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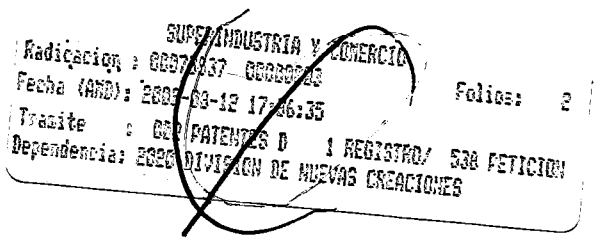

Señores
Superintendencia de Industria y Comercio
División de Nuevas Creaciones
E. S. D.

Ref: Expediente No. 00-073.837
Solicitud de Patente de Invención denominada "Artículo Absorbente Desechable que Emplea un Compuesto Absorbente"
Solicitantes: Drypers Corporation
Japan Absorbent Technology Institute (JATI)

Darío Cárdenas Navas, identificado como aparece al pie de mi firma y obrando en mi condición de apoderado de las sociedades **Drypers Corporation** y **Japan Absorbent Technology Institute (JATI)**, solicitantes de la Patente de Invención mencionada en la referencia, de acuerdo con lo dispuesto en el artículo 44 de la Decisión 486 de la Comunidad Andina, solicito al Despacho **se sirva adelantar el examen de patentabilidad (fondo)** para la patente en mención, la cual fue publicada en la Gaceta de la Propiedad Industrial No. 518 del 30 de Julio de 2.002.

Para tal efecto adjunto el recibo oficial de caja No. 02-52,284 por valor de $318.000.oo.

Atentamente,

Darío Cárdenas Navas
C.C. 17.066.629 de Bogotá
T. P. 1.250 del Consejo Superior de la Judicatura

AMR/d:/modelos/memorial/petición examen fondo.doc/
F # P-157A

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Industria y Comercio

SUPERINTENDENCIA

NIT : 800176089-2

SUPERINDUSTRIA Y COMERCIO
Radicacion : 00073837 00000003 Folios: 2
Fecha (AMD): 2002-08-12 17:36:35
Tramite : 002 PATENTES D 1 REGISTRO/ 538 PETICION
Dependencia: 2020 DIVISION DE NUEVAS CREACIONES

RECIBO OFICIAL DE CAJA : 02 - 52,284
FECHA : AGOSTO 9 DE 2002

***** C O N S I G N A C I O N *****

DEPOSITANTE	TIPO PAGO	BANCO	CUENTA	No. PAGO	FECHA PGO	Vr. PAGO
CARDENAS Y CARDENAS P.I.	CONSIGNACION	BANCO POPULAR	050-00110-6	1980767	09/08/2002	2,169,000.00

***** C O N C E P T O *****

CANT.	RENTISTICO		CONCEPTO		TOTAL CONCEPTO
1	50005-01-01	SOLICITUDES	85	EXAMEN DE PATENTABILIDAD DE INVEN	318,000.00
				TOTAL : $	318,000.00

SON: TRESCIENTOS DIEZ Y OCHO MIL PESOS

RESPONSABLE 1 _____

RECIBO DE CAJA APLICADO AL EXPEDIENTE No. 00-073.837

por + Dmpes + - Calculo observ...

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SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
DIVISIÓN DE NUEVAS CREACIONES

2020
Bogotá, D. C., 29 de Julio de 2005

Doctor
DARÍIO CARDENAS NAVAS
Representante **DRYPERS CORPORATION & JAPAN ABSORBENT TECHNOLOGY INSTITUTE**

ASUNTO

Radicación No.	**00-73837**
Trámite	002
Evento	001
Actuación	430
Oficio	06548
Folios	090

Como resultado del examen de fondo, realizado con fundamento en el artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le comunica

1) **Documentos estudiados:**

a) Para el presente estudio se tendrán en cuenta el capítulo descriptivo, comprendido en los folios 134 a 172 de la solicitud en estudio.

b) Para el presente estudio se tendrán en cuenta los dibujos comprendidos en los folios 98 a 108 de la solicitud en estudio.

c) Para el presente estudio se tendrá en cuenta el capítulo reivindicatorio que comprende 38 reivindicaciones en los folios 173 a 178 de la solicitud en estudio.

d) Conforme lo establece los artículos 9, 10 y 11 de la decisión 486 de la Comisión de la Comunidad Andina, la presente solicitud en estudio fue presentada el 28 de septiembre de 2000, y en el momento de la radicación **NO** se reclamo prioridad alguna.

2) **Objeto de la invención**

a) Las reivindicaciones 1 a 38 de la solicitud en estudio se refieren a:

i) Un artículo absorbente desechable incluye una lámina superior, una lámina posterior y un núcleo absorbente interpuesto en las mismas. Una o más de la lámina posterior, lámina superior y núcleo absorbente están construidos de un compuesto absorbente que incluye una capa absorbente de fibras finas hidratables en la forma de microfilamentos obtenidos de celulosa o de un derivado de la misma, y partículas de un polímero super absorbente (PSA) ligadas por las fibras hidratables, y un substrato no tejido que soporta la capa absorbente y donde la capa absorbente se le aplica revestimiento sobre el mismo.

ii) (18) Un artículo absorbente...

iii) (30) Un compuesto absorbente prefabricado...

b) Los anteriores productos buscan mejorar los artículos absorbentes actuales.

c) Según la Clasificación Internacional de Patentes, la codificación para esta solicitud corresponde a: A 61 F 13/15

3) **Claridad de la Solicitud**

a) El artículo 28 de la Decisión 486 de la Comisión de la Comunidad Andina de Naciones establece

> *"La descripción deberá divulgar la invención de manera suficientemente clara y completa para su comprensión y para que una persona capacitada en la materia técnica correspondiente pueda ejecutarla"*

La descripción no es clara toda vez que los dibujos no han sido presentados adecuadamente. Se tratan de fotocopias que se van deteriorando con el tiempo. Deben presentarse en original, en tinta negar indeleble y siguiendo las normas del dibujo técnico.

b) El artículo 30 de la Decisión 486 de la Comisión de la Comunidad Andina establece que

> *"Las reivindicaciones definirán la materia que se desea proteger mediante la patente. Deben ser claras y concisas y estar enteramente sustentadas por la descripción. Las reivindicaciones podrán ser independientes o dependientes. Una reivindicación será independiente cuando defina la materia que se desea proteger sin referencia a otra reivindicación anterior. Una reivindicación será dependiente cuando defina la materia que se desea proteger refiriéndose a una reivindicación anterior. Una reivindicación será dependiente cuando defina la materia que se desea proteger refiriéndose a una reivindicación anterior.- Una reivindicación que se refiera a dos o más reivindicaciones anteriores se considerará reivindicación dependiente múltiple."*

El capítulo reivindicatorio no es claro toda vez que:

i) No es clara la reivindicación 30 cuando afirma que "un compuesto absorbente... localizado en una desechable absorbente..."

ii) No se precisa la materia sobre la cual se solicita protección. Cómo se explicará en el punto 4), la presente solicitud no posee unidad de invención, por lo que no está definida la materia sobre la cual se solicita protección.

De acuerdo a lo anterior, el capítulo reivindicatorio no cumple con el requisito de claridad de acuerdo a lo establecido en el Art. 30 de la Decisión 486.

4) **Evaluación de la Unidad de Invención**

El artículo 25 de la Decisión 486 de la Comisión de la Comunidad Andina establece

> *"La solicitud de patente sólo podrá comprender una invención o un grupo de invenciones relacionadas entre sí, de manera que conformen un único concepto inventivo"*

La presente solicitud carece de unidad de invención toda vez que configura **TRES** diferentes objetos. Aunque se dirigen a **partes de un artículo absorbente desechable** la definición de la materia que caracteriza a cada una de las reivindicaciones independientes 1, 18 y 30 es muy diferente entre sí. Esto permite afirmar que no se trata del mismo producto. Todo el problema radica en configurar varias reivindicaciones independientes con materia diferente. El solicitante debe establecer una sola reivindicación independiente dirigida al **producto** en la forma más simple de la solicitud de invención. Partiendo de allí establecer reivindicaciones dependientes que amplíen esa forma más simple hasta su forma más compleja.

De acuerdo a lo anterior, la presente solicitud no cumple con el requisito de unidad de invención de acuerdo al Art. 25 de la Decisión 486.

5) **Determinación del Estado de la Técnica**

El artículo 16 de la Decisión 486 de la Comisión establece:

> *"El estado de la técnica comprenderá todo lo que haya sido accesible al público por una descripción escrita u oral, utilización, comercialización o cualquier otro medio antes de la fecha de presentación de la solicitud de patente o, en su caso, de la prioridad reconocida."*
>
> *"Sólo para el efecto de la determinación de la novedad, también se considerará dentro del estado de la técnica, el contenido de una solicitud de patente en trámite ante la oficina nacional competente cuya fecha de presentación o de prioridad fuese anterior a la fecha de presentación o de prioridad de la solicitud de patente que se estuviese examinando, siempre que dicho contenido este incluido en la solicitud de fecha anterior cuando ella se publique o hubiese transcurrido el plazo previsto en el artículo 40."*

Consultadas las bases de datos y los archivos con que cuenta la entidad, especialmente bajo las clasificaciones **A 61 F 13/15** y las más cercanas a ellas, se encontró que antes del 28 de septiembre de 2000 (fecha para determinar el estado de la técnica) habían sido publicados los documentos que se enumeran en la siguiente tabla los cuales se relacionan con artículos absorbentes desechables.

De acuerdo con lo establecido en el artículo 16 se determinó el estado de la técnica y se encontró el siguiente antecedente:

Nº	*Documento*	*Título*	*Fecha de Publicación*
D1	US 5571096	Absorbent article having breathable side panels	1996.11.05
D2	EP 0947549	Highly absorbent composite compositions, absorbent sheets provided with the compositions, and process for producing the same	1998.06.18
D3	JP 11-170414	High water-water-absorbing sheet and manufacture thereof	1999.06.29
D4	JP 11034200	Sheet like absorption material, method and apparatus for manufacturing the same	1999.02.09

6) **Evaluación de los requisitos de patentabilidad**

El artículo 14 de la Decisión 486 de la Comisión de la Comunidad Andina establece:

> *"Los Países Miembros otorgarán patentes para las invenciones, sean de producto o procedimiento, en todos los campos de la tecnología, siempre que sean nuevas tengan nivel inventivo y sean susceptibles de aplicación industrial".*

En cumplimiento con este artículo, se procedió a evaluar los requisitos de novedad, nivel inventivo y aplicación industrial con el fin de establecer la patentabilidad de la invención reivindicada en la solicitud en estudio.

a) Evaluación de la novedad y el del Nivel Inventivo

El art. 16 de la Decisión 486 de la Comisión de la Comunidad Andina establece:

> *"Una invención se considerará nueva cuando no está comprendida en el estado de la técnica." "El estado de la técnica comprenderá todo lo que haya sido accesible al público por una descripción escrita u oral, utilización comercialización o cualquier otro medio antes de la fecha de presentación de la solicitud de patente o, en su caso, de la prioridad reconocida."*
>
> *"Sólo para el efecto de la determinación de la novedad, también se considerará dentro del estado de la técnica, el contenido de una solicitud de patente en trámite ante la oficina nacional competente, cuya fecha de presentación o de prioridad fuese anterior a la fecha de presentación o prioridad de la solicitud de patente que se estuviese examinando, siempre que dicho contenido esté incluido en la solicitud de fechas de prioridad cuando ella se publique o hubiese transcurrido el plazo previsto en el artículo 40."*

El art. 18 de la Decisión 486 de la Comisión de la Comunidad Andina establece:

> *"Se considerará que una invención tiene nivel inventivo, si para una persona del oficio normalmente versada en el arte en la materia técnica correspondiente, esa invención no hubiese resultado obvia ni se hubiese derivado de manera evidente del estado de la técnica".*

De acuerdo con lo estudiado en la presente solicitud, **cada una** de las anterioridades citadas **por sí solas** relacionan la mayoría de las características de lo que aquí se quiere proteger. En muchos casos las características son iguales. En los demás relacionan criterios demasiado evidentes para un técnico medio.

b) Resumen

En conclusión los requisitos de patentabilidad de la presente solicitud se podrían ver afectados así:

Nº	Documento	Reivindicaciones afectadas	Requisito que afecta
D1	US 5571096	1 - 38	Novedad
			Nivel inventivo
D2	EP 0947549	1 - 38	Novedad
			Nivel inventivo
D3	JP 11-170414	1 - 38	Novedad
			Nivel inventivo
D4	JP 11034200	1 - 38	Novedad
			Nivel inventivo

7) **Notificación**

En cumplimiento del artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le indica que dentro del término de sesenta días contados a partir de la fecha de la notificación de la presente comunicación debe responder a la notificación. En caso de no dar respuesta al presente requerimiento, o si a pesar de la respuesta subsistieran los impedimentos para la concesión, se denegará la patente.

Notifíquese el presente oficio conforme a lo dispuesto por el numeral 5.2, literal e) del capítulo quinto del título primero de la Circular Única Nº 10 de 2001

ALIX CARMENZA CÉSPEDES DE VERGEL
Jefe División de Nuevas Creaciones

El anterior requerimiento fue notificado por fijación en la lista, de fecha

04 AGO 2005

Concepto Técnico Nº	EXAMINADOR TÉCNICO Código No.	EXAMINADOR JURÍDICO Código No.
1102	**202003**	

US005571096A

United States Patent [19]

Dobrin et al.

[11] **Patent Number: 5,571,096**

[45] **Date of Patent: Nov. 5, 1996**

[54] **ABSORBENT ARTICLE HAVING BREATHABLE SIDE PANELS**

[75] Inventors: **George C. Dobrin; Karen M. Davis,** both of Cincinnati; **David M. Weirich,** West Chester, all of Ohio

[73] Assignee: **The Procter & Gamble Company,** Cincinnati, Ohio

[21] Appl. No.: **530,036**

[22] Filed: **Sep. 19, 1995**

[51] **Int. Cl.**[6] **A61F 13/15**; A61F 13/20

[52] **U.S. Cl.** **604/383**; 604/385.1; 604/393

[58] **Field of Search** 604/358, 383, 604/385.1, 393–396

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,426,754	2/1969	Bierenbaum .	
3,881,489	5/1975	Hartwell .	
3,989,867	11/1976	Sisson .	
4,014,341	3/1977	Karami .	
4,306,559	12/1981	Nishizawa et al. .	
4,341,216	7/1982	Obenour .	
4,342,314	8/1982	Radel et al. .	
4,395,215	7/1983	Bishop .	
4,681,578	7/1987	Anderson et al. .	
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4,887,602	12/1989	O'Leary	604/385.1
4,900,317	2/1990	Buell .	
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5,085,654	2/1992	Buell .	
5,098,423	3/1992	Pieniak et al. .	
B1 4,636,207	11/1989	Buell .	

FOREIGN PATENT DOCUMENTS

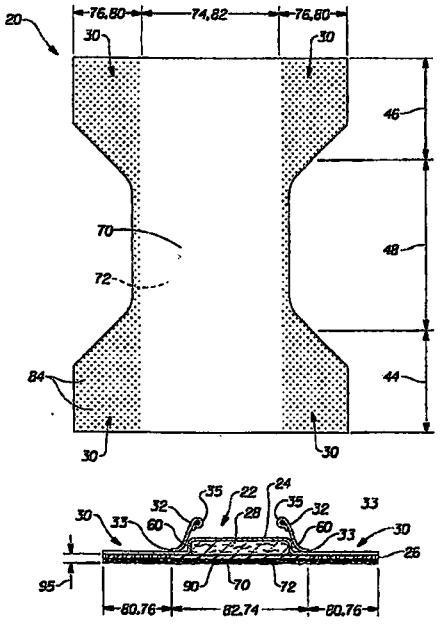
WO95/17867	7/1995	WIPO .

Primary Examiner—Debra S. Brittingham
Assistant Examiner—P. Zuttarelli
Attorney, Agent, or Firm—David M. Weirich; Steven W. Miller; Jacobus C. Rasser

[57] **ABSTRACT**

A disposable absorbent articles having breathable side panels. The disposable absorbent article preferably comprises a containment assembly including a topsheet, a backsheet and an absorbent core disposed between the topsheet and the backsheet. The absorbent core has a pair of opposing longitudinal edges, an inner surface and an outer surface. The backsheet has a garment-facing surface, a body-facing surface, a central region and an outer region. The backsheet preferably further includes at least three distinct zones, a pair of apertured zones comprising apertures and a non-apertured zone. The apertured zones preferably include at least a portion of the outer region of the backsheet and extend laterally outwardly form each of the longitudinal edges. The non-apertured zone preferably comprises the central region and is juxtaposed the outer surface of the absorbent core. The disposable absorbent article preferably further comprises a liquid and air pervious outer cover joined with the garment-facing surface of the backsheet to form a breathable laminate in the apertured zones. In preferred embodiments, a side panel extends laterally outwardly from each of the longitudinal edges of the absorbent core, each of the side panels comprising at least a portion of the laminate such that the side panels are breathable.

