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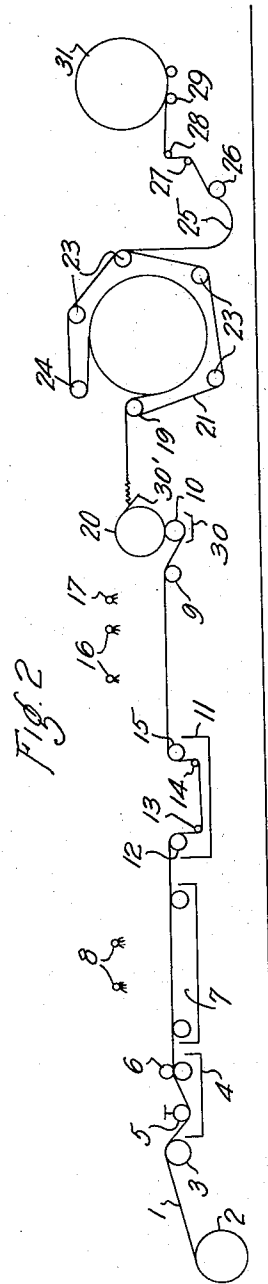
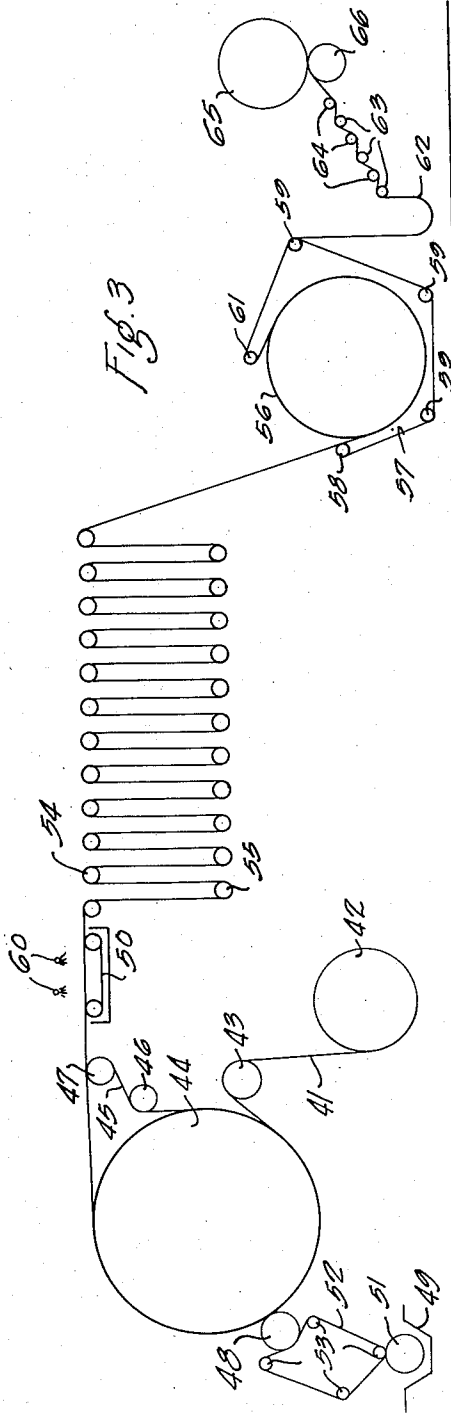
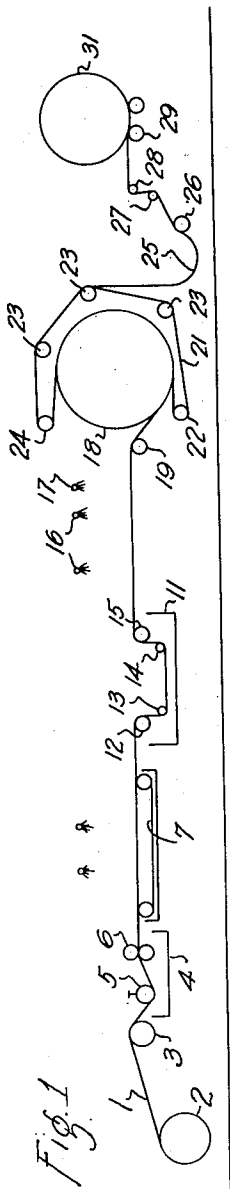
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2,018,244

