Dec. 16, 1969 R. C. SOKOLOWSKI ET AL 3,484,330

DISPOSABLE FABRIC

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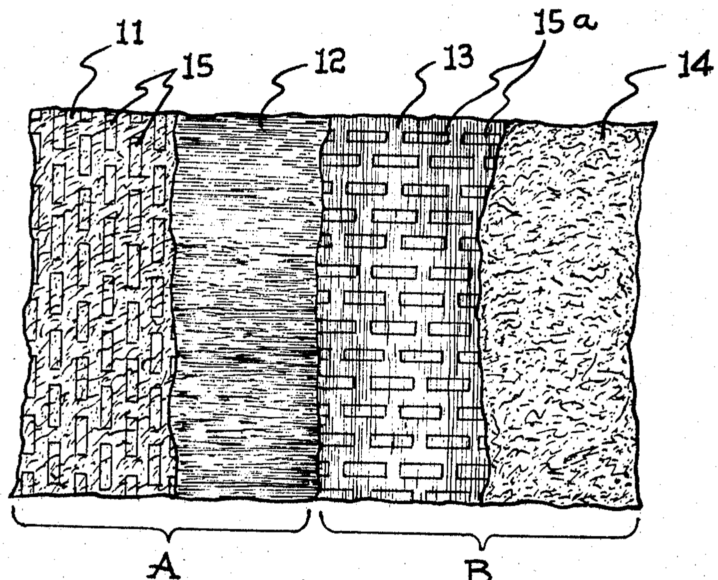

Fig. 1

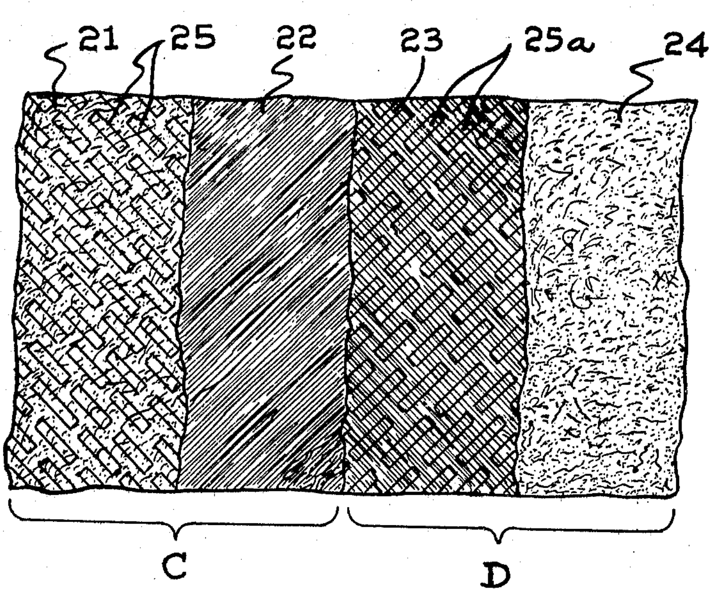

Fig. 2

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DISPOSABLE FABRIC

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ABSTRACT OF THE DISCLOSURE

A non-woven web material including outer layers of cellulose wadding and inner layers of highly drafted fibers disposed angularly to each other is disclosed. A spaced-pattern layer of adhesive is disposed between each fiber layer and its adjacent wadding layer with the fibers in each fiber layer partially embedded in and held by the adhesive of its adjacent adhesive layer and partially embedded in and held by the adhesive in the other adhesive layer where it extends between the fibers of its adjacent fiber layer and with a portion of the adhesive in both adhesive layers joined where the adhesive patterns are superimposed.

This invention relates to an improved disposable fabric. More specifically, it relates to a non-woven, multi-component web material of improved strength, hand, and feel, which is especially suited to meet the requirements set forth for single-use, disposable fabrics.

The art is replete with descriptions of materials which ostensibly are suited for uses where disposability is desirable, such as for bed sheets, pillow cases, draw sheets, stretcher sheets, surgical table covers, hospital gowns, examination gowns, dust cloths, wipers, washcloths, towels and the like. Materials previously tried for the above uses include various nonwoven webs with constructions which comprise such things as airlaid randomly arranged fibers bonded by various adhesives, carded fibers bonded by adhesives or thermoplastic fibers, laminations of carded fiber webs with creped tissues, laminations of carded webs or lightweight tissues with woven or nonwoven scrim, and various other combinations. However, in most cases, while disposability was obtained, it was achieved without meeting other requirements which are often more important than disposability. The foremost of these requirements, of course, is low cost. Others which are almost equally important involve the development of adequate strength, good conformability, high flexibility, a cloth-like hand and appearance, softness, and the absence of a paper-like look, feel, and sound. When sufficient strength is obtained, appearance, conformability, hand, and softness suffer. When the latter qualities are acheived, strength is lost or costs become excessive.

