DIAPER HAVING IMPROVED WICKING AND DRYNESS
16 Claims, 11 Drawing Figs.

ABSTRACT: A diaper is disclosed wherein the structure comprises an absorptive substrate wherein the amount of expressible moisture within the central section of the substrate is reduced relative to contiguous peripheral sections either by reduction in weight of absorbent material per unit of surface area or by compression of the absorbent material during the manufacturing operation or by introducing a waterproof film as an intermediary ply within the absorptive substrate. The purpose of the structure is to improve the surface dryness of the central section of the diaper topsheet surface and improved utilization of absorptive substrate materials toward the diaper extremities. Also disclosed is a diaper structure wherein the relation between free space available for fluid retention of the topsheet and in-use changes of absorptive capacity of the substrate's central section are specified so as to preclude or minimize surface flooding of the diaper topsheet, which is adjacent the wearer's skin.
DIAPER HAVING IMPROVED WICKING AND DRYNESS

FIELD OF THE INVENTION

This invention relates to diapers and diapering systems for infants, and more specifically to diapers of the type having a porous hydrophobic topsheet adapted to be placed adjacent an infant's skin and an absorbent substrate to absorb waste fluids from the infant.

BACKGROUND OF THE INVENTION

Diapers comprising a porous hydrophobic topsheet and a hydrophilic substrate are well known. The purpose of the combination is to reduce the amount of moisture in contact with the wearer's skin and thus reduce skin maceration, diaper rash and other unpleasantness. It should be recognized that the terms "hydrophobic" and "hydrophilic" as herein employed, while useful in their brevity actually refer, respectively, to relatively low and relatively high critical surface tensions of the materials being characterized. The hydrophobic nature of a diaper topsheet is clearly evidenced by its lack of affinity for liquid human waste relative to that of the hydrophilic or absorbent substrate and as used herein, a web is hydrophobic when a drop of liquid waste placed thereon does not spread to any appreciable degree on the web. In this respect, the threshold of hydrophobicity of a diapering material is in the vicinity of about 40 to 50 dynes per centimeter at 20°C. Thus, when a hydrophobic sheet is superimposed upon a layer of hydrophilic or less hydrophobic absorbent material to form a diaper and the hydrophobic sheet is placed next to the wearer's skin, waste fluids from the wearer pass through the hydrophilic sheet and are preferentially partitioned by and absorbed within the underlying hydrophilic layer, leaving the topsheet adjacent the wearer's skin relatively dry.

Efficacy of the above-described materials combination is limited, however, and surface wetness remains a problem. Surface wetness of the hydrophobic topsheet in the center portion of the diaper is believed to result from inefficient transfer of waste fluids from the center into the total mass of absorbent material and from repeated compression of the absorbent material in the front and central areas of the diaper due to stresses caused by the movement of the infant's thighs, the compressive stresses squeezing fluid out of the absorbent substrate and causing consequent flooding of the upper surface of the topsheet. This flooding is followed by decomposition of the absorbent material and slow reabsorption of the fluid. As used herein the terms "flooding" and "reflooding" are synonymous and connote the wetting of the surface of the diaper topsheet with waste fluids which were previously absorbed in the absorptive substrate.

Excessive wetness of the skin at the base of the infant's trunk tends to macerate the skin and thereby reduce its natural resistance to primary irritants present in or derived from its waste products. In this respect, even if the surface of a diaper is damp (as it would be if a hydrophilic topsheet were used) it is advantageous to eliminate, to any extent possible, the flooding of the diaper topsheet surface. Where this maceration problem has been recognized in diaper design, the counter measures involve concentrating absorptive materials in the central portion or along a longitudinal centerline of the diaper. This commonsense approach, "putting the absorptive material where it is needed most," is old in the art, honored frequently in practice, and yet does not solve the problem of skin wetness at the center of the diaper.

In view of the above-recited shortcomings, it is desirable therefore, to provide a diaper structure which reduces the surface wetness problem and which precludes repeated flooding of the surface of the topsheet.

OBJECTS OF THE INVENTION

It is an object of this invention therefore to provide a diaper with an improved surface dryness in its critical central area.

A further object of this invention is to provide a diaper in which the surface adjacent the wearer's skin is not subject to repeated flooding by fluids retained within the absorbent material.