33 Claims, 3 Drawing Sheets



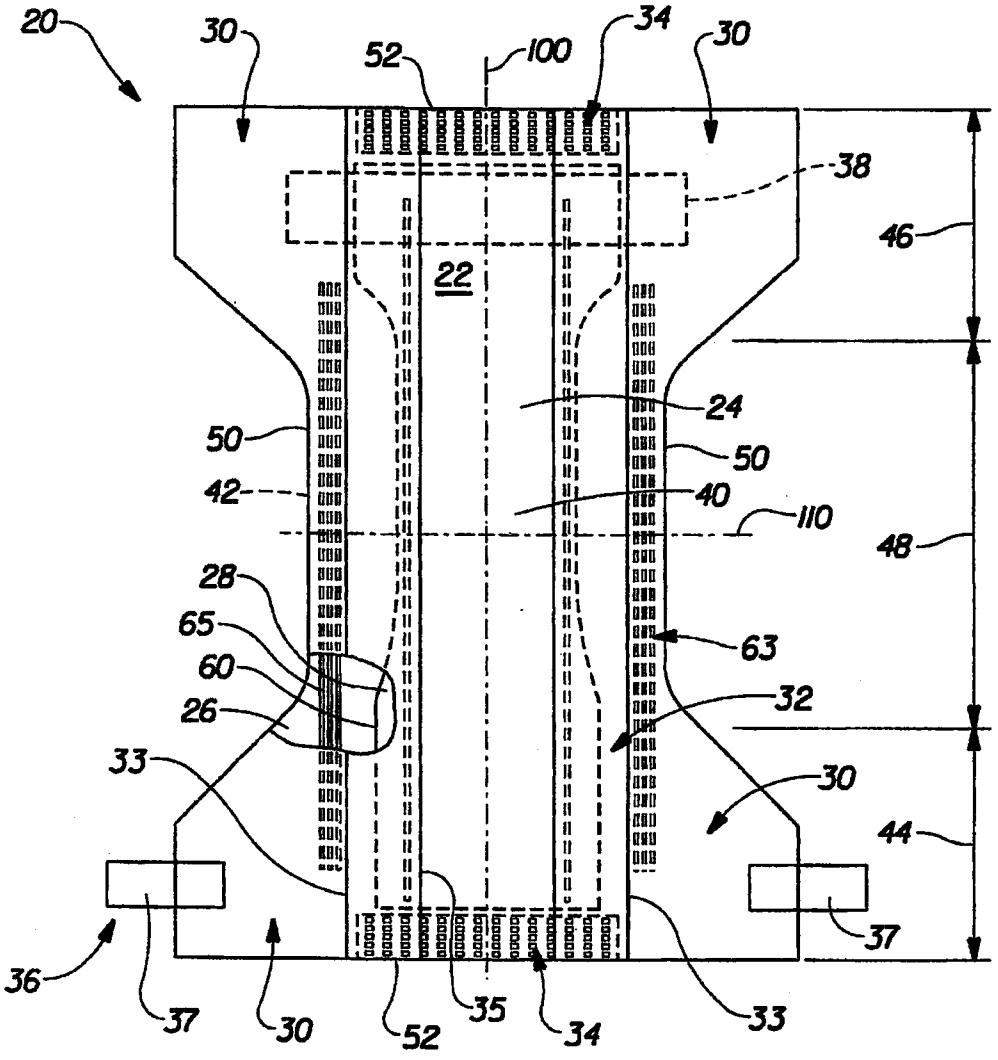

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Fig. 1

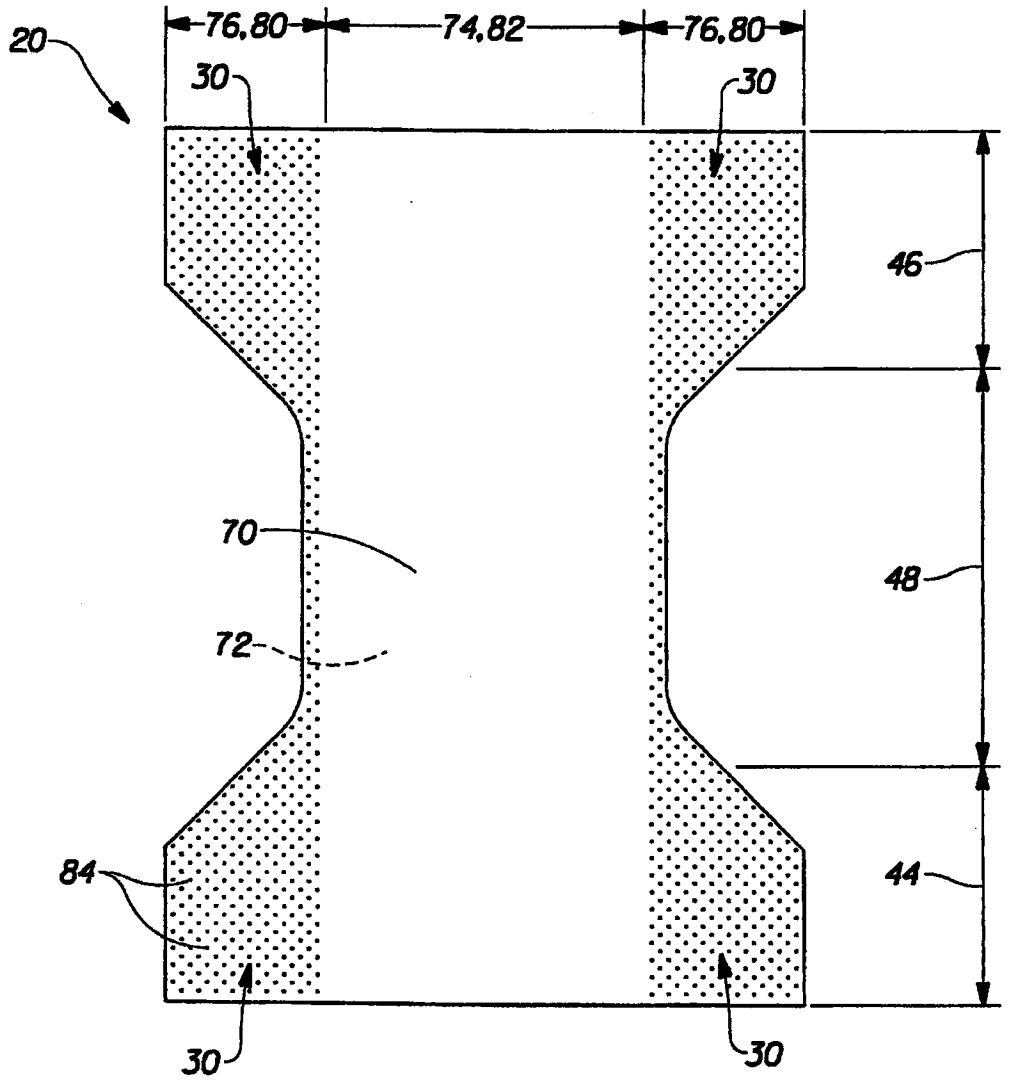

Fig. 2

ABSORBENT ARTICLE HAVING BREATHABLE SIDE PANELS

FIELD OF INVENTION

The present invention relates generally to disposable absorbent articles such as disposable diapers and, more particularly, to disposable absorbent articles having breathable side panels.

BACKGROUND OF THE INVENTION

Infants and other incontinent individuals wear disposable absorbent articles such as diapers to receive and contain urine and other body exudates. Absorbent articles function both to contain the discharged materials and to isolate these materials from the body of the wearer and from the wearer's garments and bed clothing. Disposable absorbent articles having many different basic designs are known to the art. It is also known that the exterior of disposable diapers can be covered with a flexible, liquid and vapor impervious sheet to prevent any absorbed liquid from passing through the diaper and soiling adjacent articles such as clothing, bedding and the like. These outer covers, generally referred to as backsheets, are often constructed from fluid impervious films such as polyethylene. Although such backsheets do prevent liquid from passing through the diaper, they also can make the diaper feel hot and uncomfortable to wear because of their impermeability to air and/or moisture.

Backsheets which are pervious to vapor are generally known as breathable backsheets and have been described in the art. In general, these backsheets are intended to allow the passage of vapor through them while retarding the passage of liquid. For example, U.S. Pat. No. 3,156,242 issued to Crowe, Jr. on Nov. 10, 1964 teaches the use of a microporous film as a breathable backsheet. U.S. Pat. No. 3,881,489, issued to Hartwell on May 6, 1975, teaches a breathable backsheet comprising in combination two layers, the first of which is a low void volume perforated thermoplastic film and the second of which is a porous high void volume hydrophobic tissue. U.S. Pat. No. 3,989,867 issued to Sisson on Nov. 2, 1976 teaches a breathable backsheet provided with tapered hollowed bosses which prevent the passage of liquids while allowing vapors to pass readily therethrough.

While these backsheets do provide improvements over the impermeable backsheets of the prior art, they can be relatively expensive and/or difficult to manufacture, especially at high speeds. Often, numerous layers of materials or coatings are needed to provide breathable backsheets capable of containing liquids that may be absorbed by the diaper. Further, in some cases, the breathable backsheets may not effectively contain liquid, especially when the diaper is subjected to the normal forces created by the movements of the wearer.

Therefore, it is an object of the present invention to provide a disposable absorbent article having good containment characteristics while having breathable side panels to ensure comfort for the wearer.

It is a further object of the present invention to provide a disposable absorbent article having a backsheet comprising apertured and non-apertured zones, the non-apertured zone juxtaposed the absorbent core and the apertured zone(s) extending outwardly from the non-apertured zone to form at least a portion of the side panel(s) of the disposable absorbent article.

It is yet another object of this invention to provide a disposable absorbent article having a backsheet comprising apertured and non-apertured zones, wherein the backsheet further comprises a vapor pervious and/or liquid pervious nonwoven web which provides the garment-facing surface of the backsheet a cloth-like feel.

It is still another object of the present invention to provide a disposable absorbent article having good containment and breathability characteristics that is economical and easy to manufacture at high speeds.

SUMMARY OF THE INVENTION

The present invention is directed to disposable absorbent articles having breathable side panels. The disposable absorbent article preferably comprises a containment assembly including a topsheet, a backsheet and an absorbent core disposed between the topsheet and the backsheet. The absorbent core has a pair of opposing longitudinal edges, an inner surface and an outer surface. The backsheet has a garment-facing surface, a body-facing surface, a central region and an outer region. The backsheet preferably further includes at least three distinct zones, a pair of apertured zones comprising apertures and a non-apertured zone. The apertured zones preferably include at least a portion of the outer region of the backsheet and extend laterally outwardly form each of the longitudinal edges. The non-apertured zone preferably comprises the central region and is juxtaposed the outer surface of the absorbent core. The disposable absorbent article preferably further comprises a liquid and air pervious outer cover joined with the garment-facing surface of the backsheet to form a breathable laminate in the apertured zones. In preferred embodiments, a side panel extends laterally outwardly from each of the longitudinal edges of the absorbent core, each of the side panels comprising at least a portion of the laminate such that the side panels are breathable.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as forming the present invention, it is believed that the invention will be better understood from the following description which is taken in conjunction with the accompanying drawings in which like designations are used to designate substantially identical elements, and in which:

FIG. 1 is a plan view of a disposable diaper embodiment of the present invention having portions cut away to reveal underlying structure, the inner surface of the diaper is facing the viewer;

FIG. 2 is a plan view of one embodiment of a backsheet suitable for use in the diaper of the present invention;

FIG. 3 is an enlarged, cross-sectional view of the backsheet of FIG. 2 shown with a nonwoven web joined thereto; and

FIG. 4 is an enlarged, cross-sectional view of one embodiment of a disposable absorbent article comprising the backsheet shown in FIGS. 2–3.

DETAILED DESCRIPTION OF THE INVENTION

As used herein, the term "absorbent article" refers to devices which absorb and contain body exudates, and, more specifically, refers to devices which are placed against or in proximity to the body of the wearer to absorb and contain the

various exudates discharged from the body. The term "disposable" is used herein to describe absorbent articles which are not intended to be laundered or otherwise restored or reused as an absorbent article (i.e., they are intended to be discarded after a single use and, preferably, to be recycled, composted or otherwise disposed of in an environmentally compatible manner). A "unitary" absorbent article refers to absorbent articles which are formed of separate pans united together to form a coordinated entity so that they do not require separate manipulative parts like a separate holder and liner. A preferred embodiment of an absorbent article of the present invention is the unitary disposable absorbent article, diaper **20**, shown in FIG. **1**. As used herein, the term "diaper" refers to an absorbent article generally worn by infants and incontinent persons that is worn about the lower torso of the wearer. It should be understood, however, that the present invention is also applicable to other absorbent articles such as incontinence briefs, incontinence undergarments, diaper holders and liners, feminine hygiene garments, training pants, and the like.

FIG. **1** is a plan view of the diaper **20** of the present invention in its flat-out, uncontracted state (i.e., with elastic induced contraction pulled out) with portions of the structure being cut-away to more clearly show the construction of the diaper **20** and with the portion of the diaper **20** which faces the wearer, the inner surface **40**, facing the viewer. As shown in FIG. **1**, the diaper **20** preferably comprises a containment assembly **22** comprising a liquid pervious topsheet **24**; a liquid impervious backsheet **26** joined to the topsheet; and an absorbent core **28** positioned between the topsheet **24** and the backsheet **26**. The absorbent core **28** has a pair of opposing longitudinal edges **60**, an inner surface **62** and an outer surface **64**. The diaper preferably further comprises side panels **30**; elasticized leg cuffs **32**; elasticized waistbands **34**; and a fastening system **36** preferably comprising a pair of securement members **37** and a landing member **38**.

The diaper **20** is shown in FIG. **1** to have an inner surface **40** (facing the viewer in FIG. **1**), an outer surface **42** opposed to the inner surface **40**, a rear waist region **44**, a front waist region **46** opposed to the rear waist region **44**, a crotch region **48** positioned between the rear waist region **44** and the front waist region **46**, and a periphery which is defined by the outer perimeter or edges of the diaper **20** in which the side edges are designated **50** and the end edges are designated **52**. The inner surface **40** of the diaper **20** comprises that portion of the diaper **20** which is positioned adjacent to the wearer's body during use (i.e., the inner surface **40** generally is formed by at least a portion of the topsheet **24** and other components joined to the topsheet **24**). The outer surface **42** comprises that portion of the diaper **20** which is positioned away from the wearer's body (i.e., the outer surface **42** is generally formed by at least a portion of the backsheet **26** and other components joined to the backsheet **26**). As used herein, the term "joined" encompasses configurations whereby an element is directly secured to the other element by affixing the element directly to the other element, and configurations whereby the element is indirectly secured to the other element by affixing the element to intermediate member(s) which in turn are affixed to the other element. The rear waist region **44** and the front waist region **46** extend from the end edges **52** of the periphery to the crotch region **48**.

The diaper **20** also has two centerlines, a longitudinal centerline **100** and a transverse centerline **110**. The term "longitudinal", as used herein, refers to a line, axis, or direction in the plane of the diaper **20** that is generally aligned with (e.g. approximately parallel with) a vertical plane which bisects a standing wearer into left and right halves when the diaper **20** is worn. The terms "transverse" and "lateral", as used herein, are interchangeable and refer to a line, axis or direction which lies within the plane of the diaper that is generally perpendicular to the longitudinal direction (which divides the wearer into front and back body halves).

The containment assembly **22** of the diaper **20** is shown in FIG. **1** as comprising the main body (chassis) of the diaper **20**. The containment assembly **22** preferably comprises a topsheet **24**, a backsheet **26** and an absorbent core **28** having a pair of opposing longitudinal edges **60**, an inner surface **62**, an outer surface **64**. The inner surface **62** generally faces the body of the wearer while the outer surface **64** generally faces away from the body of the wearer. When the absorbent article comprises a separate holder and a liner, the containment assembly **22** generally comprises the holder and the liner (i.e., the containment assembly **22** comprises one or more layers of material to define the holder while the liner comprises an absorbent composite such as a topsheet, a backsheet, and an absorbent core.) For unitary absorbent articles, the containment assembly **22** preferably comprises the topsheet **24**, the backsheet **26** and the absorbent core **28** of the diaper with other features added to form the composite diaper structure.

FIG. **1** shows a preferred embodiment of the containment assembly **22** in which the topsheet **24** and the backsheet **26** have length and width dimensions generally larger than those of the absorbent core **28**. The topsheet **24** and the backsheet **26** extend beyond the edges of the absorbent core **28** to thereby form the periphery of the diaper **20**. While the topsheet **24**, the backsheet **26**, and the absorbent core **28** may be assembled in a variety of well known configurations, exemplary containment assembly configurations are described generally in U.S. Pat. No. 3,860,003 entitled "Contractible Side Portions for Disposable Diaper" which issued to Kenneth B. Buell on Jan. 14, 1975; and U.S. Pat. No. 5,151,092 entitled "Absorbent Article With Dynamic Elastic Waist Feature Having A Predisposed Resilient Flexural Hinge" which issued to Kenneth B. Buell et al., on Sep. 29, 1992; each of which is incorporated herein by reference.

The absorbent core **28** may be any absorbent member which is generally compressible, conformable, non-irritating to the wearer's skin, and capable of absorbing and retaining liquids such as urine and other certain body exudates. As shown in FIG. **1**, the absorbent core **28** has a garment-facing side, a body-facing side, a pair of side edges, and a pair of waist edges. The absorbent core **28** may be manufactured in a wide variety of sizes and shapes (e.g., rectangular, hourglass, "T"-shaped, asymmetric, etc.) and from a wide variety of liquid-absorbent materials commonly used in disposable diapers and other absorbent articles such as comminuted wood pulp which is generally referred to as airfelt. Examples of other suitable absorbent materials include creped cellulose wadding; meltblown polymers including coform; chemically stiffened, modified or cross-linked cellulosic fibers; tissue including tissue wraps and tissue laminates; absorbent foams; absorbent sponges; superabsorbent polymers; absorbent gelling materials; or any equivalent material or combinations of materials.

The configuration and construction of the absorbent core **28** may vary (e.g., the absorbent core may have varying caliper zones, a hydrophilic gradient, a superabsorbent gradient, or lower average density and lower average basis weight acquisition zones; or may comprise one or more layers or structures). Further, the size and absorbent capacity of the absorbent core **28** may also be varied to accommodate

wearers ranging from infants through adults. However, the total absorbent capacity of the absorbent core **28** should be compatible with the design loading and the intended use of the diaper **20**.