The product of the present invention has largely succeeded in meeting all of the above requirements at costs which permit its satisfactory fabrication into many single-use items where disposability is desired.

Accordingly, it is the primary object of this invention to provide low cost disposable web products of the above-indicated character in which substantial strength and dimensional stability are achieved without sacrificing appearance, flexibility, hand and softness.

An additional object is to provide a disposable web material which may be folded, rumpled, and handled like conventional woven textiles without impairing the usefulness of the product for its intended purpose.

Still another object is to provide a disposable sheet material which may be produced and sold at low cost to make economically feasible on a mass-production basis,

a large number of limited use disposable products for the above-indicated and other purposes.

Other objects and advantages of the invention will be understood by reference to the following specification and accompanying drawing.

In the drawings:

FIGURE 1 is a plan view on a somewhat enlarged scale of one form of the improved product with sections of individual layers broken away to show the multi-component construction.

FIGURE 2 is a similar view of another embodiment of a suitable product.

The material represented in FIGURE 1 comprises four plies, **11, 12, 13** and **14** of lightweight flimsy material, each of which is relatively weak.

In fact, in the preferred construction, each of the individual plies, or layers, is so lightweight in nature, and so tenuous in character, that each particular layer has little utility as an individual entity. Utility is derived from the combination of the layers with each other in the manner shown and described.

In the preferred embodiment, layers **11** and **14** comprise individual plies of lightweight creped cellulose wadding sheets which have been stretched and ironed to facial tissue softness by known means. Layers **12** and **13** comprise webs of aligned fibers in which the individual fibers are stretched out and extended to substantially their entire length, and are in side-by-side alignment so that approximately 80% to 95% or the fibers are oriented and aligned substantially in one direction.

15 and **15*a*** represent a spaced pattern of flexible adhesive which serves to bond the layers together. The manner in which the adhesive bonds the layers together is important to the flexibility and handling characteristics of the finished material.

A small portion of the patterned adhesive **15** penetrates into the cellulose wadding layer **11** while the major portion of the adhesive remains on the surface. The individual fibers in layer **12** are held in their highly-drafted alignment by embedment in the adhesive **15.** The illustrated component A therefore is formed from wadding layer **11,** a patterned adhesive **15** printed on one surface of the wadding, and a layer of highly-drafted and aligned fibers **12** embedded in and held in alignment by the adhesive.

In component B, for illustrative purposes, adhesive pattern **15*a*** is shown as being superimposed on fiber layer **13.** In actuality layers **13** and **14** are joined in the same manner as described above for layers **11** and **12.** In other words, the adhesive **15*a*** partially penetrates the undersurface of the cellulose wadding **14** and the individual fibers of layer **13** are held in their highly-drafted alignment by embedment in the adhesive to form component B. One method of forming these components is described in copending application Ser. No. 465,609, now patent No. 3,327,708, filed June 21, 1965.

Each of the components A and B thus comprise a similar combination, i.e., an outer layer of cellulose wadding, an intermediate layer of patterned adhesive, and an inner layer of aligned fibers embedded in the adhesive. When these components are combined to form the final product, fiber layers **12** and **13** are arranged in face-to-face contact and preferably have the aligned fibers in one component arranged to lie in a cross direction with respect to the aligned fibers in the other component. In assembling the finished structure, the crosslaid arrangement is hot-calendered after crosslaying to permanently bond the components together.

The crosslaying of components A and B may be done by hand, or by suitable crosslaying apparatus such for example as is shown and described in U.S. Patent 2,841,202.

