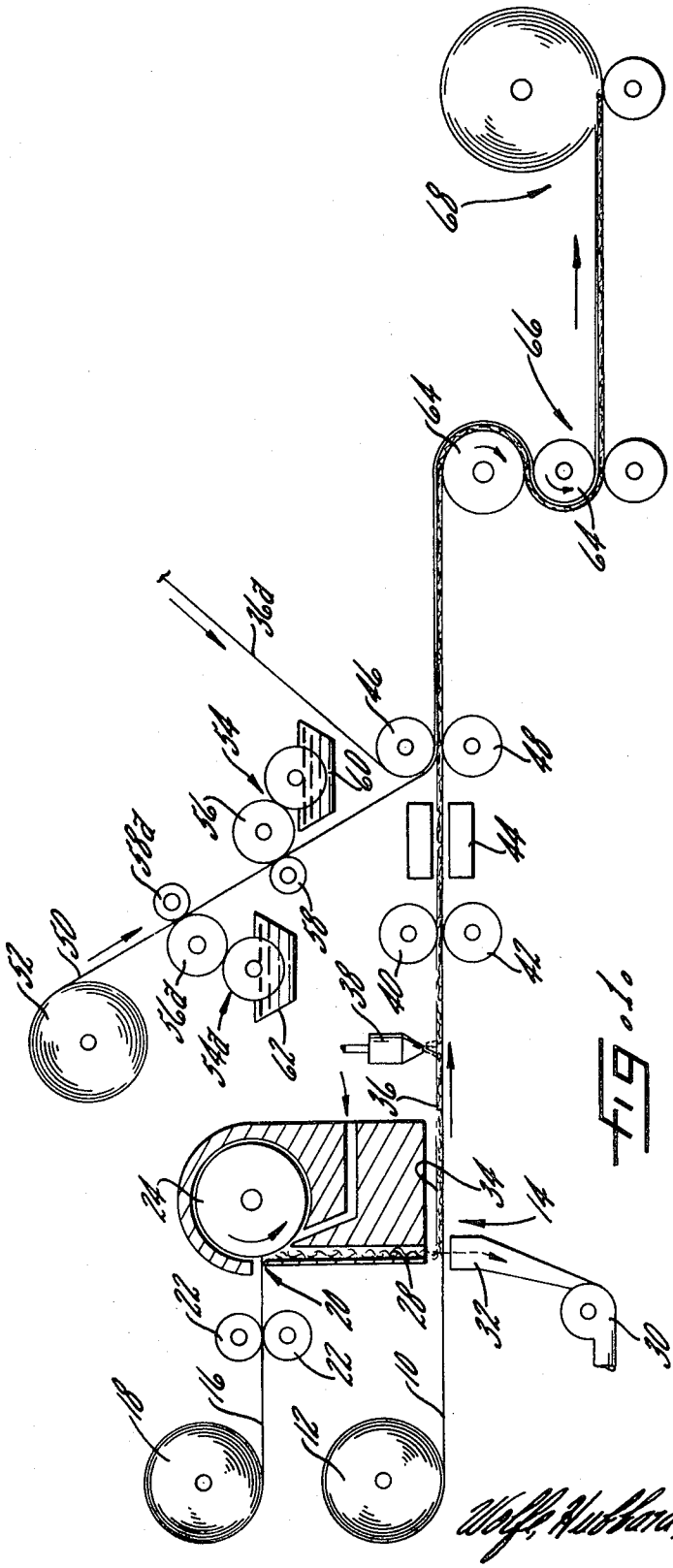
April 10, 1973 R. A. STILLINGS 3,726,750