One embodiment of the diaper **20** has an asymmetric, modified T-shaped absorbent core **28** having ears in the front waist region but a generally rectangular shape in the rear waist region. Exemplary absorbent structures for use as the absorbent core **28** of the present invention that have achieved wide acceptance and commercial success are described in U.S. Pat. No. 4,610,678 entitled "High-Density Absorbent Structures" issued to Weisman et al. on Sep. 9, 1986; U.S. Pat. No. 4,673,402 entitled "Absorbent Articles With Dual-Layered Cores" issued to Weisman et al. on Jun. 16, 1987; U.S. Pat. No. 4,888,231 entitled "Absorbent Core Having A Dusting Layer" issued to Angstadt on Dec. 19, 1989; and U.S. Pat. No. 4,834,735, entitled "High Density Absorbent Members Having Lower Density and Lower Basis Weight Acquisition Zones", issued to Alemany et al. on May 30, 1989. The absorbent core may further comprise the dual core system containing an acquisition/distribution core of chemically stiffened fibers positioned over an absorbent storage core as detailed in U.S. Pat. No. 5,234,423, entitled "Absorbent Article With Elastic Waist Feature and Enhanced Absorbency" issued to Alemany et al., on Aug. 10, 1993; and in U.S. Pat. No. 5,147,345, entitled "High Efficiency Absorbent Articles For Incontinence Management" issued to Young, LaVon and Taylor on Sep. 15, 1992. All of these patents are incorporated herein by reference.

The topsheet **24** is preferably positioned adjacent the inner surface **62** of the absorbent core **28** and is preferably joined thereto and to the backsheet **26** by attachment means (not shown) such as those well known in the art. Suitable attachment means are described with respect to joining the backsheet **26** to the absorbent core **28**. In a preferred embodiment of the present invention, the topsheet as **24** and the backsheet **26** are joined directly to each other in the diaper periphery and are indirectly joined together by directly joining them to the absorbent core **28** by any suitable attachment means.

The topsheet **24** is preferably compliant, soft feeling, and non-irritating to the wearer's skin. Further, the topsheet **24** is preferably liquid pervious permitting liquids (e.g., urine) to readily penetrate through its thickness. A suitable topsheet **24** may be manufactured from a wide range of materials such as woven and nonwoven materials; polymeric materials such as apertured formed thermoplastic films, apertured plastic films, and hydroformed thermoplastic films; porous foams; reticulated foams; reticulated thermoplastic films; and thermoplastic scrims. Suitable woven and nonwoven materials can be comprised of natural fibers (e.g., wood or cotton fibers), synthetic fibers (e.g., polymeric fibers such as polyester, polypropylene, or polyethylene fibers) or from a combination of natural and synthetic fibers. The topsheet **24** is preferably made of a hydrophobic material to isolate the wearer's skin from liquids which have passed through the topsheet **24** and are contained in the absorbent core **28** (i.e. to prevent rewet). If the topsheet **24** is made of a hydrophobic material, at least the upper surface of the topsheet **24** is treated to be hydrophilic so that liquids will transfer through the topsheet more rapidly. This diminishes the likelihood that body exudates will flow off the topsheet **24** rather than being drawn through the topsheet **24** and being absorbed by the absorbent core **28**. The topsheet **24** can be rendered hydrophilic by treating it with a surfactant. Suitable methods for treating the topsheet **24** with a surfactant include spraying the topsheet **24** material with the surfactant and immersing the material into the surfactant. A more detailed discussion of such a treatment and hydrophilicity is contained in U.S. Pat. No. 4,988,344 entitled "Absorbent Articles with Multiple Layer Absorbent Layers" issued to Reising, et al on Jan. 29, 1991 and U.S. Pat. No. 4,988,345 entitled "Absorbent Articles with Rapid Acquiring Absorbent Cores" issued to Reising on Jan. 29, 1991, each of which is incorporated by reference herein.

An alternative preferred topsheet comprises an apertured formed film. Apertured formed films are preferred for the topsheet because they are pervious to body exudates and yet non-absorbent and have a reduced tendency to allow liquids to pass back through and rewet the wearer's skin. Thus, the surface of the formed film which is in contact with the body remains dry, thereby reducing body soiling and creating a more comfortable feel for the wearer. Suitable formed films are described in U.S. Pat. No. 3,929,135, entitled "Absorptive Structures Having Tapered Capillaries", which issued to Thompson on Dec. 30, 1975; U.S. Pat. No. 4,324,246 entitled "Disposable Absorbent Article Having A Stain Resistant Topsheet", which issued to Mullane, et al. on Apr. 13, 1982; U.S. Pat. No. 4,342,314 entitled "Resilient Plastic Web Exhibiting Fiber-Like Properties", which issued to Radel. et al. on Aug. 3, 1982; U.S. Pat. No. 4,463,045 entitled "Macroscopically Expanded Three-Dimensional Plastic Web Exhibiting Non-Glossy Visible Surface and Cloth-Like Tactile Impression", which issued to Ahr et al. on Jul. 31, 1984; and U.S. Pat. No. 5,006,394 "Multilayer Polymeric Film" issued to Baird on Apr. 9, 1991. Each of these patents are incorporated herein by reference.

The backsheet **26** of the present invention is that portion of the diaper **20** which is generally positioned away from the wearer's skin and which prevents the exudates absorbed and contained in the absorbent core **28** from wetting articles which contact the diaper **20** such as bedsheets and undergarments. Thus, the backsheet **26** is preferably impervious to liquids (e.g., urine) and is preferably manufactured from a thin plastic film, although other flexible liquid impervious materials may also be used. (As used herein, the term "flexible" refers to materials which are compliant and will readily conform to the general shape and contours of the human body.) However, the backsheet **26** permits vapors to escape from the diaper **20**. A suitable material for the backsheet **26** is a thermoplastic film having a thickness of from about 0.012 mm (0.5 mil) to about 0.051 mm (2.0 mils), preferably comprising polyethylene or polypropylene.

The backsheet **26** of the present invention may comprise a single member such as the film described above, or may comprise a number of materials joined together to form the backsheet **26**. For example, the backsheet may have a central region **74** comprising one film or other member and one or more outer regions **76** joined to the central region **74** comprising the same or different films or other materials. In one preferred embodiment, the backsheet **26** comprises a central region **76** comprising a liquid impervious, non-apertured film and two opposing outer regions **76** comprising an air pervious, apertured film. The means by which any portions of such a backsheet are joined my include any means known in the art such as adhesives, heat, pressure, heat and pressure and ultrasonic bonds. Further, the backsheet **26** may comprise any number of layers of material joined together to form a laminate. If the backsheet **26** is a laminate, the layers need not be uniform throughout the backsheet. For example, the central region **74** of the backsheet **26** may comprise more layers or layers of different material than the outer regions **76**.

The backsheet **26** is preferably positioned adjacent the outer surface **64** of the absorbent core **28** and is preferably

joined thereto by any suitable attachment means known in the art. For example, the backsheet **26** may be secured to the absorbent core **28** by a uniform continuous layer of adhesive, a patterned layer of adhesive, or an array of separate lines, spirals, or spots of adhesive. Adhesives which have been found to be satisfactory are manufactured by H. B. Fuller Company of St. Paul, Minn. and marketed as HL-1258. An example of a suitable attachment means comprising an open pattern network of filaments of adhesive is disclosed in U.S. Pat. No. 4,573,986 entitled "Disposable Waste-Containment Garment", which issued to Minetola et al. on Mar. 4, 1986. Another suitable attachment means comprising several lines of adhesive filaments swirled into a spiral pattern is illustrated by the apparatus and methods shown in U.S. Pat. Nos. 3,911,173 issued to Sprague, Jr. on Oct. 7, 1975; 4,785,996 issued to Ziecker, et al. on Nov. 22, 1978; and 4,842,666 issued to Werenicz on Jun. 27, 1989. Each of these patents are incorporated herein by reference. Alternatively, the attachment means may comprise heat bonds, pressure bonds, ultrasonic bonds, dynamic mechanical bonds, or any other suitable attachment means or combinations of these attachment means as are known in the art.

Embodiments of the present invention are also contemplated wherein the absorbent core is not joined to the backsheet **26**, and/or the topsheet **24** in order to provide greater extensibility in the front waist region **46** and the rear waist region **44**. Alternative embodiments are contemplated wherein an additional member, such as a liquid impervious barrier material(s) (not shown), is positioned between the outer surface **64** of the absorbent core **28** and the backsheet **28**. Any such barrier member may or may not be joined to the absorbent core **28**. Further, the backsheet **26** may or may not be joined to any barrier material(s) that are positioned between the backsheet **26** and the absorbent core **28**.

The backsheet **26** of the present invention, as shown in FIG. **2**, preferably has a body-facing surface **72**, a garment-facing surface **70**, a central region **74** and at least one outer region **76**. Further, the backsheet **26** preferably comprises at least two distinct zones, at least one apertured zone **80** and at least one non-apertured zone **82**. In a preferred embodiment, as shown in FIGS. **1** and **4**, the backsheet **26** of the present invention comprises at least three distinct zones, a non-apertured zone **82** and two opposing apertured zones **80**. The non-apertured zone **82** preferably comprises the central region **74** of the backsheet **26** and is juxtaposed at least a portion of the outer surface **64** of the absorbent core **28**. The non-apertured zone **82** provides a liquid impervious structure that contains liquids that have passed into the containment assembly **22**. In a preferred embodiment, the non-apertured zone **82** cover the entire outer surface **64** of the absorbent core **28**. (As used herein, the term "covers" means that one member is generally, either directly or indirectly in a face to face relationship with another member.) In an especially preferred embodiment, the non-apertured zone **82** not only covers the outer surface **64** of the absorbent core **28**, but also extends laterally outwardly to at least any the location at which any barrier cuffs (described below) that may be joined to the diaper **20**, such as the proximal edge **33** of the barrier cuff **32**. (As used herein, the term "laterally outwardly" refers to a direction away from the longitudinal centerline **100**.) This ensures that any liquid absorbed by the core **28** or otherwise deposited into the containment assembly **22** of the diaper **20** will not seep through the apertured zone(s) **80** of the backsheet **26**.

The apertured zone(s) **80** of the backsheet **26** of the present invention comprise apertures **84** which permit the passage of vapors and/or liquids. As used herein, the term "aperture" refers to any opening formed in a material that permits at least the passage of vapors. Suitable apertures may comprise slits, perforations, cuts, holes or any other opening or openings that permit the passage of vapor. The apertures **84** may take on any size and shape known in the art. Further, each apertured zone **80** may comprise apertures **84** of differing size and shape. Also, the apertures **84** may be arranged in patterns that are regular or irregular. In a preferred embodiment, the apertured zones **80** comprise apertures having similar dimensions arranged in generally regular patterns. An especially preferred aperture is generally eliptical and has a major axis ranging in length from about 5 mils to about 150 mils. More preferably, the aperture has a major axis length ranging from about 10 mils to about 80 mils; and most preferably, the aperture has a major axis length ranging between about 30 and about 40 mils. Preferred methods for aperturing the apertured zones **80** of the backsheet **26** are described below.

It has been found that the apertured zones **80** can also be described in terms of the density of the apertures and the porosity. As used herein, the term "aperture density" refers to the number of apertures per square inch of material. In preferred embodiments, the aperture density is between about 50 to about 10,000 apertures per square inch and more preferably between about 500 to about 1000 apertures per square inch. The term "porosity" as used herein refers to the air permeability of a material and can be measured according to either of following tests that are well known in the art: ASTM D-737 entitled "Air Permeability of Textile Fabric", or INDA IST 70.0 entitled "Air Permeability". In a preferred embodiment, as measured by the above-referenced ASTM D-737 test, the porosity of the apertured zones is greater than or equal to about 50 cubic feet/minute/square foot of material. More preferably, the porosity is greater than or equal to about 150 cubic feet/minute/square foot of material and most preferably, the porosity is greater than or equal to about 300 cubic feet/minute/square foot of material. Further, embodiments are contemplated wherein the apertured zones **80** have porosity characteristics different from each other or different porosity characteristics within each of the apertured zones **80**.

The apertured zone(s) **80** preferably comprise at least a portion of the outer region **76** of the backsheet **26** and preferably extend laterally outwardly from the central region **74** of the backsheet **26** beyond at least one of the longitudinal edges **60** of the absorbent core **28** in at least the rear waist region **44**. More preferably, at least one apertured zone **80** extends laterally outwardly from the central region **74** beyond each of the longitudinal edges **60** forming breathable side panels **30** in both the front waist region **46** and the rear waist region **44**, as shown in FIGS. **1** and **2**. (As used herein, the term "breathable" refers to members that, at a minimum, permit the passage of vapor therethrough. Some breathable members, however, permit the passage of liquids as well as vapors.) In another preferred embodiment, the diaper **20** may also be provided with apertured zones **80** forming breathable side panels **30** that extend from the front waist region **46** through the crotch region **48** and the rear waist region **44** (FIG. **2**).

In embodiments of the present invention comprising leg cuffs **32**, as described below, the apertured zone(s) **80** may be disposed laterally inwardly or outwardly of the leg cuffs **32**. Further, the apertured zone(s) **80** may form a portion of the leg cuffs **32**. However, in a preferred embodiment, the apertured zone(s) **80** extend laterally outwardly from the proximal edge **33** of the leg cuff **32**. In another preferred embodiment of the present invention, the apertured zone(s)

80 extend laterally outwardly from a location that is laterally outboard of the proximal edge 33 of the leg cuff 32 and laterally inboard of the gasketing cuff 63. Such a configuration provides the diaper 20 with a liquid impervious gasketing seal about the legs of the wearer that prevents liquids from escaping the containment assembly 22 of the diaper 20. In yet another embodiment, the apertured zone(s) 80 extend laterally outwardly from a location laterally outboard of the gasketing cuff 63.

A method of aperturing materials to provide the breathable side panels 30 can readily be selected by those skilled in the art from techniques and designs known to the art. For example, if backsheet 26 is a thermoplastic film (such as common polyethylene film) it can be apertured to provide the apertured zone 80 to a degree which can be described in terms of a dimensionless R value defined as

$$R=\frac{D(OA)}{C}$$

wherein D is the average diameter (in centimeters) of the apertures in the film, OA is the total open area of the apertured film expressed as a percentage, and C is the average caliper (or length or height) of the apertures (in centimeters). Normally, when apertures are formed in an elastic film, they take the form of somewhat irregular cones open at both apex and base. Average diameter is the arithmetic average of the diameters of the two openings so formed. Of course, if the apertures are uniformly cut from the film without the usual formation of the cones, caliper will be the film thickness. An apertured film having an R value of between about 2 and about 40, preferably between about 5 and about 25, usually has a vapor transfer rate as suitable for use in the present invention. Examples of apertured films and methods for making the films are described in U.S. Pat. No. 3,881,489, issued to Hartwell on May 6, 1975 entitled "Breathable, Liquid Impervious Backsheet For Absorptive Devices"; U.S. Pat. No. 3,989,867, issued to Sisson on Nov. 2, 1976 entitled "Absorptive Devices Having Porous Backsheet"; U.S. Pat. No. 4,341,216, issued to Obenour on Jul. 27, 1982 entitled "Breathable Backsheet For Disposable Diapers"; U.S. Pat. No. 4,342,314 entitled "Resilient Plastic Web Exhibiting Fiber-Like Properties", issued to Radel et al. on Aug. 3, 1982; and U.S. Pat. No. 5,085,654, issued to Buell on Feb. 4, 1992 entitled "Disposable Garment With Breathable Leg Cuffs". (All of these patents are incorporated herein by reference.)

The diaper 20 preferably further comprises an outer cover 90 joined with at least a portion of the garment-facing surface 70 of the backsheet 26 forming a laminate 95. The outer cover 90 preferably comprises a nonwoven web. (However, embodiments are contemplated wherein the outer cover 90 comprises materials such as woven webs, foams, scrims, films, loose fibers, or any other material or combination of materials known in the art that will give the diaper a cloth-like look and/or feel and is at a minimum air permeable.) The outer cover 90 may cover all or substantially all of the garment-facing surface 70 of the backsheet 26, or may cover only discrete predetermined portions. In a preferred embodiment, the nonwoven web of the outer cover 90 covers all or substantially all of the backsheet 26 in order to provide the diaper with a cloth-like look and feel. Further, the outer cover 90 may provide the diaper with a low cost landing zone capable of engaging the hooks of a hook and loop type fastener. (Such a landing zone could be utilized as a portion of a primary fastening system or as a means for disposing of a soiled diaper.) Alternatively, the outer cover 90 may cover only specific portions of the backsheet 26, such as the outer regions 76. In one such embodiment, the outer cover 90 is comprised in the breathable side panels 30. Thus, the outer cover 90 may provide extra strength, bulk, aesthetic appeal or other characteristics desired in the breathable side panels 30. In another embodiment, the nonwoven web 90 is disposed only on the garment-facing surface 70 of the backsheet 26 in the central region 74.

The nonwoven web comprised in the outer cover 90 is preferably liquid and air pervious such that it may be provided juxtaposed the outer regions 76 of the backsheet 26 without substantially decreasing the rate of vapor passage permitted by the apertures 84 located in the breathable side panels 30. The nonwoven web may comprise natural fibers (e.g. cotton or wood fibers), or may comprise fibers of polyethylene, polypropylene, polyester, or any combination of such fibers. Further, the nonwoven may be carded, spunmelt, meltblown or air-through bonded or have any other characteristic or be manufactured in any manner known in the art. Preferably, the nonwoven is comprised of sufficient thermoplastic material to allow for thermal bonding of the material to other components of the diaper. An especially preferred nonwoven is a carded nonwoven made of 100% polypropylene fibers such as FPN 290 manufactured by FiberWeb North America of Simpsonville, S.C. It may be desirable, however, to provide a outer cover 90 that acts to change the perviousness (either vapor or liquid) in certain regions of the breathable side panels 30. Such may be the case in disposable article designs wherein the apertured zone(s) 80 underlie or are otherwise in contact with any portion of the article which may absorb liquids. In such cases it may be desirable to use a hydrophobic nonwoven web to help prevent any leakage of the liquids from the article.

