ABSORBENT PAD STRUCTURE, DIAPER CONSTRUCTION UTILIZING SAME AND METHODS OF MANUFACTURE THEREOF

Inventors: Bernard Martin Wehrmeyer, Park Hills, Ky.; John Richard Noel, Cincinnati, Ohio

Assignee: The Procter & Gamble Company, Cincinnati, Ohio

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Field of Search .......... 128/290 W, 284, 217, 287, 128/296, 156; 161/123, 114

References Cited
UNITED STATES PATENTS

ABSTRACT

Absorbent pad made of air-laid fiberized or disintegrated pulp lap dry embossed to provide a bilaterally staggered pattern such as a close packed hexagonal pattern of low density tufts surrounded and separated by bilaterally extending non-linear and preferably sinuous regions of higher density to provide high softness impression together with high moisture wicking and transport and high surface dryness impression, methods of manufacture thereof by patterned densification as by compression in a calender stack between a patterned roll and a generally smooth back up roll, and diapers incorporating such pads between a top sheet and a back sheet.

9 Claims, 3 Drawing Figures
FIELD OF THE INVENTION

This invention relates generally to disposable absorbent pad structures.

DESCRIPTION OF THE PRIOR ART

Absorbent pads fabricated of air-laid fiberized pulp lap and disposable diapers utilizing such pads are known in the prior art. Such air-laid structures may be formed on a paper tissue and an example of fiberizing or disintegrating pulp lap and felting thereof for manufacture of such a product is disclosed, for example, in prior U.S. Pat. Nos. 3,519,211 to Sakulich, et ano and 3,750,962 to Morgan, Jr., and co-pending application, Ser. No. 182,795, filed Sept. 22, 1971, by Kenneth B. Buell, now Pat. No. 3,825,194 and assigned to the assignee of this application. The disclosure of the aforesaid patents and application Ser. No. 182,795 are hereby incorporated herein, by reference, as fully and completely as if physically reproduced hereafter and throughout this application the term "fiberized" and "disintegrated" pulp lap and "air-laid" pads and webs are intended to refer to a product such as that formed in accordance with said patents and application.

It has also been previously suggested to fully enclose such an air-laid felt pad or bat within a tissue envelope to aid in supporting the felt during processing, including converting, and to aid in preventing disintegration thereof during use. See, e.g., Kalwaite U.S. Pat. No. 3,444,859; Schutte U.S. Pat. No. 3,741,212; Costanza et al. U.S. Pat. No. 3,769,978.

It has also been recognized that increased wicking and fluid transfer or transport within such a structure may be accomplished by densifying or compressing the structure to provide an increased density thereof as suggested in, e.g., Duncan U.S. Pat. No. 3,592,194; Krusko, U.S. Pat. No. 3,721,442 and DeKnight U.S. Pat. No. 3,769,978. It has even been suggested that a one directionally generally sinusous pattern of compressed narrow strips may produce enhanced distribution of moisture in such a structure longitudinally along such strips. However, such narrow compressed strips have also been recognized as barriers reducing transverse moisture transport and also results in a stiffer and less soft product and have been formed by processing including wetting of the pad, and thereby changing the structure from a fully dry air-laid product. See, e.g., Morin U.S. Pat. No. 2,788,003. Further, it has been suggested that compressing a pad of the general type referred to above so as to decrease the thickness thereof and increase the bulk density, not only creates increased wicking but, in addition, may produce increased flexibility. See, e.g., Gobbo, Sr. et al. U.S. Pat. No. 3,065,751. However, the mere increase in flexibility does not necessarily result in increased softness and what the prior art has apparently not recognized, is that softness and flexibility are not the same and, in fact, that structures exhibiting high flexibility may provide a very low softness impression to a user. Moreover, the prior art has also apparently not recognized that subjective surface dryness impressions are not necessarily consistent with objective tests for surface dryness and, in fact, subjective surface dryness impressions may be diametrically opposite objective surface dryness test results.

OBJECTS OF THE INVENTION

Bearing in mind the foregoing, it is a primary object of the present invention to provide a novel and improved absorbent pad structure.