A still further object of this invention is to provide a more comfortable, formfitting diaper in which wicking of fluids to the diaper's extremities is improved.

SUMMARY OF THE INVENTION

Briefly stated, the invention is a diaper comprising an absorbent body having throughout the interior of its central portion (i.e., that portion contiguous to the base of the infant's trunk and public area in use) a substantially uniform unstressed absorptive capacity per unit face area which is lower than the average of that in other portions of the absorbent pad. A further embodiment of the invention comprises as an ultimate the structure described wherein the compression of the absorbent substrate under stress of the infant's activity causes a change in absorptive capacity per unit face area of the substrate in the interior of the central portion which is exceeded by the free space available for fluid retention per unit area of hydrophobic topsheet under equal stress.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter of this invention, it is believed the invention will be better understood by reference to the following explanation and accompanying drawings in which the thickness of some of the materials are exaggerated for clarity and in which:

FIG. 1 is a perspective view of a diaper of the present invention, partially broken away to show details of construction;
FIG. 2 is a perspective view showing the form which the diaper of FIG. 1 assumes in use;
FIG. 3 is a section view taken along lines 3-3 of FIG. 2;
FIG. 4 is a diagrammatic view of a test apparatus;
FIG. 5 is a longitudinal sectional view taken along the line 5-5 of FIG. 1;
FIG. 6 is a lateral sectional view taken along the line 6-6 of FIG. 5;
FIG. 7 is a longitudinal sectional view similar to FIG. 5 and showing an alternate construction;
FIG. 8 is a longitudinal sectional view of a further embodiment of this invention;
FIG. 9 is an end view of the diaper of FIG. 8 after it has been prefolded into a box pleat structure;
FIG. 10 is a plan view of the prefolded diaper of FIG. 9; and
FIG. 11 is a perspective view of a transverse cross section through the central portion of the prefolded diaper of FIGS. 8-10 showing the approximate shape it takes preparatory for use.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, FIG. 1 illustrates a diaper embodying the subject of this invention. The diaper is a pad comprising a body or substrate 20 of absorbent material and an overlying layer or topsheet 21. The diaper has a length and width adapted to enclose the lower portion of the torso of a child, with end sections adapted to embrace the waist and cover adjacent abdominal and back areas of the child. An optional waterproof back sheet 22 is shown which can be made of, for example, a thin, plastic film of polyethylene, polypropylene, polyethylene chlorides, or other suitable flexible material. (The waterproof back sheet is not necessary to the practice of this invention inasmuch as the diaper comprising the absorbent body or substrate 20 can be used in conjunction with a separate pair of waterproof pants to protect infants' clothing; however, the backsheet 22 is particularly advantageous when used with a diaper of the type shown in FIG. 1 which has been prefolded to the configuration of FIGS. 9-11, hereafter explained.)

The central section 23 of body 20 has, at least in its interior, a substantially uniform absorptive capacity per unit face area
which is lower than that of the contiguous material, which can be achieved by providing a central section 23 which is thinner than the longitudinally contiguous material as shown in FIG. 1. Preferably, the layer or topsheet 21 is hydrophobic and subsequent description assumes that to be the case. Provision of a relatively low absorptive capacity central section 23, alone or in combination with the hydrophobic topsheet 21, facilitates wicking of an infant's liquid discharge to the diaper's extremities and results in a drier surface adjacent the infant's skin than occurs with a diaper having the combination of a hydrophobic topsheet and an absorptive pad which is substantially uniform in absorptive capacity throughout its length and width or, alternatively, has a greater absorptive capacity in its central section than in its extremities. While the reasons for this result are not fully understood, it is believed that the lower absorptive capacity central section 23 may act as a saturated source of moisture during and immediately after the infant's urinal discharge to provide a relatively large moisture gradient relative to the diaper extremities, thus providing a larger driving force for wicking to the diaper's extremities than occurs with the other described types of diaper. Within a short time, this gradient becomes reduced through the mechanism of mass transfer to the diaper's extremities and results in a lower total moisture content within the diaper's central section 23 than would otherwise occur.

FIG. 2 illustrates the diaper of FIG. 1 in the form in which it appears in use, including leg openings 24 defined when the diaper is secured to an infant and side portions 22 of back sheet 22 which are folded inwardly over the side of the absorbent pad 19.

