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United States Patent and Trademark Office

September 09, 2024

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APPLICATION NUMBER: ***14/129,401***
FILING DATE: ***December 26, 2013***
PATENT NUMBER: ***9308138***
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FIRST QUALITY 1003
PART 1 OF 3

Certified by

Katherine Kelly Vidal

Performing the Functions and Duties of the
Under Secretary of Commerce
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Application Number: 14129401 Document Date: 12/26/2013

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PTO-1390 (05-13)
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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371		Attorney Docket No. 049121-0366-00-US-504907
		U.S. Application No. (if known, see 37 CFR 1.5)
International Application No. PCT/SE2011/050859	International Filing Date 28 June 2011	Priority Date Claimed
Title of Invention ABSORBENT ARTICLE HAVING INTAKE STRUCTURE		
First Named Inventor Patrik ANDERSSON		

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. [X] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). NOTE: The express request under 35 U.S.C. 371(f) will not be effective unless the requirements under 35 U.S.C. 371(c)(1), (2), and (4) for payment of the basic national fee, copy of the International Application and English translation thereof (if required), and the oath or declaration of the inventor(s) have been received.

2. [ ] A copy of the International Application (35 U.S.C. 371(c)(2)) is attached hereto (not required if the International Application was previously communicated by the International Bureau or was filed in the United States Receiving Office (RO/US)).

3. An English language translation of the International Application (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).

4. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
   a. [X] is attached.
   b. [ ] was previously filed in the international phase under PCT Rule 4.17(iv).

Items 5 to 8 below concern amendments made in the international phase.

PCT Article 19 and 34 amendments

5. [ ] Amendments to the claims under PCT Article 19 are attached (not required if communicated by the International Bureau) (35 U.S.C. 371(c)(3)).

6. [ ] English translation of the PCT Article 19 amendment is attached (35 U.S.C. 371(c)(3)).

7. [ ] English translation of annexes (Article 19 and/or 34 amendments only) of the International Preliminary Examination Report is attached (35 U.S.C. 371(c)(5)).

Cancellation of amendments made in the international phase

8a. [ ] Do not enter the amendment made in the international phase under PCT Article 19.

8b. [ ] Do not enter the amendment made in the international phase under PCT Article 34.

NOTE: A proper amendment made in English under Article 19 or 34 will be entered in the U.S. national phase application absent a clear instruction from applicant not to enter the amendment(s).

The following items 9 to 17 concern a document(s) or information included.

9. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

10. [X] A preliminary amendment.

11. [X] An Application Data Sheet under 37 CFR 1.76.

12. [X] A substitute specification. NOTE: A substitute specification cannot include claims. See 37 CFR 1.125(b).

13. [X] A power of attorney and/or change of address letter.

14. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821–1.825.

15. [ ] Assignment papers *(cover sheet and document(s))*. Name of Assignee:

16. [ ] 37 CFR 3.73(c) Statement *(when there is an Assignee)*.

U.S. APPLN. No. (if known - see 37 CFR 1.5)	INTERNATIONAL APPLICATION No.	ATTORNEY DOCKET No.
	PCT/SE2011/050859	049121-0366-00-US-504907

17. [x] Other items or information:
(a) Front page of International Publication No. WO 2013/002686 A1
(b) Written Opinion of the International Preliminary Examining Authority
(c) International Preliminary Report on Patentability under Chapter II
(d) International Search Report/Written Opinion dated February 21, 2012
(e) International Search Report dated February 21, 2012
(f) Second and Supplementary Notice (PCT/IB/308)

The following fees have been submitted.	CALCULATIONS	PTO USE ONLY
18. [x] Basic national fee (37 CFR 1.492(a)) **$280**	$ 280.00	
19. [x] Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** All other situations **$720**	$ 720.00	
20. [x] Search fee (37 CFR 1.492(b)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority ..... **$120** International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB ..... **$480** All other situations **$600**	$ 480.00	
TOTAL OF 18, 19, and 20 =	$ 1,480.00	

[ ] Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)).
Fee for each additional 50 sheets of paper or fraction thereof **$400**

Total Sheets	Extra Sheets	Number of each addition 50 or fraction thereof (round **up** to a whole number)	RATE	
28 - 100 =	/50 =		**x $400**	$

Surcharge of **$140.00** for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h)).	$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	21 - 20 =	1	x **$80**	$ 80.00	
Independent claims	1 - 3 =	0	x **$420**	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$780**	$	
Processing fee of **$140.00** for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i)). +				$	
TOTAL OF ABOVE CALCULATIONS =				$ 1,560.00	

[ ] **Applicant asserts small entity status.** See 37 CFR 1.27. Fees above are reduced by ½.

[ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Fees above are reduced by ¾.
Applicant must attach form PTO/SB/15A or B or equivalent.

TOTAL NATIONAL FEE =	$	1,560.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property. +	$	
	$	
TOTAL FEES ENCLOSED =	$	1,560.00
	Amount to be refunded:	$
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c. ☒ The Director is hereby authorized to charge additional fees which may be required, or credit any overpayment, to Deposit Account No. 50-0573 as follows:

i. ☒ any required fee.

ii. ☐ any required fee except for excess claims fees required under 37 CFR 1.492(d) and (e) and multiple dependent claim fee required under 37 CFR 1.492(f).

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NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

Correspondence Address

☒ The address associated with Customer Number: 105855 OR ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country			Telephone		
Email					

Signature	Christopher P. Bruenjes	Date	December 26, 2013
Name (Print/Type)	Christopher P. Bruenjes	Registration No. (Attorney/Agent)	62,941

PTO/SB/14 (11-08)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	049121-0366-00-US-504907
	Application Number	
Title of Invention	ABSORBENT ARTICLE HAVING INTAKE STRUCTURE	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Patrik		ANDERSSON	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Billdal	Country Of Residence[i]	SE
Citizenship under 37 CFR 1.41(b)[i]	SE		

Mailing Address of Applicant:

Address 1	Hedens ang 45		
Address 2			
City	Billdal	State/Province	
Postal Code	427 42	Country[i]	SE

Applicant 2 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Malin		LUNDMAN	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Molnlycke	Country Of Residence[i]	SE
Citizenship under 37 CFR 1.41(b)[i]	SE		

Mailing Address of Applicant:

Address 1	Nackrosvagen 111		
Address 2			
City	Molnlycke	State/Province	
Postal Code	435 40	Country[i]	SE

Applicant 3 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Per		BERGSTROM	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Goteborg	Country Of Residence[i]	SE

PTO/SB/14 (11-08)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	049121-0366-00-US-504907
	Application Number	
Title of Invention	ABSORBENT ARTICLE HAVING INTAKE STRUCTURE	

Citizenship under 37 CFR 1.41(b) i	SE			
Mailing Address of Applicant:				
Address 1	Doktor Heymans gata 1			
Address 2				
City	Goteborg	**State/Province**		
Postal Code	413 22	**Country**i	SE	

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	105855		
Email Address	DBRIPDocket@dbr.com	Add Email	Remove Email

Application Information:

Title of the Invention	ABSORBENT ARTICLE HAVING INTAKE STRUCTURE		
Attorney Docket Number	049121-0366-00-US-504907	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	3	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	049121-0366-00-US-504907
	Application Number	
Title of Invention	ABSORBENT ARTICLE HAVING INTAKE STRUCTURE	

Customer Number	105855

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	a 371 of international	PCT/SE2011/050859	2011-06-28

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			○ Yes ◉ No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1 Remove

If the Assignee is an Organization check here. ☒

Organization Name	SCA HYGIENE PRODUCTS AB		
Mailing Address Information:			
Address 1	SE-405 03		
Address 2			
City	Goteborg	**State/Province**	
Country [i] SE		Postal Code	405 03
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the **Add** button. Add

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	049121-0366-00-US-504907
	Application Number	
Title of Invention	ABSORBENT ARTICLE HAVING INTAKE STRUCTURE	

Signature	/Christopher P. Bruenjes/			Date (YYYY-MM-DD)	2013-12-26
First Name	Christopher	Last Name	Bruenjes	Registration Number	62941

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ABSORBENT ARTICLE HAVING INTAKE STRUCTURE

CROSS-REFERENCE TO PRIOR APPLICATION

[0001] This application is a §371 National Stage Application of PCT International Application No. PCT/SE2011/050859 filed June 28, 2011, which is incorporated herein in its entirety.

