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METHOD OF MANUFACTURING AN ABSORBENT PRODUCT

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Fig. 1

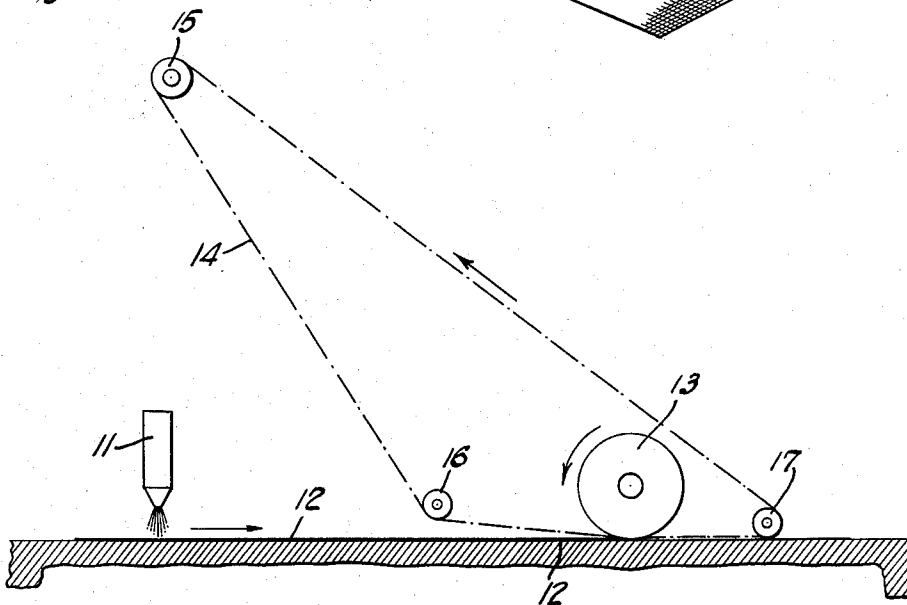


Fig. 2

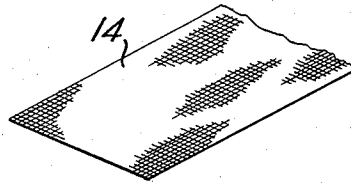
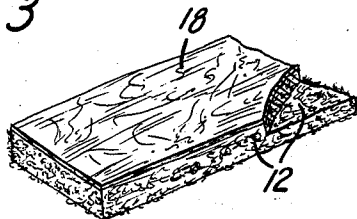


Fig. 3



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METHOD OF MANUFACTURING AN ABSORBENT PRODUCT

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9 Claims. (Cl. 154—33)

This invention relates to absorbent fibrous bodies and to methods and apparatus for making them and, more particularly, is concerned with absorbent fibrous bodies which are especially suited for use as absorbent components in sanitary napkins, surgical dressings, compresses, disposable diapers, hospital underpads and other products designed to absorb fluids.

Products designed to absorb fluids generally contain as a principal component thereof an absorbent pad or core to absorb the fluids. These pads or cores are normally made of layers of loosely compacted, absorbent fibers, such as carded cotton webs, air-laid cellulosic fibrous webs, comminuted wood pulp bats, or like materials which are highly absorbent, fluffy and porous. Unfortunately, these loosely compacted, fibrous absorbent bodies possess numerous disadvantages, notably low cohesive strength, poor shape and volume stability, low forces of capillary attraction, low fluid retentivity and low absorptive capacities under conditions of use.

For example, comminuted wood pulp bats, which are particularly suitable as absorbent components because of their highly absorbent properties, low cost and commercial availability, are very weak structurally and possess low cohesive stability, whereby they tend to fall apart too readily under stress.

Additionally, these comminuted wood pulp bats, as well as cotton fibrous webs, do not possess shape and volume stability to any marked degree and quickly become deformed and distorted upon the application of slight forces or stresses.

Furthermore, the fluid retentivity of such highly porous, fibrous absorbent bodies is not sufficiently great and, consequently, fluids which should be retained therein are squeezed out relatively easily by the application of pressures arising from normal usage of the article.

