

[54] **MANUFACTURE OF HARDWOOD
PRINTING PAPER**

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[22] Filed: **June 15, 1971**

[21] Appl. No.: **153,381**

[52] U.S. Cl. **162/142, 162/150, 162/207**

[51] Int. Cl. **D21f 11/00**

[58] Field of Search **162/207, 150, 142, 100;**
34/150, 23

[56] **References Cited**

UNITED STATES PATENTS

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FOREIGN PATENTS OR APPLICATIONS

614,598 2/1961 Canada 162/207

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[57] **ABSTRACT**

Paper capable of being converted to printing paper and capable of being processed through high speed printing machines is manufactured from 100 percent or near 100 percent hardwood groundwood pulp by a process which includes drying the wet pulp web to below 15 percent by weight moisture under substantially no physical restraint, the drying process imparting stretch and strength to the paper without causing cockling.

8 Claims, 8 Drawing Figures

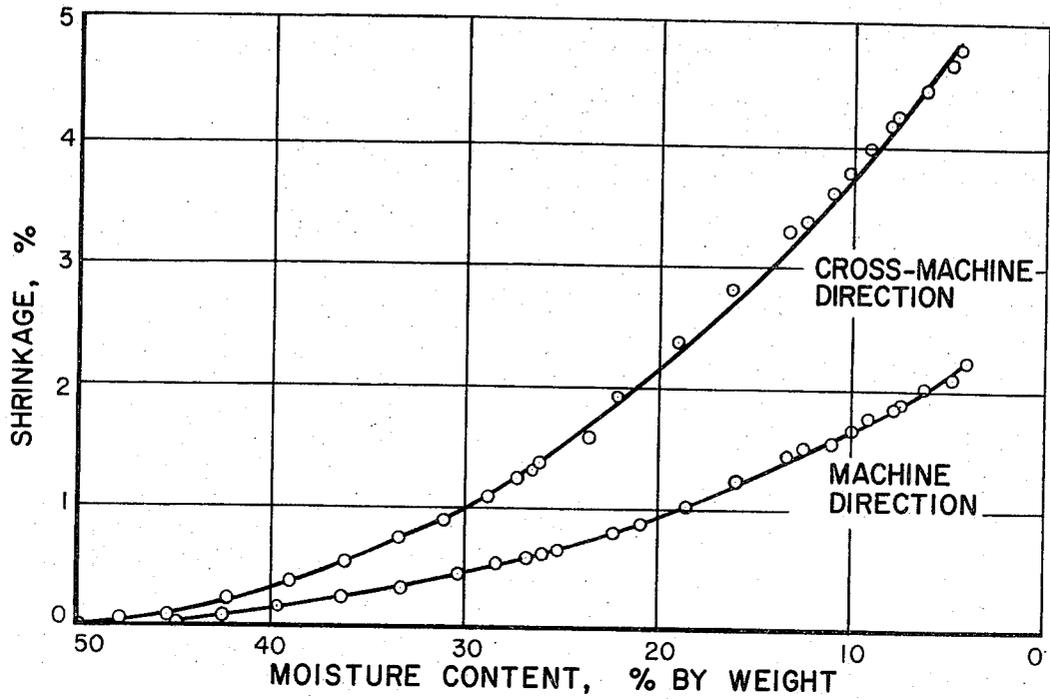


FIG. 1

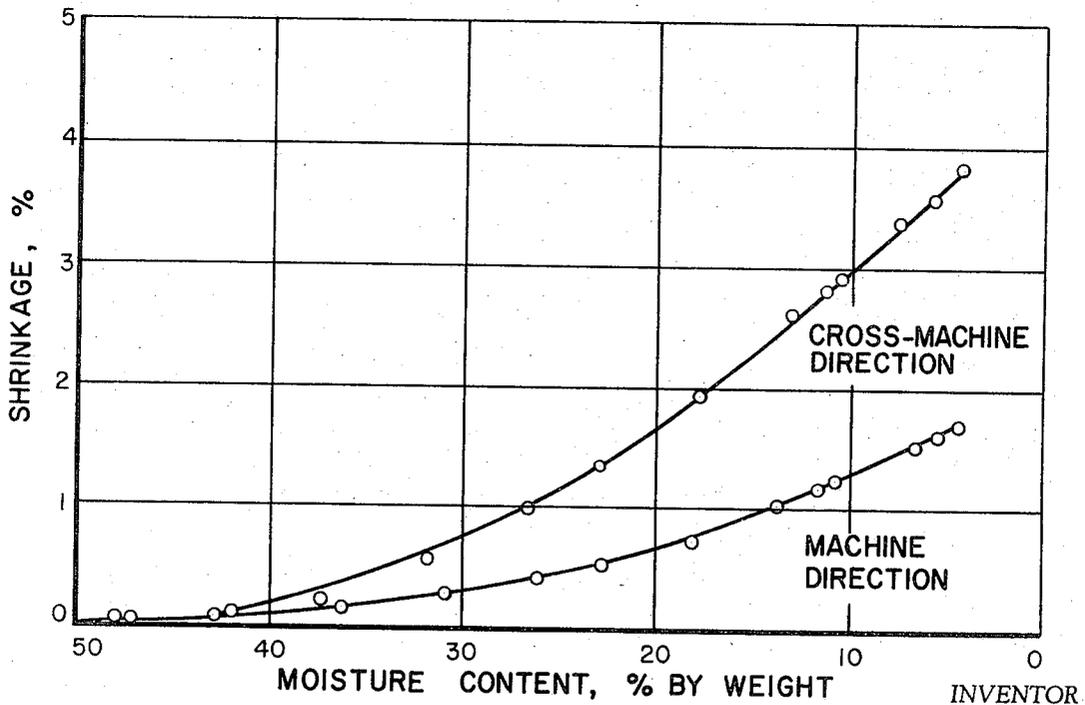
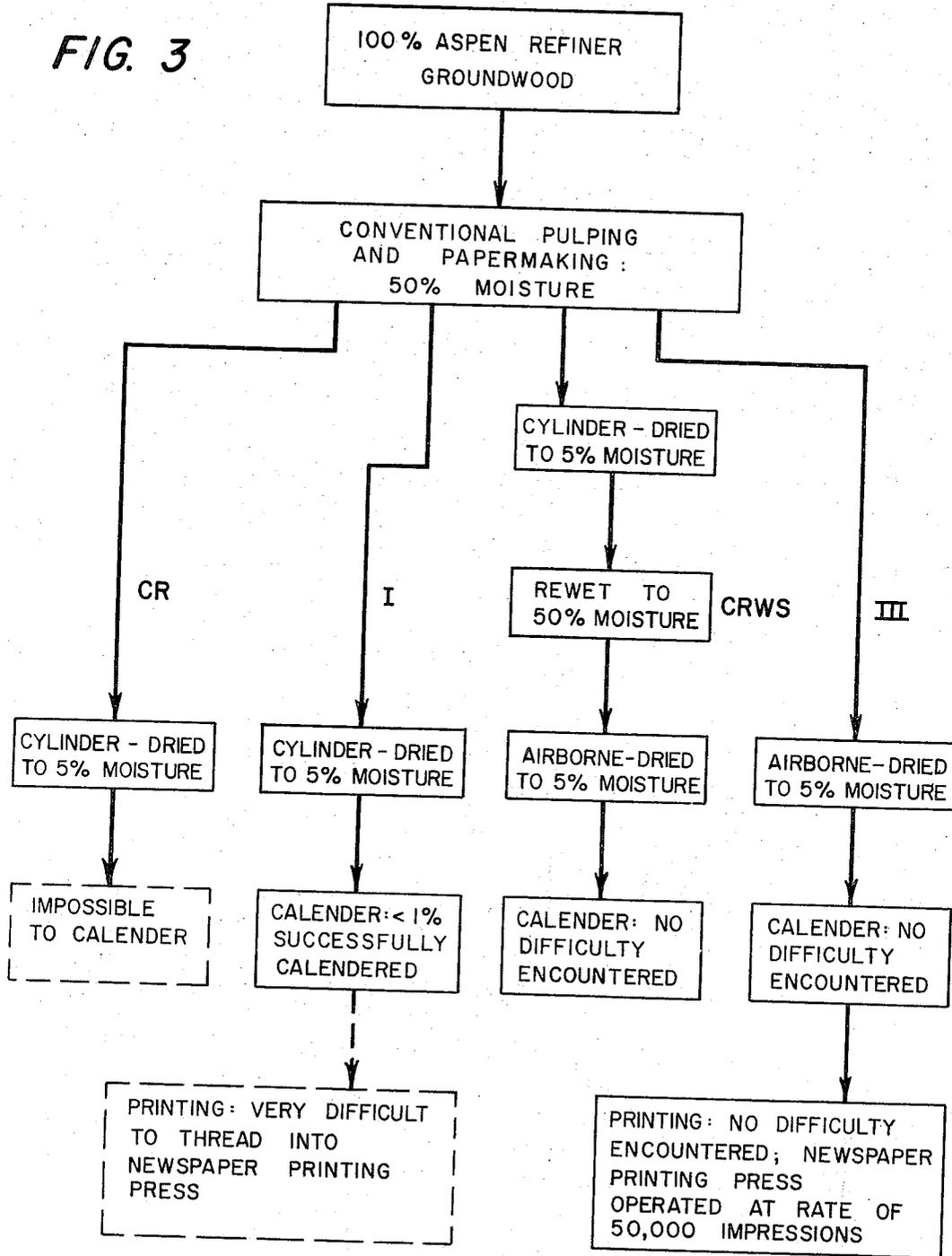