Another primary object of the present invention, in addition to the foregoing object, is to provide such novel and improved absorbent pad structures having optimized fluid wicking capabilities as well as surface dryness and softness impressions.

Yet another primary object of the present invention, in addition to each of the foregoing objects, is the provision of such a novel and improved absorbent pad structures particularly constituted for use in a disposable diaper construction and disposable diaper structures fabricated thereof.

Still another primary object of the present invention, in addition to each of the foregoing objects, is the provision of novel methods of manufacture of such absorbent pad and diaper structures.

Yet still another primary object of the present invention, in addition to each of the foregoing objects, is the provision of a novel absorbent pad fabricated of air-laid defibered pulp lap, preferably within a tissue envelope, subjected to dry pattern densification, as by patterned compression, to provide a bilaterally extending staged pattern of low density tufts surrounded by bilaterally extending non-linear and preferably sinusously extending regions of increased density particularly suitable for use in diapers and diaper-like structures and exhibiting enhanced fluid wicking characteristics, moisture retention capability, high surface dryness and high subjective surface dryness and softness impressions.

A yet further primary object of the present invention, in addition to the foregoing objects, is the provision of novel methods of subjecting air-laid webs or pads of fiberized pulp lap to patterned densifications by patterned compression from one side thereof to provide a tufted structure having a higher tuft height on said one side than on the other.

A yet still further primary object, in addition to the foregoing objects, is the provision of improved diapers and diaper like structures utilizing the improved absorbent pad structures of the present invention and utilizing such pad structures with the higher tufted side facing the top sheet for disposition facing the child's skin in use to provide maximum lofting of the densified regions away from the child's skin as well as providing the best look and feel to the outside facing surface.

The invention resides in the combination, construction, arrangement and disposition of the various component parts and elements incorporated in improved absorbent pad and diaper structures constructed in accordance with the principles of this invention and the methods of manufacture in accordance with the principles of this invention. The present invention will be better understood and objects and important features other than those specifically enumerated above will become apparent when consideration is given to the following details and description, which when taken in conjunction with the annexed drawing describes, discloses, illustrates, and shows a preferred embodiment or modification of the present invention and what is presently considered and believed to be the best mode
of practicing the principals thereof. Other embodiments and modifications may be suggested to those having the benefit of the teachings herein, and such other embodiments of modifications are intended to be reserved especially as they fall within the scope and spirit of the subjoined claims.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided an improved absorbent pad structure and a diaper structure utilizing the same fabricated of air-laid disintegrated cellulose pulp lap contained within a tissue envelope and dry embossed to provide a staggered pattern of low density tufts separated and surrounded by bilaterally extending sinuous regions of higher density providing an absorbent pad having high fluid capacity, enhanced wicking, enhanced surface dryness and exhibiting enhanced surface dryness and softness impression.

In accordance with the present invention, there is provided absorbent pad structure combining an enhanced softness impression with enhanced wicking and moisture transport capabilities to provide enhanced surface dryness impression comprising, in combination, an air laid-pad of disintegrated cellulose pulp lap contained within a paper tissue envelope providing structural integrity thereto, said pad being pattern densified to define bilaterally staggered spaced apart tufts formed by undensified regions of low density surrounded by and separated by a bilaterally extending pattern of densified intersecting non-linear higher density regions, said densified regions comprising between approximately 20 and 50 percent of the area of said pad.

DESCRIPTION OF THE DRAWING

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as forming the present invention, it is believed that the invention will be better understood from the following description which, taken in conjunction with the annexed drawing, describes, discloses, illustrates and shows a preferred embodiment or modification of the present invention and wherein:

FIG. 1 is a plan view, partially broken away, illustrating a disposable diaper having a pattern densified and tufted absorbent air-laid pad in accordance with the present invention;
FIG. 2 is an enlarged cross sectional illustration taken along line 2—2 of FIG. 1;
FIG. 3 is a cross sectional illustration diagrammatically illustrating a method of manufacture of the improved absorbent pad of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawing, there is shown and illustrated in FIGS. 1 and 2 an improved diaper structure constructed in accordance with the principals of the present invention designated generally by the reference character 10.