COMPOSITE CELLULOSIC LAMINATE AND METHOD OF FORMING SAME

Filed May 20, 1971



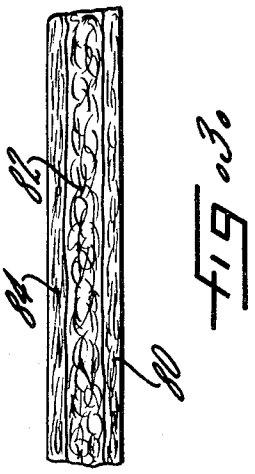


Fig. 3a

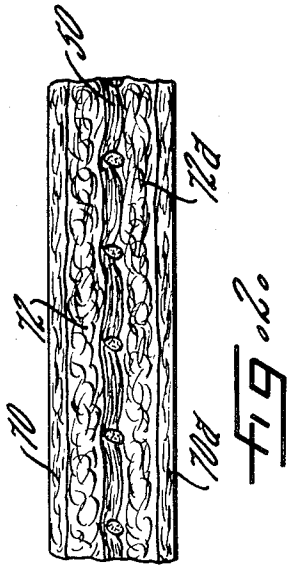


Fig. 2a

Fig. 1a

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COMPOSITE CELLULOSIC LAMINATE AND METHOD OF FORMING SAME

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U.S. Cl. 161—57 8 Claims

ABSTRACT OF THE DISCLOSURE

Paper products characterized by a superior combination of abrasion resistance, strength, absorbency and tactile properties are formed by combining an airlaid cellulosic web with a waterlaid cellulosic sheet. In one embodiment, the airlaid sheet is formed directly onto the waterlaid sheet and subsequently bonded thereto. The composite sheet may be combined with other waterlaid layers or reinforcing materials to provide products tailor made for a variety of disposable applications.

RELATED APPLICATIONS

Dunning, Ser. No. 882,257, filed Dec. 4, 1969 now U.S. Pat. No. 3,692,622, for Air-Formed Web and Method for Making Such Webs, a continuation-in-part of abandoned application Ser. No. 783,877, and Appel, Ser. No. 882,265, filed Dec. 4, 1969 now abandoned, for Pulp Picking Apparatus With Improved Fiber Forming Duct.

BACKGROUND OF THE INVENTION

This invention relates to cellulosic paper products and, more particularly, to composite paper products characterized by a superior combination of abrasion resistance, strength, absorbency and tactile properties.

The use of cellulosic paper products as "disposable materials," i.e., ones that may be discarded after only one or a small number of uses has grown rapidly. In addition to being used as sanitary wipes and toweling, disposables have found widespread usage in the hospital field as bedsheets, pillow cases, gowns and drapes of various types.

The particular requirements of the contemplated end use will determine the specific construction and type of material utilized. Often, for toweling or wipes, conventional waterformed cellulosic wadding is employed whereas other uses having higher strength requirements, such as, for example, heavy duty wipes and certain hospital applications, combine a reinforcing layer such as a nonwoven scrim with the cellulosic wadding.

The use of waterformed tissue or wadding does, however, have some deficiencies. Because of overall bonding in the sheet which occurs during water removal, sheets prepared by waterlaying inherently possess very unfavorable tactile properties (e.g., harshness, stiffness, low bulk, and poor overall softness) and absorbency. To enhance these properties, waterlaid sheets are often creped (i.e., the sheet scraped from a drier roll with a doctor blade) to artificially improve the tactile and absorbency properties by disrupting the excessive fiber bonding.

However, creping in order to improve aforementioned properties has several limitations. First of all, creping is only effective on low, e.g., less than about 15 lb., basis weight webs. Conventionally prepared creped webs with higher basis weights are quite stiff and are generally unsatisfactory for uses such as quality facial tissues. As a consequence of this, it is conventional practice to employ two plies of creped low basis weight webs for such uses. Only by doing this can a sufficiently bulky product with acceptable softness be prepared.

A second limitation associated with creping is that even with respect to low basis weight materials, the detrimental effects of the initial overall bonding is not completely offset. In a waterlaid method, there is preferential fiber orientation in the machine direction. As a result, the strength, in this direction is always higher than in the cross direction. Consequently, creped products with acceptable cross direction strength still have excessive machine direction strength. Due to this excessive strength, which is a necessary result of achieving adequate cross direction strength, the attainment of optimum tactile properties is prevented. Thus, even low basis weight creped webs do not have optimum tactile properties.