PAPER PRODUCT AND METHOD OF MAKING

Filed Oct. 7, 1931

2 Sheets-Sheet 1



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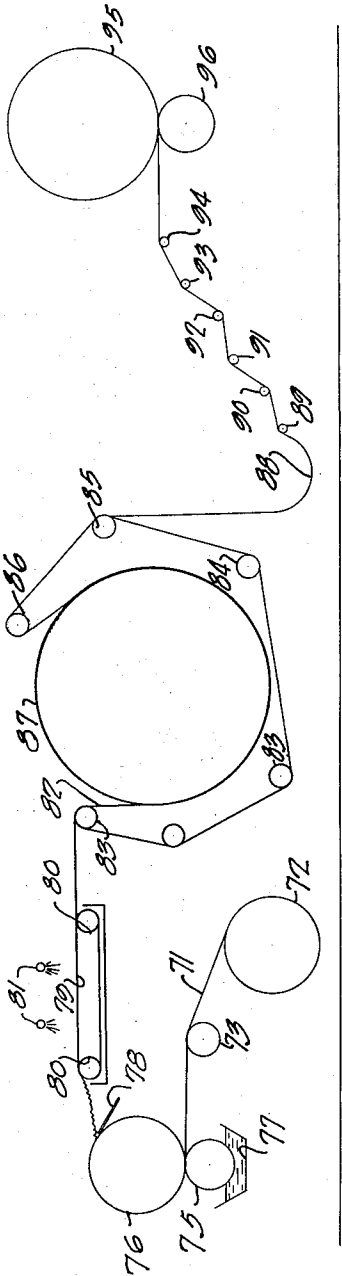
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PAPER PRODUCT AND METHOD OF MAKING

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2 Sheets-Sheet 2

Fig. 4



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PAPER PRODUCT AND METHOD OF MAKING

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This invention relates to soft tissue papers, which are strong when wet and primarily adapted for toilet and nursery purposes, and to a method of preparing the same.

5 In the manufacture of various sheet materials and like products which are designed for personal use it is essential that they shall be freely flexible and shall also present an extremely smooth and soft surface. For this reason cotton cloth or worn linen has ordinarily been employed. But in general woven textiles are expensive, and they further more present serious difficulties of disposal or laundering. On the other hand, unwoven materials such as cotton batting possess little or no mechanical strength and consequently are too readily disintegrated to serve as a sheet material and withstand any appreciable wear.

10 Paper has been resorted to as a substitute for cotton cloth in many instances, such as for paper towels, paper handkerchiefs, etc., on account of cheapness and the fact that they may be thrown away after using. But the inherent physical characteristics of papers, generally, limit their suitability for such purposes. Among such characteristics may be especially noted the stiffness of the sheet and also of the individual fibers, the continuity and density of the matrix of hydrated cellulose, sizing, or fillers, in which the fibers are embedded, the stiffening and hardening effect of the same, the insufficiency or lack of permeability and absorptivity of such sheets in respect of gases and liquids, want of strength, loss of strength and ready disintegration by friction or by wetting, or both, want of flexibility (especially when folded or twisted) and want of frictional wear resistance generally. Consequently, while paper has been employed to some extent (as for paper toweling, etc., above mentioned) it ordinarily does not possess sufficient strength for anything but brief temporary use, or, if it possesses sufficient strength, its usefulness is limited to those purposes in which extreme softness of texture is not a desideratum.

45 It is accordingly an object of the present invention to provide a relatively thin, soft, flexible sheet material of paper which shall possess sufficient strength, particularly when wet, not only to approach a light weight cloth or gauze in tensile strength but to possess appreciable resistance to wear and surface disintegration by friction. It is also an object that such a sheet shall be freely permeable or porous to air and water or other liquids, but preferably relatively impervious to solids, semi-solids, or colloidal suspensions. An-

other object is to produce such a sheet having a substantially open, randomly reticulate structure, in contrast to the closely formed matrix of papers generally. A further object is that the sheet material produced may be ultimately disintegrated by water or at least by the chemical, mechanical or bacteriological action of ordinary drainage. Other objects will appear from the following disclosure.