TECHNICAL FIELD

[0002] The disclosure pertains to an absorbent article including a fluid permeable topsheet, a fluid impermeable backsheet and an absorbent core enclosed between the topsheet and the backsheet, the absorbent core including a first absorbent layer and including an opening extending through the first absorbent layer.

BACKGROUND

[0003] Absorbent articles of the kind that is worn inside ordinary underpants include incontinence shields and sanitary napkins. As these articles have to be sized and configured to fit in the limited space available in the crotch portion of the underwear, the articles are by necessity designed with a relatively small width. For this reason, a particular problem with such articles is that they may leak at the side edges, before the full absorption capacity of the article has been utilized.

[0004] Side leakage may occur as a consequence of absorbed fluid being dispersed equally fast in all directions from the point where the fluid enters the article. This will lead to the fluid escaping the article at the side edges before being distributed to the end portions of the article. Another cause of side leakage may be when the intake capacity of the article is insufficient to allow all fluid that is exuded onto the article to directly enter inside the article. Instead, the fluid will flow on the topsheet and out over the side edges of the article where it can leak out and soil the wearer's clothing. A further drawback when fluid flows on the outside of the topsheet is that a large portion of the body-contacting topsheet will be

wet. This is of course highly undesirable as it makes the article unhygienic and unpleasant to wear.

[0005] Incontinence shields and sanitary napkins are designed to have a total absorption capacity that is large enough to absorb all fluid that is expected to be released to the absorbent article during a period of wear. However, the fluid is normally not exuded in a steady flow but as sudden gushes of relatively large volume under high pressure and during a very short time period. Accordingly, it would be desirable if the absorbent article was able to receive and contain the emitted fluid with corresponding speed.

[0006] Great efforts have been made in the past in order to overcome the side leakage problem in relation to disposable absorbent articles such as incontinence shields and sanitary napkins. However, to date no such effort has been completely successful.

[0007] International publication WO 2009/105000 discloses a laminate fibrous web having recesses with a diminishing cross-sectional area in a thickness direction of the web. The web can be used as a fluid intake material and is taught to improve fluid flow through the web.

[0008] Although the prior art laminate material may alleviate the side leakage problem to some extent, there is still a great need for further improvements of the side leakage security for the kind of absorbent article that is worn in the crotch portion of an undergarment.

SUMMARY

[0009] It is desired to provide an absorbent article having improved intake capacity, fluid distribution properties and leakage security.

[0010] In a first aspect, an absorbent article is provided having a longitudinal direction and a transverse direction, side edges extending in the longitudinal direction and end edges extending in the transverse direction and including a fluid permeable topsheet, a fluid impermeable backsheet and an absorbent core enclosed between the topsheet and the backsheet. The absorbent core includes a first absorbent layer, and the first absorbent layer has an opening extending therethrough. A fluid flow control structure is arranged between the first absorbent layer and the backsheet, the fluid flow control structure being a layered structure including a non-perforated fibrous polymeric layer and a first perforated

polymeric layer, the first perforated polymeric layer having a basis weight of from 50 g/m^2 to150 g/m^2, or a basis weight of from 60 g/m^2 to 100 g/m^2.

[0011] The fluid flow control structure provides the article with high intake capacity.

[0012] Moreover, the article in accordance with the first aspect can provide a large void volume for temporary storage of fluid. The void volume is created both by the hollow space or well formed at the opening in the absorbent layer and internally in the porous fluid flow control structure. As soon as the fluid has entered into the fluid flow control structure it may run in the open pore structure of the non-perforated layer and be distributed away from the initially wetted area of the absorbent article. The fluid flow control structure not only enhances fluid transport away from the initially wetted area but also promotes fluid distribution throughout the absorbent core both in the length direction and in the thickness direction of the article. The width of the fluid flow control structure may be smaller than the width of the first absorbent layer, whereby the fluid dispersion rate changes at the edge of the fluid flow control structure. In particular embodiments, the fluid flow control structure is a highly porous structure with less resistance to fluid flow than the first absorbent layer, implying that fluid will by preference continue to move in the fluid flow control structure. Accordingly, the edges of the fluid flow control structure may act as barriers to fluid distribution transversely to the side edges of the absorbent article, reducing the risk of side failure.

[0013] In particular embodiments, the opening through the first absorbent layer is placed in the wetting area of the article. The wetting area of the article is that part of the article which is designed to be initially wetted by emitted fluid when the article is being worn and is located in a crotch area of the absorbent article. By arranging the opening in the first absorbent layer in the wetting area, emitted fluid can flow directly into the opening and be collected and temporarily contained in the space defined by the opening and adjacent layers of the absorbent article.

[0014] The first absorbent layer in an absorbent article may have one or more openings. The opening or openings may be of any suitable shape or combination of shapes, such as circular, oval, rectangular, square, star-shaped, flower-shaped, heart-shaped, H-shaped, T-

shaped, I-shaped etc. Accordingly, the positioning, shape and size of the opening or openings may be varied within the scope of the invention.

[0015] Due to its high basis weight and the combination of a perforated layer and a non-perforated layer, the fluid flow control structure will preferably have relatively high bending stiffness. A high bending stiffness provides the absorbent article with an improved ability of resisting transverse compression between the thighs of a wearer of the article and counteracts unwanted deformation of the article during wear, such that the opening in the first absorbent layer is kept open for fluid reception throughout use of the article. The bending stiffness or flexure resistance of the laminate material in the fluid flow control structure may be 0.5 -5 N, or 1-4 N, as measured by the modified ASTM D 4032-82 CIRCULAR BEND PROCEDURE. It may be desirable that the bending stiffness of any part of the absorbent article extending laterally outside of the fluid flow control structure has a lower bending stiffness than the fluid flow control structure whereby such less stiff lateral portions of the absorbent article may act as cushioning means between the fluid flow control structure and the wearer's legs.

[0016] The absorbent article may include a second absorbent layer being arranged between the fluid flow control structure and the backsheet.

[0017] The first perforated polymeric layer may be a nonwoven, a film or a film/nonwoven laminate. In certain embodiments, the first perforated polymeric layer is a nonwoven material. Suitable polymers for the first perforated polymeric layer may be polyolefins, polyesters, polyamides and blends and combinations of such polymers with polypropylene being an exemplary polyolefin. The nonwoven materials may be carded resin bonded materials, carded through-air bonded materials, spunbond-meltbond-spunbond (SMS) materials, carded hydroentangled materials or carded thermobonded materials.

[0018] The first perforated polymeric layer may be a three-dimensionally formed layer having penetrating apertures, the apertures extending from a first surface of the layer towards a second surface of the layer, forming protrusions on the second surface and, in particular embodiments, the apertures are funnel-shaped. With a funnel-shaped aperture as used herein is implied an aperture having a tapering shape in its direction of extension such that the cross-sectional area of the aperture is diminishing when moving along the aperture.

[0019] The first perforated polymeric layer may be arranged with the second surface facing the non-perforated fibrous polymeric layer or may be arranged with the second surface facing away from the non-perforated fibrous polymeric layer.

[0020] The first perforated polymeric layer may be arranged as the first layer of the fluid flow control structure, i.e. as the layer of the structure that is located closest to the topsheet.

[0021] The apertures in the first perforated polymeric layer may have an average size of 0.5 – 5 mm, measured at the smallest diameter of the apertures.

[0022] The open area of the first perforated polymeric layer may be 5-30%, or 10-25%.

[0023] The non-perforated fibrous polymeric layer may be a high loft material of 20-120 gsm, or 60-100 gsm. The polymer for the non-perforated fibrous polymeric layer may be polyester.

[0024] The fluid flow control structure may be a three-layer structure including the non-perforated fibrous polymeric layer, the first perforated polymeric layer and a second perforated polymeric layer, the non-perforated fibrous polymeric layer being sandwiched between the first perforated polymeric layer and the second perforated polymeric layer.

[0025] The second perforated polymeric layer may be a three-dimensionally formed layer having apertures extending from a first surface of the web towards a second surface of the web and forming protrusions on the second surface.