Sanford (U.S. Pat. 3,301,246) proposes to improve the tactile properties of a waterlaid sheet by thermally predrying a sheet to a fiber consistency substantially in excess of that normally applied to the dryer surface of a paper machine. The partially dried sheet is then imprinted with a knuckle pattern of an imprinting fabric and, thereafter, dried without disturbing the imprinted knuckle pattern bonds. While this method may somewhat improve the softness, bulk, and absorbency of the resulting sheet the spaces between the knuckle bonds are still appreciably compacted by the surface tension forces present during water removal, and the fibers substantially bonded therein. Creping is still essential in order to realize maximum advantage of the proposed process, and for many uses, two plies are still necessary.

A further inhibiting factor to the use of waterlaid tissue or wadding, to some extent, is the relatively high capital investment that is required.

The pending Dunning application hereinbefore identified disclose a paper-like web with a desirable combination of strength, absorbency and tactile properties compared with conventional products. A soft, absorbent web is made by airlaying a continuum of substantially unbonded wood pulp fiber and thereafter uniting the fibers into a coherent structure by bonding the fibers at regularly patterned areas of the continuum.

The airlaid paper-like products set forth in the Dunning application thus obviate several, if not all, of the problems associated with the use of waterlaid tissue. However, by the very nature of their structure, i.e., a continuum of unbonded fibers bonded together at regularly patterned areas, such products cannot match the abrasion resistance characteristics of waterlaid webs.

It is an object of the present invention to provide a composite paper-like material characterized by a unique combination of abrasion resistance, strength, absorbency and tactile properties.

A further object is to provide a method for forming cellulosic materials having the herein described properties that minimizes the requisite capital investment.

Other objects and advantages will become apparent as the following description proceeds, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic view and illustrating apparatus for forming the composite cellulosic product of the present

invention and for subsequently uniting such products with a reinforcing layer to form a laminate;

FIG. 2 is a cross-sectional view and showing the laminate formed in FIG. 1, and

FIG. 3 is a cross-sectional view similar to FIG. 2, except illustrating a laminate suitable for use as toweling.

While the invention is susceptible of various modifications and alternative constructions, there is shown in the drawings and will herein be described in detail the preferred embodiment. It is to be understood, however, that it is not intended to limit the invention to the specific forms disclosed. On the contrary, it is intended to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Briefly, the present invention provides a paper-like product which combines certain desirable attributes of waterformed tissue layers with those of the airformed cellulosic webs disclosed in the pending Dunning application to form a base material that can be used to form a variety of laminates that may be advantageously used for a wide number of disposable applications. In a preferred embodiment, the airformed web is married with the waterformed ply during its formation.

Turning now to the drawings, FIG. 1 illustrates apparatus suitable for forming the Dunning airlaid web onto the waterlaid sheet and subsequently joining the base material with other layers to provide a laminate that may be advantageously employed in disposable applications requiring relatively high strength-to-weight ratios. As shown, a conventionally formed waterlaid sheet **10** is unwound from a roll **12** and forwarded to an airforming station, indicated generally at **14**.

While the basis weight and other characteristics of the waterlaid sheet will depend upon the requisites of the intended use, it will generally be suitable to employ a sheet with a basis weight of from about 5 to about 20 lbs./2880 ft.^{2} with a stretch of from about 10 to about 130%. It is generally preferred to use as light a sheet as is possible, consistent with the strength and abrasion resistance requirements.