5 In accordance with the present invention, a thin, light weight tissue paper is first prepared, preferably from purified wood pulp, which consists of fibers substantially of alpha cellulose and which is substantially free of cellulosic matrix, bonding matter, sizing, fillers, and the like, to form a sheet of open formation, in which the fibers are in a heterogeneous dispersed arrangement or tangle, as shown upon microscopic examination. A sheet of paper thus formed has substantially no strength when wet and comparatively little strength when dry, the dry strength depending upon the tangled arrangement of the fibers rather than adhesion or bonding therebetween. The lack or loss of mechanical strength upon wetting may be due to two causes: first, that the individual fibers quickly absorb water and are thereby rendered limp; and second, that the wetted fibers are permitted to slide freely upon one another, on account of their wetted surfaces, so that they are readily separated under tension. Probably both conditions obtain in the wetted sheet.

20 More dense or thicker sheets may in some cases be employed, but in order to provide and preserve an open formation the sheet in such instances will be either perforated with minute holes or subjected to tension to disrupt the close arrangement of the fibers. Again, the sheet may be very loosely formed on the paper making machine.

25 In the practice of the present invention, a sheet of paper of open formation, as above described, which is either thin and of light weight such as tissue paper or if of slightly heavier weight is purposely prepared in such manner as to give it a comparable degree of flexibility, softness and free permeability or porosity as already indicated,—is treated with a toughening (or converting) agent which is adapted to render the alpha cellulose fibers gelatinous and hence mutually adhesive and cohesive. Subsequently the sheet is treated to remove the reagent and to make the thus bonded fiber surfaces substantially insoluble in water. The toughening agent characteristically bonds the fibers together so that, upon subsequent wetting, the treated sheet (although of ap-

proximately the same open texture and permeability to gases, water, and the like, as the untreated sheet) is nevertheless tough and does not exhibit serious loss of its mechanical strength. Consequently, it presents the anomaly of a sheet of thin, open, porous paper which is relatively strong while wet as well as when dry.

Typically, the toughening reagent is one which acts upon the alpha cellulosic fibers per se and converts the surface portions thereof into cohesive films (without the addition of supplemental cellulosic material thereto)—whereupon the superficial cellulosic films thus formed of the fibers merge or fuse at their points or areas of contact; upon conversion or removal of the reagent the bonded fibers have more or less water permeable but strong, water insoluble surfaces and bonding films between adjacent fibers. Thus, the unwoven, unbonded, reticulated cellulose fibers are transformed into a firmly bonded but open structured, freely porous sheet. Hence the resulting sheet, which is also characteristically freely flexible, may be used for purposes similar to those for which sheets of soft cloth have heretofore been required, and not only are readily and completely saturated by water but permit the free penetration of water there-through. At the same time the sheet retains substantially all of its dry tensile strength or, in some instances, may be of somewhat greater tearing strength when wet than when dry. The latter appears to be due to the orientation of the fibers in the direction of strain.

As one instance of the invention, the toughening agent thus employed may comprise a reactive parchmentizing solution such as sulfuric acid or zinc chloride, which will react with the cellulose fibers superficially to render them mutually adhesive or cohesive and the integrated sheet thus obtained is found to be rendered appreciably resistant to subsequent disintegration by water. In any event, the toughening agent may be applied continuously in the form of a liquid treating bath, or discontinuously as a finely disseminated mist or coarse spray, when appropriate, or it may be applied in the form of a positive, continuous or discontinuous open-spaced pattern, as by printing, or by other well known modes of application. The residue of the toughening agent, if any, is promptly removed or otherwise controlled in its action upon the fibers, and the treated sheet, upon drying, may be regarded and used as the finished product, or may be given other treatments, as desired.

In this treatment, the open, randomly reticulated structure of the fibrous sheet is preserved in respect of the relationship of its fibers, so that the treated sheet is, for example, substantially as permeable to liquids as it was before the treatment. It nevertheless manifests greatly increased tensile strength when dry, and, even after complete and continued saturation with liquids such as water, its strength is only slightly less or substantially equivalent to its dry strength. Consequently, this property renders the treated paper applicable to many uses for which cloth has heretofore been regarded as indispensable, and not only is the product thus obtained capable in many instances of replacing cloth but it is in many respects preferable thereto. Moreover, while temporarily resistant to water, it is thoroughly impregnated by water so as to be crumpled up and occupy a very small volume and may ultimately be disintegrated and resolved into a fine, separate and easily dispersed pulp.

These conditions do not obtain with cloth and the like since such materials, in order to be fabricated or woven, must contain a relatively large proportion of long fibers. Moreover, the long fibers which are thus applicable for cloth, such as cotton, are not only firmly united in the yarn or thread from which the cloth is woven but the threads are permanently woven together in the fabric, and strongly resist disintegration. On the other hand, paper which has been treated as above described not only absorbs water readily but is ultimately substantially disintegrated and hence easily and safely disposed of, without danger of clogging drains or other receptacles.