Moreover, these fluffy, porous, absorbent fibrous components possess low capillary forces because of their loosely compacted structure and, when a fluid is deposited on its surface, saturation conditions are reached very quickly at the site of immediate application. At the same time, however, the adjacent portions remain relatively unsaturated and in some instances dry due to the low capillary forces of the fibrous body and consequently a highly localized fluid condition is obtained.

It is therefore seen that, although absorbent fibrous bodies have been manufactured in the past and have met with some commercial success, there still remains a considerable field for improvement toward a superior product.

In copending application Serial Number 587,015, filed on May 24, 1956, there are disclosed methods of manufacturing improved absorbent fibrous bodies which possess relatively high cohesive stability, good shape and volume stability, high forces of capillary attraction, good fluid retentivity and high absorptive capacity under conditions of use and which are especially suited for use as absorbent components in sanitary napkins, surgical dress-

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ings, compresses, disposable diapers, hospital underpads and other products designed to absorb fluids.

More specifically, the methods disclosed in said copending application comprise applying controlled amounts of moisture to the surface or surfaces of a loosely compacted, absorbent fibrous body having relatively low cohesive strength, relatively poor shape and volume stability, relatively low fluid retentivity and relatively low capillary forces and then directly applying pressure thereto within controlled limits whereby there is formed, in situ, a paper-like, densified, highly compacted cellulosic fibrous layer integral with the loosely compacted, fibrous absorbent body and possessing relatively high cohesive strength, relatively good shape and volume stability, relatively high fluid retentivity and relatively high capillary forces.

Such a densified, compacted layer, in addition to improving the cohesive strength, shape and volume stability, fluid retentivity and capillary forces of the absorbent body, also increases its fluid storage capacity under conditions of use, minimizes lateral spreading or vertical draining (strike-through) and, in general, more desirably controls the reception, absorption and retention of fluids deposited thereon.

The methods disclosed in said application for forming such a compacted layer have been found generally satisfactory but it has been observed that the compacted layer occasionally shows a tendency to adhere to the pressure-applying means and quite often stick thereto whereby it is ripped loose from the absorbent fibrous body when it is separated from the pressure-applying means. This sticking to the pressure-applying means is, of course, all the more accentuated when a sharply contoured or specially shaped roller is used, such as when embossing. It is also more pronounced when certain chemical treating agents are added to the aqueous processing liquid.

It is therefore a principal object of the present invention to provide methods of forming paper-like, densified, highly compacted cellulosic fibrous layers integral with loosely compacted, absorbent fibrous bodies in which the compacted layer shows very little tendency to adhere to the pressure-applying means during its manufacture whereby its separation from the lesser compacted part of the absorbent fibrous body is facilitated.

These objects and others which will become clear hereinafter are obtained by providing a protecting means comprising a fabricated shielding web which is positioned between the absorbent fibrous body and the pressure-applying means to prevent a direct contact therebetween during the application of pressure and thus avoid any sticking or adhering tendencies.

In the accompanying drawing and the following specification there is illustrated and described a preferred method and apparatus for carrying out the present invention, but it is to be understood that the inventive concept is not to be construed as limited thereto except as defined by the spirit of the invention and determined by the scope of the appended claims. Referring to the drawing:

Fig. 1 is a schematic showing of apparatus suitable for carrying out the methods of the present invention;

Fig. 2 is a fragmentary perspective view, on an enlarged scale, of a shielding web; and

Fig. 3 is a perspective view of a product produced in accordance with the invention.

In the embodiment of the invention shown in the drawing, processing liquid is applied by means of a spray nozzle 11 to a non-coherent, loosely compacted, absorbent fibrous body 12, moving to the right on an endless belt or on a table, as shown in Fig. 1. The absorbent body 12 is guided under a rotating roller 13 which is capable of controllably applying a predetermined pressure thereto to compact and, if desired, em-

boss the same. An endless shielding web 14 is guided around a driving roller 15 and guide rollers 16 and 17 so as to be inserted between the absorbent body 12 and pressure roller 13 to prevent direct contact between the two during the application of pressure.