FIG. 2

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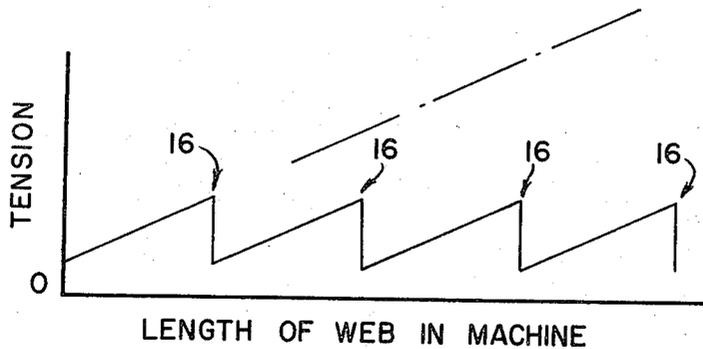
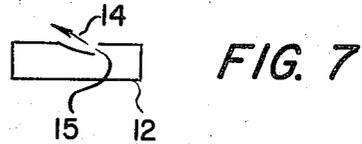
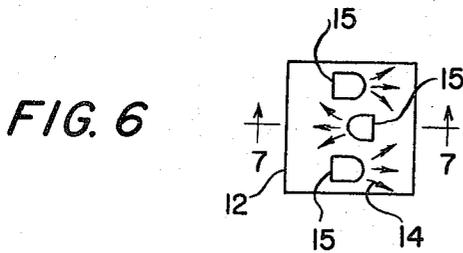
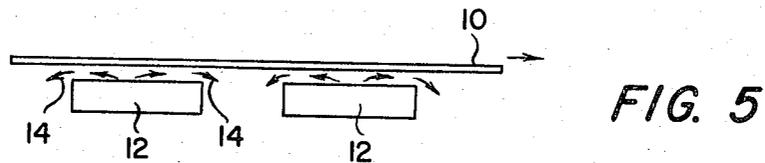
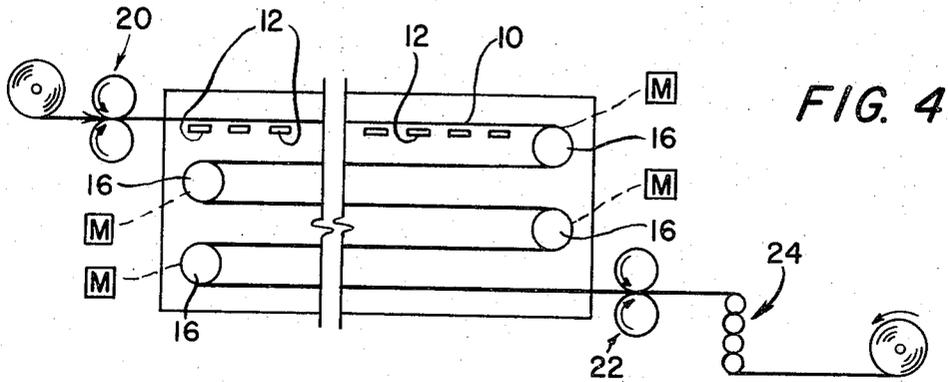
FIG. 3



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MANUFACTURE OF HARDWOOD PRINTING PAPER

This invention relates to paper and to papermaking and in particular to newsprint and the like and to a process for making the same from types of wood pulp not heretofore considered to be suitable for the purpose.

Specifically the invention is concerned with a process for making newsprint from 100 percent or near 100 percent hardwood groundwood pulp.

INTRODUCTION

Historically, and as a result of a long period of operating development, newsprint and the like is composed entirely or almost entirely of softwood pulps of which approximately 25 percent by weight is chemical softwood pulp and 75 percent by weight is mechanical (groundwood) softwood pulp. Over the years various attempts have been made to introduce hardwood mechanical (groundwood) pulps into newsprint and today, dependent on market needs, small amounts appear from time to time in North America. In Japan, at present, some manufacturers are using as much as 40 percent hardwood groundwood in the initial furnish from which newsprint is made.

There are several reasons for developing technologies for increasing and maximizing the use of hardwood groundwood pulps in papermaking:

1. In many areas of North America and Europe, the desirable soft woods are becoming, or are, in fact, depleted, and the use of hardwood is of substantial potential economic importance.
2. The manufacture of mechanical pulp is substantially pollution-free, since no malodorous gases nor conditions of high dissolved solids effluent occur.
3. Most important is the fact that a major percentage of the world's wood is hardwood, and in tropical areas of the world nothing else grows. Consequently, the development of a 100 percent or near 100 percent hardwood groundwood newsprint would facilitate the introduction of newsprint manufacture into numerous countries without requiring any importation of chemical pulps.