FIG. 3 illustrates the diaper of FIG. 2 in section and shows the placement of the thin central section 23. The section 23 is full width of the body 20 and located so that it lies between the infant's legs when they are in any of several positions within the normal range of his activity. In this connection, preferred practice places the section 23 so that it extends on the diaper in use from about 120° forward of the vertical center line of the leg openings (angle A) to about 45° rearward thereof (angle B). It may be desirable, however, from the consumer's point of view, to center the central section 23 lengthwise of the pad to avoid confusion between the front and rear of the diaper. In this event, central section 23 can encompass the angle extending from about 120° forward of the vertical center line of the leg opening 24 to about 120° rearward thereof. Thus, the thin central section 23 encompasses the locus of the infant's urinal discharge and only the thin central section 23 is subjected to repeated compression and decompression by movements of the infant's legs. This has been found to help alleviate diaper surface reflowing when combined with certain limitations (detailed below) in the variation in available free space for fluid retention (i.e., absorptive capacity) in section 23 and the overlying portions of topsheet 21, if hydrophobic, with changing compressive stresses caused by infant's activity.

With respect to absorptive properties, although section 23 is preferably uniform in absorptive capacity throughout its width, this does not necessarily have to be the case. All that is required to result in a diaper structure substantially improved with respect to overall effectiveness, fit, comfort and resistance to reflowing is that the absorptive capacity per unit of surface area of at least the interior of section 23 be measurable and uniformly less than the average absorptive capacity per unit of surface area in other portions of the diaper. Thus, instead of section 23 being thin throughout its breadth, it could be thin in the center and have a full thickness strip at each side. In this case each of the side strips should not exceed about 15 percent of the total width of section 23 so that the thin interior thereof, i.e., the area between the strips, is at least about 70 percent of the full width of the strip in a meaningful improvement. Preferably and for the same reason the absorptive area per unit of face area in the interior of section 23 should be at least about 10 percent lower than that in other portions of the diaper.

In use, central section 23 of the diaper assumes a certain state of compression with a give position of the infant's legs. This compression is reflected in the free space of the central section 23 of the absorbent body 20 relative to that of the portions of the hydrophobic topsheet 21 which lie within the bounds of section 23. Upon the infant's flooding of the diaper with waste fluids, the fluid will flow through the hydrophobic topsheet 21, saturate or nearly saturate the central section 23, and migrate by wicking toward the extremities of the diaper. Within a short time, the bulk of the fluid will be absorbed, leaving a relatively dry surface of the hydrophobic topsheet adjacent the infant's trunk. Subsequently, the normal activity of the infant will cause the absorbent material in section 23 to become compressed, thereby causing a reduction in free space available for absorption, and hence, in fluid retention or absorptive capacity. The fluid displaced by this compression will migrate back into the free space within the hydrophobic topsheet 21, and, if of sufficient volume, will reflood the surface of the hydrophobic topsheet 21. If, however, the weight of absorptive substrate which is subjected to the compression, when multiplied by the different volumetric moisture content per unit of weight of absorbent material between unstressed and stressed conditions, is lower than the free space available for fluid retention for overlying portions of the topsheet 21, flooding will be avoided. The directional rather than absolute nature of the flooding/nonflooding phenomena should be recognized, however, since surface wetness seems to reflect more the proportion of topsheet free space filled than a simplistic conception of water rising through a raft of sticks wherein the sticks above the internal water level are still dry.

The stresses to which the central section 23 of a diaper will be subjected are equivalent to a range of from about 0.1 to about 6 pounds per square inch applied uniformly to a rectangular area of our sample of hydrophilic or hydrophobic material, with a range of about 0.5 to 3.0 p.s.i. encompassing most in-use stresses encountered. One method of determining the relevant absorptive capacity parameters of diaper materials is to place a saturated sample 25 of material on a slight (e.g., 10°) incline 26 as shown in FIG. 4 and place varying weights 27 on its top surface as shown. Knowing the size of the sample 25, the dry weight, the saturated weight, and the weight of the sample after subjection to the compressive stress indicated, one can determine the unstressed absorptive capacity and the change in absorptive capacity of the material under stress per unit of weight, or, if desired, per unit face area of the material. Examples of test results obtained with some hydrophilic and hydrophobic materials are tabulated below.

