

[54] DISPOSABLE DIAPER

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[51] Int. Cl. **A61f 13/16**

[58] Field of Search **128/284, 287, 290 R, 128/290 W**

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[57] **ABSTRACT**

A disposable multi-layer diaper including at one side a porous fibrous facing layer to be brought into contact with an infant's skin, and including at the other side a water-impervious backing sheet, with a multi-layer batt being interposed between the facing layer and backing sheet. The batt layers are of different size, with the smaller layer being positioned in face-to-face engagement with the backing sheet, and with the larger layer having lateral extremities which extend beyond the smaller layer on each side thereof. The smaller batt layer and the lateral extremities of the larger layer are each adhered to the backing sheet. In a preferred embodiment of the invention, a paper-like, densified, highly compacted cellulosic layer is formed integrally with the smaller batt layer, and is positioned in face-to-face engagement with the backing sheet.

12 Claims, 4 Drawing Figures

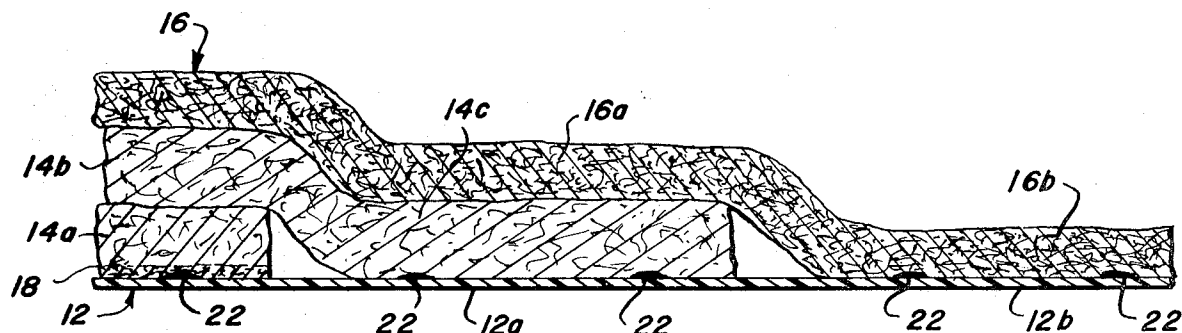


FIG. 1

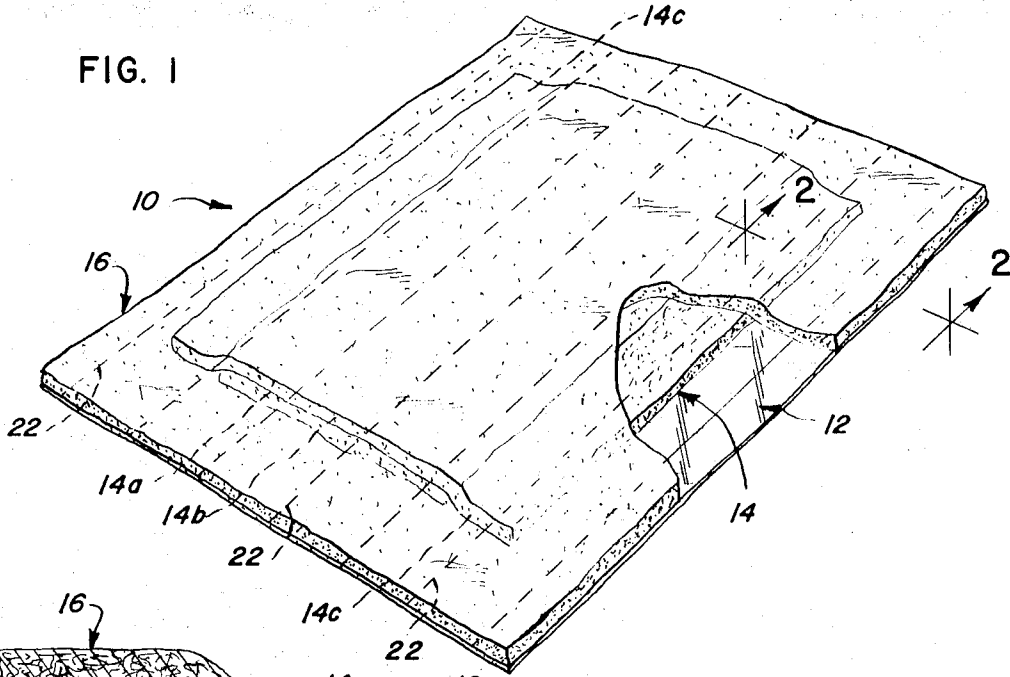


FIG. 2

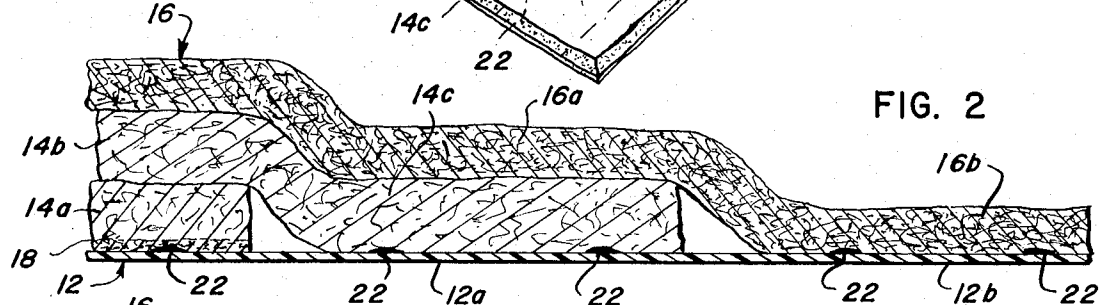


FIG. 3

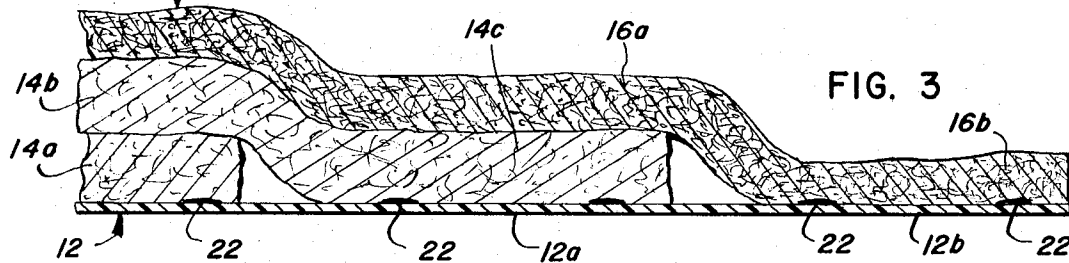
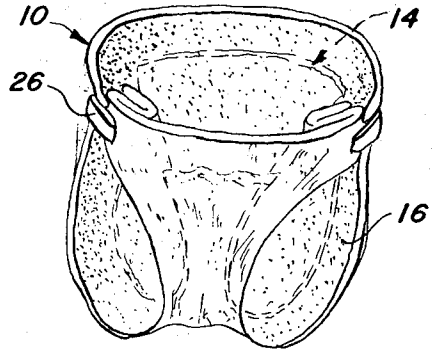


FIG. 4



DISPOSABLE DIAPER

BACKGROUND OF THE INVENTION

Disposable diapers have met with increasing commercial acceptance in recent years, primarily because of their convenience. Such diapers have conventionally included a facing layer to be brought into contact with an infant's skin, an absorbent panel adjacent thereto, and a water-impervious or a water repellent outer layer.

Known types of disposable diapers have had many functional deficiencies including inadequate absorptive capacity and inability to keep moisture away from the surface of the diaper which comes into contact with the infant's skin. Another serious drawback of prior art diapers is the tendency for liquid to leak around the edges of the diaper, particularly at night during periods of heavy discharge.

