



SUPERINTENDENCIA DE INDUSTRIA Y COM
Sr. Superintendente de Industria y Comercio
E. S. D.

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO



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Asunto	NÚMERO DE RADICACIÓN	10_067251
Trámite	SOLICITUD PATENTE DE INVENCION	
Actuación	RECURSO DE REPOSICIÓN	
Título	"NÚCLEO ABSORBENTE QUE CONTIENE PARTÍCULAS DE SAP Y MÉTODO PARA MANUFACTURAR EL MISMO".	
Solicitante	SCA HYGIENE PRODUCTS AB.	
Opositor	CMPC TISSUE S.A.	

MAURICIO PINZÓN PINZÓN, identificado como aparece al pie de mi firma, domiciliado en la ciudad de Bogotá D.C., abogado de la firma Pinzón Pinzón & Asociados, actuando en calidad de apoderado de la sociedad CMPC Tissue S.A., por medio del presente documento, me permito interponer recurso de reposición en contra de la Resolución N° 29819 del 22 de Mayo de 2013, mediante la cual se decidió declarar infundada la oposición presentada por mi poderdante y otorgar patente de invención a la solicitud de la referencia.

1. PETICIÓN.

Respetuosamente solicito que **se revoque** la Resolución N° 29819, proferida por el Señor Superintendente de Industria y Comercio el día 22 de Mayo de 2013, la cual **concedió** la patente de invención titulada "*Núcleo absorbente que contiene partículas de SAP y método para manufacturar el mismo*", sin el lleno de los requisitos exigidos en la norma, particularmente frente a la existencia de pruebas

Calle 99 No 12-39 Piso 4 Tel. PBX: (57-1) 621-9721 Fax: (57-1) 621-9671
pinzonpinzon@pinzonpinzon.com www.pinzonpinzon.com
Bogotá D.C. Colombia Sur América
NIT. 830.005.919-7

del estado del arte que desvirtúan la patentabilidad del nuevo capítulo reivindicatorio.

2. FUNDAMENTOS DE HECHO

- 2.1. El 3 de junio de 2010, la solicitante radicó la solicitud de patente de invención titulada "*Núcleo absorbente que contiene partículas de SAP y método para manufacturar el mismo*" a la cual se le asignó el expediente N° 10 - 067251. Esta solicitud corresponde a la publicación internacional PCT número WO2009/072947 del 11 de junio de 2009, cuyo número de solicitud internacional corresponde a PCT/SE2007/050952.
- 2.2. Una vez publicada dicha solicitud en la gaceta de propiedad industrial N° 628 del 20 de mayo de 2011, mi representada presentó formal oposición a la presente el día 16 de agosto de 2011, advirtiendo que los documentos ES2134805, MXPA03005454 y WO-2004084784 revelan con anterioridad la materia reivindicada, argumentado y definiendo las igualdades contenidas.
- 2.3. Seguido, la Dirección de Nuevas Creaciones procedió a realizar el examen de fondo con base en el artículo 45 de la Decisión 486 de la CAN, sobre el cual emitió el Oficio N° 15020 de fecha 22 de septiembre de 2011; y, el Oficio N° 230 de fecha 16 de enero de 2013.
- 2.4. En materia de las anterioridades expuestas en los Oficios indicados, se advierte que la invención carece de nivel inventivo respecto a los documentos del estado de la técnica referenciados como:
 - **D1** – ES2134805;
 - **D2** – US6494871;

- D3 – US20020156441;

- 2.5. En respuesta a la mención de carencia de altura inventiva, la solicitante presentó un nuevo capítulo reivindicatorio.
- 2.6. Finalmente, el Señor Superintendente de Industria y Comercio, expidió la Resolución N° 29819 el día 22 de Mayo de 2013 por la cual concede la patente de invención titulada “*Núcleo absorbente que contiene partículas de SAP y método para manufacturar el mismo*”.

3. CONSIDERACIONES

- 3.1. El examinador, en el escrito del Resolución, se refiere a los documentos D1, D3 y D3, que el solicitante respecto al nivel inventivo, **indicando** que ninguno de los tres documentos referidos podrían ser utilizados para lograr el efecto técnico, el cual sería proporcionar un núcleo absorbente de tal manera que se disminuya la obstrucción durante la fabricación de dichos núcleos, y agrega que en el caso de realizar su combinación, no sugieren o dan indicio alguno de una estructura compuesta por tres subcapas.

Finalmente, se refiere a nuestra oposición concluyendo que con el nuevo capítulo reivindicatorio, el cual consta de 11 reivindicaciones, está dirigido específicamente al núcleo absorbente que consta de tres capas, en donde las partículas SAP tienen un tamaño menor a 300 um, lo cual reduce la obstrucción por parte de las partículas SAP durante el proceso de manufactura de dichos núcleos absorbentes.

- 3.2. Cabe resaltar, que dicha oposición presentada por mi representada, se basó en el capítulo reivindicatorio inicial y si bien es cierto que la solicitante



lo modificó, también es cierto que dicho despacho debió de oficio revisar y complementar dicha oposición con la búsqueda determinada en los oficios respecto a la nueva materia que el solicitante reivindica, suministrando nuevos argumentos que puedan ser relevantes para considerar su patentabilidad.

Simplemente, dicha resolución considera que los argumentos presentados por la sociedad opositora no están debidamente sustentados y que por lo mismo, no prosperan frente a la solicitud que aquí se analiza, como elementos que permitan desvirtuar su patentabilidad y en consecuencia concede la presente.

3.3. En efecto, la resolución sólo basa su argumentación respecto a la oposición, pero no argumenta las igualdades o diferencias respecto a al documento D2: US6494871 titulado "*Sanitary absorbent napkin*" definidos en el oficio 230 de fecha 16 de enero de 2013. De hecho, no advirtió nuevos documentos con base en los cambios en las nuevas reivindicaciones anexadas en respuesta al oficio 230.

3.4. Así las cosas, la presente solicitud se concedió sin evaluar con base en la norma y de oficio el arte anterior respecto a su patentabilidad:

3.4.1. Al respecto, sólo se dispuso como que afectan la patentabilidad, las anterioridades D1:ES2134805, D2:MXPA03005454 y D3:WO2004084784, y verificando, existen otros documentos que son más relevantes frente al nuevo capítulo reivindicatorio, como lo son los documentos EP1427658 (**Anexo 1** del presente escrito), US5866242 (**Anexo 2** del presente escrito) y WO03047486 (**Anexo 3** del presente escrito) ; y existen otros relevantes que también



combinadas afectan la altura inventiva tales como US2006004336 (**Anexo 4** del presente escrito); y, WO2004049989 (**Anexo 5** del presente escrito).

- 3.4.2. El documento EP1427658 da a conocer un método de fabricación de artículos absorbentes que comprenden la compresión de los cuerpos de pulpa mediante con rodillos, en la que los cuerpos se comprimen a una densidad de más de 200 kg/m³ y sin el riesgo de obstrucción o bloqueo (párrafos [0002] - [0005]). La pulpa depositada puede comprender fibras de partículas de material superabsorbente (párrafos [0019]). Objeto similar a la materia aquí reivindicada.
- 3.4.3. El Documento US5866242 describe un núcleo absorbente (Col 1, Líneas 5-10) que tiene una densidad de 350 kg/m³ a 400 kg/m³ y que tiene una estructura de tres capas con una ventilación de aire de la capa inferior de pasta de papel, capa media o pulpa y SAP y una capa superior de pasta de papel (col.2 líneas 1 y 51 a 58 y la figura 2) en la que la capa se comprime por los rodillos (figura 1). Este documento evidencia la técnica de compresión para formar una estructura de tres capas sobre la cual la presente basa su concepto por lo que en combinación con la anterior, afecta la altura inventiva.
- 3.4.4. El Documento WO03047486 da a conocer los núcleos absorbentes que comprenden una capa superior, una capa inferior y una capa fibrosa central que comprende 50-95% en peso de SAP, en el que las partículas de SAP han tener un diámetro de partícula de 100 micrómetros o menos (Col 13 y 23). Se pulsa el núcleo absorbente entre dos rodillos de presión (ej.1). La densidad del núcleo se encuentra entre 50 kg/m³ a 450 kg/m³ (Exp.14). Desde 450 kg/m³



es más de 200 de 230 kg/m³ que compromete la actividad inventiva de la materia objeto definida en la presente solicitud. Esta anterioridad evidencia la estructura de tres capas y define similares términos de comprensión por lo que en combinación con los documentos anteriores afecta la altura inventiva.

3.4.5. El documento US2006004336 define un artículo que comprende un material compuesto absorbente estirable (30) que incluye una cantidad de partículas superabsorbentes (32) que están operativamente contenidos dentro de una matriz de fibras de polímeros elastoméricos (34). Según ésta anterioridad, el artículo de material compuesto puede incluir al menos aproximadamente 60% en peso de las partículas superabsorbentes y no más de aproximadamente 40% en peso de las fibras de polímeros elastoméricos, basado en un peso total del material compuesto. El artículo de material compuesto puede proporcionar una alta capacidad de estiramiento. Igualmente, se define el proporcionar un valor de capacidad de estiramiento de al menos aproximadamente 30%. Aspectos adicionales pueden incluir una configuración que proporciona un valor de no más de aproximadamente 2%. En otros aspectos, la anterioridad puede proporcionar un valor de no más de aproximadamente 1,2%. En aspectos adicionales, el material compuesto absorbente puede incluir partículas superabsorbentes que tienen un revestimiento de material que es procesable térmicamente.

3.4.6. El documento WO2004049989 define un producto absorbente de múltiples capas (200) que incluye una lámina fibrosa no tejida superior (235), una capa de núcleo absorbente no tejido fibroso

(237), y una fibrosa no tejida sustancialmente lámina posterior impermeable al agua (238). Cada capa o lámina de componente es fabricado en una estación de formación de fibras (201, 202, 203) y laminadas juntas en una estación de combinación (205).

3.4.7. De igual forma es de recordar que la solicitud evidenciada desde la oposición, el documento ES2134805, revela estructuras absorbentes que contienen materiales superabsorbentes o una composición de material en partículas donde la composición del material en partículas comprende tamaño de partículas relativamente estrechos, que forma hidrogeles superabsorbentes formados por métodos de polimerización en solución y mezcla con polvos inorgánicos. Las partículas según ES2134805 de material superabsorbente son de tal magnitud que al menos el 70% de dichas partículas, en peso, pasarán a través de un tamiz de malla estándar de U.S. Standard 50 con aberturas de 297 micrones y queda retenido en un tamiz de malla estándar de U.S. Standard 170 con aberturas de 88 micrones cuando dichas partículas se ensayaron de acuerdo con el ensayo de tamizado que se describe en este documento. El polvo inorgánico, tal como sílice amorfa, se entremezcla con las partículas de material superabsorbente en una cantidad de entre aproximadamente 0,1 a aproximadamente 5 partes por cada 100 partes de las partículas de material superabsorbente. Las estructuras absorbentes de ES2134805 son útiles en artículos absorbentes desechables tales como pañales, incontinencia de adultos, y similares.

- 3.5. Así las cosas, el experto en la materia puede obtener a partir de WO03047486 (**Anexo 3** del presente escrito) en combinación con EP1427658 (**Anexo 1** del presente escrito), US5866242 (**Anexo 2** del presente escrito), ES2134805 (evidenciada desde la oposición), US2006004336 (**Anexo 4** del presente escrito) y WO2004049989 (**Anexo 5** del presente escrito), donde el núcleo absorbente también se comprime con rodillos, con las pequeñas partículas y con una estructura de tres capas que se utiliza para el núcleo absorbente y que no hay problemas con la obstrucción tal y como se menciona, el experto en la materia podría llegar a utilizar el tamaño de partícula y la estructura de la capa de la para lograr el efecto deseado.
- 3.6. En vista de lo anterior, ya que los documentos citados en el presente recurso no fueron evidenciados por ese despacho y a todas luces afectan la **actividad inventiva** de la presente debido a que una persona versada en la materia a partir de la combinación de las mismas puede obtener un núcleo absorbente que también se comprime con rodillos, con las pequeñas partículas y con una estructura de tres capas que se utiliza para el núcleo absorbente de manera que se solucione el problema con la obstrucción tal y como se menciona, se deriva evidentemente y por lo tanto contradice la disposición legal, pues afecta la **altura inventiva**, requisito necesario para obtener protección por patente.

En conclusión, la presente no comprendió un examen de fondo con el lleno de los requisitos, toda vez que no se reportaron los documentos relevantes respecto al ate anterior y por lo tanto no se evaluaron y compararon. Por lo tanto, se espera esta sea negada dentro del derecho que sigue la norma, toda vez que la presente solicitud no puede ser objeto de patente debido a

que lo revelado monopoliza una técnica que se ha definido a lo largo de varios años antes de la radicación de la presente.

- 3.7. Por todo lo anterior, solicito respetuosamente que los anteriores argumentos sean evaluados frente a lo reiterado a lo largo del expediente y en consecuencia se revoque la Resolución N° 29819, proferida por el Señor Superintendente de Industria y Comercio el día 22 de Mayo de 2013, la cual concedió la patente de invención titulada *"Núcleo absorbente que contiene partículas de SAP y método para manufacturar el mismo"*.

4. FUNDAMENTOS DE DERECHO

Son fundamentos del presente recurso la Decisión 486 de la Comunidad Andina, las normas pertinentes del Código Contencioso Administrativo y las demás normas concordantes y complementarias del ordenamiento jurídico.

5. PRUEBAS

Con la presente, nos permitimos remitir copia de las anterioridades relevantes indicadas anteriormente, así:

- Anexo 1: EP1427658;
- Anexo 2: US5866242;
- Anexo 3: WO03047486;
- Anexo 4: US2006004336; y,
- Anexo 5: WO2004049989



6. NOTIFICACIONES

Recibiremos notificaciones en la Secretaría de esa Dirección o en la Calle 99 N° 12 - 39, Piso 4 de la ciudad de Bogotá D.C., teléfono 6219721.

Atentamente,


MAURICIO PINZÓN PINZÓN

C.C. No. 79.145.527 de Usaquén

T.P. No. 37/320 del C. S. de la J.

OP

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Anexo 1



(12)

EUROPEAN PATENT SPECIFICATION

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(54) METHOD AND APPARATUS FOR COMPRESSING FIBROUS BODIES.
VERFAHREN UND VORRICHTUNG ZUM KOMPRIMIEREN VON FASERKÖRPERN
PROCEDE ET APPAREIL POUR UNE COMPRESSION DE CORPS FIBREUX

(84) Designated Contracting States: AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR (30) Priority: 17.09.2001 SE 0103073 (43) Date of publication of application: 16.06.2004 Bulletin 2004/25 (73) Proprietor: SCA Hygiene Products AB 405 03 Göteborg (SE) (72) Inventors: • GÖRANSSON, Claes S-589 31 LINKÖPING (SE)	• EDWARDSON, Gunnar S-430 94 BOHUS BJÖRKÖ (SE) (74) Representative: Hyltner, Jan-Olof Albihns Stockholm AB, Box 5581 114 85 Stockholm (SE) (56) References cited: EP-A1- 0 369 974 WO-A1-00/23366 DE-A- 1 474 973 GB-A- 1 577 882 SE-B- 468 851 US-A- 4 753 693
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Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

TECHNICAL FIELD

[0001] The present invention relates to a method of compressing fibrous bodies which are held in place on a perforated support by means of negative pressure, and to an arrangement for implementing the method.

BACKGROUND OF THE INVENTION

[0002] In the manufacture of absorbent articles, such as diapers, incontinence pads, sanitary towels, panty liners and the like, use is commonly made of fluff pulp, with or without the addition of superabsorbents, bonding fibres or other materials, as the absorbent layer. The fluff pulp is supplied to a mat former or the like and is given the desired shape. The shaped pulp body is then compressed so as to obtain the desired absorption properties. The pulp bodies are often conveyed on perforated conveying tracks and are held in place on the conveying tracks by means of negative pressure (see, for example, US 4,753,693). In the case of continuous process lines for the manufacture of absorbent articles, a number of individual absorbent bodies or layers of absorbent material are often put onto a running web of surface layer material, and it is of course of utmost importance for manufacturing accuracy that the individual bodies or layers end up in the correct place on the running web.

[0003] One problem associated with compressing pulp bodies which are held in place by means of negative pressure on a perforated support is that, during compression, the fluff pulp is pressed into the perforations and remains in these after the compressed pulp body has been removed from the support. This problem is particularly marked when pulp bodies are compressed hard, that is to say pulp bodies are compressed to a density > 200 kg/m³, which means that there is a great risk of the perforations in the support being clogged or blocked after only one or a few compressions. After the perforations of the support have become clogged, it must be cleaned in order to be capable of being used again in the process line, which leads to operational stoppages or to the introduction of complicated cleaning arrangements into the process line. Clogging also means that the pulp bodies can move on the support, which results in defective products.

[0004] The object of the present invention is to eliminate completely the risk of blocking of the perforations in the support when pulp bodies are compressed.

SUMMARY OF THE INVENTION

[0005] According to the invention, this object is achieved by means of a method of compressing fibrous bodies which are held in place on a perforated support by means of negative pressure having the features of claim 1. Each fibrous body to be compressed is first ar-

ranged on a first support which comprises parts with and without perforations within the region covered by the fibrous body, a first compression of the fibrous body is brought about in those portions thereof which cover the part or parts without perforations of the first support, the partly compressed fibrous body is then transferred to a second support which comprises perforations in the part or parts covered by compressed portions of the fibrous body but is without perforations within one or more parts covered by uncompressed portions of the fibrous body, a second compression of the fibrous body is brought about when the latter is placed on the second support in those portions of the body which cover the part or parts without perforations of the second support, after which, if required, similar compression steps are repeated until all portions to be compressed of the fibrous body have been compressed.

[0006] In a preferred embodiment, the supports consist of running conveying tracks, and the fibrous bodies are retained on the first support in two lateral regions extending in the running direction and are retained on the second support in a central region extending in the running direction.

[0007] The invention also relates to an arrangement for compressing fibrous bodies having the features of claim 3, said arrangement comprising a first conveying track which is perforated in one or more regions extending in the running direction of the conveying track and interacts with one or more vacuum boxes so that a negative pressure is formed on the load-carrying side of the conveying track in its perforated region or regions, a first compression arrangement through which the first conveying track runs and which is arranged so as to compress a body conveyed on the first conveying track in those parts of the body which are located in unperforated regions of the first conveying track, a second conveying track which is perforated in one or more regions extending in the running direction of the conveying track, which regions correspond in the transverse direction to the unperforated regions of the first conveying track, and interacts with one or more vacuum boxes so that a negative pressure is formed on the load-carrying side of the second conveying track in its perforated region or regions, and a second compression arrangement through which the second conveying track runs and which is arranged so as to compress a body conveyed on the second conveying track in those parts of the body which are located in unperforated regions of the second conveying track.

[0008] In a preferred embodiment, the first and second compression arrangements consist of compression rollers, and the first and second conveying tracks consist of transfer wheels.

LIST OF FIGURES

[0009] The invention will now be described with reference to accompanying figures, where:

Fig. 1 shows diagrammatically a side view of a compression arrangement in a first embodiment of the invention, and

Fig. 2 shows a plan view of the arrangement in Figure 1.

DESCRIPTION OF EMBODIMENTS

[0010] The compression arrangement shown in Figures 1 and 2 comprises a first transfer wheel 1, a first compression roller 2 interacting with the transfer wheel 1, a second transfer wheel 3 and a compression roller 4 interacting with the transfer wheel 3. The directions of rotation of the transfer wheels and the compression rollers interacting with these are indicated by arrows in Figure 1.

[0011] The transfer wheels 1 and 3 comprise in a customary manner perforated or holed peripheral surfaces and stationary vacuum boxes 5, 6 which, in the circumferential direction, extend over that region of the circumference of the wheel through which pulp bodies are conveyed and are retained against the peripheral surface by means of the negative pressure generated by means of the vacuum box.

[0012] In accordance with the invention, the peripheral surface of the transfer wheel 1 has a central region 7 without holes or perforations, which, in the circumferential direction, extends around the entire periphery of the transfer wheel, while the regions 8 outside the central region 7 are provided with a pattern of holes 9 extending around the entire periphery of the transfer wheel. In the embodiment shown in the figures, the pattern consists of a row of individual holes 9 but the pattern can also consist of a number of parallel rows of holes, and the rows can also be displaced in the circumferential direction relative to one another. The individual holes can have any shape and can also be provided with netting which divides each individual hole 9 into a number of smaller holes. The individual holes suitably have an area of 3-20 mm², and the open area of the regions 8 should lie between 2 and 25%.

[0013] The first compression roller 2, which interacts with the transfer wheel 1, is dimensioned and positioned in such a manner that it acts in only the central region 7 of the peripheral surface of the transfer wheel 1.

[0014] The second transfer wheel 3 differs from the first transfer wheel 1 in having perforations 10 in its central region 11, which corresponds to the central region 7 without perforations of the first transfer wheel 1, and being without perforations in the regions 12 lying outside the central region 11, which correspond to the perforated regions 8 of the transfer wheel 1. The second transfer wheel 3 therefore has a central perforated region 11 and two lateral regions 12 without perforations. Otherwise, the transfer wheel 3 is constructed in the same manner as the transfer wheel 1.

[0015] The regions 7, 12 without perforations can of

course be brought about on a fully perforated transfer wheel by covering these regions with a layer of an impermeable material or blocking the holes in these regions in another manner.

[0016] The second compression roller 4 extends axially over the entire width of the peripheral surface of the second transfer wheel 3 and has a central cutout in its central part, that is to say that part of it which extends over the width of the central region 11 of the transfer wheel 3.

[0017] Figure 1 also shows a mat-forming wheel 13, from which a succession of airlaid pulp bodies is deposited on the first transfer wheel 1, and a conveyor 14, on which a succession of finished compressed pulp bodies is placed and transferred to a process line (not shown) for the manufacture of absorbent articles. Figure 1 also shows a precompression roller 15 which can advantageously be arranged so as to remove air from the pulp bodies before the actual compression. A precompression roller can also be arranged so as to interact with the second transfer wheel 3 and is then positioned in front of the compression roller 4 in the running direction.

[0018] The arrangement functions as described below.

[0019] In a customary manner, the mat-forming wheel has along its periphery a number of moulds with perforated bottoms and a vacuum box which generates a negative pressure below these bottoms as the bottoms pass by one or more mat-forming covers and onward to that point along the periphery at which the pulp bodies formed are deposited on the transfer wheel 1. The mat-forming covers supply a stream of airborne pulp fibres, to which fibres or particles of superabsorbent material or bonding fibres may be added. When the moulds of the mat-forming wheel pass below the mat-forming cover, pulp fibres are sucked into the moulds, individual pulp bodies of the desired shape being formed.

[0020] After transfer of these pulp bodies to the transfer wheel 1, the bodies are held in place on the peripheral surface of the wheel 1 by means of the negative pressure which acts on the bodies in the perforated regions 8 of the transfer wheel 1. On passing the precompression roller 15, some compression of the bodies takes place, and some air is pressed out of these. After precompression, the pulp bodies have a density of roughly 100 kg/m³. The bodies are then fed past the first compression roller 2, compression of the bodies taking place in their central part, which runs under the first compression roller 2. By virtue of the fact that, during this compression, the material of the pulp bodies is pressed against only that part 7 of the peripheral surface of the transfer wheel 1 which has no holes, there is of course no risk of the holes 9 in the regions 8 of the peripheral surface of the transfer wheel being blocked or clogged during this compression step.

[0021] The pulp bodies compressed in their central part are then transferred to the second transfer wheel 3 and, on passing the second compression roller 4, compression of the pulp bodies takes place in their lateral

parts, which pass under those parts of this roller which extend outside the perforated central region 11 of the peripheral surface of the transfer wheel 3. The widths of the first and second compression rollers 2 and 4 are selected so that the whole of the pulp bodies has been compressed after a pulp body has passed the second compression roller 4. The width of the first compression roller 2 is preferably slightly greater than the width of the central cutout of the second compression roller 4, suitably 2 mm greater, so as to ensure that the pulp bodies are compressed over their entire width. After passing the second compression roller 4, the compression of the pulp bodies is finished, and they can be supplied via the conveyor belt 14 to a material web forming part of a process line (not shown) for manufacturing absorbent articles.

[0022] If the peripheral speed of the second transfer wheel 3 is synchronous with the feed speed in such a process line, that is to say the pulp bodies can be deposited in succession with the desired mutual spacing, the finished compressed pulp bodies can be supplied directly to the process line for manufacturing absorbent articles.

[0023] By virtue of the pulp in the pulp bodies being pressed against only an unperforated support during the compression steps, the compression cannot lead to blocking of the perforations in the peripheral surfaces of the first and second transfer wheels 1 and 3.

[0024] In the arrangement described, the pulp bodies are compressed to the same density in all their parts, that is to say the nips of the first and second compression rollers and the transfer wheels interacting therewith are the same size. However, there is nothing to prevent the nips being given different sizes so that the density in the central parts of the finished compressed pulp bodies differs from the density in lateral parts. It is also possible to make use of profiled rollers in order to give the pulp bodies different density in different parts. The essential factor for the invention is that all compression of the pulp bodies takes place against a support which does not have holes.

[0025] The method and arrangement described can of course be modified within the scope of the invention. For example, the transfer wheels 1 and 3 and the compression rollers interacting therewith can change places. Furthermore, additional compression steps can be performed, for example in order to produce compression lines in the pulp body formed, these compression steps also being performed in such a manner that pulp is pressed against only unperforated supports. Moreover, linear conveyor belts can be used instead of transfer wheels, and the method can also be applied to intermittently running conveying tracks and intermittently acting compression means. Instead of a common vacuum box for the perforated lateral regions of the first transfer wheel, a separate vacuum box can be provided for each perforated region. The method can also be used with continuous fibrous mats, and the fibrous bodies or the fibrous mat do(es) not have to be produced by airlaying. The invention is therefore to be limited only by the content of the accompanying patent claims.

Claims

1. Method of compressing fibrous bodies which are held in place on a perforated support (1, 3) by means of negative pressure, each fibrous body to be compressed being first arranged on a first support (1) **characterized in that** said support comprises parts with (8) and without (7) perforations within the region covered by the fibrous body, **in that** a first compression of the fibrous body is brought about in those portions thereof which cover the part (7) or parts without perforations of the first support (1), **in that** the partly compressed fibrous body is then transferred to a second support (3) which comprises perforations in the part (11) or parts covered by compressed portions of the fibrous body but is without perforations within one or more parts (12) covered by uncompressed portions of the fibrous body, **in that** a second compression of the fibrous body is brought about when the latter is placed on the second support (3) in those portions of the body which cover the part or parts (12) without perforations of the second support, after which, if required, similar compression steps are repeated until all portions to be compressed of the fibrous body have been compressed.
2. Method according to Claim 1, **characterized in that** the supports consist of running conveying tracks (1, 3), and **in that** the fibrous bodies are retained on the first support (1) in two lateral regions (8) extending in the running direction and are retained on the second support (3) in a central region (11) extending in the running direction.
3. Arrangement for compressing fibrous bodies, comprising a first conveying track (1) which is perforated in one or more regions (8) extending in the running direction of the conveying track and interacts with one or more vacuum boxes (5) so that a negative pressure is formed on the load-carrying side of the conveying track in its perforated region or regions and a first compression arrangement (2) through which the first conveying track (1) runs **characterized in that** said first conveying track (1) is arranged so as to compress a body conveyed on the first conveying track in those parts of the body which are located in unperforated regions (7) of the first conveying track (1), said arrangement further comprising a second conveying track (3) which is perforated in one or more regions (11) extending in the running direction of the conveying track, which regions correspond in the transverse direction to the unperforated regions (7) of the first conveying track (1), and interacts with one or more vacuum boxes (6) so that a negative pressure is formed on the load-carrying side of the second conveying track in its perforated region or regions (11), and a second compression arrangement (4) through which the second convey-

ing track (3) runs and which is arranged so as to compress a body conveyed on the second conveying track in those parts of the body which are located in unperforated regions (12) of the second conveying track (3).

- 4. Arrangement according to Claim 3, **characterized in that** the first and second compression arrangements consist of compression rollers (2, 4).
- 5. Arrangement according to Claim 4, **characterized in that** the first and second conveying tracks consist of transfer wheels (1, 3).

Patentansprüche

- 1. Verfahren zum Komprimieren faserförmiger Körper, die mittels Unterdruck auf einem perforierten Träger (1, 3) in Stellung gehalten werden, wobei jeder zu komprimierende faserförmige Körper zunächst auf einem ersten Träger (1) angeordnet wird, **dadurch gekennzeichnet, dass** der Träger Teile mit (8) und ohne (7) Perforationen innerhalb des Bereichs, der durch den faserförmigen Körper bedeckt ist, umfasst, **dadurch**, dass eine erste Kompression des faserförmigen Körpers in den Abschnitten davon, die den Teil (7) oder die Teile ohne Perforationen des ersten Trägers (1) bedecken, bewirkt wird, **dadurch**, dass derteilweise komprimierte faserförmige Körper dann auf einen zweiten Träger (3) transferiert wird, der Perforationen in dem Teil (11) oder den Teilen umfasst, die durch die komprimierten Abschnitte des faserförmigen Körpers bedeckt ist, aber keine Perforationen in einem oder mehreren Teilen (12) aufweist, die durch unkomprimierte Abschnitte des faserförmigen Körpers bedeckt sind, **dadurch**, dass eine zweite Kompression des faserförmigen Körpers erfolgt, wenn letzterer auf dem zweiten Träger (3) platziert ist und zwar in den Abschnitten des Körpers, die den Teil oder Teile (12) ohne Perforation des zweiten Trägers bedecken, wonach wenn erforderlich ähnliche Kompressionsschritte wiederholt werden, bis alle zu komprimierenden Abschnitte des faserförmigen Körpers komprimiert wurden.
- 2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Träger aus einer laufenden Förderbahn (1, 3) bestehen und **dadurch**, dass die faserförmigen Körper auf dem ersten Träger (1) in zwei seitlichen Bereichen (8), die sich in Laufrichtung erstrecken, gehalten werden und dass sie auf dem zweiten Träger (3) in einem Mittelbereich (11), der sich in Laufrichtung erstreckt, gehalten werden.
- 3. Anordnung zum Komprimieren faserförmiger Körper, umfassend eine erste Förderbahn (1), die in einem oder mehreren Bereichen (8), die sich in Laufrichtung der Förderbahn erstrecken, perforiert ist und mit einer oder mehreren Vakuumböden (5) zusammenwirkt, so dass ein Unterdruck auf der Last tragenden Seite der Förderbahn in ihrem perforierten Bereich oder Bereichen erzeugt wird und eine erste Kompressionsanordnung (2), durch die die erste Förderbahn (1) läuft, **dadurch gekennzeichnet, dass** die erste Förderbahn (1) derart angeordnet ist, dass sie den auf der ersten Förderbahn geförderten Körper in den Teilen des Körpers komprimiert, die in unperforierten Bereichen (7) der ersten Förderbahn (1) angeordnet sind, wobei die Anordnung ferner umfasst: eine zweite Förderbahn (3), die in einem oder mehreren Bereichen (11), die sich in Laufrichtung der Förderbahn erstrecken, perforiert ist, welche Bereiche in der Querrichtung den unperforierten Bereichen (7) der ersten Förderbahn (1) entsprechen und die mit einer oder mehreren Vakuumböden (6) zusammenwirkt, so dass auf der Last tragenden Seite der zweiten Förderbahn in ihren perforierten Bereich oder Bereichen 11 ein Unterdruck erzeugt wird, und eine zweite Kompressionsanordnung (4), durch die die zweite Förderbahn (3) läuft und die derart angeordnet ist, dass sie die auf der zweiten Förderbahn geförderten Körper in den Teilen des Körpers komprimiert, die in unperforierten Bereichen (12) der zweiten Förderbahn (3) angeordnet sind.
- 4. Anordnung nach Anspruch 3, **dadurch gekennzeichnet, dass** die erste und zweite Kompressionsanordnung aus Kompressionswalzen (2, 4) besteht.
- 5. Anordnung nach Anspruch 4, **dadurch gekennzeichnet, dass** die erste und zweite Förderbahn aus Transferwalzen (1, 3) besteht.

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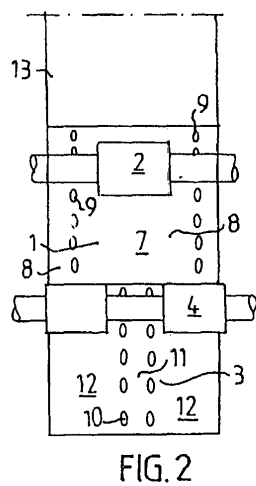
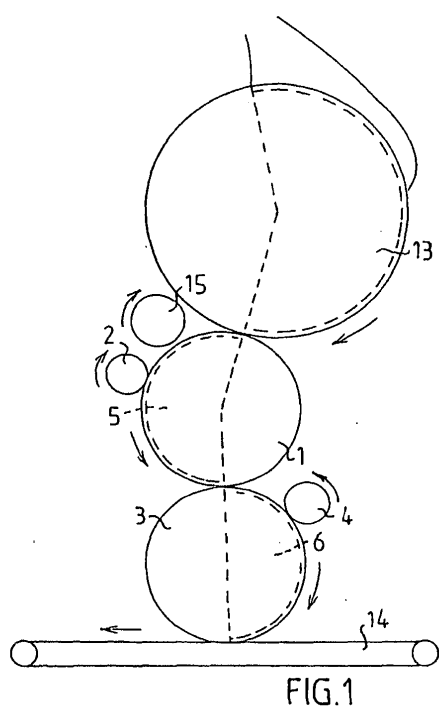
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richtung der Förderbahn erstrecken, perforiert ist und mit einer oder mehreren Vakuumböden (5) zusammenwirkt, so dass ein Unterdruck auf der Last tragenden Seite der Förderbahn in ihrem perforierten Bereich oder Bereichen erzeugt wird und eine erste Kompressionsanordnung (2), durch die die erste Förderbahn (1) läuft, **dadurch gekennzeichnet, dass** die erste Förderbahn (1) derart angeordnet ist, dass sie den auf der ersten Förderbahn geförderten Körper in den Teilen des Körpers komprimiert, die in unperforierten Bereichen (7) der ersten Förderbahn (1) angeordnet sind, wobei die Anordnung ferner umfasst: eine zweite Förderbahn (3), die in einem oder mehreren Bereichen (11), die sich in Laufrichtung der Förderbahn erstrecken, perforiert ist, welche Bereiche in der Querrichtung den unperforierten Bereichen (7) der ersten Förderbahn (1) entsprechen und die mit einer oder mehreren Vakuumböden (6) zusammenwirkt, so dass auf der Last tragenden Seite der zweiten Förderbahn in ihren perforierten Bereich oder Bereichen 11 ein Unterdruck erzeugt wird, und eine zweite Kompressionsanordnung (4), durch die die zweite Förderbahn (3) läuft und die derart angeordnet ist, dass sie die auf der zweiten Förderbahn geförderten Körper in den Teilen des Körpers komprimiert, die in unperforierten Bereichen (12) der zweiten Förderbahn (3) angeordnet sind.

Revendications

- 1. Un procédé de compression de corps fibreux lesquels sont maintenus en place sur un support perforé (1, 3) au moyen de pression négative, chaque corps fibreux devant être comprimé étant d'abord agencé sur un premier support (1), **caractérisé en ce que** ledit support comporte des parties avec (8) et sans (7) perforations à l'intérieur de la région recouverte par le corps fibreux, **en ce qu'**une première compression du corps fibreux est effectuée en ses portions qui recouvrent la partie (7) ou les parties sans perforations du premier support (1), **en ce que** le corps fibreux partiellement comprimé est ensuite transféré sur un deuxième support (3) qui comporte des perforations dans la partie (11) ou les parties recouvertes par des portions comprimées du corps fibreux mais est sans perforations à l'intérieur d'une ou plusieurs parties (12) recouvertes par des portions non comprimées du corps fibreux, **en ce**

- qu'une deuxième compression du corps fibreux est effectuée lorsque ce dernier est placé sur le deuxième support (3) dans ces portions du corps lesquelles recouvrent la partie ou les parties (12) sans perforations du deuxième support, après quoi, si nécessaire, des étapes de compression similaires sont répétées jusqu'à ce que toutes les portions devant être comprimées dans le corps fibreux aient été comprimées.
2. Un procédé selon la revendication 1, **caractérisé en ce que** les supports consistent de bandes transporteuses en continu (1, 3) et **en ce que** les corps fibreux sont retenus sur le premier support (1) en deux régions latérales (8) s'étendant dans la direction de marche et sont retenus sur le deuxième support (3) en une région centrale (11) s'étendant dans la direction de marche.
3. Un agencement pour la compression de corps fibreux, comportant une première bande transporteuse (1) laquelle est perforée dans une ou plusieurs régions (8) s'étendant dans la direction de marche de la bande transporteuse et interagit avec une ou plusieurs caisses aspirantes (5) afin qu'une pression négative soit formée sur le côté porteur de charge de la bande transporteuse dans sa région ou ses régions perforées et un premier agencement de compression (2) au travers duquel la première bande transporteuse (1) circule, **caractérisé en ce que** ladite première bande transporteuse (1) est agencée de façon à comprimer un corps transporté sur la première bande transporteuse dans ces parties du corps qui sont situées dans des régions non perforées (7) de la première bande transporteuse (1), ledit agencement comportant de plus une deuxième bande transporteuse (3) laquelle est perforée dans une ou plusieurs régions (11) s'étendant dans la direction de marche de la bande transporteuse, lesquelles régions correspondent en direction transversale aux régions non perforées (7) de la première bande transporteuse (1), et interagit avec une ou plusieurs caisses aspirantes (6) afin qu'une pression négative soit formée sur le côté porteur de la deuxième bande transporteuse dans sa région ou ses régions perforées (11), et un deuxième agencement de compression (4) au travers duquel la deuxième bande transporteuse (3) circule et lequel est agencé de façon à comprimer un corps transporté sur la deuxième bande transporteuse dans ces parties du corps qui sont situées dans des régions non perforées (12) de la deuxième bande transporteuse (3).
4. Un agencement selon la revendication 3, **caractérisé en ce que** les premier et deuxième agencements de compression consistent de rouleaux compresseurs (2, 4).
5. Un agencement selon la revendication 4, **caractérisé en ce que** les première et deuxième bandes transporteuses consistent de roues de transfert (1, 3).



Anexo 2



US005866242A

United States Patent [19]
Tan et al.

[11] **Patent Number:** **5,866,242**
[45] **Date of Patent:** **Feb. 2, 1999**

[54] **SOFT, STRONG, ABSORBENT MATERIAL
FOR USE IN ABSORBENT ARTICLES**

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5,635,239 6/1997 Chen et al. .
5,693,162 12/1997 Gustafson et al. .

[75] Inventors: **Erol Tan; Peter R. Abitz**, both of St.
Simons Island, Ga.

FOREIGN PATENT DOCUMENTS

[73] Assignee: **Rayonier Inc.**, Stamford, Conn.

0763 364 A2 9/1996 European Pat. Off. .

[21] Appl. No.: **784,536**

Primary Examiner—Christopher Raimund
Attorney, Agent, or Firm—Rockey, Milnamow & Katz, Ltd.

[22] Filed: **Jan. 17, 1997**

[57] **ABSTRACT**

[51] **Int. Cl.⁶** **B32B 7/02**

[52] **U.S. Cl.** **428/219; 442/381; 442/385;**
442/393; 442/417

[58] **Field of Search** **442/381, 385,**
442/393, 417; 428/219; 162/164.1, 157.2

An absorbent material that can be used as an absorbent core in absorbent articles such as disposable diapers, feminine hygiene products and incontinence devices is provided. An absorbent material of this invention contains a blend of cellulosic fibers and a superabsorbent material. The absorbent material has superior wicking, strength and softness properties when compared to existing core materials. The material can be air-laid as a homogeneous blend of fiber and superabsorbent in one or more layers.

[56] **References Cited**

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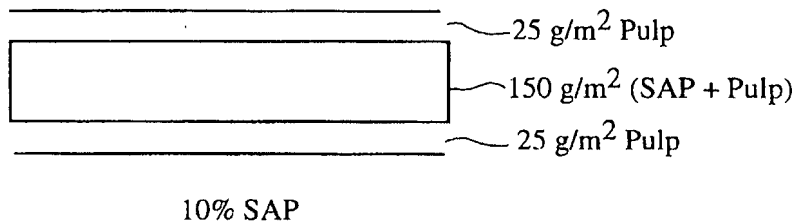
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50 Claims, 4 Drawing Sheets

Feminine Hygiene Products:

Total Basis Weight $\cong$ 200 g/cm²

Three Strata



Four Strata

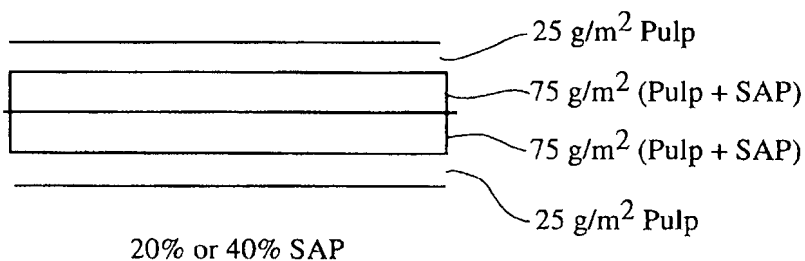


FIG. 1

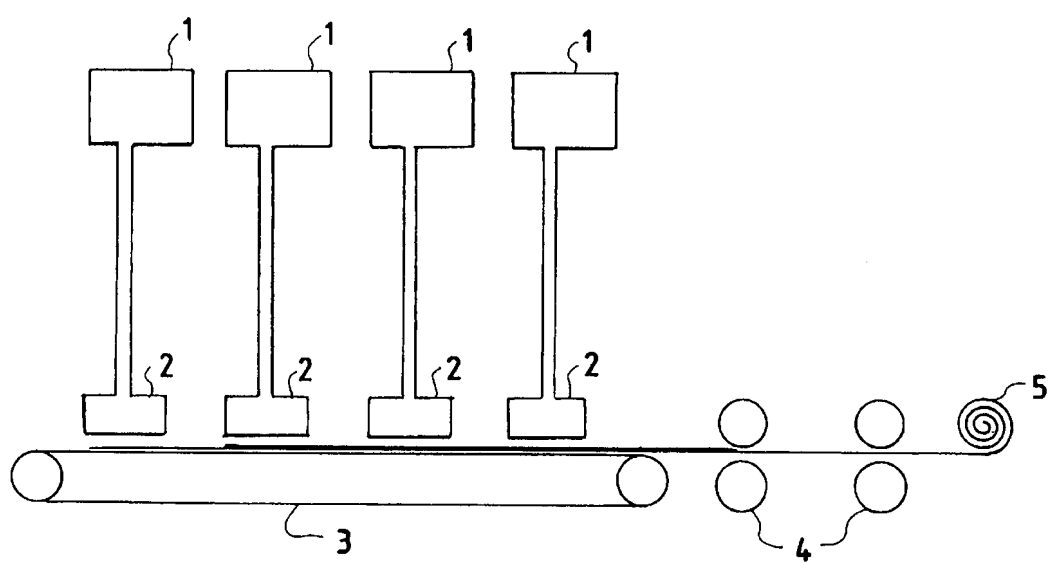
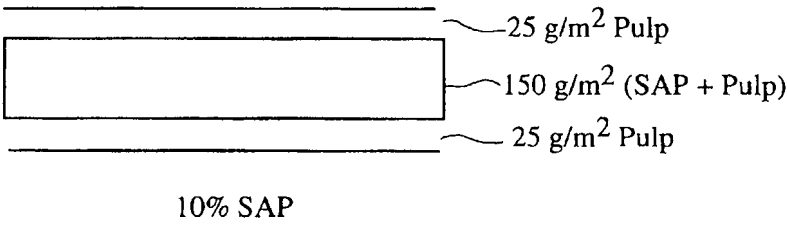


FIG. 2

Feminine Hygiene Products:
Total Basis Weight $\cong$ 200 g/cm²

Three Strata



Four Strata

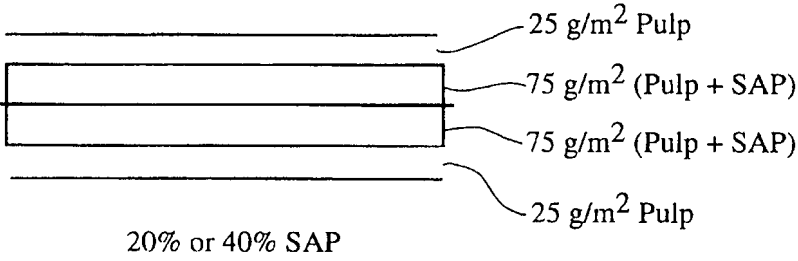
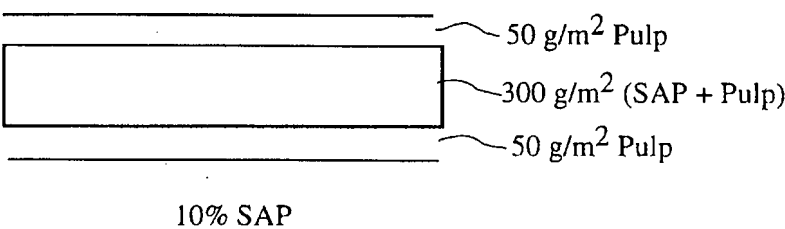


FIG. 3

Diapers and Incontinence Products:

Total Weight $\cong 400 \text{ g/cm}^2$

Three Strata



Four Strata

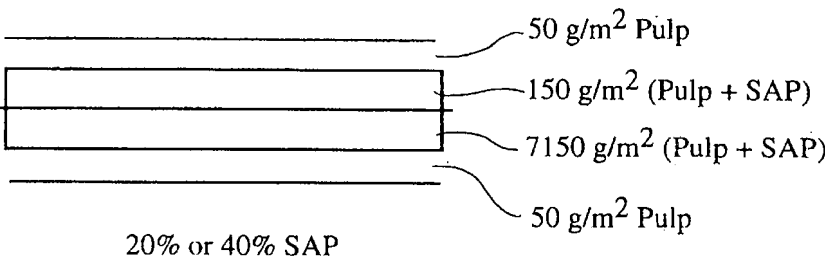
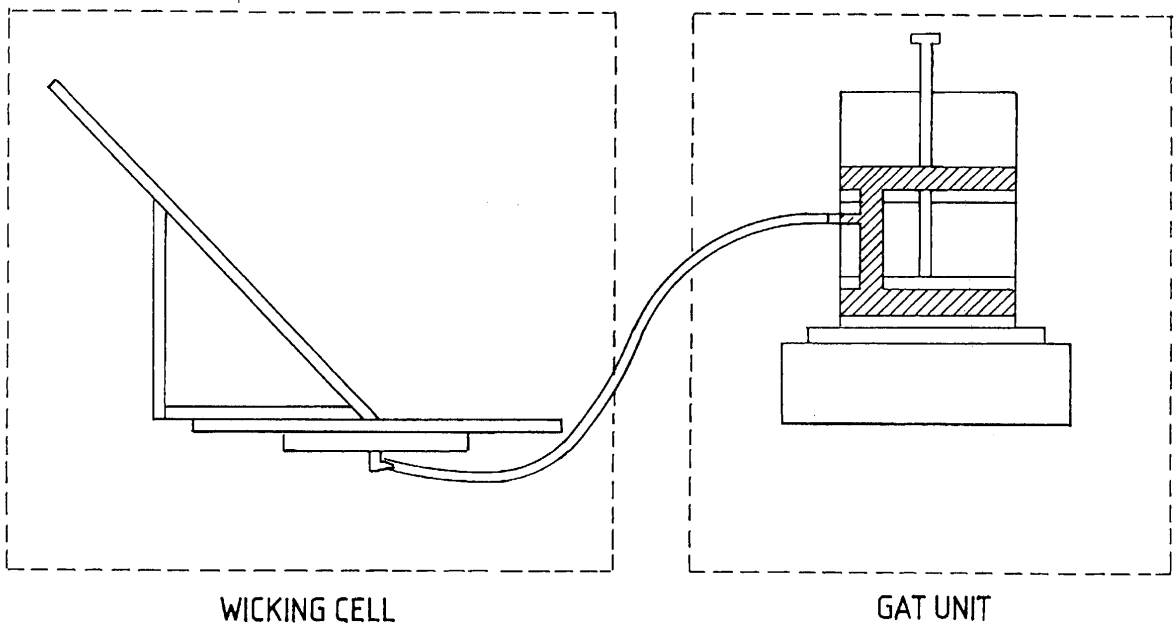


FIG. 4



**SOFT, STRONG, ABSORBENT MATERIAL
FOR USE IN ABSORBENT ARTICLES**

TECHNICAL FIELD OF THE INVENTION

This invention relates to absorbent materials to be used as absorbent cores in articles such as disposable diapers, feminine hygiene products and incontinence devices. More particularly, the present invention relates to absorbent materials that are high density, strong, soft materials with superior wicking properties.