For the above reasons it would be desirable to manufacture newsprint and the like from 100 percent or near 100 percent hardwood groundwood pulp. However, experience has shown that pulp mixtures containing more than about 80-85 percent hardwood groundwood cannot be successfully converted to newsprint by the techniques which are conventionally employed in the papermaking industry. Specifically, the paper initially formed by extracting water from a wet web of the pulp and by drying the resulting sheet in the conventional manner is physically incapable of being converted to newsprint, because the paper tears and/or crumples and is otherwise mechanically unmanageable during the calendering, slitting and rewinding, and printing operations.

The present invention solves this lack-of-strength problem by employing a special drying process by which webs of hardwood groundwood pulp and other pulps having similar characteristics are dried under little or no restraint in both machine direction and cross direction to form paper which, surprisingly, is capable of being converted to newsprint. The inherent disability of these kinds of pulps to be processed by conventional

techniques and the success of the invention in overcoming this disability will be more clearly understood from the following discussions taken with the drawings in which:

FIGS. 1 and 2 are graphs of shrinkage versus moisture content for samples of paper made from 100 percent hardwood groundwood;

FIG. 3 is a schematic flowsheet illustrating results obtained by the process of this invention and results obtained by the conventional process;

FIG. 4 is a schematic view of a drying apparatus suitable for carrying out the process of the invention;

FIG. 5 is a schematic elevational view, on an enlarged scale, of a portion of FIG. 4;

FIG. 6 is a schematic plan view of a portion of a blow box which forms part of apparatus of FIGS. 4 and 5;

FIG. 7 is a schematic sectional view on the line 7-7 of FIG. 6; and

FIG. 8 is a graph illustrating the web tension in the drying apparatus of FIG. 4.

BACKGROUND

Hardwood mechanical pulps are of course not new per se, inasmuch as such pulps have found use in the past in a variety of uncoated and coated grades of paper. These pulps, when used correctly, cut costs and improve printing quality of uncoated papers. While these latter tend to have good opacity and printing quality, their lack of strength has limited their use in all grades, but especially in newsprint. In this regard it is well known that paper suitable for newsprint must have sufficient strength to feed at high speed and run properly at high speed during the various mechanical operations involved in unrolling the paper received from the papermill, calendering the paper to obtain a smooth printable surface and movement through the printing machine. The required combination of physical characteristics (such as stiffness, toughness, tensile strength, tear resistance and stretch), referred to here merely as strength, are generally recognized in the newsprint art and need not be discussed in detail. This is not to say, however, that the relationships of these properties to each other and to papermaking process variables are perfectly understood, and as will be observed hereinafter one cannot necessarily predict the behavior of a paper solely on the basis of individual properties measured in the laboratory.

It is important to the problem of hardwood mechanical pulp utilization to recognize the basic differences in the minute anatomy of soft and hardwoods. The arbitrary terms softwood and hardwood respectively designate trees having needle or scale-like leaves and trees having broad leaves, deciduous in the Temperate Zone. Hardness or density of wood is not involved. All woods are composed of three basic components: cellulose, lignin and extractives. While there are differences between the chemical structure of hardwood and softwood lignins, the important difference, as far as this patent is concerned, lies in the variation in cell structure.

Softwoods for the most part are made up of cells whose length is several hundred times their diameter. That is, while barely visible to the eye, they are thread-like. Hardwoods, on the other hand, are made up of a wider variety of cell types characterized by a length to diameter ratio which may run from 1:1 to 20:1. The quality of individual hardwood fibers, by papermaking

standards, is inferior to softwood. Hardwood fiber is stiffer, because its ratio of length to diameter being smaller and bonding between fibers is poorer, since the inter-fiber crossings per fiber are fewer and the bond area of each is smaller. Consequently, the sheet is weaker when it contains hardwood. Hardwood mechanical pulp is even weaker than chemical hardwood pulp. This is because the wood is simply mechanically disintegrated rather than dissolved between cell walls, and while this occurs roughly along cell wall cleavage planes, many fragments are larger, many cells are ruptured and there is much more sub-cell debris. Hardwood groundwood used with adequate softwood chemical pulp has come to form a portion of the standard commercial paper grade structure. However, as previously described, past attempts to make newsprint from pulp containing more than about 80 to 85 percent hardwood groundwood resulted in a sheet which was tinny, hopelessly weak, and unprintable. The position of the paper industry at the present time seems to be that the manufacture of newsprint composed of 85 percent - 100 percent hardwood groundwood is not possible.

The problem of increasing the strength of paper is not broadly new to the papermaking industry, and it has been realized for some years that, in general, as the ability of a sheet of paper to elongate increases, there is an increase in strength. For example, methods of mechanically shrinking moist paper web in the machine direction to introduce stretch are known, U.S. patent to Cluett No. 2,624,245, issued Jan. 6, 1953, being one example. These mechanical processes are unsuitable for the present invention because they bring about too much loss of tensile strength and machine direction stiffness.