The diaper as shown in the drawing can be formed, in general, in accordance with the teachings of U.S. Pat. Re. No. 26,151, issued to R. C. Duncan et al., on Jan. 31, 1967, and the entire disclosure thereof is hereby incorporated herein by reference as fully and completely as if physically reproduced hereat.

The diaper 24 comprises an improved absorbent pad constructed in accordance with the principals of the present invention and designated generally by reference character 12. The pad 12 may be covered by a superposed top sheet 14 which is preferably moisture pervious and which may provide a barrier between the improved absorbent pad 12 and a baby's skin. The absorbent pad 12 may be backed by a back sheet 16 which is preferably moisture impervious and is larger, at least in width, than the absorbent pad 12 to provide side flaps 18 which are folded over and onto the top surface of the top sheet 14 so that the side flaps 18 of the back sheet 16 overlie the lateral marginal area of the top surface of the top sheet 14 and the absorbent pad 12 there beneath. The back sheet 16 may also be larger in length than the absorbent pad 12 and the top sheet 14 to provide end flaps 20 which are folded over and onto the top surface of the top sheet 14 so that the end flaps 20 overlie the longitudinal marginal area of the top surface of the top sheet 14 and underlying absorbent pad 12. Hence, the absorbent pad 12 is fully contained within an envelope defined by the top sheet 14 and the back sheet 16. The side flaps 18 and the end flaps 20 may be secured together at the corners and to the underlying top sheet 14 and to the edge portions of the pad 12 in any convenient manner, as by heat sealing, adhesive bonding, or like.

It is to be emphasized that although the absorbent pad 12 has been described, disclosed, illustrated, and shown as being bound on both the sides and ends by the side flaps 18 and end flaps 20, respectively, so that the absorbent pad 12 is fully contained within the envelope defined by the top sheet 14 and the back sheet 16, two of such flaps, and particularly the end flaps 20 may be eliminated while yet enabling retention of the absorbent pad 12 between the top sheet 14 and the back sheet 16. More particularly, the absorbent pad 12 may be bonded to either or both the top sheet 14 and the back sheet 16, as by, for example and without limitation, heat sealing, adhesive bonding, pressure bonding, or the like.

Further, while the present invention is particularly described, disclosed, illustrated and shown herein as applied to a diaper, it is to be expressly understood that the present invention is not limited to use against a baby for the absorption of urine, and the like, but may be utilized for many other related bandage and bandage like applications, including, by way of example only and without limitation, surgical dressings, incontinence pads, sanitary napkins, and the like.

The side flaps 18, and the end flaps 20 when provided, should have a minimum width of about ¾ inch and preferably about ¼ inch. The back sheet 16 preferably is a flexible waterproof web, e.g., a 0.001 inch thick, low density, pattern embossed, opaque polyethylene web.

The top sheet 14 may be either hydrophobic or hydrophilic and may be fabricated of a tissue paper made by a conventional water-laid process, subsequently creped; an air-laid tissue, a continuous filament non-woven web, a micro-porous film, or the like, and may be treated with wet-strength and/or bonding resins as will be apparent to those skilled in the art.

The improved absorbent pad 12 comprises a mat, pad, web, or bat 22 of air-laid disintegrated pulp lap formed, for example, in accordance with the teachings of Sakulich et al. U.S. Pat. No. 3,519,211; Morgan, Jr.
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U.S. Pat. No. 3,750,962; and co-pending Buell Application Ser. No. 182,795 filed Sept. 22, 1971 and assigned to the assignee of the instant application. The mat or bat 22 may be contained between a pair of tissue layers 24 and 26 superposed and subjacent thereto respectively.

The disclosures of the aforesaid patents are hereby expressly incorporated herein by reference as fully and completely as if fully set forth hereat.

In addition to sheer absorptive capacity, two desirable attributes of a disposable diaper and of an absorbent pad for use therein are surface dryness and softness. Air-felt density is one of the major factors controlling these attributes. The favorable density ranges are, however, different for the two attributes. Typically, low density favors a good softness impression while presenting a poor skin dryness impression. Alternatively, high density favors a good skin dryness impression while providing a poor softness impression.