BACKGROUND OF THE INVENTION

Disposable absorbent articles, such as diapers, feminine hygiene products, adult incontinence devices and the like have found widespread acceptance. To function efficiently, such absorbent articles must quickly absorb body liquids, distribute those liquids within and throughout the absorbent article and be capable of retaining those body liquids when placed under loads. In addition, the absorbent article need be sufficiently soft and flexible so as to comfortably conform to body surfaces.

While the design of individual absorbent articles varies depending upon use, there are certain elements or components common to such articles. The absorbent article contains a liquid pervious top sheet or facing layer, which facing layer is designed to be in contact with a body surface. The facing layer is made of a material that allows for the unimpeded transfer of fluid from the body into the core of the article. The facing layer should not absorb fluid per se and, thus, should remain dry. The article further contains a liquid impervious back sheet or backing layer disposed on the outer surface of the article and which layer is designed to prevent the leakage of fluid out of the article.

Disposed between the facing layer and backing layer is an absorbent member referred to in the art as an absorbent core. The function of the absorbent core is to absorb and retain body fluids entering the absorbent article through the facing layer. Because the origin of body fluids is localized, it is necessary to provide a means for distributing fluid throughout the dimensions of the absorbent core. This is typically accomplished either by providing a distribution member disposed between the facing layer and absorbent core and/or altering the composition of the absorbent core per se.

Fluid can be distributed to different portions of the absorbent core by means of a transfer or acquisition layer disposed between the facing layer and core. Because of the proximity of such an acquisition layer to the body surface of the wearer, the acquisition layer should not be formed from material that retains large amounts of fluid. The purpose of the acquisition layer is to provide for rapid transfer and distribution of fluid to the absorbent core.

The absorbent core is typically formulated of a cellulosic wood fiber matrix or pulp, which pulp is capable of absorbing large quantities of fluid. Absorbent cores can be designed in a variety of ways to enhance fluid absorption and retention properties. By way of example, the fluid retention characteristics of absorbent cores can be greatly enhanced by disposing superabsorbent materials in amongst fibers of the wood pulp. Superabsorbent materials are well known in the art as substantially water-insoluble, absorbent polymeric compositions that are capable of absorbing large amounts of fluid in relation to their weight and forming hydrogels upon such absorption. Absorbent articles containing blends or mixtures of pulp and superabsorbents are known in the art.

The distribution of superabsorbents within an absorbent core can be uniform or non-uniform. By way of example,

that portion of an absorbent core proximate to the backing layer (farthest away from the wearer) can be formulated to contain higher levels of superabsorbent than those portions of the core proximate the facing or acquisition layer. By way of further example, that portion of the core closest to the site of fluid entry (e.g., acquisition zone) can be formulated to wick fluid into surrounding portions of the core (e.g., storage zone).

In addition to blending pulp with superabsorbent material, a variety of other means for improving the characteristics of pulp have been described. For example, pulp boards can be more easily defiberized by using chemical debonding agents (see, e.g., U.S. Pat. No. 3,930,933). In addition, cellulose fibers of wood pulp can be flash-dried prior to incorporation into a composite web absorbent material (see, e.g., U.K. Patent Application GB 2272916A published on Jun. 1, 1994). Still further, the individualized cellulosic fibers of wood pulp can be cross-linked (see, e.g., U.S. Pat. Nos. 4,822,453; 4,888,093; 5,190,563; and 5,252,275). All of these expedients have the disadvantage of requiring the wood pulp manufacturer to perform time-intensive, expensive procedures during the wood pulp preparation steps. Thus, use of these steps results in substantial increases in the cost of wood pulp.

Although all of the above treatment steps have been reported to improve the absorption characteristics of pulp for use as absorbent cores, there are certain disadvantages associated with such treatments. By way of example, the manufacturer of the end use absorbent article (e.g. feminine hygiene product or diaper) must fluff the fibers in the wood pulp so as to detach the individual fibers bound in that pulp. Typically, pulp has a low moisture content which results in the individual fibers being relatively brittle. If the pulp manufacturer performs such fluffing prior to shipment to the absorbent article maker, the transportation costs of the pulp are increased. At least one pulp manufacturer has attempted to solve this problem by producing flash-dried pulp without chemical bonding agents in a narrow range of basis weights in pulp density (see U.S. Pat. No. 5,262,005). However, even with this process, the manufacturer of the absorbent article must still defiber the pulp after purchase.

There continues to be a need in the art, therefore, for a material that satisfies the absorbency requirements needed for use as absorbent core in disposable absorbent articles and which simultaneously provides time and cost savings to both the pulp manufacturer and the manufacturer of the absorbent article.

BRIEF SUMMARY OF THE INVENTION

In one aspect, the present invention provides an absorbent material having a basis weight of from about 200 g/m² to about 400 g/m², a density of from about 0.35 g/cc to about 0.40 g/cc and a ratio of Gurley stiffness (mg) to density (g/cc) of less than about 3700, wherein the material is air-laid as a bottom layer of pulp, a middle layer of pulp and superabsorbent polymer disposed in amongst the pulp, and a top layer of pulp. Preferably, the material comprises from about 10 weight percent to about 40 weight percent superabsorbent polymer. In one embodiment, the material has a basis weight of about 200 g/m² and comprises about 10 weight percent superabsorbent polymer. In another embodiment, the material has a basis weight of about 400 g/m² and comprises about 10 weight percent superabsorbent polymer.

The middle layer of a material of the present invention can comprise a first middle layer adjacent the bottom layer and

a second middle layer adjacent the top layer. In accordance with this embodiment, the material has a basis weight of about 200 g/m² and comprises from about 20 weight percent to about 40 weight percent superabsorbent polymer or has a basis weight of about 400 g/m² and comprises from about 20 weight percent to about 40 weight percent superabsorbent polymer.

In preferred embodiments, the material has a ratio of Gurley stiffness to density of less than about 3250 or 3000. Preferably, the material has a ratio of pad integrity to density of greater than about 25.0, more preferably greater than about 30.0 and, most preferably, greater than about 35.0.

In another aspect, the present invention provides an absorbent material that comprises: (a) from about 40 weight percent to about 90 weight percent cellulosic fibers; and (b) from about 10 weight percent to about 60 weight percent superabsorbent polymer, the material having a water content of less than about 10 weight percent, a density of greater than about 0.25 g/cc and a ratio of Gurley stiffness (mg) to density (g/cc) of less than about 3700.

In accordance with this aspect, the material preferably contains from about 50 to about 90 weight percent cellulosic fibers and, more preferably from about 60 to about 80 weight percent cellulosic fibers. Such a material preferably contains from about 10 to about 50 weight percent superabsorbent polymer and, more preferably from about 20 to about 40 weight percent superabsorbent polymer.

Preferred densities of such material range from about 0.30 to about 0.55 g/cc, preferably from about 0.30 to about 0.45 g/cc and, more preferably from about 0.30 to about 0.40 g/cc. In other embodiments, the ratio of Gurley stiffness to density is less than about 3250 and, preferably less than about 3000.

In another embodiment, a material has a ratio of pad integrity to density of greater than about 25.0, preferably greater than about 30.0 and, more preferably greater than about 35.0. The material of this invention can have a basis weight of from about 50 g/m² to about 700 g/m². Preferably, that basis weight is from about 100 g/m² to about 600 g/m² and, more preferably from about 200 g/m² to about 400 g/m².

A material of the present invention can be air-laid as one or more layers. Preferably, the material is air-laid as 2, 3, 4 or 5 layers. At least one of the layers can contain cellulosic fibers to the exclusion of superabsorbent polymer.

In another embodiment, a material of the present invention has a 45° wicking distribution at 5 inches of at least 5 grams of saline per gram of material. Preferably, the 45° wicking distribution at 5 inches is at least 9 grams of saline per gram of material and, more preferably at least 11 grams of saline per gram of material.

The material of the present invention is thin having a thickness of from about 0.5 mm to about 2.5 mm. In preferred embodiments, the thickness is from about 1.0 mm to about 2.0 mm and, preferably from about 1.25 mm to about 1.75 mm. The material can further comprise from about 1 weight percent to about 20 weight percent synthetic fibers.

The material of this invention has superior superabsorbent polymer retaining characteristics. The material retains more than about 85 weight percent, preferably more than about 90 weight percent and, most preferably greater than about 95 weight percent of superabsorbent polymer after shaking for 10 minutes in a Ro-Tap Sieve Shaker.

A cellulosic fiber used in a material of the present invention preferably contains wood pulp. In a preferred

embodiment, at least a portion of that pulp is produced by a process that includes the step of treating a liquid suspension of pulp at a temperature of from 15° C. to about 60° C. with an aqueous alkali metal salt solution having an alkali metal salt concentration of from about 2 weight percent to about 25 weight percent of said solution for a period of time ranging from about 5 minutes to about 60 minutes.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which form a portion of the specification:

FIG. 1 is a schematic illustration of means for air-laying absorbent material of the present invention using four air-laying heads followed by means for compacting the air-laid material.

FIG. 2 shows a three and four strata embodiments of an absorbent material of the present invention for use in a diaper or incontinence device.

FIG. 3 shows three and four strata embodiments of an absorbent material of the present invention for use as an absorbent core in a feminine hygiene product.

FIG. 4 is a schematic illustration of a device for measuring the wicking properties of absorbent material.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides novel, absorbent material that is particularly well suited for use as cores in absorbent articles such as diapers, feminine hygiene products, incontinence devices and the like. The material of the present invention is a blend or mixture of cellulosic fibers and superabsorbent disposed in and amongst fibers of that pulp. A material of this invention has a unique combination of softness, wicking and absorbency characteristics that make it particularly suitable for use in absorbent articles. An absorbent material of the present invention can be used directly by a manufacturer of the absorbent article without the need for any additional processing by that manufacturer other than cutting to the desired size and shape for the absorbent article.

The present invention relates to an absorbent material containing cellulosic fibers and superabsorbent polymers (SAP), which material is soft, thin, and of high density. Additionally, the material has enhanced absorption properties (rate and wicking) and firmly entraps SAP polymer in the fiber network without the use of any chemicals or binder. The absorbent has enough integrity (strength) to be processed on conventional disposable product manufacturing equipment without fiber breakage.

In one aspect, the present invention provides an absorbent material that contains from about 40 weight percent to about 90 weight percent cellulosic fibers; and from about 10 weight percent to about 60 weight percent SAP. The material has a water content of less than about 10 weight percent. As used herein, the phrase "weight percent" means weight of substance per weight of final material. By way of example, 10 weight percent SAP means 10 g/m² SAP per 100 g/m² basis weight of the material.

Cellulosic fibers that can be used in a material of the present invention are well known in the art and include wood pulp, cotton, flax and peat moss. Wood pulp is preferred. Pulp can be obtained from mechanical or chemi-mechanical, sulfite, kraft, pulping reject materials, organic solvent pulps, etc. Both softwood and hardwood species are useful. Softwood pulps are preferred. It is not necessary to treat cellulosic fibers with chemical debonding agents, cross-linking agents and the like for use in the present material.

An absorbent material of the present invention can contain any SAP, which SAPs are well known in the art. As used herein, the term "SAP" means a substantially water-insoluble polymeric material capable of absorbing large quantities of fluid in relation to their weight. The SAP can be in the form of particulate matter, flakes, fibers and the like. Exemplary particulate forms include granules, pulverized particles, spheres, aggregates and agglomerates. Exemplary and preferred SAPs include salts of crosslinked polyacrylic acid such as sodium polyacrylate. SAPs are commercially available (e.g., Stockhausen GmbH, Krefeld, Germany).

In accordance with a preferred embodiment, the material contains from about 50 to about 90 weight percent cellulosic fibers and, more preferably from about 60 to about 80 weight percent cellulosic fibers. Such a material preferably contains from about 10 to about 50 weight percent SAP and, more preferably from about 20 to about 40 weight percent SAP.

An absorbent material is made using air-laying means well known in the art (See FIG. 1). In accordance with FIG. 1, cellulosic fibers (e.g., pulp) are processed using a hammer mill to individualize the fibers. The individualized fibers are blended with SAP granules in a blending system 1 and pneumatically conveyed into a series of forming heads 2. The blending and distribution of absorbent materials can be controlled separately for each forming head. Controlled air circulation and winged agitators in each chamber produce uniform mixture and distribution of pulp and SAP. The SAP can be thoroughly and homogeneously blended throughout the web or contained only in specific strata by distributing it to selected forming heads. Fibers (and SAP) from each forming chamber are deposited by vacuum onto a forming wire 3 thus forming a layered absorbent web. The web is subsequently compressed using calenders 4 to achieve desirable density. The densified web is wound into a roll 5 using conventional winding equipment. The forming wire 3 can be covered with tissue paper to reduce the loss of material. The tissue paper layer can be removed prior to calendering or incorporated into the formed material.

An absorbent material of the present invention is of high density and has a density of greater than about 0.25 g/cc. In preferred embodiments, the material has density in the range of from about 0.30 g/cc to about 0.50 g/cc. More preferably, the density is from about 0.30 g/cc to about 0.45 g/cc and, even more preferably from about 0.35 g/cc to about 0.40 g/cc.

Air-laid absorbents are typically produced with a low density. To achieve higher density levels, such as preferred in the material of the present invention, the air-laid material is compacted using calenders as shown in FIG. 1. Compaction is accomplished using means well known in the art. Typically such compaction is carried out at a temperature of about 100° C. and a load of about 130 Newtons per millimeter. The upper compaction roll is typically made of steel while the lower compaction roll is a flexroll having a hardness of about 85 SH D. It is preferred that both the upper and lower compaction rolls be smooth, although the upper roll can be engraved. As set forth hereinafter in the Examples, use of an engraved upper roll may result in formation of a material having slower fluid absorption rates.

A high density absorbent material of the present invention is surprisingly and unexpectedly soft. The present material has a ratio of Gurley stiffness, measured in milligrams (mg) to density, measured in grams per cubic centimeter (g/cc) of less than about 3700. In preferred embodiments, that ratio of Gurley stiffness to density is less than about 3200 and, more preferably, less than about 3000.

Gurley stiffness is one of many indices of softness. Gurley stiffness measures the bendability or flexibility of absorbent materials. The lower the Gurley stiffness value, the more flexible the material. A material for use in absorbent materials such as diapers, sanitary napkins and the like has to be flexible so that it can comfortably conform to various body profiles. Increased flexibility is preferred. As set forth hereinafter in Example 1, Gurley stiffness was determined on absorbent material of the present invention as well as absorbent core material from two commercially available disposable diapers. The Gurley stiffness of all materials was determined at a number of different densities. The material of the present invention was substantially and significantly softer than existing, commercially available material at every density tested.

An absorbent material of the present invention is strong in light of its softness. Pad integrity is a well known measurement of absorbent material strength. A material of the present invention demonstrates strength (high pad integrity) over a wide range of densities (See the Examples hereinafter). A present material has a pad integrity, measured in Newtons (N), to density (g/cc) ratio of greater than about 25.0. In a preferred embodiment, that ratio is greater than about 30.0 and, even more preferably, greater than about 35.0. In contrast, the value of that ratio to commercially available absorbent core materials is substantially and significantly lower (e.g., less than about 24.0).

An absorbent material of this invention can be prepared over a wide range of basis weights without adversely affecting its softness or strength. Thus, the material can have a basis weight in the range of from about 50 g/m² to about 700 g/m². In a preferred embodiment, the basis weight ranges from about 100 g/m² to about 600 g/m² and, more preferably from about 200 g/m² to about 400 g/m².

An absorbent material of the present invention has enhanced wicking properties. Wicking is the ability of an absorbent material to direct fluid away from the point of fluid entry and distribute that fluid throughout the material. An absorbent material of this invention has surprisingly superior wicking properties when compared to absorbent cores from commercially available absorbent articles (e.g., Huggies® diapers). As described in detail hereinafter in the Examples, the wicking properties of two embodiments of a present invention wicked substantial amounts of fluid over 5 inches from the point of fluid entry. In a 400 g/m² basis weight, 20 weight percent SAP material, the 45° wicking distribution at 5 inches was about 12.2 grams of fluid per gram of material. That same material had a wicking distribution at 6 inches of about 7.7 grams of fluid and a distribution at 7 inches of about 1.7 grams of fluid. Similar wicking properties were seen in a 600 g/m² basis weight, 40 weight percent absorbent material of the present invention. In contrast, the absorbent core from a Huggies® diaper, had a wicking distribution at 5 inches of less than 5 grams of fluid per gram of material. The Huggies® diaper cores did not distribute any substantial amounts of fluid beyond 5 inches.

The enhanced flexibility and wicking properties of the present absorbent material has significant advantages to a manufacturer of absorbent articles. Typically such a manufacturer purchases pulp and has to process that pulp on-line in their manufacturing plant as the final article (e.g., diaper, sanitary napkin) is being made. Such processing steps may include defibering of the pulp, adding superabsorbent and the like. In an on-line system, the rapidity with which such steps can be carried out is limited by the slowest of the various steps. An example of a pulp that requires such

processing steps (e.g., defibering) is disclosed in U.S. Pat. No. 5,262,005.

The need of the manufacturer to defiberize or otherwise process existing materials on-line means that the overall production process is substantially more complex. Further, the manufacturer must purchase, maintain and operate the equipment needed to carry out such processing steps. The overall production cost is thus increased.

An absorbent material of the present invention can be directly incorporated into a desired absorbent article without the need for such processing steps. The manufacturer of the absorbent article does not have to defiber or otherwise treat the materials of the present invention in any way other than shaping the material into the desired shape. In this way, the manufacturer can speed up the assembly process and realize substantial savings in cost and time.

The material of this invention can be formed as a single blend of cellulosic fibers and SAP or air-laid as a plurality of layers or strata. In one embodiment, the material is formed as a single layer containing both cellulosic fibers and SAP. In another embodiment, the material is formed as two layers. Each of the layers can contain cellulosic fibers and SAP although it is possible to limit the SAP to only one layer. A preferred material of the present invention is air-laid as three or four lamina or strata. Those strata include a bottom layer, one or two middle layers and a top layer. Preferred embodiments of three and four layer material are set forth below. The SAP can be included in any or all of the layers. The concentration (weight percent) of SAP in each layer can vary as can the nature of the particular SAP. Five or more layer material is also contemplated by this invention.

An unexpected characteristic of the material of this invention is its ability to retain SAP when subjected to mechanical stress. In contrast to conventionally formed core materials, the material of the present invention retained over 85 percent by weight of its SAP content when subjected to 10 minutes of rigorous shaking (See, e.g., Example 4). Preferably, a material of this invention retains over 90 percent, preferably over 95 percent and, more preferably over 99 percent of its SAP under these mechanical stresses.

Even where prepared as from multiple layers, the final thickness of the formed material is low. The thickness can vary from about 0.5 mm to about 2.5 mm. In a preferred embodiment, the thickness is from about 1.0 mm to about 2.0 mm and, more preferably from about 1.25 mm to about 1.75 mm.

One embodiment of an absorbent material of the present invention is particularly well suited for use in feminine hygiene products. (See FIG. 2). Such a material has a basis weight of from about 150 g/m² to about 250 g/m² and a density between about 0.3 g/cc and 0.5 g/cc. More preferably, the density is from about 0.3 g/cc to about 0.45 g/cc and, most preferably about 0.4 g/cc.

In one embodiment, a material for use in a feminine hygiene product is air-laid as three strata: a bottom layer of pulp (without superabsorbent) with a basis weight of about 25 g/m²; a middle layer with a basis weight of about 150 g/m² and which contains from about 10 to about 30 g/m² superabsorbent and from about 120 g/m² to about 140 g/m² pulp; and a top layer of pulp (without superabsorbent) with a basis weight of about 25 g/m². Relative to the total basis weight of the material, the level of superabsorbent ranges from about 5 to about 15 weight percent (g/m² of superabsorbent per g/m² material). Preferably, the level of superabsorbent is from about 7.5 weight percent to about 12.5

weight percent of the material. Most preferably, the material contains about 10 weight percent of superabsorbent. Thus, the middle layer of the material preferably contains from about 15 g/m² to about 25 g/m² superabsorbent and from about 125 g/m² to about 135 g/m² pulp and, more preferably about 20 g/m² superabsorbent and about 130 g/m² pulp. The middle layer containing pulp and superabsorbent can be laid down as a homogeneous blend or as a heterogeneous blend wherein the level of superabsorbent varies with proximity to the bottom layer.

In another embodiment, the material is air-laid as four strata. In this embodiment, the middle layer referred to above is replaced with two middle layers: a first middle layer adjacent the top layer and a second middle layer adjacent the bottom layer. Each of the first and second middle layers independently comprises from about 10 to about 30 g/m² superabsorbent and from about 40 g/m² to about 65 g/m² pulp. When it is desired to keep absorbed fluid away from the top of the feminine hygiene product (i.e., away from the surface of the article in closest proximity to the wearer) the amount of superabsorbent in the first and second middle layers is adjusted such that there is a higher level of superabsorbent in the second middle layer. The superabsorbent in the first and second middle layers can be the same or a different superabsorbent.

Another embodiment of an absorbent material of the present invention is particularly well suited for use in diapers and incontinence products (FIG. 3). Because such articles are expected to absorb and retain larger quantities of less viscous fluid than a feminine hygiene article, such a material is heavier and, thus, has a preferred basis weight of from about 350 g/m² to about 450 g/m². The density of that material is between about 0.3 and 0.5 g/cc. More preferably, the density is from about 0.3 g/cc to about 0.45 g/cc and, most preferably about 0.4 g/cc.

In a manner similar to that described above, a material suitable for use in diapers can be air-laid as three or four strata. When three strata are used, a bottom layer has a basis weight of about 50 g/m²; a middle layer has a basis weight of about 300 g/m² and contains from about 40 to about 200 g/m² superabsorbent and from about 100 g/m² to about 260 g/m² pulp; and a top layer has a basis weight of about 50 g/m². Preferably, the middle layer contains from about 70 g/m² to about 170 g/m² superabsorbent and from about 130 g/m² to about 230 g/m² pulp. Even more preferably, the middle layer contains about 80 g/m² superabsorbent and about 220 g/m² pulp or about 160 g/m² superabsorbent and about 140 g/m² pulp. The middle layer containing pulp and superabsorbent can be laid down as a homogeneous blend or as a heterogeneous blend wherein the level of superabsorbent varies with proximity to the bottom layer.

In a four strata embodiment, the middle layer is replaced with a first and second middle layer oriented as set forth above. Each of the first and second middle layers independently contains from about 20 g/m² to about 100 g/m² superabsorbent and from about 50 g/m² to about 130 g/m² pulp. In a preferred embodiment, the second middle layer has a higher level of superabsorbent than the first middle layer. In this way, the formed absorbent material has a tendency to keep absorbed fluid away from the body surface of the wearer of the article. The superabsorbent in the first and second middle layers can be the same or different.

As set forth above, a preferred cellulosic fiber for use in the present material is wood pulp. There are certain characteristics of wood pulp that make it particularly suitable for use. Cellulose in most wood pulps has a crystalline form

known as Cellulose I which can be converted to a form known as Cellulose II. In the present material, wood pulp with a substantial portion of the cellulose as Cellulose II is preferred. Similarly, pulps having an increased fiber curl value are preferred. Finally, pulps having reduced levels of hemicellulose are preferred. Means for treating pulps so as to optimize these characteristics are well known in the art. By way of example, treating wood pulp with liquid ammonia is known to convert cellulose to the Cellulose II structure and to increase the fiber curl value. Flash drying is known to increase the fiber curl value of pulp. Cold caustic treatment of pulp decreases hemicellulose content, increases fiber curl and converts cellulose to the Cellulose II form. Thus it is preferred that the cellulosic fibers used to produce the material of this invention contain at least a portion of cold caustic treated pulp.

A description of the cold caustic extraction process can be found in U.S. patent application Ser. No. 08/370,571, filed on Jan. 18, 1995, pending which application is a continuation-in-part application of U.S. patent application Ser. No. 08/184,377, now abandoned filed on Jan. 21, 1994. The disclosures of both of these applications are incorporated in their entirety herein by reference.

Briefly, a caustic treatment is typically carried out at a temperature less than about 60° C., but preferably at a temperature less than 50° C., and more preferably at a temperature between about 10° C. to 40° C. A preferred alkali metal salt solution is a sodium hydroxide solution newly made up or as a solution by-product in a pulp or paper mill operation, e.g., hemicaustic white liquor, oxidized white liquor and the like. Other alkali metals such as ammonium hydroxide and potassium hydroxide and the like can be employed. However, from a cost standpoint, the preferable salt is sodium hydroxide. The concentration of alkali metal salts is typically in a range from about 2 to about 25 weight percent of the solution, and preferably from about 6 to about 18 weight percent. Pulps for high rate, fast absorbing applications are preferably treated with alkali metal salt concentrations from about 10 to about 18 weight percent.

The following Examples illustrate preferred embodiments of the present invention and are not limiting of the specification and claims in any way.

EXAMPLE 1

A 400 g/m² absorbent material was produced in accordance with the above procedure using cold caustic extracted pulp. Overall composition of the web was 60% pulp and 40% Stockhausen T5318 SAP. The Gurley stiffness values of the absorbent material as well as absorbent cores from commercially available diapers were measured using a Gurley Stiffness Tester (Model No. 4171E), manufactured by Gurley Precision Instruments of Troy, N.Y. The instrument measures the externally applied moment required to produce a given deflection of a test strip of specific dimensions fixed at one end and having a concentrated load applied to the other end. Those commercial core materials were densified to achieve a range of densities comparable to the material of the present invention. The results are obtained in "Gurley Stiffness" values in units of milligrams. It should be noted that the higher the stiffness of the material, the less flexible and hence the less soft it is. Table 1 presents results of test.

TABLE 1

Effect of Density On Gurley Stiffness					
Absorbent Mat'l.	Stiffness (mg)	—	1021	1175	1575
	Density (g/cc)	—	0.34	0.43	0.5
	Ratio (stiffn/den)		3303	2732	3150
Huggies®	Stiffness (mg)	1006	1313	2450	3775
Ultratrim	Density (g/cc)	.027	0.31	0.4	0.51
Med. Diaper	Ratio (stiffn/den)	3726	4235	6125	7401
Pampers®	Stiffness (mg)	1188	1638	2350	4400
Baby Dry	Density (g/cc)	0.267	0.3	0.42	0.51
Stretch Med. Diaper	Ratio (stiffn/den)	4449	5460	5595	8607

EXAMPLE 2

Absorbent materials of the present invention were made with basis weights of 400 g/m² and 600 g/m² containing 20 and 40 weight percent SAP, respectively. Wicking properties of the material and a core from a Huggies® diaper were measured using GATS system manufactured by M/K Systems of Danvers, Mass. FIG. 4 illustrates set up of the test. A 45° wicking test cell is attached to the absorption measurement device. The test cell essentially consists of a circular fluid supply unit for the test sample and 45° ramps. The fluid supply unit has a rectangular trough and liquid level is maintained at the constant height by the measuring unit. The test sample having dimension of 1"×12" was prepared. The sample was marked every inch along the length of the sample. The sample was then placed on the ramp of the test cell ensuring that one of the edges of the sample dips into the trough. The test was conducted for thirty minutes. Sample was removed after the specified period and cut along the marked distances. The cut pieces were placed into preweighed aluminum weighing dishes. The weighing dish containing wet samples were weighed again and then oven dried to a constant weight. By conducting a proper mass balance on the data, absorbency of the sample was determined at every inch. The following Table 2 presents results of the test:

TABLE 2

Wicked Distance (in)	Absorbency (g/g)		
	400/20 Mat'l.	600/40 Mat'l.	Huggies® Diaper Core
2	19.4	18.9	19.4
3	16.6	17.2	16.3
4	15.3	15	12.4
5	12.2	11.9	4.9
6	7.7	7.9	0.3
7	1.7	1.0	
8	0.2		

The data show that the absorbent web made by the invention has a capability of transporting large amounts of fluid very rapidly from the liquid source.

EXAMPLE 3

A series of samples was evaluated for the integrity of the absorbent core in a range of material density from about 0.20 g/cc to about 0.50 g/cc. The test is performed on an Instron Universal Testing Machine. Essentially, the test measures the load required to pierce through the test sample, as described in the PFI Method of 1981. A test sample having dimensions of 50×50 mm is clamped on the Instron with a

11

suitable fastening device. A 20 mm diameter piston traveling at the rate of 50 mm/min punctures the stationary sample. The force required to puncture the sample is measured. The following Table 3 presents results of the test.

TABLE 3

Density vs. Core Integrity					
Absorbent Mat'l.	Pad Integrity (N)	—	12.4	16.3	15.8
	Density (g/cc)	0.20	0.234	0.326	0.433
	Ratio (inte/den)	—	53	50	36.5
Huggies® Ultra-trim Med.	Pad Integrity (N)	4.1	5.11	7.6	8.24
	Density (g/cc)	0.19	0.254	0.328	0.455
Diaper	Ratio (inte/den)	21.6	20.4	23.0	18.2
Pampers® Baby	Pad Integrity (N)	2.9	3.9	6.6	9.37
Dry Stretch	Density (g/cc)	0.16	0.26	0.38	0.42
Diaper	Ratio (inte/den)	18.1	15.0	17.4	22.3

The above data clearly indicate the absorbent material produced by the above invention is stronger than the conventional absorbent cores in the commercial diapers.

EXAMPLE 4

An amount of loosely held SAP in various absorbent materials was determined by shaking the material in a Ro-Tap Sieve Shaker manufactured by W. S. Tyler Co., Cleveland Ohio. Absorbent cores from commercial diapers, Huggies® Ultratrim and Pampers® Baby-dry Stretch, containing approximately 40% by weight of SAP granules were carefully removed and placed in a 28-mesh (Tyler series) sieve. Additional sieves of 35-mesh and 150-mesh were attached to the first sieve forming a column of increasingly fine sieves. The column of sieves was capped on either end to prevent the loss of fiber and/or SAP. The sieve column was placed in the shaker and agitated for 10 minutes. The amount of SAP granules shaken loose from the absorbent cores, "free SAP", was determined by combining the residue contained in each of the sieves and separating the cellulosic fiber from the SAP. Comparative data for a present absorbent material containing 40% SAP were obtained in a similar fashion. The material was formed as in Example 1.

Data in Table 4 show that the present absorbent materials retained 100% of the SAP granules while the commercial cores from the Huggies® and Pampers® products lost approximately 16.6% and 29.5% by weight of the total SAP contained in the core.

TABLE 4

Determination of Free SAP in Absorbent Cores				
Product	Total Core Weight	Approximate SAP Weight	Free SAP	Approximate % Free SAP
Huggies® Ultratrim	22.63 g	9.05 g	1.51 g	16.6
Pampers® Baby-dry Stretch	20.10 g	8.04 g	2.37 g	29.5
Absorbent Mat'l.	20.45 g	8.18 g	0.00 g	0.0

EXAMPLE 5

Absorbent material produced as in Example 1 was calendered with smooth and engraved (patterned) rolls to achieve desired density. Absorption capacity of the material against various applied pressures was measured by placing a known weight on top of the absorbent material, the known weight representing a specific pressure against the absorbent

12

material, then contacting the absorbent material with a standard (0.9%) saline solution and allowing the material to absorb fluid until an equilibrium condition is attained. The following Table 5 presents results of the test:

TABLE 5

Effect Of Embossing On Absorbent Capacity				
Calender Type	Basis Weight Density		Absorption Against Load (g/m ²)	
	g/m ²	g/cm ³	0.3 psi	0.7 psi
Engraved	352	0.36	5430	4394
Smooth	405	0.35	5871	4666
Engraved	546	0.34	7912	6364
Smooth	596	0.35	8169	6518

It is evident from the test data that absorbency of calendered material with the pattern rolls is lower than the material calendered by the smooth rolls. The pattern roll essentially embosses the material. The lower absorbency may be due to damage caused to the SAP particles or to the introduction of very highly densified areas into the material as a result of the embossing. Damage to SAP granules and creation of super-densified zones in the absorbent material can have a negative impact on absorbent capacity. Therefore, it is preferred to calender the material with a smooth roll.

What is claimed is:

1. An absorbent material having a basis weight of from about 200 g/m² to about 400 g/m² which has been air-laid as a bottom layer of pulp, a middle layer of pulp and super-absorbent polymer disposed in amongst the pulp, and a top layer containing at least some pulp with said layers having been compacted together at an elevated temperature between a pair of rolls to establish a density of from about 0.35 g/cc to about 0.40 g/cc and a ratio of Gurley stiffness (mg) to density (g/cc) of less than about 3700.
2. The material of claim 1 comprising from about 10 weight percent to about 40 weight percent superabsorbent polymer.
3. The material of claim 2 having a basis weight of about 200 g/m² and comprising about 10 weight percent superabsorbent polymer.
4. The material of claim 2 having a basis weight of about 400 g/m² and comprising about 10 weight percent superabsorbent polymer.
5. The material of claim 1 wherein the middle layer comprises a first middle layer adjacent the bottom layer and a second middle layer adjacent the top layer.
6. The material of claim 5 having a basis weight of about 200 g/m² and comprising from about 20 weight percent to about 40 weight percent superabsorbent polymer.
7. The material of claim 5 having a basis weight of about 400 g/m² and comprising from about 20 weight percent to about 40 weight percent superabsorbent polymer.
8. The material of claim 1 wherein the ratio of Gurley stiffness to density is less than about 3250.
9. The material of claim 1 wherein the ratio of Gurley stiffness to density is less than about 3000.
10. The material of claim 1 having a ratio of pad integrity (newtons) to density (g/cc) of greater than about 25.0 newtons-g/cc.
11. The material of claim 1 having a ratio of pad integrity (newtons) to density (g/cc) of greater than about 30.0 newtons-g/cc.
12. The material of claim 1 having a ratio of pad integrity (newtons) to density (g/cc) of greater than about 35.0 newtons-g/cc.

13

13. The absorbent material in accordance with claim 1 in which said temperature is elevated at least to about 100° C.

14. An absorbent material having a top surface and a bottom surface and comprising:

(a) from about 40 weight percent to about 90 weight percent cellulosic fibers; and

(b) from about 10 weight percent to about 60 weight percent superabsorbent polymer, the material having been compacted at an elevated temperature between a pair of rolls to establish a water content of less than about 10 weight percent, a density of greater than about 0.25 g/cc, a ratio of Gurley stiffness (mg) to density (g/cc) of less than about 3700 and a pad integrity of greater than about 12 newtons, the top surface of said absorbent material being substantially free of superabsorbent polymer.

15. The material of claim 14 containing from about 50 to about 90 weight percent cellulosic fibers.

16. The material of claim 14 containing from about 60 to about 80 weight percent cellulosic fibers.

17. The material of claim 14 containing from about 10 to about 50 weight percent superabsorbent polymer.

18. The material of claim 14 containing from about 20 to about 40 weight percent superabsorbent polymer.

19. The material of claim 14 having a density of from about 0.30 to about 0.50 g/cc.

20. The material of claim 14 having a density of from about 0.30 to about 0.45 g/cc.

21. The material of claim 14 having a density of from about 0.30 to about 0.40 g/cc.

22. The material of claim 14 having a ratio of Gurley stiffness to density of less than about 3250.

23. The material of claim 14 having a ratio of Gurley stiffness to density of less than about 3000.

24. The material of claim 14 having a ratio of pad integrity to density of greater than about 25.0.

25. The material of claim 14 having a ratio of pad integrity to density of greater than about 30.0.

26. The material of claim 14 having a ratio of pad integrity to density of greater than about 35.0.

27. The material of claim 14 having a basis weight of from about 50 g/m² to about 700 g/m².

28. The material of claim 14 having a basis weight of from about 100 g/m² to about 600 g/m².

29. The material of claim 14 having a basis weight of from about 200 g/m² to about 400 g/m².

30. The material of claim 14 that is air-laid as a plurality of layers.

31. The material of claim 30 that is air-laid as 3, 4 or 5 layers.

32. The material of claim 30 wherein at least one layer comprises pulp without superabsorbent polymer.

33. The material of claim 14 that has a 45° wicking distribution at 5 inches of at least 5 grams of saline per gram of material.

34. The material of claim 14 that has a 45° wicking distribution at 5 inches of at least 9 grams of saline per gram of material.

35. The material of claim 14 that has a 45° wicking distribution at 5 inches of at least 11 grams of saline per gram of material.

36. The material of claim 14 that has a thickness of from about 0.5 mm to about 2.5 mm.

37. The material of claim 14 that has a thickness of from about 1.0 mm to about 2.0 mm.

38. The material of claim 14 that has a thickness of from about 1.25 mm to about 1.75 mm.

14

39. The material of claim 14 further comprising from about 1 weight percent to about 20 weight percent synthetic fibers.

40. The material of claim 14 that retains more than about 90 weight percent of superabsorbent polymer after shaking for 10 minutes in a Ro-Tap Sieve Shaker.

41. The material of claim 14 that retains more than about 95 weight percent of superabsorbent polymer after shaking for 10 minutes in a Ro-Tap Sieve Shaker.

42. The absorbent material in accordance with claim 14 in which said temperature is elevated at least to about 100° C.

43. An absorbent material having a top surface and a bottom surface and comprising:

(a) from about 40 weight percent to about 90 weight percent cellulosic fibers; and

(b) from about 10 weight percent to about 60 weight percent superabsorbent polymer, the material having been compacted at an elevated temperature between a pair of rolls to establish a water content of less than about 10 weight percent, a density of greater than about 0.25 g/cc, a ratio of Gurley stiffness (mg) to density (g/cc) of less than about 3700, a ratio of pad integrity (newtons) to density (g/cc) of greater than about 25.0 newtons-g/cc, and 45° wicking distribution at 5 inches of at least 5 grams of saline per gram of material, the top surface of said absorbent material being substantially free of superabsorbent polymer.

44. The absorbent material in accordance with claim 43 in which said temperature is elevated at least to about 100° C.

45. An absorbent material having a basis weight of from about 200 g/m² to about 400 g/m², a density of from about 0.35 g/cc to about 0.40 g/cc and a ratio of Gurley stiffness (mg) to density (g/cc) of less than about 3700, wherein the material is air-laid as a bottom layer of pulp, a middle layer of pulp and superabsorbent polymer disposed in amongst the pulp, and a top layer of pulp wherein cellulosic fibers comprise said pulp produced by a process that includes the step of treating a liquid suspension of pulp at a temperature of 15° C. to about 60° C. with an aqueous alkali metal salt solution having an alkali metal salt concentration of from about 2 weight percent to about 25 weight percent of said solution for a period of time ranging from about 5 minutes to about 60 minutes.

46. An absorbent material comprising:

(a) from about 40 weight percent to about 90 weight percent cellulosic fibers; and

(b) from about 10 weight percent to about 60 weight percent superabsorbent polymer, the material having a water content of less than about 10 weight percent, a density of greater than about 0.25 g/cc, a ratio of Gurley stiffness (mg) to density (g/cc) of less than about 3700, and a pad integrity of greater than about 12 newtons wherein the cellulosic fibers comprise pulp produced by a process that includes the step of treating a liquid suspension of pulp at a temperature of from 15° C. to about 60° C. with an aqueous alkali metal salt solution having an alkali metal salt concentration of from about 2 weight percent to about 25 weight percent of said solution for a period of time ranging from about 5 minutes to about 60 minutes.

47. An absorbent material comprising:

(a) from about 40 weight percent to about 90 weight percent cellulosic fibers; and

(b) from about 10 weight percent to about 60 weight percent superabsorbent polymer, the material having a water content of less than about 10 weight percent, a

15

density of greater than about 0.25 g/cc, a ratio of Gurley stiffness (mg) to density (g/cc) of less than about 3700, a ratio of pad integrity to density of greater than about 25.0 newtons-g/cc, and 45° wicking distribution at 5 inches of at least 5 grams of saline per gram of material wherein the cellulosic fibers comprise pulp produced by a process that includes the step of treating a liquid suspension of pulp at a temperature of from 15° C. to about 60° C. with an aqueous alkali metal salt solution having an alkali metal salt concentration of from about 2 weight percent to about 25 weight percent of said solution for a period of time ranging from about 5 minutes to about 60 minutes.

48. An absorbent material having a top surface and a bottom surface and comprising:

- (a) from about 40 weight percent to about 90 weight percent cellulosic fibers; and
- (b) from about 10 weight percent to about 60 weight percent superabsorbent polymer, the material having been compacted at an elevated temperature between a pair of rolls to establish a water content of less than about 10 weight percent, a density of greater than about 0.25 g/cc and a ratio of Gurley stiffness (mg) to density

16

(g/cc) of less than about 3700; and the capability of the material to retain more than about 85 weight percent of superabsorbent polymer after shaking for 10 minutes in a Ro-Tap Sieve Shaker, the top surface of said absorbent material being substantially free of superabsorbent polymer.

49. The absorbent material in accordance with claim 48 in which said temperature is elevated at least to about 100° C.

50. An absorbent material having a top surface and a bottom surface and comprising:

cellulosic fibers and superabsorbent polymer disposed amongst at least some of said cellulosic fibers, the material having been compacted at a temperature of at least about 100° C. to establish a water content of less than about 10 weight percent, a density of greater than about 0.25 g/cc, a ratio of Gurley stiffness (mg) to density (g/cc) of less than about 3700, and a pad integrity of greater than about 12 newtons, the top surface of said absorbent material being substantially free of superabsorbent polymer.

* * * * *

Anexo 3

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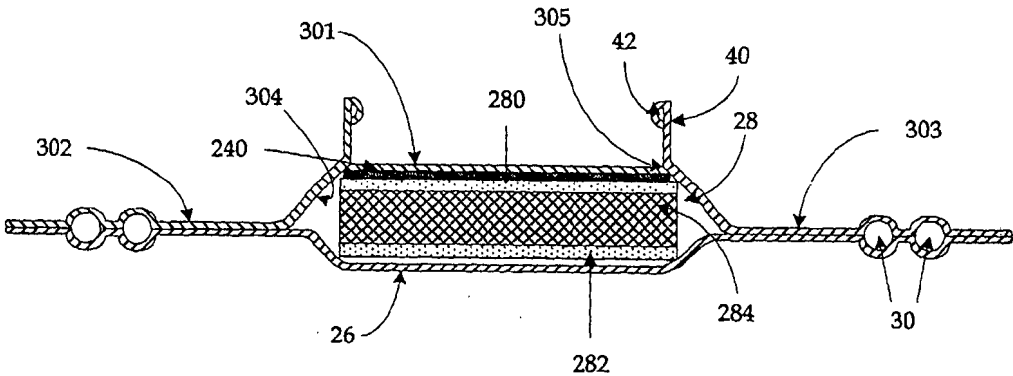
(71) Applicant: PARAGON TRADE BRANDS, INC.
[US/US]; 180 Technology Parkway, Norcross, GA 30092 (US).
(72) Inventors: JOHNSTON, Lee, W.; 1015 Rivermist Drive, Suwanee, GA 30024 (US). LITVAY, John, D.; 3776 Scotts Mill Ron, Duluth, GA 30096 (US). MOLEE, Kenneth, John; 860 Lakelair Landing, Suwanee, GA 30024 (US).
(74) Agents: CAMPBELL, Christopher, C. et al.; Intellectual Property Department, Hunton & Williams, Suite 1200, 1900 K Street, N.W., Washington, DC 20006-1109 (US).

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(54) Title: IMPROVED CONVECTION OF ABSORBENT CORES PROVIDING ENHANCED THERMAL TRANSMITTANCE



(57) Abstract: The present invention generally relates to an absorbent article (10) that includes a top sheet (24), a back sheet (26), and an absorbent core (28) disposed between the top sheet (24) and the back sheet (26). The absorbent article (10) has enhanced thermal transmittance by evincing a lower thermal resistance (clo) of less than about 1.7 watts/m², as measured in a Thermolabo apparatus. The absorbent article (10) of the invention preferably has a low density, low basis weight core, and it provides improved comfort.



WO 03/047486 A1

IMPROVED CONVECTION OF ABSORBENT CORES PROVIDING ENHANCED THERMAL TRANSMITTANCE

FIELD OF THE INVENTION

The present invention relates generally to an absorbent core for a disposable absorbent garment, and more particularly to improved convection of an absorbent core comprising superabsorbent polymer (SAP) dispersed in a fibrous
5 matrix. The absorbent garment of the invention provides improved comfort, and has enhanced thermal transmittance.

BACKGROUND OF THE INVENTION

Traditionally, disposable absorbent garments such as infant diapers or training pants, adult incontinence products and other such products were constructed
10 with a moisture-impervious outer backing sheet, a moisture-pervious body-contacting inner liner sheet, and a moisture-absorbent core sandwiched between the liner and backing sheets. Much effort has been expended to find cost-effective materials for absorbent cores that display favorable liquid absorbency and retention. Superabsorbent materials in the form of granules, beads, fibers,
15 bits of film, globules, etc., have been favored for such purposes. Such superabsorbent materials generally are polymeric gelling materials that are capable of absorbing and retaining even under moderate pressure large quantities of liquid, such as water and body wastes, relative to their own weight.

The superabsorbent material generally is a water-insoluble but water-swella-
20 ble polymeric substance capable of absorbing water in an amount at least ten times the weight of the substance in its dry form. In one type of superabsorbent material, the particles or fibers may be described chemically as having a back bone of natural or synthetic polymers with hydrophilic groups or polymers containing hydrophilic groups being chemically bonded to the back bone or in
25 intimate admixture therewith. Included in this class of materials are such modified polymers as sodium neutralized cross-linked polyacrylates and

polysaccharides including, for example, cellulose and starch and regenerated cellulose which are modified to be carboxylated, phosphonoalkylated, sulfoxylated or phosphorylated, causing the SAP to be highly hydrophilic. Such modified polymers may also be cross-linked to reduce their water-

5 solubility.