The application of the invention will be described with reference to specific instances of treatment of paper tissue, in sheet or web form, with the reagents above defined by means of apparatus illustrated in the accompanying drawings, in which:

Fig. 1 is a diagrammatic illustration of apparatus for treating plain tissue;

Fig. 2 is a similar illustration of apparatus for making creped paper stock;

Fig. 3 is an illustration of apparatus for printing the paper with a toughening agent; and

Fig. 4 is an illustration of apparatus for both printing and creping the sheet material.

For example, in carrying out the invention as indicated in Fig. 1, a sheet or web of tissue paper of high alpha cellulose content (typically of light weight,—e. g., having a weight of 9 to 15 lbs. per ream on the basis 20"×30"—480, or tissue commonly designated as "facial tissue" or "handkerchief stock") may serve as the raw material. This is characterized by consisting substantially entirely of fine, bleached, or unbleached alpha cellulose fibers (with or without a small amount of cotton fibers) which form an open, tangled, heterogeneous arrangement, substantially without bonding material, cellulosic matrix, sizing, filling, etc., as above stated, and typically has a sufficiently open formation to permit the free passage of water and to present definite apertures there-through when viewed under the microscope, (e. g. at 10 diameters).

Referring to the drawings, a sheet of such tissue paper 1 is drawn from the roll 2, passed over roll 3 and thence through the treating bath contained in tank 4, in which it is submerged by a guide roll 5.

The treating or toughening solution in the instant case, may be composed of sulfuric acid, in which case it is preferably relatively concentrated (of the order of 66%) and the treatment is of relatively short duration so as to avoid appreciable hydration of the paper with consequent swelling of the fibers and closing of the interstices or pore spaces therebetween. Nevertheless the sheet is uniformly wetted by the reagent which is effective upon the alpha cellulose fibers, superficially to soften the same enough to promote adhesion between the crossed and contacting fibers. Profound degeneration or gelatinization of the fibers, with consequent swelling of the fibers and closing of the interstices is specifically avoided. To this end (and also to facilitate subsequent handling and preserve the integrity of the sheet) the wetted sheet is promptly withdrawn and passed between squeeze rolls 6 and thence to the horizontal apron 7 where it is supported and washed as by sprays of water from the perforated pipes 8, 8. The acid in the sheet is then preferably neutralized by passing through

a suitable reagent in tank 11, in which it is submerged by guide rolls 12, 13, 14, 15. For this purpose, a solution of caustic soda or sodium bicarbonate or ammonia may be employed, (or any suitable alkaline neutralizing agent) of sufficient concentration to neutralize the residual acid left upon the sheet and to check its further action. Additional neutralizing tanks may be used, if required. The sheet is then again washed by sprays of water (or other volatile liquid) as indicated at 16. It may also be treated with a non-volatile liquid or softening agent, such as glycerine, and the like, as by spray 17 or equivalent apparatus, suitable therefor. It is then passed over a heated drying drum 18, by means of guide roll 19 and conveyor belt 21 which is carried by rollers 22, 23, 24. Additional treating and washing means and drying drums may be added to those indicated if desired. The sheet 1, as it comes from the drying drum 18, and conveyor belt 21, is allowed to hang freely in a loop 25 and is then passed over and under tensioning rolls 26, 27, 28, 29, and finally gathered upon the roll 31.

In such treatment of the tissue there is but little tendency for the fibers to felt together and consequently, since the fibers are given such brief treatment as not to cause them to swell appreciably, the structural relationship and arrangement of the same is preserved substantially as in the original paper sheet and without filling or closing of the interstices. The individual fibers, however, acquire a relatively continuous sheath which upon subsequent washing, neutralization and drying, is more resistant to the weakening action of water than the untreated fiber but is not thereby rendered unduly stiff or brittle, or water-repellant, so that water for example may wet and pass freely through openings between such treated fibers almost as readily as before but does not penetrate between their points of contact enough to weaken the paper sheet. Consequently, the tensile strength of the sheet is not appreciably decreased even though it be thoroughly wet with water.

As a modification of the procedure above described, it may be desired to impart slight elasticity or stretchability to the sheet. This may be effected upon the paper treated as above by creping the sheet, which is preferably carried out in a continuous operation with the treating step, or by embossing, etc.