A significant advance in the art is provided by the diaper constructions disclosed and claimed in commonly assigned, copending Mesek et al. application Ser. No. 6,864 filed Jan. 29, 1970. The diaper structure illustrated therein includes, in order; a fibrous facing layer which is to be brought into contact with the infant's skin; an absorbent panel comprising a batt of highly porous, loosely compacted cellulose fibers having a paper-like, densified, highly compacted cellulosic fibrous layer integral with the loosely compacted batt; and an impervious backing sheet adhered to the densified layer portion of the batt throughout the interface therebetween. The facing layer is of porous construction and its fibers have less wettability for water than the fibers of the loosely compacted batt, resulting in a tendency for liquid to flow from the facing web into the batt. The densified fibrous layer has a smaller average pore size than the loosely compacted batt resulting in a tendency for liquid to flow from the batt into the densified layer.

In one embodiment of the diaper disclosed in the above mentioned application, having particular utility during periods of heavy discharge, the absorbent panel of the diaper includes a relatively small second batt, similar to the batt already named, superimposed on the larger first named batt. This construction not only provides an increased absorptive capacity for the diaper, but also provides for greater compressibility at the center of the diaper because of the increased batt thickness. When the batt portion of the diaper is compressed by the infant's weight, the distances between adjacent fibers is decreased, i.e., there is a smaller effective capillary radius between adjacent fibers, particularly in the center section of the batt portion of the diaper. In consequence of this, there is a greater wickability at the more highly compressed center portion of the batt as compared to the less compressed marginal portions. This latter construction tends to keep liquid in place in the center portion of the diaper, and prevents it from leaking around the edges thereof.

In the last mentioned diaper embodiment, the integral densified layer portion of the larger batt is in face-to-face engagement with the backing sheet, thus helping the urine to spread laterally throughout the length and width of the batt beyond the edges of the smaller batt. The rapid spread of the urine by means of the densified layer is desirable, but carrying the liquid to the peripheral edges of the larger batt increases the likelihood of leakage at the edges of the diaper.

SUMMARY OF THE INVENTION

The diaper of the present invention represents an improvement upon the multi-layer batt, heavy discharge type of diaper disclosed in the above mentioned Mesek et al. application, by virtue of minimizing the likelihood of urine leaking from the edges of the diaper. To achieve this important result, the diaper of the present invention includes an absorbent panel consisting of two differently sized, superposed batt layers of highly porous, loosely compacted cellulose fibers, sandwiched between a porous facing layer and a water-impervious sheet, with the smaller of the batt layers being positioned adjacent the backing sheet, and with the larger batt layer being positioned over the smaller batt layer. The marginal side portions of the larger batt layer extend outwardly beyond the sides of smaller batt layer and are adhered to the backing sheet. The smaller batt layer includes a paper-like, densified, highly compacted cellulosic fibrous layer integral therewith, which is in face-to-face engagement with the water-impervious sheet and adhered thereto.

In consequence of the construction of the diaper of the present invention, urine passing into the superposed layers of the absorbent batt through the facing layer flows preferentially into the densified layer of the smaller batt to draw the liquid away from the infant's skin. The urine flowing into the densified layer tends to spread laterally because of its wicking action, but because the densified layer is confined to the central portion of the diaper, the urine is similarly confined, and any tendency for urine to leak around the edges of the diaper is minimized. The increased compressibility resulting from the double thickness at the center of the diaper, combined with the compression caused by the infant's weight, provides for greater wickability at the center of the diaper, so that there is a cooperative relationship with the centrally located densified layer which tends to concentrate urine away from the side edges of the diaper. Further, the less dense overhanging extremities of the larger batt layer provide, in effect, a barrier which also contributes to the retention of urine in the center of the diaper.

The construction of the diaper of the invention, as a whole, provides a mechanism for rapidly transporting urine laterally from the point of discharge from the infant, and for spreading urine throughout most of the absorbent panel, while at the same time retarding the lateral flow before the urine reaches the edges of the batt. It also provides a mechanism for holding a urine discharge of limited content within the central portion of the diaper by a combination of a densified layer of limited area in the central region of the diaper and a greater overall batt density in the central region, provided by the action of the infant's weight on the thickened central portion (the superposed batts) of the diaper.