As set forth in the figure, the driving roller 15 and the guide rollers 16 and 17 are so positioned that the shielding web 14 contacts the absorbent body 12 in the vicinity of the pressure roller 13, travels therewith for a short distance and then leaves the absorbent body at an obtuse angle. No sticking or adhering of the compacted layer 18 to the shielding web is noted and there is no tendency of such layer to separate from the lesser compacted part of the absorbent fibrous body.

The angle at which the shielding web 14 leaves the treated absorbent fibrous body 12 is important and, although the nature of the shielding web may be such and the conditions of moisture, application of pressure, etc., may be so selected that an acute angle of separation of less than 90° may be employed, an obtuse angle of greater than 90° and up to 180° is customarily used. Substantially the same effect is obtained by using a relatively small roller for the guide roll 17 whereby the shielding web is quickly removed from contact with the absorbent fibrous body by being quickly "peeled" backwardly therefrom at a small radius of curvature and at the desired obtuse angle. In such a case, the diameter of the guide roller 17 should be as small as possible but must be sufficiently large as to meet strength, rotational and other engineering and practical requirements.

The particular liquids which are applied by the spray nozzle 11 are characterized by their ability to produce or contribute to a permanent set of the deformation achieved in compressing and/or embossing the absorbent body. The object of the liquid setting agent is to stabilize the compressive deformation and to improve the coherence of the absorbent body. In the absence of such liquid setting agents, it is necessary to apply much higher pressures to set the compressed absorbent body. Moreover, dry compressed absorbent bodies remain substantially non-coherent and the set is largely lost in subsequent contact with water and other swelling or treating agents.

The setting mechanism in the described operation is that of forming hydrate bonds between the wetted and compressed fibers which is a well-known and fundamental reaction in the process of paper making. Water is the most convenient and economical bonding fluid for cellulosic absorbent bodies but it may be partially or completely replaced by other strongly polar fluids such as glycols, glycerol, sorbitol, etc. If desired, the stabilizing effect of the water bond can be enhanced by well-known textile sizing and finishing agents, such as natural and synthetic gums, including starches, dextrins, casein, etc., thermoplastic and thermo-setting resins including polyvinyl acetate, polyvinyl chloride, copolymers thereof, etc., waxes, etc. These auxiliary processing agents are preferably used in aqueous solution, suspension or dispersion.

The shielding webs may be woven, knitted, braided or felted fabricated materials made from natural and/or synthetic fibers, monofilaments, multifilaments and staple yarn, and even of glass or flexible metallic wires. Fibers of high mechanical resistance made from nylon, "Orlon," saran, saponified acetate rayon, and other flex- and abrasion-resistance synthetic materials may be used. Alternatively, such synthetic materials may be used in blends with naturally occurring yarns. For example, in the case of a woven fabric, the warp threads may be cotton and the filling or weft threads may be nylon, such as when longitudinal lines are to be embossed into the absorbent body.

It is also to be noted that the shielding web itself is capable of embossing the absorbent fibrous body. For example, a ribbed effect may be obtained by using a twill cloth for the shielding web. Actually, any type of

fabricated material having a pronounced contoured surface can be used to create a complementary surface effect in the absorbent fibrous body.

If increased stretchability is desired in the shielding web, it may be of knitted or specially woven construction such as an elastic "Helenca" woven fabric. The shielding web may contain rubber threads, such as "Lastex," or the like. A fair degree of stretchability may also be obtained with mercerized-shrunk, natural cellulosic fabrics or by bias cutting of woven cloth.