It is known to provide absorbent laminates comprised of, for example, an upper layer, a lower layer, and a central fibrous layer containing from 30% to 95% by weight SAP. U.S. Patent No. 6,068,620, the disclosure of which is incorporated herein by reference in its entirety and in a manner consistent with the present

10 disclosure, discloses that the upper and lower layers are comprised of tissue, airlaid fluff pulp or synthetic non-woven fibrous layers. The upper and lower layers are said to provide thinner absorbent materials, and to assist in maintaining the integrity of the core, the laminate layered arrangement is said to minimize gel blocking, and the laminate can be folded in various configurations.

15 It generally is desirable to make absorbent articles as thin as possible, yet still thick enough to provide suitable absorption. H1565 proposes using a superabsorbent web made of superabsorbent particulate material in a continuous matrix of cellulose acetate fibers. The superabsorbent material is dispersed in the fibrous web by immobilizing it with a binder. Other documents

20 disclosing incorporating superabsorbent polymers and various fibrous materials in absorbent cores include, inter alia, U.S. Patent Nos. 5,350,370, and 5,436,066, the disclosures of each of which are incorporated by reference herein in their entirety.

Various materials used to make absorbent garments, as well as the thickness of

25 its constituent parts can lead to high insulation, and consequently, less comfort. Various methods have been proposed to enhance an absorbent article's comfort. For example, many absorbent articles have extra elastic material to provide a better fit. H1969, H1,978 and H1,989 disclose a method of enhancing comfort by incorporating breathable microporous films having zoned breathability. The

breathable films are said to have varying water vapor transmission rates (WVTR) in various zones to provide the requisite breathability. High WVTR levels in nonabsorbent areas are said to increase wearer comfort, which these documents allege can be measured by dry and wet heat transfer, and the permeability index.

Various mechanisms have been proposed in the past to determine the thermal resistance properties and moisture resistance properties of fabrics. For example, sweating hot plates have been used, which generally operate by maintaining a constant plate surface temperature, a known water vapor pressure at the surface of the plate, and constant environmental conditions, such as air temperature, humidity, and velocity. With the use of insulation and a surrounding guard, these traditional plates create a 1-dimensional flow of heat through test fabrics. Consequently, the thermal resistance and moisture resistance of fabrics can be calculated employing equations based on the recorded changing power input and changing water input used to maintain the plate surface at a selected temperature and water vapor pressure, respectively.

United States Patent No. 5,749,259, the disclosure of which is incorporated by reference herein in its entirety, discloses a sweating hot plate and related method wherein the surface temperature of the plate is not constant but rather varies so that the plate, when used to test fabric placed thereon, will have a changing surface temperature that approximates the changing skin surface temperature of a human. Thus, the sweating hot plate disclosed in this document may be employed to predict the thermal comfort of the fabric directly.

SUMMARY OF THE INVENTION

It would be desirable to provide an absorbent garment having an improved ability to retain fluids and consequently, to prevent leakage. It also would be desirable to provide an absorbent core that includes an increased amount of superabsorbent polymers to absorb greater amounts of fluids, but at the same time, is not appreciably thicker. It also would be desirable to provide an

absorbent core that has the above mentioned characteristics, and in addition has improved thermal transmittance to improve the comfort of the garment.

It is therefore a feature of an embodiment of the invention to provide an absorbent garment having an improved ability to retain fluids. It is an
5 additional feature of an embodiment of the invention to provide an absorbent garment that includes an absorbent core having SAP particles dispersed in a fibrous matrix, where the absorbent core has high dry and wet strength for processing and in-use performance. An additional feature of various
10 embodiments of the invention is providing an absorbent core that has good fluid acquisition, distribution, and storage characteristics, preferably is thinner than conventional cores, and has improved thermal transmittance.

These and other features of the invention can be achieved by an absorbent article including a top sheet, a back sheet and an absorbent core disposed between the top sheet and the back sheet. The absorbent core of the invention is comprised
15 of a fibrous layer containing superabsorbent polymer particles (SAP). The absorbent article has an intrinsic thermal resistance (R_{cf}) of less than about 0.20 ($\Delta^{\circ}\text{C m}^2/\text{watt}$), as measured on a 20x20 inch sample in a Thermolabo apparatus. The absorbent article preferably has an R_{cf} of less than about 0.19 $\Delta^{\circ}\text{C m}^2/\text{watt}$, as measured on a 20x20 inch sample in a Thermolabo apparatus.

20 In accordance with an additional feature of an embodiment of the invention, there is provided an absorbent article including a top sheet, a back sheet and an absorbent core disposed between the top sheet and the back sheet. The absorbent core of the invention is comprised of a fibrous layer containing superabsorbent polymer particles (SAP). The absorbent article has a thermal
25 resistance (clo) of less than about 1.7 w/m^2 , as measured in a Thermolabo apparatus.

In accordance with an additional feature of an embodiment of the invention, there is provided a method of making an absorbent article that includes providing a topsheet material and a backsheet material. The method also

includes preparing an absorbent core that includes SAP dispersed in a fibrous matrix, and disposing the absorbent core between the topsheet and the backsheet. The absorbent article made by the method has an intrinsic thermal resistance (Rcf) of less than about $0.25 \Delta^{\circ}\text{C m}^2/\text{watt}$, as measured on a 20x20 inch sample in a Thermolabo apparatus, and an Rcf of less than about $0.19 \Delta^{\circ}\text{C m}^2/\text{watt}$, as measured on a 20x20 inch sample in a Thermolabo apparatus. The absorbent article made by the method also preferably has a thermal resistance (clo) of less than about $1.7 \text{ w}/\text{m}^2$.

In addition to the foregoing advantages, the absorbent garment having the absorbent core with improved thermal transmittance improves the comfort of the garment by allowing body heat to more rapidly transmit to the outer environment. Further, due to the thinness of the resulting product, less packaging material is needed for the same amount of product, and shipping and handling costs are lowered.

These and other features and advantages of the preferred embodiments will become more readily apparent when the detailed description of the preferred embodiments is read in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a partially cut-away view of an embodiment of the present invention, shown with elastic members fully stretched in the main portion of the garment;

Figure 2 is a cross-sectional view of the absorbent garment in Figure 1 taken along line A-A, illustrating one embodiment for the absorbent laminate core of the invention;

Figure 3 is a schematic illustration of an environmental chamber used in the Test Methods to determine the heat transfer characteristics of the absorbent article of the invention; and

Figure 4 is a schematic illustration of various skin models used in the Test Methods to determine the heat transfer characteristics of the absorbent article of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 As used herein, the terms "absorbent garment," "absorbent article" or simply "article" or "garment" refer to devices that absorb and contain body fluids and other body exudates. More specifically, these terms refer to garments that are placed against or in proximity to the body of a wearer to absorb and contain the various exudates discharged from the body. A non-exhaustive list of examples
10 of absorbent garments includes diapers, diaper covers, disposable diapers, training pants, feminine hygiene products such as feminine pads and adult incontinence products. Such garments may be intended to be discarded or partially discarded after a single use ("disposable" garments). Such garments may comprise essentially a single inseparable structure ("unitary" garments), or
15 they may comprise replaceable inserts or other interchangeable parts.

The present invention may be used with all of the foregoing classes of absorbent garments, without limitation, whether disposable or otherwise. The embodiments described herein provide, as an exemplary structure, a diaper for an infant, however this is not intended to limit the claimed invention. The
20 invention will be understood to encompass, without limitation, all classes and types of absorbent garments, including those described herein. Preferably, the absorbent core is thin in order to improve the comfort and appearance of a garment. The importance of thin, comfortable garments is disclosed, for example, in U.S. Pat. No. 5,098,423 to Pieniak *et al.*, the disclosure of which is
25 herein incorporated by reference in its entirety.

Throughout this description, the expressions "upper layer" and "lower layer" that refer to the layers surrounding the absorbent core of the invention are used merely to describe one layer above the core, and one layer below the core. The upper layer need not always remain vertically above the core, and the lower

layer need not always remain vertically below the core. The upper and lower layer need not be included. Indeed, many embodiments of the invention encompass various configurations of the absorbent laminate core whereby the laminate is folded in such a manner that the upper layer ultimately becomes the
5 vertically highest and vertically lowest layer at the same time. Other configurations are contemplated within the context of the present invention.

Throughout this description, the term "disposed" and the expressions "disposed on," "disposing on," "disposed in," "disposed between" and variations thereof (e.g., a description of the article being "disposed" is interposed between the
10 words "disposed" and "on") are intended to mean that one element can be integral with another element, or that one element can be a separate structure bonded to or placed with or placed near another element. Thus, a component that is "disposed on" an element of the absorbent garment can be formed or applied directly or indirectly to a surface of the element, formed or applied
15 between layers of a multiple layer element, formed or applied to a substrate that is placed with or near the element, formed or applied within a layer of the element or another substrate, or other variations or combinations thereof.

Throughout this description, the expression "tow fibers" relates in general to any continuous fiber. Tow fibers typically are used in the manufacture of staple
20 fibers, and preferably are comprised of synthetic thermoplastic polymers. Usually, numerous filaments are produced by melt extrusion of the molten polymer through a multi-orifice spinneret during manufacture of staple fibers from synthetic thermoplastic polymers in order that reasonably high productivity may be achieved. The groups of filaments from a plurality of
25 spinnerets typically are combined into a tow which is then subjected to a drawing operation to impart the desired physical properties to the filaments comprising the tow.

The present invention relates generally to absorbent articles, and in particular to an absorbent article that contains a topsheet, a backsheet, and an absorbent core

- disposed between the topsheet and the backsheet. The absorbent core of the invention is comprised of a fibrous layer containing superabsorbent polymer particles (SAP). The absorbent article has an intrinsic thermal resistance (Rcf) of less than about $0.25 \Delta^{\circ}\text{C m}^2/\text{watt}$, as measured on a 20x20 inch sample in a
- 5 Thermolabo apparatus, and an Rcf of less than about $0.19 \Delta^{\circ}\text{C m}^2/\text{watt}$, as measured on a 20x20 inch sample in a Thermolabo apparatus. The absorbent article also preferably has a thermal resistance (clo) of less than about 1.7 w/m^2 . It is preferred in the present invention that the Rcf of a 20 in. x 20 in. sample of the absorbent article be less than about $0.185 \Delta^{\circ}\text{C m}^2/\text{watt}$, more preferably less
- 10 than about $0.182 \Delta^{\circ}\text{C m}^2/\text{watt}$, and most preferably less than about $0.18 \Delta^{\circ}\text{C m}^2/\text{watt}$. It also is preferred that the absorbent article have a thermal resistance (clo) of less than about 1.65 w/m^2 , more preferably less than about 1.60 w/m^2 , even more preferably less than about 1.53 w/m^2 , and even more preferably less than about 1.47 w/m^2 , and most preferably, less than about 1.40 w/m^2 .
- 15 The absorbent article of the invention preferably has a front waist region, a rear waist region and a crotch region positioned between the front and rear waist regions. The front waist region and rear waist region can be associated with one another to form a waist opening, and two leg openings. Those skilled in the art recognize that "front" and "rear" in the context of the invention denote for
- 20 clarity purposes only the front and rear of a user, and that the absorbent article could be reversed whereby the previously described "front" portion becomes the rear portion, and vice versa. For purposes of this description, however, the front generally denotes the front portion of the wearer, and it is understood that this is the portion of the garment that has the desirable thermal transmittance
- 25 properties described herein.
- Leg elastics preferably are provided along the leg openings for securely holding the leg openings against the thighs of the wearer to improve containment and fit. A fastening system, either resealable or permanent, preferably holds the absorbent article around the wearer's waist. The fastening system assists in
- 30 associating the front waist region with the rear waist region. A pair of stand-up

leg gathers or waist containment flaps may be attached to or formed from the body's side surface of the top sheet.

A particularly preferred embodiment of the absorbent article of the invention includes an absorbent laminate core comprising at least three layers. Each
5 absorbent core laminate preferably comprises a high efficiency, SAP-containing central fibrous layer disposed between upper and lower tissue layers.

Other non-SAP-containing roll good materials such as latex or thermally bonded airlaid fluff pulp, (e.g., roll good available from Buckeye or Fort James), or synthetic spunbonded, carded, or hydro-entangled non-woven may be
10 positioned above and below the absorbent core. In a particularly preferred embodiment of the invention, at least the central fibrous layer of the absorbent laminate core contains 30-95% by weight particulate or fibrous SAP and at least one other fibrous or particulate material that is capable of maintaining high SAP efficiency. As described in U.S. Patent No. 6,068,620, SAP efficiency can be
15 expressed as the ratio of the actual SAP absorbency under load, or AUL (expressed as grams of saline absorbed per gram of SAP in the laminate), and the maximum SAP AUL obtained under ideal conditions of low basis weight where gel blocking does not occur. SAP concentrations of 50-95% provide thinner roll good composites for efficient shaping and handling. High SAP concentrations
20 also provide thinner absorbent cores that can provide new options for product design. The absorbent cores of the invention can be made using either a wet or dry process.

Forming the absorbent core of the invention with one or more inner layers disposed between an upper and lower layer is believed to decouple key
25 performance attributes of traditional absorbent cores. As recognized by skilled artisans, the various layers of an absorbent core typically are designed with competing interests. A compromise usually is made at the sacrifice of the optimal performance attributes of each of the individual layers. By decoupling the performance attributes of the individual layers, the absorbent core of the

preferred embodiments optimizes the key characteristic performance attributes of each of the laminated inner layers, thereby resulting in overall improved performance over previously known absorbent cores, or absorbent laminates.

Absorbent articles also typically are designed with competing thermal transmittance interests. Outer layers often are rendered breathable to allow more moisture and thermal energy to escape. The inner absorbent cores, however, are designed to retain moisture, which has a tendency to trap the thermal energy in the article. While not intending on being bound by any theory, the present inventors believe that the absorbent cores described herein, which preferably are relatively thin cores and comprised of low density materials and arranged in a configuration to have high SAP efficiency, provide improved thermal transmittance, when compared to conventional absorbent articles employing conventional absorbent cores. The improved thermal transmittance translates into an absorbent garment having improved comfort.

The invention now will be described with reference to the attached drawings illustrating preferred embodiments of the invention. For clarity, features that appear in more than one Figure have the same reference number in each Figure.

Figure 1 is a partially cut away depiction of an exemplary embodiment of an absorbent garment 10 (preferably a disposable absorbent garment) of the present invention. The embodiment shown in Figure 1 is an infant's diaper, however, this depiction is not intended to limit the invention, and those skilled in the art appreciate that the invention covers other types of absorbent articles. For simplicity, however, the invention will be described with reference to an infant's diaper. The garment 10 of Figure 1 is depicted in a generally flattened position, with the body-facing side facing down, and with the various elastic components depicted in their relaxed condition with the effects of the elastics removed for clarity (when relaxed, the elastics typically cause the surrounding material to gather or "shirr"). In the flattened position, the garment 10 may have a generally hourglass shaped structure, but it may also have any other shape

suitable for the given application, such as a rectangular shape, a trapezoidal shape, a "T" shape, and the like.

As used herein, the longitudinal axis 100 of the garment is the dimension of the garment corresponding to the front-to-rear dimension of the user, and the lateral
5 axis 102 of the garment is the dimension corresponding to the side-to-side dimension of the user.

In use, the invention comprises a pant-like garment 10 having a waist-encircling region and a crotch region. The waist-encircling region may comprise a first waist region 12, disposed adjacent to, for example, the back waist region of a
10 wearer's body, and a second waist region 14, disposed adjacent to, for example, the front waist region of a wearer's body. The first and second waist regions 12, 14, may correspond to the front and back of the wearer's body, respectively, depending on whether garment 10 is attached in front of or behind the subject
15 wearer. The first and second waist regions are joined together at or near their lateral edges 18, causing the longitudinally distal edges 20 of the garment 10 to form the perimeter of a waist opening. A crotch region 16 extends between the first and second waist regions 12, 14, and the crotch edges 22 form the perimeter of a pair of leg openings, when the garment 10 is placed on a subject wearer.

The garment 10 preferably comprises a topsheet 24, and a backsheet 26, which
20 may be substantially coterminous with the topsheet 24. When the garment 10 is being worn, the topsheet 24 faces the wearer's body, and the backsheet 26 faces away from the wearer. An absorbent core 28 preferably is disposed between at least a portion of the topsheet 24 the backsheet 26.

An embodiment of the present invention may further comprise various
25 additional features. One or more pairs of elastic gathers 30 may extend adjacent the crotch edges 22. The garment 10 may also comprise one or more waste containment systems, such as inboard standing leg gathers 40, which preferably extend from the second waist region 14 to the first waist region 12 along opposite sides of longitudinal center line 100 (only one standing leg gather

system 40 is shown in Figure 1 for purposes of clarity). One or both of the first and second waist regions 12, 14 may also be equipped with strips of elastic waist foam 32 or other elastically extensible material, which help contract the garment around the wearer's waist, providing improved fit and leakage prevention.

- 5 The absorbent garment 10 also preferably includes fastening elements to enable attachment of the first waist region 12 to second waist region 14. Fastening elements preferably include a pair of tabs 34 that extend laterally away from opposite lateral edges 18 of the first waist region 12 of the garment 10. The tabs 34 may comprise an elastically extensible material (not shown), and may be
10 designed to stretch around a wearer's waist to provide improved fit, comfort, and leakage protection. Such elasticized tabs 34 may be used in conjunction with, or in lieu of, waist foam 32, or other elastically extensible materials 32.

- At least one fastening mechanism 36 (collectively referred to as "fastener 36") is attached to each tab 34 for attaching the tab to the second waist region 14,
15 thereby providing the garment 10 with a pant-like shape, and enabling garment 10 to be fixed or otherwise fitted on the wearer. The fasteners 36 may attach to one or more target devices 38 located in the second waist region 14.

- Although not shown in the drawings, the absorbent garment 10 may also include grips attached along one of its edges proximal to each tab 34 to enable a
20 caregiver to pull the grips, and not on the ends of the tabs 34, around the wearer and over the target devices 38 to thereby secure the fasteners 36 to the one or more target devices 38.

- The various parts of the garment 10 can be attached to one another or associated with one another to form a structure that preferably maintains its shape during
25 the useful life of the garment 10. As used herein, the terms "attached," "joined," "associated," and similar terms encompass configurations whereby a first part is directly joined to a second part by affixing the first part directly to the second part, by indirectly joining the first part to the second part through intermediate members, and by fixing the relative positions of various parts by capturing parts

between other parts. Those skilled in the art will appreciate that various methods or combinations of methods may be used to securely join the respective parts of the garment 10 to one another.

The topsheet 24 and backsheet 26 may be constructed from a wide variety of materials known in the art. The invention is not intended to be limited to any specific materials for these components. The topsheet 24 and backsheet can be shaped and sized according to the requirements of each of the various types of absorbent garment, or to accommodate various user sizes. In an embodiment of the invention in which the garment 10 is a diaper or an adult incontinence brief, the combination of topsheet 24 and backsheet 26, may have an hourglass shape, as seen in Figure 1, or may have a rectangular, trapezoidal, "T" shape, or other shape.

Due to the wide variety of backing and liner sheet construction and materials currently available, the invention is not intended to be limited to any specific materials or constructions of these components. The back sheet 26 preferably is made from any suitable pliable liquid-impervious material known in the art. Typical back sheet materials include films of polyethylene, polypropylene, polyester, nylon, and polyvinyl chloride and blends of these materials. For example, the back sheet can be made of a polyethylene film having a thickness in the range of 0.02-0.04 mm. The backsheet 26 may be pigmented with, for example, titanium dioxide, to provide the garment 10 with a pleasing color or to render the backsheet 26 opaque enough that exudates being contained by the garment 10 are not visible from outside the garment. In addition, the backsheet 26 may be formed in such a manner that it is opaque, for example, by using various inert components in the polymeric film and then biaxially stretching the film. Other backsheet materials will be readily apparent to those skilled in the art. The backsheet 26 preferably has sufficient liquid imperviousness to prevent any leakage of fluids. The required level of liquid imperviousness may vary between different locations on the garment 10.

The backsheet 26 may further comprise separate regions having different properties. In a preferred embodiment, portions of the backsheet 26 are air-permeable to improve the breathability, and therefore comfort, of the garment 10. The different regions may be formed by making the backsheet 26 a composite of different sheet materials, chemical treatment, heat treatment, or other processes or methods known in the art. Some regions of the backsheet 26 may be fluid pervious. In one embodiment of the invention, the backsheet 26 is fluid impervious in the crotch 16, but is fluid pervious in portions of the first and second waist regions 12, 14. The backsheet 26 may also be made from a laminate of overlaid sheets of material.

The moisture-pervious top sheet 24 can be comprised of any suitable relatively liquid-pervious material known in the art that permits passage of liquid there through. Non-woven liner sheet materials are exemplary because such materials readily allow the passage of liquids to the underlying absorbent laminate core 28. Examples of suitable liner sheet materials include non-woven spunbond or carded webs of polypropylene, polyethylene, nylon, polyester and blends of these materials.

The backsheet 26 may be covered with a fibrous, nonwoven fabric such as is disclosed, for example, in U.S. Patent 4,646,362 issued to Heran *et al.*, the disclosure of which is hereby incorporated by reference in its entirety and in a manner consistent with this disclosure. Materials for such a fibrous outer liner include a spun-bonded nonwoven web of synthetic fibers such as polypropylene, polyethylene or polyester fibers; a nonwoven web of cellulosic fibers, textile fibers such as rayon fibers, cotton and the like, or a blend of cellulosic and textile fibers; a spun-bonded nonwoven web of synthetic fibers such as polypropylene; polyethylene or polyester fibers mixed with cellulosic, pulp fibers, or textile fibers; or melt blown thermoplastic fibers, such as macro fibers or micro fibers of polypropylene, polyethylene, polyester or other thermoplastic materials or mixtures of such thermoplastic macro fibers or micro fibers with cellulosic, pulp or textile fibers. Alternatively, the backsheet 26 may

comprise three panels wherein a central poly backsheet panel is positioned closest to absorbent laminate core 28 while outboard non-woven breathable side backsheet panels are attached to the side edges of the central poly backsheet panel. Alternatively, the backsheet 26 may be formed from microporous poly coverstock for added breathability.

As illustrated in more detail in Figure 2, the top sheet 24 may be formed of three separate portions or panels. Those skilled in the art will recognize, however, that top sheet 24 need not be made of three separate panels, and that it may be comprised of one unitary item. A first top sheet panel 301 may comprise a central top sheet panel formed from preferably a liquid-pervious material that is either hydrophobic or hydrophilic. The central top sheet panel 301 may be made from any number of materials, including synthetic fibers (e.g., polypropylene or polyester fibers), natural fibers (e.g., wood or cellulose), apertured plastic films, reticulated foams and porous foams to name a few. One preferred material for a central top sheet panel 301 is a cover stock of single ply non-woven material which may be made of carded fibers, either adhesively or thermally bonded, perforated plastic film, spunbonded fibers, or water entangled fibers, which generally weigh from 0.3-0.7 oz./sq. yd. and have appropriate and effective machine direction and cross-machine direction strength suitable for use as a baby diaper cover stock material. The central top sheet 301 panel preferably extends from substantially the second waist region 14 to the first waist region 12, or a portion thereof.

The second and third top sheet panels 302, 303 (e.g., outer top sheet panels), in this alternative embodiment may be positioned laterally outside of the central top sheet panel 301. The outer top sheet panels 302, 303 are preferably substantially liquid-impervious and hydrophobic, preferably at least in the crotch area. The outer edges of the outer top sheet panels may substantially follow the corresponding outer perimeter of the back sheet 26. The material for the outer top sheet portions or panels is preferably polypropylene and can be

woven, non-woven, spunbonded, carded or the like, depending on the application.

The inner edges 304 (FIG. 2) of the outer topsheet portions or panels 302, 303 preferably are attached by, e.g., an adhesive, to the outer edges 305 of the inner
5 topsheet portion or panel 301. At the point of connection with the outer edges 305 of the inner topsheet portion or panel 301, the inner edges 304 of the outer topsheet portions or panels 302, 303 extend upwardly to form waste containment flaps 40. The waste containment flaps 40 preferably are formed of the same material as the outer topsheet portions or panels 302, 303, as in the embodiment
10 shown. They are preferably an extension of the outer topsheet portions or panels 302, 303.

The waste containment flaps 40 may be treated with a suitable surfactant to modify their hydrophobicity/hydrophilicity as desired, and they may be treated with skin wellness ingredients to reduce skin irritation. Alternatively, the waste
15 containment flaps 40 may be formed as separate elements and then attached to the body side liner. In this alternative embodiment, the central topsheet portion or panel 301 may extend past the connection point with the waste containment flaps 40, and even extend to the periphery of the backsheet 26.

The waste containment flaps 40 preferably include a portion that folds over onto
20 itself to form a small enclosure. At least one, and depending on the size of the enclosure sometimes more than one, elastic member 42 may be secured in the enclosure in a stretched condition. As has been known at least as long the disclosure of Tetsujiro, Japanese Patent document 40-11543, when the flap elastic 42 attempts to assume the relaxed, unstretched condition, the waste containment
25 flaps 40 rise above the surface of the central topsheet portion or panel 301.

The topsheet 24 (as well as topsheet portions 301, 302, 303) may be made of any suitable relatively liquid-pervious material currently known in the art or later discovered that permits passage of a liquid there through. Examples of suitable topsheet materials include nonwoven spun-bonded or carded webs of

polypropylene, polyethylene, nylon, polyester and blends of these materials, perforated, apertured, or reticulated films, and the like. Nonwoven materials are exemplary because such materials readily allow the passage of liquids to the underlying absorbent laminate core 28. The topsheet 24 preferably comprises a
5 single-ply nonwoven material that may be made of carded fibers, either adhesively or thermally bonded, spunbonded fibers, or water entangled fibers, which generally weigh from 0.3 - 0.7 oz./sq. yd. and have appropriate and effective machine direction (longitudinal) and cross-machine (lateral) direction strength suitable for use as a topsheet material for the given application. The
10 present invention is not intended to be limited to any particular material for the topsheet 24, and other topsheet materials will be readily apparent to those skilled in the art.

The topsheet 24 may further comprise several regions having different properties. In one embodiment of the present invention, the laterally distal
15 portions of the topsheet 24, especially those used to make second and third top sheet panels 302, 303, preferably are substantially fluid impervious and hydrophobic, while the remainder of the topsheet 24 (e.g., central top sheet panel 301) is hydrophilic and fluid pervious. Different topsheet properties, such as fluid perviousness and hydrophobicity, may be imparted upon the topsheet 24
20 by treating the topsheet 24 with adhesives, surfactants, or other chemicals, using a composite of different materials, or by other means. The topsheet 24 may also be made from a laminate of overlaid sheets of material. The topsheet 24 also may be treated in specific areas like the crotch region, with skin wellness ingredients such as aloe, vitamin E, and the like.

25 As noted elsewhere herein, the topsheet 24 and backsheet 26 may be substantially coterminous, or they may have different shapes and sizes. The particular design of the topsheet 24 and backsheet 26 may be dictated by manufacturing considerations, cost considerations, and performance considerations. Preferably, the topsheet 24 is large enough to completely cover
30 the absorbent laminate core 28, and the backsheet 26 is large enough to prevent

leakage from the garment 10. The design of topsheet 24 and backsheet 26 is known in the art, and a skilled artisan will be able to produce an appropriate topsheet 24 and an appropriate backsheet 26 without undue experimentation.

5 The topsheet 24 and the backsheet 26 may be associated with one another using a variety of methods known in the art. For example, they may be thermally, ultrasonically, or chemically bonded to one another. They also may be joined using lines of hot melt adhesive or mechanical fasteners, such as thread, clips, or staples. In one embodiment, a hydrophilic adhesive, such as Cycloflex as sold by National Starch, a corporation headquartered in Bridgewater, New Jersey, is
10 used to join the topsheet 24 to the backsheet 26. The particular joining method may be dictated by the types of materials selected for the topsheet 24 and backsheet 26.

As mentioned above, absorbent garment preferably is provided with leg elastics 30 extending through crotch region 16, adjacent crotch edge 22. The absorbent
15 garment of the invention also preferably is provided with waist elastic material 32 optionally in the first and second waist regions, 12, 14, respectively, to enable and assist in stretching around the wearer. The waist elastics 32 may be similar structures or different to impart similar or different elastic characteristics to the first and second waist regions 12, 14 of the garment. In general, the waist
20 elastics may preferably comprise foam strips positioned at the first and second waist regions 12, 14, respectively. Such foam strips preferably are about 1/2 to about 1 1/2 inches wide and about 3-6 inches long. The foam strips preferably are positioned between the top sheet portions 24 or panels (301, 302, 303) and the back sheet 26. Alternatively, a plurality of elastic strands may be employed as
25 waist elastics rather than foam strips. The foam strips preferably are comprised of polyurethane, but can be any other suitable material that decreases waist band roll over, reduces leakage over the waist ends of the absorbent garment, and generally improve comfort and fit. The first and optional second waist foam strips 32 preferably are stretched 50-150%, preferably 100% more than their

unstretched dimension before being adhesively secured between the back sheet 26 and top sheet 24.

Each edge 22 that forms the leg openings preferably is provided with an adjacent leg elastic containment system 30. In the preferred embodiment, three strands of elastic threads (only two strands are shown in Figure 2 for purposes of clarity) are positioned to extend adjacent to leg openings between the outer top sheet portions or panels 302, 303 and the back sheet 26. Any suitable elastomeric material exhibiting at least an elongation (defined herein as $(L_S - L_R)/L_R$ where L_S is the stretch length of an elastic element and L_R is retracted length, multiplied by 100 to obtain percent elongation) in the range of 5%-350%, preferably in the range of 200%-300%, can be employed for the leg elastics 30. The leg elastics 30 may be attached to the absorbent article 10 in any of several ways which are known in the art. For example, the leg elastics 30 may be ultrasonically bonded, heat/pressure sealed using a variety of bonding patterns, or glued to the garment 10. Various commercially available materials can be used for the leg elastics 30, such as natural rubber, butyl rubber or other synthetic rubber, urethane, elastomeric materials such as LYCRA (DuPont), GLOSPAN (Globe) or SYSTEM 7000 (Fulflex).

The fastening elements, preferably a fastening system 34 (e.g., tab 34) of the preferred embodiment, is attached to the first waist region 12, and it preferably comprises a tape tab or mechanical fasteners 36. However, any fastening mechanism known in the art will be acceptable. Moreover, the fastening system 34 may include a reinforcement patch below the front waist portion so that the diaper may be checked for soiling without compromising the ability to reuse the fastener. Alternatively, other absorbent article fastening systems are also possible, including tapes, adhesives, safety pins, buttons, and snaps.

As stated previously, the invention has been described in connection with a diaper. The invention, however, is not intended to be limited to application only in diapers. Specifically, the absorbent cores of the preferred embodiments may

be readily adapted for use in other absorbent garments besides diapers, including, but not limited to, training pants, feminine hygiene products and adult incontinence products. Indeed, given the enhanced thermal transmittance, the absorbent articles of the present invention are particularly suitable for use in
5 adult incontinence products and feminine hygiene products.

The underlying structure beneath the topsheet 24 may include, depending on the diaper construction, various combinations of elements, but in each embodiment, it is contemplated that the absorbent garment will preferably include an absorbent core 28. For example, an additional layer 280 may be disposed
10 between the topsheet 24 and absorbent core 28, as shown in Figure 2, and/or other additional layers may be disposed between these layers, or between absorbent core 28 and backsheet 26. The additional layer(s) 280 may include a fluid transfer layer, a fluid handling layer, a storage layer, a wicking layer, a fluid distribution layer, and any other layer(s) known to those having ordinary
15 skill in the art.

Although the absorbent core 28 depicted in FIG. 2 has a substantially rectangular cross-sectional and plan view shape, other shapes may be used, such as a "T" shape or an hourglass shape. The shape of the absorbent core 28 may be selected to provide the greatest absorbency with a reduced amount of material. The
20 absorbent core may be associated with the topsheet 24, backsheet 26, or any other suitable part of the garment 10 by any method known in the art, in order to fix the absorbent core 28 in place. In addition to the respective layers in the absorbent core 28, as will be described in greater detail hereinafter, the overall absorbent core 28 may be enclosed within a tissue wrapping, as disclosed in U.S.
25 Patent No. 6,068,620, the disclosure of which is incorporated by reference herein in its entirety. Skilled artisans are capable of designing and wrapping a suitable absorbent core 28 of the invention, using the guidelines provided herein.

The absorbent core 28 may extend into either or both of the first and second waist regions 12, 14. The absorbent core 28 of one preferred embodiment of the

invention preferably includes at least three (3) layers whereby two of the layers are outer layers, (280, 282, Fig. 2), preferably outer tissue layers 280, 282, and one of the inner layers is a central fibrous layer 284 that preferably contains more than 50% by weight SAP.

- 5 Upper layer 280 and lower layer 282 can be made of any suitable material capable of containing the inner layer(s) of absorbent core 28. Preferably, upper layer 280 is hydrophilic and fluid pervious, and lower layer 282 is hydrophobic and fluid impervious. More preferably, upper layer 280 and lower layer 282 are comprised of the same tissue-like material.
- 10 In a preferred embodiment, the central fibrous layer 284 of absorbent core 28 comprises super absorbent polymer distributed within a fibrous structure. Central fibrous layers 284 of this type generally are known in the art, and exemplary absorbent cores are described in U.S. Pat. No. 6,068,620 and U.S. Pat. No. 5,281,207, both issued to Chmielewski, and U.S. Pat. No. 5,863,288, issued to
- 15 Baker, the disclosures of each of which are herein incorporated by reference in their entirety and in a manner consistent with this disclosure.

- Certain fibrous and particulate additives preferably are used as constituent elements of an absorbent core to maintain high SAP efficiencies when the SAP concentration is in the range of about 50-95%, more preferably about 60-90%,
- 20 and most preferably about 75-85%. Super absorbent polymers of the surface cross-linked variety perform best in these laminates. The above-described particulate additives preferably are constituent elements of the central fibrous layer 284, and preferably include, but are not limited to, cellulose acetate fibers, rayon fibers, Courtauld's LYOCELL fibers, polyacrylonitrile fibers, surface-
- 25 modified (hydrophilic) polyester fibers, surface-modified polyolefin/polyester bicomponent fibers, surface-modified polyester/polyester bicomponent fibers, cotton fibers, or blends thereof. Of the foregoing, cellulose acetate is the most preferred fibrous additive for use in central fibrous layer 284.

In addition, rayon, Courtauld's LYOCELL, polyacrylonitrile, cotton fibers and cotton linters have similar properties to cellulose acetate and are alternatively preferred. The remaining fibers, surface-modified polyolefin/polyester bicomponent fibers, and surface-modified polyester/polyester bicomponent
5 fibers are also believed to be effective fibrous additives. To maintain high SAP concentrations, the concentration of fibrous additives in the central fibrous layer 284 of the absorbent core 28 of the invention preferably is about 5-50%, more preferably about 10-30%, and most preferably about 15-25%. Most preferably, the central fibrous layer 284 comprises from about 75-85% SAP and from about
10 15-25% fibrous additives selected from the foregoing group.

The fibrous component of the central fibrous layer 284 most preferably is a crimped tow of cellulose acetate or polyester. Alternatively, the fibrous component of the central fibrous layer 284 may be a low-density roll good made in a separate process. Still further yet, the fibrous component could also be a
15 carded web formed on-line. Optionally, it is advantageous to introduce from about 1-5% of a thermally bondable fiber into the fibrous component of the central fibrous layer 284 for wet strength and core stability in use.

Particulate additives may be added to central fibrous layer 284 in addition to or as a substitute for the foregoing fibrous additives in order to maintain high SAP
20 efficiency. The particulate additives preferably are insoluble, hydrophilic polymers with particle diameters of 100 μm or less. The particulate additives are chosen to impart optimal separation of the SAP particles. Examples of preferred particulate additive materials include, but are not limited to, potato, corn, wheat, and rice starches. Partially cooked or chemically modified (*i.e.*, modifying
25 hydrophobicity, hydrophilicity, softness, and hardness) starches can also be effective. Most preferably, the particulate additives comprise partially cooked corn or wheat starch because in this state, the corn or wheat are rendered larger than uncooked starch and even in the cooked state remain harder than even swollen SAP. In any event, regardless of the particulate additive chosen, one of
30 the many important criteria is to use particulate additives that are hard

hydrophilic materials relative to swollen SAP or which are organic or inorganic polymeric materials about 100 microns in diameter. Fibrous and particulate additives can be used together in these absorbent laminates. Examples of SAP/particulate and SAP/fiber/particulate additives include those described in,
5 for example, U.S. Patent No. 6,068,620.

Any superabsorbent polymer (SAP) now known or later discovered may be used in central fibrous layer 284, so long as it is capable of absorbing liquids. Useful SAP materials are those that generally are water-insoluble but water-swella-
10 ble polymeric substance capable of absorbing water in an amount that is at least ten times the weight of the substance in its dry form. In one type of SAP, the particles or fibers may be described chemically as having a back bone of natural or synthetic polymers with hydrophilic groups or polymers containing hydrophilic groups being chemically bonded to the back bone or in intimate admixture therewith. Included in this class of materials are such modified
15 polymers as sodium neutralized cross-linked polyacrylates and polysaccharides including, for example, cellulose and starch and regenerated cellulose which are modified to be carboxylated, phosphonoalkylated, sulfoxylated or phosphorylated, causing the SAP to be highly hydrophilic. Such modified polymers may also be cross-linked to reduce their water-solubility.

20 Commercially available SAPs include a starch modified superabsorbent polymer available under the tradename SANWET® from Hoechst Celanese Corporation, Portsmouth, VA. SANWET® is a starch grafted polyacrylate sodium salt. Other commercially available SAPs include a superabsorbent derived from polypropenoic acid, available under the tradename DRYTECH® 520
25 SUPERABSORBENT POLYMER from The Dow Chemical Company, Midland Mich.; AQUA KEEP manufactured by Seitetsu Kagaku Co., Ltd.; ARASORB manufactured by Arakawa Chemical (U.S.A.) Inc.; ARIDALL 1125 manufactured by Chemdall Corporation; and FAVOR manufactured by Stockhausen Inc.; HYSORB manufactured by BASF Aktiengesellschaft, Ludwigshafen, Germany.
30 A particularly preferred SAP is one designated P-7700, which is available from

BASF, Ludwigshafen, Germany. Any of these SAP could be used in the invention either alone or in combination with one another, so long as the absorbent article has the thermal transmittance properties described herein.

In accordance with the present invention, improved absorbent articles are
5 advantageously based upon continuous crimped filament tow, and accordingly, the central fibrous layer 284 is advantageously prepared there from. This fiber structure has high structural integrity, and as such, is distinct from a matrix of discontinuous fibers described as fluff in the prior art. The high structural integrity enables the production of stronger webs than those formed from
10 discontinuous fibers, which in turn are believed to enable the production of thinner absorbent pads. In addition, the use of such fibers enables the production of ultra low density absorbent cores, when compared to absorbent cores prepared by dispersing SAP particles in fluff.

Beneficially, cellulose ester tow is used. Non-limiting examples of suitable
15 cellulose esters include cellulose acetate, cellulose propionate, cellulose butyrate, cellulose caproate, cellulose caprylate, cellulose stearate, highly acetylated derivatives thereof such as cellulose diacetate, cellulose triacetate and cellulose tricaproate, and mixtures thereof such as cellulose acetate butyrate. A suitable cellulose ester will include the ability to absorb moisture, preferably is
20 biodegradable, and is influenced not only by the substituent groups but also by the degree of substitution. The relationship between substituent groups, degree of substitution and biodegradability is discussed in W. G. Glasser *et al*, BIOTECHNOLOGY PROGRESS, vol. 10, pp. 214-219 (1994), the disclosure of which is incorporated herein by reference in its entirety.

25 Continuous filament tow useful in the present invention is beneficially moisture-absorbent and biodegradable. Accordingly, cellulose acetate tow is typically preferred for use in the invention. Typically, the denier per fiber (dpf) of the tow fiber will be in the range of about 1 to 9, preferably about 3 to 6. For the same weight product, filaments of lower dpf may provide increased surface area and

increased moisture absorption. Total denier may vary within the range of about 20,000 to 60,000, depending upon the process used.

It is particularly preferred in the invention to use tow having crimped filaments. Crimp aids in opening. Separation of filaments resulting from bloom
5 advantageously results in increased available filament surface area for superabsorbent material immobilization and increased moisture absorption. Gel blocking also may be reduced by using crimped tow in the fibrous absorbent core 284. As therefore may be understood, more crimp is typically better, with
10 in excess of about 20 crimps per inch being usually preferred. Continuous filament, cellulose ester tow having crimped filaments with about 25 to 40 crimps per inch, is commercially available from Hoechst Celanese Corporation, Charlotte, N.C.

It is especially preferred in the present invention to prepare a relatively low density, low basis weight core material that is thin, when compared to
15 conventional cores made with fluff pulp and SAP. Continuous cellulose acetate tow that has been opened using conventional opening procedures preferably is used as the fibrous component, and it is preferred to use the tow in an amount ranging from about 1% to about 45% by weight, preferably, from about 3% to about 30% by weight, and most preferably from about 12% to about 20% by
20 weight, based on the combined weight of the fibrous material and SAP in the absorbent core. Most preferably, the cellulose acetate is used in an amount of about 17% by weight.

It is especially preferred to make the absorbent core material by first applying adhesive to one surface of a tissue layer having a basis weight within the range
25 of from about 10 to about 30 grams/m², ("gsm") most preferably, about 16 gsm. The opened continuous filaments of cellulose acetate tow, commercially available from Celanese Acetate, Charlotte, North Carolina, then preferably is supplied and deposited on the adhesive side of the tissue layer. Super absorbent polymer (SAP) particles, most preferably P- 7700, available from BASF AG,

Ludwigshafen, Germany, is disposed on and in the opened continuous filaments of cellulose acetate tow. The SAP is distributed in an amount ranging from about 55% to about 99% by weight, based on the combined weight of the fibrous material and SAP in the absorbent core, more preferably from about 70% to
5 about 97% by weight, even more preferably from about 80% to about 88%, and most preferably about 83% by weight.

The absorbent core preferably is formed by disposing a second tissue layer on the central fibrous layer containing the mixture of SAP and tow fibers, which is deposited on a tissue layer. It is preferred that the second tissue layer have a
10 basis weight within the range of from about 10 to about 40 grams/m², ("gsm"), more preferably from about 12 to about 30 gsm, and most preferably, about 16 gsm. It also is preferred that the first tissue layer be treated to render it hydrophobic, which may occur by virtue of application of adhesive, and the second tissue layer be hydrophilic, either naturally, or by treating with the
15 appropriate surfactant, as is known in the art.

If desired, a superabsorbent, absorptive pad of multiple layer thickness, may be provided. To this end, the tow may be, for example, lapped or crosslapped in accordance with conventional procedures. In this way, a superabsorbent, absorptive material of a desired weight and/or thickness may be provided. The
20 specific weight or thickness will depend upon factors including the particular end use.

The SAP may be provided in any particle size, and suitable particle sizes vary greatly depending on the ultimate properties desired. Those skilled in the art are capable of selecting a suitable particle size for use in the present invention,
25 using the guidelines provided herein.

It has been known to prepare absorbent cores comprised of cellulose acetate tow or other polymeric fibers and SAP, as described in H1565, and U.S. Patent Nos. 5,436,066, and 5,350,370, the disclosures of each of which are incorporated by reference herein in its entirety. It was conventional to add tackifying agents,

specific size fibers, or specific fibers in combination with fluff, in order to prepare the absorbent core and immobilize the SAP particles. The present inventor believes that these additional materials may add to density of the core, or otherwise adversely affect the overall thermal transmittance of the absorbent article made there from. Thus, it is preferred not to use ethylene glycol, tackifying agents, and very small particulate fibers in the invention, although they may be used to the extent they do not increase the overall clo value of the absorbent article to about 2.0.

The total basis weight of the absorbent core 28 including fibrous materials, SAP, tissue, additional layers, and additives, can be anywhere from about 350-2000 grams per square meter (gsm), preferably from about 600 to about 1500 gsm, more preferably from about 650 to about 1350 gsm, and most preferably from about 750 to about 1000 gsm, the upper and lower limits of each and any of these ranges may be interchanged. The foregoing fibrous additives maintain high SAP efficiency at high SAP concentrations even when they are mixed with soft or hard wood fluff pulp fibers.

The density of the absorbent core 28 including fibrous materials, SAP, tissue, additional layers, and additives, preferably ranges from about 0.05 to about 0.45 g/cm³, more preferably from about 0.05 to about 0.3 g/cm³, even more preferably from about 0.06 to about 0.25 g/cm³, even more preferably from about 0.075 to about 0.11 g/cm³, and most preferably from about 0.08 to about 0.10 g/cm³. The density of the absorbent core material can be measured using standard techniques well known in the art.

Optionally, about 1-10%, preferably about 5%, by weight of thermally bondable synthetic fibers can be added to the absorbent core 28 to impart additional wet strength to the laminate. This will improve the stability of the core during use of the diaper. The preferred synthetic fibers are polyolefin/polyester fibers and polyester/polyester bicomponent fibers.

While, as discussed above, the present invention is premised in part on the discovery that certain fibrous and particulate additives maintain high SAP efficiencies when the SAP concentration is in the range of about 50-95%, fluff/SAP central fibrous layers 284 that contain greater than about 50% SAP

5 may require additional structural or design measures to contain the SAP in the layer and provide adequate wet strength for overall core stability in manufacture and use. One solution is to adhesively or thermally bond the absorbent material to improve wet strength and core stability. This, unfortunately, results in slower than adequate rates of absorption and poor SAP efficiency. Another solution

10 resides in the discovery that a high SAP concentration central fibrous layer 284 may be hydrogen bonded to additional fibrous layers. When a highly concentrated SAP-containing central fibrous layer 284 is hydrogen bonded to upper and lower layers 280, 282, or optionally is wrapped by a fibrous layer (not shown), the SAP efficiency is not impaired, wet strength increases, and the

15 upper and lower layers 280, 282, and optional wrapping layer add stability to the core during manufacture. The structure and composition of the absorbent cores 28 preferably are designed for optimal strength, SAP containment, and liquid distribution. Skilled artisans are capable of designing absorbent cores 28 to optimize the foregoing attributes, using the guidelines provided herein.

20 Depending on whether a wet or dry process is used to make the absorbent cores 28, bonding central fibrous layer 284 with tissue layers 280, 282, can be achieved with hydrogen or adhesive bonds. If the material used to form the absorbent cores 28 contains about 1-5% by weight thermally bondable synthetic fibers, bonding can be achieved with thermal bonds. When the upper and lower layers

25 280, 282 are tissue layers and are hydrogen bonded using water to middle layer 284, unexpectedly good "core utilization" is realized. "Core utilization" is the percentage of the total capacity of a core that can be absorbed in a demand absorbency test. This unexpected performance improvement is believed to be the result of the good liquid distribution achieved with a high density, non-gel

30 blocking central fibrous layer 284, and using tissue layers 280, 282 that are

intimately bonded to the fibers of the inner layers 284 of the absorbent core 28. It is especially preferred in the present invention to use a dry process for forming the absorbent core 28. That is, the SAP, tissue layers, and fibrous material all are formed into the absorbent core without saturation with water or other solvent.