In addition to the advantages described above with respect to the handling of urine discharge by the diaper of this invention, it also provides enhanced structural stability. As described above, both of the batt layers are directly adhered to the backing sheet (which is ordinarily the strongest structural element of the diaper), the smaller batt layer being adhered to the backing sheet throughout the interface therebetween, and the larger batt layer having its marginal side portions adhered to the backing sheet. Thus, each of the batt lay-

ers is positively anchored to the backing sheet against movement and against disintegration. The increased structural integrity is of especial importance in a diaper that can hold a large volume of urine since the increased weight of the urine-saturated diaper subjects it, and particularly its relatively flimsy absorbent panel, to increased stress.

The improved structural stability is of particular importance in embodiments of the diaper in which the facing layer is relatively weak in comparison to the backing sheet, such as in embodiments in which the facing layer is a bonded mixture of long and short fibers and the backing sheet is a polyethylene film.

The increased strength imparted to the diaper by virtue of having both layers of the absorbent panel directly adhered to the backing sheet has applicability even in diaper structures which have no densified layer and in which each batt is loosely compacted throughout its thickness. In fact, the increased strength imparted by direct adhesion to the backing sheet is more advantageous in a diaper without a densified layer since a densified layer provides structural strength to a loosely compacted batt of cellulosic fibers and the absence of such a layer makes external reinforcement all the more desirable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, with certain portions broken away, of an open unfolded diaper in accordance with one embodiment of this invention;

FIG. 2 is a partial cross-section of the diaper of FIG. 1 taken generally along line 2—2 of FIG. 1;

FIG. 3 is a partial cross-sectional view similar to FIG. 2 illustrating an alternate embodiment of this invention; and

FIG. 4 is a perspective view on a reduced scale of the diaper in its configuration after being put on an infant.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings, and particularly to FIGS. 1 and 2, diaper assembly 10, when fully opened and laid out flat, comprises, in order, fibrous facing layer 16 adapted to be positioned adjacent the skin of an infant, absorbent fibrous panel, or batt 14, and a water-impervious sheet 12. Fibrous layer 16 is rectangular in shape, equal in dimension, and coterminous with backing sheet 12.

Batt 14 includes a first layer 14a in a face-to-face juxtaposition with backing sheet 12, and layer 14a is also rectangular in shape, but substantially smaller than backing sheet 12 and facing layer 16, and disposed centrally thereof. Batt 14 includes a second rectangular layer 14b wider than batt layer 14a, but smaller than backing sheet 13 and facing layer 16. Batt layer 14b is disposed centrally above batt layer 14a to provide marginal side portions 14c that extend outwardly an equal amount beyond the sides of batt layer 14a, with side portions 14c being sandwiched between intermediate portions 12a of backing sheet 12 and downwardly stepped intermediate portions 16a of facing layer 16. The marginal portions 12b and 16b (i.e., the portions extending beyond batt layer 14b) of sheet 12 and facing layer 16, respectively, are in face-to-face engagement with one another. Backing sheet 12 is adhered to layers 14a, 14b and 16 at the interface therebetween, as will hereinafter be described.

In the preferred embodiment of the invention, moisture-impervious sheet 12 is formed of polyethylene having a thickness of approximately 0.001 inch. The sheet may be smooth, or may be embossed to improve its drape and feel. Other suitable flexible moisture-impervious sheets may be used in accordance with the invention, such as, for example, polyethylene terephthalate sheets having a thickness of about 0.0005 inch.

Batt layers 14a and 14b are formed of loosely compacted short cellulose fibers, such as wood pulp fibers, or cotton linters, or mixtures thereof, which are primarily held together by interfiber bonds requiring no added adhesive, as is known in the art. Briefly, this batt is a low bulk density coherent web of loosely compacted cellulose fibers, preferably comminuted wood pulp fibers in the form of so-called "fluff."

The term "short fibers," as used herein, refers to fibers less than about $\frac{1}{4}$ inch in length, in contrast to "long fibers," or "textile length fibers," which are longer than about $\frac{1}{4}$ inch in length, and generally are between about $\frac{1}{2}$ and $2\frac{1}{2}$ inches in length. The former are substantially less costly than the latter. The classification of fibers by length may be carried out by the Clark Classification procedure described in the test manual of the Technical Association of Pulp and Paper Industry (TAPPI-T233 SU64).