More recently, Canadian patent to Allander No. 614,598 issued Feb. 14, 1961 discloses that the strength of paper can be increased during its manufacture by introducing stretch capability into the sheet by a drying operation which includes the step of drying the paper in the range 50 to 20 percent by weight moisture while being transported airborne, thereby permitting the sheet to shrink freely under low restraint.

Even more recently U.S. patent to Ihrman No. 3,523,865 issued Aug. 11, 1970 discloses the production of extensible paper by a combination of mechanical shrinking with airborne drying of the sheet to about 15 percent by weight moisture. Apparatus for use in airborne drying of sheet material is disclosed in U.S. patent to Allander et al. No. 2,678,237 issued May 11, 1954. None of the prior art processes, however, is directed toward making newsprint from hardwood groundwood, nor are any of them suitable for this purpose.

A more detailed consideration of the disability of prior shrinking processes to impart sufficient strength to make newsprint from hardwood groundwood and the success of the present invention requires some analysis of cockling. Cockling is the formation of waves and ripples on the surface and within the body of a sheet of paper during the last stages of the drying of the sheet. Specifically, the art has long recognized that cockling occurs during drying in the range below about 15 percent by weight moisture unless special procedures are used. While some papers are deliberately cockled to produce special surface effects, cockling is totally unacceptable for most papers requiring any further sur-

face finishing or high-speed printing. In order to prevent cockling, drying in the range below about 15 percent by weight moisture is carried out by physically restraining the sheet during this stage, usually by drying the sheet while in contact with heated rolls (known as machine drying). The surface contact between the rolls and the sheet prevents deformation of the sheet, but at the same time this prevents further shrinkage, and therefore there is no further increase in strength.

DETAILED DESCRIPTION

Now, the present invention is based to a considerable extent on the discovery that paper made from hardwood groundwood does not cockle and on the more surprising discovery that this absence of cockling permits an unexpectedly high degree of stretch, and hence strength, to be imparted to this paper by drying under low-restraint conditions in the range below about 15 percent moisture. By low-restraint conditions is meant primarily the previously referred to airborne conveying technique in which the continuous sheet is conveyed and conveyed by a gaseous medium free of restraint except for such tension as is required to make the sheet travel. This permits free fiber shrinkage to occur which is translated into web shrinkage. This latter appears in the form of stretch at a later time during use.

The advantageous moisture-shrinkage relationship is illustrated by the graphs of FIGS. 1 and 2 which are plots of shrinkage versus moisture content, under conditions of substantially no physical restraint, for 100 percent hardwood groundwood machine-made papers. The data were obtained by air-drying individual 18-inch square sheets of paper resting on beds of sand in an enclosure and by periodically measuring the dimensions of the sheets and weighing the sheets to determine loss of water.

FIG. 1 shows the relationship for paper which has never been dried during its manufacture, and FIG. 2 shows the relationship for paper which has been fully dried and then rewet. Neither paper cockled, even at 4 percent moisture. The significance of the curves is that they clearly illustrate the great additional shrinkage which is introduced when the sheets are dried in the range below about 15 percent moisture. Specifically, it will be seen from the slopes of the curves that, during the last stages of drying, a further small reduction in moisture content effects a relatively large increase in shrinkage. The production of this high shrinkage characteristic, with no cockling, is the essential feature of the present invention, because it has been found that hardwood groundwood papers dried under little or no restraint in continuous drying machines of proper design can be converted to newsprint.

An analysis of the data of FIGS. 1 and 2, in terms of shrinkage rate, appears in Tables I and II below. As the drying proceeds from 50 percent moisture to 3 percent moisture, web shrinkage occurs in both directions at a rapid and changing rate. If an arbitrary rate of 1 is assigned to the shrinkage rate in the 50 percent to 40 percent moisture range, it will be seen that for the never-dried paper the shrinkage rate is double in the 40 percent to 30 percent moisture range, triple in the 30 percent to 20 percent moisture range, quintuple in the 20 percent to 10 percent moisture range, and again triple in the 10 percent to 3 percent moisture range. In the case of the rewet web, while the absolute level of shrinkage is lower, the rate changes are even higher. It

is evident from this that if maximum shrinkage is the goal, it is essential to take advantage of shrinkage in the 20 percent to 3 percent moisture range as well as that in the 30 percent to 20 percent moisture range.