Given the results tabulated above, or results similarly obtained for materials not included in the above list, one can then determine a workable combination of materials in which the absorptive capacity of the hydrophobic topsheet material under maximum design stress (e.g., 3.0 p.s.i.) is sufficient to contain an appreciable amount of the fluid contained in the central section 23 which tends to reflow the surface of topsheet 21 when the diaper is subjected to compression encompassing the design stress range (e.g., 0.5 to 3.0 p.s.i.). For example, in a diaper having a single ply topsheet as described in the tabulation above and a central section 23 consisting of a single ply of the cellulose wadding described therein, roughly one-third of the fluids squeezed out of section 23 by a 3 p.s.i. stress would be retained in the interstices of the topsheet 21. As an ultimate, a 4-ply topsheet 21 of the material described combined with a single ply creped cellulose central section 23 would preclude surface reflowing altogether. Alternatively, a 6-8 basis weight tissue underlying a single ply of topsheet 21 would also preclude flooding.

FIGS. 5 and 6 illustrate in section the manner in which the thin central section 23 can be provided. The hydrophobic layer comprises a body 20 of compressible absorptive material which is initially of substantially uniform thickness and in which the thinner central section 23 has been provided by locally compressing the body 20 beyond its elastic limit to a
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<table>
<thead>
<tr>
<th>Sample</th>
<th>Number of Sample</th>
<th>Number of Piles</th>
<th>Sample Area (sq cm)</th>
<th>Wt. of Sample</th>
<th>Absorptive Capacity (inches), 0.1 psi</th>
<th>Compress. Operations</th>
<th>Absorptive Capacity (inches)</th>
<th>Change in average absorptive capacity over design stress range</th>
<th>0.1 psi</th>
<th>0.3 psi</th>
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<tr>
<td></td>
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<td>5.0</td>
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<td></td>
<td></td>
<td>6.8</td>
<td>7.0</td>
</tr>
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<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>4.8</td>
<td></td>
<td></td>
<td></td>
<td>6.6</td>
<td>7.0</td>
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<td></td>
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<td>4.8</td>
<td></td>
<td></td>
<td></td>
<td>6.6</td>
<td>7.0</td>
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<td></td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
<td>6.6</td>
<td>7.0</td>
</tr>
</tbody>
</table>

1. % H₂O/g, dry absorptive material.
2. % H₂O/g, dry absorptive material. This is the change in average absorptive capacity at 0.1 psi value after initial compression to the indicated high pressure of the range (i.e., the 1 psi and the 3 psi value). This will reflect the conditions because a certain amount of preconditioning will take place contemporaneously with and soon after the diaper is applied. Basis weight of about 15 lbs/1,000 ft.².
3. Made from Southern Kraft fibers (Foley fluff) and having a weight of 3 grams.
4. % S pulp having a basis weight (air-dry) of 24.8 #3,000 ft.² after creping.
5. Comprised rayon, manila and kraft fibers bonded with latex binder (available from C. H. Dexter and Sons Company, Windsor Locks, Conn., and identified as X-1406 (3)).
6. No valid data—sample did not wet without pressure being applied.

Fraction of its uncompressed thickness. One material which is readily adaptable to this construction and is suitable for a disposable diaper is creped cellulose wadding. Alternatively, the material can comprise an airfelt made of airlaid pulp fibers, or a mixture of airfelt and creped wadding. The body 20, when made of creped cellulose wadding, will perform satisfactorily consistent with cost limitations when it comprises plies of wadding having a combined basis weight (air dry) of 120-245 pounds per 48 or 3,000 square feet after creping. Since increasing the free space and thus the absorptive capacity of 1 pound of paper under moderate stress is desirable, the plies of wadding are preferably highly creped, i.e., about 45 percent to 70 percent crepe—present crepe being equal to 100 times the quotient of the reduction in length caused by the creping of a piece of tissue divided by the length of the piece of tissue in its initial uncreped form. The thin central section 23 can be formed in the body 20 described above by locally increasing the basis weight (by equipment and techniques readily apparent to those skilled in the art) beyond its elastic limit and to a point where the free space content is approximately 85 percent to 95 percent of its total volume. In this condition, the change in fluid retention capacity of the body 20 in the thin section 23 over the aforementioned stress range of 0.5 to 3 p.s.i. will range from 4 to 12 cubic centimeters per gram of absorptive substrate (of a specific gravity of 1.5). If the free space content exceeds 95 percent, too much moisture will be absorbed therein and cause reflooding problems; if it is much less than about 85 percent, the material tends to stiffen and become undesirable from a comfort standpoint. The approximate free space content of a fibrous mass can be determined experimentally by measuring the dry weight in grams of a sample (Wₐ), the weight in grams of the sample saturated with water (Wₐ), and using the following formula in which S.G. is the specific gravity, in grams/cubic centimeter, of the material comprising the fibers (for example, cellulose has a S.G. of about 1.5):