- 5 The absorbent article preferably contains the absorbent core 28 disposed between backsheet 24 and topsheet 26. At least one additional layer 240, (Figure 2) also may disposed anywhere between backsheet 24 and topsheet 26. The at least one additional layer can be any layer selected from a fluid acquisition layer, a distribution layer, an additional fibrous layer optionally containing SAP, a wicking layer, a storage layer, or combinations and fragments of these layers.
- 10 Such layers may be provided to assist with transferring fluids to the absorbent core 28, handling fluid surges, preventing rewet, containing absorbent material, improving core stability, or for other purposes. Skilled artisans are familiar with the various additional layers that may be included in absorbent article, and the
- 15 present invention is not intended on being limited to any particular type of materials used for those layers. Rather, the invention encompasses all types of wicking layers, all types of distribution layers, etc., to the extent that type of layer 240 is utilized.

- One element that is useful as an additional layer 240 in the absorbent article 10 of
- 20 the invention is a fluid acquisition layer, or fluid handling layer. The fluid acquisition layer 240 typically comprises a hydrophilic fibrous material, and serves to quickly collect and temporarily hold discharged body fluid. A portion of discharged fluid may, depending upon the wearer's position, permeate the acquisition layer 240 and be absorbed by the central fibrous layer 284 in the area
- 25 proximate to the discharge. However, since fluid is frequently discharged in gushes, the central fibrous layer 284 in such area may not absorb the fluid as quickly as it is discharged. Therefore, the fluid acquisition layer 240 hereof also facilitates transport of the fluid from the point of initial fluid contact to other parts of the absorbent core 28. In the context of the present invention, it should

be noted that the term "fluid" includes, but is not limited to, liquids, urine, menses, perspiration, and water based body fluids.

The function of the fluid acquisition layer 240 is relatively important. The fluid acquisition layer 240 preferably has sufficient capillary suction to more fully
5 drain the topsheet 24 and yet not exhibit excessive fluid retention to make it difficult for the underlying layer (e.g., central fibrous layer 284) to desorb the acquisition layer 240. The acquisition layer 240 may be comprised of several different materials including nonwoven or woven webs of synthetic fibers including polyester, polypropylene, or polyethylene, natural fibers including
10 cotton or cellulose, blends of such fibers, foams, fluff pulp, apertured films, or any equivalent materials or combinations of materials.

Another useful layer 240 for use in the absorbent article 10 of the invention includes a fluid distribution layer 240. Fluid distribution layer 240 of the invention can include any combination or all of three basic components:
15 chemically stiffened, twisted, and curled bulking fibers, high surface area fibers, and binder fibers. In a preferred embodiment of the invention, fluid distribution layer 240 comprises from about 20% to about 80% of the chemically stiffened, twisted, and cured fibers, from about 10% to about 80% of a high surface area fiber, and from 0% to about 50% of a thermoplastic binding means for increasing
20 physical integrity of the web. All percentages herein refer to weight percentages based on total dry web weight. Preferably, the fluid distribution layer 240 will comprise between about 45% and about 60% of chemically stiffened, twisted, and cured fibers, between about 5% and about 15% of a hot melt fibrous binding means, and between about 30% and about 45% high surface area cellulose
25 binding means. More preferably, the fluid distribution layer 240 comprises about 10% thermoplastic binding means, about 45% chemically stiffened, twisted, and cured fibers, and about 45% high surface area fibers.

Chemical additives also can be used as binding means, and are incorporated into the acquisition/distribution layer at levels typically of about 0.2% to about 2.0%,

dry web weight basis. The three basic fiber components are described in greater detail in U.S. Patent No. 5,549,589, the disclosure of which is incorporated by reference herein in its entirety, and in a manner consistent with this disclosure.

Fluid distribution layer 240 also may be comprised of non-woven or woven
5 webs of synthetic fibers, natural fibers, foams, carded, thermal bonded materials, and the like.

Another useful layer in the absorbent article 10 of the invention includes a storage layer 240. Such storage layers 240 typically have limited transport and wicking capabilities but high storage or retention capacity, and rely upon the
10 central fibrous layer 284 to distribute incoming fluid over a larger area. It is preferred to dispose storage layer 240 between absorbent core 28 and backsheet 26, or between upper and lower tissue layers 280, 282.

Storage layers or members 240 may be of generally conventional design and composition, selected with regard to the particular application. The storage
15 layer or member 240 may be monolayer or multilayer, homogeneous or stratified, profiled or uniform, etc. Materials suitable for use in such storage layers 240 may be natural or synthetic in origin, woven, non-woven, fibrous, cellular, or particulate, and may include particles, layers, or regions of absorbent polymeric gelling materials. Other preferred materials include fluff pulp and
20 SAP composites, either air laid or wet laid, and high capacity resilient foam materials. Storage layer 240 may also have any desired size and/or shape as may prove suitable for a particular application, including square, rectangular, oval, elliptical, oblong, etc. They may also take on a three-dimensional shape or may be substantially planar in nature.

25 Another useful layer 240 in absorbent article 10 is a wicking layer 240. Wicking layers usually have both fluid acquisition and fluid distribution properties. For example, vertical wicking, which is in general the ability to transport fluids vertically from the topsheet 24 to the absorbent core 28, is related in many respects to fluid acquisition. Horizontal wicking, which is in general the ability

to transport fluids along the horizontal 100 and vertical 102 axes of Figure 1, is related in many respects to fluid distribution.

Any conventional wicking materials can be used for the wicking layer 286 of the invention. High internal phase emulsion (HIPE) foams such as those disclosed
5 in U.S. Patent No. 5,650,222 can be used, braided materials such as those disclosed in H1,585, and other conventional fibrous and strand materials can be used. The disclosures of U.S. Patent No. 5,650,222 and H1,585 are incorporated by reference here in their entirety, and in a manner consistent with the present invention.

10 Wicking layer 240 also may be comprised of two or more sublayers containing absorbent materials with differing wicking characteristics. Any of the materials discussed in this context can be used for any and all of the wicking layers 240. In accordance with the embodiment of the invention discussed immediately above, the wicking layer 240 may include a first member that is made of a material that
15 is capable of rapidly transferring, in the z-direction (e.g., orthogonal to the plane formed by horizontal 100 and vertical 102 axes of Figure 1), body fluid that is delivered to topsheet 24. The first member may be designed to have a dimension narrower than the dimension of the absorbent core 28. In this regard, the sides of the first member preferably are spaced away from the longitudinal
20 sides of the absorbent core 28 so that body fluid is restricted to the area within the periphery of the first member, before it passes down and is absorbed into central fibrous layer 284 (or the second member of the wicking layer 240). This design is believed to enable the body fluid to be combined in the central area of the absorbent core 28 and to be wicked downward so that a greater quantity of
25 the central fibrous layer 284 can be utilized.

A suitable material for use as a first member having high wicking capacity in the z-direction, is a material available from Kimberly-Clark Corporation, in Neenah, Wis. known as PRISM. PRISM is described in U.S. Pat. No. 5,336,552, which is hereby incorporated by reference in its entirety, and in a manner consistent with

this disclosure. PRISM generally is a nonwoven fabric and comprises extruded multicomponent polymeric strands including first and second polymeric components arranged in substantially distinctive zones across the cross-section of the multicomponent strands and extending continuously along the length of the multicomponent strands. Preferably, the strands are continuous filaments which may be formed by spunbonding techniques. The second component of the strands constitutes at least a portion of the peripheral surface of the multicomponent strands continuously along the length of the multicomponent strands and includes a blend of a polyolefin and an ethylene alkyl acrylate copolymer. Bonds between the multicomponent strands may be formed by the application of heat.

More specifically, the first polymeric component of the multicomponent strands is present in an amount of from about 20 to about 80 percent by weight of the strands, and the second polymeric component is present in an amount from about 80 to about 20 percent by weight of the strands. Preferably, the first polymeric component of the multicomponent strands is present in an amount of from about 40 to about 60 percent by weight of the strands and the second polymeric component is present in an amount from about 60 to about 40 percent by weight of the strands.

The term "strand" as used herein refers to an elongated extrudate formed by passing a polymer through a forming orifice such as a die. Strands include fibers, which are discontinuous strands having a definite length, and filaments, which are continuous strands of material. The nonwoven fabric of the present invention may be formed from staple multicomponent fibers. Such staple fibers may be carded and bonded to form the nonwoven fabric. Preferably, however, the nonwoven fabric of the present invention is made with continuous spunbond multicomponent filaments which are extruded, drawn and laid on a traveling forming surface.

The types of nonwoven materials that may be employed in any of the wicking layers 240 of the invention include powder-bonded-carded webs, infrared bonded carded webs, and through-air-bonded-carded webs. The infrared and through-air bonded carded webs can optionally include a mixture of different
5 fibers, and the fiber lengths within a selected fabric web may be within the range of about 1.0 to 3.0 inch and an average bulk density of about 0.02 g/cc to about 0.06 g/cc.

The first member of wicking layer 240 also may be a nonwoven fibrous web which includes about 75 percent polyester fibers of at least 6 denier, such as PET
10 (polyethylene terephthalate) fibers available from Celanese AG. The polyester fibers have a length ranging from about 1.5 to 2.0 inches in length. The remaining 25 percent of the fibrous web can be composed of bicomponent binder fibers of not more than 3 denier, and preferably about 1.5 denier. The bicomponent fiber length ranges from about 1.5 to 2 inches. Suitable
15 bicomponent fibers are wettable, polyethylene/polypropylene bicomponent fiber, available from Chisso, a business having offices located in Osaka, Japan. The bicomponent fiber can be a composite, sheath-core type with the polypropylene forming the core and polyethylene forming the sheath of the composite fiber. The polyester fibers and bicomponent fibers generally are
20 homogeneously blended together and are not in a layered configuration. The fibers can be formed into a carded web which is thermally bonded, such as by through-air bonding or infrared bonding.

The second member of wicking layer 240 may be positioned vertically below the first member, and it preferably has a higher wicking capacity along the
25 longitudinal 100 and vertical 102 axes of Figure 1, than the first member. Preferably, the second member has a wicking capacity at least three time greater than the first member. The second member can be equal in width to the first member, but preferably will be wider. It is preferred that the width of the wicking layer 240 in general be the same as or greater than the width of central
30 fibrous layer 284.

The second member can be a hydrophilic material formed from various types of natural or synthetic fibers including cellulose fibers, surfactant treated meltblown fibers, wood pulp fibers, regenerated cellulose, cotton fibers or a blend of other fibers. Preferably, the second absorbent member is a material

5 described in U.S. Pat. No. 4,100,324, and is generally known as coform. Coform is available from the Kimberly-Clark Corporation located in Neenah, Wis. and is generally a nonwoven material having a fabric-like finish and is made up of an airform matrix of thermoplastic polymeric fibers and a multiplicity of individualized wood pulp fibers. The thermoplastic fiber polymers generally

10 have an average diameter of less than 10 microns with the individualized wood pulp fibers dispersed throughout the matrix and serving to space these microfibers from each other. The material is formed by initially utilizing the primary air stream with the meltblown microfibers and the secondary air stream containing wood pulp fibers and merging the two under turbulent conditions to

15 form an integrated air stream along a forming surface. The fiber-like appearance of this material provides a visual appealing absorbent. Also inherent in the coform material is increased resiliency compared to conventional cellulosic absorbents.

Other suitable materials for use as wicking layer 240 include high-density air

20 laid fluff pulps, high-density wet laid fluff pulp, and multi-groove fibers such as 4DG deep groove fiber.

Various combinations of any of the above-mentioned layers also may be used as the at least one additional layer 240. For example, additional layer 240 may be comprised of a combination of a wicking layer and a distribution layer. Hence,

25 the additional layer 240 will have both wicking and distribution properties. Skilled artisans will be capable of designing additional layers 240 to have desired properties by combining various layer attributes, or by fragmenting the layer, using the guidelines provided herein.

The dimensions of additional layer(s) 240 may be the same as or different from the dimensions of central fibrous layer 284 and/or upper layer 280 and lower layer 282. It is preferred that additional layer(s) 240 have a width in the lateral direction (102) of anywhere from about 10 mm to about 100 mm, and preferably
5 from about 25 mm to about 80 mm.

It is contemplated in the present invention that the absorbent core 28 be folded as it is disposed between the topsheet 24 and backsheet 26. Absorbent core 28 can be folded in any suitable manner, including any and all of those disclosed in U.S. Patent No. 6,068,620. Those skilled in the art will appreciate that the
10 absorbent core 28 can be folded such that the adjacent sides are touching one another, or so that channels are formed in certain areas. For example, the absorbent core 28 can be folded in the form of a "C" where the curled ends may be spaced apart to form a channel there between, and the lower edges of the curled ends may be disposed adjacent the upper edges of the bottom portion of
15 the folded article. Alternatively, another absorbent material, or another absorbent core 28 may be disposed in the space formed by the standard "C" fold. The same considerations may be given to the "G" fold and the "U" fold where the spaces formed by these folds may be filled with another absorbent material, another absorbent core 28, or the folds may be made tight enough so that little or
20 no space is formed. Other possible arrangements include a "Z" fold, and a pleated absorbent core 28, as will be appreciated by those skilled in the art.

The absorbent core 28 of the preferred embodiments is particularly ideal for narrow crotch diapers and training pants. Narrow crotch training pants either must typically sacrifice absorbent capacity at the narrowed portion as a result of
25 reduced absorbent surface area, or must alternatively provide a thicker absorbent core to compensate for the reduced surface area. As the thickness of the core increases, comfort, fit and wearability decrease. By using the high absorbency absorbent core 28 of the preferred embodiments in a narrow crotch absorbent garment, the absorbent capacity through the central crotch area is not
30 sacrificed while comfort, fit and wearability are improved. In addition, the

thermal transmittance of the absorbent garment is enhanced by using the thin absorbent core 28 of the invention.

Thermal transmittance, or heat transfer, is an important factor when considering the comfort of the absorbent garment. The comfort of an article of clothing can
5 be measured analytically, which is extremely important in measuring the comfort of an absorbent garment worn by an infant who is incapable of providing sage subjective evidence of comfort. There are a variety of methods available to analytically measure the comfort of an article of clothing, including the sweating hot plate apparatus disclosed in U.S. Patent No. 5,749,259, the
10 disclosure of which is incorporated by reference here in its entirety. Dry hot plates also can be used to measure heat transfer and other thermal transmittance characteristics. In the examples below, the following Test Conditions were used to measure the thermal transmittance characteristics.

15 Test Conditions

Large Hot Plate Heat Transfer (watts/m² °C)

Heat transfer makes it possible to predict the body heat that will flow from the skin surface through the material into the surrounding atmosphere. Heat and moisture transfer properties are key properties affecting clothing comfort. These
20 thermal properties were analyzed using a Holometric Guarded Hot Plate Thermal Measuring System. A Tenny Model T30 chamber was used to obtain and maintain the required ambient conditions. The large hot plate enabled measuring the intrinsic thermal resistance (R_{cl}) for a 20 in. x 20 in. sample.

The testing protocol was carried out in accordance with the requirements set out
25 in ASTM F1868-98 Standard Test Method for Thermal and Evaporative Resistance of clothing Materials using a Sweating Hot Plate; Part C. The specifics of the test and allowable refinements are as follows:

For a given replicate the temperatures, humidity, voltage, and current were measured at 1 minute intervals.

- 5 After ten measurements, the values were averaged and recorded. The test continued until six consecutive average values met the method requirement of less than a 3% drift per hour. In the examples below, the maximum-minimum difference for R_{ct} were nominally less than 2 percent.

R_{cf} = the average intrinsic thermal resistance of the sample.

- 10 R_{cf} is determined by subtracting the average dry bare plate resistance (R_{cbp}) from the average of the total thermal resistance (R_{ct}) of the specimen tested.

R_{ct} = total thermal resistance of the specimen and surface air layer ($^{\circ}\text{C m}^2/\text{watts}$). It can be determined in accordance with the following equation:

$$R_{ct} = \frac{(T_s - T_a)A}{H}$$

where:

- 15 T_s is the temperature of the skin surface;
 T_a is the temperature of the ambient environment;
 A is the area of the sample; and
 H is the heat transfer rate due to heat ($\text{watts}/\text{m}^2 \Delta T$)
- 20 The test typically is conducted such that the area is constant (e.g., a 20 in. x 20 in. sample), and T_a is constant. Knowing the heat transfer rate of the bare plate, the thermal resistance of the sample can be determined by subtracting the bare plate thermal resistance from the total thermal resistance.

Thermolabo Test - Small Hot Plate Heat Transfer and clo

Clo is a unit of thermal resistance that indicates the insulating ability of the test material. The value is derived from a measure of dry heat transfer (e.g., non-sweating hot plate). Materials having higher clo values provide wearers with more thermal protection, or insulation. A clo value of 1 represents a typical
5 man's business suit expected to maintain thermal comfort for a person in a normal indoor environment. Requirements vary from 0.5 clo for summer wear to 4-5 clo for outdoor winter clothing. Humans are capable of perceiving a difference of about 0.1 clo. Given the fact that most infants remain indoors, and if taken outdoors, typically are covered with insulating clothing, the clo values
10 for infant absorbent garments should be low. This holds true for other absorbent garments, especially those typically worn underneath other clothing.

The "thermolabo" is one of a group of laboratory instruments developed by Dr. Sueo Kawabata. Kawabata, S., et al., "Applications of the New Thermal Tester 'Thermolabo' to the Evaluation of Clothing Comfort," in OBJECTIVE
15 MEASUREMENTS: APPLICATIONS TO PRODUCT DESIGN AND PROCESS CONTROL., Eds. S. Kawabata et al., The Textile Machinery Society of Japan (1985). The thermolabo consists of three components including: (i) a box containing a thin copper heat capacitor fitted with a temperature sensing device used for measuring the amount of heat and rate of heat flow through fabric specimens
20 during testing; (ii) a water-box with constant temperature water flow to provide a constant temperature base needed for the testing; and (iii) an insulated hot plate fitted into a box with preset temperature control possibilities.

The ability of moisture and heat to permeate through fabrics is one of the factors to consider in determining comfort. The thermal property measurements of
25 q_{max} , conductance, and dry and wet heat transfer may be measured using the Thermolabo II instrumentation. The standard specimen size for these measurements is smaller than the large hot plate, typically on the order of about 5 in. x 5 in. The specimens are tested for three repetitions, each of the tests being described in more detail below.

Heat Transfer

The heat and moisture properties of the 5 in. x 5 in. samples are analyzed using a system consisting primarily of two parts: (i) an environmental control chamber (Figure 3); and (ii) a component to simulate the skin/body (configurations in
5 Figure 4).

Environmental Chamber

The environmental chamber used to obtain the required test conditions was a Tabai ESPEC's Platinous Lucifer Model PL-2G, with programmable low temperature and humidity. A rough schematic of such a system is illustrated in
10 Figure 3. The environmental chamber 310 houses a Lucite plastic sub-chamber 320 that provides precise control of air velocity. A skin simulating guarded hot plate 340 with sweating capabilities via sweating micropump 360 is positioned inside the air chamber. The sample 330 typically is placed directly on the guarded hot plate 340 for dry measurements, or can be configured in any of the
15 configurations illustrated in Figure 4. For the examples described below, an air current of 20 cm/sec. impinges vertically on the surface of the guarded hot plate 340, as shown by the arrows in Figure 3.

The temperature and humidity can be controlled within chamber 310 via a computer programmable temperature and humidity controller 350. The thin
20 copper heat capacitor fitted with a temperature sensing device can be detected in the controller amplifier detector digital indicator 370, which in turn is programmable and controllable via computer 380.

Simulated Skin Models

Four simulated skin models are depicted in Figure 4: (i) dry; (ii) dry/air space;
25 (iii) wet; and (iv) wet/air space. For the dry model, a guarded hot plate 420 is used as a heat source, and the specimen 410 is placed directly on it, as shown at the top of Figure 4. For the wet model, (third from the top in Figure 4) simultaneous heat and moisture transfer is measured using a sweating hot plate

featuring four simulated sweating glands supplying water to the heated surface at the rate of about 0.077 ml/min/gland. The water flow is controlled using a peristaltic micropump 360 (Figure 3) to deliver water to the hot plate via line 450, while the surface of the hot plate 420 is covered with a highly wettable and dimensionally stable skin simulating membrane 440 to allow the water to spread rapidly and evenly over the surface. Heat transfer from the plate 420 through the sample test fabric 410 is determined in Watts/m² °C.

The dry/air space model is illustrated by the second from the top drawing in Figure 4. Here, the specimen 410 is positioned on top of the hot plate 420 with an air space 430 between the specimen and the surface of the hot plate 420. The rate of heat loss of the hot plate 420 is measured. The wet/air space model is illustrated by the bottom drawing in Figure 4. Here, skin simulating membrane 440 is positioned on the hot plate 420 and wetted by simulated sweat glands through line 450, only this time, an air space 430 separates skin simulating membrane 440 from the specimen 410.

The following equation is used to calculate the clo values:

$$\text{clo (watts/m}^2\text{)} = (1/\text{Dry Heat Transfer Rate})/0.155$$

where Dry Heat Transfer Rate is in watts/m² °C.

Thus, the clo values reported will represent the clo for both the sample tested and the bare plate. To determine the clo value for the sample alone, one need only subtract the bare plate clo value from the total clo value. The thermal resistance also can be determined by the thermal resistance equation presented earlier.

The invention now will be explained with reference to the following examples.

25 EXAMPLES

A variety of samples were tested for thermal resistance using the testing procedures outlined above. In the first example, both 20 in. x 20 in. samples and

5 in. x 5 in. samples were used, and in the second example, only 5 in. x 5 in. samples were used.

Example 1

A diaper was prepared in a conventional manner, with the exception that the
5 absorbent core was prepared in the following manner to have the following
characteristics. A series of absorbent cores were prepared by depositing
approximately 3 grams per core of continuous filament cellulose acetate tow
fiber available from Celanese Acetate, Charlotte, North Carolina, which had
been opened, on a tissue having a basis weight of 16 grams/m² (gsm). The
10 tissue first was treated with adhesive and the non-treated side was contacted
with a rotating drum having a vacuum chamber disposed therein to draw the
tissue paper onto the drum. The opened cellulose acetate tow fibers then were
deposited on the adhesive-treated side of the tissue paper.

Approximately 15 grams per core of P-7700 SAP, commercially available from
15 BASF AG, Ludwigshafen, Germany then were deposited on the opened cellulose
acetate tow fibers and tissue as the components rotated on the rotating drum. A
second tissue paper having a basis weight of 16 gsm, not treated with adhesive,
then was applied over the SAP, cellulose acetate tow and first tissue paper to
form the absorbent core unit, which then was pressed between two nip rollers.
20 The opened ends of the upper and lower tissue layers were sealed with
adhesive, and the absorbent cores cut to length. The dry formed cores had a
basis weight of about 790 gsm, and a density of about 0.095 g/cm³, and were
designated as core sample A.

Conventional diapers were prepared in a manner identical to those used to
25 prepare diapers commercially available from Paragon Trade Brands, Norcross,
Georgia, except that instead of the conventional absorbent cores, core sample A
was used during the assembly. For the large hot plate test, portions of the
diapers that included the absorbent core were cut from several diapers to make a
20x20 sample. The portions were cut from center of the training pants products

so that they essentially included a non-woven topsheet material, a fluid transfer layer, (40 gsm carded thermal bonded transfer layer), the absorbent core, and a non-woven backsheet. The samples were designated Sample A.

Comparative samples were obtained in the same manner as described above,
5 except that large training pants TP2001, available from Paragon Trade Brands, Norcross, Georgia were used. The absorbent cores had a basis weight of about 979 gsm, and a density of about 0.13 g/cm³. The samples, as cut from the training pant TP2001 had a top sheet, a transfer layer that was a carded, thermal-bonded transfer layer (40 gsm basis weight), absorbent core, and backsheet.
10 These samples were designated Sample B.

The heat transfer characteristics then were determined using the Large Hot Plate Heat Transfer protocol outlined in the Test Methods section above. The intrinsic thermal resistance of Samples A and B are reported in table 1 below.

Additional samples were cut from the same materials used to make Samples A
15 and B above, only these samples were cut to provide a 5 in. x 5 in. sample. The respective samples were designated as samples A' and B'. The clo values were determined on samples A' and B' using the Thermolabo protocol described in the Test Methods section above. The results are found in Table 2 below:

Table 1

Sample	Rcf (Watts/m ² °C)	clo (w/m ²)
Bare plate	-	0.4761
A	0.1788	1.63
B	0.2455	2.06

20 - indicates that no values were obtained for Rcf for the bare plate.

Table 2

Sample	clo (w/m ²)
Bare plate	0.321

A'	1.50
B'	2.05

The above examples reveal that the absorbent articles made using the improved convection cores of the present invention provide more comfort than conventional absorbent articles containing conventional cores. The clo values
5 reveal that the inventive low convection cores have a clo value of about 1.179 (clo (A) - clo (bare plate) or 1.50 - 0.321), whereas conventional absorbent articles have clo values of about 1.73. The intrinsic thermal resistance values (rcf) reported in Table 1 for the inventive samples also was significantly lower than
10 the intrinsic thermal resistance of conventional samples (e.g., about a 27% improvement).

Example 2

A diaper was prepared in a conventional manner as in Example 1 above, with the exception that the absorbent core was prepared in accordance with the procedures outlined above in Example 1 for core sample A. Core sample A had
15 a basis weight of about 790 gsm, and a density of about 0.095 g/cm³, which is the same as that used in Example 1. A 5 inch by 5 inch sample was removed from the central portion of the diaper, whereby the sample included a non-woven topsheet, a fluid transfer layer, the absorbent core, and a non-woven backsheets. This sample was designated as Sample A.

20 Commercially available diapers of similar size and quality to Sample A were obtained, and the same size 5 in. x 5 in. samples were removed from the central portion of these diapers. The densities and basis weights for the absorbent cores for these diapers are provided in Table 3 below. The samples were designated by letters H, P, and L.

The thermal resistance (clo) was determined for Samples A, H, P, and L by using the Thermolabo procedures outlined in the above Test Methods section. The results are found in Table 2.

Table 3

Sample	Density (g/cm ³)	Basis Weight (g/m ²)	clo (W/m ²)
Bare Plate	-	-	0.326
A	0.095	790	1.704
H	0.12	1013	2.509
L	0.11	1031	2.532
P	0.11	1015	2.336

5 - indicates that no values were obtained.

It is clear to see from the table above that absorbent articles made with the absorbent cores of the present invention had significantly lower thermal resistance than conventional absorbent articles. Indeed, the clo value for the 5 in. x 5 in. samples of the invention was about 1.374, whereas the comparative samples all had clo values above 2.0. The absorbent articles of the present invention therefore have a greater thermal transmittance (e.g., greater heat loss), than conventional absorbent articles. Indeed, the absorbent articles of the invention provide up to a 33% decrease in thermal resistance, providing unexpectedly improved comfort.

15 Other embodiments, uses, and advantages of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. The specification should be considered exemplary only, and the scope of the invention is accordingly intended to be limited only by the following claims.

What is claimed is:

1. An absorbent article comprising:
 - a topsheet;
 - a backsheet;
 - an absorbent core disposed between the topsheet and the backsheet;wherein the absorbent article has a thermal resistance (clo) of less than about 1.7 watts/m², as measured in a Thermolabo apparatus.
2. The absorbent article of claim 1, whereby the topsheet and the backsheet form a first waist region, a second waist region longitudinally opposite the first waist region, and a crotch region there between, and the absorbent article further comprises
 - at least one fastening element attached to a lateral edge of the first waist region; and
 - one or more target devices attached to the article in the second waist region, where at least one fastening element and the one or more target devices are capable of attaching to one another, the one or more target devices being located so that the first waist region and second waist region of the garment may be joined to one another to secure the garment on a wearer.
3. The absorbent article of claim 1, further comprising elastic leg gathers comprising one or more elastic materials disposed adjacent a lateral edge of the crotch region, and standing leg gathers disposed on the topsheet adjacent a lateral edge of the crotch region.
4. The absorbent article of claim 2, wherein the at least one fastening element comprises a hook portion of a hook and loop fastener and the one or more target devices comprise the loop portion of a hook and loop fastener.

5. The absorbent article of claim 2, wherein the at least one fastening element is an adhesive tape and the one or more target devices comprise a tape receiving surface.
6. The absorbent article of claim 2, wherein the at least one fastening element is comprised of a pair of laterally extending tabs disposed on the lateral edges of the first waist region, whereby the laterally extending tabs each include at least one fastening element.
7. The absorbent article of claim 1, further comprising a fluid acquisition layer disposed between the topsheet and the backsheet.
8. The absorbent article of claim 1, further comprising a distribution layer disposed between the topsheet and the backsheet.
9. The absorbent article of claim 1, further comprising a wicking layer disposed between the topsheet and the backsheet.
10. The absorbent article of claim 1, further comprising a storage layer disposed between the topsheet and the backsheet.
11. The absorbent article of claim 1, further comprising a fragmented layer disposed between the topsheet and the backsheet.
12. The absorbent article of claim 1, further comprising a combination of a wicking layer and a distribution layer disposed between the topsheet and the backsheet.
13. The absorbent article of claim 1, wherein the absorbent core comprises:
 - an upper layer;
 - a lower layer; and
 - a central fibrous layer disposed between the upper layer and the lower layer, the central fibrous layer comprising a mixture of at least a fibrous material and superabsorbent polymer (SAP).

14. The absorbent article of claim 1, wherein the absorbent core has a density within the range of from about 0.05 to about 0.45 g/cm³.
15. The absorbent article of claim 1, wherein the absorbent core has a basis weight within the range of from about 650 to about 1350 g/cm².
16. The absorbent article of claim 13, wherein the SAP is selected from the group consisting of a water swellable polymer of water soluble acrylic or vinyl monomers crosslinked with a polyfunctional reactant, a starch modified polyacrylic acid, a hydrolyzed polyacrylonitrile, alkali metal salts of hydrolyzed polyacrylonitrile, and mixtures thereof.
17. The absorbent article of claim 16, wherein the SAP is a starch grafted polyacrylate sodium salt.
18. The absorbent article of claim 13, wherein the fibrous material is selected from the group consisting of a crimped tow of cellulose acetate or polyester, a low-density roll good, a carded web, and mixtures or combinations thereof.
19. The absorbent article of claim 18, wherein the absorbent core further comprises from about 1-5% of a thermally bondable fiber.
20. The absorbent article of claim 18, wherein the fibrous material is a crimped tow of cellulose acetate.
21. The absorbent article of claim 13, wherein the central fibrous layer comprises from about 50% to about 95% by weight super absorbent polymer (SAP), and has a SAP efficiency of at least 80%.
22. The absorbent article of claim 13, wherein the central fibrous layer further comprises particulate additives.
23. The absorbent article of claim 22, wherein the particulate additives comprise insoluble, hydrophilic polymers having particle diameters of 100 µm or less.

24. The absorbent article of claim 22, wherein the particulate additives are selected from the group consisting of potato, corn, wheat, and rice starches, and partially cooked or modified starches.
25. The absorbent article of claim 1, wherein the absorbent article has an intrinsic thermal resistance (Rcf) of less than about $0.25\text{ }^{\circ}\text{C m}^2/\text{Watts}$, as measured on a 20×20 inch sample in a Thermolabo apparatus.
26. The absorbent article of claim 25, wherein Rcf is less than about $0.17\text{ }^{\circ}\text{C m}^2/\text{Watts}$.
27. The absorbent article of claim 1, wherein the absorbent article has a clo of less than about 1.65 watts/m^2 .
28. The absorbent article of claim 27, wherein the clo is less than about 1.40 watts/m^2 .
29. The absorbent article of claim 1, wherein the absorbent core has a thickness within the range of from about 5 to about 20 mm.
30. A method of making an absorbent article comprising:
- a) preparing a topsheet and a backsheet;
 - b) preparing an absorbent core by dispersing superabsorbent polymer particles (SAP) within a fibrous matrix; and
 - c) disposing the absorbent laminate core between the topsheet and the backsheet,
- wherein the absorbent article has a thermal resistance (clo) of less than about 1.7 watts/m^2 , as measured in a Thermolabo apparatus.
31. The method of claim 30, wherein preparing the absorbent core comprises:
- supplying an upper layer;
 - supplying a lower layer; and
 - preparing a central fibrous layer by intimately mixing at least a fibrous material and superabsorbent polymer (SAP) particles; and

disposing the central fibrous layer between the upper layer and the lower layer.

32. The method of claim 30, wherein the absorbent core has a density within the range of from about 0.05 to about 0.45 g/cm³.
33. The method of claim 1, wherein the absorbent core has a basis weight within the range of from about 650 to about 1350 g/cm².
34. The method of claim 31, wherein the SAP is selected from the group consisting of a water swellable polymer of water soluble acrylic or vinyl monomers crosslinked with a polyfunctional reactant, a starch modified polyacrylic acid, a hydrolyzed polyacrylonitrile, alkali metal salts of hydrolyzed polyacrylonitrile, and mixtures thereof.
35. The method of claim 34, wherein the SAP is a starch grafted polyacrylate sodium salt.
36. The method of claim 31, wherein the fibrous material is selected from the group consisting of a crimped tow of cellulose acetate or polyester, a low-density roll good, a carded web, and mixtures or combinations thereof.
37. The method of claim 31, wherein the absorbent core further comprises from about 1-5% of a thermally bondable fiber.
38. The method of claim 36, wherein the fibrous material is a crimped tow of cellulose acetate.
39. The method of claim 31, wherein the central fibrous layer comprises from about 50% to about 95% by weight super absorbent polymer (SAP), and has a SAP efficiency of at least 80%.
40. The method of claim 31, wherein the central fibrous layer further comprises particulate additives.

41. The method of claim 40, wherein the particulate additives comprise insoluble, hydrophilic polymers having particle diameters of 100 μm or less.
42. The method of claim 41, wherein the particulate additives are selected from the group consisting of potato, corn, wheat, and rice starches, and partially cooked or modified starches.
43. The method of claim 30, wherein the absorbent article has an intrinsic thermal resistance (R_{cf}) of less than about $0.25\text{ }^{\circ}\text{C m}^2/\text{Watts}$, when measured on a 20 x 20 inch sample in a Thermolabo apparatus.
44. The method of claim 43, wherein R_{cf} is less than about $0.19\text{ }^{\circ}\text{C m}^2/\text{Watts}$.
45. The method of claim 30, wherein the absorbent article has a clo of less than about 1.65 watts/m^2 .
46. The method of claim 45, wherein the clo is less than about 1.40 watts/m^2 .
47. The method of claim 30, wherein the absorbent core has a thickness within the range of from about 5 to 20 mm.
48. The method of claim 30, further comprising folding the absorbent core prior to disposing the core between the topsheet and the backsheet.
49. The method of claim 48, wherein the absorbent core is folded into a "C" configuration.

Figure 1

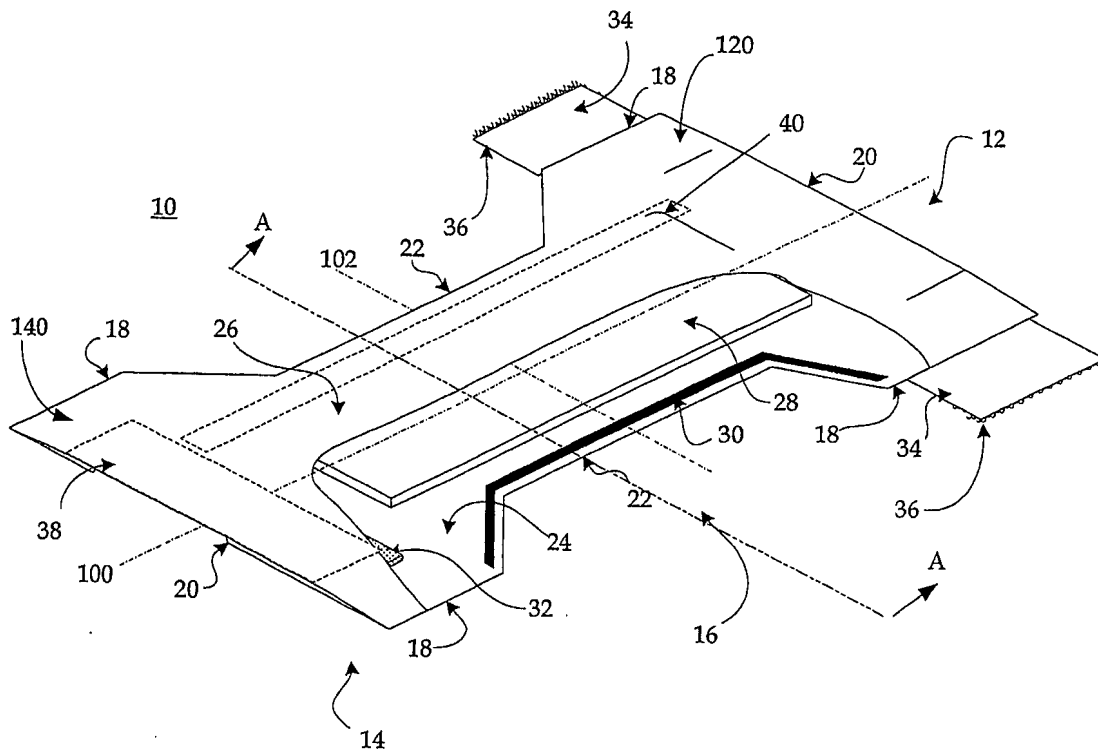


Figure 2

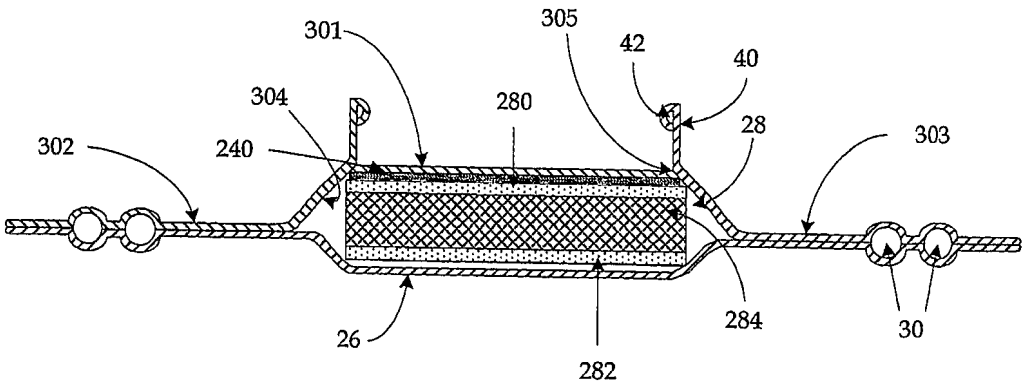


Figure 3

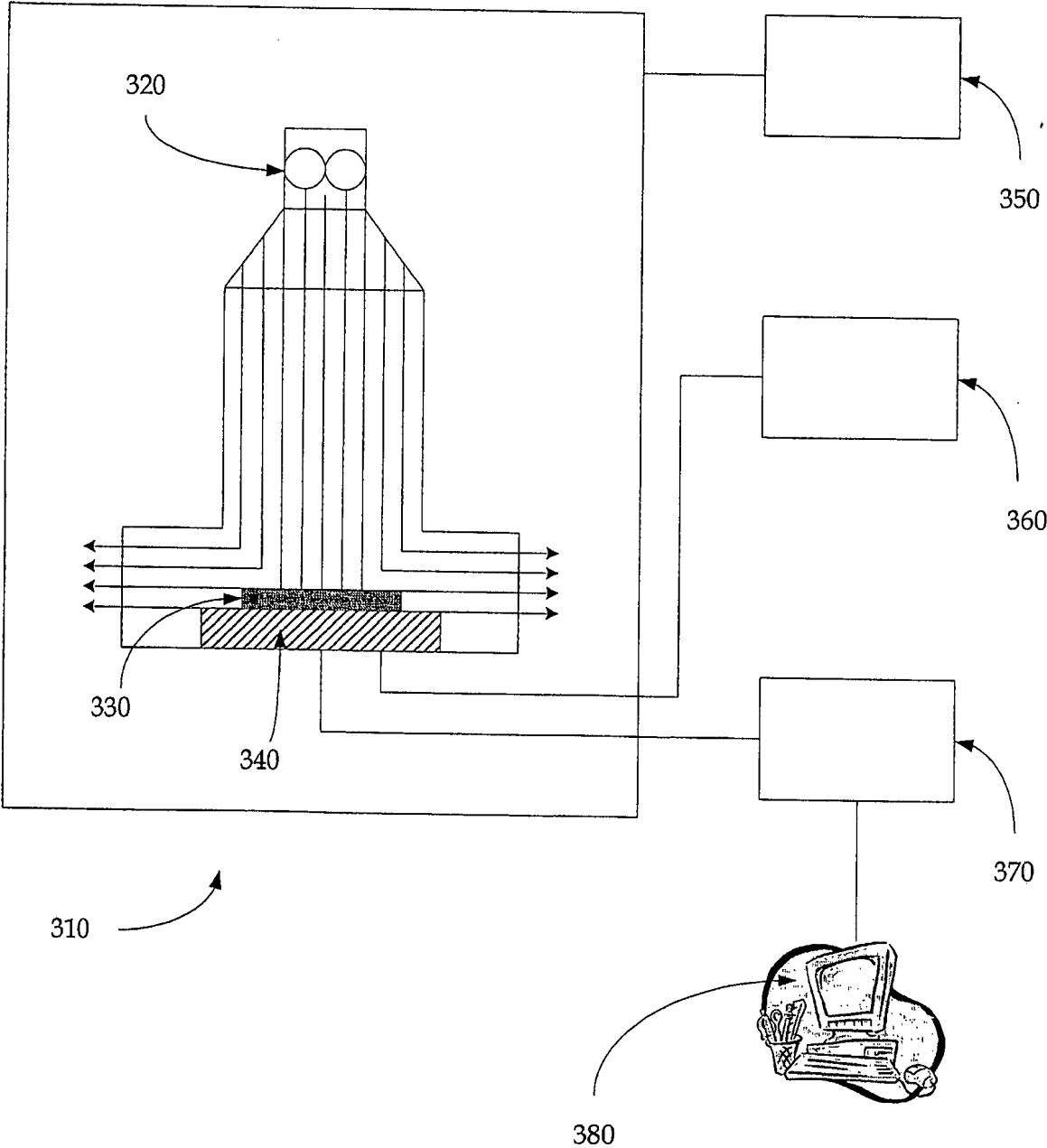
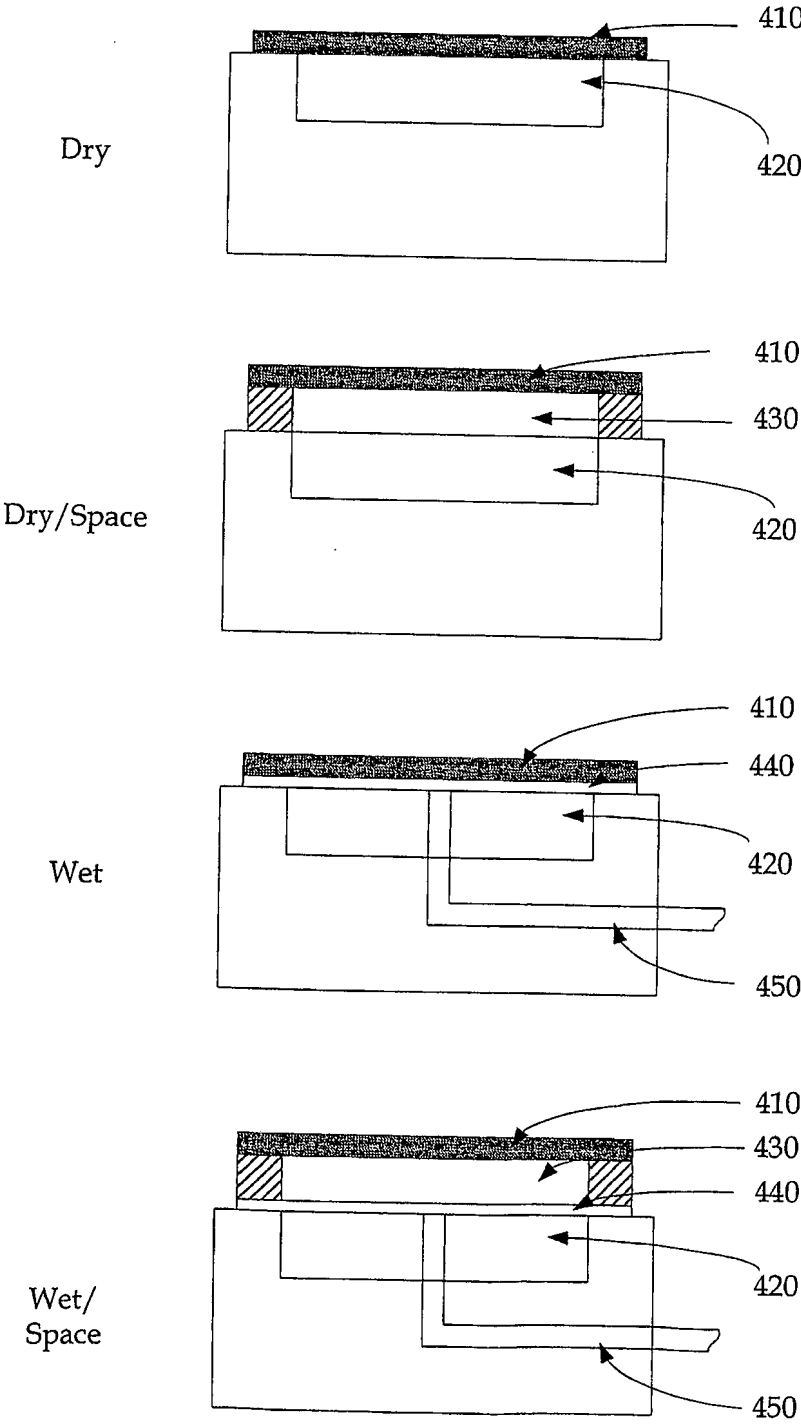


Figure 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/37647

A. CLASSIFICATION OF SUBJECT MATTER IPC(7) : A61F 13/15 US CL : 604/370,378 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) U.S. : 604/365,367,370,378,389,391 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,350,370 A (JACKSON et al) 27 September 1994 (27.09.1994), entire document.	1-2, 6, 14-15, 25-30, 32-33, and 43-47
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Y		3-5, 7-13, 16-24, 31, 34-42, and 48-49
Y	US 6,258,076 B1 (GLAUG et al) 10 July 2001 (10.07.2001), column 6, lines 16-35; column 7, lines 66+; column 8, lines 14-15, 22-24, 43-46.	3-5
Y	US 5,653,702 A (BROHAMMER et al) 05 August 1997 (05.08.1995), figure 3.	7-13, 16-22, 31, and 34-40
Y	US 6,068,620 A (CHMIELEWSKI) 30 May 2000 (30.05.2000), column 12, lines 10-24.	22-24 and 40-42
Y	US 3,814,100 A (NYSTRAND et al) 04 June 1974 (04.06.1974), figure 1, column 1, lines 10-12.	48 and 49
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 24 January 2003 (24.01.2003)		Date of mailing of the international search report 25 FEB 2003
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230		Authorized officer Weilin Lo Telephone No. (703) 308-1148

Anexo 4



US 20060004336A1

(19) **United States**

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(54) **STRETCHABLE ABSORBENT COMPOSITE WITH LOW SUPERABSORBENT SHAKE-OUT**

(52) U.S. Cl. 604/368

(76) Inventors: Xiaomin Zhang, Appleton, WI (US);
David Martin Jackson, Alpharetta, GA (US);
Lisa Marie Jacobsen, Roswell, GA (US);
Jian Qin, Appleton, WI (US);
Dave Allen Soerens, Neenah, WI (US)

Correspondence Address:
KIMBERLY-CLARK WORLDWIDE, INC.
401 NORTH LAKE STREET
NEENAH, WI 54956

(21) Appl. No.: 10/883,174

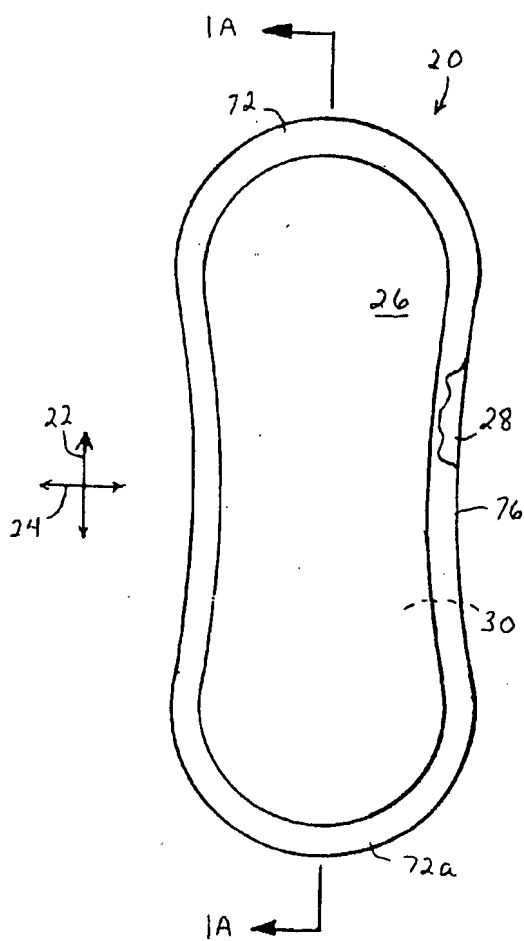
(22) Filed: Jun. 30, 2004

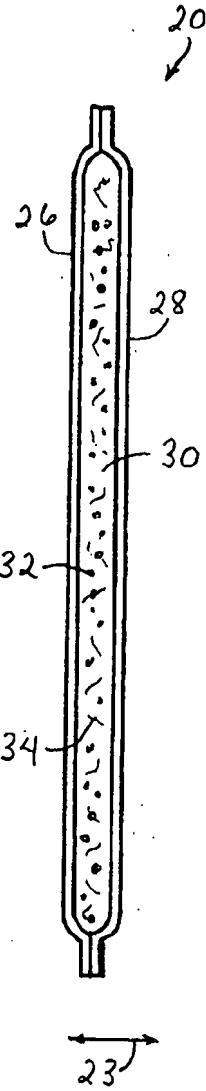
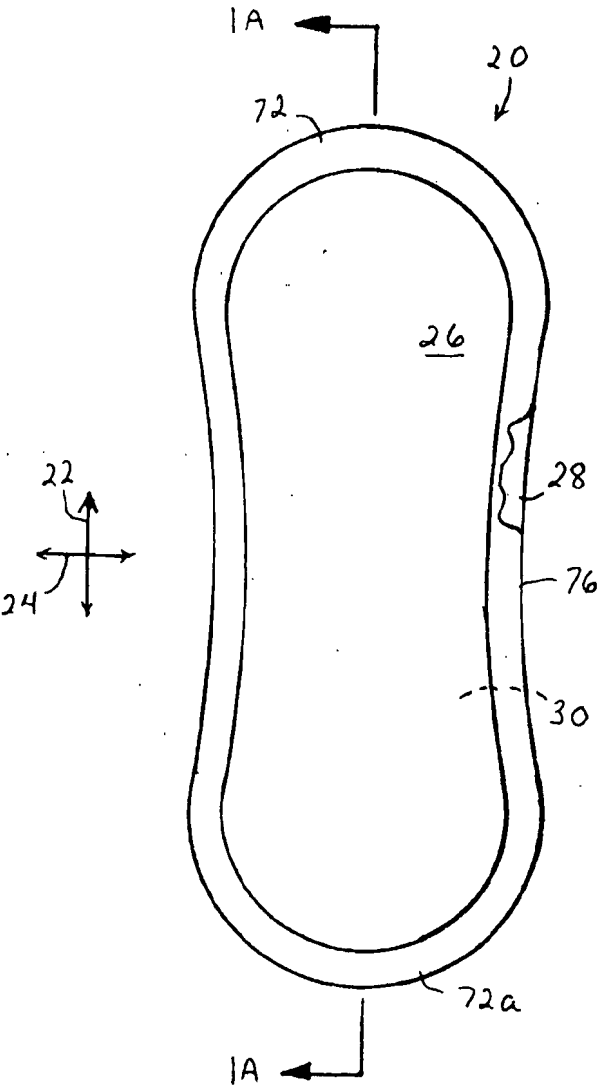
Publication Classification

(51) Int. Cl. A61F 13/15 (2006.01)

(57) **ABSTRACT**

An article comprises a stretchable absorbent composite (30) that includes a quantity of superabsorbent particles (32) which are operatively contained within a matrix of elastomeric polymer fibers (34). In particular aspects, the composite article can include at least about 60 wt % of the superabsorbent particles and not more than about 40 wt % of the elastomeric polymer fibers, based on a total weight of the composite. In other aspects, the composite article can provide a high stretchability. Additional aspects can provide a low shake-out. Particular configurations can, for example, provide a stretchability value of at least about 30%. Additional aspects can include a configuration that provides a shake-out value of not more than about 2%. In other aspects, the invention can provide a shake-out value of not more than about 1.2%. In further aspects, the absorbent composite can include superabsorbent particles having a coating of treatment-material that is thermally processible. Additional aspects can include a treatment-material which is water soluble.