TABLE I

Range, % Moisture	Shrinkage		Change			
	MD	CD	MD	Rate	CD	Rate
50-40	.16	.36	.16	1.0	.36	1.0
40-30	.43	1.0	.27	1.7	.64	1.8
30-20	.92	2.16	.49	3.1	1.16	3.2
20-10	1.7	3.8	.78	4.9	1.64	4.6
10-3.75	2.24	4.8	.54	3.4	1.0	2.8

TABLE II

Range, % Moisture	Shrinkage		Change			
	MD	CD	MD	Rate	CD	Rate
50-40	.10	.20	.10	1.0	.20	1.0
40-30	.25	.70	.15	1.5	.50	2.5
30-20	.70	1.70	.45	4.5	1.00	5.0
20-10	1.30	3.00	.60	6.0	1.30	6.5
10-3.75	1.70	3.80	.40	4.0	.80	4.0

Whether or not it is worthwhile, as a practical matter, to shrink under no restraint in the range 50 to 30 percent moisture (50 to 70 percent dry) range is questionable, since the amount and rate change is low and the shrinkage forces are of a low level and may not be able to be retained. It is again emphasized that, except in the manufacture of cockle grades, that is, those papers of commerce which are deliberately cockled, the area above 80 to 85 percent dry has previously been thought of as impossible or impractical in terms of unrestrained drying. For example, in manufacturing sack kraft the paper is removed from unrestrained drying at about 80 to 85 percent dry and run over normal cylindrical driers with felts which effectively prevent shrinkage and the formation of cockle. However, in the previous discussion of cockling, it was shown that a 100 percent hardwood groundwood paper is so nearly free from the tendency to cockle, that it can be dried to over 95 percent dry and still be entirely suitable for subsequent calendering and printing.

The surprising discovery that groundwood hardwood web does not cockle is not understood, because the basic causes of cockling are poorly understood, and no thorough analysis has ever been made. However, a number of cause-and-effect factors have emerged, and from them it is possible to establish a working theory concerning it. Table III lists degree of cockle for several different papers brought to dryness of over 95 percent under totally unrestrained conditions. The terms "free" and "slow" respectively indicate the tendency of the pulp to permit the flow-through of water.

TABLE III

FURNISH	DEGREE OF COCKLE
1. Cotton linters (free)	slight to moderate
2. Beaten rag pulp (slow)	severe
3. Unbeaten kraft softwood (free)	slight to moderate
4. Well-beaten kraft softwood (slow)	severe
5. Hardwood Groundwood (slow)	absent to very slight

It is evident from these data that the degree of cockle is not related to fiber length alone. This is apparent from the great variation in cockle between linters and rag pulp or between unbeaten and well-beaten kraft.

Neither does freeness nor slowness entirely determine cockle, since hardwood groundwood, the slowest, has little or no cockle. It appears that most outstandingly important is the degree and range of size variation of furnish components. It can be seen that the linters or unbeaten kraft, most individual components would be large. The rag pulp or beaten kraft, on the other hand, would contain a large amount of smaller materials, including debris, cell fragments, etc., in addition to many whole cells. The hardwood groundwood, by its nature would have far less such variation since the size range of its components is much narrower. It is probable that such factors as absolute maximum component size and shrinkage characteristics are also important, but the size range appears to be the property which is indicative of proneness to cockle.

It will be realized from the discussion so far that the process of the present invention makes the difference between success and failure in the manufacture of newsprint and the like from groundwood hardwood. The invention is not, however, limited to 100 percent hardwood groundwood papers, and in fact a manufacturer in the temperate zone would usually not expect to continually obtain a furnish which is always completely 100 percent groundwood hardwood. Moreover, from the discovery that the absence of a cockling tendency permits unrestrained drying to very low moisture content, it is evident that the present invention is broadly applicable to any furnishes which are sufficiently non-cockling when unrestrainedly dried above the 80 percent to 85 percent dry range to permit calendering, printing or other surface sensitive converting or use operations.

In practice it is contemplated that the primary utility of the invention lies in drying furnishes containing a major proportion, for example 85 percent or more, of hardwood groundwood. However, it is not possible to specify an absolute minimum hardwood content for the furnish because the presence of other furnish components, such as those identified in Table III, will affect the cockling characteristic of the paper. Therefore, suitable furnishes are those which consist essentially of hardwood groundwood, that is, furnishes which contain sufficient hardwood to render the initial paper web too weak and brittle for calendering and printing when dried in the range below about 15 percent moisture under such restraint that no significant shrinkage occurs. In view of the apparent direct relationship between the range of fiber size in the furnish and the tendency of the resulting paper to cockle, a further characteristic of furnishes suitable for the present invention can be identified in terms of a range of fiber sizes which render the paper essentially non-cockling under the aforementioned drying conditions.

EXAMPLE

FIG. 3 illustrates schematically and in flow sheet form a group of papermaking, drying and printing runs carried out with a 100 percent hardwood groundwood furnish for the purpose of comparing the properties of the paper dried under low restraint with the properties of the same paper dried in a conventional manner.

Initially, a furnish of 100 percent Aspen refiner groundwood was prepared by a conventional refining operation. The furnish was then pulped with water, and the resulting slurry was supplied to a conventional papermaking machine which formed the slurry into a running web and dewatered the web. The wet web was then partially dried to about 40 percent–50 percent by weight moisture by passing it over internally steam-heated cylinders. Several tons of this still wet paper were wound up into rolls during several different runs under substantially identical conditions.