It may also be desirable to provide the disposable article of the present invention with extensibility or elasticity in all or a portion of the side panels 30. (As used herein, the term "extensible" refers to materials that are capable of extending in at least one direction to a certain degree without undue rupture. The terms "elasticity" and "elastically extensible" refer to extensible materials that have the ability to return to approximately their original dimensions after the force that extended the material is removed. As used herein, any material or element described as "extensible" may also be elastically extensible unless otherwise provided.) Extensible side panels 30 provide a more comfortable and contouring fit by initially conformably fitting the diaper to the wearer and sustaining this fit throughout the time of wear well passed when the diaper has been loaded with exudates since the side panels allow the sides of the diaper to expand and contract. Extensible side panels 30 further provide more effective application of the diaper 20 since even if the diaperer pulls one side panel 30 farther than the other during the application (asymmetrically), the diaper 20 will "self-adjust" during wear. While the extensible side panels 30 may be constructed in a number of configurations, examples of diapers with extensible side panels are disclosed in U.S. Pat. No. 4,857,067, entitled "Disposable Diaper Having Shirred Ears" issued to Wood, et al. on Aug. 15, 1989; U.S. Pat. Nos. 4,381,781 issued to Sciaraffa, et al. on May 3, 1983; 4,938,753 issued to Van Gompel, et al. on Jul. 3, 1990; and in 5,151,092 issued to Buell et al. on Sep. 29, 1992; each of which are incorporated herein by reference.

The extensible side panels 30, or any other elements of the diaper 20 in which extensibility or elasticity is desirable such as the waistbands 34 may comprise materials that have been "prestrained", or "mechanically prestrained" (i.e., subjected to some degree of localized pattern mechanical

stretching to permanently elongate the material), or structure elastic-like webs (SELF), as described below. The materials may be prestrained using deep embossing techniques as are known in the art. Alternatively, the materials may be prestrained by directing the material through an incremental mechanical stretching system as described in U.S. Pat. No. 5,330,458 entitled "Absorbent Article With Elastic Feature Having A Portion Mechanically Prestrained" issued to Buell et al., on Jul. 19, 1994. The materials are then allowed to return to their substantially untensioned condition, thus forming a zero strain stretch material that is extensible, at least up to the point of initial stretching. Examples of zero strain materials are disclosed in U.S. Pat. Nos. 2,075,189 issued to Galligan on Mar. 30, 1937; 3,025,199 issued to Harwood on Mar. 13, 1962; 4,107,364 and 4,209,563 issued to Sisson on Aug. 15, 1978 and Jun. 24, 1980, respectively; 4,834,741 issued to Sabee on May 30, 1989; and 5,151,092 issued to Buell et al., on Sep. 29, 1992. All of the above referenced patents are hereby incorporated by reference.

Alternatively, the extensible side panels **30** or any portions of the side panels **30** or the materials included in the side panels or any other element of the diaper **20** in which extensibility is desirable may comprise a structural elastic-like film (SELF) web. A structural elastic-like film web is an extensible material that exhibits an elastic-like behavior in the direction of elongation without the use of added elastic materials. The SELF web includes a strainable network having at least two contiguous, distinct, and dissimilar regions. One of the regions is configured so that it will exhibit resistive forces in response to an applied axial elongation in a direction parallel to the predetermined axis before a substantial portion of the other region develops significant resistive forces to the applied elongation. At least one of the regions has a surface-pathlength which is greater than that of the other region as measured substantially parallel to the predetermined axis while the material is in an untensioned condition. The region exhibiting the longer surface-pathlength includes one or more deformations which extend beyond the plane of the other region. The SELF web exhibits at least two significantly different stages on controlled resistive force to elongation along at least one predetermined axis when subjected to an applied elongation in a direction parallel to the predetermined axis. The SELF web exhibits first resistive forces to the applied elongation until the elongation of the web is sufficient to cause a substantial portion of the region having the longer surface-pathlength to enter the plane of applied elongation, whereupon the SELF web exhibits second resistive forces to further elongation. The total resistive forces to elongation are higher than the first resistive forces to elongation provided by the first region. SELF webs suitable for the present invention and the method for making such webs are more completely described in the co-pending, commonly assigned U.S. patent application Ser. No. 08/203,456, which has been allowed, entitled "Absorbent Article With Multiple Zone Structural Elastic-Like Film Web Extensible Waist Feature" filed by Donald C. Roe, et al. on Feb. 24, 1994; and in the co-pending, commonly assigned U.S. patent application Ser. No. 08/203,087 entitled "Web Materials Exhibiting Elastic-Like Behavior" filed by Charles W. Chappell, et al. on Feb. 28, 1994, which are incorporated herein by reference.

The diaper **20** preferably further comprises elasticized leg cuffs **32** for providing improved containment of liquids and other body exudates. Each elasticized leg cuff **32** may comprise several different embodiments for reducing the leakage of body exudates in the leg regions. (The leg cuff can be and is sometimes also referred to as leg bands, side flaps, barrier cuffs, or elastic cuffs.) U.S. Pat. No. 3,860,003 describes a disposable diaper which provides a contractible leg opening having a side flap and one or more elastic members to provide an elasticized leg cuff (gasketing cuff). U.S. Pat. No. 4,909,803 entitled "Disposable Absorbent Article Having Elasticized Flaps" issued to Aziz et al. on Mar. 20, 1990, describes a disposable diaper having "stand-up" elasticized flaps (barrier cuffs) to improve the containment of the leg regions. U.S. Pat. No. 4,695,278 entitled "Absorbent Article Having Dual Cuffs" issued to Lawson on Sep. 22, 1987; and U.S. Pat. No. 4,795,454 entitled "Absorbent Article Having Leakage-Resistant Dual Cuffs" issued to Dragoo on Jan. 3, 1989, describe disposable diapers having dual cuffs including a gasketing cuff and a barrier cuff. U.S. Pat. No. 4,704,115 entitled "Disposable Waist Containment Garment" issued to Buell on Nov. 3, 1987, discloses a disposable diaper or incontinence garment having side-edge-leakage-guard gutters configured to contain free liquids within the garment. (Each of these patents are incorporated herein by reference.)

While each elasticized leg cuff **32** may be configured so as to be similar to any of the leg bands, side flaps, barrier cuffs, or elastic cuffs described above, it is preferred that each elasticized leg cuff **32** comprise at least an inner barrier cuff comprising a barrier flap and a spacing element such as described in the above-referenced U.S. Pat. No. 4,909,803. In a preferred embodiment, the elasticized leg cuff **32** additionally comprises an elastic gasketing cuff **63** with one or more elastic strands **65**, positioned outboard of the barrier cuff such as described in the above-referred U.S. Pat. No. 4,695,278. Further, as shown in FIG. **4**, the elasticized leg cuff **32** preferably has a proximal edge **33** and a distal edge **35**. The distal edge **35** of the elasticized leg cuff **32** is that part of the elasticized leg cuff **32** which is spaced away from the chassis **22** of the diaper when the diaper **20** is being worn. The proximal edge **33** is that part of the elasticized leg cuff **32** which is joined to the chassis **22** of the diaper **20**. The proximal edge **33** is generally located laterally inboard of the periphery of the diaper **20**. A portion of the elasticized leg cuff **32**, however, may extend laterally outwardly from the proximal edge **33** such that the material covers at least a portion of the outer region **76** of the backsheet **26**. (not shown). An example of an elasticized cuff **32** having a portion extending laterally outwardly over most or all of the outer region **76** of the backsheet **26** is described in the above-referenced U.S. Patent **4,795,454** issued to Dragoo, which is hereby incorporated by reference herein.

The diaper **20** preferably further comprises an elasticized waistband **34** that provides improved fit and containment. The elasticized waistband **34** is that portion or zone of the diaper **20** which is intended to elastically expand and contract to dynamically fit the wearer's waist. The elasticized waistband **34** preferably extends longitudinally outwardly from at least one of the waist edges of the absorbent core **28** and generally forms at least a portion of the end edge of the diaper **20**. Disposable diapers are generally constructed so as to have two elasticized waistbands, one positioned in the rear waist region and one positioned in the front waist region, although diapers can be constructed with a single elasticized waistband. Further, while the elasticized waistband **34** or any of its constituent elements can comprise a separate element affixed to the diaper **20**, the elasticized waistband **34** may be constructed as an extension of other elements of the diaper such as the backsheet **26** or the topsheet **24**, preferably both the backsheet **26** and the topsheet **24**. Embodiments are also contemplated wherein the elasticized waistband **34** comprises apertures, as

described above, to provide breathability in the waist regions. The elasticized waistband **34** may be constructed in a number of different configurations including those described in U.S. Pat. No. 4,515,595 entitled "Disposable Diapers with Elastically Contractible Waistbands" issued to Kievit et al. on May 7, 1985 and the above referenced U.S. Pat. No. 5,151,092 issued to Buell; each of these references being incorporated herein by reference.

The diaper **20** also comprises a fastening system **36** which forms a side closure which maintains the rear waist region **44** and the front waist region **46** in an overlapping configuration such that lateral tensions are maintained around the circumference of the diaper to maintain the diaper on the wearer. Exemplary fastening systems are disclosed in U.S. Pat. Nos. 3,848,594 issued to Buell on Nov. 19, 1974; 4,662,875 issued to Hirotsu and Robertson on May 5, 1987; 4,869,724 issued to Scripps on Sep. 26, 1989; 4,846,815 issued to Scripps on Jul. 11, 1989; 4,894,060 issued to Nestegard on Jan. 16, 1990; 4,946,527 issued to Battrell on Aug. 7, 1990; and 5,326,612 entitled "Nonwoven Female Component For Refastenable Fastening Device And Method of Making the Same" issued to David J. K. Goulait on Jul. 5, 1994. Each of these patents are incorporated herein by reference.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

What is claimed is:

1. A disposable absorbent article having a front waist region, a rear waist region, a crotch region located between said front waist region and said rear waist region, a pair of opposed side edges, a first end edge located in said front waist region and a second end edge located in said rear waist region, the absorbent article comprising:

a containment assembly comprising an absorbent core having a pair of opposing longitudinal edges, an inner surface and an outer surface; and

a breathable laminate comprising a backsheet and an air pervious outer cover, said backsheet being positioned between said containment assembly and said air pervious outer cover, said backsheet comprising a formed film having a garment-facing surface, a body-facing surface, a central region, two apertured zones and a non-apertured zone; said non-apertured zone comprising said central region and being juxtaposed said outer surface of said absorbent core; said apertured zones comprising apertures and extending continuously laterally outwardly from said central region beyond said longitudinal edges of said absorbent core and continuously longitudinally from said end edge located in said front waist region through said crotch region to said end edge located in said rear waist region,

at least a portion of said garment-facing surface of said backsheet being joined with said outer cover juxtaposed at least said apertured zones.

2. The disposable absorbent article of claim **1** wherein said outer cover comprises an air pervious nonwoven web.

3. The disposable absorbent article of claim **2** wherein said air pervious nonwoven web is also liquid pervious.

4. The disposable absorbent article of claim **1** wherein said outer cover is juxtaposed the entire garment-facing surface of said backsheet.

5. The disposable absorbent article of claim **1** wherein at least a portion of said body-facing surface of said backsheet is joined with at least a portion of said outer surface of said absorbent core.

6. The disposable absorbent article of claim **1** wherein said apertures are generally eliptical.

7. The disposable absorbent article of claim **6** wherein each said aperture has a major axis length of between about 5 mils and about 150 mils.

8. The disposable absorbent article of claim **1** wherein said apertured zone has an aperture density of between about 50 and about 10,000 apertures per square inch.

9. The disposable absorbent article of claim **6** wherein said apertured zone has a porosity of greater than or equal to about 50 cubic feet per minute per square foot.

10. The disposable absorbent article of claim **1** wherein said apertured zone comprises apertures of different sizes.

11. The disposable absorbent article of claim **1** wherein said apertured zone comprises apertures of different shapes.

12. The disposable absorbent article of claim **1** wherein said backsheet comprises a single member.

13. The disposable absorbent article of claim **1** wherein said backsheet comprises at least two members joined together.

14. A disposable absorbent article having a front waist region, a rear waist region, a crotch region located between said front waist region and said rear waist region, a periphery defined by a pair of opposed side edges, a first end edge located in said front waist region and a second end edge located in said rear waist region, the absorbent article comprising:

a containment assembly comprising a topsheet, a backsheet and an absorbent core disposed between said topsheet and said backsheet, said absorbent core having a pair of opposing longitudinal edges, an inner surface and an outer surface; a pair of leg cuffs each having a proximal edge joined to said containment assembly laterally outboard of said opposing longitudinal edges and a distal edge: said backsheet comprising a formed film and having a garment-facing surface, a body-facing surface, a central region; said backsheet comprising at least three distinct zones, a non-apertured zone comprising said central region and being juxtaposed said outer surface of said absorbent core and a pair of apertured zones comprising apertures, one of said apertured zones extending laterally outwardly from each of said proximal edges of said leg cuffs to said periphery of the absorbent article;

an air pervious outer cover joined with said garment-facing surface of said backsheet to form a breathable laminate in said apertured zones; and

a side panel extending laterally outwardly from each of said longitudinal edges of said absorbent core each said side panel comprising said laminate such that said side panels are breathable.

15. The disposable absorbent article of claim **14** wherein said outer cover comprises a nonwoven web.

16. The disposable absorbent article of claim **14** wherein said nonwoven web is liquid pervious.

17. The disposable absorbent article of claim **14** wherein said outer cover is juxtaposed the entire garment-facing surface of said backsheet.

18. The disposable absorbent article of claim **14** wherein at least a portion of said body-facing surface of said backsheet is joined with at least a portion of said outer surface of said absorbent core.

19. The disposable absorbent article of claim **14** wherein said side panels further comprise at least a portion of said topsheet.

20. The disposable absorbent article of claim 14 wherein each said side panel comprises at least two apertured zones having different porosity characteristics.

21. The disposable absorbent article of claim 14 wherein said apertures are generally eliptical.

22. The disposable absorbent article of claim 21 wherein each said aperture has a major axis length of between about 5 mils and about 150 mils.

23. The disposable absorbent article of claim 14 wherein said apertured zones have an aperture density of between about 50 and about 10,000 apertures per square inch.

24. The disposable absorbent article of claim 14 wherein said apertured zones have a porosity of greater than or equal to about 50 cubic feet per minute per square foot of material.

25. The disposable absorbent article of claim 14 wherein each said apertured zones comprises apertures of different sizes.

26. The disposable absorbent article of claim 14 wherein each said apertured zone comprises apertures of different shapes.

27. The disposable absorbent article of claim 14 wherein said backsheet comprises a single member.

28. The disposable absorbent article of claim 14 wherein said backsheet comprises at least two members joined together.

29. The disposable absorbent article of claim 14 wherein said side panels are elastically extensible.

30. The disposable absorbent article of claim 29 wherein said side panels comprise a structural elastic-like film.

31. The disposable absorbent article of claim 14 further comprising a pair of gasketing cuffs.

32. The disposable absorbent article of claim 31 wherein said apertured zones extend laterally outwardly from a location that is laterally outboard of said proximal edge of said elasticized leg cuffs and is laterally inboard of said gasketing cuffs to said periphery of the absorbent article.

33. The disposable absorbent article of claim 14 wherein said apertured zones have the following characteristics: each said aperture is generally eliptical and has a major axis length of between about 5 mils and about 150 mils; said apertured zones have an aperture density of between about 50 and about 10,000 apertures per square inch; and said apertured zones have a porosity of greater than or equal to about 50 cubic feet per minute per square foot.

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(54) HIGHLY ABSORBENT COMPOSITE COMPOSITIONS, ABSORBENT SHEETS PROVIDED WITH THE COMPOSITIONS, AND PROCESS FOR PRODUCING THE SAME

(57) Composite compositions containing, as the major components, fine hydratable microfibril fibers obtained from cellulose or derivatives thereof and a solid capable of swelling with water, wherein at least part of the surface of the solid is coated with the fine microfibril fibers, and a process for producing the same. The solid capable of swelling with water is exemplified by particulate polymer absorbents to which short fibers have been added as the third component. These composite absorbents may be located on supporting sheets made of, for example, a nonwoven fabric to give composite absorbent sheets applicable to various absorbent products including diapers for infants and adults.

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Description

Background of the Invention

Field of the Invention

[0001] The present invention relates to a new type absorbent composite wherein a water swellable solid body, particularly consisting of particles of various sin and shapes from powder to pellets is improved in functioning and handling characteristics. More particularly, the present invention relates to a highly absorbent composite composed of of containing an absorbent polymer as a water swellable solid body and having a shape entirely different from conventional absorbent materials and a capability of stably absorbing a liquid of much higher quantity than its own volume and to a highly absorbent composite mainly composed of the composite.

[0002] The highly absorbent composite of the present invention can widely be used in diapers for babies and adults, feminine hygiene products, products for handling liquid and solid wastes of animals, and medical blood absorbent products just like conventional highly absorbent products and thus is particularly useful as a super thin pulpless absorbent making the best use of the capabilities of a so-called absorbent polymer. In addition, the absorbent composite can be used for a cold insulator, water holding material, an anti-dewing material, covering material of submarine cables, material for preventing water related accidents.

[0003] In addition, the present invention relates to methods and apparatuses for making the absorbent composite and the composite mainly composed of the absorbent composite.

[0004] Moreover, the present invention relates to an absorbent sheet which provides also the leakage resistance of a conventional backsheet when the absorbent composite is used in absorbent products in combination with various sheet substrates, to an absorbent sheet which provides also the acquisition capability of a conventional topsheet when the absorbent composite is used in absorbent products in combination with various sheet substrates, and to an absorbent sheet which can be used alone providing also the capabilities of conventional backsheet and topsheet.

