The Paper trade is essentially".

Page 97: "CHAPTER TWELVE" was misprinted as "CHAPTER THIRTEEN".