Paper-like densified layer 18 of batt layer 14a is formed by a slight moistening of one surface of the batt followed by the application of pressure thereto. The nature of the batt and of its densified layer and the method of producing the same are described in U.S. Pat. No. 3,017,304, dated Jan. 16, 1962.

The composite density of batt 14, including the densified layer of batt layer 14a, should be above about 0.07 gm./cc., and preferably between about 0.10 and 0.15 gm./cc. The foregoing density values are applicable to the diaper as produced. In storage and handling, the loft or thickness of the batt is increased to some extent, resulting in lowered densities.

Facing layer 16 is made up of a mixture of fibers consisting predominantly of short cellulosic fibers such as wood pulp fibers or cotton linters, in amounts of about 75 percent to about 98 percent, the balance being textile length fibers such as rayon. Short cellulosic fibers such as wood pulp fibers or cotton linters are substantially less expensive than textile length cellulosic fibers such as cotton and rayon, and this low cost is a factor in reducing the cost of the facing layer component of the diaper of this invention.

In facing layer 16, the short fibers are in uniform admixture with 2 percent to 25 percent by weight of textile length fibers, such as 1.5 denier rayon fibers uniformly cut to $1\frac{1}{2}$ inches length. The short and long fibers are randomly and substantially uniformly dispersed and bonded with a bonding agent such as a self-cross-linking acrylic emulsion. One bonding agent that has been applied with considerable success is a latex of a polyethyl-acrylate copolymer containing small amounts of acrylonitrile and a cross-linking monomer sold under the trademark HYCAR 2600 $\times$ 120. The bonding agent should be of the low viscosity type with a viscosity less than 5 centipoises. The facing web is also treated with a wetting agent, preferably an anionic surfactant, to partially counteract the water repellency of the bonding agent and bring the facing layer to the desired degree of wettability. A typical surfactant

which has been found to be suitable is the ionic sulfonated alkyl ester sold under the trademark TRITON GR-5. Facing layers of this character are described in greater detail in commonly-owned copending United States patent application Ser. No. 729,784.

Facing layers suitable for use in this invention have fabric weights in the range of 1 to 5 oz./yd.² and densities less than 0.15 gm./cc., generally in the range between 0.05 and 0.01 gm./cc. The dry strength of the facing layer, for a fabric having a weight of about 1.5 oz./yd.², is at least 0.15 lbs./in. of width in the machine direction and at least 0.08 lbs./in. of width in the cross direction. The fabrics have unusually good elongation, loft, softness and drape characteristics in comparison to prior products incorporating any substantial amount of short fibers.

For a more detailed description of facing layers and batt layers, such as fibrous layer 16 and batt layers 14a and 14b, as well as the methods of producing them, reference may be made to the above mentioned application Ser. No. 6,864, the disclosure of which is hereby incorporated herein in its entirety by this reference.

As is explained in application Ser. No. 6,864, an important aspect of the improved diaper is the provision for selective wettability among the above described fibrous components, such that the moisture is selectively drawn from the facing layer into the body of the batt and then from the body of the batt into the densified layer thereof. Specifically, when liquid, such as urine, flows into a small area on the outer surface of facing layer 16, it flows preferentially into underlying batt layer 14b rather than to other areas of the facing layer, thus tending to restrict wetting in the facing layer to a small area and to move the liquid away from the infant's skin.

When an infant's weight rests on the aforescribed diaper construction having the stepped batt panels, there is a tendency for the uncompressed absorbent material of batt layers 14a and 14b to be compressed by the weight. Since there is a greater thickness of material in the center of the diaper than at the margins thereof, there will be greater pressure (and hence more compression) at the center. This results in a smaller effective capillary radius in the central section, and greater wickability of the more highly compressed center portion as compared to the less compressed marginal portions 14c. As a result, urine passing into the central portion of batt layer 14b tends to flow preferentially into the underlying batt layer 14a, rather than into the marginal portions 14c of batt layer 14b.

The liquid which flows through batt layer 14b and into batt layer 14a flows preferentially into underlying densified layer 18, rather than to other areas of the loosely compacted batt layer, thus tending to move the liquid farther from the infant's skin. The liquid flowing into densified layer 18 tends to spread laterally because of its wicking action, and liquid which might pass through the densified layer during discharge (when flow is rapid) is held back by the impervious backing sheet for sufficient time to permit absorption to take place.