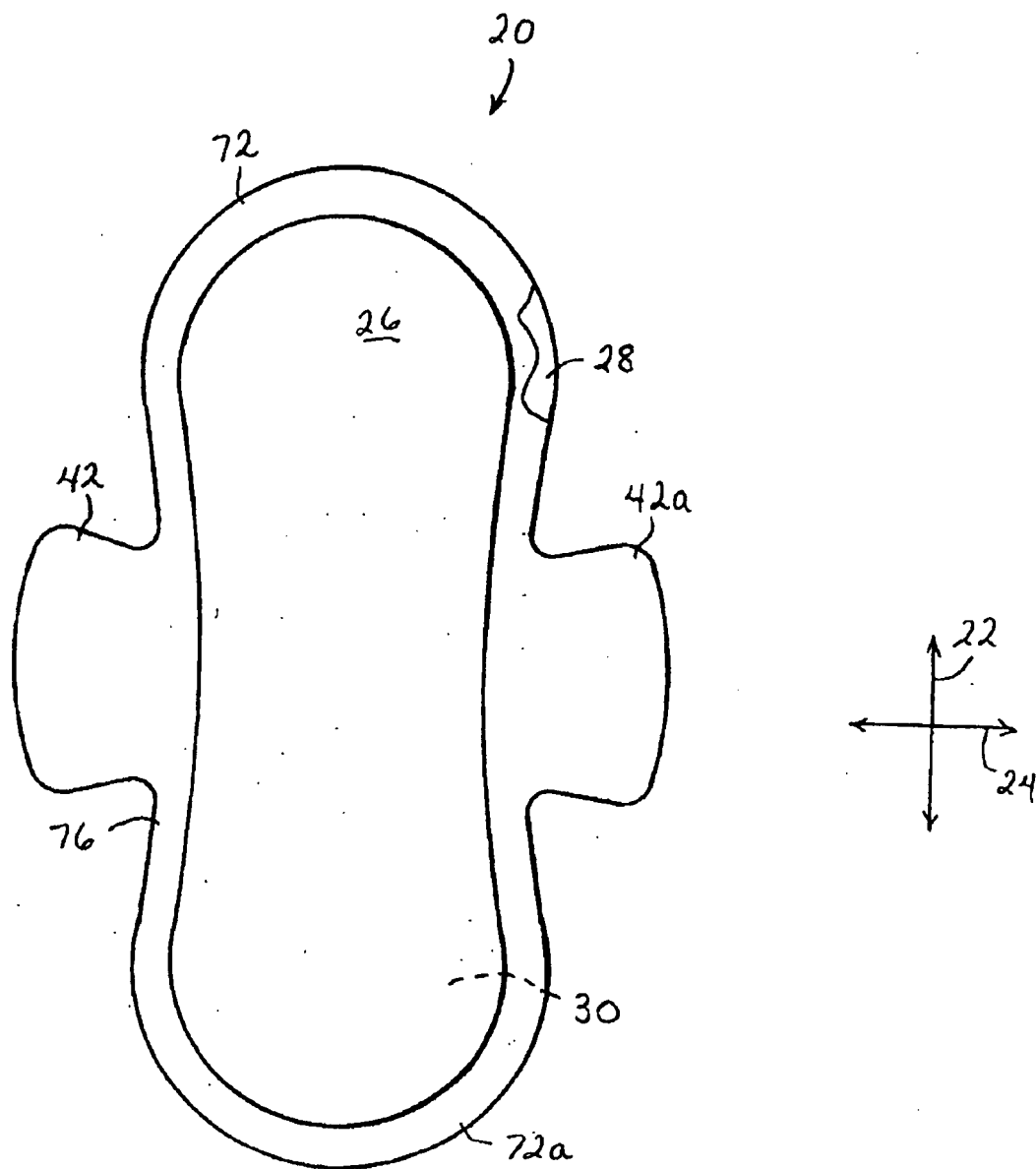
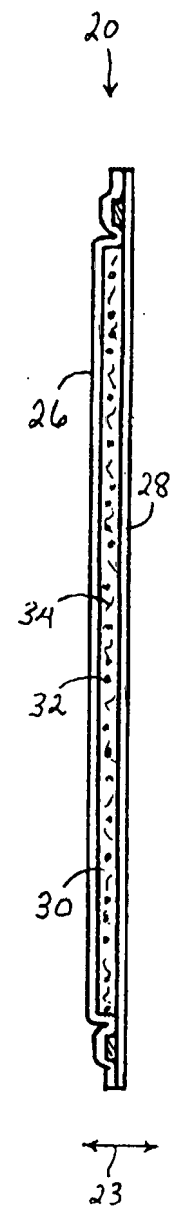
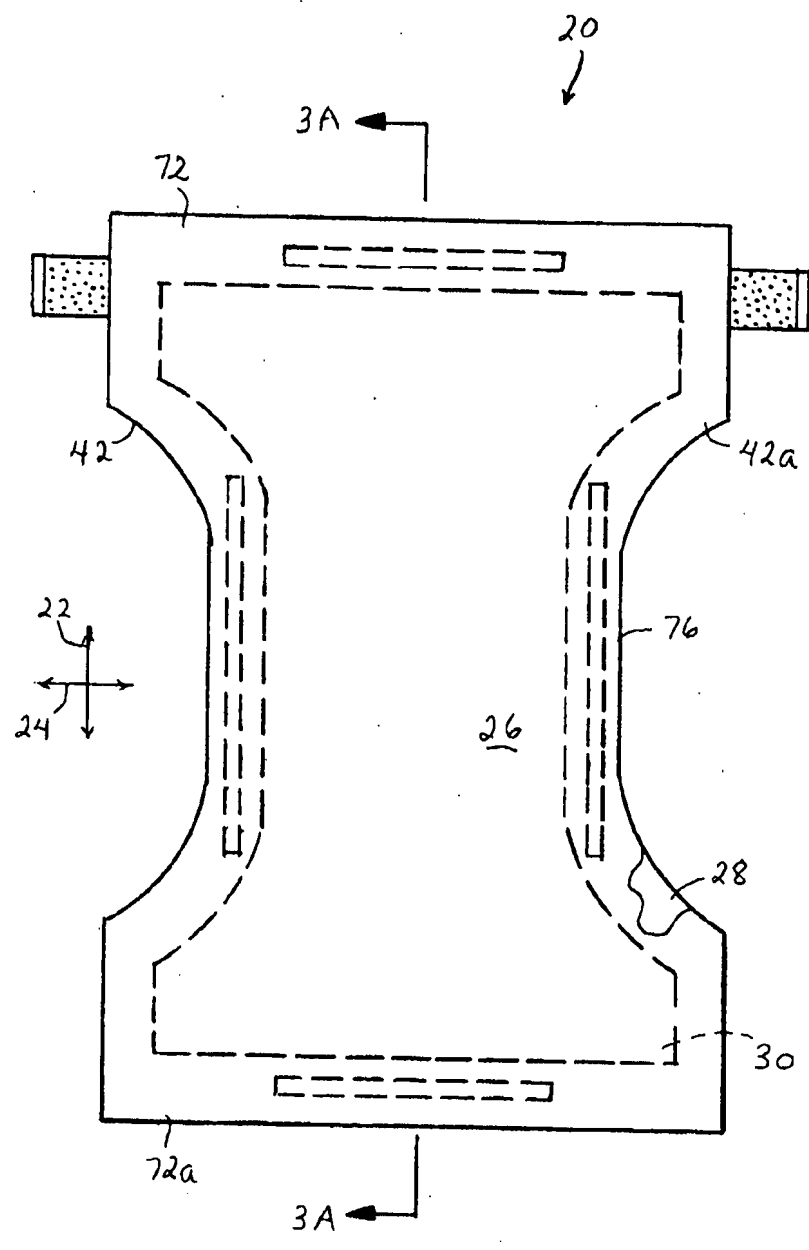


FIG. 2



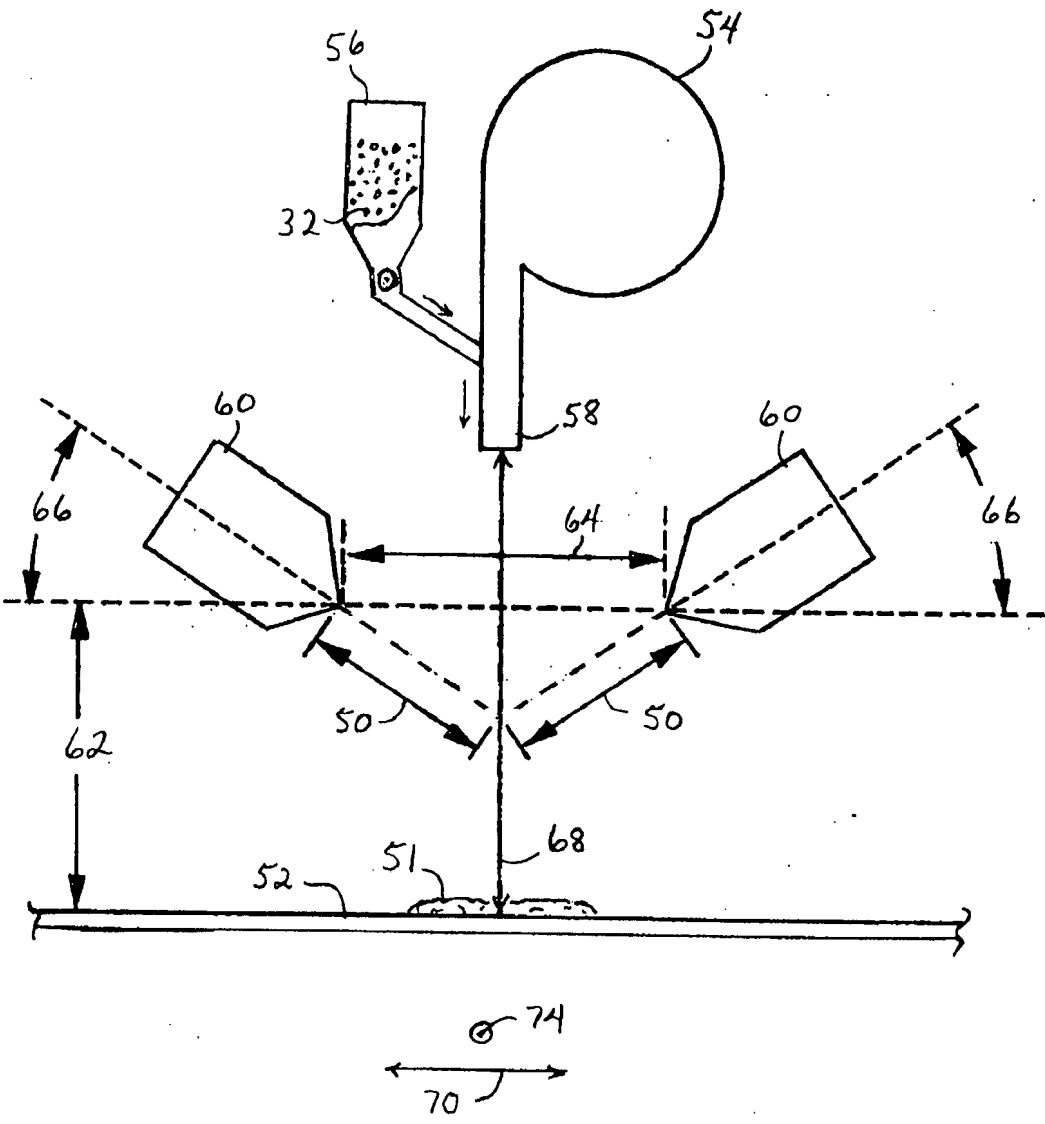


FIG. 4

STRETCHABLE ABSORBENT COMPOSITE WITH LOW SUPERABSORBENT SHAKE-OUT

FIELD OF THE INVENTION

[0001] The present invention relates to an absorbent composite article. More particularly, the present invention pertains to an absorbent composite which can be incorporated in a personal care article, such as an absorbent feminine care article, adult incontinence article, children's training pant, infant diaper, or the like.

BACKGROUND OF THE INVENTION

[0002] Absorbent products intended to absorb discharged body fluids are well known in the art. Such absorbent products generally comprise a fibrous mass or other absorbent body which can absorb and hold the body fluids. Similarly, it is well known that, feminine care articles have been employed to absorb and hold liquids, such as urine, blood and/or menses. The absorbent articles have included various systems of liquid-handling layers, such as intake layers, distribution layers, retention layers and the like. The absorbent articles have also included operative amounts of superabsorbent materials to provide increased absorbent capacity. Additionally, the absorbent articles have included patterns of embossments distributed on the bodyside surface of the article to provide a hinging action, or to inhibit or direct a desired flow of liquids. Other arrangements of the absorbent articles have included wing portions which can help to hold the article in place at a selected location in a wearer's undergarment. Various fasteners have been employed to secure the wing portions in a desired configuration during ordinary use. The fasteners have included adhesive fasteners as well as interengaging mechanical fasteners, and the mechanical fasteners have included conventional, hook-and-loop fasteners. Particular arrangements of the various components of the absorbent articles have been configured to provide desired levels of extensibility or elastomeric stretchability.

[0003] Conventional absorbent systems, however, have not provided desired levels of stretchability in combination with desired levels of containment of superabsorbent particles in a fibrous matrix. When such conventional absorbent systems have been constructed to provide a composite which includes superabsorbent particles within a matrix of fibers, the composite has not adequately provided desired levels of stretchability and particle-containment. The particles of superabsorbent materials have not been adequately held and retained in the associated matrix of fibers, and the absorbent composite has exhibited excessive amounts of particle shake-out. As a result, such conventional system have required additional envelope structures of barrier materials to contain superabsorbent particles that have detached from composite, and to prevent the particles from contacting the body of a user.

BRIEF DESCRIPTION OF THE INVENTION

[0004] Generally stated, the present invention provides an article comprising a stretchable absorbent composite including a quantity of superabsorbent particles which are operatively contained within a matrix of elastomeric polymer fibers. In particular aspects, the composite article can include at least about 60 wt % of the superabsorbent

particles and not more than about 40 wt % of the elastomeric polymer fibers, based on a total weight of the absorbent composite. In other aspects, the composite article can provide a high stretchability. Additional aspects of the composite article can be configured to provide a low shake-out. Particular configurations of the invention can provide a stretchability value of at least about 30%. Additional aspects can provide a shake-out value of not more than about 2%. In other aspects, the invention can provide a shake-out value of not more than about 1.2%. Further aspects of the absorbent composite can include superabsorbent particles having a coating of treatment-material that is thermally processible. Additional aspects can include a treatment-material which is water soluble.

[0005] By incorporating its various features and configurations in desired arrangements, the article of the invention can, for example, provide an improved absorbent composite having a desired combination of stretchability, absorbent capacity and particle-containment. The article can provide improved fit and comfort. The article can also be more efficiently manufactured by eliminating the need for additional barrier or containment components while also providing desired levels of absorbent capacity and stretchability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The various features, aspects and advantages of the present invention will become better understood with reference to the following description, appended claims and accompanying drawings where:

[0007] FIG. 1 shows a representative, partially cut-away, top, plan view of a bodyside of a representative personal care article which includes the absorbent composite of the invention.

[0008] FIG. 1A shows a representative view of a longitudinal cross-section through the article representatively shown in FIG. 1.

[0009] FIG. 2 shows a representative top, plan view of a bodyside of a representative personal care article which includes wing-type side panels.

[0010] FIG. 3 shows a representative, partially cut-away, top, plan view of a bodyside of another representative personal care article which includes the absorbent composite of the invention.

[0011] FIG. 3A shows a representative view of a longitudinal cross-section through the article representatively shown in FIG. 3.

[0012] FIG. 4 shows a representative process and apparatus for producing an elastomeric, absorbent composite web.

DETAILED DESCRIPTION OF THE INVENTION

[0013] It should be noted that, when employed in the present disclosure, the terms "comprises", "comprising" and other derivatives from the root term "comprise" are intended to be open-ended terms that specify the presence of any stated features, elements, integers, steps, or components, and are not intended to preclude the presence or addition of one or more other features, elements, integers, steps, components, or groups thereof.

[0014] By the terms "particle", "particles", "particulate", "particulates" and the like, it is meant that the material is generally in the form of discrete units. The units can comprise granules, powders, spheres, pulverized materials or the like, as well as combinations thereof. The particles can have any desired shape such as, for example, cubic, rod-like, polyhedral, spherical or semi-spherical, rounded or semi-rounded, angular, irregular, etc. Shapes having a large greatest dimension/smallest dimension ratio, like needles, flakes and fibers, are also contemplated for inclusion herein. The terms "particle" or "particulate" may also include an agglomeration comprising more than one individual particle, particulate or the like. Additionally, a particle, particulate or any desired agglomeration thereof may be composed of more than one type of material.

[0015] As used herein, the term "nonwoven" refers to a fabric web that has a structure of individual fibers or filaments which are interlaid, but not in an identifiable repeating manner.

[0016] As used herein, the terms "spunbond" or "spunbonded fiber" refer to fibers which are formed by extruding filaments of molten thermoplastic material from a plurality of fine, usually circular, capillaries of a spinneret, and then rapidly reducing the diameter of the extruded filaments.

[0017] As used herein, the phrase "meltblown fibers" refers to fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into a high velocity, usually heated, gas (e.g., air) stream which attenuates the filaments of molten thermoplastic material to reduce their diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly disbursed meltblown fibers.

[0018] "Coform" as used herein is intended to describe a blend of meltblown fibers and cellulose fibers that is formed by air forming a meltblown polymer material while simultaneously blowing air-suspended cellulose fibers into the stream of meltblown fibers. The coform material may also include other materials, such as superabsorbent particles. The meltblown fibers containing wood fibers are collected on a forming surface, such as provided by a foraminous belt. The forming surface may include a gas-pervious material, such as spunbonded fabric material, that has been placed onto the forming surface.

[0019] "Elastomeric" and "elastic" are used interchangeably to refer to a material or composite that exhibits properties which approximate the properties of natural rubber. The elastomeric material is generally capable of being stretched or otherwise deformed, and then recovering a significant portion of its shape after the stretching or deforming force is removed.

[0020] "Polymers" include, but are not limited to, homopolymers, copolymers, such as for example, block, graft, random and alternating copolymers, terpolymers, etc. and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" shall include all possible configurational isomers of the material. These configurations include, but are not limited to isotactic, syndiotactic and atactic symmetries.

[0021] The phrase "complex liquid" describes a liquid generally characterized as being a viscoelastic liquid com-

prising multiple components having inhomogeneous physical and/or chemical properties. It is the inhomogeneous properties of the multiple components that challenge the efficacy of an absorbent or adsorbent material in the handling of complex liquids. In contrast with complex liquids, simple liquids, such as, for example, urine, physiological saline, water and the like, are generally characterized as being relatively low-viscosity and comprising one or more components having homogeneous physical and/or chemical properties. As a result of having homogeneous properties, the one or more components of simple liquids behave substantially similarly during absorption or adsorption, although some components of the simple liquids may be absorbed or adsorbed more readily than others.

[0022] Although a complex liquid is generally characterized herein as including specific components having inhomogeneous properties, each specific component of a complex liquid generally has homogeneous properties. Consider for example a representative complex body-liquid having three specific components: red blood cells, blood protein molecules and water molecules. Upon examination, one skilled in the art could easily distinguish between each of the three specific components according to their generally inhomogeneous properties. Moreover, when examining a particular specific component such as the red blood cell component, one skilled in the art could easily recognize the generally homogeneous properties of the red blood cells.

[0023] The phrase "absorbent article" refers to devices which can absorb and contain body liquids, and more specifically, refers to devices which are placed against or near the skin to absorb and contain the various liquids discharged from the body. The term "disposable" is used herein to describe absorbent articles that are not intended to be laundered or otherwise restored or reused as an absorbent article after a single use. Examples of such disposable absorbent articles include, but are not limited to: health care related products including surgical drapes, gowns, and sterile wraps; personal care absorbent products such as feminine hygiene products (e.g., sanitary napkins, pantliners, tampons, interlabial devices and the like), infant diapers, children's training pants, adult incontinence products and the like; as well as absorbent wipes and covering mats.

[0024] Disposable absorbent articles can include a liquid pervious topsheet, a backsheet joined to the topsheet, and an absorbent core positioned and held between the topsheet and the backsheet. The topsheet is operatively permeable to the liquids that are intended to be held or stored by the absorbent article, and the backsheet may or may not be substantially impervious or otherwise operatively impermeable to the intended liquids. The absorbent article may also include other components, such as liquid wicking layers, liquid intake layers, liquid distribution layers, transfer layers, barrier layers, wrapping layers and the like, as well as combinations thereof. Disposable absorbent articles and the components thereof can operate to provide a body-facing surface and a garment-facing surface. As used herein, a body-facing or bodyside surface means that surface of the article or component which is intended to be disposed toward or placed adjacent to the body of the wearer during ordinary use, while the outward, outward-facing or garment-side surface is on the opposite side, and is intended to be disposed to face away from the wearer's body during ordinary use.

Such outward surface may be arranged to face toward or placed adjacent to the wearer's undergarments when the absorbent article is worn.

[0025] FIGS. 1 through 3A, illustrate examples of a suitable article 20, such as the representatively shown personal care, absorbent articles, which can be configured to incorporate the present invention. The article can comprise an absorbent body structure, and the absorbent body can include an absorbent composite component 30. Desirably, the absorbent composite has a significant amount of stretchability and includes particles of superabsorbent material (SAM). Additionally, the superabsorbent particles can be operatively contained within a matrix of fibers. Accordingly, the article can comprise a stretchable absorbent composite 30 that includes a quantity of superabsorbent particles 32 which are operatively contained with a matrix of fibers. Desirably, the fibrous matrix can include an operative amount of elastomeric polymer fibers 34. In particular aspects, the composite 30 can include at least about 60 wt % of the superabsorbent particles, and not more than about 40 wt % of the elastomeric polymer fibers, based on a total weight of the composite. In other aspects, the stretchable composite can provide a high stretchability value. Additional aspects of the stretchable composite can include a configuration that provides a distinctively low shake-out value. Particular configurations of the invention can, for example, provide a stretchability of at least about 30%. Another aspect of the invention can include a configuration which provides a shake-out value of not more than about 2%. In still other aspects, the invention can provide a shake-out value of not more than about 1.2%, not more than about 1%, or not more than about 0.5%. Further aspects of the absorbent composite of the invention can include superabsorbent particles having a coating of treatment-material that is thermally processible. Additional aspects can include a treatment-material which is water soluble.

[0026] In desired arrangements, for example, the article 20 and its associated components (e.g. absorbent composite 30) can have a lengthwise longitudinal direction 22 along an appointed y-axis of the article, a transverse, laterally extending, cross-direction 24 along an appointed x-axis of the article, and a thickness dimension along an appointed z-direction 23 of the article. Additionally the article can include first and second longitudinally opposed end portions 72 and 72a, and an intermediate portion 76 located between the end portions. As representatively shown, the longitudinal dimension of the article is relatively larger than the lateral dimension of the article. The article 20 may further include a bodyside cover or topsheet 26, and an outercover baffle or backsheet 28. The absorbent structure can be positioned between the topsheet and backsheet components, and the topsheet and backsheet may or may not be substantially co-terminus. Particular configurations can include a topsheet and backsheet that extend beyond the terminal edges of the absorbent body, and the extending portions of the topsheet and backsheet can be attached to each other to provide a perimeter bond. In desired arrangements, the topsheet can be liquid-permeable, and the backsheet can be operatively liquid-impermeable. In still other aspects, the absorbent body structure can include an elastomeric absorbent composite 30, and may further include additional absorbent components, such as an intake component, a distribution component, a shaping component, a retention component or the like, as well as combinations thereof. Any or all of the

components employed in the article may be configured to have elastomeric properties that are similar to those exhibited by the stretchable absorbent composite 30. The various components, particularly the absorbent components, can have corresponding configurations of absorbent capacities, configurations of densities, configurations of basis weights and/or configurations of sizes which are selectively constructed and arranged to provide desired combinations of liquid intake time, absorbent saturation capacity, absorbent retention capacity, liquid distribution along the thickness and x-y directions of the article, shape maintenance, and aesthetics.

[0027] By incorporating its various features and configurations, alone and in operative combinations, the article of the invention can provide an improved absorbent composite having a desired combination of stretchability, absorbent capacity and particle-containment. The article can be less susceptible to premature leakage, and can provide improved comfort and fit, improved protection and increased confidence to the wearer. Additionally, the article can be more efficiently manufactured to provide desired levels of absorbent capacity and low shake-out of particles. For example, the article can help eliminate the need for additional barrier or wrapping components to contain excessive amounts of loose superabsorbent particles.

[0028] The absorbent composite component 30 can include an operative amount of elastomeric polymer fibers. In a particular aspect, the amount of elastomeric polymer fibers can be at least a minimum of about 5 wt %, based on the total weight of the stretchable absorbent composite 30. The amount of polymer fibers can alternatively be at least about 7 wt % and can optionally be at least about 10 wt % to provide desired benefits. In another feature, the amount of elastomeric polymer fibers can be not more than a maximum of about 40 wt %. The amount of polymer fibers can alternatively be not more than about 25 wt %, and can optionally be not more than about 15 wt % to provide improved benefits.

[0029] If the amount of elastomeric polymer fibers is outside the desired values, various disadvantages can occur. An insufficient amount of meltblown polymer fiber may provide an inadequate level of structural integrity, and an inadequate ability to stretch and retract elastomerically. An excessively high amount of meltblown fiber may hold the superabsorbent particles too tightly and may not allow a sufficient amount of swelling. The restricted swelling of the superabsorbent particles can excessively limit the absorbent capacity of the composite. Where the meltblown polymer is generally hydrophobic, an excessively large amount of meltblown fiber may undesirably limit the intake rate at which the composite acquires liquid, and may limit the distribution of liquid to other parts of the absorbent composite.

[0030] The elastomeric material of the polymer fibers may include an olefin elastomer or a non-olefin elastomer, as desired. For example, the elastomeric fibers can include olefinic copolymers, polyethylene elastomers, polypropylene elastomers, polyester elastomers, polyisoprene, cross-linked polybutadiene, diblock, triblock, tetrablock, or other multi-block thermoplastic elastomeric and/or flexible copolymers such as block copolymers including hydrogenated butadiene-isoprene-butadiene block copolymers; stereoblock polypropylenes; graft copolymers, including eth-

ylene-propylene-diene terpolymer or ethylene-propylene-diene monomer (EPDM) rubber, ethylene-propylene random copolymers (EPM), ethylene propylene rubbers (EPR), ethylene vinyl acetate (EVA), and ethylene-methyl acrylate (EMA); and styrenic block copolymers including diblock and triblock copolymers such as styrene-isoprene-styrene (SIS), styrene-butadiene-styrene (SBS), styrene-isoprene-butadiene-styrene (SIBS), styrene-ethylene/butylene-styrene (SEBS), or styrene-ethylene/propylene-styrene (SEPS), which may be obtained from Kraton Inc. of Houston, Tex., under the trade designation KRATON elastomeric resin or from Dexco, a division of ExxonMobil Chemical Company, under the trade designation VECTOR (SIS and SBS polymers); blends of thermoplastic elastomers with dynamic vulcanized elastomer-thermoplastic blends; thermoplastic polyether ester elastomers; ionomeric thermoplastic elastomers; thermoplastic elastic polyurethanes, including those available from E. I. Du Pont de Nemours Co., under the trade name LYCRA polyurethane, and ESTANE available from Noveon, Inc.; thermoplastic elastic polyamides, including polyether block amides available from Ato Chemical Company, under the trade name PEBAX polyether block amide; thermoplastic elastic polyesters, including those available from E. I. Du Pont de Nemours Co., under the trade name HYTREL, and ARNITEL from DSM Engineering Plastics of Evansville, Ind., and single-site or metallocene-catalyzed polyolefins having a density of less than about 0.89 grams/cubic centimeter, available from Dow Chemical Co. under the trade name AFFINITY; and combinations thereof.

[0031] As used herein, a tri-block copolymer has an ABA structure where the A represents several repeat units of type A, and B represents several repeat units of type B. As mentioned above, several examples of styrenic block copolymers are SBS, SIS, SIBS, SEBS, and SEPS. In these copolymers the A blocks are polystyrene and the B blocks are a rubbery component. Generally these triblock copolymers have molecular weights that can vary from the low thousands to hundreds of thousands and the styrene content can range from 5% to 75% based on the weight of the triblock copolymer. A diblock copolymer is similar to the triblock but is of an AB structure. Suitable diblocks include styrene-isoprene diblocks, which have a molecular weight of approximately one-half of the triblock molecular weight having the same ratio of A blocks to B blocks.

[0032] In desired arrangements, the polymer fibers can include at least one material selected from the group consisting of styrenic block copolymers, elastic polyolefin polymers and co-polymers and EVA/AMA type polymers.

[0033] In particular arrangements, for example, the elastomeric material of the polymer fibers can include KRATON blend G 2755 from Kraton Inc.; and various commercial grades of low crystallinity, lower molecular weight metallocene polyolefins available from ExxonMobil Chemical Company under the VISTAMAXX trade designation. The KRATON material is believed to be a blend of styrene ethylene-butylene styrene polymer, ethylene waxes and tackifying resins. The VISTAMAXX material is believed to be metallocene propylene ethylene co-polymer.

[0034] In another feature, the polymer fibers include an operative amount of a surfactant. The surfactant can be combined with the polymer fibers in any operative manner.

Various techniques for combining the surfactant are conventional and well known to persons skilled in the art. For example, the surfactant may be compounded with the polymer employed to form the meltblown fibers. In a particular feature, the surfactant may be configured to operatively migrate or segregate to the outer surface of the fibers upon the cooling of the fibers. Alternatively, the surfactant may be applied to or otherwise combined with the polymer fibers after the fibers have been formed.

[0035] The polymer fibers include an operative amount of a surfactant, based on the total weight of the fibers and surfactant. In particular aspects, the polymer fibers can include at least a minimum of about 0.1 wt %, as determined by water extraction. The amount of surfactant can alternatively be at least about 0.15 wt %, and can optionally be at least about 0.2 wt % to provide desired benefits. In other aspects, the amount of surfactant can be generally not more than a maximum of about 2 wt %. The amount of surfactant can alternatively be not more than about 1 wt %, and can alternatively be not more than about 0.5 wt % to provide improved performance.

[0036] If the amount of surfactant is outside the desired ranges, the various disadvantages can occur. For example, an excessively low amount of surfactant may not allow the hydrophobic meltblown fibers to wet with the absorbed liquid. An excessively high amount of surfactant may allow the surfactant to wash off from the fibers and undesirably interfere with the ability of the composite to transport liquid. Where the surfactant is compounded or otherwise internally added to the elastomeric polymer, an excessively high level of surfactant can create conditions that cause a poor formation of the polymer fibers.

[0037] In desired configurations, the surfactant can include at least one material selected from the group that includes polyethylene glycol ester condensates and alkyl glycoside surfactants. For example, the surfactant can be a GLUCOPON surfactant which can be composed of 40% water, and 60% d-glucose, decyl, octyl ethers and oligomers.

[0038] A particular example of a sprayed-on surfactant can include a water/surfactant solution which includes 16 L of hot water (about 45° C. to 50° C.) mixed with 0.20 Kg of GLUCOPON 220 UP surfactant and 0.36 Kg of ALCHOVEL Base N-62 surfactant. This is a 1:3 ratio of the GLUCOPON 220 UP surfactant to the ALCHOVEL Base N-62 surfactant. GLUCOPON 220 UP is available from Cognis Corporation, a business having offices located in Cincinnati, Ohio, U.S.A. ALCHOVEL Base-N62 is available from Uniqema, a business having offices located in New Castle, Del., U.S.A. When employing a sprayed-on surfactant, a relatively lower amount of sprayed-on surfactant may be desirable to provide the desired containment of the superabsorbent particles. Excessive amounts of the liquid surfactant may hinder the desired attachment of the superabsorbent particles to the molten, elastomeric meltblown fibers.

[0039] An example of an internal surfactant or wetting agent that can be compounded with the elastomeric fiber polymer can include a MAPEG DO 400 PEG (polyethylene glycol) ester. This material is available from BASF, a business having offices located in Freeport, Tex., U.S.A. Other internal surfactants can include a polyether, a fatty acid ester, a soap or the like, as well as combinations thereof.

[0040] In particular feature, an operative amount of the polymer fibers can have a fiber diameter of not less than a minimum of about 8 microns (μm). Another feature can have a configuration in which an operative amount of the polymer fibers have a fiber diameter of not more than a maximum of about 20 μm . In a further feature, not more than 20 wt % and desirably, not more than about 15 wt % of the meltblown, elastomeric polymer fibers in the absorbent composite 30 have a fiber diameter of less than 8 μm . Still another feature can have a configuration in which not more than about 20 wt % and desirably, not more than about 15 wt % of the elastomeric polymer fibers have a fiber diameter greater than about 20 μm .

[0041] If the amount or proportion of the small polymer fibers (fiber diameter less than about 8 μm) is too great, the absorbent composite 30 may exhibit inadequate levels of stretchability. An overly great amount of the small polymer fibers may also excessively tie down the superabsorbent particles and not allow a desired amount of swelling in the superabsorbent particles. Additionally the smaller fibers can become stress crystallized, and the tensions (modulus) of the stretchable composite 30 can be too high.

[0042] If the amount or proportion of large polymer fibers (fiber diameter greater than about 20 μm) is too great, the absorbent composite 30 may exhibit inadequate levels of particle containment. The meltblown elastomeric fibers may not provide a sufficient amount of fiber surface area, and the superabsorbent particles, may not be adequately contained and held in the matrix of elastomeric, polymer fibers.

[0043] In another feature, the elastomeric polymer fibers can be produced from a polymer material having a selected melt flow rate (MFR). In a particular aspect, the MFR can be up to a maximum of about 300. Alternatively, the MFR can be up to about 230 or 250. In another aspect, the MFR can be a minimum of not less than about 20. The MFR can alternatively be not less than about 100, and can optionally be not less than about 175 or 180 to provide desired performance. The described melt flow rate has the units of grams flow per 10 minutes ($\text{g}/10\text{ min}$). The parameter of melt flow rate is well known and can be determined by conventional techniques, such as by employing test ASTM D-1238-70 "extrusion plastometer" Standard Condition "L" 230° C. and 2.16 kg applied force.

[0044] A further feature of the stretchable absorbent composite can include a configuration in which a relatively low, normalized load value is needed to provide a desired strain elongation. Desired arrangements of the stretchable absorbent composite can be configured to include fibers formed from selected elastomeric materials. When such elastomeric material is formed into a meltblown fibrous web, the resulting, fibrous web can provide a low normalized load when stretched. In a desired feature, the stretchable, fibrous web formed from the elastomeric material can provide a strain elongation of at least about 30%. The low normalized load value of the fibrous web may also be provided at greater levels of elongations. Desirably, the low normalized load value can continue to be provided at strains of up to about 100%. For purposes of the present disclosure, the load is normalized to 1-inch (2.54 cm) of width and to 65 grams per square meter of basis weight—g/inch, normalized with

respect to each 65 g/m^2 increment of basis weight of the meltblown web (g/inch):

$$\left(\frac{\text{load in grams} \times \text{sample width in inches}}{\text{g}/\text{m}^2 \times \text{sample basis weight in g}/\text{m}^2}\right) \times (65)$$

[0045] In a particular aspect, the normalized load value can be not more than a maximum of about 300 g/inch. The normalized load can alternatively be not more than about 250 g/inch, and can optionally be not more than about 210 g/inch to provide desired performance. The normalized, load value represents a retractive, tensile load in grams-force generated by a meltblown web which includes the identified polymer. Examples of the normalized load values provided by meltblown webs constructed from selected elastomeric materials are set forth in Table A.

TABLE A

Polymer	Load at 100% Elongation:	
	g/inch per 65 g/m^2 of basis weight (g/inch)	
KRATON G2755	141.83	
PLTD 1723, 2.2 psig	368.48	
PLTD 1723, 4 psig	419.40	
PLTD 1776, 2.2 psig	315.58	
PLTD 1776, 4 psig	356.95	
PLTD 1777, 2.2 psig	253.63	
PLTD 1777, 4 psig	299.74	
PLTD 1778, 2.2 psig	201.36	
PLTD 1778, 4 psig	233.59	

PLTD = Propylene-based developmental elastomer available from Exxon-Mobil Chemical Company, Houston, Texas, U.S.A.

[0046] The tension values in Table A provide a version of the modulus for the meltblown web. It can be noted that a web made with an olefin elastomer, such as the PLTD 1778 grade of olefin polymer, can exhibit a retractive force that approaches the low retractive force of a web made with KRATON synthetic rubber. In addition, it can be noted that the retractive tension load is affected by the draw force placed on the fiber as the fiber is formed during the meltblowing operation, as provided by the primary air pressure that is set forth in pounds per square inch gauge (psig) next to each polymer code designator. Additionally, it is noted that the higher primary air pressure values can generate a somewhat smaller diameter fiber.

[0047] The polymer fibers can be produced from a quantity of molten polymer (polymer-melt) which has been processed at a distinctive melt-temperature. In a particular aspect, the melt-temperature can be at least a minimum of about 200° C., or about 204° C. (about 400° F.). The melt-temperature can alternatively be at least about 235° C., and can optionally be at least about 240° C. to provide improved performance. In other aspects, the melt-temperature can be up to a maximum of about 268° C. (about 515° F.) or 315° C., or more. The melt-temperature can alternatively be up to about 260° C., and can optionally be up to about 255° C. to provide desired effectiveness.

[0048] The selected melt-temperatures can help the polymer fibers stay operatively soft and sticky for a longer time period after the molten fibers have departed the meltblowing die. This longer time can allow an increased penetration of the superabsorbent particles into the soft, hot polymer material, and can allow the polymer fibers to finish solidifying and quenching with the superabsorbent particles attached to the polymer fibers. If the melt-temperature is too low, the

coated superabsorbent particles may not properly activate and adhere to the meltblown fibers. If the melt-temperature is too high, the meltblown fibers may exhibit poor formation and/or may exhibit excessively reduced stretch properties.

[0049] Additionally, the melt-temperature is appropriately regulated to be less than a degradation temperature at which the desired properties of elastomeric polymer material begin to excessively deteriorate. In particular configurations, for example, the elastomeric polymer material can have a degradation-temperature of not less than a minimum of about 315° C. (about 600° F.).

[0050] The absorbent structure (e.g. absorbent composite 30) can also include a significant amount of base superabsorbent material (e.g. the superabsorbent prior to any desired surface treatment described in the present disclosure), and the base superabsorbent material can desirably be in the form of particles or particulates. Superabsorbent materials suitable for use in the present invention are known to those skilled in the art, and may be in any operative form, such as particulate form. Generally stated, the superabsorbent material can be a water-swallowable, generally water-insoluble, hydrogel-forming polymeric absorbent material, which is capable of absorbing at least about 15 times, desirably at least about 20 times, more desirably at least about 40 times, and possibly about 60 times or more its weight in physiological saline (e.g. 0.9 wt % sodium chloride). The hydrogel-forming polymeric absorbent material may be formed from organic hydrogel-forming polymeric material, which may include natural material such as agar, pectin, and guar gum; modified natural materials such as carboxymethyl cellulose, carboxyethyl cellulose, chitosan salt, and hydroxypropyl cellulose; and synthetic hydrogel-forming polymers. Synthetic hydrogel-forming polymers include, for example, alkali metal salts of polyacrylic acid, polyacrylamides, polyvinyl alcohol, ethylene maleic anhydride copolymers, polyvinyl ethers, polyvinyl morpholinone, polymers and copolymers of vinyl sulfonic acid, polyacrylates, polyvinyl amines, polyquaternary ammonium, polyacrylamides, polyvinyl pyridine, and the like. Other suitable hydrogel-forming polymers include hydrolyzed acrylonitrile grafted starch, acrylic acid grafted starch, and isobutylene maleic anhydride copolymers and mixtures thereof. The hydrogel-forming polymers are desirably lightly crosslinked to render the material substantially water insoluble. Crosslinking may, for example, be by irradiation or covalent, ionic, Van der Waals, or hydrogen bonding. Suitable base superabsorbent materials are available from various commercial vendors, such as the Dow Chemical Company, Degussa Superabsorber, Inc., BASF Inc. and others. The superabsorbent material may desirably be included in an appointed storage or retention portion of the absorbent system, and may optionally be employed in other components or portions of the absorbent article.

[0051] The amount of superabsorbent material in the absorbent composite 30 can be at least a minimum of about 60 wt %, as determined with respect to the total weight of the composite. The amount of superabsorbent material can alternatively be at least about 65 wt %, and can optionally be at least about 70 wt % or 75 wt % to provide improved benefits. In other aspects, the amount of superabsorbent material can be up to a maximum of about 95 wt %, or more. The amount of superabsorbent material can alternatively be

up to about 90 wt %, and can optionally be up to about 85 wt % to provide desired effectiveness.