\[
\text{percent free space} = \frac{W_{d} - W_{e}}{W_{a}/\text{S.G.} + (W_{d} - W_{e})} \times 100
\]

The length and placement of section 23, as noted above in connection with the description of FIG. 3, should be such that it encompasses the normal range of activity of an infant's legs when the diaper is in use. A diaper having the construction described above can, for example, have an overall lengthwise body 20 dimension of 16 inches and, as shown in FIG. 5, the length L of central section 23 can comprise about 35-45 percent of this dimension, i.e., about 5 to 7 inches. In the case described, section 23 can be placed a dimension M of from about 2 to about 4 inches from the front 28 of the body 20.

A topsheet 21 which when combined with the creped cellulose wadding described above will retain an appreciable quantity of the fluids tending to reflood its surface when the diaper is stressed can comprise, for example, a nonwoven sheet made of 0.75 to 3 denier rayon, 1-9/16 inches long, staple containing approximately 20-35 percent thermoplastic binder (as, for example, copolymers of an ester of acrylic acid such as is sold by the Rohm and Haas Company and identified as HA-8 and/or HA-24), and having a weight of about 15-25 grams per square yard. For best results in processing such a sheet, surfactants should be minimal in the binder emulsion and avoided in the final bath. The topsheet 21 as described has an absorptive capacity, i.e., free space available for fluid retention, under design maximum in-use stresses of 3 pounds per inch square of 3-4 grams water per gram of topsheet.

The topsheet 21 in the embodiment described above can be secured to the absorbent body 20 in any convenient manner; for example, as shown in FIGS. 5 and 6. In FIG. 5, the ends of the topsheet 21 are shown folded under the absorbent body 20 and adhesively secured to the underside thereof at 29. FIG. 6 illustrates how the topsheet 21 is folded over the sides of the body 20 and adhesively secured at 30. The adhesive applied along areas 29 and 30 is desirably only slowly soluble, if soluble at all, in water so as to obviate the danger of separation of the topsheet 21 from the body 20 in use.

The waterproof back sheet 22, when used, desirably comprises a low density, opaque polyethylene web 0.7-1.5 mils thick which is adhesively bonded to the hydrophobic topsheet 21 along the underfolded portions thereof at 36, as shown in FIG. 6. In the preferred structure embodying this invention, which is described below in connection with FIGS. 8-11, the back sheet is preferably about 1 inch to 4 inches longer and about 2 inches to 4 inches wider than the absorbent body 20.

FIG. 7 illustrates an alternate means for providing a thin central section 43. This alternate comprises making the absorbent body 21 from a thin layer 31 of absorbent material which runs the length of the diaper and the thicker sections of absorbent body 21 from one or more layers 32 of absorbent material secured to the layer 31 and topsheet 21 by sewing or other suitable means. Layers 31 and 32 can be different materials; for example, in a single use diaper, layer 31 can be a material having a relatively small capillary size and low compressibility under the 0.5 to 3 p.s.i. stresses hereinafter described such as 10 pounds per 3,000 square feet basis weight; Kraft tissue creped at 12-18 percent, and the layers 32 can be of relatively large capillary highly absorbent material such as airlaid felt or highly creped cellulose wadding, or mixtures thereof, without regard to its compressibility under the inuse stresses. An airlaid felt can comprise air-deposited pulp fibers, such as softwood papermaking fibers, or other suitable fibers capable of being formed into an absorptive structure, and the fibers can be lightly bonded, if desired, by a suitable adhesive such as starch, melamine formaldehyde or other bonding material. A hydrophobic topsheet 21, waterproof back sheet 22 and securing members 31 and 32 can be employed as described in...
connection with the embodiment of FIGS. 1-7 apply equally here. A specific example of the FIG. 8 structure is a diaper wherein the substrate 33 is made of creped cellulose wadding and topsheet 34 is made of a single ply of non-woven rayon, both of which are described above in connection with FIG. 5, and a single ply of wadding lies between topsheet 34 and insert 35.