The rolls of still-wet paper were transported to a different plant for further drying and to yet a further plant for calendering. Four batches coded as CR, I, CRWC and III were processed under essentially identical conditions, except for the manner of drying.

Batches CR and I were cylinder-dried to less than 5 percent by weight moisture by passing the still wet webs (40–50 percent by weight moisture) over internally steam-heated cylinders. As explained previously, this is a conventional last-stage drying operation employed for most papers which are subsequently to be converted to paper having a printable surface. However, it was found that both of these dried batches were incapable of being successfully calendered as a result of their weakness and/or brittleness and the ease with which they could be perforated. Specifically, an attempt was made to feed a web of batch CR to a three-nip calender operated without applied pressure, but it was not possible to calender the web, regardless of adjustments made to the equipment, due to web failure initiated by edge tears both in and out of the stack of calender rolls. In addition, the web was highly brittle so that web failure also resulted from breaking and crushing of the web within the stack.

These same adverse properties were exhibited only to a slightly lesser extent by webs of batch I. Specifically it was possible with persistent efforts by the operators of a two-nip calender, operated without applied pressure, to calender and wind up only about 50 pounds out of several tons of uncalendered paper. The 50 pounds which was obtained was transported to a commercial newspaper printing plant where the paper was fed into a high-speed newspaper printing machine only with great difficulty as a result of the same adverse properties which rendered the calendering operation unsuccessful.

Batch CRWS was first conventionally cylinderdried to less than 5 percent by weight moisture, re-wet to 50 percent moisture and then airborne-dried to less than 5 percent moisture, under substantially no physical restraint in either the machine direction or the cross machine direction, on a drying machine of the type illustrated in simplified form in FIGS. 4, 5, 6 and 7. The resulting dry paper was processed without any unusual difficulties on a three-nip calender without applied pressure.

Batch III, still containing about 40 percent–50 percent moisture, was dried to less than 5 percent moisture on the same airborne drying machine as was batch CRWS. The resulting dry paper was processed without difficulty on a two-nip calender without applied pressure. The calendered paper was transported to the same printing plant as batch I and was successfully fed to the same high-speed printing press. The press was run at the rate of 50,000 impressions per hour for 14 minutes to produce a different four-page centerfold for

each of two sections of a newspaper. No unusual difficulties were encountered in threading up or operating the press.

These runs show conclusively that paper made from 100 percent groundwood can be converted to newsprint and processed by high-speed newspaper printing presses, if a suitable combination of properties referred to collectively as strength, is first imparted to the paper by drying below about 15 percent moisture under low physical restraint. If the paper is dried to the same degree under restraint, as by the conventional cylinder drying operation, the resulting product is incapable of being calendered or printed.

A more detailed analysis of the calendered papers I and III revealed that the tear strength of III exceeded that of I by 3 percent in the machine direction (MD) and by 8 percent in the cross direction (CD). The tensile strength of III was below that of I by 12 percent MD and 8 percent CD. Stretch of III exceeded that of I by about 22 percent MD and about 30 percent CD.

Tensile Energy Absorption (TEA) response of I and III to calendering was complex. In the case of I there was a TEA gain of 6 percent MD and a TEA loss of 5 percent CD. For III there were TEA increases of about 5 percent MD and 3 percent CD. Direct comparison of TEA's of I and III showed that III is 10 percent higher MD and 21 percent higher CD.

Fold tests were also carried out on the uncalendered and calendered papers of batches I and III, the test consisting of repetitive line flexure fatiguing to total sample failure. There was little difference between the results of such tests made on uncalendered I, calendered I and uncalendered III. However, calendered III exhibited approximately twice the resistance to failure by folding as did the uncalendered III.

Thus it will be appreciated that the special unrestrained drying operation of the present invention not only renders the hardwood groundwood paper capable of subsequent conventional calendering but also complements the calendering operation by enabling the latter to impart improved properties to the paper. The improved properties are generally the same as those of conventional commercial newsprint (for example newsprint made from 25 percent spruce sulfite pulp and 75 percent spruce groundwood pulp), in terms of tear strength, opacity and tensile strength. Individual properties may vary between the two types of paper, however. Calendered paper of batch III, for example, was found to have a tear strength slightly lower and a tensile strength slightly higher than a typical conventional newsprint.