[0052] If the amount of superabsorbent is outside the desired values, the absorbent composite may have an inadequate combination of high absorbent capacity and low bulk. Large levels of other absorbent materials, such as woodpulp may be needed to provide the desired level of absorbency, and these other materials can excessively increase the thickness of the absorbent composite, and can excessively decrease stretchability of the composite.

[0053] The superabsorbent particles can further include a distinctive surface treatment material. In a particular aspect, the surface treatment can include an operative coating with the surface treatment material. In a particular aspect, the surface treatment can include a polymer that is thermally processible. In another aspect, the surface treatment can include a polymer that is water soluble. The coating may be discontinuous or substantially continuous, as appropriate for providing an operative surface treatment of the superabsorbent particles.

[0054] Generally stated, the treatment-material can desirably have a melt-temperature which is greater than the temperature of the air or other gas that carries the superabsorbent particles to the appointed web forming area. The coating polymer can desirably provide an operative amount of stickiness at temperatures above the melting-point or softening-point of the coating polymer. In a desired feature, the surface treatment material can have a treatment-material melting-point temperature which is at least a minimum of about 60° C. Accordingly, the treatment material can suitably activate and soften to become operatively sticky during the meltblown web-forming process, and the superabsorbent particles can more effectively attach to the fibers incorporated in the formed web of absorbent composite material. The treatment material can alternatively have a melting-point temperature of at least about 70° C., and can optionally have a melting-point temperature of at least about 80° C. In another feature, the melting-point temperature of the treatment-material can be up to about 100° C., or more. In further aspects, the treatment-material, melting-point temperature can be not more than about 220° C., and alternatively, can be not more than about 150° C. to provide improved performance.

[0055] If the melting-point temperature of the treatment material is outside the desired values, the treated superabsorbent particles may excessively stick together and undesirably agglomerate. The excessively stuck-together particles of superabsorbent can undesirably reduce the efficiency and effectiveness of the web-forming process employed to produce the absorbent composite 30.

[0056] The surface treatment can also include a polymer that is hydrophilic and water soluble. In a particular feature, the coating polymer can be solution-coated onto the superabsorbent particles by employing any operative application technique. Such solution coating techniques are conventional and well known in the art. The water solubility of the coating polymer can advantageously help to provide greater cohesion between the coating polymer and the particulate superabsorbent. The greater cohesion can then more effectively cooperate with the thermal processibility of the coating polymer. As a result, the superabsorbent particles can be more effectively held and contained with the matrix of elastomeric polymer fibers.

[0057] The base superabsorbent materials can be operatively surface treated with a treatment material that includes one or more agents that exhibit desired thermoplastic properties. The selected agent or agents on the surface of the treated superabsorbent materials can operatively soften or melt upon heating; e.g. upon contacting hot air or the hot surfaces of other objects during the melt blowing process described herein. The heated surface-treatment material can operatively form bonds with the fibers incorporated in the absorbent composite, such as the thermoplastic elastomeric fibers and cellulosic wood pulp fibers. Accordingly, the surface treating material can promote a melt blown interaction among all of the components employed in the process of producing the absorbent composite 30. The surface treatment material can help to significantly enhance the retention of the superabsorbent particle retention, and help reduce the shake-out of superabsorbent particles.

[0058] Any operative thermoplastic agent can be incorporated into the surface treatment material that is coated onto the surface of superabsorbent materials to enhance thermal stickiness. A particular aspect of the invention can include a surface treatment material which has been configured to provide a superabsorbent material having a desired Thermal Stickiness Index (TSI) value, which is further described in the TEST METHODS section of the present disclosure. A particular feature of the invention can include a superabsorbent material which exhibits a TSI value of at least about 40. The TSI value can alternatively be at least about 60, and can optionally be at least about 80 to provide improved benefits. If the TSI parameter is outside the desired values, there can be insufficient attachment between the superabsorbent particles and the fibers in the absorbent composite 30. As a result, the absorbent composite can exhibit excessive amounts of particulate shake-out.

[0059] In conventional structures, surface coated superabsorbents have incorporated hydrophobic, thermoplastic coating materials, such as polyolefin surface coatings. Such surface treated superabsorbents, however, did not exhibit desired levels of stickiness and bonding integrity. To overcome the difficulties of the prior arrangements of coated superabsorbents, the present invention can be configured to incorporate one or more of the aspects and features set forth in the present disclosure.

[0060] In a particular feature, the surface treatment material can include a hydrophilic thermoplastic polymer, which is a thermally processible. Another feature of the invention can incorporate a surface treatment material which includes water soluble polymer. In a further feature, the invention can include a solution coating process which places the treatment material on the superabsorbent particle and promotes strong bonds between the coating and the particles. Various distinctive factors can influence the effectiveness of thermal stickiness provide by the surface coating. Such factors can, for example, include the cohesion strength of the selected, thermally-sticky coating material; the bond strength provided by the coating material; and the total number of bonds formed by the surface coating material. A thermally processible coating polymer with low cohesion can provide inadequate integrity and inadequate shake-out resistance even if perfect bonds are formed between the superabsorbent particles and adjacent particles or fibers. For example, wax is a thermally meltable polymer but provides insufficient cohesion. The low cohesion wax material is very easy torn apart

and its corresponding bonds are easily breakable. Bond strength refers to the total energy required to separate bonds at the interface between two materials. In general, materials in the same nature tend to have higher bond strength. For example, a hydrophilic polymer forms stronger bonds with another hydrophilic polymer than with a hydrophobic polymer.

[0061] An important interfacial structure between two polymers which can help enhance bonding integrity is a structure that has been referred to by the nomenclature of an Interpenetrating Polymer Network (IPN). IPN pertains to macromolecular chains of a polymer which penetrate through the interface into another polymer domain, or vice versa. Such a penetrating network can promote bond strength, and typically occurs only between compatible polymers. The process employed to coat one polymer onto the other may affect the formation of the desired IPN structure. For example, when a thermally processible and water-soluble polymer (e.g., a hydroxypropyl cellulose, HPC, or a polyethylene oxide, PEO) is coated or otherwise applied onto a base superabsorbent polymer (e.g., a crosslinked sodium polyacrylate), there are two primary coating techniques. One application technique is to spray fine droplets of molten HPC or PEO onto the surface of superabsorbent particles. A second technique is to dissolve the HPC or PEO into water to form a solution, and then mix the solution with dry superabsorbent particles to allow the particles to absorb the solution. The first technique typically produces a coating with no IPN formation. The second technique can promote the formation of the IPN at the interface between the superabsorbent particle and the surface coating material due to a swelling of the superabsorbent, and a diffusion and penetration of water molecules into superabsorbent particles during the operation of the coating technique.

[0062] The factor which relate to the total numbers of bonds formed in the absorbent composite can depend upon the morphology of the coating material. When a hydrophobic polymer material is coated onto the surface of a superabsorbent particle, the hydrophobic polymer tends to form droplets on the particle surface due to a lack of compatibility between the superabsorbent polymer material and the coating polymer material. Such morphology can result in a low efficiency of utilization of the coating polymer (such efficiency is proportional to the coated surface area covered by the coating material). A hydrophilic coating material (e.g., a polymer that is hydrophilic, thermally processible and water soluble) can have greater compatibility with the superabsorbent polymer, and can be more capable of forming a more extensive thin layer of the coating material. The coating layer can cover the whole (or approximately the whole) outer-surface of the superabsorbent particle when the particle is coated by a solution coating process. The resulting morphology can produce a significantly larger amount of particle surface area that is coated by the thermally sticky coating material which employing a reduced amount of the coating material. As a result, the coating material can be utilized with significantly higher efficiency. The higher utilization efficiency of the coating material can increase the number of bonds formed between a superabsorbent particle and other particles and/or fibers in the absorbent composite.

[0063] The superabsorbent particles can, for example, also include a surface treatment material which is thermally

processable. Additionally, the surface treatment material can be water soluble. The thermally processible and water soluble coating materials (e.g. coating polymers) have a melting or softening temperature (i.e., T_m) and are capable of dissolving in water. Suitable thermally processible and water soluble polymers include, but are not limited to, modified polyvinyl alcohol, polyethylene oxide, polypropylene oxide, ethylene oxide-propylene oxide copolymer, polyethylene glycol, polypropylene glycol, ethylene glycol-propylene glycol copolymer, polyacrylic acid copolymers, quaternary ammonium acrylate, methacrylate, or acrylamide copolymers, modified polysaccharides, such as hydroxypropyl cellulose, methyl cellulose, methyl ethyl cellulose, polyethylene imine, as well as mixtures or other combinations thereof. The molecular weight of the selected polymer can be important. In general, a higher molecular weight polymer can provide a desired, higher intrinsic cohesion. When the molecular weight of a coating polymer is too high, however, an aqueous solution of the coating polymer can have an excessive level of viscosity, which may potentially create difficulties in conducting desired surface treating operations. In a particular aspect of the invention, the molecular weight of a thermally processible and water soluble surface treatment (e.g. coating) polymer can be at least a minimum of about 5,000. The molecular weight can alternatively be at least about 10,000, and can optionally be about 50,000. In another aspect the molecular weight of the surface treatment material can be up to a maximum of about 10,000,000. The molecular weight can alternatively be not more than about 1,000,000, and can optionally be not more than about 500,000 to provide improved benefits.

[0064] As previously mentioned, the thermally processible and water soluble, surface treatment material can desirably be coated onto the surface of the superabsorbent particle by employing an aqueous solution of the surface treatment material to promote the formation of a desired IPN. When the surface treatment material (e.g. polymer) is dissolved into an operative aqueous solution, the solution can have a selected concentration of the surface treatment material. In a particular feature, the concentration of the surface treatment material in the solution can be at least a minimum of about 0.01 wt %. The concentration of the surface treatment material can alternatively be at least about 0.1 wt %, and can optionally be at least about 0.5 wt % to provide improved benefits. In other aspects, the concentration of the surface treatment material can be up to a maximum of about 20 wt %, or more. The concentration of the surface treatment material can alternatively be up to about 10 wt %, and can optionally be up to about 5 wt % to provide improved effectiveness.

[0065] If the molecular weight and/or concentration of the surface treatment material outside the desired values, the treatment material may not adequately provide a desired, deeper penetration of the coated polymer into the superabsorbent polymer material. As a result, the superabsorbent material may exhibit insufficient levels of thermal stickiness, bonding strength and absorbency.

[0066] A selected amount of the thermally processible and water soluble, surface treatment material can be coated onto the surfaces of a superabsorbent particles to provide a desired, overall thermal stickiness of the coated superabsorbent particles.

[0067] In a particular aspect, the coating amount can be at least a minimum of about 0.1 wt %, as determined with respect to the total dry weight of the coated superabsorbent material. The coating amount can alternatively be at least about 0.3 wt %, and can optionally be at least about 0.5 wt % to provide improved benefits. In other aspects, the coating amount of the surface treatment material can be up to a maximum of about 10 wt %, or more. The coating amount can alternatively be up to about 7 wt %, and can optionally be up to about 5 wt % to provide improved effectiveness.

[0068] The surface treated superabsorbent material can retain a selected level of high absorbency. In a particular aspect, the surface treated superabsorbent particles can exhibit a centrifuge retention capacity (CRC) of at least about 15 g/g. The centrifuge retention capacity can alternatively be at least about 20 g/g, and can optionally be at least about 25 g/g to provide improved performance. The centrifuge retention capacity test is described in detail in the TEST METHODS section of the present disclosure.

[0069] The elastomeric absorbent composite can further include a definite, discrete amount of hydrophilic fibers, such as cellulose or cellulosic fibers. The amount of hydrophilic fibers may be in an amount greater than 0 wt %, and in particular configurations of the invention, can be at least about 5 wt % or 7 wt % to provide desired benefits. In another aspect, the amount of cellulosic or other hydrophilic fibers can be up to a maximum of about 35 wt %, based upon the total weight of the elastomeric absorbent composite. The amount of hydrophilic fibers can alternatively be up to a maximum of about 25 wt %, and can optionally be up to about 15 wt %.

[0070] The selected amounts of cellulosic or other hydrophilic fiber can help provide increased levels of liquid intake and wicking. Excessive amounts of hydrophilic fibers, however, can undesirably reinforce the composite structure and excessively limit properties such as elasticity, stretch and recovery. Additionally, overly large amounts of the hydrophilic fiber can lead to excessive cracking of the absorbent composite during extension and stretching.

[0071] The cellulosic fibers may include, but are not limited to, chemical wood pulps such as sulfite and sulfate (sometimes called Kraft) pulps, as well as mechanical pulps such as ground wood, thermomechanical pulp and chemithermomechanical pulp. More particularly, the pulp fibers may include cotton, typical wood pulps, cellulose acetate, rayon, thermomechanical wood pulp, chemical wood pulp, debonded chemical wood pulp, milkweed floss, and combinations thereof. Pulps derived from both deciduous and coniferous trees can be used. Additionally, the cellulosic fibers may include such hydrophilic materials as natural plant fibers, cotton fibers, microcrystalline cellulose, microfibrillated cellulose, or any of these materials in combination with wood pulp fibers. Suitable cellulosic fibers can, for example, include: NB 416 a bleached southern softwood Kraft pulp (which is available from Weyerhaeuser Co., a business having offices located in Federal Way, Wash., U.S.A.); CR 54 a bleached southern softwood Kraft pulp (which is available from Bowater Inc., a business having offices located in Greenville S.C., U.S.A.); SULPHATATE HJ a chemically modified hardwood pulp (which is available from Rayonier Inc., a business having offices located in Jesup Ga., U.S.A.); NF 405 a chemically treated bleached

southern softwood Kraft pulp (which is available from Weyerhaeuser Co.); and CR 1654 a mixed bleached southern softwood and hardwood Kraft pulp (which is available from Bowater Inc.). Desired configurations of the absorbent composites of the invention can, for example, include a pulp fiber content which is in the range of about 0 to 35 wt %.

[0072] In a further feature, the formed absorbent composite having the elastomeric fibers and superabsorbent particles can be subjected to a post heat-treatment to help improve the containment of the superabsorbent particles. In a particular heat-treatment, the formed absorbent composite can be subjected to a temperature of 100° C. for a time period of 5 minutes. In another desired treatment, the formed absorbent composite can be subjected to a temperature of 70° C. for 60 minutes. The absorbent composite is stretchable, and more particularly, can be elastically stretchable. In a particular feature, the absorbent composite can have a stretchability value of at least about 30%. In particular aspects, the stretchability value can be at least a minimum of about 50%. The stretchability value can alternatively be at least about 60%, and can optionally be at least about 75% to provide improved benefits. In other aspects, the stretchability value can be up to a maximum of about 300%, or more. The stretchability value can alternatively be up to about 200%, and can optionally be up to about 100% to provide desired effectiveness.

[0073] If the stretchability parameter is outside the desired values, composite may not be sufficiently flexible to provide desired levels of fit and conformance to the shape of the user. A donning of a product that includes the composite 30 can be more difficult. For example, training pant products may be accidentally stretched to large amounts before use, and the absorbent system may rip and tear. As a result, the absorbent composite may exhibit excessive leakage problems.

[0074] The stretchability of an overall layer or other component can be determined by employing the Composite Stretchability Test, which is described in the TEST METHODS section of the present disclosure. In a desired feature, the selected, desired stretchability value can be achieved with an applied stretching force of 150 grams-force (gmf) per inch of width of the test specimen (0.58 N/cm)

[0075] Another feature of the invention can include superabsorbent particles which have been combined with the elastomeric polymer fibers during a formation of the polymer fibers, and the formation of the polymer fibers has included a meltblowing operation. Where the absorbent composite 30 includes cellulosic fibers, the superabsorbent particles can be operatively mixed with the cellulosic fibers, and the mixture can then be operatively combined with the meltblown polymer fibers.

[0076] The stretchable absorbent composite can provide an improved holding and retention of the superabsorbent particles in the matrix of elastomeric fibers. In a particular aspect, the absorbent composite 30 can be configured to provide a superabsorbent shake-out value of not more than a maximum of about 2%. The provided shake-out value can alternatively be not more than about 1.2%, and can optionally be not more than about 1% to provide improved benefits. In further features, the shake-out value can be not more than about 0.8% or not more than about 0.5% to provide further improved benefits. A suitable technique for

determining the superabsorbent shake-out value of an absorbent composite can employ the Shake-Out Test, which is described in the TEST METHODS section of the present disclosure.

[0077] Techniques and systems for producing nonwoven fibrous webs which include meltblown fibers are well known in the art. For example, a suitable technique is disclosed in U.S. Pat. No. 4,100,324 to R. A. Anderson. Other suitable techniques are described in U.S. Pat. No. 5,350,624 to W. A. Georger, and U.S. Pat. No. 5,508,102 to W. A. Georger. Absorbent, elastomeric meltblown webs containing high amounts of superabsorbent are described in U.S. Pat. No. 6,362,389, to D. J. McDowall. The entire disclosures of these documents are incorporated herein by reference in a manner that is consistent herewith. The meltblowing techniques can be readily adjusted in accordance with conventional know-how to provide turbulent flows that can operatively mix the selected fibers and superabsorbent particles. In a desired arrangement, the particles and selected fibers can be substantially homogeneously mixed during the process of forming a web of the stretchable absorbent composite material. The techniques can also be readily adjusted in accordance with conventional knowledge to provide the desired weight percentages of the selected fibers and superabsorbent particles.

[0078] With reference to FIG. 4, a meltblowing process and apparatus for forming a stretchable, absorbent composite web 51 can have an appointed machine-direction 74 which extends longitudinally along the processing sequence of the process and apparatus, and an appointed lateral cross-deckle direction 70 which extends transversely. For the purposes of the present disclosure, the machine-direction is the direction along which a particular component or material is transported length-wise along and through a particular, local position of the apparatus and process. The cross-deckle direction 70 can lie generally within the plane of the material being transported through the method and apparatus, and is aligned perpendicular to the local machine-direction. Accordingly, with reference to the arrangement representatively shown in FIG. 4, the machine-direction 74 extends perpendicular to the plane of the sheet of the drawing. As representatively shown, the process and apparatus can include a conventional fiberizer 54 which, if desired, provides the desired amount of cellulosic fibers; an operative supply 56 of superabsorbent particles 32; and a delivery chute 58 which directs the superabsorbent particles and cellulosic fibers, if any, into the cooperating portions of the forming process. The superabsorbent supply system 56 can include any conventional metering device for providing a desired, flow rate of particles into the process. The forming process can further include a system of meltblowing dies 60 which provide the desired elastomeric polymer fibers, and a foraminous forming surface 52 on which a composite web can be formed. The forming surface can, for example, be provided by a forming belt or by the generally cylindrical, peripheral surface of a rotatable forming drum. The composite web 51 can be formed in a substantially continuous operation, and the web can include the superabsorbent particles operatively held in contained in the matrix of elastomeric polymer fibers 34, as well as any incorporated cellulosic fibers.

[0079] In particular configurations, selected processing parameters can be appropriately controlled to produce desired characteristics in the stretchable absorbent composite 30. For example:

[0080] Melt-temperature—Higher melt-temperatures can provide better containment of the incorporated particles (less shake-out). The elastomeric polymer can stay molten longer, thereby increasing the chance that the particles will hit and attach to molten/softened polymer.

[0081] Die-to-Die Width—This parameter is the distance 64 representatively shown in FIG. 4. A smaller die-to-die width 64 can give higher containment of the incorporated particles. The meltblown polymer fibers travel a smaller distance before contacting the superabsorbent particles, and the particles can more readily connect to and be captured by the still soft and sticky polymer material. The die-to-die width distance 64 can, for example, be within the range of about 11.4-17.8 cm (about 4.5-7 inch). In a desired configuration, the die-to-die width can be about 14 cm (about 5.5 inch).

[0082] Relative Humidity—Lower relative humidity can provide a higher containment of the incorporated particles. Ambient, liquid moisture can hinder the attachment between the particles and the polymer fibers. The particles may preferentially attach to the liquid instead of the polymer.

[0083] External Surfactant—Lower amounts of externally-applied (e.g. sprayed-on) surfactant can provide a higher containment of particles. The liquid surfactant can hinder the attachment between the particles and the polymer fibers. The particles may preferentially attach to the liquid instead of the polymer.

[0084] Vacuum—This parameter is the vacuum level (e.g. measured in inches of water) that is generated under the foraminous forming surface and the composite web during the web forming operation. A higher vacuum can provide a higher containment of particles. The higher vacuum can help provide a tighter, more locked-together structure.

[0085] Fiber Diameter/Primary air pressure—This parameter is the air pressure of the forming gas (e.g. air) that is generated close to the exit of the air channels that are typically incorporated at the tip of the meltblowing die 60. The primary air pressure can, for example be expressed in the units of "psig" (pounds per square inch—gauge). For example, a selected exit air velocity, typically in the range of 0.4-1.0 Mach can be provided at the air exit, depending on the primary air pressure and the air gap spacing employed within the meltblowing die. The air gap spacing is measured from a knife edge of the meltblowing die tip to an inside edge of the air plate in the meltblowing die. In a typical arrangement, the air gap spacing can be within the range of about 0.015-0.084 inch. A higher, primary-air pressure can create smaller fibers and help provide a higher containment of the particles. The smaller fibers can provide an increased amount of surface area to which the particles can attach. The smaller fibers are also more flexible and can more readily entangle around a superabsorbent particle.

[0086] Die angle—This parameter is the angle 66 representatively shown in FIG. 4. A large angle from the horizontal can reduce contact between the polymer fibers and the particles. The reduced contact can decrease the containment of the particles in the composite, and can also create a non

homogenous (layered) sheet which can degrade the containment of the superabsorbent particles. The die angle 66 can, for example be within the range of about 35°-65° from horizontal. In a particular arrangement, the die angle can be about 45° from horizontal.

[0087] Forming Height (Die-to-table)—This parameter is the distance 62 between the meltblowing die 60 and the forming surface 52. A lower forming height can provide a higher containment of particles. Fiber entanglements can form more quickly and can help hold and secure the particles in the composite web. The forming height 62 can, for example, be within the range of about 25.4-40.6 cm (about 10-16 inch). Particular arrangements can incorporate a forming height of about 33 cm (about 13 inch).

[0088] Chute Height (Chute to table)—This parameter is the minimum distance 68 between the exit of the delivery chute 58 and the forming surface 52. A lower chute height 68 may give higher containment of the particles, as long as the particles are sufficiently attached to the polymer fibers before hitting the table. It is believed that the velocity of the particles can shoot the particles straight down the middle region of the system of meltblowing dies employed to form the elastomeric polymer fibers, and can quickly move the particles into the molten polymer. When the fibers and particles hit the table. The chute height 68 can, for example, be within the range of about 25.4-46 cm (about 10-18 inch). Particular arrangements of the process and apparatus can include a chute height of about 41.3 cm (about 16.25 inch).

[0089] Additionally, the configuration of the process and apparatus can provide a slant distance 50. Particular aspects of the process and apparatus can be configured to provide a slant distance within the range of about 4-6 inch (about 10-16.3 cm). In a desired arrangement, the slant distance can be about 5 inch (about 13 cm) to provide desired benefits.

[0090] The process and apparatus can also be arranged to provide a selected chute angle. In the various configurations of the invention, the outlet opening of the delivery chute 58 can have a short-axis and a long-axis. As representatively shown in FIG. 4, the short axis can extend generally along the cross-deckle direction 70 and the long-axis can extend generally perpendicular to the plane of the drawing sheet. The chute angle is the angle between the long-axis of the delivery chute and the local machine-direction. A chute angle of zero degrees can, for example, have the long-axis of the delivery chute 58 aligned along the machine-direction of the process and apparatus. Additionally, the long-axis can be approximately centered along the cross-deckle direction 70 of the forming surface. A chute angle of 20 degrees can have the long-axis of the delivery chute rotated 20 degrees away from the local machine-direction at the position of the delivery chute. The long-axis of the delivery chute can also be substantially centered along the cross-deckle direction of the forming surface. In particular aspects, the chute angle can be within the range of about 0°-90°. Desired arrangements of the process and apparatus can include a chute angle of about 20° to provide desired performance.

[0091] A further feature of the invention can include an elastomeric, absorbent composite 30 which has been subjected to a distinctive curing operation after the formation of the composite web material. The curing operation can include a distinctive curing time, and can further include a

distinctive curing temperature. In a particular aspect, the curing time can be at least a minimum of about 5 minutes. The curing time can alternatively be at least about 10 minutes, and can optionally be at least about 30 minutes to provide desired benefits. In other aspects, the curing time can be up to a maximum of about 75 minutes, or more. The curing time can alternatively be up to about 70 minutes, and can optionally be up to about 60 minutes to provide desired effectiveness.

[0092] In another aspect, the absorbent composite 30 can be subjected to a curing temperature which is at least a minimum of about 60° C. The curing temperature can alternatively be at least about 70° C., and can optionally be at least about 80° C. to provide improved performance. In other aspects, the curing temperature can be up to a maximum of about 130° C., or more. The curing temperature can alternatively be up to about 120° C., and can optionally be up to about 100° C. to provide improved effectiveness.

[0093] If the curing time and/or curing temperature are outside the desired values, the superabsorbent particle may not be sufficiently bonded to the fibers in the absorbent composite, and the absorbent composite can exhibit excessive levels of particle shake-out. In other effects, the absorbent composite may exhibit an insufficient level of stretchability.

[0094] The absorbent composite 30 can have a selected density, as determined under a confining pressure of 0.05 psi (0.345 KPa). In a particular feature, the absorbent composite density can be at least a minimum of about 0.1 grams per cubic centimeter (g/cm³). The density of the absorbent composite can alternatively be at least about 0.25 g/cm³, and can optionally be at least about 0.3 g/cm³. In another feature the absorbent composite density can be up to about 0.4 g/cm³. The sample density can affect the shake-out value of the absorbent composite. A higher density can be helpful to decrease the superabsorbent shake-out from the absorbent composite. Desired configurations of the stretchable absorbent composite can have a density within the range of about 0.20 to 0.35 g/cm³.

[0095] As previously mentioned, the article 20 may further include a backsheet, and a liquid-permeable topsheet. Additionally, the absorbent composite 30, which includes the matrix of elastomeric polymer fibers and the superabsorbent particles, can be operatively sandwiched between the topsheet and backsheet.

[0096] The bodyside liner or topsheet 26 that may be included in the article 30 can include a layer constructed of any operative material, and may be a composite material. For example, the topsheet layer can include a woven fabric, a nonwoven fabric, a polymer film, a film-fabric laminate or the like, as well as combinations thereof. Examples of a nonwoven fabric include spunbond fabric, meltblown fabric, coform fabric, a carded web, a bonded-carded-web, a bicomponent spunbond fabric or the like as well as combinations thereof. Other examples of suitable materials for constructing the topsheet layer can include rayon, bonded carded webs of polyester, polypropylene, polyethylene, nylon, or other heat-bondable fibers, polyolefins, such as copolymers of polypropylene and polyethylene, linear low-density polyethylene, aliphatic esters such as polylactic acid, finely perforated film webs, net materials, and the like, as well as combinations thereof. In desired arrangements, the topsheet layer can be configured to be operatively liquid-permeable.

[0097] A more particular example of a suitable topsheet layer material can include a bonded-carded-web composed of polypropylene and polyethylene, such as has been employed as a topsheet stock for KOTEX brand pantliners, and has been obtainable from Vliesstoffwerk Christian Heinrich Sandier GmbH & Co. KG, a business having an address at Postfach 1144, D95120 Schwarzenbach/Saale, Germany. Other examples of suitable materials are composite materials of a polymer and a nonwoven fabric material. The composite materials are typically in the form of integral sheets generally formed by the extrusion of a polymer onto a web of spunbond material. In a desired arrangement, the topsheet layer 26 can be configured to be operatively liquid-permeable with regard to the liquids that the article is intended to absorb or otherwise handle. The operative liquid-permeability may, for example, be provided by a plurality of pores, perforations, apertures or other openings, as well as combinations thereof, that are present or formed in the topsheet layer. The apertures or other openings can help increase the rate at which bodily liquids can move through the thickness of the topsheet layer and penetrate into the other components of the article (e.g. into the absorbent structure 30). The selected arrangement of liquid-permeability is desirably present at least on an operative portion of the topsheet layer that is appointed for placement on the bodyside of the article. The topsheet layer 26 can provide comfort and conformability, and can function to direct bodily exudates away from the body and toward the absorbent structure 30. In a desired feature, the topsheet layer 26 can be configured to retain little or no liquid in its structure, and can be configured to provide a relatively comfortable and non-irritating surface next to the body-tissues of a female wearer. The topsheet layer 26 can be constructed of any material which is also easily penetrated by bodily fluids that contact the surface of the topsheet layer.

[0098] The topsheet 26 can also have at least a portion of its bodyside surface treated with a surfactant and/or a menses modifier to increase the surface energy of the material surface or reduce the viscoelastic properties of the menses, and to render the topsheet more hydrophilic and more wettable to body fluids. The surfactant can permit arriving bodily liquids to more readily penetrate the topsheet layer. The surfactant may also diminish the likelihood that the arriving bodily fluids, such as menstrual fluid, will flow off the topsheet layer rather than penetrate through the topsheet layer into other components of the article (e.g. into the absorbent body structure). In a particular configuration, the surfactant can be substantially evenly distributed across at least a portion of the upper, bodyside surface of the topsheet 26 that overlays the upper, bodyside surface of the absorbent.

[0099] The topsheet 26 may be maintained in secured relation with the absorbent structure 30 by bonding all or a portion of the adjacent surfaces to one another. A variety of bonding articles known to one of skill in the art may be utilized to achieve any such secured relation. Examples of such articles include, but are not limited to, the application of adhesives in a variety of patterns between the two adjoining surfaces, entangling at least portions of the adjacent surface of the absorbent with portions of the adjacent surface of the topsheet, or fusing at least portions of the adjacent surface of the topsheet to portions of the adjacent surface of the absorbent.

[0100] The topsheet 26 typically extends over the upper, bodyside surface of the absorbent structure, but can alternatively extend around the article to partially or entirely, surround or enclose the absorbent structure. Alternatively, the topsheet 26 and the backsheet 28 can have peripheral margins which extend outwardly beyond the terminal, peripheral edges of the absorbent structure 30, and the extending margins can be joined together to partially or entirely, surround or enclose the absorbent structure.

[0101] The backsheet 28 that may be included in the article can include a layer constructed of any operative material, and may or may not have a selected level of liquid-permeability or liquid-impermeability, as desired. In a particular configuration, the baffle or backsheet 28 may be configured to provide an operatively liquid-impermeable backsheet structure. The backsheet may, for example, include a polymeric film, a woven fabric, a nonwoven fabric or the like, as well as combinations or composites thereof. For example, the backsheet may include a polymer film laminated to a woven or nonwoven fabric. In a particular feature, the polymer film can be composed of polyethylene, polypropylene, polyester or the like, as well as combinations thereof. Additionally, the polymer film may be micro-embossed. Desirably, the backsheet 28 can operatively permit a sufficient passage of air and moisture vapor out of the article, particularly out of an absorbent (e.g. storage or absorbent structure 30) while blocking the passage of bodily liquids. An example of a suitable backsheet material can include a breathable, microporous film, such as a HANJIN Breathable Backsheet available from Hanjin Printing, Hanjin P&C Company Limited, a business having offices located in Sahvon-li.Jungan-mvu.Kongju-City, Chung cheong nam-do, Republic of South Korea. The backsheet material is a breathable film, which is dimple embossed and contains: 47.78% calcium carbonate, 2.22% TiO_2 , and 50% polyethylene.

[0102] In a particular feature, the polymer film can have a minimum thickness of no less than about 0.025 mm, and in another feature, the polymer film can have a maximum thickness of no greater than about 0.13 mm. Bicomponent films or other multi-component films can also be used, as well as woven and/or nonwoven fabrics which have been treated to render them operatively liquid-impermeable. Another suitable backsheet material can include a closed cell polyolefin foam. For example, closed cell polyethylene foam may be employed. Still another example of a backsheet material would be a material that is similar to a polyethylene film which is used on commercially sold KOTEX brand pantliners, and is obtainable from Pliant Corporation, a business having offices located in Schaumburg, Ill., USA.

[0103] The absorbent body structure that is included in the article can be operatively configured to provide desired levels of absorbency and storage capacity, and desired levels of liquid acquisition and distribution. More particularly, the absorbent body can be configured to hold a liquid, such as urine, menses, other complex liquid or the like, as well as combinations thereof. As representatively shown, the absorbent body can include a matrix of absorbent fibers and/or absorbent particulate material, and the absorbent fiber can include natural and/or synthetic fiber. The absorbent body may also include one or more components that can modify menses or inter-menstrual liquids.

[0104] In desired configurations, the elastomeric absorbent composite 30 can provide a specific retention capacity and a total retention capacity. The specific retention capacity of an overall layer or other component can be determined by employing the Centrifuge Retention Capacity Test, which is described in the TEST METHODS section of the present disclosure. The total absorbent retention capacity of an overall layer or other component can be determined by multiplying its specific saturation capacity times the total weight of such component.

[0105] In optional arrangements, a selected configuration of garment adhesive, such as one or more strip regions, may be distributed onto the garment-side of the article to help secure the article to a wearer's undergarment. Typically, the garment adhesive is distributed over the garment-side of the backsheet, and one or more layers or sheets of release material can be removably placed over the garment adhesive to top-sheet the adhesive for storage prior to use.

[0106] The article 20 can include a system of side-panels 42, which can provide desired "ear" or "wing" portions, depending on the desired configuration of the article. The side-panels can be unitarily formed from a selected component of the article, such as the topsheet and/or the backsheet, and are integrally connected to appointed sections of the side regions along a selected portion of the article. In adult or infant incontinence products, for example, the side-panels may be joined to extend laterally from the longitudinal end regions of an individual product, and may be configured to operatively encircle a wearer's waist. In feminine care products, the side-panels may be joined to extend laterally from the intermediate portion 76 of the article, and may be configured to be operatively wrapped and secured around the side edges of a wearer's undergarment to help hold the article in place. Alternatively, the side-panels or wings can be separately provided members that are subsequently attached or otherwise operatively joined to the appointed portion of the article 20.

[0107] The side-panel portions 42 can have any operative construction, and can include a layer of any operative material. Additionally, each side-panel can comprise a composite material. For example, the side-panels may include a spunbond fabric material, a bi-component spunbond material, a necked spunbond material, a neck-stretched-bonded-laminate (NBL) material, a meltblown fabric material, a bonded carded web, a thermal bonded carded web, a through-air bonded carded web or the like, as well as combinations thereof.

[0108] Each side-panel 42 can be joined to its corresponding side region of the article in any operative manner. For example, the side-panel can be joined to the topsheet 26, the backsheet 28 or another article component, as well as any combination thereof. In the illustrated example, each side-panel 42 is joined to the outward, garment-side surface of the backsheet 28, but may optionally be joined to the bodyside surface of the backsheet. The side-panel can be attached with hotmelt adhesive, but any other operative adhesive or attachment mechanism may alternatively be employed.

[0109] In another feature, each side-panel portion 42, or any desired combination of the employed side-panel portions, can include a panel-fastener component which is cooperatively joined to an appointed, landing zone or

engagement surface of the article. The panel-fastener can include a system of interengaging mechanical fasteners, a system of adhesive fasteners or the like, as well as combinations thereof.

[0110] Each side-panel 42 can, for example, include a loop or other "female" component of an interengaging mechanical fastener system. Alternatively, each side-panel can include a hook or other "male" component of the mechanical fastener system. Any operative hook component may be employed. For example, a suitable hook component materials can include a J-hook, mushroom-head hook, flat-top nail-head hook, a palm-tree hook, a multiple-J hook or the like, as well as combinations thereof. Alternatively, either or both side-panels 42 can include a panel-fastener system which incorporates an operative adhesive. The adhesive may be a solvent-base adhesive, a hotmelt adhesive, a pressure-sensitive adhesive, or the like, as well as combinations thereof.

[0111] In the various arrangements of the present invention, the hook component can be configured to have a particularly selected hook concentration or density (hooks per unit area). In a particular aspect, the hook density can be at least a minimum of about 1500 hooks/in² (about 232 hooks/cm²). The hook density can alternatively be at least about 2000 hooks/in² (about 310 hooks/cm²), and can optionally be at least about 3000 hooks/in² (about 465 hooks/cm²) to provide improved performance. In another aspect, the hook density can be not more than a maximum of about 7000 hooks/in² (about 1085 hooks/cm²). The hook density can alternatively be not more than about 6000 hooks/in² (about 930 hooks/cm²), and can optionally be not more than about 5000 hooks/in² (about 775 hooks/cm²) to provide improved performance.

[0112] Examples of suitable hook materials can include 85-Series and 61-Series hook materials available from Velcro, U.S.A., a business having offices located in Manchester, N.H., U.S.A. The hook materials can have a hook density of about 775 hooks/cm².

[0113] In particular arrangements, the material of the loop component may include a nonwoven fabric having continuous bonded areas defining a plurality of discrete unbonded areas. The fibers or filaments within the discrete unbonded areas of the fabric are dimensionally stabilized by the continuous bonded areas that encircle or surround each unbonded area, such that no support or backing layer of film or adhesive is required. The unbonded areas are specifically designed to afford spaces between fibers or filaments within the unbonded area that remain sufficiently open or large to receive and engage hook elements of the complementary hook material. In particular, a pattern-unbonded nonwoven fabric or web may include a spunbond nonwoven web formed of single component or multi-component melt-spun filaments. At least one surface of the nonwoven fabric can include a plurality of discrete, unbonded areas surrounded or encircled by continuous bonded areas. The continuous bonded areas dimensionally stabilize the fibers or filaments forming the nonwoven web by bonding or fusing together the portions of the fibers or filaments that extend outside of the unbonded areas into the bonded areas, while leaving the fibers or filaments within the unbonded areas substantially free of bonding or fusing. The degree of bonding or fusing within the bonding areas desirably is sufficient to render the

nonwoven web non-fibrous within the bonded areas, leaving the fibers or filaments within the unbonded areas to act as "loops" for receiving and engaging hook elements. Examples of suitable point-unbonded fabrics are described in U.S. Pat. No. 5,858,515 entitled PATTERN-UNBONDED NONWOVEN WEB AND PROCESS FOR MAKING THE SAME, by T. J. Stokes et al., and granted Jan. 12, 1999 (attorney docket No. 12,232); the entire disclosure of which is incorporated herein by reference in a manner that is consistent herewith.

[0114] In the construction of the article 20, the various components may be assembled and held together with any operative securement mechanism or system. For example, the desired attachments or securements can include adhesive bonds, cohesive bonds, thermal bonds, ultrasonic bonds, pins, snaps, staples, rivets, stitches, welds, zippers, or the like, as well as combinations thereof.

Test Methods

Composite Stretchability Test

[0115] To determine the stretchability of a material, a predetermined amount of elongation is chosen: e.g. 30%, 50%, 100% etc. The amount of stretch provides a corresponding stretch ratio: e.g. 130%, 150% 200% etc. For each level of stretchability testing, three specimens are tested and all three must pass in order to consider the sample as having the respective level of stretchability. A sufficient amount of stretching force is applied to the specimen, as needed to generate the selected amount of stretching. Each specimen is tested only once, even if the specimen is not damaged.

[0116] The stretchability of a composite is measured after 3 cycles with each cycle including (a) stretching to a predetermined ratio of extension, and (b) releasing the stretching force, thereby allowing the stretched composite to retract back towards its original dimension.

[0117] Stretchability is defined according to the following equation:

$$\text{Stretchability} = (L_e - L_o) \times 100\% / L_o$$

wherein L_e is the length after extension (i.e., at the predetermined ratio), and L_o is the original sample length. For a sample to be qualified as having a predetermined stretchability, the sample must be able to demonstrate all of the following requirements:

[0118] (1) The sample must be able to reach the predetermined stretch ratio.

[0119] (2) The sample must be able to retract at least 70% of the extension within a 1-minute interval after the applied stretching force is removed, as measured in the third stretching cycle. The percent retraction is defined as:

$$\text{Retraction (\%)} = \{1 - (L_f - L_o) / (L_e - L_o)\} \times 100\%$$

wherein L_f is the sample length after the force has been released for 1-minute, L_e is the length after extension (i.e., the predetermined ratio), and

[0120] L_o is the original sample length before extension.

[0121] (3) The sample must meet the first criterion after the first and second extension, and meet the second criterion after the third extension on the same speci-

men. (In carrying out the test, the retraction criterion is measured only after the third extension).

[0122] Desirably, the sample exhibits no visible structural defects, such as excessive voids or cracks, after the stretchability testing.

[0123] The absorbent composite was cut into 3-inch (7.62 cm) by 7-inch (17.78 cm) specimens. An INSTRON 4443, available from Instron Corporation of Canton, Mass., was used to measure stretchability. A substantially equivalent testing device may optionally be employed. Each specimen was mounted onto the equipment vertically with two clamps and the locations of the clamps were marked on the specimen. The distance between the two clamps (L_0) was 4 inches (10.16 cm). The specimen was stretched by moving the upper clamp upward at a rate of 500 mm/min and held for 5 seconds at the predetermined length of extension (L_e). After 5 seconds of holding, the upper clamp was returned to the original position and the specimen was free to retract. The second cycle of stretching was started after the upper clamp was back in the original position for 10 seconds, followed by the third cycle. The stretching and retraction procedure for the second and third cycles was the same as the first cycle. The specimen was removed from the equipment after completion of the third stretching cycle and laid on the bench. The distance between the two marks (L_e) was measured after the specimen was relaxed for 1 minute. For each absorbent composite, test specimens were prepared and subjected to stretchability testing with respect to both the machine direction (MD) and the cross-machine direction (CD) of the absorbent composite. The lower stretchability value measured from the CD and MD directions was chosen to represent stretchability of the absorbent composite.

Shake-Out Test

[0124] A suitable apparatus and procedure for determining the shake-out value of a sample material is described in PCT publication WO 02/076520 entitled HIGH SUPERABSORBENT CONTENT WEBS AND A METHOD FOR MAKING THEM published Oct. 3, 2002 (attorney docket No. 15275). The entire disclosure of this document is incorporated herein by reference.

[0125] The susceptibility of a superabsorbent/fiber web to the migration and escape of superabsorbent material (SAM) can be measured by employing a Shakeout Test procedure which involves agitating web samples in a controlled fashion and determining the total loss of web mass from the sample. A sample of the stretchable absorbent composite is prepared in the shape of a rectangular plate which has a length of 9 inch (22.86 cm) and a width of 4 inch (10.16 cm). The sample has the density that would be present when the absorbent composite is incorporated in its intended end-product article. Any tissues or other layers that were employed during the process of airforming the sample materials are removed from all specimens before conducting the Shakeout Test.

[0126] The Shakeout Test can be conducted by employing a Model # RX-24 PORTABLE SIEVE SHAKER (herein after referred to as "RX-24") available from W. S. Tyler Inc., a business having offices located in Mentor, Ohio, U.S.A. The shaker apparatus is modified in the manner described in PCT publication WO 02/076520, which corresponds to U.S. patent application Publication 2002/0183703 A1 (attorney

docket No. 15275). The entire disclosure of this document is incorporated herein by reference in a manner that is consistent herewith. For use in the Shakeout Tests, the RX-24 is modified to shake web samples and allow a determination of the web's resistance to the migration of superabsorbent material (SAM), based on the mass of web material lost during the shaking. The modifications to the shaker apparatus involve making changes to the guide frame in the manner described in PCT publication WO 02/076520. In addition to the changes to the guide frame described in this PCT publication, a modified sample holder was employed in the shakeout test. The sample holder had a frame made of polyacrylate plate and two pieces of mesh screen. The frame had a length of 17 inch (43.18 cm), a width of 11.5 inch (29.21 cm) and a thickness of 0.20 inch (0.51 cm). The frame had a rectangular opening with a length of 15.25 inch (38.74 cm) and a width of 6.25 inch (15.88 cm), and the opening was substantially centered in the frame. One piece of mesh screen with a dimension slightly larger than the opening was operatively joined on each side of the frame (e.g. with duct tape) to hold the test sample. The mesh screen had 0.4 cm×0.4 cm square openings, and the total weight of the sample holder was about 500 grams. A substantially equivalent shaker system may optionally be employed.

[0127] To perform the Shakeout Test, the absorbent composite sample is laid at the center of the sample holder, and the sample holder is laid horizontally flat (i.e. parallel to the floor) upon the wire screen employed to support the sample on the modified RX-24. The RX-24 then shakes the web at a frequency of approximately 520 cycles per minute for a period of five minutes. If any sheets of tissue paper or other material have been placed above or below the sample to facilitate the lifting or handling of the web samples, those sheets are removed prior to shaking.

[0128] After the completion of the shaking portion of the test, the mass loss and the superabsorbent-loss are determined by comparing the total remaining mass of the absorbent composite sample with the original mass of the sample when the sample was initially placed on the support screen, in accordance with the following formula:

$$\text{Mass loss (\%)} = 100\% \times ((M_0 - M_{\text{end}}) / M_0)$$

where: M_0 =sample mass prior to shakeout test (e.g. grams);

[0129] M_{end} =sample mass remaining after test (e.g. grams).

Mass that is lost from the sample will generally fall through the openings in the support screen. Any mass that remains on the screen is counted as mass loss. The shake-out value (%) is the total mass loss (%) produced at the above-described shaking conditions.

[0130] While the foregoing discussion has described in detail one desirable method for conducting the Shakeout test using a specific type of apparatus, it will be appreciated that those skilled in the art will be able to prepare other apparatus that will allow equivalent testing in which agitation applied to webs will yield the identical results in terms of web loss as that achieved by the disclosed Shakeout Test. Accordingly, the scope of the Shakeout Test will include any equivalent test methods for determining web loss.

Centrifuge Retention Capacity (CRC) Test

[0131] The Centrifuge Retention Capacity (CRC) Test measures the ability of the superabsorbent material to retain

liquid therein after being saturated and subjected to centrifugation under controlled conditions. The resultant retention capacity is stated as grams of liquid retained per gram weight of the sample (g/g). The sample to be tested is prepared from particles which are prescreened through a U.S. standard 30 mesh screen and retained on a U.S. standard 50 mesh screen. As a result, the sample comprises particles sized in the range of about 300 to about 600 microns (micrometers). The particles can be prescreened by hand or automatically and are stored in a sealed airtight container until testing.

[0132] The retention capacity is measured by placing 0.2 ± 0.005 grams of the prescreened sample into a water-permeable bag which will contain the sample while allowing a test solution (0.9 weight percent sodium chloride in distilled water) to be freely absorbed by the sample. A heat-sealable tea bag material, such as that available from Dexter Corporation of Windsor Locks, Connecticut, U.S.A., as model designation 1234T heat-sealable filter paper works well for most applications. The bag is formed by folding a 12.7 cm by 7.62 cm (5-inch by 3-inch) sample of the bag material in half and heat-sealing two of the open edges to form a 6.35 cm by 7.62 cm (2.5-inch by 3-inch) rectangular pouch. The heat seals should be about 0.635 cm (0.25 inches) inside the edge of the material. After the sample is placed in the pouch, the remaining open edge of the pouch is also heat-sealed. Empty bags are also made to serve as controls. Three samples (e.g., filled and sealed bags) are prepared for the test. The filled bags must be tested within three minutes of preparation unless immediately placed in a sealed container, in which case the filled bags must be tested within thirty minutes of preparation.