The topsheet 34 can be secured to the hydrophilic substrate 33 in a manner similar to that in which topsheet 21 is secured to substrate 20 in FIG. 5. Similarly, back sheet 36 can be secured to the underturned portions of topsheet 34 to provide an envelope around substrate 33 as also described above in connection with FIG. 5.

The invention described above can be embodied in any of the rectangular pad forms described above and also applied in the usual manner for rectangular diapers. The present invention, however, is also particularly useful when embodied in a box pleat configuration as shown by FIGS. 9-11. As described in U.S. Pat. Re. 26,151, R.C. Duncan et al., issued Jan. 31, 1967, the box pleat structure shown by FIGS. 9-11 provides a diaper which will effectively prevent leakage of an infant's waste fluids from the diaper and thereby substantially eliminate the problem of soiling of clothing. In view of the improved retention of fluid over such a structure, it becomes advantageous to promote efficient use of the absorptive material in the diaper and to promote dryness of the surface adjacent the base of the infant's trunk. The present invention when embodied in the box pleat diaper structure will provide this improvement to that structure. It also provides a structure which is more comfortable and better fitting when the central section is reduced in thickness to some extent.

Details of the box pleat structure are fully described in U.S. Pat. Re. 26,151, R.C. Duncan et al., issued Jan. 31, 1967, the disclosure of which is hereby incorporated by reference. However, FIGS. 9-11 and the accompanying explanation are herein included to illustrate the embodiment of the present invention in such a structure.

FIGS. 9 and 10 illustrate the FIG. 8 pad embodiment pre-folded into the box pleat structure. As shown in FIG. 9, the pad 33a and back sheet 36 structure is folded at 38 to provide a pair of oppositely disposed inside panels B and E overlying central panel C (the panels B and E not overlapping but, rather, juxtaposed or slightly spaced at their inner ends 39) and is folded at 39 to provide a pair of outwardly facing terminal panels A and D overlying inside panels B and E respectively, whereby each of panels A and D has an outer side edge 40. The respective panels are not secured to each other at the ends of the pad so that the pad will be freely laterally spreadable; however, panels B and E can, if desired, be spot glued to panel C at the pad's longitudinal center to facilitate application of the diaper to an infant. The spots of adhesive so applied, as is explained in the Duncan et al. patent, maintain the pad in a prefolded configuration at its center while allowing the ends to be spread around the infant's waist.

FIG. 11 shows the interior of the prefolded diaper of FIGS. 9 and 10 with the ends spread outwardly in preparation for the application of the diaper to an infant. In use, the ends of the diaper are spread, as shown, to go around the waist of the infant, the central portion of the diaper remaining folded where the diaper passes between the infant's legs, and the overlap of the end portions of panels A and D, when the diaper is fastened, defining the leg openings. After the diaper is applied to the infant, its pleated construction and the child's natural movements cause the side edges of the pleat in the diaper center area to become bent downwardly. When this happens the flaps 36a, which comprise portions of the back sheet 36 which are folded over panels A and D, assume a position contiguous to the infant's legs along an area of the inner, rear and front portions of the thighs adjacent the junction thereof with the child's torso. In this position, the flaps are very effective in preventing of minimizing leakage from the diaper. When the diaper is constructed in accordance with the present invention.
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Each pair of samples was then touched and felt in the center by each of twelve panelists and their impressions of surface dryness were recorded according to a 0 to 4 grading scale wherein 0 means a particular pair of samples exhibit equivalent surface dryness. 1 means that one of a pair of samples is to a low degree of confidence somewhat drier than its opposite, 2 means that one of a pair of samples is to a high degree of confidence somewhat drier than its opposite, 3 means that one of a pair of samples is considerably drier than its opposite, and 4 means that one of a pair of samples is much drier than its opposite.