In accordance with one feature of this embodiment, the airformed part of the ply is formed directly onto the tissue part. As shown, a dry wood pulp sheet **16** is unwound from a roll **18** and forwarded to a picking chamber **20** by feed rolls **22**, powered by means not shown. To separate the pulp sheet into its individual fibers, a conventional picker roll **24** having teeth around its circumference is employed. The picker roll **24** separates the pulp sheet into its individual fibers which are conveyed through the forming duct **28** and onto the moving waterformed cellulosic layer **10**. Air from a source **30** in combination with a vacuum box **32** creates a downwardly moving stream of air which assists in collecting an airformed web **34** onto the cellulosic layer **10**. While customary air-forming techniques may be utilized in preparing the web, the forming duct illustrated in FIG. 1 is particularly efficient in obtaining an especially suitable web, especially at higher speeds. The illustrated duct has a width approximately equal to the height of the picker teeth and is positioned so as to tangentially receive the fibers as they leave the picker. By using a duct with such a width, fiber velocity can be maintained essentially constant throughout the length of the duct. Webs formed in this manner have exceptionally good uniformity and are substantially free of fiber flocking.

The appropriate size of the forming duct and its arrangement with respect to the picker and the forming surface are described in detail in the previously identified copending Appel application.

The basis weight of the airlaid portion is dependent upon the desired ply weight for the contemplated end use and the characteristics required. It is generally preferred to use as high a basis weight of the airformed web as is consistent with such characteristics. Typically, this will mean that the basis weight of the airformed layer will be from about 5 to about 50 lbs./2880 ft.^{2}.

The type of cellulosic fibers used is not critical, and the type of pulp employed for example, will generally be determined by the type of texture desired; cedar pulp imparting a soft and fluffy texture, while southern pine pulps yield a slightly wooly texture and more body.

The airlaid, waterlaid composite is then forwarded to a moisturizing station at which the moisture content is raised to a level which is satisfactory for bonding the composite as will hereinafter be described. As shown, the composite **36** is forwarded below a water spray **38**. Any conventional sprayhead may be employed although it is desirable to employ a nozzle capable of emitting a generally uniform spray. It has been found desirable to maintain the moisture level at about 6 to 35% (based upon the weight of the humidified composite), 10–30% being preferred.

The humidified composite is then formed into a coherent structure by bonding the airlaid continuum at regularly spaced areas. This may be accomplished, as shown in the illustrative embodiment, by passing the composite through a nip formed by a smooth hard roll **40** and a patterned steel roll **42**. The configuration of the pattern on roll **42** is not particularly important although this can, to a limited extent, influence directional strength characteristics. To avoid compaction other than in those areas to be specifically bonded, the sides of the raised portions are, desirably, comparatively steep, with raised pattern heights of 0.015–0.030 being useful. The pressure applied should be sufficient to cause the airlaid fibers in the individual areas to form hydrogen bonds to bond the airlaid web to form a coherent structure and to bond the airlaid web to the waterlaid sheet. The pressure exerted on an individual bond area should be at least 2,000 p.s.i. and be sufficient to decrease the thickness of the airlaid web in the bonded areas by at least 2.5 times and desirably 5 times.

The total bonded area and the bond frequency can be varied within certain limits to secure the desired combination of strength, absorbency, tactile properties and delamination resistance. Total bond areas of about 5 to 40% may be employed, and the frequency may vary from 10 to 40 per inch across both dimensions. As the total bonded area increases in the range set forth, strength and delamination resistance increase but absorbency and tactile properties are detrimentally affected to some extent.

The bonded composite is then typically subjected to a drying step, as shown at **44**, and can be rolled up and stored for later use. Drying may be accomplished by any conventional means, but through drying has been found to be advantageous.

The thus-formed composite is an inexpensive, lightweight material having a superior combination of abrasion resistance, strength, absorbency and tactile properties. As such, it may be employed as a substitute in any disposable application where waterlaid tissue has previously been used.