[0133] The bags are placed between two, polytetrafluoroethylene (e.g. TEFLON material) coated fiberglass screens having 7.62 cm (3 inch) openings (available from Taconic Plastics, Inc., a business having offices located in Petersburg, N.Y., U.S.A.) and submerged in a pan of the test solution at 23 degrees Celsius, making sure that the screens are held down until the bags are completely wetted. After wetting, the samples remain in the solution, for about 30 ± 1 minutes, at which time they are removed from the solution and temporarily laid on a non-absorbent flat surface. For multiple tests, the pan should be emptied and refilled with fresh test solution after 24 bags have been saturated in the pan.

[0134] The wet bags are then placed into the basket of a suitable centrifuge capable of subjecting the samples to a g-force of about 350. A suitable centrifuge is a HERAEUS LABOFUGE 400 having a water collection basket, a digital rpm gauge, and a machined drainage basket adapted to hold and drain the bag samples. Where multiple samples are centrifuged, the samples must be placed in opposing positions within the centrifuge to balance the basket when spinning. The bags (including the wet, empty bags) are centrifuged at about 1,600 rpm (e.g., to achieve a target g-force of about 350), for 3 minutes. The bags are removed and weighed, with the empty bags (controls) being weighed first, followed by the bags containing the samples. The amount of solution retained by the sample, taking into account the solution retained by the bag itself, is the specific, centrifuge retention capacity (CRC) of the sample, expressed as grams of retained liquid per gram of sample. More particularly, the specific retention capacity is determined in accordance with the following formula:

$$\frac{(\text{Sample \& bag weight after centrifuge}) - (\text{empty bag weight after centrifuge}) - (\text{dry sample weight})}{\text{dry sample weight}}$$

[0135] The three samples are tested and the results are averaged to determine the retention capacity (CRC) of the superabsorbent material. The samples are tested at 23 ± 1 degrees Celsius and 50 ± 2 percent relative humidity.

Thermal Stickiness Index (TSI) Test

[0136] The superabsorbent particles before the test were prescreened to have a particle size range from 300 microns to 600 microns. Five grams of the screened superabsorbent particles were weighed and added into a 100 ml PYREX glass beaker. The beaker was gently shaken to form a uniform layer of the superabsorbent sample on the bottom of the beaker. The beaker was then placed in a convectional oven at 150° C. for 10 minutes. The beaker was taken out of the oven and cooled at room temperature for at least 15 minutes until the temperature of the beaker was back to room temperature. Turn the cooled beaker up side down and collect all the superabsorbent particles that falls out of the beaker. Weights of the original amount of superabsorbent in the beaker and the amount of superabsorbent fallen out of the beaker were used to determine the thermal stickiness index (TSI), in accordance with the following formula:

$$TSI = \frac{W_{original} - W_{fallen}}{W_{original}} \times 100$$

[0137] The following Examples describe particular configurations of the invention, and are presented to provide a more detailed understanding of the invention. The Examples are not intended to limit the scope of the present invention in any way. From a complete consideration of the entire disclosure, other arrangements within the scope of the claims will be readily apparent to one skilled in the art.

EXAMPLES

[0138] Superabsorbent particles with thermally processible, water soluble polymer coatings have been prepared in accordance with the following.

[0139] A first, Coating Polymer 1 solution included a first combination of two monomer solutions 1A and 1B, which were prepared separately:

[0140] Solution No. 1A was prepared as follows: 22.0 grams of a 75% solution of (3-acrylamidopropyl)trimethyl ammonium chloride (0.08 moles) were added to 70 grams of deionized water, followed by 43 grams of hydroxyethyl methacrylate (0.32 mol) and 12 grams of PEG 200 (molecular weight 200). Then, 0.36 grams (1.02×10^{-3} moles) of ascorbic acid were added to the solution. This mixture was stirred with a magnetic stir bar at about 60 rpm in a bath of water at about 23° C. until the ascorbic acid was dissolved and the mixture cooled to 23° C.

[0141] Solution No. 1B was prepared in the following manner: 22.0 grams of a 75% solution of (3-acrylamidopro-

pyl)trimethyl ammonium chloride (0.08 moles) were added to 70 grams of deionized water, followed by 43 grams of hydroxyethyl methacrylate (0.32 mol) and 12 grams of PEG 200 (molecular weight 200). Then 0.74 grams of 30% aqueous hydrogen peroxide were added. This mixture was stirred with a magnetic stir bar at about 60 rpm in a bath of water at about 23° C. to provide a clear solution cooled to 23° C.

[0142] Solution No. 1B was added to Solution No. 1A while stirring with a magnetic stir bar. A thermocouple was used to monitor the temperature and observe the reaction exotherm. No polymerization exotherm was evident so the mixture was placed into a water bath and the temperature was raised to 70° C. over a time period of 35 minutes. An exotherm was evidenced by a rise in temperature to 74° C. over a period of 1 minute, and the solution became highly viscous. The reaction beaker was removed from the water bath after 90 minutes from the time that Solution No. 1B was added to Solution No. 1A. 300 grams of deionized water were added to reduce the polymer concentration to about 26%.

[0143] A second, Coating Polymer 2 solution included a second combination of two monomer solutions 2A and 2B which were prepared separately:

[0144] Solution No. 2A was prepared as follows: 73.2 grams (1.016 moles) of acrylic acid were added to 12 grams polyethylene glycol (mol. wt.=200) and 16.3 grams of sodium hydroxide in 100 grams of water (40% neutralization), and 0.5 grams of ascorbic acid. This solution was cooled in an ice bath following dissolution of the ascorbic acid.

[0145] Solution No. 2B was prepared as follows: 28.8 grams of a 75% solution of (3-acrylamidopropyl)trimethyl ammonium chloride (0.10 moles) were added to 100 grams of deionized water followed by 12 grams of PEG 200 (molecular weight 200). To this solution were added 1.04 g of 30% aqueous hydrogen peroxide.

[0146] Solution No. 2B was added to Solution No. 2A in an ice bath while stirring with a magnetic stir bar. A thermocouple was used to monitor the temperature and observe the reaction exotherm. The polymerization reaction began after about 5 minutes of mixing. Once the exotherm reaction was detected, water was added gradually to keep the solution viscosity suitable for stirring. A total of 300 gram of water was added over 20 minutes. A maximum polymerization temperature of 65° C. was observed about 8 minutes after the mixing of the two monomer solutions 2A and 2B. The polymer concentration was found, by evaporation of the water to be about 22%.

[0147] Quantities of superabsorbent particles were coated with Coating polymer 1 and other quantities of superabsor-

bent particles were coated with Coating polymer 2. For the coating each quantity of coated superabsorbent particles, the following procedure was employed.

[0148] Each employed solution of Coating polymer was diluted to 6.67% with distilled water. 750 grams of the selected polymer solution was added to the mixing bowl of a HOBART Mixer, model N-50, available from Hobart Canada, North York, Ontario, Canada. With the solution agitated at a speed setting of "3", 500 grams of superabsorbent was added. The mixture became a fluffy mass of slightly swollen superabsorbent. The swollen superabsorbent was dried for 3 days at 80° C. and then de-agglomerated with a GRANU-GRINDER, available from C. W. Brabender, a business having offices located in Hackensack, N.J., U.S.A. The particles were then sieved to remove particles larger than 850 microns.

[0149] The samples in Tables 1, 2 and 3 were made under the same process conditions, except that there were some variations in the employed Primary Air Temperature (PAT). The samples in Tables 1 and 3 were made with a PAT about 280° C. In Table 2, with the different elastic polymers, the primary air temperature varied, and had the values set forth in Table 2. With the samples in Tables 1, 2 and 3, the Elastic polymer-Superabsorbent-Pulp weight ratios were 15:75:10, and for all of the samples, the basis weight was 425 grams per square meter (g/m²). The pulp employed in the samples was SULPHATATE HJ woodpulp, commercially available from Rayonier Inc., a business having offices located at Jesup, Ga., USA. The elastomeric polymer employed in the samples of Tables 1 and 3 was KRATON G2755 elastomer, which is available from Kraton Inc. of Houston, Tex., U.S.A. The superabsorbents SXM 9543, SXM 9394 and FAVOR 880, are all available from Degussa Superabsorber Inc., a business having offices located at Greensboro, N.C., U.S.A. The Bipolar superabsorbent E1239-11 is available from BASF Inc., a business having offices located at Portsmouth, Va., U.S.A.

TABLE 1

Composite Shake-Out with Various SAMs			
Sample No.	SAM Types	Shake-out %	Stretchability %
1	SXM 9543	4.10	100
2	SXM 9394	1.33	100
3	BASF Bipolar E1231-99	1.90	100
4	FAVOR 880	3.38	100

Note:
All samples in Table 1 contained 75 wt % superabsorbent material, 15 wt % KRATON G2755 elastomeric fiber, and 10 wt % Sulfate-HJ woodpulp.

[0150]

TABLE 2

Composite Shake-Out with Different Elastic Polymers						
Sample No.	Elastomeric Polymers	Temperature (° C.)		Shake-out (%)	Stretchability (%)	Vendors
		Melt-Temp T _m	Primary Air Temp			
5	ESCORENE UL 7710 (EVA)	138-204	140-218	4.80	50	ExxonMobil Chemical

TABLE 2-continued

Composite Shake-Out with Different Elastic Polymers						
Sample No.	Elastomeric Polymers	Temperature (° C.)		Shake-out (%)	Stretchability (%)	Vendors
		Melt-Temp T _m	Primary Air Temp			
6	EXACT (PE) 4023	210-263	229-279	2.51	100	Company, Houston, Texas, U.S.A. ExxonMobil Chemical Company, Houston, Texas
7	Boston Compound (80% AFFINITY PE plastomer 8185/ 15% 3 M Tackifier REGLAREZ 1126/5% DOWLEX (WAX) 2503	204-232	224-252	5.58	50	Dow Chemical, Freeport, Michigan, U.S.A.
8	KRATON G2755	249-274	279-281	1.33	100	Kraton Inc., Houston, Texas
9	DOW (200 MI) PE plastomer XUS9800.05	132-209	162-267	1.45	50	Dow Chemical, Freeport, Michigan
10	DOW (500 MI) PE plastomer XUS9800.05	151-218	177-218	10.9	50	Dow Chemical, Freeport, Michigan
11	PLTD 1723 (Propylene-based developmental elastomer)	243	243-274	2.06	50	ExxonMobil Chemical Company, Houston, Texas

Note:
All samples in Table 2 contained 75 wt % SXM 9394 superabsorbent, 15 wt % elastomeric polymer fiber, and 10 wt % Sulfate-HJ woodpulp.
EVA = ethylene vinyl acetate
PE = polyethylene

[0151] In Table 3, the superabsorbent materials in samples 13 and 16 were surface treated with Polymer 1. The superabsorbent materials in samples 14 and 17 were surface treated with Polymer 2.

TABLE 3

Composite Shake-Out with the SAM coated by polymer				
Sample No.	Superabsorbent Types	SAM Shake-out (%)		Stretchability (%)
		Non-cured	*Heat-cured	
12	SXM 9543	8.55	5.67	100
13	SXM 9543 coated by Polymer 1	4.77	3.93	100
14	SXM 9543 coated by Polymer 2	2.78	1.92	100
15	SXM 9543	8.47	5.73	100
16	SXM 9543 coated by Polymer 1	4.80	3.19	100
17	SXM 9543 coated by Polymer 2	1.89	1.16	100

Samples 12, 13 and 14 were cured at 100° C. for 5 minutes; samples 15, 16 and 17 were cured at 70° C. for 60 minutes.

Samples 12, 13 and 14 were cured at 100° C. for 5 minutes; samples 15, 16 and 17 were cured at 70° C. for 60 minutes.

[0152] A third, Coating Polymer 3 solution included a polyethylene oxide, POLYOX N3000, available from Union Carbide. The coating solution was prepared by dissolving 25 grams of the polyethylene oxide (PEO) in 1,250 grams of distilled water. The dry powder of the POLYOX N3000 was slowly added into the mixing bowl of a HOBART Mixer, model N-50 (available from Hobart Canada, North York, Ontario, Canada) containing the 1,250 grams of distilled water while the mixer was stirred at the stirring setting "1". The solution was stirred until a homogenous solution was obtained. 500 grams of dry superabsorbent particles were then added into the prepared solution while stirring at the above-described stirring setting. The coated, swollen superabsorbent particles were dried at 80° C. until the particles were completely dried. The dried, treated superabsorbent material was de-agglomerated with a GRANU-GRINDER, available from C. W. Brabender, a business having offices located in Hackensack, N.J., U.S.A. The coated superabsorbent particles were then sieved to remove particles larger than 850 microns.

[0153] A fourth, Coating Polymer 4 solution included a hydroxypropyl cellulose, KLUCEL GF, available from Her-

cules Inc. The hydroxypropyl cellulose (HPC) was dissolved into an operative solution. The solution recipe, relative amounts of dry superabsorbent and coating polymer solution, and process of applying the polymer solution and the subsequent processing of the dried, coated superabsorbent material were the same as those employed with the Coating Polymer 3.

[0154] A fifth, Coating Polymer 5 solution included a combination of two monomer solutions 5A and 5B which were prepared separately.

[0155] Solution No. 5A was prepared as follows: 144 grams (2.0 moles) of acrylic acid were added to 15 grams polyethylene glycol (mol. wt.=8000) and 8.0 grams of sodium hydroxide in 200 grams of water (10% neutralization). Then, 2.0 grams of ascorbic acid were added, and this solution was cooled in an ice bath following the dissolution of the ascorbic acid.

[0156] Solution No. 5B was prepared as follows: 144 grams (2.0 moles) of acrylic acid were added to 83 grams polyethylene glycol (mol. wt.=8000) and 8.0 grams of sodium hydroxide in 200 grams of water (10% neutralization). Also added were 4.0 grams of 30% aqueous hydrogen peroxide.

[0157] Solution No. 5B was added to Solution No. 5A in an ice bath while stirring with a magnetic stir bar. A thermocouple was used to monitor the temperature and observe the reaction exotherm. The polymerization reaction began after about 5 minutes of mixing. Once the exotherm reaction was detected, water was added gradually to keep the solution viscosity suitable for stirring. A total of 700 gram of water was added over 20 minutes. A maximum polymerization temperature of 75° C. was observed about 10 minutes after the mixing of the two monomer solutions 5A and 5B. After the polymerization was complete a solution of 96 grams (0.2 mole) of diethanol methyl amine in 300 gram of water was added to further neutralize the polymer to 30 mole percent. The polymer concentration was found, by evaporation of the water to be about 22.3%.

[0158] A sixth, Coating Polymer 6 solution included a combination of two monomer solutions 6A and 6B which were prepared separately.

[0159] Solution No. 6A was prepared as follows: 86.4 grams (1.2 moles) of acrylic acid were added to 43 grams polyethylene glycol (mol. wt.=200) and 14.4 grams of sodium hydroxide in 100 grams of water (30% neutralization). Then, 0.5 grams of ascorbic acid were added, and this solution was cooled in an ice bath following the dissolution of the ascorbic acid.

[0160] Solution No. 6B was prepared as follows: 97 grams of an 80% solution of (2-acryloyloxy ethyl)trimethyl ammonium chloride (0.4 moles) were added to 150 grams of deionized water. To this solution were added 1.04 grams of 30% aqueous hydrogen peroxide.

[0161] Solution No. 2B was added to Solution No. 2A at 30° C. while stirring with a magnetic stir bar. A thermocouple was used to monitor the temperature and observe the reaction exotherm. The polymerization reaction began after about 2 minutes of mixing. Once the exotherm reaction was detected, water was added gradually to keep the solution viscosity suitable for stirring. A total of 250 gram of water

was added over 20 minutes. A maximum polymerization temperature of 60° C. was observed about 5 minutes after the mixing of the two monomer solutions 2A and 2B. The polymer concentration was found, by evaporation of the water to be about 22%.

[0162] Quantities of superabsorbent particles were coated with Coating polymer 5, and other quantities of superabsorbent particles were coated with Coating polymer 6. For the coating of each quantity of coated superabsorbent particles, the following procedure was employed.

[0163] Each employed solution of Coating polymer was diluted to 6.67% with distilled water. 750 grams of the selected polymer solution was added to the mixing bowl of a HOBART Mixer, model N-50, available from Hobart Canada, North York, Ontario. With the solution agitated at a speed setting of "3", 500 grams of superabsorbent was added. The mixture became a fluffy mass of slightly swollen superabsorbent. The swollen superabsorbent was dried for 3 days at 80° C. and then de-agglomerated with a GRANUGRINDER, available from C. W. Brabender, a business having offices located in Hackensack, N.J., U.S.A.

[0164] Table 4 shows CRC and TSI data of surface treated superabsorbents (e.g. SXM 9543 and SXM 9394) employing Coating Polymer 2, Coating Polymer 3 (PEO), Coating Polymer 4 (HPC), Coating Polymer 5, and Coating Polymer 6.

TABLE 4				
Absorbency (CRC) and TSI of Surface Treated Superabsorbent Materials				
Superabsorbent (SAM) Composition			Properties of Treated SAMs	
SAM	Coating Polymer	Amount	CRC (g/g)	TSI (%)
SXM 9543	NA	0	23.0	0
SXM 9543	Polymer 1	10%		
SXM 9543	Polymer 2	10%	20.4	1.6
SXM 9543	Polymer 3	5%	22.0	100
SXM 9543	Polymer 4	5%	22.0	100
SXM 9394	NA	0	27.0	0
SXM 9394	Polymer 2	10%	24.0	9.8
SXM 9394	Polymer 3	5%	26.0	100
SXM 9394	Polymer 4	5%	26.0	100
SXM 9394	Polymer 5	10%	23.4	15.3
SXM 9394	Polymer 6	10%	23.3	4.2

[0165] In Table 5, the elastomeric polymer in the melt-blown fiber was VISTAMAXX 2210, which is available from ExxonMobil Chemical Company, a business having offices located Houston, Tex., U.S.A. The pulp was NB 416, which is available from Weyerhaeuser Co., a business having offices located Federal Way, Wash., U.S.A. The basis weight of the absorbent composite web was about 500 grams per square meter. The superabsorbent material in samples 19 and 21 was SXM 9394 coated by 5% PEO (Polymer 3), and the superabsorbent material in samples 23 and 25 was SXM 9543 coated by 5% PEO (Polymer 3). The samples in Table 5 were made with a Primary Air Temperature (PAT) of about 206° C.

TABLE 5

Composite Shake-Out with the SAM coated with polymer								
Sample No.	Superabsorbent (SAM) Types	Pulp wt %	VISTAMAXX		SAM Shake-out (%)			
			2210 wt %	SAM wt %	TSI (%)	Non-cured	Heat-cured	Stretchability (%)
18	SXM 9394	10	15	75	0	2.60	2.15	30
19	SXM 9394	10	15	75	100	1.15	0.92	30
	coated by Polymer 3							
20	SXM 9394	0	17	83	0	2.60	2.35	50
21	SXM 9394	0	17	83	100	1.50	0.81	50
	coated by Polymer 3							
22	SXM 9543	10	15	75	0	11.10	8.22	30
23	SXM 9543	10	15	75	100	7.76	3.45	30
	coated by Polymer 3							
24	SXM 9543	0	17	83	0	18.84	14.50	50
25	SXM 9543	0	17	83	100	6.59	3.03	50
	coated by Polymer 3							

Note:
heat curing was conducted at 70° C. for 60 minutes.

[0166] In Table 6, the elastic polymer was VISTAMAXX 2210 polymer; the pulp was NB 416 pulp; the Elastic polymer/SAM/Pulp weight ratios were 15:75:10; the basis weight was about 500 grams per square meter. The samples in Table 6 were made with a Primary Air Temperature (PAT) about 221° C.

pound (about 17 grams per square meter) White Forming Tissue available from American Tissue, Inc., Neenah, Wis., U.S.A. A second sheet of forming tissue was put on the top of the airformed composite. The airformed absorbent composite can then be compressed to a desired density by employing a suitable compression device, such as a Carver

TABLE 6

Composite Shake-Out with the SAM coated by polymer					
Sample No.	SAM types	SAM TSI (%)	Shake-out (%)		Stretchability (%)
			Non-cured	Heat-cured	
25	SXM 9394	0.0	2.02	1.76	30
26	SXM 9394	9.8	3.85	3.86	30
	coated by Polymer 2				
27	SXM 9394	15.3	5.30	4.59	30
	coated by Polymer 5				
28	SXM 9394	4.2	4.53	3.73	30
	coated by Polymer 6				

Note:
heat curing was conducted at 70° C. for 60 minutes; all samples in Table 6 contained 75 wt % SAM, 10 wt % pulp fiber and 15 wt % VISTAMAXX 2210 elastic polymer.

[0167] To provide a comparison, conventional airformed absorbent composite samples made with superabsorbent particles and woodpulp fluff can be tested with and without containment tissues. Airformed absorbent composites were made by combining superabsorbent particles and matrix fibers in an airforming system to mix and laying down a web of intermingled superabsorbent particles and matrix fibers. The web of intermingled superabsorbent particles and matrix fibers is formed directly onto a porous sheet of tissue. An example of a suitable porous tissue is designated as 9.8

Press. The SAM/pulp airformed absorbent composite in samples 29 and 30 of the following Table 7 were made with 75% SXM 9394 superabsorbent material, and 25% CR 1654 woodpulp which is available from Bowater Inc. The basis weight of the airformed absorbent composite web was about 500 grams per square meter, and the samples were compressed to a density of about 0.27 g/cm³. A Shake-out test was conducted on a specimen which included a sheet of forming tissue on each side of the absorbent composite, and

on a specimen of the absorbent composite which did not include the tissue sheets.

TABLE 7

SAM/Pulp Airformed Composite Shake-Out, With And Without Tissues					
Sample No.	Sample test conditions	Pulp wt %	SAM wt %	Shake-out (%)	Stretchability (%)
29	With tissues	25	75	15.7	0
30	Without tissues	25	75	80.0	0

[0168] Those skilled in the art will recognize that the present invention is capable of many modifications and variations without departing from the scope thereof. Accordingly, the detailed description and examples set forth above are meant to be illustrative only and are not intended to limit, in any manner, the scope of the invention as set forth in the appended claims.

1. An article comprising, a stretchable absorbent composite including a quantity of superabsorbent particles which are operatively contained within a matrix of elastomeric polymer fibers, wherein

said composite includes at least about 60 wt % of the superabsorbent particles and not more than about 40 wt % of the elastomeric polymer fibers, based on a total weight of the composite; and

said composite provides a stretchability value of at least about 30% and a shake-out value of not more than about 1.2%.

2. The article as recited in claim 1, wherein said composite provides a shake-out value of not more than about 1%.

3. The article as recited in claim 1, wherein said composite provides a shake-out value of not more than about 0.8%.

4. The article as recited in claim 1, wherein said composite article includes at least about 5 wt % of the elastomeric polymer fibers.

5. The article as recited in claim 1, wherein said polymer fibers include an olefin elastomer material.

6. The article as recited in claim 1, wherein said polymer fibers include an operative amount of a surfactant.

7. The article as recited in claim 1, wherein said polymer fibers include at least about 0.1wt % of an operative surfactant, based on a total weight of the polymer fibers and surfactant.

8. The article as recited in claim 1, wherein the composite further includes an amount of cellulosic fibers and the amount of cellulosic fibers is at least about 5 wt %, and up to about 35 wt %, based on the total weight of the composite.

9. The article as recited in claim 1, wherein said superabsorbent particles are surface treated with a thermoplastic coating.

10. The article as recited in claim 1, wherein said superabsorbent particles coating includes at least one material selected from the group consisting of modified polyvinyl alcohol, polyethylene oxide, polypropylene oxide, ethylene oxide-propylene oxide copolymer, polyethylene glycol, polypropylene glycol, ethylene glycol-propylene glycol copolymer, modified polysaccharides, such as hydroxypropyl cellulose, methyl cellulose, methyl ethyl cellulose, polyethylene imine, and combinations thereof.

11. The article as recited in claim 1, wherein said superabsorbent particles have a TSI at least about 40 and a CRC value at least about 20 g/g.

12. The article as recited in claim 1, wherein said superabsorbent particles have a TSI at least about 60 and a CRC value at least about 20 g/g.

13. The article as recited in claim 1, wherein said superabsorbent particles have a TSI at least about 80 and a CRC value at least about 20 g/g.

14. The article as recited in claim 1, wherein an operative amount of said polymer fibers have a fiber diameter which is not more than a maximum of about 20 μ m and not less than a minimum of about 8 μ m.

15. The article as recited in claim 1, wherein not more than about 20 wt % of said polymer fibers have a fiber diameter which is larger than about 20 μ m; and not more than about 20 wt % of said polymer fibers have a fiber diameter which is less than about 8 μ m.

16. The article as recited in claim 1, wherein said polymer fibers have been produced from a quantity of polymer-melt processed at a temperature of at least about 200° C.

17. The article as recited in claim 1, wherein said superabsorbent particles have been combined with said polymer fibers during a formation of the polymer fibers, and the formation of the polymer fibers has included a meltblowing operation.

18. The article as recited in claim 1, wherein the composite article has a stretchability value of at least about 50%.

19. The article as recited in claim 1, wherein the composite article has a stretchability value of up to about 300% or more.

20. The article as recited in claim 1, wherein the elastomeric polymer fibers have been produced from a polymer material having a melt flow rate of at least about 100 g/10 min.

21. The article as recited in claim 1, further including a liquid-permeable topsheet and a backsheet; wherein the matrix of elastomeric polymer fibers and the superabsorbent particles are operatively sandwiched between the topsheet and backsheet.

22. The article as recited in claim 1, wherein

the absorbent composite includes at least about 5 wt % and not more than about 25 wt % of the elastomeric polymer fibers, and includes not more than about 15 wt % of cellulosic fibers, based on the total weight of the absorbent composite;

the absorbent composite further includes an operative amount of surfactant;

the superabsorbent particles include a thermally processible, water soluble surface coating material;

the surface coating material has a melting-point temperature which is at least about 60° C.;

the elastomeric polymer fibers have been produced from a polymer material having a melt flow rate of not less than-about 100 g/10 min;

the elastomeric polymer fibers have been produced from a quantity of polymer-melt having a temperature of at least about 200° C. and not more than about 315° C.

23. An article comprising, a stretchable absorbent composite including a quantity of superabsorbent particles which are operatively contained within a matrix of elastomeric polymer fibers, wherein

said composite includes at least about 60 wt % of the superabsorbent particles and not more than about 40 wt % of the elastomeric polymer fibers, based on a total weight of the composite;

said composite provides a stretchability value of at least about 30% and a shake-out value of not more than about 2%;

the superabsorbent particles include a thermally processible surface treatment material; and

the surface treatment material has a treatment-material melting-point temperature which is at least about 60° C.

24. The article as recited in claim 23, wherein the thermally processible surface treatment material is water soluble.

* * * * *

Anexo 5



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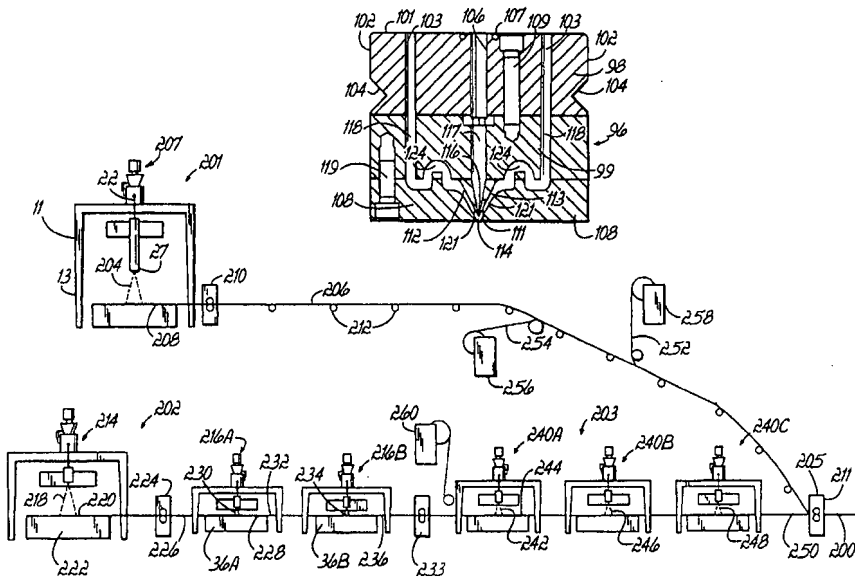
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- (72) Inventor: ALLEN, Martin, A.; 37 Ridgetop Court, Dawsonville, GA 30534 (US).
- (74) Agents: ROONEY, Kevin, G. et al.; Wood, Herron & Evans, L.L.P., 2700 Carew Tower, Cincinnati, OH 45202 (US).
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(54) Title: ABSORBENT COMPOSITE PRODUCT AND PROCESS AND APPARATUS FOR MANUFACTURE THEREOF



(57) Abstract: A multi-layer absorbent product (200) includes a fibrous nonwoven top sheet (235), a fibrous nonwoven absorbent core layer (237), and a fibrous nonwoven substantially water-impervius back sheet (238). Each component layer or sheet is manufactured at a fiberizing station (201, 202, 203) and laminated together at a combining station (205). The preferred melt spinning apparatus is spunbond for the top sheet (235), meltblowing for the core layer (237), and a combination of spunbond and meltblowing for the bottom sheet (238).

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Pinzonpinzon.com No 12-39 Piso 4 Tel. PBX: (57-1) 621-9721 Fax: (57-1) 621-9671
pinzonpinzon@pinzonpinzon.com www.pinzonpinzon.com

Bogotá D. C. Colombia Sur América
NIT. 830.005.919-7

ABSORBENT COMPOSITE PRODUCT AND PROCESS AND APPARATUS FOR MANUFACTURE THEREOF

Field of the Invention

The invention generally relates to equipment and processes for in-line manufacture of absorbent products. The equipment and the process utilize synthetic resins, such as thermoplastics, for the in-line manufacture of a multi-layer absorbent product. The invention also relates to a composite absorbent product comprising at least an impervious nonwoven bottom sheet, an absorbent nonwoven core, and a nonwoven top sheet.

Background of the Invention

The equipment used for in-line manufacture of absorbent products, such as diapers, sanitary napkins, adult incontinent pads and the like, is generally referred to as converter equipment and the process is generally referred to as converting. The converter equipment processes separate rolls of stock material into the composite absorbent product. The converter equipment generally comprises stations for manufacturing the composite absorbent product as follows:

- (a) An absorbent core forming station comprising a hammermill is fed by pulp roll stock, such as cellulosic material with or without superabsorbent. The hammermill fiberizes the pulp, and a drum form or flat

screen then forms the fiberized pulp. Alternatively, the absorbent core material can be supplied in roll form.

- 5 (b) A top sheet station supplies a top sheet or coverstock layer comprising a nonwoven, such as spunbond polypropylene. The top sheet is unwound from a roll and applied to the core layer.
- (c) A bottom sheet station for supplying a liquid-impervious backsheet, such as polyethylene film, which is applied to the top sheet/core combination.

10 The absorbent product is a composite comprising a top sheet or cover stock, an intermediate core layer of absorbent material, and a bottom sheet or back sheet of impervious film. Most converter equipment includes devices for adding a variety of options, such as elastic waistbands and legbands, tab applicators, frontal tape applicators, transfer layers, and the
15 like.

A characteristic common to all converter equipment and processes is that they use only roll stock to form the layers of the absorbent product. The roll stocks are separately manufactured into rolls, typically off site, and then transported to the site of use. These rolls are
20 processed by the converter equipment to form multiple layer absorbent products.

Converter equipment typically comprises a large complex laminating machine which requires significant horizontal and vertical plant space. The complex equipment requires constant attention and fine tuning.

Also, converter equipment generally produces a one-line output so the unit output is directly proportional to the line speed. Accordingly, the converter equipment must operate at extremely high speed, such as at line speeds of 700 to 1200 ft./min., to be economical.

- 5 As the converter equipment handles only preformed roll stock, it has a serious operational disadvantage. That is, once the multiple rolls are installed, the composition, properties or dimensions of the roll stocks cannot be changed. In order to produce two different types of absorbent products, or absorbent products with different properties, the converter
- 10 must be shut down and a new roll or rolls substituted for the existing roll or rolls. For these reasons, it would be desirable to eliminate one or, preferably, more of the conventional roll stocks and form different layers of an absorbent composite product in-line.

Summary of the Invention

- 15 The method and apparatus of the present invention most preferably involve fiberizing or melt spinning a synthetic resin, such as thermoplastic, at three separate stations. These three stations comprise a top sheet forming station, a core layer forming station, and a bottom sheet forming station.
- 20 The top sheet forming station includes at least one fiberizing die, such as a spunbond die, to form a nonwoven top sheet which is delivered in-line to a combining station. The bottom sheet forming station includes at least one spunbond die and, preferably, one or more additional

meltblowing dies to form a water-impervious composite bottom sheet. The bottom sheet is preferably conveyed directly (in-line) to the core layer forming station where one or more meltblowing dies deposit a meltblown layer or a plurality of meltblown sublayers onto the bottom sheet to form a
5 bottom sheet/core layer composite. The bottom sheet/core layer composite is conveyed in-line to the combining station where it is laminated with the top sheet to form an absorbent composite in accordance with the invention. In particular, the absorbent composite of this invention preferably comprises:

- 10 (a) an inner top sheet of strong, fluid-permeable nonwoven;
- (b) a middle absorbent core layer of a nonwoven composed of hydrophilic micro-sized fibers, with preferably a sublayer of a coarser nonwoven in contact with the top sheet to aid in distributing liquid permeating the top
15 sheet; and
- (c) a substantially fluid-impermeable back sheet of a strong nonwoven for containing the core layer and retaining fluid collected or absorbed therein.

Variations in the invention include using fiberizing dies at two
20 stations, such as the top sheet and core layer forming stations, with roll stock used at the third station. Other variations of fiberizing dies and roll stock may be used as well. Also, the three layers may be affixed to one another, whether using fiberizing dies or roll stock, in various orders not

withstanding that a preferred order of manufacture is specifically described herein.

The absorbent composite may be made an overall width transverse to the machine direction equal to multiple widths of each individual absorbent product. In such an embodiment, the composite width is slit longitudinally along the machine direction to form a plurality of slits, each slit being equal to the width of one absorbent product. The slits are then cut at longitudinal intervals to form individual absorbent products.

As described herein, the present invention contemplates several embodiments. Advantages and distinguishing features of some or all embodiments may be summarized as follows:

- (1) The absorbent composite comprises three or more layers or sheets of micro-sized fibers.
- (2) Fiberizing or melt spinning of each component sheet or layer of the composite avoids the need for a converter. Thermoplastic resin is processed on site to form the compound sheets or layers and conveyed in-line to the combining station.
- (3) The in-line manufacture of the component sheets or layers permits the rapid and easy change of materials (e.g., polymer grade), properties of the sheets or layers, and operating conditions.
- (4) The manufacture of the large widths equal to several widths of individual absorbent products permits the line

to operate at only a fraction of the speed of converters
in achieving the same unit output.

Additional objectives, advantages and features of the invention
will become more readily apparent to those of ordinary skill in the art upon
5 review of the following detailed description of the preferred embodiments,
taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

Figure 1 is a side elevation schematic view of a line for
fiberizing and laminating three nonwoven sheets or layers to form an
10 absorbent composite.

Figure 2 is a side elevational of a line illustrating three
extruders arranged in line for preparing a composite comprising three
different types of nonwoven sheets or layers.

Figure 3 is a cross-sectional view illustrating the three
15 component layers of the disposable laminate.

Figure 4 is an enlarged front view of a meltspinning assembly
shown in each of the extruders of Figure 2.

Figure 5 is an enlarged view of a meltblowing insert useable in
the assembly of Fig. 4.

20 Figure 6 is an enlarged view of a spunbond die insert useable
in the assembly of Fig. 4.

Figure 7 is a top plan view, shown in schematic, illustrating a
line for manufacturing disposable articles by longitudinally slitting the line

output to form a plurality of parallel strips that are cross cut into individual articles.

Figure 8 is a schematic view similar to Fig. 1 illustrating another embodiment of the present invention.

5 Detailed Description of the Preferred Embodiments

As mentioned above, the preparation of a composite absorbent comprises at least three main layers: (a) a top sheet, (b) an absorbent core layer, and (c) a substantially fluid-impervious bottom sheet. At least two of the layers are nonwovens prepared by extruding a thermoplastic polymer to
10 form a nonwoven layer which is combined in-line with the other two layers. The term "in-line," as used herein, means the continuous laminating of an extruded nonwoven layer with another layer without the usual intermediate step of forming rolls of the nonwoven layer. It is preferred that at least two of the layers be formed by in-line extrusions. In the most preferred
15 embodiment, all three layers are formed by in-line extrusion.

Figure 1 illustrates the most preferred embodiment as comprising three stations: a top sheet forming station 201, a bottom sheet forming station 202, and a core layer forming station 203. Nonwovens are formed at each station. The order of stations shown and described herein
20 is preferred, but the order of operation may be changed as well.

The term "nonwoven" refers to a sheet, web or batt of directionally or randomly oriented fibers, made by bonding or entangling the fibers through mechanical, thermal, or chemical means. Nonwoven fabrics

exclude paper and products which are woven, knitted, tufted, or felted by wet milling. The fibers are preferably man-made synthetics.

Although nonwovens may be made by a number of processes, the most popular processes --and those preferred for use in the present invention-- are meltblowing and spunbond processes, both of which involve melt spinning of thermoplastic material. Meltblowing is a process for the manufacture of a nonwoven fabric wherein a molten thermoplastic is extruded from a die tip to form a row of fibers. The fibers exiting the die tip are contacted with converging sheets or jets of hot air to stretch or draw the fibers down to microsize diameter. The fibers are then deposited onto a collector in a random manner and form a nonwoven fabric.

The spunbond process involves the extrusion of continuous filaments through a spinneret. The extruded filaments are maintained apart and the desired orientation of the filaments is achieved by rotating the spinneret, by electrical charges, by controlled air streams, or by the speed of the collector. The filaments are collected on the collector and bonded by passing the layer of filaments through compacting roll and/or hot roll calendaring.

Spunbonded webs generally have large average diameter (e.g., 12-100 microns, typically 12-50 microns) which are heavier and stiffer than meltblown fibers. The meltblown fibers are generally smaller in average diameter (0.5 to 15 microns) than the spunbond fibers, but the meltblowing die assemblies can be operated to make much larger fibers.

A paper presented at "Fiber Producer Conference 1983," in Greenville, South Carolina, entitled "Nonwoven Fabrics: Spunbonded and Meltblown Processes" describes the two processes in detail. The disclosure of this paper are incorporated herein by reference. It should be noted that

5 the terms "fibers" and "filaments" when used in connection with nonwovens and processes for manufacturing nonwovens are interchangeable.

The Absorbent Product

The absorbent product of the present invention comprises at

10 least three separate main layers that contribute separate properties and functions to the composite. As shown in Fig. 3, the absorbent product 200 comprises three main layers:

- a top sheet 235,
- a core layer 237, and
- 15 a bottom sheet 238.

The top sheet 235, sometimes referred to as cover sheet, covers the core layer 237 and contacts the wearer. It accordingly must exhibit comfort and be capable of transmitting fluid to the core layer 237. The top sheet preferably is made up of spunbound fabric, which exhibits a

20 clothlike band and is fluid permeable. The fluid is generally a body fluid such as urine.

The core layer 237 is the absorbent layer and may comprise two sublayers, a thin acquisition and distribution layer 239 and a main absorbent layer 241. The core layer 237 preferably is made of a meltblown

hydrophilic polymer which exhibits high absorbency. The difference between the distribution layer 239 and main absorbent layer 241 is one of degree, the former being made of coarser fibers (at least 5%, preferably 10%, and most preferably 25% coarser) than those of the latter to promote liquid distribution from the top sheet 235 to layer 241.

The bottom sheet 238, sometimes referred to as the back sheet, is a substantially liquid impervious sheet. This sheet generally is a thermoplastic film, but in accordance of a preferred embodiment of the present invention, is a combination of a spunbound layer and a meltblown layer, as described in detail below.

Each of the sheets or layers 235, 237, and 238 may be composed of a plurality of sublayers to impart or enhance the desired properties thereto.

The three distinct layers of the composite absorbent thus perform separate and diverse functions. When using conventional converters in accordance with the prior art, each layer, in roll stock, must be preselected, leaving no flexibility for altering the properties or dimensions of each selected layer. The in-line manufacture and lamination of layers in accordance with the present invention offers many significant advantages over the converter approach, but one advantage stands out; and that is the exceptional flexibility -- within the limits of the equipment employed.

The Process and Apparatus

The preferred process and apparatus of the present invention will be described with reference to Fig. 1, it being understood that other embodiments, such as that depicted in Fig. 8, are also contemplated.

5 With reference to Figure 1, the in-line manufacture of an absorbent composite 200 comprises three main fiberizing stations: a top sheet forming station 201, a back sheet forming station 202, and a core forming station 203. As described in detail later, each station may include more than one fiberizing die for applying more than one layer at each
10 station. (The term "fiberizing," as used herein, means the extrusion of a thermoplastic into filaments of fibers.)

Top Sheet Forming Station

The top sheet forming station 201 includes a die assembly 207 for extruding a plurality of synthetic fibers 204. The fibers are
15 collected into a web 206 which, after further processing, is delivered, in an in-line fashion, to a layer combining station 205. Note that web 206 corresponds to top sheet 235, shown in Fig. 3. The top sheet 235 is the layer of the absorbent product that contacts the wearer, must be liquid permeable, and must possess a certain amount of integrity for assemblage
20 and retention of the core layer. For this reason, the preferred top sheet 235 is a spunbonded web manufactured by a spunbond die. Although most spunbond dies may be used, the preferred top sheet forming station includes a die assembly 207 shown in Fig. 1 and described in more detail below.

A synthetic thermoplastic resin such as polypropylene is processed through the die assembly 207 into filaments 204 which are collected on a moving conveyor 208 (e.g., screen) as a loose web. The web is passed through a calendar 210 to bond the filaments together forming web 206. The web 206 is conveyed along rollers 212 to the combining station 205.

Any of the thermoplastic resins used in spunbond dies may be used to form layer 206. Polymers are copolymers of propylene and ethylene are preferred polymers with polypropylene being the most preferred.

Bottom Sheet Forming Station (202)

In order to provide the properties and strengths necessary for the bottom sheet 238 (i.e., back sheet), station 202 is preferably a combination of a spunbond die assembly 214 and at least one meltblowing die assembly. Preferably, station 202 uses two meltblowing die assemblies 216A and 216B. As schematically illustrated in Fig. 1, the spunbond die assembly 214 processes a thermoplastic resin such as polypropylene into filaments 218 which are collected as a web 220 onto a moving conveyor (e.g., a screen), described in more detail below with reference to Fig. 2. The web 220 is then passed through a calendar 224 to bond the filaments into a strong integrated web 226. Note that web 226 corresponds to backsheet layer 238 shown in Fig. 3. Since the back sheet 238 must be substantially liquid impermeable, the nonwoven web 226 should be treated to reduce its permeability. The terms "liquid impervious" and "liquid

impermeable" are used interchangeably herein, meaning an aqueous liquid will not pass therethrough under conditions for use. This can be accomplished by spraying a sealant (e.g., an adhesive) onto a surface of the web 226, but preferably is achieved by meltblowing one or more layers of thermoplastic fibers onto the surface of web 226 by meltblowing die assemblies 216A and 216B.

As web 226 is conveyed under die assembly 216A by moving conveyor 228, or screen, meltblown fibers 230 are deposited thereon forming spunbond/meltblown composite 232. Continuous conveyance brings the two-layer composite 232 under the second meltblowing die 216B, where additional meltblowing of thermoplastic fibers 234 are sprayed onto the top surface of the spunbond/meltblown (SB/MB) composite 232 forming a three-layer SB/MB/MB composite 236.

The composite 236 is then passed through calendar 233 to thermobond the three layers together. In lieu of the calendar, adhesive may be used to bond the three layers together. Note that in this preferred embodiment, the SB/MB/MB composition 236 corresponds to backsheet 238 shown in Fig. 3.

The gradation of the fiber sizes in the back sheet results in a substantially liquid impermeable layer. The small-sized meltblown fibers combined with their strongly hydrophobic nature acts as a barrier for water. Moreover, the spunbond outer (exposed) layer gives the product a matte finish, strength, and a soft flexible hand. The liquid-impervious back sheet

should be greater than 300 mm, as measured by RCST (raising column strike-through).

An important property of the back sheet 236 made at station 202 is that it is liquid (e.g., water) impermeable but air permeable (i.e.,
5 breathable). This not only provides comfort to the wearer, but has a manufacturing advantage. The air permeability permits meltblown layer or layers to be deposited thereon at station 203. In the meltblown process, the air/fiber mixture is delivered to a perforated conveyor such as a screen. The air passes the screen leaving the fibers accumulated in a randomly
10 packed deposit on the screen. Back sheets such as film do not possess air permeability and therefore are not readily adapted for receiving meltblown fibers thereon.

Core Forming Station

The third fiberizing station 203 comprises one or more
15 meltblown die assemblies. In Figure 1, three meltblowing die assemblies 240A, 240B, and 240C are shown. The dies can be operated to (a) extrude identical fibers to form identical webs, (b) extrude different fibers using the same type of resin, or (c) extrude different fibers using different types of resin.

20 The back sheet 238 leaving station 202 is conveyed successively under the meltblowing die assemblies 240A, 240B, and 240C to receive a buildup of webs thereon. The back sheet 236, which can be a single web or a composite, is passed under the first die assembly 240A where thermoplastic fibers 242 are deposited thereon forming a composite

244. Composite 244 is then passed successively under die assemblies 240B and 240C where fibers 246 and 248 increase the thickness of the core layer. The final core layer made by station 203 comprises a stack-up of three sublayers. It is preferred that the web formed from fibers 248 on
5 coarser (larger average fiber diameter) than the webs formed from fibers 244 and 246. The coarser fiber layer serves as a liquid acquisition and distribution layer for liquid permeating the top sheet as described below. The composite 250 exiting station 203 may be viewed as a composite of a back sheet 236 and a core layer 237, each of which may be made up of
10 one or more sublayers as described above.

Combining Station

The top sheet 206 and core/bottom sheet composite 250 are brought together and passed through counter-rotating rollers 211 of the combining station 205. An adhesive may be applied to one of the
15 confronting surfaces to add strength to the laminate.

The final product is a composite 200 (shown in Fig. 3) comprising a top sheet 235, a core layer 237, and a back sheet 238. As will be described in more detail below, the composite 200 is further processed through in-line stations to complete and package the absorbent
20 products such as diapers.

In-Line Fiberizing Die Assemblies

As noted above, the fiberizing die assemblies (e.g., meltblowing and spunbond dies) useable at the various stations according to the present invention can be any of a variety of commercially available



designs. The preferred fiberizing die assemblies, however, are disclosed in Fig. 2 and described in detail in U.S. Patent Application Serial No.

09/033,833, the disclosure of which is incorporated herein by reference.