[0026] The layers in the fluid flow control structure may be attached to each other by means of an adhesive. However, other means of joining of the layers such as thermo-bonding by hot embossing or ultrasonic bonding may be used as well as layers being joined without using any bonding means. The fluid flow control structure has an overall planar shape. In particular embodiments, the non-perforated fibrous polymer layer has uniform thickness and a uniform pore structure. In further embodiments, bonding between the layers is carried out so as to have minimum impact on the shape and pore structure of the non-perforated fibrous polymer layer.

[0027] The polymer materials of the fluid flow control structure may be non-absorbent materials which do not retain any fluid in the material itself. The function of the fluid flow control structure is to provide the absorbent article with temporary fluid holding capacity and to distribute fluid in the article. As the polymer materials in the fluid flow control

structure may be hydrophobic, and may have a wetting angle (θ) of 90° or close to 90° implying that they have no or very low wettability when contacted with aqueous fluids, it is may be an advantage if the components of the fluid flow control structure have been treated to lower the wetting angle and render them hydrophilic, i.e. wettable by body fluids. A perfectly wettable material has a wetting angle (θ) of 0°. Any commonly known method for rendering a hydrophobic material hydrophilic may be used, such as treatment with surfactants, plasma or corona treatment, etc.

[0028] One aspect of an example embodiment concerns a three-layer fluid flow control structure, wherein both the first perforated polymeric layer and the second perforated polymeric layer may be a three-dimensionally formed layer having penetrating, including, for example, funnel-shaped apertures, extending from a first surface of the layer towards a second surface of the layer and forming protrusions on the second surface. Both perforated polymeric layers may be arranged with the second surface facing the non-perforated fibrous polymeric layer arranged between the perforated polymeric layers.

[0029] The apertures in the first and second perforated polymeric layers may be out of register with each other. When the apertures in the first and second perforated polymeric layers are out of register with each other, fluid impinging one of the layers cannot pass directly through the thickness of the fluid flow control structure but is forced to take a more tortuous path through the fluid flow control structure. Moreover, when fluid enters the fluid flow control structure through a first perforated polymeric layer that is arranged facing the topsheet of the article at least some of the fluid travels downward towards the backsheet. When the fluid reaches the second perforated polymeric layer at a non-perforated location, the fluid will run along the second perforated polymeric layer and be distributed inside the fluid flow control structure until it eventually may escape through an aperture in the second perforated polymeric layer. The second perforated polymeric layer may be a three-dimensionally shaped material with apertures forming protrusions on the side of the second perforated polymeric layer that is facing the non-perforated fibrous polymer layer of the fluid flow control structure. In such case, a network of interconnected channels is formed between the protrusions in which network the fluid may be captured

and may flow a long distance away from the initially wetted area before leaving the fluid flow control structure.

[0030] Three-dimensionally shaped first and second perforated polymeric layers may be oriented with the apexes of the apertures, i.e. the protrusions, directed towards the non-perforated fibrous polymer layer or away from the non-perforated fibrous polymer layer. The three-dimensionally shaped first and second perforated polymeric layers and the high-loft non-perforated fibrous polymeric layer together contribute to the void volume of the fluid flow control structure and to the ability of the structure to contain and move fluid therethrough.

[0031] When the fluid flow control structure is a three-layer structure including a non-perforated fibrous polymeric layer that is sandwiched between a first perforated polymeric layer and a second perforated polymeric layer, the second perforated polymeric layer may be different from the first perforated polymeric layer with regard to chemical composition, physical composition, three-dimensionality, open area, aperture size etc. Alternatively, the second perforated polymeric layer may be identical to the first perforated polymeric layer. The second perforated polymeric layer may thus have a basis weight, open area and aperture size corresponding to the first perforated polymeric layer.

[0032] Both perforated polymeric layers may be three-dimensionally formed layers as disclosed herein. Each layer may have penetrating apertures that originate in a first surface of the layer and extend towards a second surface of the layer, with the apexes of the apertures forming protrusions at the second surface of the layer. The apertures may be tubular structures, including, for example, funnel-shaped with a diminishing cross-sectional area when moving in a direction from the first surface to the second surface of the perforated layer.

[0033] Alternatively, one or both perforated polymer layers may be two-dimensional layers. When at least one of the perforated polymer layers is a three-dimensionally formed layer, such three-dimensionally formed perforated layer may be arranged with the first surface facing away from the non-perforated polymeric layer or with the first surface facing towards the non-perforated polymeric layer. In an absorbent article according to an embodiment of the invention, a three-dimensionally formed perforated polymer layer being

oriented with the protrusions facing towards the topsheet of the article will generally promote fluid distribution in the X-Y plane, i.e. in the longitudinal and transverse directions of the article, to a higher extent than a three-dimensionally formed perforated polymer layer being oriented with the protrusions facing towards the backsheet of the article which will generally promote fluid transport in the Z-direction of the article, i.e. in the thickness direction.

[0034] The first and second perforated polymeric layers may pass fluid therethrough but act as protective barriers that prevent particles and fibres from entering the fluid flow control structure and interfering with fluid transport inside the fluid flow control structure. The particles and fibres may be absorbent materials from such as absorbent polymer particles commonly known as "superabsorbents", cellulose fluff pulp fibres, etc.

[0035] The fluid flow control structure may have a high resistance to compression as measured in the Compression Test disclosed herein. Accordingly, the thickness of the flow control structure at 5 kPa may be 60-80% of the thickness at 0.5 KPa at a first, second and third compression performed according to the compression test disclosed herein.

[0036] In an absorbent article according to an embodiment of the invention, the first absorbent layer may have more than one opening extending therethrough. The openings may be placed in the same general area of the absorbent article, such as in a crotch portion of the article or may be placed in different portions of the article such as in two or more of the crotch portion and the end portions. The crotch portion, as used herein, is the portion of the article that is designed to be placed in the crotch of a wearer and to be in contact with the pudendal area of the wearer. The crotch portion includes the wetting area of the article and can be asymmetrically placed in the longitudinal direction of the article. The end portions are placed on either side of the crotch portion in the longitudinal direction of the article. The article may be designed with end portions that are specifically adapted to be placed towards the front or the rear of a wearer and may then differ in size, shape, etc. to allow a user to apply the article in a correct way inside the underwear.

[0037] The absorbent article may be provided with means for fastening of the article in ordinary underwear or other supporting pant-garment. The fastening means may be

adhesive fasteners, frictional fasteners, mechanical fasteners such as the hook part of a hook-and-loop fastener or combinations of different types of fasteners, as known in the art.

[0038] The absorbent article may be a diaper of the open type that is fastened around the lower torso of a wearer by means of tape fasteners, belts or similar or may be a closed-type pant diaper. The absorbent article may alternatively be of a kind that is worn inside a supporting panty or with a holder, such as a sanitary napkin, a panty liner or an incontinence protector. In certain embodiments, the absorbent article is an incontinence protector.

[0039] An absorbent article may comprise a fluid permeable topsheet, disposed at the surface of the incontinence protector which is intended to be facing a wearer of the incontinence protector, a backsheet disposed at the surface of the incontinence protector that is intended to be facing the undergarment of the wearer, and an absorbent core, enclosed between the topsheet and the backsheet.

[0040] The covering may be of a kind where the topsheet and the backsheet of the incontinence protector extend together laterally outside of the absorbent core along the whole circumference of the absorbent core and are connected to each other in an edge join around the periphery of the absorbent core. An edge join may be formed in any suitable manner as known in the art such as by means of adhesive, ultrasonic bonding, thermobonding, stitching, etc. Alternative covering arrangements such as wrapped-around covers are also conceivable within the scope of the invention.

[0041] The topsheet may include any material which is suitable for the purpose. Examples of commonly found topsheet materials are nonwoven materials, perforated plastic films, plastic or textile mesh, and fluid permeable foam layers. Laminates include two or more topsheet materials are also commonly employed, as are topsheets including different materials within different parts of the fluid permeable wearer-facing surface. In certain embodiments, the topsheet is a non-apertured nonwoven web.