Since the densified layer is confined to the central portion of the diaper, the capacity of the diaper to retain and confine liquid in this area, as compared to prior art diapers, is markedly improved. Liquid in excess of the absorptive capacity of densified layer 18 is forced back by impervious layer 12 into the dry portion

of loosely compacted batt layer 14a, thus utilizing the additional absorptive capacity therein. Once batt layer 14a becomes saturated, liquid will migrate into the superposed dry portions of batt layer 14b to take advantage of the additional absorptive capacity thereof, and it will be appreciated that liquid will initially flow into the dry portions of the relatively highly compressed central portion of batt layer 14b before it flows into the less highly compressed marginal portions 14c thereof. The net result is that the loosely compacted marginal portions 14c act as dam-like barriers that cooperate with the densified portion 18 of batt layer 14a to confine liquid at the central portions of the diaper. Only after the relatively highly compressed central portions of batt layers 14a and 14b become saturated will liquid flow into the marginal portions 14c, and thus it will be appreciated that the diaper of the present invention effectively minimizes the likelihood that liquid will escape around the edges of the diaper.

As noted above, because of the increased absorptive capacity provided by the double layer batt construction, the aforescribed diaper is especially adapted for use during periods of heavy discharge. In previous types of heavy duty type diapers, problems have been encountered in retaining the various batt layers in place when the diaper becomes saturated, since the increased weight attributable to the larger absorbed volume subjects the diaper to increased stresses not normally encountered in a diaper having a smaller absorptive capacity. This problem is particularly acute, since the loosely compacted fibrous layers that are conventionally used as the absorbent panel of the diaper are usually relatively flimsy and weak when compared to the facing layer and particularly to the backing layer, which ordinarily has much greater structural integrity than the other layers of the diaper.

The diaper of the present invention obviates the problems noted in the preceding paragraph by having both layers of the absorbent panel and facing layer adhered to the backing sheet substantially through the interface therebetween. With reference to FIGS. 1 and 2, it will be noted that parallel lines of adhesive 22 are utilized to adhere the densified layer 18 of batt layer 14a, as well as the marginal portions 14c of batt layer 14a and 16b of facing layer 16, to the backing sheet 12. Other adhesive patterns may be utilized, as will occur to those skilled in the art. In any event, since marginal portions 14c of batt layer 14b and batt layer 14a in its entirety are each secured to backing sheet 12, both batt layers are firmly anchored in place against movement and against disintegration.

Referring now to FIG. 3, the diaper construction illustrated therein is similar to the previously described embodiment, so that the same reference numerals are used to designate the common elements. The diaper of FIG. 3 differs from the previously described embodiment in that the densified layer 18 has been eliminated from the lower batt layer 14a. However, as with the previous embodiment, batt layer 14b is a loosely compacted fibrous member that is rectangular in shape and wider than the underlying rectangular batt layer 14a to provide overhanging marginal side portions 14c that are adhered to backing sheet 12, along with batt layer 14a, by parallel lines of adhesive 22. Batt layer 14a is loosely compacted throughout its thickness and hence is relatively weak, as contrasted to the batt layer 14a of the embodiment of FIGS. 1 and 2 whose strength is

augmented by the presence of densified layer 18. Nevertheless, by virtue of having both batt layers secured to backing sheet, the diaper construction of FIG. 3 has adequate strength to withstand the increased stresses which occur when the diaper becomes saturated.

The diaper is normally packaged and sold in a folded condition, as is described in detail in the above mentioned application Ser. No. 6,864. Briefly, the opposite sides of the diaper are folded inwardly toward one another, with the folded portions then being folded outwardly to provide a three ply arrangement, as is shown in FIG. 3. The folded over portions are adhered to the main body of the diaper by centrally disposed spots of adhesive, and when it is desired to use the diaper, the folds of the diaper are opened on opposite sides of the adhesive spots, and the end portions of the diaper are placed around the waist of the infant. The overlapping corners of the end portions of the diaper are secured together by pinning, or by adhesive strips 26 that may be attached to the backing sheet 12.