Prior Art

[0005] A main absorbent component used in a absorbent product, which absorbs water and liquid exudates, is composed of a combination of fluff type wood pulp and so-called super absorbent polymer (hereinafter referred to as the "SAP"). However, in recent years, in order to improve the distribution efficiency of absorbent products, to reduce the inventory and display space thereof, and to save natural resources, social needs for reducing the dimensions of otherwise relatively bulky absorbent products are becoming strong.

[0006] A means for making an absorbent product more compact and thinner, in a combination of SAP and pulp, would be to increase the content of SAP that has a higher absorbency than that of pulp by 2 to 10 times and accordingly decrease the content of pulp. Eventually, if the content of the SAP is made 100 percent, the thinnest and most compact absorbent product would be able to be obtained.

[0007] However, as the content of the SAP increases, when it absorbs water, so-called "gel blocking phenomenon" due to the characteristic of SAP occurs. Thus, the absorbent product does not work as designed. At the present time, it is said that the ratio of the contents of the SAP and pulp is at most 1 to 1. A structure in which the ratio of the contents of the the SAP to pulp is 2 or higher to 1, or so-called pulpless in which the content of the SAP is nearly 100 percent is very difficult to achieve at the present time. According to the conventional concepts generally applied in the field of absorbent products, the term "pulpless" means that the ratio of the contents of pulp to the SAP is approximately 1 or lower.

[0008] So far, various attempts for the pulpless structure have been made. A fiber type or web type SAP is made by directly spinning into acrylic acid type fiber or partially hydrolyzing acrylic acid type fiber. Another method is to make a web type absorbent polymer by impregnating a web with a monomer such as acrylic monomer and then polymerizing the monomer applying ultraviolet ray or electron beam. Still other method is to make an absorbent polymer sheet by carboxymethylating a non-woven fabric of cellulose or the like and then partially cross-linking the carboxymethyl cellulose.

[0009] However, so far, no successfully commercialized examples have been reported because of high costs of raw materials and high capital investments involved.

[0010] Liquid exudates discharged from living bodies are very different from each other depending upon their environmental and living conditions, and the frequency of discharging is not constant among them. Therefore, absorbent sheets used in many kinds of absorbent products need, responding to varied environs, to exhibit stably the capability of absorbing quickly and frequently.

[0011] As described above, a conventional two component (pulp and the SAP) absorbent is capable of meeting the need of frequently absorbing to some extent by taking advantage of the temporary retaining by pulp of liquids and the stably retaining by the SAP of liquids. However, an absorbent product in which the content of the SAP is made high or

the SAP alone is used in order to secure high absorbency has a serious drawback; upon a liquid being discharged at first the SAP starts to absorb it all at once and thus an initial absorbing is very speedy but as the discharging is repeated, the absorbing speed drastically decreases.

Summary of the Invention

[0012] A first embodiment of the present invention provides a highly absorbent composite comprising hydratable fine fibers in the form of microfibril obtained from cellulose or an derivative thereof, and water swellable solid particles, at least part of the surfaces of said water swellable solid particles being covered with said fine fibers in the form of microfibril.

[0013] Said hydratable fine fibers in the form of microfibril obtained from cellulose or an derivative thereof useful in the present invention will be hereinafter referred to as the "HFFM".

[0014] The absorbent composite can be formed in a three dimensional structure such as powder type, particle type, pellet type, sheet type, and any other type, and also in a sheet type with a supporting sheet of a non-woven fabric or the like as the base.

[0015] The present invention further provides a method of making the absorbent composite. The method comprises the steps of dispersing a water swellable solid body and the HFFM, in a dispersion medium comprising a mixture of an organic solvent and water, the organic solvent being capable of controlling the swelling of the water swellable solid body and dispersing the HFFM and thus being miscible with water, of separating the water swellable solid body and the HFFM from the resultant dispersion liquid from the dispersion medium, and of removing the liquid component and of drying them.

[0016] The absorbent composite of the present invention is basically a composite of a water swellable solid body and the HFFM covering the solid body. Examples of a water swellable solid body are various kinds of polysaccharides, flocculents, super water swellable absorbent polymer (the SAP) particles and the like. Among them, a drawback of the SAP, which is that the SAP is not easy to handle and store because of its high water absorbency, can be solved by covering it with the HFFM according to the present invention. In addition, in a structure in which the SAP particles are bonded together with the HFFM, the SAP particles are each held in position by the HFFM and an appropriate space surrounding each particle is secured. Thus, an extremely thin absorbent sheet is obtained.

[0017] A second embodiment of the present invention provides an absorbent sheet, wherein a supporting sheet and an absorbent layer provided on at least either surface of the supporting sheet are provided and wherein the absorbent layer has the HFFM, the SAP particles, and a short-cut staple fiber component having longer fiber length than the average particle diameter of the SAP particles and has an improved dimensional stability when wet swollen.

[0018] In the present invention, the short-cut staple fiber component having longer fiber length than the average diameter of the SAP particles connects the SAP particles with each other and at the same time provides a network structure which covers in network the top surface of a layer formed by the SAP particles and thus serves to prevent the SAP particles as wet swollen from going away.

[0019] The present invention further provides a method of making the absorbent sheet. The method comprises the steps of preparing a three-component dispersion slurry by adding and dispersing a short-cut staple fiber component and the SAP particles in a dispersion liquid wherein the HFFM is dispersed in a dispersion medium, of forming a layer of the slurry by spreading the three- component dispersion slurry onto a supporting sheet, of removing the dispersion medium from the slurry layer, and then of drying.

[0020] The absorbent sheet of this embodiment of the present invention consists of four components the SAP particles, the HFFM, a short-cut staple fiber component, and a substrate fabric supporting them. The SAP particles are a basic component giving a water absorbing capability. The SAP is available in various forms such as film and non-woven fabric besides the above described particles.

[0021] The HFFM prevents the SAP from settling as the dispersion stabilizer and also the SAP particles from coagulating with each other in making the absorbent sheet of the present invention and, after the absorbent sheet is made, play the role of a binder to bond the SAP particles together and the SAP with the substrate fabric. The short-cut staple fiber component takes the SAP particles into a network structure in cooperation with a supporting sheet by dividing the SAP particles covered with the HFFM and then covering the SAP particles in a network form.

[0022] A third embodiment of the present invention provides a composite absorbent sheet, wherein, in an absorbent sheet provided with a liquid pervious supporting sheet and an absorbent layer containing the SAP particles as bonded onto either surface of the liquid pervious supporting sheet, the absorbent layer forms a plurality of high absorbing regions having higher absorbing capability than otherwise as distributed onto the surface of the liquid pervious supporting sheet in a desired pattern.

[0023] In the composite absorbent sheet of the present invention, a liquid such as discharged liquid exudates, when it comes into contact with surface of the liquid pervious supporting sheet of an absorbent sheet, i.e., the surface where no absorbent layer exists, is first absorbed by the liquid pervious supporting sheet, penetrates inside the sheet by virtue

of the liquid permeability, then diffuses, and contacts and is absorbed by an absorbent layer provided in contact with the opposite side of the surface where the liquid was discharged. The speed of absorption of the absorbent sheet as a whole is determined by the speed of absorption and diffusion into the liquid pervious supporting sheet and by the speed of the swelling and the absorption which occur in succession from the surface of the absorbent layer into its inside.

[0024] Therefore, if there is any difference in the thickness or density of the absorbent layer, as a liquid is discharged, the swelling and absorption progress first from thinner regions or regions of lower density. Also, if there is any difference in particle diameter of the SAP particles contained in the absorbent layer, the swelling and absorption progress first from regions of smaller diameters of particles. A basic concept of the present invention is that differences in absorbing capability caused by distributing regions of higher absorbency onto the surface of an absorbent sheet in a desired pattern are made to be reflected in differences in swelling and absorbing speeds.

[0025] In addition, by giving irregularly shaped circumference to the absorbent layer, the length of the circumference is made much longer than a straight or simply curved line of the circumference which would be if the irregular shape were not given, and therefore, a liquid once absorbed by the supporting sheet is absorbed rapidly by the absorbent layer having the long contact line so that the absorbing speed is thus further improved.

[0026] In order to distribute and form in a desired pattern the component forming the absorbent layer onto the supporting sheet, a method of making the component a slurry and applyng and fixing the slurry onto the supporting sheet in a desired pattern meeting objectives is effective. The method needs to consist of a dispersing step where a slurry dispersion liquid containing the SAP particles is prepared, of a coating step where the dispersion liquid prepared in the dispersing step is applied onto the surface of the liquid pervious supporting sheet to form a plurality of regions of higher absorption distributed in a desired pattern and having higher absorbing capability than otherwise, and of a drying step where the absorbent layer formed in the coating step is dried.

[0027] In addition, the present invention provides an apparatus for working the methods. The apparatus comprises a plurality of nozzles for applying a dispersion slurry liquid containing the SAP particles in bands onto either surface of a liquid pervious supporting sheet running continuously and a supplying means for supplying the dispersion slurry liquid to the nozzles, and is characterized in that the supplying means has a mechanism of pulsating the flow of the dispersion liquid.

[0028] The present invention further provides an apparatus for making an absorbent sheet wherein a plurality of nozzles for applying a dispersion slurry liquid containing the SAP particles in bands onto either surface of a liquid pervious supporting sheet running continuously and a supplying means for supplying the dispersion slurry liquid to the nozzles are provided, and wherein the nozzles each have a plurality of discharging outlets.

[0029] The apparatus can be provided with a hot pressing means for pressing the liquid pervious supporting sheet as heated after a dispersion slurry liquid is applied.

[0030] A fourth embodiment of the present invention provides an absorbent tube, wherein the absorbent tube is composed of a supporting sheet consisting of a fiber web and the SAP particles or fibers supported by either surface of the supporting sheet, and wherein the supporting sheet is formed in a tube shape with the surface supporting the SAP facing inside.

[0031] The absorbent tube of the present invention has a novel three-dimensional structure, wherein a space for the SAP to swell is provided as the inherent structure of the absorbent by forming a tube of an absorbent sheet supporting the SAP.

[0032] In the absorbent tube of the present invention by virtue of the above described structure, an absolute quantity of the SAP existent in a unit area is approximately two times as much as that of an absorbent of a plane structure, and the absorbing capability of a unit area is also approximately two times as high as that of an absorbent of a plane structure. In addition, in the absorbent tube of the present invention, because the SAP is supported as attached onto the inner wall of a tube shaped supporting sheet, an adequate space for swelling is secured, and even if the SAP has swollen to its maximum absorbing capability absorbing a liquid, the absorbent as a whole still maintains its flexibility.

[0033] Various types of absorbent sheets have been spreaded so far. In order to make the function of an absorbent as used in an absorbent product exhibit to its maximum, the absorbent before it absorbs a liquid needs to be very thin like an underwear so that a sufficient space for swelling needs to be provided not to prevent the swelling of the absorbent. The present invention satisfies the need adequately, and provides an absorbent exhibiting an outstanding absorbing capability as assisted by the capability of a supporting sheet to diffuse a liquid.

[0034] The present invention further provides an absorbent product, wherein a absorbent tube consisting of a highly absorbent composite having a three-dimensional structure as described in the above is disposed in regions of desired absorptions as an absorbent core. The absorbent tube of the present invention is flat as not yet swollen and extremely thin like a crushed flat hollow tube, and when swollen absorbing water rises up as it as a whole swells with the cross-section area showing a nearby circular shape for the inside vacancy is filled with the SAP which increases in volume as swollen. In the absorbent product of the present invention, a single absorbent tube may be disposed in the absorbing region, but more preferably, a plurality of absorbent tubes are disposed in parallel. In the latter case, the structure is more stable and more flexible, and may more smoothly follow the body movement of the wearer of the absorbent prod-

uct.

[0035] A fifth embodiment of the present invention provides an absorbent sheet, wherein a liquid impervious sheet material one of whose surfaces has many dents and absorbent material received and fixed in the dents are provided and thus leakage resistance and absorbing capability are imparted at the same time. In this embodiment of the present invention, the absorbent composite forms a structure where in the many dents provided on one of the surfaces of a liquid impervious sheet material, absorbent material containing absorbent polymer particles is filled. The composite absorbent has leakage resistance and absorbing capability at the same time satisfying the following requirements:

(1) A liquid impervious sheet material having dents on its surface, and, preferably, air permeability as well as water proofing is used.
(2) Absorbent material having such absorbing capability that is as high as possible is used.
(3) Absorbent material is filled and fixed in the dents.

[0036] The commonest form of material having a structure of dents as used in the present invention is flexible thermoplastic film such as polyethylene, polypropylene, and EVA of approximately 5 to 50 micron thickness on which many holes or recesses of given shapes are formed by mechanical punching, thermal forming, vacuum forming, or the like. Liquid impervious sheet material can also be used effectively and efficiently part of which has openings formed which are filled with absorbent material, to be described later, so that water proofing and leakage resistance are imparted.

[0037] Absorbent material to fill the dents needs to be of fine sizes to fill a relatively small space, and at the same time to have a high absorbing capability per a unit volume to secure a required absorbency with the quantity of the material to fill the small space.

[0038] The liquid impervious sheet material is, for example, thermoplastic film of 5 to 50 micron thickness, or a conjugate of 5 to 50 thick thermoplastic film and non-woven fabric. The dents formed on the sheet material may have the same liquid imperviousness as otherwise, or, an alternative configuration is that, in the bottoms of all or part of the dents, opening or porous portions which, as they are, liquid may pass through may exist and are stopped up with the absorbent material. The absorbent sheet of this configuration is liquid impervious as a whole, and at the same time, with the absorbent material received ad fixed in the recesses, exhibits a high liquid absorbing capability so that it combines the two functions of a liquid impervious sheet and an absorbent.

[0039] As a method of filling and fixing the dents provided on a liquid impervious sheet material with the SAP or absorbent material containing the SAP, a method generally applied in making absorbents for use in diapers and sanitary napkins can be applied as it is. One preferable method comprises the steps of dispersing, for example, the SAP and the HFFM in air current, of filling the dispersed materials into the dents, and of fixing the filled dents by means of hot melt.

[0040] If each and every dent on a liquid impervious sheet material is provided with an opening or liquid pervious structure, by supplying the liquid impervious sheet material onto a conveyor with a vacuum provided and supplying the slurry from above the liquid impervious sheet material continuously, the liquid contained in the slurry passes the sheet material through the opening or liquid pervious structure to be separated, leaving only the solid component in the slurry in the dents. Further, by removing the liquid component and drying, the SAP particles or the SAP particles and the sheet material are bonded by the HFFM with each other, and fixed in the positions that they are situated, so that water proofing is imparted, too. By selecting an appropriate ratio between the quantity of the SAP and the quantity of the HFFM as well as the properties of the HFFM, preferable properties can be imparted as material for an absorbent: while desired leakage resistance and some air permeability are obtained at the same time.

[0041] The SAP which is used for these purposes should be particles, preferably, fine particles, so that it may be held stably in a small space, and specifically, the diameter of the particles should be 0.4 mm or less, or, more preferably, 0.3 mm to 0.1 mm. Very fine particles, such as those of 0.1 mm diameter, can be coexistent with coarser particles, such as those of 0.4 mm or coarser. In case fiber material such as wood pulp is made to coexist with the SAP, the more the content of the SAP, the better the result: the content of the SAP is preferably 50 percent or higher.

[0042] As discussed in the above, in making the composite absorbent of the present invention, the HFFM, the SAP and, as required, a short-cut staple fiber component are dispersed in a dispersion medium. A particularly effective dispersion medium is a polyvalent alcohol, which has the tendency to be highly viscous at a low temperature and logarithmically to reduce in viscosity as heated. Specifically, by utilizing the behavior in the relation between temperature and viscosity of a mixed system of a polyvalent alcohol and water, the transferring and forming are carried out while the system is stably maintained which is made at a low temperature and highly viscous at the time of dispersion and storing, and the forming and removal of the liquid component are made easier while the system is heated and hydrated at the time of removing the liquid component so that the viscosity is decreased and the liquidity is increased.

Detailed Description of the Invention

[0043] Hereunder, the elements constituting each structure of the highly absorbent composite and the absorbent

sheet provided with the absorbent composite of the present invention will be described.

[0044] In a first aspect of the present invention, the absorbent composite is composed of the SAP and the HFFM.

[0045] In a second aspect of the present invention, the absorbent composite is composed of the SAP, the HFFM, and a short-cut staple fiber component, which is larger than the SAP.

[0046] In a third aspect of the present invention, either of the absorbent composites of the first and the second aspects forms an absorbent sheet combined with a supporting sheet.

[0047] If components are extracted from these absorbent composites and these absorbent sheets to be made by combining the absorbent composites, the following four components will come out.

[0048] First of all, each component will be described:

(1) SAP particles

[0049] Absorbent polymer particles, herein called the "SAP", are generally carboxy methyl cellulose, polyacrylic acid and polyacrylates, cross-linked acrylate polymers, starch-acrylic acid grafted copolymers, hydrolysates of starch-acrylonitrile grafted copolymers, cross-linked polyoxyethylene, cross-linked carboxymethyl cellulose, partially cross-linked water swellable polymers such as polyethylene oxide and polyacrylamide, isobutylenemaleic acid copolymer, etc. Base polymer particles are obtained by drying any of these polymers. Then, after treatment is applied to increase the cross-linking density of the surface of the particles, and at the same time, a blocking inhibitor is added to control the blocking of product particles due to absorbing moisture.

[0050] Also, an amino acid cross-linked polyaspartic acid which is biodegradable or a microorganism based highly absorbent polymer which is a cultured product of Alcaligenes Latus is added, too.

[0051] SAP products are available on the market in such forms as particles, granules, films, and non-woven fabrics. The SAP product in any of such forms can be used in the present invention. A preferable SAP product for the present invention is in such forms as particles, granules, pellets, flakes, short needless and the like which can be uniformly dispersed in a dispersion medium. In this specification of the present invention, the term "particle(s)" is used to generally mean any of these forms.