While it is preferred to integrally form the airlaid web on the waterlaid sheet since the bonding step not only provides a coherent or strong airlaid web but also provides desirable delamination resistance with a minimum adverse effect on the absorbency and tactile properties. However, it should be appreciated that the airlaid web could also be separately formed as in the pending Dunning application and then adhesively bonded to the waterlaid sheet with a discontinuous pattern, as is well known and as is often employed to form two-ply waterlaid products.

In accordance with one aspect of the present invention, the composite base material can be employed to form a laminate with a superior strength-to-weight ratio and an optimum use of the desirable attributes of the composite. As shown in FIG. 1, the composite **36** is forwarded to a nip formed between squeeze rolls **46** and **48**. A second

composite 36*a*, formed in the same manner as the first composite (the apparatus not being shown), is also forwarded to the squeeze roll nip with the airlaid web sides of both composites being positioned to face each other.

To provide for increased strength, a reinforcing layer is included as the central layer. While any of the conventionally used reinforcing layers for disposable applications such as woven gauze may be employed, it is desirable to utilize a bonded web of random laid continuous filaments or a nonwoven scrim comprising a set of spaced warp or machine direction threads and a set of spaced fill or cross direction threads. The two sets of threads are thus disposed in a face-to-face relation to each other and are adhesively bonded together where the threads of one set cross the threads of the other set. A variety of means are known, one desirable method being shown in U.S. Pat. 2,841,202 to H. W. Hirschy.

The typical synthetic materials used in such scrims include rayon and nylon. While the denier and the frequency of the threads employed will be dependent upon such factors as the strength, absorbency and tactile properties required, it will generally be satisfactory to use either mono or multifilament yarns having a denier of from about 10 to 100 or even perhaps 200 or 400 with the warp and fill threads being anywhere from about 1 to about 12 threads/per inch.

Any conventional adhesive may be utilized such as, for example, a plastisol including a polyvinyl chloride homopolymer or a copolymer with at least 90% by weight of polyvinyl chloride plasticized with a material such as dioctyl phthalate, dioctyl sebacate or the like. Various latex adhesives such as acetate/ethylene copolymer emulsions or acrylonitrile-butadiene emulsions or solvent-based adhesives such as polyvinyl acetate in acetone may also be used.

Turning again to FIG. 1, a nonwoven scrim **50** is unwound from a roll **52** and adhesive is applied to both sides of the scrim as shown at printing stations **54**, **54***a*. While shown as coming from a roll, it should be appreciated that the scrim could, of course, be used directly after it has been formed. The surface of printing rolls **56**, **56***a*, having backup rolls **58**, **58***a*, respectively, may be provided with an intaglio pattern to which adhesive may be supplied in various ways well known to those skilled in the art. As shown, the lower portion of the printing rolls **56**, **56***a* may be submerged in dip pans **60**, **62** and pick up the adhesive directly from the pans with the excess adhesive being removed by doctor blades (not shown), thus leaving only the intaglio patterned surface filled.

The grooves on the roll can be in any patterned configuration; however, it is important that the pattern be substantially open or discontinuous and that, after printing, the area of the bond which is occupied by adhesives be not more than about 25% of the total area, and preferably only about 15% or less of the area. The particular amount of adhesive which is employed will, of course, be dependent upon the requirements of the intended end use. Also, the type of adhesive used is not particularly critical and those identified in connection with the scrim itself may suitably be used.

The laminate is formed by bringing the adhesively coated scrim **50** into the nip formed by squeeze rolls **46**, **48**. The adhesive is activated by passing around heated rolls **64** and is then calendered as at **66**. The laminate may then be wound up as shown at **68**.

The resulting scrim-reinforced laminate, as illustrated in FIG. 2, comprises outer waterlaid plies **70**, **70***a* which present strong, relatively abrasion resistant outer surfaces which protect the inner airlaid plies **72**, **72***a* that provide the laminate with its superior absorbency and tactile properties. The central scrim layer **50** as has been noted, imparts significant strength increases. This construction may be advantageously used in those applications, such as heavy duty wipes and hospital gowns, where a superior strength-to-weight ratio is required.