In other words, typical low density favors a good softness/flexibility impression while high density favors a good wicking/skin dryness impression.

In accordance with the present invention, a pattern dry densification of the pad 12 (including both the fiber mat or bat 22 and the envelope tissues 24 and 26) is performed to provide a bilateral staggered pattern of tufts 28 of substantially undensified, i.e., low density regions separated and surrounded by a generally non-linear bilaterally extending pattern of densified regions 30 of higher density so that the resultant absorbent pad structure exhibits both good skin dryness and good softness impression.

The high density regions 30 which, as heretofore pointed out, are bilaterally extensive provide good wicking and fluid transport throughout the pad 12. Good wicking allows the moisture to be spread more evenly throughout the absorbent material and aids in attaining good skin dryness.

The low density regions or tufts 28 provide a good softness impression as well as providing regions having high liquid absorptive capacity spaced throughout the pad, providing a good skin dryness impression and, being of substantial height and resilience, tend to raise or loft the high density, wetter feeling regions from the baby's skin.

Previously suggested schemes for compressing of air felts or pads to provide sufficient high density area to offer good wicking and skin dryness are stiff and boardy, while uncompressed pads which offer flexibility and softness do not provide sufficiently high density to provide significant wicking and skin dryness. As has been pointed out hereinabove, it has been previously suggested to provide some localized compression of small portions of absorbent pads. However, such localized compression has been performed, usually together with the application of water or other liquid, either immediately prior to or during such compression, and such localized compression has been applied to only a small percentage of the pad and primarily for bonding of the pad fibers or layers together. Moreover, such compressions, done wet or with the addition of moisture, even if done at staggered location, adversely affects the softness of the pad. Furthermore, if such compression is effected along linear strips, as has been previously suggested for increasing wicking and fluid transport in the direction of the compressed strips, the adverse effect of such compressed strips on the overall softness of the pad is especially consequential, and although wicking and liquid transport parallel such compressed strips may be improved thereby, such stripes actually inhibit fluid transport in the transverse direction and act as barriers to wicking and fluid transport perpendicular thereto. The densification pattern of the present invention, however, provides sufficient high density area for good wicking and skin dryness while remaining soft and flexible. In accordance with the present invention, the high density areas are basically non-linear and, in fact, preferably extend sinuously bilaterally of the pad 12 so as to maintain flexibility which appears to be a major factor in overall softness impression.

Densification patterns providing densification of approximately twenty to fifty percent of the total area appear to be preferable, although somewhat lower and higher percentages may provide acceptable, although not optimum results. Below ten percent area densification, however, insufficient wicking occurs and above approximately seventy percent densification, the densification pattern becomes inconsistent, and difficult to maintain and unsatisfactory softness impressions result.

In accordance with the present invention, and with reference now more particularly to FIG. 3, the patterned densification of the air-felt or absorbent pad 12 may be obtained by densifying the air-felt pad with, for example, a two roll calender stack 32 in which the pad or air-felt 12 is compressed between a patterned roll 34 which has been debossed with pockets 36 defining the design pattern and a smooth backup roll 38 cooperating therewith. The density in the high density region 30 may be controlled by the pressure and separation between the patterned roll 34 and the smooth backup roll 38. The density in the low density regions or tufts 28 may be controlled by either passing the air-felt or pad 12 through a calender stack designated generally by the reference character 40, comprising smooth surfaced pressure and backup rolls 42 and 44, respectively prior to passage between the rolls 34 and 38 or by controlling the depth of the debossed regions or pockets 36 in the pattern roll 34 corresponding to the low density regions or tufts 28.

Preferably, the pattern of tufts is staggered so that no straight lines can be extended across the densified region 30 which extends for any substantial distance in any direction. In other words, preferably the tufts or low density region 28 are of sufficient diameter and spacing that, in any direction, their edges extend past one another. Further, the tufts should be of sufficient size to maintain their integrity, i.e., approximately % inch to % inch diameter with the preferable size being approximately 9/16 inch in diameter.