Figure 2 illustrates the bottom sheet forming station 202 as comprising die assemblies 214 and 216A and core forming station 203 as comprising die assembly 240A in accordance with one embodiment of the invention. Note that the other die assemblies, 216B of station 202 and die assemblies 240B and 240C of station 203 (if used) can be identical respectively to die assemblies 216A and 240A described with reference to Fig. 2.

10 The fiberizing die assemblies 214, 216A, and 240A of the multi-station line may include many of the same components. Accordingly, the same reference numerals will designate the corresponding components of each die assembly. For example, the extruder at each die assembly 214, 216A or 240A, is designated by reference numeral 22.

15 Referring specifically to die assembly 214, this station comprises a support structure which may be in the form of four vertical legs 11 (two of which are shown in Fig. 2 and two being obscured) interconnected by cross beams 12. Each of the legs 11 are hollow and are concentrically mounted over internal legs 13 which are anchored to the floor. The legs 11 and 13 may be of any cross section but are preferably square and are sized to permit telescopic movement therebetween. The means for telescopically moving the outer legs 11 in relation to the inner legs 13 may take a variety of forms including hydraulic rams. The preferred height adjuster, however, is a conventional screw jack assembly 50 located

at the upper end of each leg 11. The jack assembly 50 comprises a gear box driven by drive shaft which turns screw. Screw is threaded to bushing affixed to the upper end of leg 11. Turning the screw in one direction raises the legs 11 and support structure 15. The support structure 15 and equipment mounted thereon is thus moveable vertically between an upper position (die assembly 214) and a lower position (die assembly 216A).

A melt spinning assembly, shown generally as 16, is mounted on the moveable support structure 15 by air pipes which include a pair of vertical air pipes 18 and a horizontal pipe section 19. There are two pairs of air pipes 18, one pair being mounted on each side of the melt spinning assembly 16. One pair is connected to opposite ends of air box 20 (see Fig. 4) of the melt spinning assembly 16 as described below. The horizontal pipe 19 of each pair of pipes may be secured to cross beam 12. Thus, the melt spinning assembly 16 is suspended on the moveable support structure 15. The term "melt spinning assembly" is used herein in the generic sense for fiberization referring to both meltblowing and spunbond die assemblies. The melt spinning assembly 16 of die 214 includes spunbond die insert 65 shown in Fig. 6.

An extruder 22 mounted on the moveable support structure comprises hopper 23, barrel 24, and polymer feed line 25. The polymer feed line 25 delivers polymer melt to the melt spinning assembly 16 as described in more detail below.

Positioned directly under the melt spinning assembly 16 and in alignment therewith are a pair of air quench ducts 26 and a filament

drawing device 27. These two components, 26 and 27, are both supported on a platform 28 in stacked relationship by brackets. The pair of ducts 26 define a quench zone 45 therebetween. The drawing device 27 is also constructed as a pair of conduits defining a filament drawing or stretching zone 46 therebetween. The vertical space between the quench ducts 26 and the drawing device 27 may include sheet metal housing 47 and the vertical space between drawing device 27 and platform 28 may include sheet metal housing 29. The platform 28 has an opening 32 formed therein. The filaments 30 discharging from the melt spinning assembly 16 descend through the quench zone 45, housing 47, draw zone 46, housing 29, opening 32, and are deposited as filaments 218 onto conveyor 36. The components 26, 27, 47, and 48 may be mounted on a wheeled carriage so that this assembly may be moved as a unit to the operating position or moved at right angles to the conveyor 36 to an offline position.

The conveyor 36 may traverse in underlying relationship all three assemblies 214, 216A, and 240A or, as illustrated in Fig. 2, may be in sections 36 and 36A to accommodate calendar 224. The collectors 36 and 36A are adapted to collect filaments from each die assembly. The conveyors 36 and 36A are each perforated or a fine-mesh screen to permit the passage of air therethrough. Vacuum means 25 positioned under conveyor 36 and 36A at each die assembly may be used to withdraw the air and debris.

Air is delivered to the quenching ducts 26 as shown schematically by arrows 34, and air is delivered to the filament drawing device 27 as shown by arrows 35.

The drawing device may be of any prior art construction including those described in U.S. Patents 4,340,563 or 5,545,371, the disclosures of which are incorporated herein by reference. The spunbond filaments are stretched in the drawing device and laid down on collector 36 as web 220 which is passed through calendar 224 to form web 226.

The melt spinning assembly 16 shown in Fig. 4 comprises a die 51, positive displacement pump 52 such as a gear pump, motor 53, gear box 54, and shaft 56. The polymer feed line 25 delivers polymer melt to the spinning assembly 16. Motor 53 drives pump 52 which receives the polymer melt and delivers the same at metered rates to the die 51 which distributes and discharges the melt through orifices as filaments 30.

Air connectors 57 and 58 mounted on each side of the die 51 connect to the air lines 18 which deliver pressurized hot air to the die 51 in its meltblowing mode (Fig. 5). The gear pump 52, motor 53, and gear box 54 may be similar to that described in U.S. Patent 5,236,641, the disclosure of which is incorporated herein by reference. The die 51 comprises a die body 61 having a downwardly opening cavity 62 formed in its lower end. Die body 61 may be constructed in halves as illustrated in Fig. 4, wherein one half has an internal passage 67 connected to line 25 for feeding the polymer melt to the inlet of pump 52. The cavity 62 is defined by two elongate side walls 63 and top surface 64. Elongate, V-shaped

grooves are formed on each side wall 63, as illustrated. The die body 61 has longitudinally spaced passages for interconnecting air connectors 57 with opposite sides of the cavity 62.

The die body 61 may have formed therein a conventional

5 "coathanger" distribution passage for feeding a polymer melt to the die inserts described below. Electrical heaters may be mounted in the die block 61 for maintaining the temperature of the die body at the operating level. As mentioned previously, the air box 20 on each side of the die body 61 is suspended between pipes 18. Each air box 20 defines an internal elongate

10 square chamber which extends substantially the entire length of the die body 61 and is connected to the air connector 57 through plate by welded connections. The connector 57 may be a welded assembly of plates which in combination define an internal air chamber and is bolted to each side of body 61 by bolts. Each connector 57 conducts air through passages 92 to

15 the die inserts 65. The die insert assembly 65 which fits into and is mounted within cavity 62 may be in the form of a meltblowing die (herein referred to as meltblowing die insert) shown in Fig. 5 or may be in the form of a spunbond spinneret (herein referred to as a spunbond die insert) shown in Fig. 6.

20 Referring first to the embodiment using the meltblowing die insert 96, this assembly comprises a support member 98 and a die tip 99 mounted thereon. Members 98 and 99 are joined by a series of bolts (one shown as 109). Member 98 has a top surface 101 which contacts surface 64 of cavity 62, and has side walls 102 which fit in close conformity with

the side walls 63 of cavity 62. Also formed in the support member 98 are a pair of longitudinally extending V-shaped grooves 104. These grooves align with the cavity grooves with the insert 96 mounted in cavity 62. A plurality of air holes 103 extend vertically through the support member 98.

5 The inlet of each air passage 103 is aligned with the outlet 92 of each air passage formed in the die body 61. Also formed in the support member 98 is an elongate channel 106 that extends through the longitudinal axis thereof. The inlet of channel 106 registers with channel 72 of the die body with the meltblowing die insert 96 mounted in cavity 62. An O-ring 107

10 surrounds the inlet 106.

The die tip assembly 99 comprises a die tip 107 and a pair of air plates 108. The die tip 99 has a downwardly projecting triangular nosepiece 11 defined by converging surfaces 112 and 113. Surfaces 112 and 113 meet at apex 114, and a plurality of orifices 116 are spaced

15 longitudinally along the apex 114. A polymer flow channel 117 extends through the die tip 99 and has an inlet which is aligned with polymer flow passage 106 of support member 98. The flow passage 117 pinches down to deliver polymer to the orifices 116. The nosepiece 111 may be integrally formed in the die tip 99 as illustrated or it may be a separate piece bolted to

20 the body of the die tip 99.

Also formed in the die tip 99 are air passages 118 which register with air passages 103 of support member 98. The air plates 108 are mounted on the die tip 99 by a plurality of bolts, one shown as 119. The air plates 108 flank the nosepiece 111 and define a converging gap

121 between confronting edges of the air plates 108 and surfaces 112 and 113. Each air plate 108 defines with a confronting surface of the die tip a tortuous air passage 124.

The meltblowing die tip insert 96 fits in close conformity in
5 cavity 62 of the die body 61. The polymer flow passages and air passages of the assemblies are respectively in fluid communication so that air flows through the assembly and discharges as converging air sheets at the apex 114 of the nosepiece as polymer flows from the pump 52 through the die body 61, the meltblowing die insert 96 discharging as filaments through
10 orifices 116 of the die tip.

The spunbond die insert 97, shown in Fig. 6, comprises a support member 126 which may be substantially identical to support member 98 described previously except no air passages are formed therein. The support member 126, however, does have the top surface 127, side
15 surfaces 128, and V-shaped grooves 129 which may be identical surfaces 101, 102, and grooves 104, respectively of the meltblowing die insert 96. Support member 126 is provided with a polymer opening or channel 131 which aligns with channel 72 of the die body 61 with the die insert 97 mounted in cavity 62. Note that since there are no air passages in support
20 member 126, the air passages 92 in the die body 61 are blocked off by surface 127.

The support member 126 is attached to spunbond spinneret 132 which comprises a body member 133 and a spinneret plate 134 bolted together by a plurality of bolts 135. The body member 133 in combination

with the plate 134 defines a feed chamber 136 having an inlet in registry with passage 131 of the support member 128. The spinneret plate 134 includes a plurality of flow passages 137 formed therein which reduce down to orifices 138 at their outlets. The orifices 138 may be in
5 accordance with well-known spunbond practices. (See for example U.S. Patents 4,340,563; 5,028,375 and 5,545,371).

Each of the die inserts 96 and 97 are selectively inserted into the cavity 62 of the die body 61 and maintained there in place by a pair of square bars 141 which fit into square holes defined by V-grooves 66 and
10 104 or 129 on each side wall of the cavity 62. With the selected die insert 96 or 97 in place and the bars 141 inserted, bolts 142 spaced along, and threaded thereto, each side of die body 61 engages one side of the bar 141 so that turning the bolts in one direction clamps the insert sealing onto top surface 64.

15 The above description of the die body 61 and meltblowing or spunbond die inserts 96 and 97 makes it clear that the system can be readily converted from one mode to the other by simply selecting the insert die and inserting it into the cavity 62. This, of course, requires the adjustment of the moveable support structure 15 to accommodate the
20 operating mode. The means for inserting the die insert 96 or 97 into cavity 61 may be manual or automatic. Assembly 214 shown in Fig. 2 depicts the spunbond mode and assemblies 216A and 240A depict the meltblowing modes, where polymer melt is delivered from the extruder 22 through the melt spinning assembly 16 provided with meltblowing die insert 96 and

discharged as micro-sized filaments from the row of orifices 116. The filaments are contacted on opposite sides by converging hot air streams and carried to and deposited on the conveyor 36A.

For the spunbond mode of operation (assembly 214), the

5 spunbond die insert 97 is inserted in the die body 61. The moveable substructure 15 is moved to its upper position. The quench air assembly 26 and filament drawing device 27 are positioned in place by moving the carriage to the position shown in Fig. 2. Air is delivered to the quench

10 ducts 26 and to the drawing device 27 while filaments 30 extruded through orifices 138 descend from the spinning assembly 16 through the quench zone 45 and drawing zone 46. The filaments 218 leaving the drawing device are deposited on the conveyor 36.

Fiberizing die assembly 216A is provided with a meltblowing die insert 65A. The other components including extruder 22, platform 12,

15 telescopic supports 11, 13, polymer delivery line 25, piping 18, motor 53 and drive assembly 54, 56, and pump 52 may be same as those described for die assembly 214.

Fiberizing assembly 240A represents the core forming station 203, where in the assembly 240A, the melt spinning assembly 16 is

20 provided with a meltblowing die insert 96 and is mounted above the drawing device 27. As illustrated, the device 27 may be mounted on the platform 28 which may be mounted on a carriage for removing or inserting the device 27 in the line. Sheet metal may be also used to define housings 38 and 39 through which the meltblown fibers must pass. As the fibers

pass through housing 38, drawing zone 46 and housing 39, the downwardly converging sheets of air contact the meltblown filaments imparting drag forces to further drawdown the fibers. The additional drawdown by the use of the filament drawing device produces micro-sized
5 fibers in the range of 0.5 to 5 microns, preferably 1 to 2 microns.

Note that in this alternative mode of meltblowing operation, the DCD (die to collector distance) is much larger than the DCD for conventional meltblowing as is apparent by comparing assemblies 216A and 240A. With the drawing device 27, the DCD ranges from 3 to 8 feet,
10 preferably from 3 to 7 feet and most preferably 4 to 6 feet. The assembly 240A is adapted to produce a high loft web (e.g., basis weight between 5 and 500 GSM, preferably between 20 and 100 GSM). Additional die assemblies may be added at each station as desired, and as illustrated in Fig. 1. The fiberizing die assembly 207 for manufacturing the spunbond
15 top sheet may be identical to assembly 214 shown in Fig. 2.

Operation

In operation, the top sheet 206 is made at station 201 by continuously fiberizing and calendaring a thermoplastic to form a web which is conveyed to the combining station 205. Optional components 252, 254,
20 described in more detail below, may be prepared at stations 256 and 258 and attached to web 206 between stations 201 and 205.

Simultaneously, the bottom sheet 238 is made by fiberizing and calendaring a thermoplastic to form web 226, which is conveyed successively under meltblowing die assemblies 216A and 216B of station

202 where additional fiberized layers are superimposed on web 226. The composite exits station 202 through calendar 233 as bottom sheet 238 and is conveyed to the core forming station 203.

In station 203, one or more fiberization die assemblies (e.g., 240A, 240B, and 240C) arranged in series continuously deposit one or more layers or sublayers onto web 238. The nonwoven webs formed in station 203 are characterized as high loft absorbent webs.

The webs exit station 203 as composites 250, which for purposes of the present invention, comprise a core layer 237 overlying bottom sheet 238, even though each of these components 237 and 238 may consist of one or more sublayers bonded together by glue, entanglement or other methods. The core layer/bottom sheet composite 250 is combined with top sheet 235 in calendar 205 forming the composite 200. The component layers may be bonded together, for example, by adhesives or thermobonding. As described in more detail below, the width of composite in exiting calendar may range from just a few inches (e.g., 6") to several feet.

In a preferred embodiment, schematically depicted in Fig. 7, the composite web 200 exiting calendar 205 is several feet wide to allow for slitting the web 200 into a plurality of individual longitudinal strips 200A, 200B, 200C, etc., each strip being approximately the width of a single diaper. The slitting may be carried out by a conventional slitter indicated at 209.

The individual strips (200A, 200B, and 200C) are processed through conventional facilities which may include one or more of the following: (a) leg cutouts at station 213, (b) frontal tape attachment at station 215, fastener attachments at station 219, and cut off at longitudinal intervals at station 221. These steps may be performed by modules similar to that used in converters.

As schematically illustrated in Fig. 7, the composite web 200 exiting calendar 250 at slit 209 is slit into individual strips 200A, 200B, 200C, etc. which are separated using rollers (not shown) and are in parallel and processed through the steps mentioned above.

A significant advantage of separating the composite web 200 into a plurality of strips (200A, 200B, etc.) vis-à-vis the converter approach is that the apparatus for carrying out the present invention can be operated at only a fraction of the line speed of the converter. Since the conventional converter processes only a single series of diapers, economics require faster and faster operation. For example, line speeds of state-of-the-art converters process from 400 to 800 diapers per minute. The apparatus for carrying out the preferred method of the present invention which simultaneously produces a number (n) of strips (200A, 200B, etc.) can be operated at a fraction (1/n) of the speed of converter and achieve the same diaper output. For example, the number of strips (200A, 200B, etc.) shown in Fig. 7 is ten. Therefore, this equipment can operate at 1/10 the speed of a single-line converter and achieve the same diaper output rate. Note also that the total width of composite 200 is equal to (n)(t) when n is the number of slits

and t is the width of each slit. Preferably n ranges from 2 to 20 and t ranges from 2 inches to 20 inches.

The resin used in the spunbond die assembly 207 or 214 can be any of the commercially available spunbond grades, including a wide
5 range of thermoplastic such as polyolefins, polyamides, polyesters, PVA, PVC, polyvinyl alcohol, cellulose acetate, elastomers such as Kraton™G, and the like. Polypropylene, because of its availability, is the preferred thermoplastic.

The resin used in the meltblowing dies may be any of the
10 commercially available meltblowing grade thermoplastic resins. These include a wide range of polyolefins such as polyethylene homopolymers and copolymers and elastomers such as Kraton™G. Specific thermoplastics include ethylene acrylic copolymers, nylon, polyamides, polyesters, polystyrene, poly(methyl) methacrylate, polytrifluoro-
15 chloroethylene, polyurethanes, polycarbonates, silicone sulfide, and poly(ethylene terephthalate), and blends of the above. The preferred resin is polypropylene. The above list is not intended to be limiting, as new and improved meltblowing thermoplastic resins continue to be developed.

The following are representative parameters of the preferred
20 embodiment of the present invention:



Polymer Melt			
5	Temp. (°C)	175 to 300	200 to 270
	Rate (Gr./hole/min)	0.1 to 5	0.2 to 1.2
	Primary Air		
5	Temp. (°C)	175 to 300	200 to 275
	Rate (SCFM/in)	2 to 100	5 to 30

Bottom Sheet Forming Station (202)

		<u>Broad Range</u>	<u>Preferred Range</u>
10	Spunbond Dies*		
	Number	1 or 2	1
	Meltblowing Dies		
	Number	0 to 4	1 to 2
15	Orifice diameter (mm)	0.1 to 1.0	0.3 to 0.4
	Orifice spacing (mm)	0.05 to 1.0	0.1 to 0.3
	DCD (inches)	3 to 20	3 to 8
20	Polymer		
	Temp (°C)	175 to 300	200 to 270
	Rate (Gr./hole/min)	2 to 5	0.3 to 1.2
20	Primary Air		
	Temp (°C)	175 to 300	200 to 275
	Rate (SCFM/in)	2 to 100	5 to 30

*The length, orifice, quench ducts, collector specification and operating conditions may be the same as described for station 201.

Absorbent Composite

25 With reference to Fig. 3, the three-component composite 200 comprises top sheet 235, bottom sheet 238, core layer 237 including main absorbent layer 239 and acquisition/distribution layer 241. The properties and dimensions of the preferred component 200 may be as follows:



		Type of Web	Layers	Avg. Fiber Size (microns)	Basic Wt. (GSM)
	Top sheet (235)				
5	Preferred:	nonwoven	1	12 to 100	4 to 40
	Most Preferred:	spunbond	1	12 to 50	4 to 40
	Core Layer (237)				
	Layer 239	preferred	1	5 to 100	2 to 100
		most preferred	1	5 to 50	10 to 50
10	Layer 241	preferred	1 to 2	2 to 30	2 to 100
		most preferred	1 to 2	1 to 15	10 to 50
	Bottom sheet (238)				
		Spunbond	1	12 to 100	2 to 100
		Meltblown	1-2	1 to 15	.5 to 20

The preferred absorbent composite should have a thickness between 10 mil to 500 inches, with the percentage proportion of each layer being as follows: top sheet 235, 1 to 10%; core layer 237, 25 to 75%; and bottom sheet, 1 to 10%. The preferred thickness of the product will be between 25 mil and 200 mil; the most preferred is between 25 and 100 mil.

OPTIONAL EQUIPMENT

Most diaper lines include facilities for applying optional diaper features, which include leg elastic, frontal tapes, waistbands, etc. These options can be applied in the conventional manner. Fig. 1 schematic illustrates leg applicator 260 as feeding thin elastic leg sections for attachment to bottom sheet 238. Waistband applicator 256, delivers waistbands 254 for attachment to the bottom surface of top sheet 206, and applicator 258 delivers leg cuffs (barriers) for attachment to the top surface of top sheet 206. Absorbent enhancing material such as superabsorbents may be added at strategic locations along the line.

ALTERNATIVE EMBODIMENT

It has been stated that at least two, and most preferably three, of the stations 201, 202, and 203, are in-line fiberizing stations. Figure 8 illustrates a preferred embodiment comprising two fiberizing stations (e.g., 201 and 203), and a backsheet roll station 202A. The roll 262 may be any liquid-impervious sheet material but is preferably a plastic film such as polyethylene or polypropylene film.

In the Figure 8 embodiment, the stations 201 and 203, respectively, form the top sheet 235 and core layer 237 as described previously and are conveyed to the combining station 205. Simultaneously, the film sheet 264 is unwound and delivered to the combining station 205 where all three layers are laminated together through calendar 205. A nonwoven layer unwound from station 202A may be combined with sheet 264, if desired.

While the present invention has been illustrated by a description of various embodiments and while these embodiments have been described in considerable detail, it is not the intention of the Applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. The invention in its broader aspects is therefore not limited to the specific details, representative apparatus and methods as shown and described. This has been a description of the present invention, along with the preferred methods of practicing the present invention as



152

currently known. However, the invention itself should only be defined by the appended claims, wherein I claim:

1. A method of manufacturing a composite absorbent article, the method comprising:
- (a) fiberizing a thermoplastic polymer to form a nonwoven top sheet on a moving collector;
- 5 (b) withdrawing the top sheet from the collector and delivering the same in-line to a combining station;
- (c) fiberizing a thermoplastic polymer at a bottom sheet forming station to form a nonwoven, substantially liquid-impervious bottom sheet on a moving collector;
- 10 (d) withdrawing the bottom sheet from the bottom sheet forming station and delivering the bottom sheet in-line to a core forming station;
- (e) fiberizing a thermoplastic polymer at the core forming station to deposit a nonwoven core layer on the bottom sheet delivered
- 15 from the bottom sheet forming station to form a core layer/bottom sheet composite;
- (f) withdrawing the core layer/bottom sheet composite from the core forming station and delivering the same in-line to the combining station; and
- 20 (g) laminating together the top sheet delivered from the top sheet forming station and the composite delivered from the core forming station to form a composite comprising a top sheet, a bottom sheet, and a core layer sandwiched therebetween.

2. The method of claim 1, wherein the fiberizing at the top sheet forming station is by a spunbond die to form a spunbond top sheet.
3. The method of claim 1, wherein the fiberizing at the bottom sheet forming station is by a spunbond die for forming a spunbond bottom sheet.
4. The method of claim 3, wherein the fiberizing at the bottom sheet forming station is by at least one spunbond die and at least one meltblowing die arranged in series to form a bottom sheet comprising a spunbond layer and a meltblown layer.
5. The method of claim 3, wherein the fiberizing at the core forming station is by at least one meltblowing die and wherein at least one meltblown layer is deposited on the bottom sheet.
6. The method of claim 5, wherein the core forming station comprises two or more meltblowing dies for depositing two or more meltblown layers in stacked relationship onto the bottom sheet.
7. The method of claim 1 and further comprising the step of withdrawing the three-layer composite from the combining station and passing the same through a cutting station wherein the composite is cut at longitudinal intervals to form a plurality of absorbent articles.

8. The method of claim 7, wherein prior to cutting the composite at longitudinal intervals, the composite is slit in the machine direction to form a plurality of longitudinal slits.
9. The method of claim 8, wherein the number of slits is n and the width of each slit is t , whereby the composite entering the cutting station has a width of $n \times t$.
10. The method of claim 9, wherein n ranges from 2 to 20, and t ranges from 2 inches to 20 inches.
11. The method of claim 10, wherein n ranges from 5 to 15, and t ranges from 6 to 12 inches.
12. The method of claim 1, wherein step (a) forms a spunbond nonwoven.
13. The method of claim 1, wherein the thermoplastic polymer in all stations is a polymer or copolymer of propylene or ethylene.
14. The method of claim 1, wherein fiberizing at the core forming station forms a meltblown nonwoven having an average fiber size of between 0.5 to 100 microns.

15. The method of claim 14, wherein the thermoplastic polymer of step (c) is a polymer or copolymer of propylene or ethylene.

16. A method of manufacturing a three-layer composite absorbent, comprising the steps of:

- 5 (a) continuously forming a top sheet layer by (i) extruding a thermoplastic polymer into fibers and (ii) collecting the fibers on a moving collector to form a nonwoven top sheet thereon;
- (b) continuously forming an absorbent core layer by (i) extruding a thermoplastic polymer to form fibers, and (ii) collecting the
10 fibers on a moving collector to form a nonwoven absorbent core layer thereon;
- (c) continuously withdrawing the top sheet and the core layer from their respective collectors; and
- (d) continuously laminating the top sheet and core layer
15 withdrawn in step (c) with a bottom sheet to form a three-layer composite.

17. The method of claim 16, wherein the bottom sheet is a film of a synthetic polymer.

18. The method of claim 16, wherein the bottom sheet is a nonwoven layer.

19. The method of claim 16, wherein the bottom sheet is formed by (i) extruding a thermoplastic polymer to form fibers and (ii) collecting the fibers on a moveable collector.

20. The method of claim 19, wherein the fibers of the core layer
5 are deposited directly onto the bottom layer.

21. A method of manufacturing a composite absorbent article comprising:

- (a) fiberizing a thermoplastic polymer at a top sheet forming station to form a nonwoven top sheet on a moving collector;
- 10 (b) withdrawing the top sheet from the collector and delivering the top sheet in-line to a combining station;
- (c) fiberizing a thermoplastic polymer at a bottom sheet forming station to form a nonwoven, substantially liquid-impervious bottom sheet on a moving collector;
- 15 (d) withdrawing the bottom sheet from the bottom sheet forming station and delivering the bottom sheet in-line to the combining station;
- (e) forming a thermoplastic polymer into a core layer;
- (f) delivering the core layer to the combining station; and
- 20 (g) combining the top sheet, bottom sheet, and core layer into a composite at the combining station.

22. An in-line system for forming a composite absorbent product which comprises:

- (a) a combining station;
- (b) a top sheet forming station comprising a spunbond die for forming a spunbond top sheet;
- (c) a conveyor for delivering the top sheet in-line from the top sheet forming station to the combining station;
- (d) a bottom sheet forming station comprising a spunbond die for forming a spunbond bottom sheet;
- 10 (e) a core forming station comprising at least one meltblowing die for fiberizing a thermoplastic polymer into micro-sized meltblown fibers to form a core layer;
- (f) a conveyor for delivering the bottom sheet in-line to the core forming station where the core layer is formed on the bottom sheet to
- 15 form a composite of the bottom sheet and the core layer thereon; and
- (g) a conveyor for delivering the composite from the core forming station in-line to the combining station for laminating the composite to the top sheet.

23. The system of claim 22, wherein the bottom sheet forming station further includes at least one meltblowing die downstream of the spunbond die whereby the bottom sheet forming station forms a spunbond layer having at least one meltblown layer deposited thereon.



24. The system of claim 22, wherein the core forming station comprises three meltblowing dies arranged in series for producing the core layer comprising three meltblown layers.
25. The system of claim 22 and further comprising a slitting station downstream of the combining station for slitting the composite leaving the combining station into longitudinal slits.
26. The system of claim 25 and further comprising a cutting station for receiving the slits and cutting them at longitudinal intervals into individual articles.
27. A composite absorbent article comprising:
 - (a) a top sheet comprised of thermoplastic spunbond material;
 - (b) a core layer comprising (i) a first sublayer of a thermoplastic meltblown material having an average fiber size of 1 to 50 microns, and (ii) a second sublayer of a thermoplastic material having an average fiber size of 2 to 30 microns, the fibers of said second layer being on average larger than the fibers of the first sublayer and being bonded to the top sheet and the first sublayer, and
 - (c) a bottom sheet comprising (i) a spunbond layer and (ii) at least one meltblown layer, said meltblown layer being bonded to the first

sublayer of the core layer and the spunbond layer (i), said bottom sheet being substantially liquid impervious.

28. The composite absorbent of claim 27, wherein the top sheet, the core layer, including sublayers, and the bottom sheet including the spunbond layer and meltblown layer have the following characteristics:
- the top sheet having average fiber size of 12 to 50 microns;
 - the first meltblown sublayer of the core layer having an average fiber size of 5 to 50 microns;
 - the second meltblown sublayer having an average fiber size of 1 to 25 microns;
 - the average fiber size of the first sublayer being at least 10% coarser than those of the first sublayer;
 - the spunbond layer of the bottom sheet having an average fiber size of 12 to 100 microns, and
 - the meltblown layer of the bottom sheet having an average fiber size of 1 to 15 microns.

29. The composite of claim 28, wherein the bottom sheet comprises a spunbond layer and two meltblown layers.

30. The composite of claim 27, wherein the top sheet, core layer, and bottom sheet are made of polymers or copolymers of propylene or ethylene.

31. An in-line system for forming disposable hygienic absorbent products, comprising:

- (a) a combining station;
- (b) a top sheet forming station having a first spunbond die
5 and a first calender downstream from said first spunbond die for forming a top sheet that is liquid permeable;
- (c) a first conveyor for delivering the top sheet in-line from said top sheet forming station to said combining station;
- (d) a bottom sheet forming station having a second
10 spunbond die and a second calender downstream from said second spunbond die, first and second meltblowing dies downstream from said second calender for forming a substantially liquid impermeable bottom sheet comprising a spunbond layer and two meltblown layers;
- (e) a core forming station having at least a third
15 meltblowing die for forming an absorbent core layer;
- (f) a second conveyor for delivering the bottom sheet in-line to said core forming station where the core layer is formed on the bottom sheet to form a composite comprising the bottom sheet and the core layer;
and
- (g) a third conveyor for delivering the composite from said
20 core forming station in-line to said combining station for laminating the composite to the top sheet to form the disposable hygienic absorbent products.

32. The system of claim 31 and further comprising a slitting station downstream from said combining station for slitting the disposable hygienic products leaving said combining station into longitudinal strips.
33. The system of claim 32 and further comprising a cutting station for receiving the strips and cutting them at longitudinal intervals into individual disposable hygienic products.
34. The system of claim 31, wherein said bottom sheet forming station further has a third calender downstream from said first and second meltblowing dies.
- 10 35. The system of claim 31, wherein said core forming station further comprises fourth and fifth meltblowing dies for forming the absorbent core layer comprising three meltblown layers.

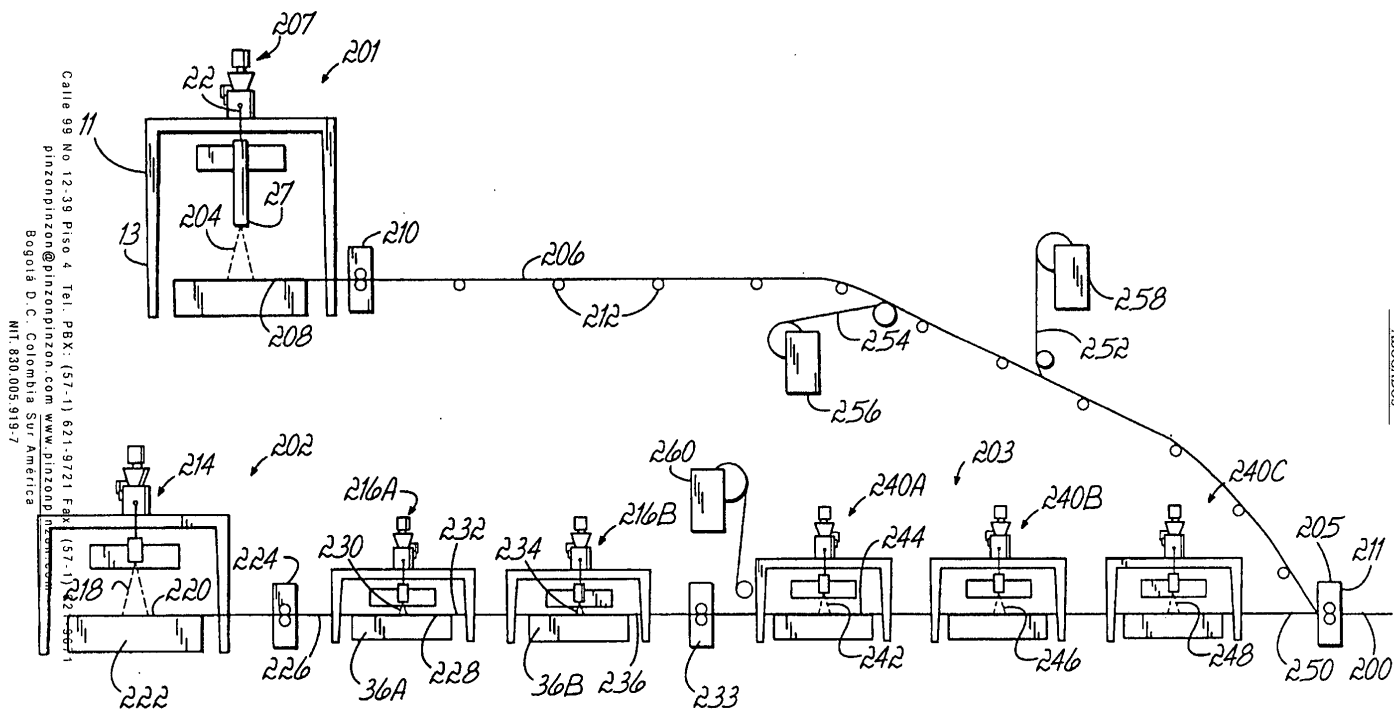


FIG. 1

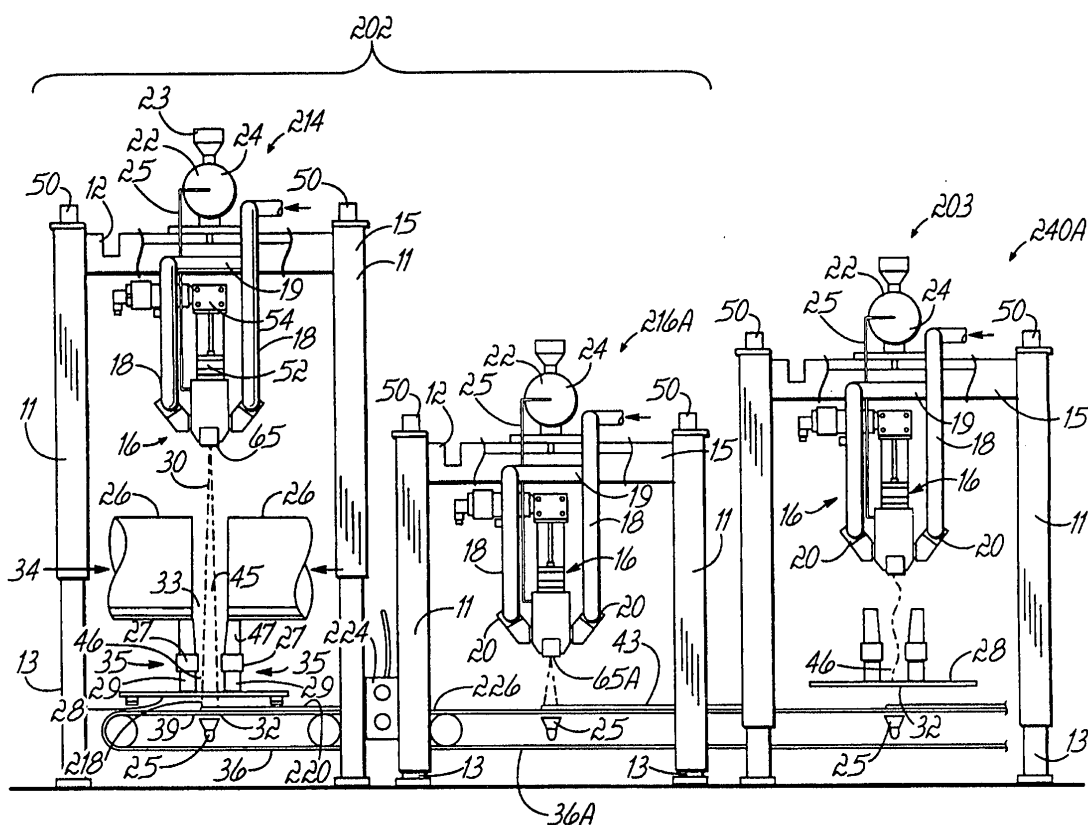


FIG. 2

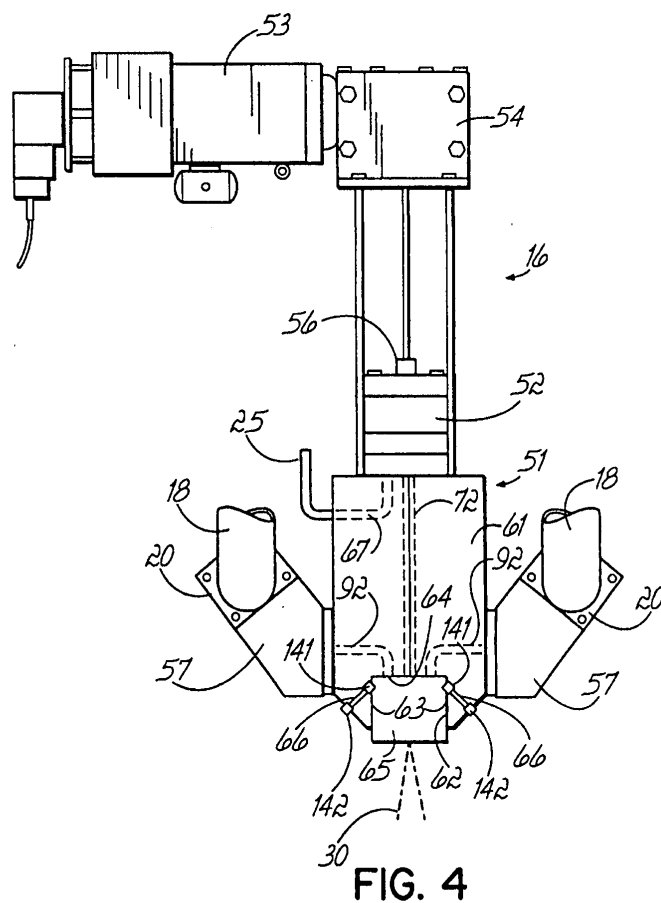


FIG. 4

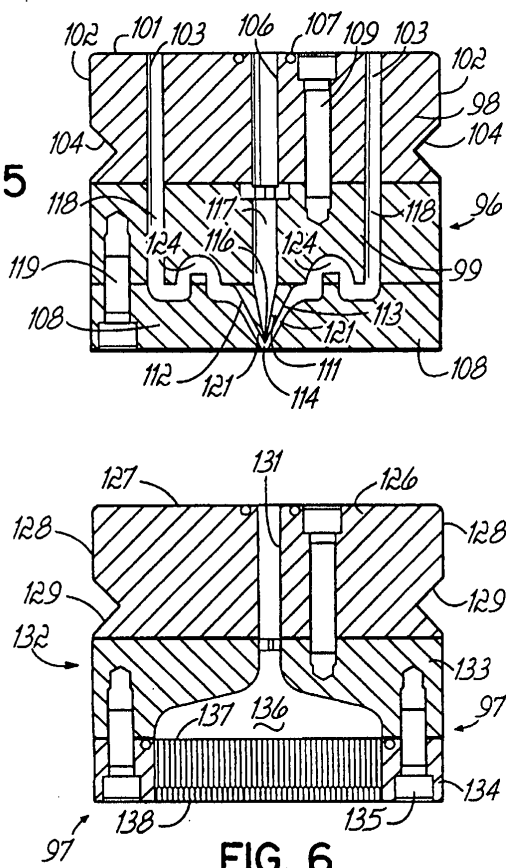


FIG. 6

FIG. 5

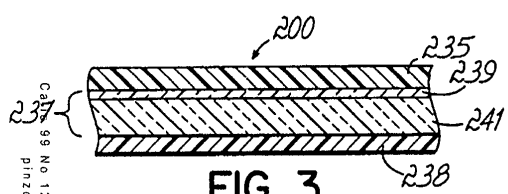


FIG. 3

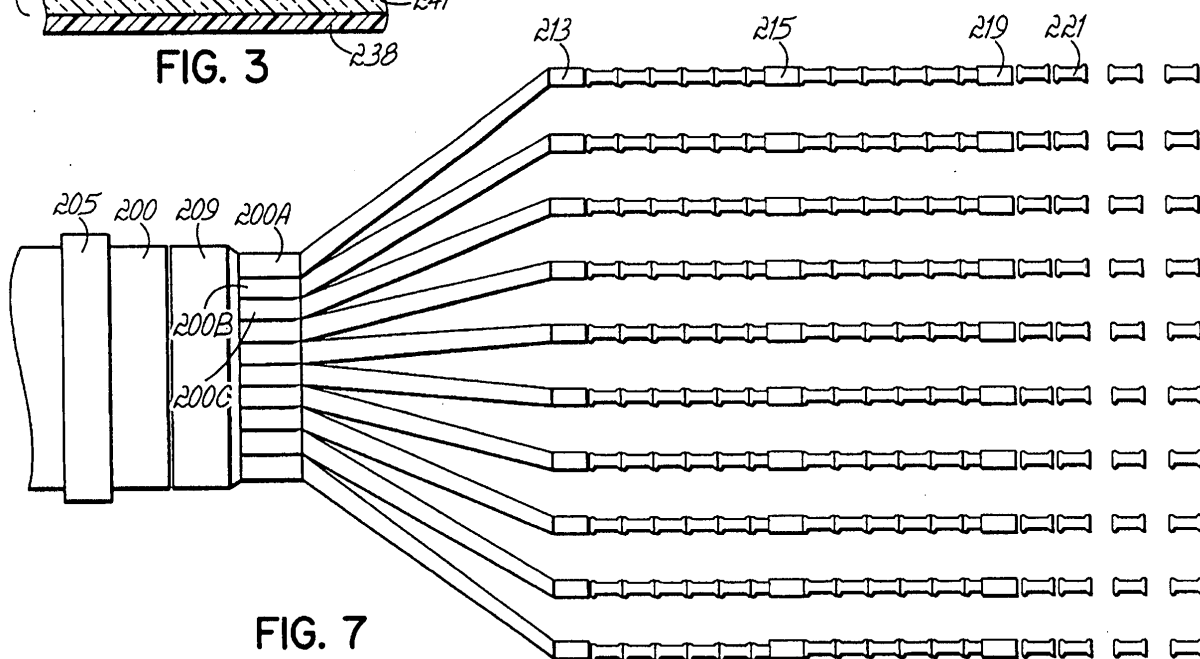


FIG. 7

237
C. 99 No. 12-39 Piso 4 Tel. PBX: (57-1) 621-9721 Fax: (57-1) 621-9677
pinzonpinzon@pinzonpinzon.com www.pinzonpinzon.com
Bogotá D. C. Colombia Sur América
MT. 830.005.919-7



Calle 99 No 12-39 Piso 4 Tel. PBX: (57-1) 621-9721 Fax: (57-1) 621-9671
pinzonpinzon@pinzonpinzon.com www.pinzonpinzon.com
Bogotá D.C. Colombia Sur America
NIT. 830.005.919-7

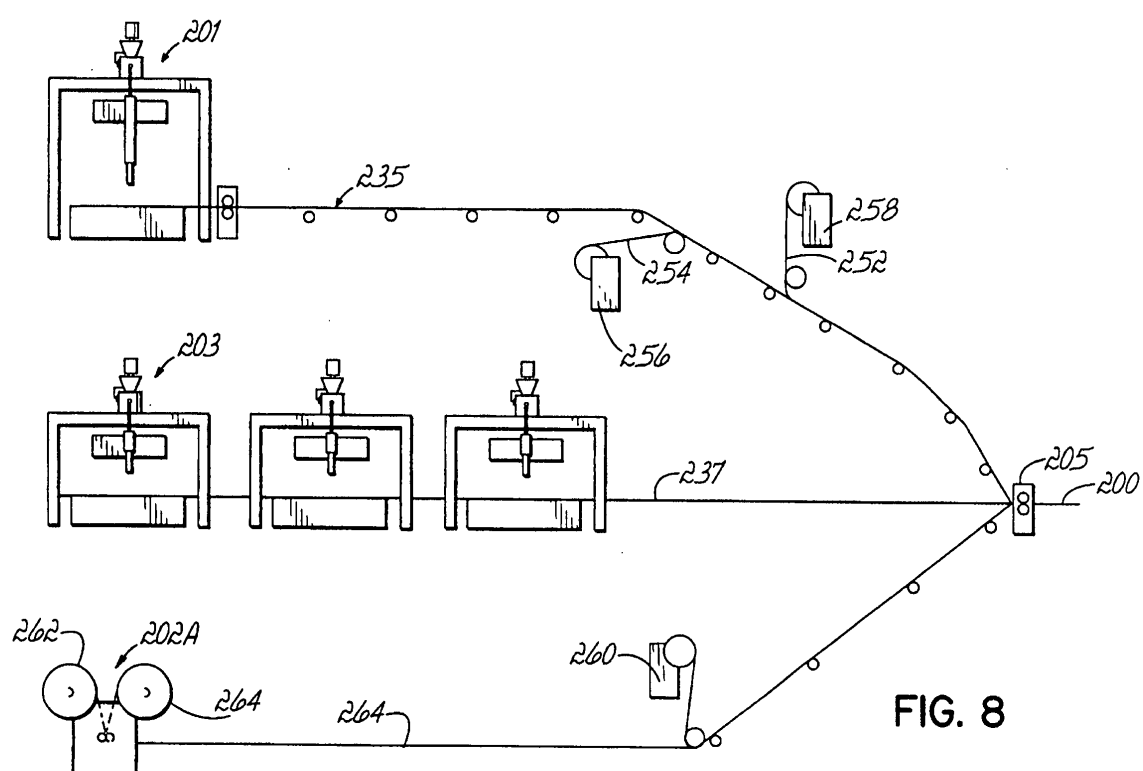


FIG. 8

INTERNATIONAL SEARCH REPORT

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International Application No
PCT/US 02/38419

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61F13/15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61F D04H B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, EPO-Internal, PAJ

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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 96 17569 A (KIMBERLY CLARK CO) 13 June 1996 (1996-06-13) claims 7,13-15,21; figure 2 page 9 page 11 page 21 -page 26 ---	27-30
Y	US 6 114 596 A (NAYAK RAHUL K ET AL) 5 September 2000 (2000-09-05) claim 1; figure 8 column 2, line 34,35 column 5, line 40 - line 45 column 8, line 11 - line 16 column 8, line 23 column 8, line 38 -column 9, line 2 --- -/--	27-30

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

'A' document defining the general state of the art which is not considered to be of particular relevance

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'O' document referring to an oral disclosure, use, exhibition or other means

'P' document published prior to the international filing date but later than the priority date claimed

'T' later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

'X' document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search
12 March 2003

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Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Telex 37651 epo NL, PBX: (57-1) 621-9771
Fax: (+31-70) 340-2040
pinzon@pinzonpinzon.com www.pinzonpinzon.com

Authorized officer
Settelle U

Bogotá D.C. - Colombia Sur América

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170

INTERNATIONAL SEARCH REPORT



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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT

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International Application No
PCT/US 02/38419

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pinzonpinzon@pinzonpinzon.com www.pinzonpinzon.com