The absorbent fibrous bodies of this invention contain fibers of short fiber length less than one-quarter of an inch, such as comminuted wood pulp fibers, cotton linters, or the like, which, in the presence of moisture and pressure, are capable of forming a relatively dense, more or less coherent, relatively stable structure formed as a result of interfiber bonds between the moistened and compressed fibers similar to the hydrate bonds between fibers in paper. Cellulosic fibers, such as wood pulp fibers and cotton linters which have short fiber lengths as noted above, are preferred in making the fibrous bodies of this invention because they readily form such interfiber bonds, when moistened and compressed. Such fibers are additionally commercially desirable inasmuch as they are inexpensive, readily available and highly absorbent. Other fibers capable of developing interfiber bonds, similar to the bonds between fibers in paper in the presence of moisture and pressure may also be used. In addition, natural or synthetic fibers, such as silk, wool, linen, nylon and cellulose acetate fibers, may be used in combination with the fibers capable of forming interfiber bonds in the presence of moisture and pressure.

It is believed that the formation of the densified skin is due to the formation of hydrate bonds between contacting moistened fibers, which bonds are similar to the bonds between the fibers in paper. If additional bonding is desired, then any sizing material such as synthetic resin, starch, etc., may be added to the aqueous processing liquid to increase the adhesion of the hydrate bonds. By the proper selection of the amount of moisture applied to the fibers and by the proper selection of the degree of compression imposed, the properties of the densified skin may be varied, as desired or required. The thickness, density, strength and other characteristics of the densified skin also depend upon the uniformity by which the moisture is applied, the depth to which it penetrates and the degree to which the fibers are compressed. For example, by finely spraying a web of wood pulp fibers having a fiber length of less than ¼ inch with about 0.0015 cc. of water per square centimeter of web surface and then exposing the web to a pressure of, for instance, about 40 pounds per square inch, a densified, coherent, papery skin is obtained on the surface of the web which had been moistened.

The amount of moisture used may vary from about 0.0005 to about 0.03 cc. of water per square centimeter of web surface depending upon the thickness of the web, the thickness of the paper-like, densified skin desired, with the lesser amounts of moisture being used for thinner webs and yielding extremely thin papery skins and the greater amounts of moisture being used for thicker webs and yielding skins of a greater thickness.

Within the more commercial aspects of the present invention, however, it has been found that a range of from about 0.001 to about 0.004 cc. of water per square centimeter of web surface is economically desirable. Such values have been found particularly suitable for webs and bats having a thickness of from about ½ to about 1 centimeter.

It is to be appreciated that, although spraying is described as the illustrative method of applying the moistening liquid, other methods may be used. For example, the absorbent fibrous material may be placed in or passed through a humidified atmosphere filled with water

or steam vapor whereby it may pick up moisture to 10-12% or more by weight.

The amounts of pressure to be applied to the moistened surfaces may be varied from about 5 to about 1000 or more pounds per square inch, with the commercially preferable range extending from about 10 to about 100 pounds per square inch.

An endless shielding web belt, 70 mm. wide and weighing 125 grams per square meter and made of bleached cotton print cloth was used under pressures of about 10 pounds and about 60 pounds per square inch in the presence of 0.0015 cc. of water per square centimeter. Such methods resulted in the conversion of lesser and greater proportions respectively of the original web into the dense paper-like layers.

The use of moistures of 0.001 and 0.003 cc. per square centimeter was evaluated with a shielding web of "Helenca" elastic nylon woven fabric under a pressure of about 40 pounds per square inch. The lesser amount of moisture (0.001) yielded an extremely thin, papery layer whereas the greater amount of moisture (0.003) yielded a heavier bonded layer usable where such density and strength was desirable.

Another trial was made under similar conditions but increasing the moisture to 0.004 cc. of water vapor per square centimeter of web surface and using a smooth, densely woven twill fabric made of nylon, rayon and cellulose acetate, weighing 305 grams per square meter. This time the compacted layer was considerably thicker than that obtained previously and the thickness of the completed integral web was reduced correspondingly. Still another trial was made under similar conditions, using a knitted light cotton tricot weighing 214 grams per square meter as the shielding web but using a very heavy spray of water. The resulting article was stronger and more cardboard-like and well suited for uses and purposes where such characteristics were desired.

The moisture or liquid may also be applied so as to penetrate completely through the absorbent fibrous body and conversion to a more solid body may then be accomplished by the application of sufficient pressure.