[0042] The backsheet is preferably fluid impermeable. However, backsheet materials that are only resistant to fluid penetration may be used particularly in instances where relatively small amounts of urine are expected to be taken up by the incontinence protector. The backsheet may be a thin, flexible, fluid-impermeable plastic film, but fluid-impermeable

nonwoven materials, fluid impermeable foams and fluid impermeable laminates are also contemplated within the scope of the invention. The backsheet may be breathable, implying that air and vapor may pass through the backsheet. Furthermore, the backsheet may have an outer, garment-facing surface of a textile material such as nonwoven.

[0043] The absorbent core may be made up of any suitable absorbent or fluid uptake material as known in the art, such as one or more layers of cellulose fluff pulp, foam, fiber waddings, etc. The absorbent core may contain fibers or particles of highly absorbent polymer material, commonly known as superabsorbents, which are materials having the ability to absorb and retain large quantities of fluid upon formation of a hydrogel. The superabsorbents may be mixed with cellulose fluff pulp and/or may be arranged in pockets or layers in the absorbent core. The absorbent core may further incorporate components for improving the properties of the absorbent core. Some examples of such components are binder fibers, fluid-dispersing materials, fluid acquisition materials, etc. as known in the art.

[0044] The absorbent article may include more than one absorbent core. The cores may be an upper larger core and a lower, smaller core.

[0045] The article may further include components such as elastic elements. The elastic elements may be arranged along the side edges of the absorbent article. Elastic elements arranged along the side edges of the absorbent article improve the anatomical fit of the article by inducing longitudinal bending of the article in conformation with the curvature in a wearer's crotch.

[0046] When the absorbent core includes a first absorbent layer and a second absorbent layer the fluid flow control structure may be arranged between the first absorbent layer and the second absorbent layer. The first absorbent layer may be placed beneath and in direct contact with the topsheet. Alternatively, the first absorbent layer may be placed in indirect contact with the topsheet through one or more intervening components such as tissue layers, acquisition layers or further absorbent layers. Similarly, the second absorbent layer may be placed directly beneath the fluid flow control structure and in direct contact with the fluid flow control structure and the backsheet but may alternatively be in indirect contact with one or both of those components by intervening components.

[0047] The absorbent layers of the core may be homogeneous structures or may in themselves be layered structures such as absorbent laminates of the same or different materials. The absorbent layers may have uniform thickness or may vary in thickness in different parts of the layers. Similarly, the basis weight and composition may vary within the absorbent layers. By way of example, an absorbent layer may include a mixture of absorbent and/or non-absorbent fibres and superabsorbent material, wherein the ratio of superabsorbent material to fibres may vary in the layer.

[0048] The fluid flow control structure may be of rectangular shape and may be surrounded in the longitudinal and lateral directions by portions of the absorbent core. Although other shapes and configurations for the fluid flow control structure may be used, it is generally advantageous if the fluid flow control structure has the same or smaller width than the absorbent core and also the same or shorter length than the absorbent core. The fluid flow control structure has a highly porous internal structure with less resistance to fluid flow than conventional absorption materials. This means that the fluid dispersion rate changes at the edge of the fluid flow control structure so that fluid reaching the edge will continue to move primarily in the fluid flow control structure where the flow resistance is low before being absorbed by the core material. In this way, the edges of the fluid flow control structure act as barriers to fluid distribution transversely to the side edges of the absorbent article, thus reducing the risk of side failure. Conventional absorption materials such as cellulose fluff pulp, and superabsorbents have comparatively smaller capillaries than the fluid flow control structure. A fibrous structure with fine capillaries has a low fluid uptake capacity, but high fluid retention capability once the fluid has entered the structure. A superabsorbent material has even lower uptake rate and higher retention capability than the fibrous absorbent structures due to fluid uptake in such materials being driven mainly by osmotic pressure.

[0049] The components in the absorbent article may be connected to each other by conventional means such as construction adhesive, heat bonding, ultrasonic bonding, etc. It may not be necessary to bond internal components of the absorbent article to each other by special bonding means. Accordingly, it may suffice that such components are held together by frictional forces.

TEST METHODS

[0050] The modified ASTM D 4032-82 CIRCULAR BEND PROCEDURE

Apparatus:

[0051] The apparatus is a modified Circular Bend Stiffness Tester, having the following parts:

[0052] - A smooth-polished steel plate platform which is 102.0 x 102.0 x 6.35 millimeters having an 18.75 millimeter diameter orifice. The lap edge of the orifice should be at a 45 degree angle to a depth of 4.75 millimeters.

[0053] - A plunger having an overall length of 72.2 millimeters, a diameter of 6.25 millimeters, a ball nose having a radius of 2.97 millimeters and a needle point extending 0.88 millimeter therefrom having a 0.33 millimeter base diameter and a point having a radius of less than 0.5 millimeter, the plunger being mounted concentric with the orifice and having equal clearance on all sides. Note that the needle point is merely to prevent lateral movement of the test specimen during testing. Therefore, if the needle-point significantly adversely affects the test specimen (for example, punctures an inflatable structure), then the needle-point should not be used. The bottom of the plunger should be set well above the top of the orifice plate. From this position, the downward stroke of the ball nose is to the exact bottom of the plate orifice.

[0054] - A force-measurement gauge and more specifically an Instron inverted compression load cell. The load cell has a load range of from 0.0 to 10 N.

[0055] - An actuator, and more specifically an Instron™ tester having an inverted compression load cell. The Instron ™ tester is made by the Instron Engineering Corporation, Canton, Massachusetts.

Number and preparation of specimens:

[0056] In order to perform the procedure for this test, 10 test specimens of 37.5 x 37.5 millimeter are cut from the tested laminate material.

Procedure:

[0057] The procedure for the CIRCULAR BEND PROCEDURE is as follows. The specimens are conditioned by leaving them in a room which is 21 ± 1° and 50 ± 2% relative humidity for a period of two hours. The test plate is leveled. The plunger speed is

set at 50.0 centimeters per minute per full stroke length. A specimen is centered on the orifice platform below the plunger such that the body surface of the specimen is facing the plunger and the garment surface is facing the platform. The indicator zero is checked and adjusted, if necessary. The plunger is actuated. Touching the specimen during the testing should be avoided. The maximum force reading to the nearest gram is recorded. The above steps are repeated until all five of the identical specimens have been tested.

Compressibility

Procedure:

[0058] The principle of the method is to slowly compress a material with a metal rod to a force of 5 N while continuously measuring the thickness of the material. The result includes the data points for force and extension. The force translates to a pressure given the contact area of the rod. The metal rod is cylindrical and has a diameter of 10 mm with a flat base. The rod is mounted in a 10N load cell in the upper fixture of an Instron testing apparatus. A flat plate is mounted in the bottom fixture and is centered under the rod so that a sample may be placed on top of the plate and be compressed without movement of the plate. The rate of movement of the rod is 5 mm per minute. These settings have been pre-programmed into an Instron Bluehill program called "New Mecano 5 N", but before running a test, the program settings should be checked in order to make sure that all limits are set to their proper values. Running with a modified version could lead to damage to the equipment, especially the sensitive load cell.

Running a test:

[0059] The first run is an empty run without a sample. This run is used to find the zero thickness position, which is where the steel plate stops the rod. The empty run typically generates forces higher than the maximum limit set before the rod stops, because of the rapid increase in force that occurs when the rod impacts the metal and for which the apparatus cannot compensate sufficiently quickly. Care should be taken to ascertain that the load cell can withstand the impact without being damaged. Special settings can be used for the empty run to lower the limiting maximum force and the speed of the rod.

[0060] When the rod stops, the Instron equipment awaits user input. The extension is then manually reset to zero. This ensures that the extension is set to zero at the exact correct point where the rod touches the base and the extension is measured relative to the bottom plate. The rod may thereafter be manually moved up so that a sample can be placed on the lower plate.

[0061] To test a sample, the rod is moved manually so that it is above the surface of the sample and the program is started. The rod moves down at a speed of 5 mm per minute until the limiting force is reached.

Samples:

[0062] The samples are squares with 50 millimeter sides punched from the tested material. If the material has varying thickness, the samples are taken from the thickest parts of the material. The rod is pressed into the centre of the sample and each sample is tested three times without being moved between runs. Ten samples of each tested material are used, giving thirty measurements in total.