When components A and B are crosslaid and calendered together at elevated temperature, the adhesive **15** and **15***a* softens sufficiently for a portion of the adhesive in one component to migrate toward, and to join with, the adhesive in the other component wherever the adhesive in one component occupies a planar area below or above a planar area occupied by the adhesive in the other component. The finished structure comprises outer layers **11** and **14** of cellulose wadding; inner layers **12** and **13** of highly-drafted and aligned fibers; and two layers of adhesive **15** and **15***a* in a spaced pattern located primarily between the wadding layer and the fiber layer. Each of said adhesive layers partially penetrates its adjacent cellulose wadding layer, and the individual fibers of the adjacent fiber layer are held embedded in the respective adhesive layer. In addition each adhesive layer is joined with the other adhesive layer in a unitary bond wherever the two adhesive layers overlie each other. The result is a unitary laminate of high strength, good flexibility, and soft hand. During the calendering operation, in which the temperature and pressure is sufficient to cause the adesive to flow, there is also some migration of adhesive toward the fibers of the other component in areas where there is no matching adhesive present in the other component. In such cases the fibers of the opposing component are embedded in the adhesive of the other component to some extent to form a bond of slightly less strength than that of either the fiber-adhesive bond in the basic component or the adhesive-adhesive bond between components.

The embodiment shown in FIGURE 2 is similar to that of FIGURE 1 except for the arrangement of the fiber layers with respect to each other.

As in FIGURE 1, the material comprises four plies **21**, **22**, **23** and **24** of lightweight, flimsy material. Layers **21** and **24** comprise stretched and ironed lightweight cellulose wadding and layers **22** and **23** comprise layers of highly-drafted and aligned individual fibers. **25** and **25***a* represent a spaced pattern of flexible adhesive which serves to bond the wadding and fiber layers together in the same manner as described with respect to the material shown in FIGURE 1 to form components C and D.

The significant difference between the embodiment of FIGURE 1 and the embodiment of FIGURE 2 is that the fibers in the fiber layers of components A and B in FIGURE 1 are respectively lined up parallel with, and perpendicular to, the length of the fabric while the fibers in components C and D in FIGURE 2 are perpendicular to each other but disposed at an angle of 45° to the length and width of the fabric.

The FIGURE 1 embodiment, therefore is relatively intractable when either lengthwise and crosswise forces are exerted because the highly-drafted and aligned fibers in layers **12** and **13** are extended to substantially their full length in the lengthwise and crosswise directions and permit little stretching. The FIGURE 2 embodiment, on the other hand, may be stretched considerably in both directions because the aligned fiber layers **22** and **23** are disposed so that the fibers in one layer are perpendicular to the fibers in the other layer, with each of the layers disposed at an angle of 45° to the length or width of the fabric. This construction permits extension of the fabric in the transverse and lengthwise dimensions in a manner similar to a lazy tong arrangement. In the FIGURE 2 construction, the fibers in each layer do not stretch, but when force is applied lengthwise or transversely of the fabric act as hinges where they cross each other. Thus by varying the angularity in which the fiber layers in components A and B, or C and D, are aligned, it is possible to build into the laminated product, within reasonable limits, any desired degree of stretch in either direction.

As indicated previously, in manufacturing the finished product, components A, B, C or D are usually fabricated in continuous lengths and then crosslaid in the desired fashion. In fabricating the components, the cellulose wadding has first applied to one of its surfaces a pattern

of adhesive in a form which partially penetrates into the wadding with the major portion remaining on the surface. The fiber layer is then formed by passing multiple slivers of fibers in side-by-side alignment through a draw frame which draws out the individual fibers and aligns the fibers in side-by-side relationship into a flat sheet in which most of the fibers are stretched out to substantially their full length and held in tensioned alignment. The aligned fibers, while still under tension, are then deposited onto the adhesive-carrying wadding sheet, and in such condition are subsequently pressed and embedded into the adhesive by the action of a heated calender roll.

Two of the components, thus obtained, are then crosslaid with their fiber sides in face-to-face contact, and the crosslaid arrangement is again hot-calendered at a temperature and pressure sufficiently high to cause the adhesive in each layer to flow around the embedded fibers and to join the other layer at spaced intervals as previously described.

While various adhesives may be employed, advantages reside in the use of plastisols, which as is well known, are colloidal dispersions of synthetic resins in a suitable organic ester plasticizer. While adhesives of this nature are known, those found particularly useful for incorporation in the product of this invention include vinyl chloride polymers, and copolymers of vinyl chloride with other vinyl resins, plasticized by organic phthalates, sebacates, adipates, or phosphates. These combinations provide a fast curing plastisol adhesive characterized by relatively low viscosity, low migration tendencies, and minimum volatility. Such adhesives remain soft and flexible after curing, can be reactivated by the application of heat and pressure, such as by hot-calendering for the aforesaid lamination purposes, and insure that the resultant laminated product retains the desired softness, and proper hand and feel.