In practice, however, it has been found acceptable to define the densification pattern to position the low density, undensified regions or tufts 28 in a close packed regular hexagonal arrangement as shown in FIG. 1 even if, as shown, extremely narrow linear regions may exist, i.e., as designated by the center lines a, b, and c in FIG. 1 and as shown in emphasized form and designated 46 in FIG. 2 without substantially adversely affecting the softness impression, provided that such linear regions are very narrow so as to constitute only a small percentage of the total area of the pad 12 and the generally sinuously bilaterally extending pattern of densification.

It is also to be emphasized that, as used herein, the term "bilateral" or "bilaterally" is used and intended
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to mean extending in or having vectors extending in at least two directions, and not limited to only two directions. Hence, within the meaning hereof, the generally
hexagonal pattern of FIG. 1 having lines of direction A, B, and C is a bilaterally extending one, having lines of definition extending both generally towards the ends (i.e., line A, as well as B and C) of the diaper 10 and generally towards the sides (i.e., lines B and C) thereof.

The term “tuft” as used herein is intended to cover and define a region of low density having substantial area projecting from the surrounding high density region a significant amount and possessing substantial resilience and height. Hence, tufts of the present invention may have diameters on the order of ¾ to ¾ inch or more, having a thickness 2–3 times the thickness of the densified region.

EXAMPLE 1

To substantiate the surface dryness qualities of the present invention, a test was run, the object of which was to compare the subjective surface dryness of diapers incorporating the same average basis weight and the same average density air-felt pads, differing only in that one sample was of generally uniform density while the other had been subjected to pattern densification in accordance with the present invention. Sample L was a disposable diaper incorporating an air-felt pad having a generally uniform density of approximately 0.14 grams per cubic centimeter and a generally uniform thickness of approximately 0.085 inches. Sample N was a similar disposable diaper using a similar air-felt pad having an average density of approximately 0.14 grams per cubic centimeter but which had been subjected to pattern densification over approximately 50 percent of the area to provide generally circular tufts arranged in a close packed hexagonal staggered pattern of the type shown in FIG. 1 covering approximately 50 percent of the area and having a diameter of approximately 9/16 inches and an overall tuft height of approximately 0.150 inches. The densified regions extended bilaterally sinuously around and between the undensified tufts and had been densified to a thickness of approximately 0.50–0.60 inches. The densified regions accordingly had a density of approximately 0.20 grams per cubic centimeter. The samples were laid flat and each was wet with 114 cubic centimeters of a one percent saline solution adjusted to have a surface tension of 45 dynes. The test solution was applied generally to the center of each sample and allowing the sample approximately 30 minutes in which to absorb the water. Except when being tested, the samples were kept under polyethylene to minimize evaporation.

Each pair of samples was then touched and felt in a blind box by two members of a panel of ten panelists and their impressions of surface dryness were recorded according to a 0–4 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 dryer than its opposite, 2 means that one pair of samples is to a high degree of confidence somewhat dryer 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. Each pair of samples was only submitted to two panelists to substantially eliminate any effect of continued handling of the apparent surface dryness.

The scores as outlined above were then statistically manipulated to minimize effects due to differences in human sensitivity and any tendency 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 (the structure subjected to pattern densification in accordance with the present invention) was taken as the standard and given a score of 0, i.e., the structure L (the uniform density pad) was scored relative to structure N. The score was expressed in the form of a yardstick which corresponds to the smallest significant difference in grade. A net score difference of 1.0 yardsticks represents a difference which is statistically significant and a 95 percent level of confidence. A difference less than 1.0 yardsticks indicates that no significant exists between samples up to 95 percent confidence level. The sample L achieved a net score of −2.5 yardsticks indicating that the sample N which had been subjected to the pattern densification of the present invention did, to a high degree of confidence exhibit a skin dryness impression substantially higher than that of the uniform density product sample L. A difference of 2.5 yardsticks indicates a clearly significant difference at the 95 percent level of confidence.