Results:

[0063] The result is the complete set of data points for force versus extension. The force is typically recalculated into pressure using the force measured divided by the bottom area of the rod. The result may be plotted and reported or a specific pressure may be chosen and the thickness noted, so that the result is a thickness for a given pressure.

Open Area and Hole Diameter Measurement

[0064] The following method may be used to determine the open area and hole diameter for an apertured material:

Apparatus:

[0065] - a Nikon microscope

[0066] - a personal computer

[0067] - software NIS-Elements BR 3.10

Procedure:

[0068] - collect a sample of the apertured material

[0069] - position the sample on the reading surface of the microscope

[0070] - start the software

[0071] - catch a representative image of the sample

[0072] - perform the analysis of the properties by contrast technique involving highlighting of the areas occupied by the holes.

[0073] The software calculates the diameters of the highlighted holes as major diagonal and minor diagonal of a rhombus inscribed in the hole. The ratio between the diameters is used to determine the actual average conformation of the holes to a circular shape, wherein a ratio of 1 implies a perfectly circular shape.

[0074] The average hole area value obtained by means of the software is used to calculate the percent open area.

[0075] Alternative methods for determining open area and hole diameter may be used, such as manual methods and methods based on scanning electron microscopy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0076] Embodiments of the invention will be described in greater detail below with reference to the figures shown in the appended drawings.

[0077] Figure 1 shows an incontinence protector according to an embodiment of the invention, seen from the side which will be facing the undergarment when the incontinence protector is being worn;

[0078] Figure 2 shows a cross-section through the incontinence protector in Fig. 1, taken along the line II-II;

[0079] Figure 3 shows a section through a fluid flow control structure according to an embodiment of the invention;

[0080] Figure 4 shows an exploded perspective view of a fluid flow control structure according to an embodiment of the invention; and

[0081] Figures 5a-d show absorbent layers having openings therein.

DESCRIPTION OF EMBODIMENTS

[0082] The absorbent article is exemplified by an incontinence protector as shown in Figs. 1 and 2. It is to be understood that the invention is equally applicable to any type of

hygienic absorbent article. Such articles include incontinence protectors, sanitary napkins, panty liners, diapers with tape fasteners, pant diapers or belted diapers.

[0083] Fig. 1 shows a urine incontinence protector 1 seen from the side of the incontinence protector 1 that is intended to be facing towards a wearer's body when the incontinence protector 1 is being worn.

[0084] The incontinence protector 1 includes a fluid permeable topsheet 2, a backsheet 4 and an absorbent core 6, enclosed between the topsheet 2 and the backsheet 4.

[0085] The topsheet 2 and the backsheet 4 of the incontinence protector 1 are shown to extend together laterally outside of the absorbent core 6 along the whole circumference of the absorbent core 6 and are connected to each other in an edge join 7 around the periphery of the absorbent core 6.

[0086] The topsheet 2 and the backsheet 4 may include any material suitable for the particular purpose, as disclosed herein.

[0087] The incontinence protector 1 as shown in Figs. 1 and 2 has elongate, generally rectangular shape when fully extended in all directions. The word "generally" in this context means that, for instance, the corners of the incontinence protector 1 may be rounded, or that the edges of the incontinence protector 1 may not be completely linear as is illustrated in Fig 1. The shape of the incontinence protector 1 shown in Fig. 1 should not be considered limiting to the invention. Accordingly, any other suitable shape may be used, such as hourglass shape, trapezoidal shape, triangular shape an oval shape, etc. The shape of the article may be symmetrical about a transverse centre line through the article, as shown in Fig. 1 or may be asymmetrical with end portions having differing shapes and/or differing sizes.

[0088] The incontinence protector 1 in Figs. 1 and 2 has two longitudinal side edges 8, 9 having equal length and extending generally in the same direction as a longitudinal center line 10 through the incontinence protector 1. Front and rear end edges 11, 12 extend transversely to the longitudinal center line 10 at the ends of the incontinence protector. The rear end edge 12 is intended to be orientated rearwards during use of the incontinence protector 1, and the front end edge 11 is intended to be facing forwards towards the abdomen of the wearer.

[0089] The incontinence protector 1 has a front end portion 13, a rear end portion 14 and a crotch portion 15 located intermediate the end portions 13,14. The crotch portion 15 is that portion of the incontinence protector 1 which is intended to be placed against the crotch of a wearer during wearing of the protector 1 and to constitute the main acquisition area for body fluid that reaches the protector 1.

[0090] The incontinence protector 1 further has fastening means 16 for fastening of the incontinence protector 1 inside a supporting pant garment, such as a pair of underpants. The fastening means 16 is in the form of two longitudinally extending bands of pressure sensitive adhesive arranged on the garment-facing surface of the backsheet 4. In Fig. 2, the fastening means 16 is shown to be covered by a releasable protective layer 17. The protective layer may be a siliconized paper, a nonwoven or any other releasable material as is known in the art. Before placing the incontinence protector in the supporting pant garment, the protective layer is removed from the fastening means 16 to expose the adhesive and make it available for fastening to the pant garment.

[0091] The fastening means 16 is optional to the invention and may be omitted, if desired. When using an adhesive fastening means, any suitable adhesive pattern may be used such as full coating of the backsheet, one or more longitudinal adhesive band, transverse bands, dots, circles, curves, stars, etc. Furthermore, the fastening means 16 may be a mechanical fastener such as hook-type fasteners, clips, press studs, etc. or may be a frictional fastener such as a frictional coating or open-celled foam. Combinations of different types of fasteners are also conceivable.

[0092] The absorbent core 6 of the incontinence protector 1 shown in Figs. 1 and 2 includes a first absorbent layer 22 and a second absorbent layer 23. A fluid flow control structure 24 is arranged between the first absorbent layer 22 and the second absorbent layer 23. In the incontinence protector 1 in Figs. 1 and 2, the first absorbent layer 22 is placed beneath and in direct contact with the topsheet 2. Alternative arrangements may be used, as disclosed herein.

[0093] The first absorbent layer 22 and the second absorbent layer 23 are shown to have generally rectangular shapes. The second absorbent layer 23 is placed beneath the first absorbent layer 22. The second absorbent layer 23 is somewhat smaller than the first

absorbent layer 22 so that the first absorbent layer 22 extends beyond the second absorbent layer 23 forward and rearward in the incontinence protector 1. The size and shape of the absorbent layers may be different from those shown in the figures without departing from the invention. Moreover, the second absorbent layer 23 may be omitted in the absorbent article or the article may include one or more further absorbent layers.

[0094] The first absorbent layer 22 has an opening 25 extending completely through the layer 22 in the crotch portion 15 of the incontinence protector 1. The opening 25 has elongate shape. Without departing from the invention, the shape, size and location of the opening 25 in the first absorbent layer 22 may be different from what is shown in Fig. 1, as described herein.

[0095] The topsheet 2 is shown to extend down into the cavity 26 that is defined by the opening 25 in the first absorbent layer 22 and the topsheet-facing surface of the fluid flow control structure 24. The cavity 26 is located in the wetting area of the incontinence protector 1 and will in use be placed directly beneath the urethra and the vaginal opening of a female wearer. Any body fluid that is released to the incontinence protector 1 will directly be collected in the cavity 26 and be temporarily contained therein until it is distributed further into and throughout the absorbent core 6.

[0096] A portion of the fluid that is collected in the cavity 26 may be absorbed by the first absorbent layer through the walls of the cavity 26. However, the majority of the fluid will continue downward in the incontinence protector 1, through the bottom of the cavity 26 and into the fluid flow control structure 1 where it is distributed longitudinally and laterally along the flow control structure 24, as described in more detail with reference to Figs 3 and 4.

[0097] The fluid flow control structure 24 is shown in Fig. 1 to be of rectangular shape and to be surrounded in the longitudinal and lateral directions by portions of the absorbent core 6. It is generally advantageous if the fluid flow control structure 24 has smaller width and also is shorter than the absorbent core 6.

[0098] The components in the incontinence protector 1 may be connected to each other by conventional means such as construction adhesive, heat bonding, ultrasonic bonding, etc. It may not be necessary to bond internal components of the incontinence protector to each

other by special bonding means. Hence, it may suffice that such components are held together by frictional forces.