For example, the sheet 1 may be led through similar apparatus (as shown diagrammatically in Fig. 2, in which like numerals indicate corresponding parts in Fig. 1) comprising the treating tank 4, washing device 8, neutralizing tank 11, and washing spray 16, and thence over guide roll 9 and between creping rolls 10 and 20. The lower creping roll may dip into a creping bath 30 if desired, but frequently the sheet, when wet with water is per se sufficiently adhesive to the creping roll. The upper creping roll is provided with a doctor blade 30'.

In this manner, the treatment of the paper is effected substantially as before but in addition the softened sheet is given irregular wrinkles or folds running transversely of the sheet. A too sharp creping or a high-crepe ratio (which is the ratio of the length of the uncreped sheet to that of the creped sheet) may appreciably increase the ream weight and apparent body of the sheet, and may tend slightly to stiffen the sheet so that it will form sharp corners upon folding. Accordingly, the sheet may be creped across the

sheet, but it is usually preferable to form a relatively coarse and low crepe ratio for those purposes in which a thin sheet and very soft texture is required. The crepe ratio may be controlled by suitably regulating the tension upon the creped sheet, an increase of tension tending to stretch out and reduce the crepe ratio or practically to remove the creped appearance and increased thickness of the sheet, if desired.

In order to effect further softening and flexibility of the sheets, whether prepared with or without creping, a softening agent such as a neutral or physiologically harmless non-volatile liquid, typically glycerine, di-ethylene glycol, etc., may be applied, before creping, as at 17, or by adding the same to the creping bath or by appropriate subsequent treatment of the sheet therewith, not shown.

A sample of paper which before treatment would permit the passage of 40 cc. or more of 20 water per unit area per minute therethrough, was found to be pervious to substantially the same extent after being treated in the manner above described. At the same time it manifested improved dry strength and upon wetting preserved approximately 42% of its dry strength in the machine direction of the sheet and 38% of its dry strength transversely of the sheet. It nevertheless wetted freely with water and showed substantially no tendency to swell or disintegrate for several hours. Upon ingestion with acids or alkalis and particularly with ferments which are commonly encountered in drainage, disintegration is activated, and water alone may be eventually effective to separate and disperse the fibers.

The creping also renders the sheet effectively thicker in some respects without decreasing its porosity or permeability to liquids, or other qualities. Thus, for example, a plurality of creped sheets placed face to face will have greater absorberency than a like pad formed of uncreped sheets.

As a further modification of the invention the toughening or converting agent may be applied to the fibrous sheet in predetermined areas or patterns instead of by uniform wetting or saturation throughout. This may be effected, for example, with suitable apparatus as diagrammatically illustrated in Fig. 3. The paper sheet 41 is drawn from roll 42, passed over guide roller 43 to printing cylinder 44 which is preferably covered by a conveyor belt 45 and carries the sheet 41 around the cylinder and then a short distance away from the cylinder, by passing over offset guide rolls 46, 47. In its passage on the cylinder 44, the sheet 41 is imprinted by means of a printing roll 48 which is "inked" with one or another of the toughening agents or parchmmentizing solutions above described, contained in tank 49, by means of a fountain roller 51 and web 52 carried by rollers 53, 53. The printing cylinder may carry any appropriate design,—e. g., to produce a continuous pattern of the composition with untreated areas spaced apart thereby or may have a discontinuous pattern of the composition with a continuous untreated area therebetween. Of these types, the former will be stronger, the latter somewhat more porous or open.

The parchmmentizing solution is preferably washed out, the sheet being passed, on supporting belt 50, beneath a series of showers 60, which may also contain neutralizing solutions more quickly to check the gelatinizing and bonding action of the parchmmentizing reagent.

The printed sheet is then passed successively 75

over and under rows of guide rollers 54, 55, forming a series of vertical festoons, in the course of which the sheet is dried, usually with the application of artificial heat by means of hot air ducts (not shown). At this stage the sheet may also be treated with a softening agent, such as glycerine, etc., as before. The sheet is then passed over drying drum 56, by means of a belt 57 carried on rollers 58, 59 and 61. The sheet then falls in a loose fold 62 from which it passes over and under tensioning rolls 63, 64 to rewinder or take-up roll 65 upon which it is firmly held by guide roll 66, contacting therewith.