EXAMPLE 2

Unwet samples of the diaper structures referred to in Example 1 were submitted to a similar panel of ten panelists and their impressions of softness were recorded according to the same 0–4 grading scale. The resultant scores were then statistically manipulated as described in accordance with Example 1 and the net score yielded a result of −2.5 yardsticks for the sample L (uniform density air-felt) relative the sample N (subjected to pattern densification) on the basis of softness impression indicating that the diaper structure incorporating the pattern densified air-felt of the present invention exhibited a clearly significant difference at the 95 percent level of confidence that the pattern densified structure exhibited a substantially improved softness impression over the similar weight basis structure of generally uniform density.

EXAMPLE 3

To substantiate that a substantial percentage of the area of the air-felt pad must be subjected to densification to provide significant wicking, a series of sample diapers were prepared having tufted air-felt pads subjected to varying percentages of densification and tests were run, the object of which was to determine the amount of moisture retained at the point of liquid loading and at various distances therefrom. Sample 1 was a diaper having an air-felt pad that had not been subjected to any pattern densification, i.e., 0 percent densified. Sample 2 was a diaper prepared having an air-felt pad subjected to pattern densification extending over 30 percent of the area. Sample 3 was a diaper prepared having an air-felt pad subjected to pattern densification over 50 percent of the area. Sample 4 was a diaper having an air-felt pad subjected to pattern densification over 70 percent of the area and sample 5 was a diaper having an air-felt pad which had been compressed or densified over the entire 100 percent. For each of samples 2, 3, and 4, the densification pattern was as generally indicated in FIG. 1 of the drawing, in
each case utilizing 9/16 inch diameter undensified circular tufts and the densification was done in a dry state. Each of the pads then had added to it at its center a quantity of water providing for 3X loading thereof. By 3X loading is meant a quantity of test liquid equal to three times the weight of the absorbent pad structure. This measured quantity of liquid was then poured onto the center of each diaper and approximately 30 minutes was allowed for absorption and wicking thereof. At the end of the 30 minute period, the diapers were sectioned into a center strip 3 inches wide, i.e., by cutting 1 ½ inches to each side of the centerline and the remainder of the diaper was then sectioned into 2 inch wide strips. The liquid loading, i.e., weight of water per weight of cellulose for each strip was then determined. To compensate for crosswise variations of the diaper, the values obtained on either side of the centerline at the same distance were averaged. Results are tabulated below:

<table>
<thead>
<tr>
<th>Liquid Loading (grams of liquid/grams of cellulose)</th>
<th>At Varying Distances from Centerline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample No.</td>
<td>Centerline at 2.5&quot;</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>1</td>
<td>6.8</td>
</tr>
<tr>
<td>2</td>
<td>4.75</td>
</tr>
<tr>
<td>3</td>
<td>4.7</td>
</tr>
<tr>
<td>4</td>
<td>4.7</td>
</tr>
<tr>
<td>5</td>
<td>5.15</td>
</tr>
</tbody>
</table>

Accordingly, it was determined that any densification of 30 percent or higher of the area resulted in substantially increased wicking outwardly from the center and the wicking capabilities were not significantly affected by the percentage of densification over 30 percent.

EXAMPLE 4

To further define the lower limit of percentage area densified which would produce significant wicking, an additional series of tests was run, utilizing the same procedure set forth in Example 3 above, utilizing a pattern densification which, however, was not bilateral but, rather, comprised densification of the diaper pad along 5/16 inch wide densified transversely extending areas with the spacing between the densified regions being varied to provide differing percentage area densification.

Sample 1 was, again, completely undensified, i.e., 0 percent. Sample 2 was densified over 10 percent of the area, sample 4 was densified over 30 percent of the area, sample 5 was densified over 50 percent of the area and sample 6 was completely densified, i.e., 100 percent densified. Results are tabulated below:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Softness Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>0.7</td>
</tr>
<tr>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td>4</td>
<td>-0.03</td>
</tr>
<tr>
<td>5</td>
<td>-0.31</td>
</tr>
<tr>
<td>6</td>
<td>-0.31</td>
</tr>
<tr>
<td>7</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

From the results tabulated, it is apparent that the pattern densification of the general pattern shown and illustrated in FIG. 1 is substantially softer than straight line pattern densification of the same area and, in addition, that pattern densification in excess of approximately 50 percent results in only a very small change in softness impression. Further, pattern densification of less than approximately 30 percent in the pattern shown illustrated in FIG. 1 has very small adverse affect on overall softness and that over 50 percent there was already a significant decrease in overall softness approaching that of complete densification.