The scores as outlined above were then statistically manipulated to minimize effects due to differences in human sensitivity and the tendencies of panelists to be biased according to the order in which the samples were touched or for other reasons. The result of the statistical manipulation was a group of overall scores for the four structures wherein the structure designated N was taken as the standard and given a score of zero, i.e., each of structures R, S, and T was scored relative to structure N. The scores thus derived were negative numbers indicating that structures R, S, and T exhibited wetter surfaces than that of structure N according to the scoring system explained above. The net scores are tabulated below.

Sample designation:  

<table>
<thead>
<tr>
<th>Dry wadding weight, grams</th>
<th>H₂O added, grams</th>
<th>H₂O removed, grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>24.06</td>
<td>49.31</td>
</tr>
<tr>
<td>2</td>
<td>23.52</td>
<td>49.26</td>
</tr>
<tr>
<td>3</td>
<td>23.46</td>
<td>49.26</td>
</tr>
</tbody>
</table>

From the results tabulated, it is apparent that a substantial part of the moisture added was wicked to the extremities of the diapers having thin center sections as compared to that having a heavier center section.

EXEMPLARY II

Each of twelve sample topsheet substrate combinations was prepared, the twelve samples comprising three identical samples of each of four different structures (designated N, R, S, and T). The samples were paired in the pattern N-R, N-S, N-T, R-S, R-T, S-T and were wet by adding water to the center of each sample and allowing the sample at least 5 minutes in which to absorb the water. Except when being tested, samples were kept under polyethylene to minimize evaporation. Each sample of a given structure was wet identically with other samples having the same structure. The structures of the samples, weight of wadding in each structure, and the amount of water added to each structure as a multiple of the wadding weight are tabulated below.

Sample designation:  

<table>
<thead>
<tr>
<th>Dry wadding weight, grams</th>
<th>H₂O added, grams</th>
<th>H₂O removed, grams</th>
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<tbody>
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<tr>
<td>1</td>
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<td>2</td>
<td>23.52</td>
<td>49.26</td>
</tr>
<tr>
<td>3</td>
<td>23.46</td>
<td>49.26</td>
</tr>
</tbody>
</table>

With what is claimed:

1. A diaper comprising an absorbent body having a length and width adapted to be applied to the lower portion of the torso of a child, said body having end sections adapted to embrace the waist and cover adjacent abdominal and back areas of the child and a central section adapted to lie between the child's legs substantially throughout their normal range of movement, said absorbent body being continuous from end to end and having throughout the interior of its central section a

The wadding was a creped cellulose wadding as hereinafter described.

The topsheets used were of cation and an anionic binder. The designations are designations of C. H. Dexter and Sons Company to indicate two different topsheet compositions. X-1496-2 is approximately .9 mill thicker than X-1496-2 and is somewhat more hydrophobic.

As multiple of wadding weight.
substantially uniform unstressed absorptive capacity per unit face area which is lower than the average unstressed absorptive capacity per unit face area in other portions of said absorbent body, said interior of said central section comprising at least 70 percent of the width of said absorbent body.

2. The diaper recited in claim 1 wherein said central section comprises that portion of the diaper which lies between about 45° rearward to about 120° forward of the vertical center line of the leg openings of the diaper affixed to an infant.

3. The diaper of claim 1 wherein said absorbent body comprises a compressible material and the interior of said central section is permanently compressed to result in a free space content which is about 85 percent to 95 percent of its total volume.

4. The diaper of claim 3 wherein said compressible material is selected from the group consisting of highly creped cellulose wadding, airlaid felt of pulp fibers and mixtures thereof.

5. The diaper of claim 1 wherein said absorbent body of material includes a thin sheet of water-impermeable material extending the length of the said central section and the major portion of the width of the said absorbent pad, said sheet being located between the top surface and the bottom surface of said absorbent pad.

6. The diaper of claim 1 wherein one face of the absorbent body is covered by a porous hydrophobic topsheet.

7. The diaper of claim 1 wherein said absorbent body comprises a plurality of layers of absorbent material, the interior of said central section comprising at least one layer of said material and the other said portions of the absorbent body contiguous to said central section comprising a plurality of layers of absorbent material which is cumulatively thicker than the material in the interior of said central section.