(2) HFFM

[0052] In the present invention, a micro-network structure holding the SAP particles in position is fixed with the HFFM. The structure prevents the SAP particles from coagulating with each other, and stabilizes and makes uniform dispersion condition in making the composite absorbent of the present invention, and serves as a binder for binding the SAP particles with each other and the SAP with a supporting sheet after drying is carried out.

[0053] The HFFM is, in general, extremely fine fibrous material of 2.0 to 0.01 microns in average diameter, and of 0.1 microns or finer on average, and sufficiently water resistant to prevent the structure from collapsing immediately after or when the SAP absorbs water and so swells, and besides, has such properties as do not hinder the permeability of water and the swelling of the SAP. What is specially noteworthy here is that the HFFM has an extremely strong hydratable property of binding with water. By virtue of the strong hydratable property, the HFFM hydrates when dispersed in a medium containing water to show a high viscosity which serves to maintain a stable dispersion condition.

[0054] A characteristic of the hydrating property of microfibril is a high amount of retained water. For example, the desired hydrating property of microfibril after their dispersion is centrifuged at 2,000 G for 10 minutes as calculated by the following formula should be 10 ml/g or higher, and preferrably 20 ml/g or higher:

$$\text{Amount of water retained (ml/g)} = \text{Precipitated volume (ml)/Microfibrils (g)}$$

[0055] In this specification of the present invention, the term "HFFM" is used to mean generally strongly hydratable fibrous materials in the form of microfibril. In some cases, the HFFM of 2.0 microns or larger in average diameter can be used, and may be a mixture of so-called fibrils and the HFFM.

[0056] The HFFM can be obtained by microfibrillating cellulose or a cellulose derivative. For example, the HFFM is obtained by grinding and sufficiently beating wood pulp. The HFFM is called "microfibrillated cellulose (MFC)", and if further fibrillated, is called "super microfibrillated cellulose (S-MFC)".

[0057] Also, the HFFM can be obtained by grinding and sufficiently beating finely cut fiber of man-made cellulosic fiber such as Polynosic modified rayon staple fiber, Bemberg cuprammonium rayon yarn, and solvent spun Lyocell rayon fiber.

[0058] Alternatively, the HFFM can also be obtained by metabolizing microorganism. In general, acetic acid bacteria such as Acetobactor Xylinum is cultivated, while stirred, in a nutrient containing an appropriate carbon source so as to generate crude HFFM, which is in turn refined to obtain the HFFM. Such HFFM is called "bacteria cellulose(BC)".

[0059] Also, so-called fibril type material which is obtained by coagulating under a shear force a copper ammonium

solution of cellulose, an amine oxide solution of cellulose, an aqueous solution of cellulose xanthate, or an acetone solution of cellulose, all of which can be spun into fibers, is refined to obtain microfibril-type material, which material can also be used for the present invention. The details of the HFFM are described in Japanese Patent Examined Publication Nos. SHO 48-6641 and SHO 50-38720.

[0060] Such HFFM is commercially available under trademarks "CELLCREAM" (made by Asahi Chemical Industry Co..Ltd.), "CELLISH" (made by Daicel Chemical Industries, Ltd.), and so forth.

[0061] MFC, S-MFC, and BC are particularly preferable for the present invention. The technical details of the S-MFC are described in Japanese Patent Publication No. HEI 8-284090 ,and of the BC in Japanese Patent Examined Publication No. HEI 5-80484.

[0062] How to use the MFC and the S-MFC, (both being hereinafter referred to as the "MFC") is explained in detail below. The MFC which is concentrated to approximately 30 percent of solid content is available on the market. To use such concentrated MFC, an additional procedure of diluting and refining such MFC is required, which requires an additional time, and the concentrating needs an additional cost. For the present invention, the MFC whose concentrated solid content is 10 percent or lower is preferable. However, if the MFC is diluted to 2 percent or lower, the water content will become too high, and the selection of the contents of the MFC in an organic solvent/water mixture system will be too narrow. In case the MFC in a diluted system like this is used, it is recommended that a organic solvent/water system in which an organic solvent to be used in a dispersion medium is used rather than a simple water system in microfibrillating raw material pulp. Hence, a dispersion liquid of the MFC which is diluted to around 2 percent can also be used for the present invention.

[0063] How to use the BC is also described in detail below. The BC is obtained as a metabolized product of microorganism. Depending on the methods of cultivating and harvesting, the concentrations and the forms of the BC will be different. In order to obtain as uniform concentrations and forms as possible, a refining treatment is recommended. Macerating harvested and refined BC which is diluted to 2 percent or lower by means of a mixer or a defibrator will make finer and more uniform HFFM in coagulated condition, and its viscosity will be much increased and its capacity of binding the SAP will also be improved. For the present invention, therefore, the use of the BC which is refined is recommended.

(3) Short-cut staple fiber component

[0064] The preferable denier of short-cut staple fibers constituting a short-cut staple fiber component is 10 or more times as coarse as that of the MFC. The average denier is preferably approximately 0.01 denier or corner and approximately 3.0 denier or finer.

[0065] In the present invention, the length of short-cut staple fibers constituting a short-cut staple fiber component is an important element. The short-cut staple fibers which are to divide in sections the SAP particles covered by the MFC and to cover the particles in a network structure need to have longer fiber length than the average diameter of the SAP particles. In general, the average particle diameter of the SAP available on the market is approximately 0.1 mm to 0.6 mm.

[0066] The SAP which is made by dispersion polymerization has relatively small particle diameter. If such SAP is used, short-cut staple fibers which are relatively short can adequately be used. On the hand, if the SAP in pelletized or flake form is used, short-cut staple fibers which are relatively long should preferably be used.

[0067] These short-cut staple fibers play the role of covering swollen SAP. If the short-cut staple fibers swell or dissolve in the same way as the SAP, they will not be effective. The short-cut staple fibers, therefore, need to have a property that they will not swell or dissolve in water.

[0068] The short-cut staple fibers which can be effectively used for the present invention are grouped into the following two kinds:

(i) Pulp state fibers

[0069] Typical pulp fibers are wood pulp obtained by digester reclaiming needle- or broad-leaved trees, linter pulp obtained with cotton linter as raw material, or the like. Other pulp state fibers are obtained by shear coagulation, flush spinning, or spray spinning of polymer solutions to make solidified fibers: acetate (ACe) fibril, polyacrylonitrile (PAN) fibril, polyethylene (PE) based synthetic fiber pulp, polypropylene (PP) based synthetic fiber pulp or the like are available. In addition, in case fine SAP is used, pulp state fiber obtained from strained lees of beet or coffee beans can also be used as the short-cut fibers.

[0070] PP and PE based synthetic fiber pulps are easy to thermally melt, and as such preferably used to make more stable structure by thermal treatment.

(ii) Short cut synthetic fibers

[0071]

- Of cellulosic fibers such as rayon, Polynosic modified rayon, and Lyocell, short-cut staple fibers and their fibrillated materials of 10 mm or shorter in fiber length made for making paper.
- Short-cut staple fibers such as PET, PP, PVA, and PAN, and short-cut staple fibers of bicomponent fibers such as low melting point polyester/PET, PP/PE, and PE/PET.
- Short-cut fibers of very fine fibers obtained by blending of different polymers, or by spinning is land-like fibers.

[0072] Particularly, bicomponent fibers such as PE/PET, PE/PP, and low melting point polyester/PET are preferable to aim at stabilizing the SAP by heat treatment through utilizing the effects of the component in the composite fibers that is easy to thermally dissolve. Also, those of such fibers on which an antibacterial agent or a deodorant is applied are preferable.

(4) Supporting sheet

[0073] A supporting sheet functions as follows: through binding the SAP particles covered and bonded by the MFC to a supporting sheet, the strength and dimensional stability are improved, and the liquid to be absorbed through the supporting sheet is diffused and distributed, and the SAP particles are stopped up in the dents, raised fibers, entangled fibers, or vacancies which are likely to exist on the supporting sheet so that the stability is achieved.

[0074] The supporting sheets which can be used for the present invention are described in detail here: In the present invention porous sheets such as dry laid fluff pulp mat and its bonded sheet, wet formed pulp mat, carded dry laid non-woven fabric, spun lace, spun bond, melt-blown non-woven fabric, and non-woven fabric made of opened tow of acetate or polyester fibers can be used. A supporting sheet is preferably of a bulky structure to hold and stabilize the SAP particles in its spaces. As for the bulkiness of the supporting sheet, an apparent density as calculated from a thickness measured using a thickness gauge (as described later) and a weight should be 0.2 g/cm^3 or less, and preferably 0.1 g/cm^3 or less.

[0075] To obtain such bulky non-woven fabric, the following means are taken:

〈Web comprising a combination of finer denier fibers and coarser denier fibers〉

[0076] While coarser denier fibers are high in resilience and compression resistance, but a web of such coarser fibers is not high in bonding strength, finer fibers give the opposite tendency. Therefore, it is preferable to combine both types of fibers. Such combination is obtained by blending coarser denier fibers and finer denier fibers or laying a layer of coarser denier fibers on top of a layer of finer denier fibers. To achieve an object of the present invention, a two-layer structure, particularly, a non-woven fabric comprising a combination of a layer of hydrophilic fibers which are relatively high in density and of finer denier and a layer of hydrophobic fibers which are relatively low in density and of coarser denier, is preferable.

〈Non-woven fabric given bulkiness〉

[0077] In addition to combining fibers of different deniers, shrinkable fibers can be combined. By shrinking such shrinkable fibers, an uneven surface having dents or a corrugated surface having furrows is made, which is a method of making a bulky supporting sheet as is suitable for the present invention.

〈Bulky supporting sheet whose surface is treated〉

[0078] By flocking a non-woven fabric of a smooth surface or raising a relatively thick non-woven fabric mechanically, a bulky supporting sheet suitable for the present invention can be made.

[0079] The composite absorbent sheet of the present invention comprising the above-described four components is required to have the following structure in order to fully exhibit the functions as are expected of an absorbent sheet: the sheet needs to have a stable structure so that when it is dry it can be folded, slitted and stretched to extend, and formed to be corrugated, and when it is worn to absorb body exudates, it needs to have outstanding absorbing and diffusing capabilities, and after it is used, no SAP particles should exfoliate or come off.

[0080] Even if the absorbing rate is high, the sheet should not have such structure which may collapse. On the other hand, even if the SAP particles are stably fixed, if the sheet takes a long time to absorb and swell, it will not be suitable

INTERNATIONAL SEARCH REPORT

International application No.
PCT/[illegible]

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,628,737 A (DORBIN ET AL.) 13 MAY 1997, WHOLE DOCUMENT.	
A	US 5,918,179 A (ULKS ET AL.) 06 JULY 1999, WHOLE DOCUMENT .	
A	US 4,731,071 A (PIGNUEL) 15 MARCH 1988, WHOLE DOCUMENT.	
A	US 5,695,324 A (WEINICH) 09 DECEMBER 1997, WHOLE DOCUMENT.	

meate, but liquid does permeate. For this purpose, a non-woven fabric made of natural fiber, chemical fiber and synthetic fiber provides a preferable supporting sheet. Especially, in case the HFFM of cellulose fiber is used as a bonding agent, cellulose fiber which has a bonding to hydrogen is preferably combined to make a supporting sheet.

[0097] In the present invention, an absorbent layer is formed by applying the above-described slurry onto the surface of a liquid pervious supporting sheet, and it is required that as a result of such application of the slurry a plurality of highly absorbing regions having higher absorbing capability distributed in a desired pattern need to be formed.

[0098] A representative means of forming an absorbent layer as non-uniformly distributed is to form a distribution in a pattern by pulsating in some appropriate way the discharging quantity or width of a slurry dispersion liquid or to form the absorbent layer yet to be solidified after the slurry is applied.

[0099] Means for pulsating the dispersion liquid as discharged is to use a plunger pump or a tube pump which discharges the liquid with pulsation. When a pump which does not pulsate the quantity of discharge is used, a device of giving pulsation needs to be installed at the side of discharging.

Brief description of the drawings

[0100]

Fig. 1 is a graph showing the relationship between the concentration and the viscosity of the HFFM in a solvent,
Fig. 2 is an explanatory diagram showing a process of obtaining the HFFM from cellulose;
Fig. 3 is a graph showing the concentration of an organic solvent and the swelling rate of the SAP in a dispersion medium;
Fig. 4 is a graph showing the relationship between the viscosity of ethylene glycol and of propylene glycol and the temperature from minus 10° C to 100-140°C;
Fig. 5 is a graph showing the relationship between the viscosity of propylene glycol and the temperature in an aqueous solution for the cases of mixing ratios of 4/6, 6/4 and 8/2;
Fig. 6 is an explanatory diagram showing a concept of forming various absorbent composites from slurry dispersion liquids;
Fig. 7 is a sectional view of an absorbent composite embodying the present invention; Fig. 7(a) shows an absorbent composite in particles, and Fig. 7(b) shows an absorbent composite in flake;
Fig. 8 shows a sheet material consisting of an absorbent composite embodying the present invention; Fig. 8(a) is a schematic sectional view and Fig. 8(b) is a sketch of a microphotograph thereof;
Fig. 9 shows another sheet material consisting of an absorbent composite embodying the present invention; Fig. 9(a) is a schematic longitudinal section and Fig. 9(b) is a sketch of a microphotograph thereof;
Fig. 10 is a schematic longitudinal sectional view of a composite sheet material embodying the present invention;
Fig. 11 is a longitudinal sectional view of a composite sheet material embodying the present invention;
Fig. 12 is a longitudinal sectional view of a composite sheet material embodying the present invention;
Fig. 13 is a longitudinal sectional view of a composite sheet material embodying the present invention;
Fig. 14 is a partial perspective view of a composite sheet material embodying the present invention;
Fig. 15 is a longitudinal sectional view of a composite sheet material embodying the present invention;
Fig. 16 is an explanatory drawing typically showing an example of an absorbent sheet having a distribution of patterns;
Fig. 17 is an explanatory drawing typically showing another example of an absorbent sheet having a distribution of patterns;
Fig. 18 is an explanatory drawing typically showing still other example of an absorbent sheet having a distribution of patterns;
Figs. 19(A), (B) and (C) are longitudinal sectional views of different forms of an absorbent tube embodying the present invention;
Fig. 20(A) is a sectional view of an absorbent sheet which can be used for the present invention, and Fig. 20(B) is a cross sectional view of an absorbent tube consisting of the absorbent sheet of Fig. 20(A);
Fig. 21(A) is a sectional view of an absorbent sheet which can be used for the present invention, and Fig. 21(B) is a cross sectional view of an absorbent tube consisting of the absorbent sheet of Fig. 21(B);
Fig. 22 is a cross sectional view of another example of an absorbent tube of the present invention;
Fig. 23 is a plan view of an example of an absorbent product of the present invention;
Fig. 24 is a fragmentary sectional view taken along section line A-A of Fig. 23;
Fig. 25 is a sectional view of another absorbent product of the present invention as shown in the same way as in Fig. 23;
Fig. 26 is a sectional view of other absorbent product of the present invention as shown in the same way as in Fig. 23;

Fig. 27 is a sectional view of still other absorbent product of the present invention as shown in the same way as in Fig. 23;

Fig. 28 is a sectional view of an absorbent tube, as swollen, used in the absorbent product of the present invention as shown in Fig. 24;

Fig. 29 is a sectional view of still other absorbent of the present invention as shown in the same way as in Fig. 23;

Fig. 30 is a sectional view of still other absorbent of the present invention as shown in the same way as in Fig. 23;

Fig. 31 is a cross sectional view of other example of the absorbent tube of the present invention;

Fig. 32 is a cross sectional view of other example of the absorbent tube of the present invention;

Fig. 33 is a cross sectional view of other example of the absorbent tube of the present invention;

Fig. 34 is a cross sectional view of other example of the absorbent tube of the present invention;

Fig. 35 is a cross sectional view of other example of the absorbent tube of the present invention;

Fig. 36 is a sectional view of a supporting sheet which can be used to constitute the absorbent tube of the present invention;

Fig. 37 is a sectional view show the condition where the SAP particles are carried and held by the supporting sheet of Fig. 37;

Fig. 38 is a fragmentary sectional view of an absorbent product constituted by using an absorbent tube having the structure of Fig. 37;

Fig. 39 is a partial perspective view of a porous liquid impervious sheet constituting the absorbent of the present invention;

Fig. 40 is a plan view showing a part of the surface of the absorbent sheet of the present

Fig. 41 is a longitudinal sectional view of the absorbent sheet of Fig. 40;

Fig. 42 is a schematic diagram showing a process of making the absorbent sheet of the present invention;

Fig. 43 is a plan view of a liquid impervious sheet material used for the absorbent sheet of the present invention;

Fig. 44 is a plan view showing the condition where in the recesses of the liquid impervious sheet of Fig. 43 absorbent material is filled;

Fig. 45 is a fragmentary plan view showing other absorbent sheet of the present invention;

Fig. 46 is a fragmentary longitudinal sectional view of Fig. 45;

Fig. 47 is a fragmentary plan view showing still other absorbent sheet of the present invention;

Fig. 48 is a block diagram showing an example of a process of adding a short-cut staple fiber component to the HFFM in the present invention;

Fig. 49 is a block diagram showing an example of a process of adding a short-cut staple fiber component to the HFFM in the present invention;

Fig. 50 is a block diagram showing an example of a process of adding a short-cut staple fiber component to the HFFM in the present invention;

Fig. 51 is a block diagram showing an example of a process of adding a short-cut staple fiber component to the HFFM in the present invention;

Fig. 52 is a fragmentary longitudinal sectional view showing an absorbent sheet of the present invention while it is in dry condition;

Fig. 53 is a fragmentary longitudinal sectional view showing the absorbent sheet shown in Fig. 52 while it is in wet condition;

Fig. 54 is a fragmentary longitudinal sectional view showing other absorbent sheet of the present invention while it is in dry condition;

Fig. 55 is a plan view showing an example of an absorbent sheet of the present invention;

Fig. 56 is a fragmentary enlarged sectional view of the absorbent sheet of Fig. 55;