In contradistinction, the embodiment illustrated in FIG. 3 may be used in those applications where such strength requirements are not involved. Thus, as shown, a composite base material, comprising an outer waterlaid ply **80** protecting its airlaid inner ply **82**, has adhesively bonded thereto, preferably in a discontinuous pattern as is well known, a second waterlaid ply **84** to protect the other surface of the airlaid ply. This construction may be used in toweling and other applications where the strength of the FIG. 2 embodiment is not essential. Quite obviously, if desired, two composites could be laminated together with their airlaid sides together to form a functionally similar material.

Thus, as has been seen, the present invention provides a lightweight composite base material which captures the best attributes of waterlaid cellulosic materials and airlaid webs. The base material is quite versatile and may be combined with other materials used with waterlaid sheets to tailor make a disposable product for a specific application.

I claim as my invention:

1. A lightweight, reinforced cellulosic laminate comprising a scrim reinforcing layer, an airlaid web having a basis weight of about 5 to 50 lbs./2880 ft.^{2} and comprising a continuum of substantially unbonded cellulosic fibers interrupted by a pattern of bonded fiber areas occupying about 5–40% of the web area, the bonded areas being spaced less than about the average fiber length apart and the continuum having a thickness at least about 2.5 times the thickness of the bonded areas, said airlaid web being bonded to said scrim and a waterlaid cellulosic sheet having a basis weight of from about 5 to about 20 lbs./2880 ft.^{2} being bonded to said airlaid web.

2. The lightweight, reinforced cellulosic laminate of claim **1** wherein an airlaid web and waterlaid sheet are bonded to each side of the scrim.

3. The lightweight, reinforced cellulosic laminate of claim **2** wherein the scrim comprises a nonwoven scrim having a set of spaced warp threads extending in the longitudinal direction and a set of spaced fill threads extending transversely of the warp threads in a face-to-face relation to each other, the two sets of threads being adhesively bonded together where the threads of one set cross the threads of the other set, the thread denier being in the range of from about 10 to about 400 and the frequency being from about 1 to about 12 threads per inch.

4. A method of forming a reinforced cellulosic laminate which comprises combining a waterlaid sheet of cellulosic fibers having a basis weight of from about 5 to about 20 lbs./2880 ft.^{2} and an airlaid web having a basis weight of from about 5 to about 50 lbs./2880 ft.^{2} comprising a continuum of substantially unbonded cellulosic fibers interrupted by a pattern of bonded fiber areas occupying about 5 to 40% of the web area, the bonded areas being spaced less than about the average fiber length apart and the web having a thickness of at least about 2.5 times the thickness of the bonded areas, with a scrim reinforcing layer in such a fashion that the airlaid web is adjacent the scrim and bonding the various layers together to form a laminate.

5. The method of claim **4** wherein airlaid webs and waterlaid sheets are positioned on both sides of said scrim reinforcing layer.

6. The method of claim **5** wherein the scrim is a nonwoven scrim comprising a set of spaced warp threads extending in the machine direction and a set of spaced fill threads extending in the transverse direction, the two sets of threads being disposed in a face-to-face relation to each other and being adhesively bonded together where the threads of one set cross the threads of the other set.

7. A composite cellulosic laminate characterized by a superior combination of abrasion resistance, strength, absorbency and tactile properties comprising a continuum of substantially unbonded, airlaid cellulosic fibers interrupted by a pattern of bonded fiber areas occupying from about 5 to about 40% of the bond area, the bonded areas being spaced less than about the average fiber length apart and the continuum having a thickness of at least about 2.5 times the thickness of the bonded areas, and a waterlaid sheet of cellulosic fibers having a basis weight of from about 5 to about 20 lbs./2880 ft.^{2} bonded to said airlaid web.

8. The composite of claim 7 wherein the waterlaid sheet is bonded to the airlaid sheet at the bonded areas.

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