EXAMPLE 5

To substantiate that the softness impression was a function of the percentage area densified and to determine the effective limits thereof, sample diapers were prepared having differing percentages of area densified surrounding undensified and generally circular regions or tufts of 9/16 inch diameter in the pattern shown and illustrated generally in FIG. 1 and submitted to expert panels for testing. Additionally, samples were prepared having straight line pattern densification as described above in Example 4 and also submitted for softness comparison to the expert panel. Sample 1 was completely undensified. Sample 2 was densified in accordance with the pattern of FIG. 1 with 30 percent densification. Sample 3 was pattern densified in the pattern of FIG. 1 over 50 percent of the area. Sample 4 was fully densified, i.e., over 100 percent of the area. Sample 5 was pattern densified in the straight line pattern described above over 10 percent of the area. Sample 6 was pattern densified in the straight line pattern described above over 20 percent of the area. Sample 7 was pattern densified in the straight line pattern defined above over 50 percent of the area.

The samples were paired and presented in pairs to the panelists in blind boxes and the panelists assigned a softness score of 0–4 to each pair using the criteria described in Example 1 above. Each sample was assigned a separate score based upon the impression of the panelist. For example, if in comparing two samples a panelist decided that one sample was, to a high degree of confidence somewhat softer than the other sample, the sample found softer would receive a score of +2 and the other sample a score of −2. All scores received by a sample were then added and divided by a factor equal to the product of the number of panelists times the number of samples to provide a comparative softness grade. Results are tabulated below, the higher softness grade indicated increased softness impression.
of a diaper structure utilizing the pattern densified pads of the present invention, objective basis. A series of test pads were prepared of 4 inch by 4 inch size comprising a pattern densified air-felt pad are disposed between a top sheet and back sheet as in a diaper structure. Sample 1 was a pad wherein the air-felt was undensified, i.e., 0 percent densified. Sample 2 was a pad having 5/16 inch wide linear densification over 20 percent of the area. Sample 3 was a pad having 5/16 inch wide linear densification over 20 percent of the area. Sample 4 was a pad having 5/16 inch wide linear densification over 30 percent of the area. Sample 5 was a tufted pad having 9/16 inch diameter undensified tufts and densified over 30 percent of the area. Sample 6 was a pad having 5/16 inch wide linear densification over 50 percent of the area. Sample 7 was a tufted pad having 9/16 inch diameter undensified regions and densified over 50 percent of the area. Sample 8 was a tufted pad having 1 1/16 inch diameter undensified tufts and densified over 50 percent of the area. Sample 9 was densified over 100 percent of the area.

Each of the samples was placed on a flat surface and a two inch diameter flat bottomed cup having a plurality of spaced apart apertures in the bottom was disposed on top of each sample. A measured quantity of test liquid equal to three times the weight of the pad was then added to the cup and allowed to disperse into the pad through the apertured bottom. After a wait of three minutes, two plies of previously weighted filter paper were placed on each sample and loaded with a two inch diameter weight applying a loading of 0.5 pounds per square inch to the filter paper. After a wait of two minutes, the filter paper was weighed and the additional weight thereof due to absorbed liquid was noted. The increase in weights are tabulated below.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Increase in Weight in Grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.96</td>
</tr>
<tr>
<td>2</td>
<td>1.88</td>
</tr>
<tr>
<td>3</td>
<td>1.82</td>
</tr>
<tr>
<td>4</td>
<td>1.80</td>
</tr>
<tr>
<td>5</td>
<td>1.40</td>
</tr>
<tr>
<td>6</td>
<td>1.14</td>
</tr>
<tr>
<td>7</td>
<td>1.03</td>
</tr>
<tr>
<td>8</td>
<td>1.23</td>
</tr>
<tr>
<td>9</td>
<td>0.66</td>
</tr>
</tbody>
</table>

The results tabulated, it is apparent that increased densified area does result in improved surface dryness; that a tufted pattern is a notable improvement over a straight densified pattern and that over 50 percent densification provides only very small increases in surface dryness. The test further indicated that a 9/16 inch diameter tuft was substantially more effective in reducing surface dryness than a 1 1/16 inch diameter tuft.