Fig. 57 is a flow chart showing an example of a process of making a supporting sheet to be used in the present invention;

Fig. 58 is an explanatory drawing showing the sectional view of the supporting sheet made by the process of Fig. 57;

Fig. 59 is a fragmentary hatched plan view showing an example of a supporting sheet suitable Fig. 60 is a fragmentary enlarged sectional view of Fig. 59;

Fig. 61 is a schematic longitudinal sectional view of an apparatus for making a composite sheet material according to the present invention;

Fig. 62 is a schematic longitudinal sectional view showing a modified example of the apparatus of Fig. 61;

Fig. 63 is a schematic longitudinal sectional view showing another coating apparatus to be used in the apparatus shown in Fig. 61;

Fig. 64 is a plan view of a grooved roll used in the apparatus of Fig. 63;

Fig. 65 is a cross sectional view of a supporting sheet which is coated with a dispersion liquid by the apparatus shown in Fig. 63 and Fig. 64;

Fig. 66 is a perspective view schematically showing an example of an apparatus for making an absorbent sheet of the present invention;

Fig. 67 shows an example of a nozzle for discharging a slurry dispersion liquid to be applied in the apparatus of Fig. 66: (A) is a side view thereof and (B) is a bottom view thereof;

Fig. 68 shows another example of a nozzle for discharging a slurry dispersion liquid to be applied in the apparatus of Fig. 66: (A) is a side view thereof and (B) is a bottom view thereof;

Fig. 69 is a perspective view showing an example of a nozzle for discharging a slurry dispersion liquid to be used for making an absorbent sheet of the present invention;

Fig. 70 is a perspective view showing an example of a nozzle for discharging a slurry dispersion liquid to be used for making an absorbent sheet of the present invention;

Fig. 71 is a perspective view showing an example of a nozzle for discharging a slurry dispersion liquid to be used for making an absorbent sheet of the present invention;

Fig. 72 is an explanatory drawing showing an example of the condition where a nozzle contacts a liquid pervious supporting sheet;

Fig. 73 is an explanatory drawing showing another example of the condition where a nozzle contacts a liquid pervious supporting sheet;

Fig. 74 is a schematic flow diagram showing an apparatus for making an absorbent sheet of the present invention;

Fig. 75 is a schematic flow diagram showing another apparatus for making an absorbent sheet of the present invention;

Fig. 76 is a schematic flow diagram showing other apparatus for making an absorbent sheet of the present invention;

Fig. 77 is an explanatory drawing showing a method of measuring a stiffness and flexibility (mm);

Fig. 78 is a fragmentary sectional view taken along section line A - A of Fig. 77;

Fig. 79 is a chart drawing showing a criterion of the bonding stability of the SAP;

Fig. 80 is a plan view showing a composite absorbent sheet prepared for incorporating into a sample piece in an example of the present invention;

Fig. 81 shows other example of a composite absorbent of the present invention: (a) is a plan view thereof and (b) is a sectional view thereof;

Fig. 82 is an explanatory drawing showing a process of making still other form of a composite absorbent of the present invention;

Fig. 83 shows an incontinent pad for a woman in which a composite absorbent of the present invention is applied: (a) is a plan view thereof,(b) is a sectional view of the composite absorbent, (c) is a perspective view showing the condition where the composite absorbent of (a) is folded, (d) is a side view of a finished incontinent pad for a woman;

Fig. 84 is a perspective view showing material of an absorbent tube used in an example of the present invention;

Fig. 85 is a cross sectional view of an absorbent tube constituted by the material of Fig. 84;

Fig. 86 is a cross sectional view of an absorbent tube used in an example of the present invention;

Fig. 87 shows an example of setting a viscosity and a temperature in each area of a process with propylene glycol as an example: (A) is a process flow thereof, (B) is a chart showing a fluctuation of temperature in each area of the process, and (C) is a chart showing a fluctuation of viscosity in each area of the process;

Figs. 88 (A) through (E) each are an explanatory drawing showing an embodiment of how the preparation of a dispersion slurry is carried out in each step leading to a coating header;

Fig. 89 is an explanatory drawing showing, with steam as a source of heating and hydrating, the order of a process consisting of removal of the liquid component by decompression in a liquid phase of a formed SAP sheet containing propylene glycol and removing the liquid component in a gaseous phase by hot air drying and fluctuations of propylene glycol/water composition and of residual quantity of propylene glycol;

Fig. 90 is an explanatory drawing showing a process of applying a slurry onto a supporting sheet in many bands extending in parallel at intervals; and

Fig. 91 is an explanatory drawing showing a process of applying a slurry onto a supporting sheet in many bands extending in parallel in contact with each other.

Detailed Description of the Preferred Embodiments

[0101] The present invention will be described in detail with reference to the accompanying drawings.

[0102] Fig. 1 is an example showing the concentration and viscosity of super microfibrillated cellulose in the form of microfibril (hereinafter sometimes referred to as the "S-MFC") in a dispersion liquid. It will be understood from Fig. 1 that even at low concentration a high viscosity is still maintained. The dispersion liquid of the HFFM exhibits a structural viscosity, and a fluidized orientation is exhibited and the viscosity is reduced when a shear force is applied. However, as

the shear force is reduced, the viscosity is restored. Thus, if the SAP particles are added and dispersed in the dispersion medium of the HFFM, in a low sheared dispersion state, the SAP particles are stably taken in a network structure of the HFFM, and consequently, the SAP of a high concentration can stably be dispersed. The dispersion is transferred with ease by means of a pump or the like, because then the viscosity is deceased.

[0103] Therefore, when the SAP is dispersed in a dispersion medium of the HFFM, the SAP of a high concentration can be stably dispersed. In the process where the dispersion medium is removed, the HFFM are in a plaster state to form a network structure as they are firmly self-bonded and contain and mechanically enclose the SAP particles, and as the HFFM is bonded with each other in the effect of hydrogen bons, hold securely the SAP particles.

[0104] Fine fibers in the form of microfibril (the "HFFM") can be obtained by microfibrillating cellulose or its derivative. For example, by grinding and sufficiently beating wood pulp, the HFFM is obtained in a process as shown in Fig. 2. The HFFM is sometimes referred to as the "MFC"
(microfibrillated cellulose) and if further fibrillated, as the "S-MFC" (super microfibrillated cellulose).

[0105] Next, a method of making a highly absorbent composite composed of the above-described HFFM and the SAP is described below:

[0106] According to the present invention, in making the above-described highly absorbent composite, the dispersion behavior of the SAP in a dispersion medium of the HFFM and the behavior of the HFFM after removing the liquid component are ingeniously utilized. In other words, the highly absorbent composite of the present invention can be obtained by dispersing the SAP particles and the HFFM in a dispersion medium that is a mixture of an organic solvent miscible with water and water where the HFFM is stably hydrated and dispersed, by separating the SAP particles and the HFFM from the resultant dispersion liquid, and by removing the liquid component, followed by drying . As a result of this procedure, a typical pulpless highly absorbent composite where the content of the SAP is 90 percent or higher can be obtained.

[0107] To prepare a dispersion liquid of the HFFM, a dispersion liquid where the HFFM isdispersed in water is first prepared as a stock liquid. As the concentration of the stock liquid becomes higher, an apparatus preparing the HFFM dispersion becomes more compact. On the other hand, however, the viscosity of the stock liquid increases at higher concentrations, which makes the handling of the stock liquid more difficult. Therefore, a water dispersion liquid with a concentration of 10 percent or lower, preferably 5 to 1 percent, is used. The stock liquid is added to a dispersion medium consisting of an organic solvent and water to obtain a dispersion liquid of the HFFM having a prescribed concentration of the HFFM and a viscosity accompanied by the concentration. As a means of adding and mixing the SAP to the dispersion liquid, a means of dispersing the SAP particles into the above-described dispersion liquid is generally applied.

[0108] By dispersing the HFFM and the SAP in this dispersion liquid of an organic solvent and water, a network structure of the HFFM is formed and the SAP particles are incorporated in the network structure so that a stable dispersion state is secured. When the dispersion medium is removed later, the physical entwined structure of the HFFM and the stable hydrogen bonding of the HFFM with each other are formed, and as a result, it is assumed that a three dimensional structure is formed.

[0109] The mixture ratio of an organic solvent and water is established in a range enabling the formation of a network structure of the HFFM and suppressing as much as possible the absorption of water by the SAP.

[0110] Of the above-described organic solvents, representative solvents are described here. In the graph of Fig. 3 is shown the relationship between the concentration of an organic solvent and the water absorbing ratio of the SAP in the case that as such organic solvent methyl alcohol, ethyl alcohol, and acetone are used. It is shown in Fig. 3 that in case ethyl alcohol or acetone is used, when the concentration of the solvent is 50 percent or lower, the water absorbing ratio of the SAP sharply increases, and that, in case methyl alcohol is used, when the concentration is 60 percent or lower, the water absorbing ratio of the SAP sharply increases. It is, therefore, preferable to have a higher concentration of an organic solvent.

[0111] Of the above-described solvents, solvents of polyvalent alcohols are more viscous, and among them ethylene glycol and propylene glycol are relatively easy to handle and easily available on the market. Fig. 4 shows the relationship between the viscosity and the temperature from minus 10°C to 12°C for both of them. With safety to the environment and to the persons who wear sanitary material taken into consideration, the most preferable organic solvent is propylene glycol (hereinafter abbreviated as the "PG").

[0112] The above-described solvents are used mainly in mixture with water in the present invention. An appropriate mixture ratio between water and a solvent needs to be selected in order to prevent coagulation and swelling of the SAP particles and to disperse stably the SAP particles with the MFC and the short-cut staple fiber component. The mixture ratio of solventwater is approximately 9/1 to 5/5. If water is more than 5/5, the swelling of the SAP is rapidly increased, and if a solvent is more than 9/1, the MFC starts to settle. The transition region and nature are somewhat different depending on the kinds of the solvents used. If the PG is taken as an example, a particularly preferable mixture ratio is 6/4 to 8/2. Fig. 5 shows the relationship between the viscosity and the temperature of the PG in an aqueous solution for the mixture ratios of 4/6, 6/4 and 8/2. It is shown that, as the content of water increases, the viscosity relatively decreases, and that a difference in viscosity caused by difference in temperature is large even when the solvent is in an

aqueous solution.

[0113] On the other hand, in order to hydrate and disperse the HFFM stably, it is more advantageous to have higher content of water in a dispersion medium. Therefore, an appropriate range of the ratio of an organic solvent/water is 90/10 to 40/60. Note that the ratio varies to some extent depending upon the organic solvents used and the properties of the SAP used.

[0114] The dispersion concentration each of the SAP and the HFFM in coexistence in this dispersion medium and the ratio in concentration between the SAP and the HFFM are described in more detail below. The concentration of the SAP is selected from a range of 60 percent or lower, preferably 50 percent to 5 percent from the standpoint of ease to handle, although it may be somewhat different depending upon the methods of slurry transportation. A preferable concentration of the HFFM is selected to obtain the bonding strength and the dispersion stability of the SAP. To maintain a good dispersion stability, the concentration of the HFFM needs to be 0.2 percent or higher, preferably 0.3 percent to 1.0 percent.

[0115] At this concentration of the HFFM, a dispersion medium containing the HFFM exhibits a good dispersion stability. Even after the medium is allowed to stand for a long period of time, no settling occurs.

[0116] Experimental results show that, as the concentration of the HFFM increases, the dispersion stability improves. When the concentration of the HFFM was 0.3 percent, no settling occurred for one hour. At the concentration of 0.5 percent, no settling occurred for 65 hours. It proves that, with this good dispersion stability, not only the coating procedure becomes easier, but also, the HFFM enclose the SAP particles completely so that a stable dispersion is realized.

[0117] As the ratio of the HFFM to the SAP (MFC/SAP x 100(%)) increases, the strength of the absorbent composite becomes higher, but at the same time, the absorbent composite hardens to a paper-like hand. Therefore, the ratio of the HFFM to the SAP is preferably 20 % or lower. On the other hand, at the ratio of 0.3% or lower, a sufficient bonding strength cannot be obtained. The bonding strength is evaluated by applying a cellophane adhesive tape method for measuring a surface strength. The results of applying the method to the evaluation of the bonding strength show that more preferable range of the ratio is 5 % to 0.5 %.

[0118] Next, a method of forming a composite from a dispersion liquid which is made by dispersing the HFFM and the SAP in a dispersion medium is described with reference to the accompanying drawings below. As a method of forming an absorbent composite from the above-described dispersion liquid slurry, for example, as shown in a conceptual drawing of Fig. 6, (1) by drying a block-like substance obtained by separating the solvent from the slurry and crushing the substance into particles, composite particles with the surface of the SAP covered by the HFFM, cubic-shaped as shown in Fig. 7(a) or flake-shaped as shown in Fig. 7(b), are obtained, (2) if the slurry is poured into a mold made of, for example, a net and solid and liquid components are separated and dried, a pellet-, rod-, cylinder-, or corrugated-plate-shaped three dimensional formed composite is obtained depending upon the mold used, and (3) if thin film is formed continuously and dried, a composite sheet is obtained.

[0119] An absorbent composite obtained in each of the above-described manners has flexibility depending upon the water content. Therefore, a composite sheet is formed in a mat shape together with fibers, for example, by an air-laid method and the mat is moistened, pressed, and dried so that it can be reformed into a sheet shaped composite.

[0120] Next, a method of directly forming a sheet from a dispersion liquid, which can be widely used, is described in detail. As described in the above, a network structure of the HFFM, while maintaining a condition where the SAP is stably and firmly held inside, enables the formation of a very thin layer. In other words, a dispersion liquid where the HFFM and the SAP are dispersed in a dispersion medium is applied onto a suitable flat surface, and a sheet-shaped highly absorbent composite can be formed which is composed of only the HFFM and the SAP.

[0121] A highly absorbent composite of a shape described in the above is shown in Fig. 8(a). In Fig. 8(a), reference numerals 11 and 12 represent the HFFM and the SAP particles, respectively. In fact, as shown in Fig. 8(b) which is a sketch of a microphotograph magnified by 70 times, each SAP particle is completely covered by the HFFM and at the same time, the SAP particles are taken in a network structure of the HFFM as the adjoining particles are entwined with each other by the HFFM.

[0122] Alternatively, when a dispersion liquid is applied onto a suitable supporting sheet, a highly absorbent composite sheet material composed of the supporting sheet and an absorbent composite layer is obtained after the dispersion liquid is dried. When a porous non-woven fabric is used as the supporting sheet, part of the dispersion liquid enters spaces made by the fibers of the non-woven fabric depending upon the density of the non-woven fabric, and a composite sheet where non-woven fabric 13 and the absorbent composite layer 10 are entwined as they are in contact with each other is formed as shown in Fig. 9(a) and Fig. 9(b) which is a sketch of a microphotograph, after the liquid is dried. A preferable density of the non-woven fabric is 0.2 g/cm^3 or lower in terms of the apparent specific density, and, more preferably, 0.01 to 0.1 g/cm^3.

[0123] Preferable fibers constituting the non-woven fabric are, from a viewpoint of the permeability of a liquid, a hydrophilic material such as cotton, rayon and wood pulp or synthetic fibers treated to be hydrophilic such as polyethylene, polypropylene and polyester. In particular, the HFFM which is of the S-MFC or the BC has a very strong hydrogen bonding strength in addition to being easily entangled physically. Therefore, when a cellulosic supporting sheet is used, such HFFM is more strongly and stably bonded with each other and with the supporting sheet in a dry state, and exhib-

its an outstanding permeability in a wet state.

[0124] In addition, in a structure as shown in Fig. 9, other sheet material 14 can be bonded in contact with the highly absorbent composite layer 10 as against the non-woven fabric 13, as shown in Fig. 10. If, as this other material 14, a liquid impervious sheet material is used, the composite sheet of Fig. 10 alone may have the function of an absorbent product composed of a topsheet, an absorbent, and a backsheet.

[0125] Furthermore, in the structure of Fig. 9, a highly absorbent composite layer can be provided not only on the whole front surface of a supporting sheet, but also partially in a desired pattern. For example, as shown in Fig. 11, a plurality of the absorbent composite layers 10 are provided in bands of a desired width at prescribed intervals only on either surface of the supporting sheet 13, with the composite supporting sheet folded in between the adjoining absorbent composite layers in a zigzag pattern. Since a composite sheet of this structure has a larger volume of the absorbent composite layer 10 per unit area than a flat composite sheet, and accordingly a higher absorbing capability than the latter. Alternatively, as shown in Fig. 12, when the top portions of the zigzag pattern are largely brought down in one direction, the volume of the absorbent composite layer 10 per unit area can be further increased. In addition, as shown in Fig. 13, the top portions of the zigzag pattern can be brought down outwardly in mutually opposing directions to either side with a flat area provided in the center.

[0126] Such a zigzag structure provides a free and sufficient space that enables the SAP as used in an absorbent product to easily swell by absorbing a liquid.

[0127] Fig. 14 shows an example of a highly absorbent composite sheet material as composed according to the present invention. This highly absorbent composite sheet material has a structure where a highly absorbent composite layer 10 is disposed in bands extending in parallel to each other at prescribed intervals on either surface of the supporting sheet 13 made of a elastic substance, over the highly absorbent composite layer a corrugated (zigzag) liquid pervious non-woven fabric 14 is disposed, and in the bottom portions of the zigzag of the non-woven fabric 14 the non-woven fabric 14 and the supporting sheet 13 are bonded in the bonding areas 15. Thus, each highly absorbent composite layer 10 is contained in the channel 16 which is formed between the supporting sheet 13 and the non-woven fabric 14. A highly absorbent composite sheet material of a structure described in the above can be preferably used, for example, in absorbent products such as feminine hygiene products and diapers, as highly elastic and absorbent sheet material: the highly absorbent composite sheet material has a high elasticity in the direction perpendicular to the longitudinal direction of the highly absorbent composite layer 10. In this case, the non-woven fabric 14 is used in contact with the body of a wearer, and body exudates of the wearer are first absorbed by and distributed in the non-woven fabric 14 and then absorbed by the highly absorbent composite layer 10. As the absorbed amount of body exudates increases, the volume of the highly absorbent composite layer 10 increases. However, since each band of the highly absorbent composite layer 10 is contained in the channel 16 formed between the supporting sheet 13 and the non-woven fabric 14, the layer is allowed to swell freely.