It will be understood by those skilled in the art that variations and modifications of the specific embodiments described above may be employed without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A multi-layer diaper comprising: a water-impervious backing sheet; an absorbent batt in juxtaposition with said backing sheet, said batt including a first highly porous, loosely compacted, cellulosic fibrous layer having a paper-like, densified, compacted cellulosic fibrous layer of relatively high wettability and relatively high fluid retentivity formed integrally therewith, said densified layer being positioned in face-to-face engagement with said backing sheet, said batt further including a second highly porous, loosely compacted, cellulosic fibrous layer wider than said first layer and being of uniform density throughout its thickness, said second layer having its midportion positioned face-to-face engagement with said first layer with marginal portions of said second layer extending outwardly beyond the sides of the first layer, said marginal portions being disposed in face-to-face engagement with said backing sheet and adhered thereto; and a porous facing layer disposed over the second layer of said batt, said loosely compacted batt layers having greater wettability to water than said facing layer.

2. The diaper of claim 1 wherein said backing sheet and said facing layer are substantially rectangular and substantially coextensive, said second batt layer is substantially rectangular, narrower than said backing sheet and facing layer, and centrally disposed with respect thereto to provide marginal portions of said diaper in which said backing sheet and said facing web are in direct contact with each other.

3. The diaper of claim 2 wherein said first batt layer is also substantially rectangular and disposed centrally of said second batt layer.

4. The diaper of claim 1 wherein the fiber content of said facing layer comprises from about 75 to about 98

weight percent of short fibers having a fiber length less than $\frac{1}{4}$ inch and from about 2 to about 25 weight percent of long fibers having a fiber length between about $\frac{1}{2}$ and about $2\frac{1}{2}$ inches.

5. The diaper of claim 1 wherein the fibers of said facing layer are bonded together by a water repellent polymeric bonding agent and wherein the fibers of said facing layer are coated with a surfactant.

6. The diaper of claim 1 wherein said first batt layer and the marginal portions of said second batt layer are adhered to said backing sheet by an adhesive discontinuously distributed over the entire interface between them.

7. The diaper of claim 6 wherein said first batt layer and the marginal portions of said second batt layer are adhered to said backing sheet by parallel lines of adhesive.

8. A multi-layer diaper comprising: a water-impervious backing sheet; an absorbent batt in juxtaposition with said backing sheet, said batt including a first highly porous, loosely compacted, cellulosic fibrous layer having a paper-like, densified, compacted cellulosic fibrous layer of relatively high wettability and relatively high fluid retentivity formed integrally therewith, said densified layer being positioned in face-to-face engagement with said backing sheet and adhered thereto by parallel lines of adhesive, said batt further including a second highly porous, loosely compacted cellulosic fibrous layer wider than said first layer, said second layer having its mid-portion positioned in face-to-face engagement with said first layer with marginal portions of said second layer extending outwardly beyond the sides of the first layer, said marginal portions being disposed in face-to-face engagement with said backing sheet and adhered thereto by parallel lines of adhesive; and a porous facing layer disposed over the second layer of said batt, said batt layers having greater wettability to water than said facing layer.

9. The diaper of claim 8 wherein said backing sheet and said facing layer are substantially rectangular and substantially coextensive, said second batt layer is substantially rectangular, narrower than said backing sheet and facing layer, and centrally disposed with respect thereto to provide marginal portions of said diaper in which said backing sheet and said facing web are in direct contact with each other.

10. The diaper of claim 9 wherein said first batt layer is also substantially rectangular and disposed centrally of said second batt layer.

11. The diaper of claim 8 wherein the fiber content of said facing layer comprises from about 75 to about 98 weight percent of short fibers having a fiber length less than $\frac{1}{4}$ inch and from about 2 to about 25 weight percent of long fibers having a fiber length between about $\frac{1}{2}$ and about $2\frac{1}{2}$ inches.

12. The diaper of claim 8 wherein the fibers of said facing layer are bonded together by a water repellent polymeric bonding agent and wherein the fibers of said facing layer are coated with a surfactant.

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