From the above, it is seen that loosely compacted absorbent fibrous bodies, which possess relatively low cohesive strength, relatively poor shape and volume stability, relatively low fluid retentivity, and relatively low capillarity, are converted to bodies possessing a relatively dense, compacted, coherent skin which creates sufficient strength, shape and volume stability, fluid retentivity, and capillarity as to render the resulting structure especially suited and highly desirable for use as absorbent components in surgical dressings, sanitary napkins, compresses, disposable diapers, hospital underpads, and other products designed to absorb body fluids.

It is, of course, realized that various modifications and changes may be made within the spirit of the invention. For example, various materials such as highly absorbent wadding paper, gauze, non-woven fabrics, and the like, may be placed on the humidified or wetted web surface so that, after the pressure has been applied, the materials become integral with the thin paper-like skin which is formed.

It is also contemplated that various materials such as bactericides, fungicides, dyestuffs, softening agents, sizing materials, adhesives, and the like, may be included in the water used for moistening the surfaces of the webs. These processes reflect the well-known possibilities of mechanically modifying paper to obtain desired results. Additionally, if desired, a second spray nozzle may be employed opposite nozzle 11, or the entire apparatus set forth in the figure may be duplicated on the other side of the absorbent fibrous body 12 (below body 12 in the figure) whereby two dense, compacted layers are formed, one on each surface of the absorbent fibrous body 12. The resulting product is of application where

greater strength, shape and volume stability, fluid retentivity and capillarity are desired or required.

While I have shown and described what I believe to be preferred embodiments of my invention in the matter of simplicity and durability of construction, it will be appreciated that the details of such construction may be more or less modified within the scope of the claims without departure from the principles of construction or material sacrifice of the advantages of the preferred designs.

I claim:

1. The method of producing an absorbent component for use in an absorbent product which comprises forming dry a highly porous, loosely compacted, absorbent fibrous body containing cellulosic fibers shorter than one-quarter of an inch, said body having low cohesive strength, low capillarity, poor shape and volume stability, and low fluid retentivity, applying moisture to the body to moisten only the surface portion thereof, positioning a shielding web on the moistened surface of said body, applying pressure to said body through said shielding web to form in the moistened surface portion of said body an integral, densified, compacted, porous, absorbent fibrous layer having high cohesive strength, increased capillarity, good shape and volume stability and high fluid retentivity.

2. The method of producing an absorbent component for use in an absorbent product which comprises forming dry a highly porous, loosely compacted, absorbent fibrous body containing cellulosic fibers shorter than one-quarter of an inch, said body having low cohesive strength, low capillarity, poor shape and volume stability, and low fluid retentivity, applying moisture to the body to moisten only the surface portion thereof with from about 0.0005 to about 0.03 cc. of water per square centimeter of surface area, positioning a shielding web on the moistened surface of said body, applying pressure to said body through said shielding web to form in the moistened surface portion of said body an integral, densified, compacted, porous, absorbent fibrous layer having high cohesive strength, increased capillarity, good shape and volume stability and high fluid retentivity, and separating said shielding web from said body.

3. The method of producing an absorbent component for use in an absorbent product which comprises forming dry a highly porous, loosely compacted, absorbent fibrous body containing cellulosic fibers shorter than one-quarter of an inch, said body having low cohesive strength, low capillarity, poor shape and volume stability, and low fluid retentivity, applying moisture to the body to moisten only the surface portion thereof with from about 0.0005 to about 0.03 cc. of water per square centimeter of surface area, positioning a shielding web on the moistened surface of said body, applying from about 5 to about 100 pounds per square inch of pressure to said body through said shielding web to form in the moistened surface portion of said body an integral, densified, compacted, porous, absorbent fibrous layer having high cohesive strength, increased capillarity, good shape and volume stability and high fluid retentivity, and separating said shielding web from said body.