[0099] The function of a fluid flow control structure 24 and its use in an absorbent article such as the incontinence protector 1 in Figs. 1 and 2 will now be described with reference to Figs. 3 and 4. The fluid flow control structure 24 in Figs. 3 and 4 is a three-layer structure including a non-perforated fibrous polymeric layer 31 that is sandwiched between a first perforated polymeric layer 32 and a second perforated polymeric layer 33.

[0100] The perforated polymeric layers 32,33 are three-dimensionally formed layers. Each layer 32,33 has penetrating apertures 34 that originate in a first surface 32',33' of the layer and extend towards a second surface 32'',33'' of the layer, with the apexes of the apertures 34 forming protrusions 35 at the second surface 32'',33''. The apertures are tubular structures and can be, for example, funnel-shaped, as seen in Fig. 3. The distance between the first surface 32',33' and the second surface 32'',33'' is the apparent thickness of the respective layers 32,33.

[0101] When fluid 36 reaches the first surface 32' of the first perforated polymeric layer 32, it spreads slightly on the surface 32' before passing through the apertures 34 into the non-perforated fibrous polymeric layer 31, as is shown in Fig 3. The non-perforated fibrous polymeric layer 31 offers very little resistance to fluid flow, whereby the fluid runs relatively freely in the layer 31 until it is finally moved by gravity down to the second perforated layer 33 where further downward movement is restricted by the second surface 33'' of the second perforated layer 33. A small amount of fluid may run out of the fluid flow control structure 24 by entering the openings at the apexes of the protrusions 35 on the second perforated layer 33. However, most of the fluid will spread further on the second surface 33'' of the second layer 33 by running in the interconnected channel network 37 that is formed between the protrusions 35, as illustrated in Fig. 4.

[0102] The fluid that is captured in the interconnected channel network 37 will generally not exit the fluid flow control structure 24 until it reaches the edges of the fluid flow control structure 24 or when the channel network 37 is saturated with fluid such that the fluid level raises above the height of the protrusions 35. Accordingly, the fluid 36 will be distributed along the second surface 33'' in all directions from the initial point of fluid

impact. The apertures 34 may be distributed in the perforated polymeric layers 32,33 so that fluid dispersion takes place to a greater degree in a direction corresponding to the longitudinal direction of the absorbent article in which the fluid flow control structure 24 is placed than in a direction transverse thereto. As shown in Fig. 4, the perforated polymeric layers 32,33 have apertures 34 arranged in staggered rows, such that generally linear channels are formed between the apertures 34 in a longitudinal direction L of the layers 32,33 and non-linear channels are formed in the transverse direction T. Such an arrangement of the apertures 34 in the second perforated polymeric layer 33 serves to promote longitudinal fluid flow in the fluid flow control structure and limit transverse fluid flow.

[0103] Figs. 5a-5d illustrate that the first absorbent layer in an absorbent article may have one or more openings of different shapes and configurations. The particular configurations shown in Figs. 5a-d should not be regarded as limiting to the invention but are only offered as examples of the many variations that are possible within the scope of the invention. Fig. 5a shows a first absorbent layer having multiple circular openings in the crotch portion of the layer. Fig. 5b shows a first absorbent layer having three elongate openings in the front portion of the layer and a single elongate opening in the rear portion of the layer. Fig. 5c shows a first absorbent layer having an opening shaped as a duck's foot and Fig. 5d shows a first absorbent layer having an H-shaped opening. The layer shown in Fig. 5a may, for instance, be suitable when a large total opening area is desired without compromising the wish of having a coherent layer that will not fall apart or otherwise deform during production of the absorbent article. A layer such as shown in Fig. 5b and 5c and having a large open area positioned to the front, may be particulary useful in sanitary napkins for day-time use. The Fig. 5b layer would additionally work well in absorbent articles intended for night-time use where fluid may run rearward between the wearer's buttocks. The Fig. 5d layer may be particularly suited for incontinence protectors where it may be desired to quickly channel fluid from the crotch portion of the absorbent article towards the ends thereof.

[0104] Figs. 5a-d are also intended to show that the first absorbent layer, as well as the overall absorbent article may have any suitable shape, as known in the art.