8. The diaper of claim 7 wherein the said one layer of absorbent material extends the length and substantially the breadth of said absorbent pad and has a small capillary size and low compressibility relative to that of the material comprising the said other portions of the absorbent body contiguous to the central section thereof.

9. The diaper of claim 8 wherein the said one layer of absorbent material is low creped tissue having a basis weight of about 10 pounds per 3,000 square feet creped at 12 to 18 percent and the other layers of said absorbent material are selected from the group consisting of highly creped cellulose wadding, having a basis weight of between about 9 to 28 pounds per 3,000 square feet, an airlaid felt comprising air-deposited pulp fibers and mixtures thereof.

10. A diaper having a length and width adapted to be applied to the lower portion of the torso of a child, said diaper having end sections adapted to embrace the waist and cover adjacent abdominal and back areas of the child and a central portion adapted to lie between the child's legs substantially throughout their normal range of movement, said diaper comprising an absorbent body of hydrophilic material and a porous topsheet covering one face of said absorbent body; said absorbent body being continuous from end to end and having throughout the interior of its central section a substantially uniform absorptive capacity per unit face area which is lower than the average absorptive capacity per unit face area in other portions of said absorbent body, said interior of said central section comprising the major portion of the width of said absorbent body, said topsheet being hydrophobic and having a free space available for fluid retention per unit free area under a compressive stress of about 3 pounds per square inch which exceeds the change in absorptive capacity occurring per unit face area in the interior of the central section of said absorbent body when the compressive stress thereon changes from about 0.1 pound per square inch to about 3 pounds per square inch.

11. The diaper of claim 10 wherein said absorbent body comprises a compressible material and the interior of said central section is permanently compressed to a free space content which is about 85 percent to 95 percent of said material and the other portions of the absorbent body comprising a plurality of layers of absorbent material which is cumulatively thicker than the material in said central section.

12. The diaper of claim 10 wherein said absorbent body comprises a plurality of layers of absorbent material, the interior of said central section comprising at least one layer of said material and the other portions of the absorbent body comprising a plurality of layers of absorbent material which is cumulatively thicker than the material in said central section.

13. The diaper of claim 10 wherein said absorbent body includes a thin sheet of water-impermeable material extending the length of said central section and the major portion of the width of said absorbent pad, said sheet being located between the top surface and the bottom surface of said absorbent body.

14. A diaper having a length and width adapted to be applied to the lower portion of the torso of a child, said diaper having end sections adapted to embrace the waist and cover adjacent abdominal and back areas of the child and a central section adapted to lie between the child's legs substantially throughout their normal range of movement, said diaper comprising a pad formed into a box pleat configuration by means of a multiplicity of longitudinal folds, said folds being unsecured at the ends of said pad whereby the pad is freely laterally spreadable at said ends, said box pleat configuration including a central panel, a pair of oppositely disposed inside panels connected to the sides of said central panel and folded in nonoverlapping relationship with one another over one face of said central panel with the inner sides of said inside panels juxtaposed, and a pair of outwardly facing terminal panels overlying said inside panels, each of said terminal panels having an outer side edge which comprises a free edge of said pad; said pad being continuous from end to end and comprising an absorbent body, a porous topsheet overlying the absorbent body and secured thereto, said absorbent body having throughout the interior of its central section a substantially uniform unstressed absorptive capacity per unit face area which is lower than the average unstressed absorptive capacity per unit face area in other portions of said absorbent body, said interior comprising the major portion of the width of said body; said diaper including a thin waterproof back sheet on the side of the absorbent body which is opposite said topsheet, which back sheet has a width exceeding that of the said pad so as to provide oppositely disposed side flaps which are folded inwardly to enclose the side edges of said pad and overlie a portion of said terminal panels.

15. The diaper of claim 14 wherein said topsheet is hydrophobic and has free space available for fluid retention per unit face area when subjected to a compressive stress of about 3 pounds per square inch which exceeds the change in absorptive capacity per unit face area in the central section of said absorbent body occurring when the compressive stress thereon changes from about 0.1 to about 3 pounds per square inch.

16. The diaper of claim 14 wherein said absorbent body of material includes a thin sheet of water-impermeable material extending the length of the said central section and the major portion of the width of the said absorbent pad, said sheet being located between the top surface and the bottom surface of said absorbent pad.