Accordingly, the examples above indicated that surface dryness characteristics established are 20 percent area pattern densification as the lower limit for effective wicking and that 20 percent was effective to produce a satisfactory surface dryness impression. The tests also indicated that higher than 50 percent of area densification was not effective in a further increasing surface. Further, the softness test indicated that 50 percent pattern densification was the approximate upper limit to acceptable softness impression and that 50 percent and above marked deterioration in softness and loss of stability occurred. Further, the tests indicated that although an overall area densification range of approximately 20 to 50 percent was acceptable, that preferably a pattern densification within the range of 30 to 40 percent was preferable.

While the invention has been described, disclosed, illustrated and shown in terms of an embodiment or modification which has assumed in practice, the scope of the invention should not be deemed to be limited by the precise embodiment or modifications herein described, disclosed, illustrated or shown, such other embodiments or modifications as may be suggested to those having the benefit of the teachings herein be intended to be reserved especially as their fall within the scope and spirit of the claims here appended.

What is claimed is:

1. Absorbent pad structure combining high wicking and moisture transport capability with high liquid absorbative capacity to provide high surface dryness impression and high softness impression comprising, in combination:

an air laid pad of generally uniform weight basis consisting essentially of disintegrated cellulose pulp lap contained within a paper tissue envelope defining therewith means for providing structural integrity thereto, together with means for providing regions having high liquid absorbative capacity spaced apart throughout the pad, and means for providing enhanced capillary wicking and thereby providing high liquid transport of absorbed moisture within the pad to portions of the pad remote from the point of moisture application, wherein said means for providing regions of high liquid absorbative capacity comprises a bi-laterally staggered array of spaced apart generally circular tufts formed by undensified regions of relatively low density, and said means for providing enhanced capillary wicking comprises a bi-laterally extending pattern of intersecting non-linear higher density regions densified essentially only by the application of selective pressures thereto surrounding, separating and extending between each of said low density tufts, said non-linear densified high density regions comprising between approximately twenty and fifty percent of the area of said pad to thereby enable said staggered array of spaced apart generally undensified generally circular tufts and said bi-laterally extending pattern of intersecting non-linear higher density regions together to define means for providing both high dryness impression and high softness impression without substantial stiffening of the pad.

2. Diaper structure comprising an absorbent pad structure as defined in claim 1 disposed between a urine permeable top sheet and a back sheet.

3. Absorbent pad structures defined in claim 1 wherein said higher density densified regions comprise between approximately thirty and forty percent of the area of said pad.

4. Absorbent pad structure defined in claim 1 wherein said pattern densification comprises the region formed by compression effected substantially from an absorbent face of said pad structure so that a residual density gradient exists normally through said pad and said tufts extend with substantial
height and resilience above said higher density regions to loft said higher density regions away from surfaces in contact with said absorbent face and the pad resilience additionally extends said tufts a lesser distance from the densified region on the reverse side of the pad.

5. Diaper structure comprising an absorbent pad structure defined in claim 4 disposed between a urine permeable top sheet and a back sheet.

6. Absorbent pad structure defined in claim 4 wherein said nonlinear high density regions extend generally sinuously bilaterally across said pad, and wherein said low density generally circular tufts are arranged generally in a close packed hexagonal array and are of generally uniform diameters of between approximately three-eighths and three-quarters of an inch.

7. Diaper structure comprising an absorbent pad structure defined in claim 6, disposed between a urine permeable top sheet and a back sheet.

8. Absorbent pad structures defined in claim 6 having an average density of approximately 0.14 grams per cubic centimeter and wherein said circular regions are approximately 9/16 inch diameter.

9. Diaper structure comprising an absorbent pad structure as defined in claim 8 disposed between a urine permeable top sheet and a back sheet.

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