[0128] Fig. 15 shows a highly absorbent composite sheet material embodying the present invention. A liquid impervious sheet designated by reference numeral 21 in Fig. 15 is liquid impervious and reasonably elastic. A highly absorbent composite sheet material 22 is laid on top of the liquid impervious sheet 21. Both of them are bonded with each other at many bonding areas 23 extending in lines or bands parallel with each other disposed at prescribed intervals. The bonding areas 23 are formed by thermally fusing, by a conventional method such as heat sealing and high frequency bonding, the liquid impervious sheet 21 and the highly absorbent composite sheet material 22 with a predetermined width. In between the adjoining bonding areas 23 and 23, the length of the highly absorbent composite sheet material 22 is longer than the length of the liquid impervious sheet 21, and, therefore, in between the bonding areas 23 and 23, a channel 24 is formed between the highly absorbent composite sheet material 22 and the liquid impervious sheet 21 by the sagging of the former. The highly absorbent composite sheet material 22 has a structure, as shown in Fig. 15, where, on either surface of a supporting sheet 13 of spun-bond or dry-laid non-woven fabric made of polyolefine such as PP and PE, an absorbent composite layer 10 is supported which layer 10 is disposed on the side facing the liquid impervious sheet 21. A sheet product of this structure is outstanding in retaining stably its own sheet shape even when the sheet product absorbs a large amount of liquid.

[0129] Figs.16 to 18 show typically examples of an absorbent sheet having a distribution of patterns as obtained by the above-described means. Fig. 16 shows a pattern made by utilizing pulsation, Fig. 17 shows a pattern made by utilizing a branched nozzle, and Fig. 18 shows a pattern made in combination of the two. Examples of a distribution of higher absorbing regions are classified into the following three types: (1) on top of a thin absorbent layer distributed on the whole area a partially thick layer exists; (2) parts of a supporting sheet exposed without any absorbent layer, and parts thereof with such absorbent layer exist separately; and (3) in the higher absorbing regions thin and thick layers coexist. The distribution pattern of high absorbing regions is, for example, a pattern of islands in the sea as shown in Fig. 16, a continuous band-type pattern with a thin margin as shown in Fig. 17, and a combination of island and band patterns as shown in Fig. 18. An absorbent sheet which is coated with a slurry in a distribution of patterns is bonded with a supporting sheet stably by press, and the structure is fixed by removing the liquid component and drying. In doing so, a absorbent sheet yet to be dried which has a distribution of patterns, is high in difference in thickness, and contains

a lot of solvent is likely to adhere on a press roll and to partially peel off. To prevent this, a means of pressing an absorbent sheet covered with tissue or non-woven fabric is available, but an effective means is as follows: an absorbent sheet is first heat pressed to fit well a supporting sheet and the absorbent layer on the roll is subjected to removal of the liquid component to fix the structure so that the surface is stabilized. Then, if peeling is done only after the surface is thus stabilized, no absorbent sheet is wound on the roll without any covering.

[0130] Figs. 19(A), (B), (C) and D) show typically the simplest shape of a absorbent tube of the present invention. In Figs. 19, reference numeral 401 represents a supporting sheet in tube, and 402 represents the SAP carried by the supporting sheet 401 only on the inner wall. In the absorbent tube as shown in Fig. 19(A) the supporting sheet 401 is formed having a cross-section of a closed ring, and made into tube with the adjoining of both ends bonded with an adhesive agent 403 such as hot melt type adhesive agent, and carries the SAP 402 nearly uniformly on the whole surface of the inner wall. In Fig. 19(B), a reinforcing sheet 404 is disposed at the adjoining point of both ends of the supporting sheet 401, and both ends of the supporting sheet 401 together with the reinforcing sheet 404 are bonded with the adhesive agent 403. In the absorbent tube of Fig. 19(C), a flat supporting sheet 401 carrying the SAP 402 on one surface is formed into tube only with one end of the supporting sheet 401 with the surface carrying the SAP 402 inside, and the side ends of both of them facing each other in opposition are adjoined as laid on top of each other with a appropriate width of margin provided and the portion where they are adjoined is bonded with the adhesive agent 403. Thus, on one end of the flat absorbent is a tube formed. In the absorbent tube of Fig. 19 (D), on the side end disposed outside no SAP 402 exists, and, therefore, the adhesive agent 403 is directly applied on the surface of the supporting sheet 401.

[0131] As a supporting sheet which can be used in the present invention, substantially all kinds of sheet material composed of fiber web, if they are liquid pervious and do not have openings large enough for the SAP particles to pass through, can be used. Examples thereof are melt blown non-woven fabric, foamed net, extruded fibrillated net, spunbond non-woven fabric, carded web non-woven fabric, spun-laced non-woven fabric, and any combinations of the foregoing materials.

[0132] The basic roles of this supporting sheet are to carry the SAP stably and, at the same time, to prevent the SAP swollen by absorbing a liquid from leaking and going out of an absorbent tube. If required, the supporting sheet can be given other roles by selecting the kinds and shapes of the constituting materials of the supporting sheet. For example, by selecting a cellulosic fiber or a blending with a cellulosic fiber as the fiber constituting the supporting sheet, the diffusion of liquid into carried SAP can be increased. Also, another example of giving a different role is that, by using non-woven fabric which is of high elongation, can be elongated with a small force, for the supporting sheet, the sheet itself can be elongated by the absorption and swelling of the SAP. By utilizing these effects, the liquid absorbing capability of the SAP can be made to exhibit to the maximum extent, and the diameter of the absorbent tube while no liquid is absorbed can be made small which in turn makes small absorbent products using such small absorbent tube. In this specification, the term "high elongation" of a substance means the property that the substance can be elongated or extended easily by a small force applied at least in one direction.

[0133] A composite sheet obtained by this method has a structure, for example, as typically shown in Fig. 20(A). In Fig. 20(A), reference numeral 411 represents a supporting sheet, 412 represents the SAP, and 413 represents the HFFM which bonds the particles of the SAP 412 are bonded with each other and on the supporting sheet 411. Because this composite sheet can be formed as an extremely thin sheet as thin as 1 mm, it can be formed in tube as shown in Fig. 20(B), and is suitable as an absorbent tube of the present invention.

[0134] Fig. 21(A) shows a composite sheet of a structure where, unlike an absorbent tube shown in Fig. 21(B) in which particles of the SAP 412 are distributed in nearly uniform density, blocks in which a plurality of the SAP 412 particles are gathered are formed which blocks are disposed in a suitable distribution. An absorbent tube as shown in Fig. 21(B) can be formed by Folding the composite sheet of Fig. 21(A) in the shape of a tube with the surface thereof carrying the SAP 412 particles facing inside. In the structures of Fig. 19 tubes in an O-letter shape are formed by directly bonding the side ends of the supporting sheet with each other, but in the structures of Figs. 20(B), 21(B) and 22, tubes in a C-letter shape are formed where the side ends of a supporting sheet as it is made in such tube area bit away from each other. The absorbent of a tube in such C-letter may dispose a slit between the side ends of a supporting sheet facing either upward or downward. Also, another sheet material 414 may be bonded by means of adhesive 403 to the slit as shown in Fig. 22.

[0135] It should be noted that in the above description and in the sketches that are shown in the description to follow a absorbent tube is shown in a circle or ellipse or a shape that is somewhat swollen in order to help better understand it, but in fact, the absorbent tube before it absorbs liquid to swell takes a shape that is flat or collapsed.

[0136] One or a group of absorbent tubes having a structure described in the above can be incorporated into a conventional absorbent product as an absorbent core, but in practice, are advantageously used as linked to a sheet comprising an absorbent product. For example, one absorbent tube or a plurality of absorbent tubes disposed in parallel to each other comprises or comprise an absorbent core as linked in an absorbing region of an absorbent product to a liquid pervious inner sheet disposed on the side of the absorbent product in contact with the skin of a wearer or a leakage resistant outer sheet.

[0137] Fig. 23 shows a disposable diaper as an absorbent product of the present invention having a structure described in the above. In Fig. 23, reference numeral 500 represents the body of an absorbent product. This body 500 is, as shown in Fig. 24, composed of a liquid pervious inner sheet 520 and of a liquid impervious outer sheet 530, and in its absorbing region three absorbent tubes 501, 502 and 503 disposed in parallel to each other are contained. The absorbent tubes 501, 502 and 503 are, in this embodiment of the present invention, linked to a liquid impervious outer sheet 530 by means of an adhesive 504 such as hot melt adhesive.

[0138] Fig. 25 shows a sectional view of the structure of another absorbent product of the present invention like Fig. 22. In this example, the inner sheet 520 is linked to the outer sheet 530 on both sides of the absorbent tube by adhesive 504.

[0139] In the example of Fig. 26, the absorbent tube 502 disposed in the center is wider than the absorbent tubes 501 and 503 disposed on the respective sides of the absorbent tube 502 so that both side ends of the absorbent tube 502 are laid on the side ends of the absorbent tubes 501 and 503.

[0140] In the example of Fig. 27, the relation in widths among the absorbent tubes 501, 502 and 503 is the same as in the example of Fig. 26, but the absorbent tubes 501 and 503 on the sides are disposed at positions higher than the absorbent tube 502 disposed in the center and the inside ends of the absorbent tubes 501 and 503 are laid on the side ends of the absorbent tube 502.

[0141] The absorbent products of the present invention provided with an absorbent core of a configuration shown each in Fig. 24 to 27 exhibit a high absorbing property with the absorbing capability of the above-described absorbent tubes. Particularly, in a configuration as shown in Figs. 26 and 27 where each absorbent tube is partially laid on an adjoining absorbent tube, because the amount of the SAP per unit area can be made larger, further higher absorbing property can be expected. For example, a condition where the absorbent tubes 501, 502 and 503 have absorbed to swell in a configuration of Fig. 26 is shown in Fig. 28. Also, in examples of Figs. 24 to 27, each absorbent tube may be linked to the inner sheet 520, too, so that the absorbent tube may be secured in position.

[0142] In the absorbent products of the present invention, an absorbent core to be disposed in an absorbing region may be comprised only by a plurality of absorbent materials, as described in the above, but one of the absorbent tubes may be replaced by another absorbent 506, as shown in Fig. 29.

[0143] Alternatively, as shown in Fig. 30, a configuration can be made where absorbent tubes of long length and narrow width 507 are disposed in parallel to each other and tapes 508 made of a soft hand sheet such as non-woven fabric extending along the outer sides of each absorbent tube are disposed. This tape 508 allows a liquid coming to the absorbing region to reach the absorbent tube 507 and at the same time improves the touch existing between the absorbent tube and the skin of a wearer.

[0144] The number and the size of the absorbent tubes disposed in the absorbing region of an absorbent product can be selected depending upon the shape, use and desired absorbing property of the absorbent product, and the selection can easily be made by those skilled in the art.

[0145] In the descriptions and drawings made and shown in the above, the above-mentioned absorbent tubes are shown to have a virtually ellipsoidal cross-section, but the absorbent tube is normally thin having a flat shape before it absorbs a liquid to swell, as shown in Fig. 31. If the absorbent tube is of a single layer, the circumference length of the cross-section is constant regardless of the shape of the cross-section. The longer the circumference length is, the larger the area becomes to be provided to carry the SAP 402, and when the SAP 402 swells and increases in volume, the thickness or the height of the absorbent tube becomes larger. Figs. 32 to 35 show examples where the supporting sheet 401 is provided with a gusset for such purpose. In the example of Fig. 32, a gusset 510 is disposed on the top surface of the absorbent tube, and in the examples of Figs. 33 to 35, a gusset 510 is disposed on each side end of the absorbent tube. Note that in Fig. 34 the side ends on which gussets 510 are provided are linked at portions facing each other by heat sealing 511, forming a cell 512 as distinguished from the rest.

[0146] In the absorbent tube of the present invention, a supporting sheet can be composed of any sheet material which is liquid pervious and has some degree of softness and tear strength. A preferable material is a non-woven fabric 601 as described in the above, and a non-woven fabric of an absorbent composite as shown in Fig. 36 can also be advantageously used. This composite non-woven fabric 601 may be made by composing one or two kinds of staple fiber 602 such as PET and rayon with spun bond non-woven fabric 601 made of synthetic fiber such as polypropylene by means of water jet entanglement. A composite non-woven fabric like this has a feature where the spun bond non-woven fabric 601 functions as the inner sheet and, as shown in Fig. 37, on the surface of the staple fiber the SAP 402 particles are securely held so that there is no need to cover the absorbent core with the inner sheet.

[0147] Fig. 38 shows an absorbent product of a structure where the absorbent sheet 600 of Fig. 37 is formed into a tube and linked to the outer sheet 411 of an absorbent product by means of adhesive 504, and on both sides leg gathers 603 are provided composed of a liquid impervious sheet. Either side of each leg gather 603 is linked to the outer sheet 411, and the other side is made to face the end of the other leg gather 603 at some interval in which interval the center portion of the absorbent tube 600 is located.

[0148] Other examples of an absorbent sheet of the present invention are described with reference to the accompa-

with the SAP side upward with the side of the supporting sheet in contact with the liquid, and measure the time until the liquid disperses on the whole surface of the sample and the applied SAP finishes swelling on the whole surface.

3) Thickness of supporting sheet (mm)

[0169] Cut a circle of 5 cm diameter from the supporting sheet to make a sample. Measure using a thickness gauge of Daiei Chemical Precision Instruments Mgt. Co., Ltd. with the area of the probe of 15 cm^2 (43.7 mm diameter) and the measuring pressure of 3 g/cm^2.

4) Apparent density of supporting sheet (g/cm^3)

[0170] Calculate from the weight (g/cm^2) and the thickness of the supporting sheet by the following formula:

$$\text{Apparent density}(g/cm^3)=[\text{weight}(g/m^2)/10^4]\times[10/\text{thickness}(mm)]$$

[0171] Other composite absorbent sheet embodying the present invention are described where an absorbent sheet is provided with a liquid pervious supporting sheet and an absorbent layer containing the SAP particles bonded to either surface of the liquid pervious supporting sheet with the absorbent layer forming a plurality of high absorbing regions having higher absorbing capability than the other regions as distributed in a desired pattern on the surface of the liquid pervious supporting sheet.

[0172] Fig. 55 typically shows a plurality of high absorbing regions having higher absorbing capability of the absorbent layer and low absorbing regions having lower absorbing capability on the supporting sheet embodying the present invention; on the drawing the white colored pans show high absorbing regions 210 and the black colored pans show low absorbing regions 220.

[0173] Fig. 56 is a longitudinal cross-sectional view of a part of the absorbent sheet shown in Fig. 55. Reference numeral 203 represents a supporting sheet made of material such as non-woven fabric having an appropriate liquid perviousness, and on either surface of this supporting sheet 203 absorbent layers 200 are provided forming regions of higher absorbing capability 210 and regions of lower absorbing capability 220.

[0174] The absorbent layers 200 are composed of the SAP particles 201 and the HFFM 202 existing around each particle 201, and the HFFM 202 bonds the SAP particles 201 together and is bonded to the surface of the supporting sheet 203 to function as a means of transferring a liquid to be absorbed to each particle.

[0175] In the examples shown in Figs. 55 and 56, the difference in absorbing capability between the high absorbing region 210 and the low absorbing region 220 of the absorbent layer is realized by the difference in the thickness of the absorbent layer. This thickness is represented apparently by the configuration of the layer of the absorbent polymer, and as shown in Fig. 56, the thinner layer is in one layer, and the thicker layer is in two or more layers.

[0176] An example of non-woven fabric having preferable properties as material of the absorbent sheet of the present invention is, as previously proposed in Japanese Patent Examined Publication No. HEI 9-59862 of the present applicant, non-woven fabric where spun bond having a bi-component structure is used, stretched and heat set by a method shown in Fig. 57 to provide a cross-sectional structure as shown in Fig. 58. This non-woven fabric has a property of being more likely to elongate much only in one direction. In Fig. 58, the preferable range of H is 0.2 mm to 2 mm, and the preferable range of L is 1 mm to 5 mm.

[0177] Another example of non-woven fabric is, as previously proposed by the present applicant in his Japanese Patent Application No HEI 8-345410, non-woven fabric where a highly elastic net and a fiber web are partially laminated. This laminated non-woven fabric has a structure, as shown in Figs. 59 and 60, where on both surfaces of a net 407 where longitudinal elastic string 405 and lateral elastic string 406 are intersected with each other and bonded at points of intersection, identical or different webs 408 and 409 are laminated, and the net and the web are bonded along bonding lines 410 arranged in parallel to each other so that the laminated non-woven fabric has a property of being likely to elongate much only in one direction perpendicular to the bonding lines 410.

[0178] The SAP can be beforehand carried by a supporting member previously formed in the shape of a sheet, but can also be introduced into a supporting sheet when the supporting sheet is manufactured by practising the present invention. An absorbent composite can be obtained, for example, by making a carded web of easy-to-melt synthetic staple fiber and fibrous SAP, by, after laminating a pulp, the SAP and easy-smelt staple fibers by an air-laid method, heat treating to fix the laminated composite, or by, after impregnating a non-woven web with acrylic acid monomer, polymerizing and cross-linking such impregnated non-woven web. The surface of the carried SAP may be exposed or may be covered by tissue or the like.

[0179] Next, with reference to the accompanying drawings, an apparatus suitable for making the absorbent composite of the present invention is described below:

[0180] In Fig. 61, reference numeral 31 represents a tank for storing ion-exchanged water, 32 represents a tank for