4. The method of producing an absorbent component for use in an absorbent product which comprises forming dry a highly porous, loosely compacted, absorbent fibrous body containing cellulosic fibers shorter than one-quarter of an inch, said body having low cohesive strength, low capillarity, poor shape and volume stability, and low fluid retentivity, applying moisture to the body to moisten only the surface portion thereof, positioning a shielding web in the form of a woven fabric on the moistened surface of said body, applying pressure to said body through said shielding web to form in the moistened surface portion of said body an integral, densified, compacted, porous, absorbent fibrous layer having high cohesive strength, increased capillarity, good shape and volume

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stability and high fluid retentivity, and separating said shielding web from said body.

5. The method of producing an absorbent component for use in an absorbent product which comprises forming dry a highly porous, loosely compacted, absorbent fibrous body containing cellulosic fibers shorter than one-quarter of an inch, said body having low cohesive strength, low capillarity, poor shape and volume stability, and low fluid retentivity, applying moisture to the body to moisten only the surface portion thereof, positioning a shielding web in the form of a knitted fabric on the moistened surface of said body, applying pressure to said body through said shielding web to form in the moistened surface portion of said body an integral, densified, compacted, porous, absorbent fibrous layer having high cohesive strength, increased capillarity, good shape and volume stability and high fluid retentivity, and separating said shielding web from said body.

6. The method of producing an absorbent component for use in an absorbent product which comprises forming dry a highly porous, loosely compacted, absorbent fibrous body containing cellulosic fibers shorter than one-quarter of an inch, said body having low cohesive strength, low capillarity, poor shape and volume stability, and low fluid retentivity, applying moisture to the body to moisten only the surface portion thereof, positioning a shielding web on the moistened surface of said body, applying pressure to said body through said shielding web to form hydrate-bonds between fibers in the moistened surface portion of said body and to form an integral, densified, compacted, porous, absorbent fibrous layer having high cohesive strength, increased capillarity, good shape and volume stability and high fluid retentivity, and separating said shielding web from said body.

7. The method of producing an absorbent component for use in an absorbent product which comprises forming dry a highly porous, loosely compacted, absorbent fibrous body containing cellulosic fibers shorter than one quarter of an inch, said body having low cohesive strength, low capillarity, poor shape and volume stability, and low fluid retentivity, applying moisture to the body to moisten only the surface portion thereof, positioning a patterned shielding web on the moistened surface of said body, applying pressure to said body through said shielding web to form in the moistened surface portion of said body an integral, densified, compacted, porous, absorbent fibrous layer having high cohesive strength, increased capillarity, good shape and volume stability and high fluid retentivity, and separating said shielding web from said body.

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8. The method of producing an absorbent component for use in an absorbent product which comprises forming dry a highly porous, loosely compacted, absorbent fibrous body containing cellulosic fibers shorter than one-quarter of an inch, said body having low cohesive strength, low capillarity, poor shape and volume stability, and low fluid retentivity, applying moisture to the body to moisten only the surface portion thereof, positioning a shielding web on the moistened surface of said body, applying pressure to said body through said shielding web by passing said body and said web through a rotating pressure roll to form in the moistened surface portion of said body an integral, densified, compacted, porous, absorbent fibrous layer having high cohesive strength, increased capillarity, good shape and volume stability and high fluid retentivity, and separating said shielding web from said body.

9. The method of producing an absorbent component for use in an absorbent product which comprises forming dry a highly porous, loosely compacted, absorbent fibrous body containing cellulosic fibers shorter than one-quarter of an inch, said body having low cohesive strength, low capillarity, poor shape and volume stability, and low fluid retentivity, advancing said body, applying moisture to the body to moisten only the surface portion thereof, positioning an endless shielding web on the moistened surface of said body, said web advancing at the same rate as said body, applying pressure by means of roller devices to said body through said shielding web to form in the moistened surface portion of said body an integral, densified, compacted, porous, absorbent fibrous layer having high cohesive strength, increased capillarity, good shape and volume stability and high fluid retentivity, separating said shielding web from said body, and guiding said shielding web in an endless closed circuit so as to have a portion thereof continuously positioned between said absorbent fibrous body and said roller devices for applying pressure.

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