While plastisols are preferred, polyvinyl resins per se, plasticized or unplasticized, such as polyvinyl acetate, and copolymers may also be used. Other flexible adhesive may also be used, including acrylic resins such as the alkyl acrylates, and butadiene resins such as butadiene-styrene and butadiene acrylonitriles.

The adhesive pattern shown in FIGURES 1 and 2 comprises a spaced brick-like arrangement. Other suitable patterns for the adhesive may be employed, including continuous lines, spaced circles, dots, V's, herringbones, etc. The important consideration is that in order to maintain flexibility and hand the adhesive pattern be limited to as small an area as is necessary for the required strength in the finished product. For best flexibility, spaced patterns are preferred to continuous lines. In manufacturing products suitable for various uses, satisfactory flexibility has been retained when up to 25% of the total area of the component webs are covered. Where less flexibility is needed it is feasible to cover more of the total area.

The creped cellulose wadding layer employed, preferably has a basis weight before creping of between about 4 and 12 pounds per 2880 square-foot ream. The sheet may have a crepe ratio, before stretching and ironing, of between about 1.1 and 2.5 as it is creped off the drier of the paper machine. Preferably, the wadding contains wet strength resins, although such latter treatment is not essential. When wet strength is desired, any conventional method of imparting wet strength may be employed such as those described in TAPPI Monograph No. 13, "Wet Strength in Paper and Paperboard." The methods usually employed comprise incorporating a melamine formaldehyde, urea formaldehyde, polyalkylene polyamine, or similar resin in the pulp furnish.

When a finished product of high porosity is desired the creped wadding sheet may be formed in such a manner as to produce an open or perforated sheet. A patterned or specially woven screen in the forming area of the paper machine may be utilized for such purpose, or the formed sheet may be subsequently perforated by a suitable needling operation.

It is preferred that the creped web be stretched and ironed after creping to reduce the originally high crepe ratio to about 1.1 to 1.5 in order to produce a soft sheet such as is customarily used in the manufacture of facial tissues. This is important in giving the final product soft cloth-like appearance and feel. When softness is not important higher crepe ratios may be employed. Generally, the wadding sheet should possess good bulk, softness, absorbency, permeability, and strength.

The fibers employed should preferably be of a denier in the range of 0.5 to 3, although deniers up to 5 have been used. Staple length fibers are preferred for the highly-drafted web arrangement, since they are usually in a manageable length in the range of ½ to 3 inches or longer, with the majority of fibers being at least one inch in length. Synthetic fibers are preferred and may be selected from such fibers as the rayons, including acetate and viscose, nylon; polyesters; acylonitriles; polyolefins, such as polyethylene and poly-propylene; polyamides and the like.

The webs formed from such fibers should be as lightweight as possible commensurate with handleability. On the drawing frame, suitable webs in the weight range of 3 to 20 grams per square yard have been successfully drafted and laminated, to form the components used in this invention, at speeds of from 20 feet per minute to well over 500 feet per minute.

The highly-drafted fiber portion of the components preferably should have approximately 80% to 95% of their fibers oriented substantially in one direction. This high degree of alignment is important to the strength of the product and should be distinguished from conventional carded webs wherein only about 50% to 70% of the fibers are substantially longitudinally aligned, and which webs require substantial thickness to provide adequate strength. Whenever the term highly-drafted webs is used in the specification and claims, it means webs in which about 80% to 95% of the fibers are extended to their full length in side-by-side relationship and substantially aligned in one direction. When a synthetic tow of continuous filaments is employed, as in the alternate embodiment, the degree of alignment is considerably higher, of course.

In cross-laminating the wadding-adhesive-fiber components to form the finished product an unexpected increase in tensile strength in both directions is achieved. This tensile strength increase is significantly higher than would be expected by a simple addition of the tensile strengths of several samples of material similar to components A, B, C, or D were measured, with the following results:

Sample No.	Tensile Strength in lbs./inch — Machine Direction	Tensile Strength in lbs./inch — Cross Direction
1	3.22	.20
2	3.21	.19
3	3.20	.21
4	3.25	.20
5	3.69	.18
6	3.00	.18
Average	3.26	.19

In these samples the highly-drafted fiber layer comprised 1.5 denier viscose rayon fibers averaging about 2.5 inches in length and having a weight of about 7.1 grams per square yard. The cellulose wadding layers comprised a sheet which before creping had a basis weight of 6.5 pounds per 2880 square feet and a crepe ratio of about 2.2. This sheet was stretched and ironed to a finished crepe ratio of about 1.2. The wadding was printed with a plastisol adhesive in a brick-like pattern to cover approximately 21% of the surface area. The particular adhesive employed consisted of 100 parts polyvinyl chloride resin dispersed in 60 parts by weight of dioctyl phthalate thinned with mineral spirits.