Again, the sheet may be printed or impregnated with the parchментizing reagent and creped directly as for example by means of the apparatus shown in Fig. 4. The paper sheet or web 71 may be drawn from a roll 72, passed over guide roll 73 and thence to the printing roll 75. The latter may dip directly into the parchментizing solution contained in tank 77—or it may be wetted by a supplementary roll (not shown) which dips into the parchментizing bath. If the pattern is relatively coarse or open supplementary wetting of the sheet may be desired. The sheet or web 71 may conveniently be passed between the printing roll 75 and creping roll 76, the two being closely spaced or held tightly together as the case may be. In either event, the paper sheet is suitably treated with the reagent, which may also serve, in conjunction with the adhesiveness of the softened cellulose fibers, adhesively to retain the sheet upon the creping roll. As the creping roll 76 is revolved, the sheet becomes more firmly adherent to the creping roll (facilitated by heating the roller internally, usually by steam) and is then removed from the roll by contact with a doctor blade 78, mounted against the surface at a suitable angle. The paper is not only removed from the roll, but also creped. The creped sheet is received by a conveyor belt 79, carried by rollers 80 upon which it may be washed and/or neutralized by sprays 81 and thence passes to belt 82, supported by rolls 83 to 86, which carries the sheet into contact with the drying drum 87. The latter is rotated and delivers the dried or partially dried sheet into a free loop or festoon 88 from which it is drawn over and under guide rolls 89 to 94 (which may be driven to prevent stretching of the creped paper) and gathered onto roll 95 and firmly held thereon by roller 96.

The printed or saturated sheet may be washed either before or upon the creping roll 76, so that, upon being creped by the doctor blade it may be simply dried and rolled up. Again it may be found desirable in the above mode of procedure, to first crepe the paper sheet and then to print it with the reagent solution. This might be done by making obvious changes in the arrangement of the apparatus, accordingly. Other treatments may be combined with those described, or other sequences of operation, to impart special properties to the treated sheet, such as the application of softening agents, as above mentioned, the addition of medicaments, deodorants, powders, and the like.

It is to be noted that in each of the several modifications of the invention above described, while the original tissue is preferably composed in large part or entirely of wood fibers, such as alpha cellulose, it may also contain a small proportion or be substantially entirely composed of cotton fibers,

commonly referred to as rag fibers in the art. Such fibers, by intermingling with the others and frictional engagement therewith, may in fact be employed to impart appreciable strength and toughness to the sheet.

The product of the invention is characterized by having a soft, freely pliable texture, is permeable or porous to water while preventing to a large degree the percolation of solid matter there-through, and manifests an increased tensile strength, greater than the untreated paper, and temporarily retains such strength in large part, even when thoroughly wetted with water, although it may be eventually completely disintegrated under the ordinary conditions encountered in sewage or drainage. Consequently it lends itself to the fabrication of many toilet and nursery accessories where soft cotton or other textile materials have heretofore been regarded as essential; and in some respects, such as cost, lightness of weight, disposability, etc., it is to be preferred.

For example, such sheet materials, and especially creped paper, made in accordance with the invention, is eminently suitable for use as diaper cloth or as a lining for cloth diapers of the usual type. The material may be cut to suitable size and shape and used in single sheets (as "liners" so-called) or in a number of superposed sheets, which may be either plain or creped, or both. Various combinations and arrangements will suggest themselves to users of the material, as well as other purposes for which the properties of the sheet material thus provided recommend it as particularly applicable.

It is to be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. The method of preparing a thin, soft flexible porous sheet of paper, which comprises quickly parchментizing only the surfaces of the fibers of a sheet of tissue paper of open formation to bind the fibers together with a water resistant bond without substantially filling the interstices of the paper.

2. The method of treating a soft flexible porous sheet of tissue paper, composed substantially of alpha cellulose fibers in open formation, which comprises parchментizing only the surfaces of the fibers to bind them together with a water resistant bond which does not substantially affect the openness of said formation.

3. An article of the character described comprising a soft flexible sheet of tissue paper of open formation, characterized in that the surfaces of the paper fibers are converted into a water resistant bond which binds the fibers together without substantially filling the interstices between the fibers.

4. An article of the character described comprising a soft flexible porous sheet of tissue paper composed substantially of alpha cellulose fibers in open formation, the surface stratum of each fiber being in the form of a water resistant bond which binds the fiber to contiguous fibers without substantially affecting the openness of said formation.

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