The special low-restraint drying operation is preferably carried out in a machine of the type illustrated in FIGS. 4, 5, 6 and 7 wherein the wet or moist web 10 passes through a heating zone while being supported upon a gaseous medium so that the web is permitted to shrink freely in the machine direction and cross direction of the web 10. The heating zone includes a plurality of blow boxes 12 arranged in tiers, each tier consisting of horizontal parallel boxes disposed within a given horizontal plane and having a length equal to the width of the web 10. Heated air or other heated gaseous medium is supplied under pressure to the interior of each box 12 and is discharged as jets 14 (FIG. 6) directed alternately in the forward and backward direction relative to the direction of web travel. Eyelid openings 15 are provided in the top wall of each box 12 and evenly

distributed along its length for the purpose of generating the jets 14. The web 10 is led back and forth over the tiers of blow boxes 12 by rolls 16 located at opposite ends of the heating zone. The heated air jets 14 form cushions of air upon which the web 10 floats freely so that the weight of the web 10 is supported by the air cushion, not by the rolls 16. Due to interaction between the static and the dynamic air pressure upon the web, the paper web will be held at a constant distance, determined essentially by the velocity of the air, from the tops of the blow boxes 12. An overpressure in the boxes, for example, of the order 1 inch water column, has proven to give stable running conditions. There is only a very slight friction between the web and the air cushions and therefore the paper web is fully or almost fully unrestricted to shrink in the cross machine direction.

Unrestricted shrinking of the web 10 in the machine direction is permitted, in spite of the tension force which must be applied to the web 10, by driving each of the rolls 16 at a peripheral speed appropriate to the respective portion of the web. This can be accomplished by driving each roll 16 with a variable speed electric motor M the speed of which is adjusted to give a roll speed equal to the web speed, the latter being essentially based on the initial entry speed of the web decreased by an amount dependent on the amount of machine direction shrink imparted to the web at the location of the particular roll 16. The same result can be obtained with a single motor connected to each roll 16 through a variable speed transmission. In practice the rolls will be arrived at by on stream adjustment of the motors M to about the lowest speed at which the web will travel smoothly through the machine.

The effect of adjusting the roll speed in the manner described is to reduce the force, called the draw tension, required to move the web 10. The tension in the web leaving each driven roll 16 is very close to zero but increases as that portion of the web approaches the next downstream roll. If that next roll and the subsequent rolls are merely idlers, the tension in the web continues to increase until the web is finally discharged from the machine by whatever nip roll arrangement or driven roll is employed to pull the web through the machine. While the increase in tension between any two idler rolls in sequence may be small, the overall tension in the whole machine is significant and would adversely affect the machine direction shrink required by the present invention. The difference between the use of idlers and the use of independently driven rolls is illustrated graphically in FIG. 8 wherein the solid line shows the increase in tension between rolls 16 and the dashed line illustrates the increase in tension which would occur if the rolls 16 were idlers and if the nips 20 and 22 were the only means for driving the web 10 through the machine.

It has been established by operating experience that in actual practice the web tension within such a dryer can be reduced to less than 10 percent of the tension normal in a cylinder drying section normally employed.

In FIG. 4 a calender 24 is shown for purposes of simplicity as being adjacent the drying machine, although in the actual tests described above the calendering op-

eration was carried out in a different plant from the drying operation.

What is claimed is:

1. A process for making paper suitable for calendering and printing from a continuous moist paper web manufactured from a furnish which contains a major proportion of hardwood groundwood fibers, said fibers being present in an amount sufficient to render the web too weak and brittle for calendering and printing when dried under physical restraint, said process comprising drying the moist web by passing it through a drying zone wherein the moisture content is reduced to below about 15 percent by weight moisture while the web is under substantially no physical restraint and shrinks freely in transverse and longitudinal directions in the plane of the web, thereby imparting to the resulting paper strength sufficient to enable the paper to be calendered and processed by high speed printing machines.

2. A process as in claim 1 wherein the web is dried to at least 5 percent by weight moisture while supported on a heated gaseous medium in the drying zone.

3. A process as in claim 1 wherein the web consists essentially of hardwood groundwood fibers.

4. A process for making newsprint comprising: preparing a pulp-in-water dispersion in which the pulp contains a major proportion of hardwood groundwood fibers, said fibers being present in an amount sufficient to render the web too weak and brittle for calendering and printing when dried under physical restraint; forming a continuous wet web of said fibers by extracting water, subsequently drying the web to below about 15 percent by weight moisture and simultaneously shrinking the web in its machine direction and in the cross machine direction, said drying and shrinking being carried out by supporting the moving web on a heated gaseous medium in a drying zone whereby free shrinkage occurs in both of said directions; and calendering the resulting dried paper to produce a surface receptive to printing.

5. Machine-made printing paper containing at least 85 percent hardwood groundwood fibers and having a calendered surface receptive to printing, said printing paper being capable of being processed by high-speed printing presses and having been formed by drying a continuous moist web of the fibers under substantially no physical restraint to less than 15 percent by weight moisture the proportion of hardwood ground wood fibers in the web being sufficient to render the web too weak and brittle for calendering and printing when dried under physical restraint.

6. A process as in claim 2 wherein the web contains at least 85 percent by weight hardwood groundwood fibers.

7. A process as in claim 4 wherein the web contains at least 85 percent by weight hardwood groundwood and wherein said drying step dries the web to at least 5 percent by weight moisture.

8. Printing paper as in claim 5 containing 100 percent by weight hardwood groundwood.

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