Components taken from the same batches as the tested samples were then crosslayed in the form shown in FIGURE 1 and the tensile strength measured again with the following results:

Sample No.	Tensile Strength in lbs./inch — Machine Direction	Tensile Strength in lbs./inch — Cross Direction
1	5.21	4.20
2	5.47	6.10
3	5.11	5.01
4	5.86	5.87
5	4.78	6.58
6	6.72	5.49
Average	5.53	5.54

As was expected, the cross direction strength increased considerably since the structural arrangement in each direction of the fabric was now substantially the same. It will be seen that while the average sum of the tensile strength for the components is 3.45, the resulting average tensile strength in each direction was 5.53+, or an increase in total tensile strength by a factor of about 1.6. This increase is much more than would be normally expected and appears synergistic in nature.

Disposable web materials of the above-described character have been made in weights ranging from as low as 25 grams per square yard to as high as 75 grams per square yard. Ideally, of course, the material should be made as lightweight as possible commensurate with the strength requirements needed in the eventual end-use product.

It will be seen that varying combinations of the individual elements in the laminated material may be employed to build different physical properties into the finished product. For example, the slivers fed to the draw frame may comprise alternating lightweight and heavyweight fibers; or, thermoplastic fibers may be included in admixture with the slivers or as the entire fiber content of certain slivers; or, the fiber layer extending crosswise may be of lighter-weight than the fiber layer extending lengthwise, and vice versa; or, the wadding on one side may be treated for water-resistance, fire-resistance, vermin-resistance and the like while the other layer is untreated; etc. This ability to vary the nature of the individual elements while retaining the basic structure offers almost unlimited possibilities to tailor-make products for specific end uses.

What is claimed is:

1. An improved disposable web material comprising a unitary, multi-component structure which includes cellulose wadding, lightweight webs of highly drafted staple length fibers closely spaced in side-by-side relationship and in which 80 to 95 percent of the fibers are parallelly aligned in fully extended and straight condition, and adhesive binder; said structure comprising a top and a bottom layer of said wadding, inner layers of said fiber webs adjacent each of said wadding layers with the fiber direction in one fiber layer being disposed angularly to the fiber direction in the other fiber layer, a spaced-pattern layer of adhesive disposed substantially between said top wadding layer and its adjacent fiber layer, and a spaced-pattern layer of adhesive disposed substantially between said bottom wadding layer and its adjacent fiber layer; each of said adhesive layers partially penetrating its adjacent wadding layer; the fibers in each of said fiber layers being partially embedded in and held in said parallelly aligned, fully extended and straight condition by its adjacent adhesive layer and partially embedded in and held in said condition by the adhesive in the other of said adhesive layers where it extends between fibers in its adjacent fiber layer in areas where said adhesive patterns are not superimposed thereby increasing the number of

adhesive bonds for the fibers in each of said fiber layers, a portion of the adhesive in each of said adhesive layers joining the adhesive in the other of said adhesive layers at regularly spaced points throughout the structure in areas where said adhesive patterns are superimposed and where said adhesive extends between fibers in each of said fiber layers thereby increasing the strength of the adhesive bonds between the fibers in each of said fiber layers at said points.

2. The web material of claim **1** in which the adhesive is a flexible, thermopastic resin.

3. The web material of claim **1** in which the adhesive is a plastisol.

4. The web material of claim **1** in which the cellulose wadding has a basis weight before creping of between about 4 and 12 pounds per 2880 square foot ream.

5. The web material of claim **1** in which the cellulose wadding contains wet strength resin.

6. The web material of claim **1** in which the fibers are staple length synthetic fibers with a denier of from 0.5 to 3.

7. The web material of claim **1** in which the fibers are synthetic fibers selected from the group consisting of rayon, polyesters, acrylonitriles, polyolefins, and polyamides.

8. The web material of claim **1** in which the fibers in one of said fiber layers are disposed parallel with the length of the material and the fibers in the other layer are disposed perpendicular to the length of the material.

9. The web material of claim **1** in which the fiber direction in one of said fiber layers is normal to the fiber direction in the other of said layers.

10. The web material of claim **9** in which the fiber direction in both layers is at an angle of about 45° to the length and width of the material.

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