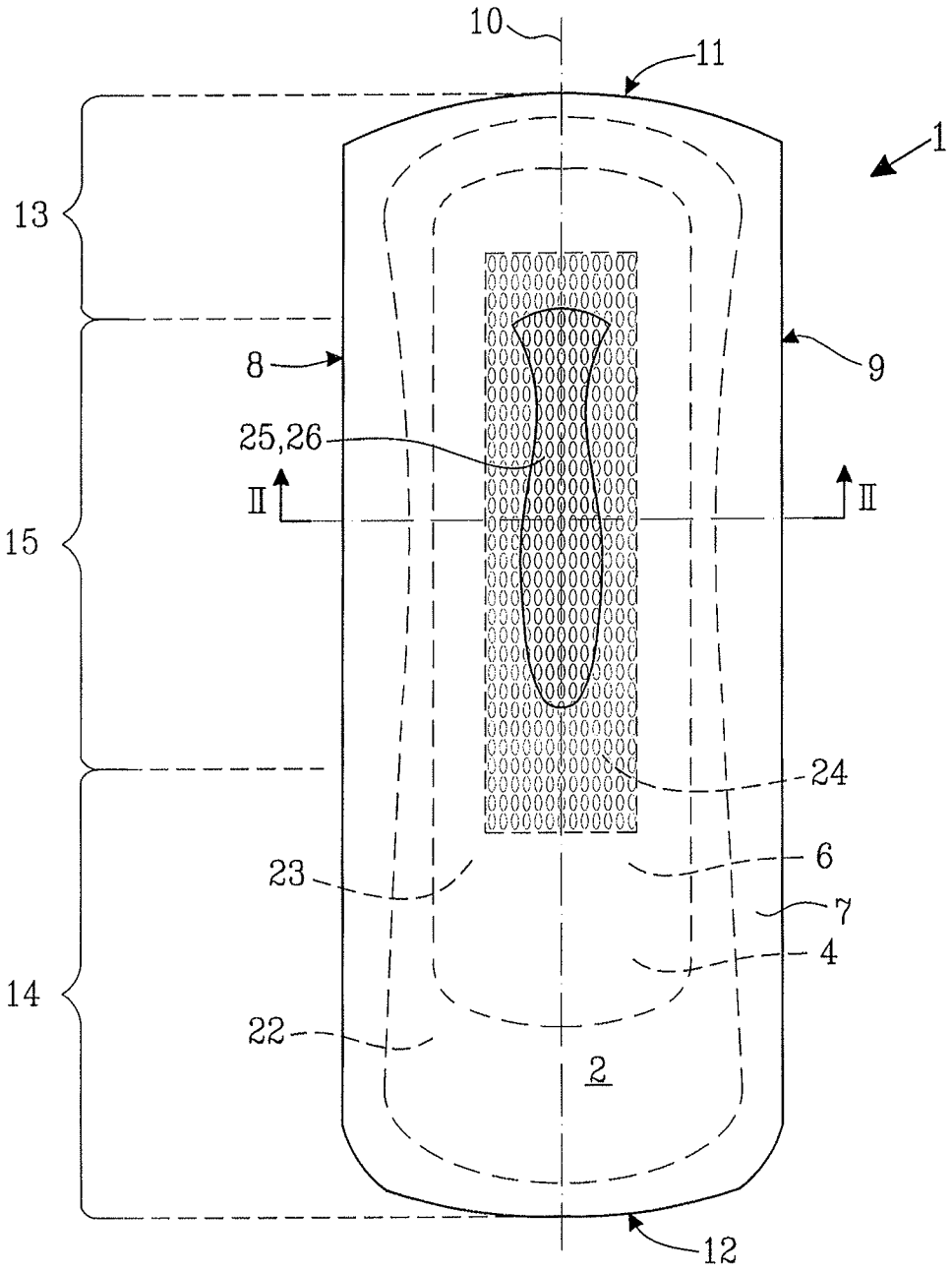

10
11
1
13
8
9
25,26
II
II
15
24
23
6
7
4
14
22
2
12

Fig. 1

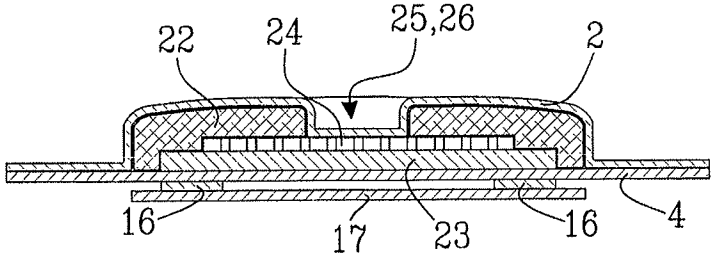

22
24
25,26
2
16
17
23
16
4

Fig. 2

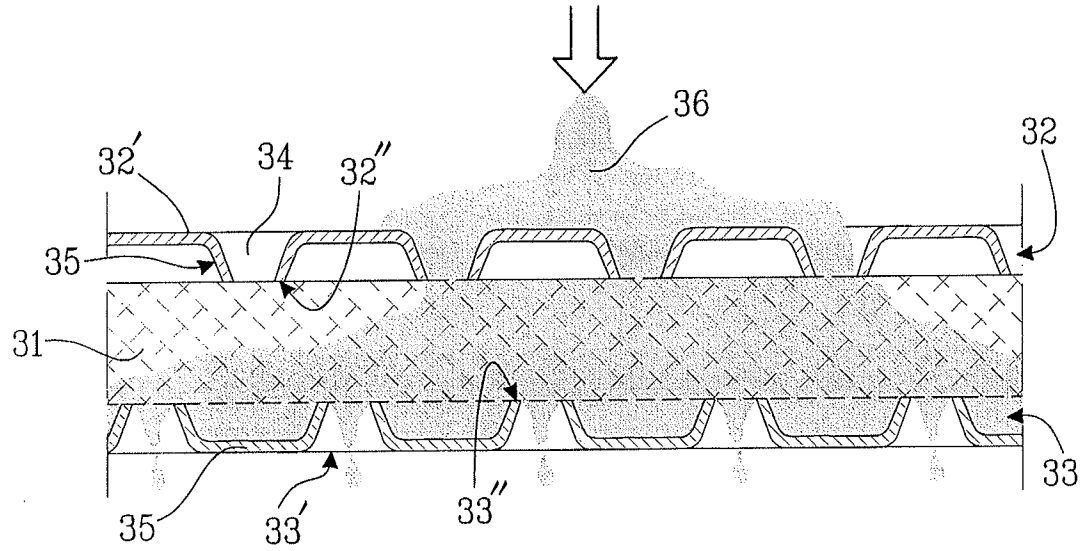


Fig.3

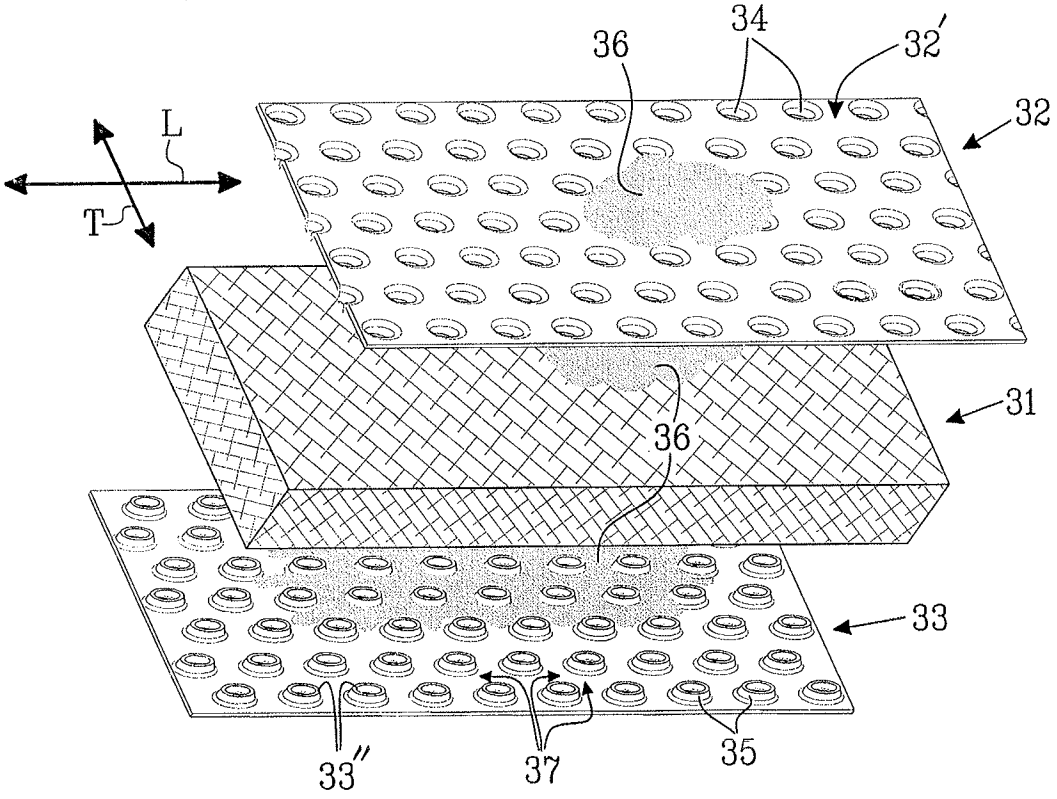


Fig.4

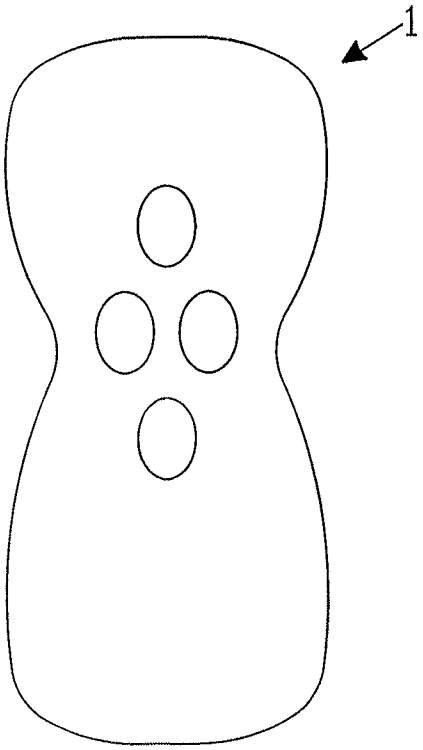


Fig.5a

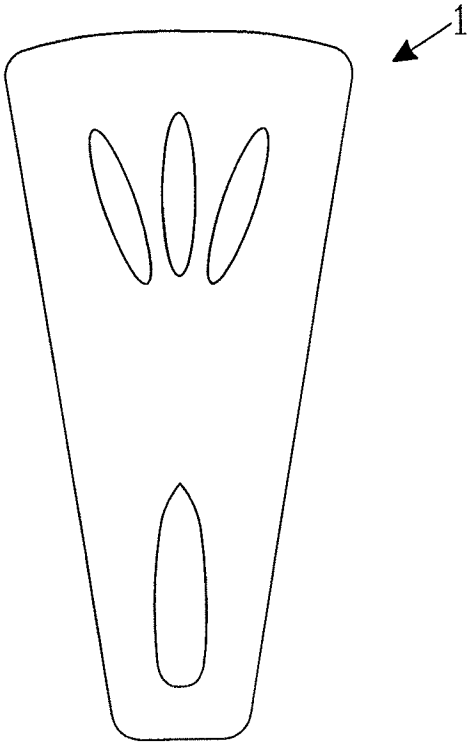


Fig.5b

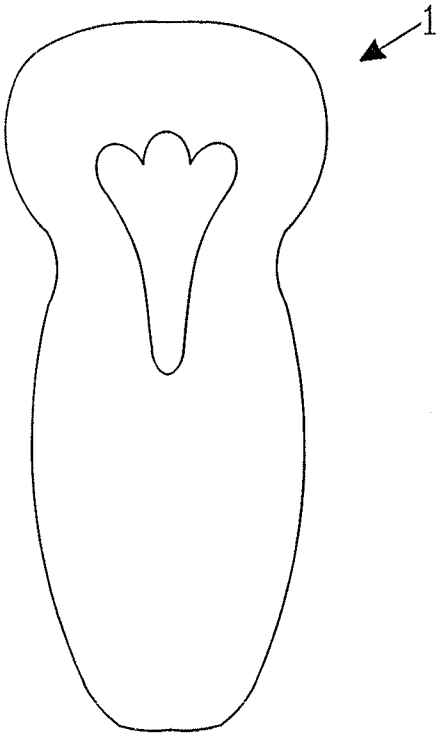


Fig.5c

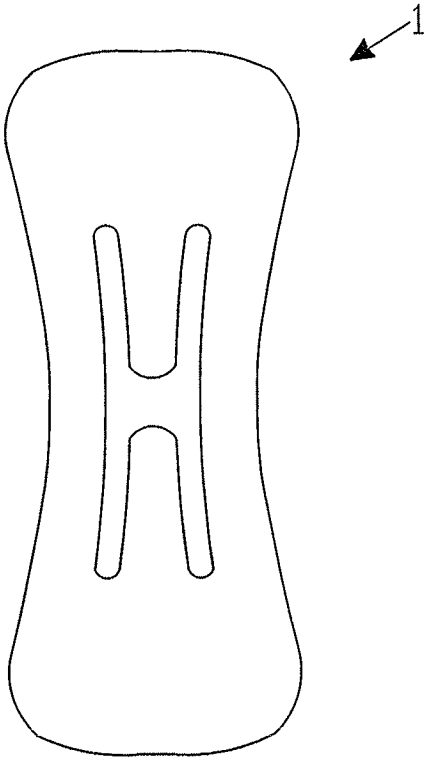


Fig.5d

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

ATTORNEY DOCKET NO.: 049121-0366-00-US-504907

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

ABSORBENT ARTICLE HAVING INTAKE STRUCTURE

The specification of which:

is attached hereto; or

was filed as United States application Serial No. _____ on _____ and was amended on _____ (if applicable); or

was filed as PCT international application Number PCT/SE2011/050859 on June 28, 2011 and was amended under PCT Article 19 on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office information which is material to the patentability of claims presented in this application in accordance with Title 37, Code of Federal Regulations Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate or Section 365(a) of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign applications(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

PRIOR FOREIGN APPLICATION(S):

COUNTRY (if PCT, indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No

I hereby claim the benefits under Title 35, United States Code Section 119(e) of any United States provisional application(s) listed below.

U.S. PROVISIONAL APPLICATIONS

U.S. PROVISIONAL APPLICATION NO.	U.S. FILING DATE:

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) or Section 365(c) of any PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to the patentability of claims presented in this application in accordance with Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT:

U.S. OR PCT INTERNATIONAL APPLICATIONS		STATUS (Check One)		
APPLICATION NO.	FILING DATE	PATENTED	PENDING	ABANDONED
		☐	☐	☐
		☐	☐	☐
		☐	☐	☐
		☐	☐	☐

POWER OF ATTORNEY: As a named inventor, I hereby appoint the registered practitioners included in the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to that Customer Number.

Customer Number: **105855**

Direct Telephone Calls To:

Ronald L. Grudziecki
202-842-8802

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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POST OFFICE ADDRESS		
FOURTH INVENTOR'S SIGNATURE		DATE

Listing of Inventors Continued on attached page(s): ☐ Yes ☒ No

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re APPLICATION of:	)
	)
Patrik ANDERSSON et al.	)
	)
PCT Application No.: PCT/SE2011/050859	)
	)
U.S. Application No. To Be Assigned	)
	)
Filed: Concurrently Herewith	)
	)
FOR: ABSORBENT ARTICLE HAVING INTAKE STRUCTURE	)

PRELIMINARY AMENDMENT

Mail Stop AMENDMENT
Commissioner for Patents
P. O. Box 1450
Alexandria, Virginia 22313-1450

Madam:

Prior to examination of the above-identified application on the merits, please amend the application as follows:

Amendments to the Specification begin on Page 2.

Amendments to the Abstract begin on Page 3.

Amendments to the Claims begin on Page 4.

Remarks begin on Page 10.

IN THE SPECIFICATION:

Please substitute the specification with the enclosed Substitute Specification. Pursuant to 37 C.F.R. §1.25, a marked-up version of the specification showing changes is also enclosed. No new matter is added.

IN THE ABSTRACT:

Please amend the Abstract as follows:

An absorbent article ~~(1) comprising~~ including a fluid permeable topsheet ~~(2)~~, a fluid impermeable backsheet ~~(4)~~ and an absorbent core ~~(6)~~ enclosed between the topsheet ~~(2)~~ and the backsheet ~~(4)~~. The absorbent core ~~(6) comprises~~ includes a first absorbent layer ~~(22)~~ having an opening ~~(25)~~ extending therethrough. A fluid flow control structure ~~(24)~~ is arranged between the first absorbent layer ~~(22)~~ and the backsheet ~~(4)~~. The fluid flow control structure ~~(24)~~ is a layered structure ~~comprising~~ including a non-perforated fibrous polymeric layer ~~(31)~~ and a first perforated polymeric layer ~~(32)~~ having a basis weight of from 50 g/m^2 to100 g/m^2.

~~(Fig. 1 for publication)~~

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of the claims in the application:

Listing of Claims:

Claim 1 (Currently Amended): An absorbent article ~~(1)~~ having a longitudinal direction and a transverse direction, side edges ~~(8,9)~~ extending in the longitudinal direction and end edges ~~(11,12)~~ extending in the transverse direction and comprising a fluid permeable topsheet ~~(2)~~, a fluid impermeable backsheet ~~(4)~~ and an absorbent core ~~(6)~~ enclosed between said topsheet ~~(2)~~ and said backsheet ~~(4)~~, said absorbent core ~~(6)~~ comprising a first absorbent layer ~~(22)~~ having an opening ~~(25)~~ extending therethrough, ~~**characterized in that**~~ wherein a fluid flow control structure ~~(24)~~ is arranged between said first absorbent layer ~~(22)~~ and said backsheet ~~(4)~~, said fluid flow control structure ~~(24)~~ being a layered structure comprising a non-perforated fibrous polymeric layer ~~(31)~~ and a first perforated polymeric layer, ~~(32)~~ wherein the polymers in the first perforated polymeric layer ~~(32)~~ are selected from polyolefins, polyesters, polyamides and blends and combinations thereof, [[said]] the first perforated polymeric layer ~~(32)~~ having a basis weight of from 50 g/m^2 to150 g/m^2.

Claim 2 (Currently Amended): [[An]] The absorbent article according to claim 1, wherein the first perforated polymeric layer ~~(32)~~ has a basis weight of from 60 g/m^2 to 100 g/m^2.

Claim 3 (Currently Amended): [[An]] The absorbent article according to claim 1 ~~or 2~~, wherein [[said]] the first perforated polymeric layer ~~(32)~~ is a nonwoven, a film or a

film/nonwoven laminate~~, said first perforated polymeric layer (32) preferably being a nonwoven material~~.

Claim 4 (Currently Amended): [[An]] The absorbent article according to claim 1~~, 2 or 3~~, wherein [[said]] the first perforated polymeric layer ~~(32)~~ is a three-dimensionally formed layer having penetrating apertures ~~(34), the apertures (34) preferably being funnel-shaped and~~ extending from a first surface ~~(32')~~ of [[said]] the first perforated polymeric layer towards a second surface ~~(32'')~~ of [[said]] the first perforated polymeric layer and forming protrusions ~~(35)~~ on said second surface ~~(32'')~~.

Claim 5 (Currently Amended): [[An]] The absorbent article according to claim 4, wherein [[said]] the first perforated polymeric layer ~~(32)~~ is arranged with said second surface ~~(32'')~~ facing [[said]] the non-perforated fibrous polymeric layer ~~(31)~~.

Claim 6 (Currently Amended): [[An]] The absorbent article according to claim 4, wherein [[said]] the first perforated polymeric layer ~~(32)~~ is arranged with said second surface ~~(32'')~~ facing away from [[said]] the non-perforated fibrous polymeric layer ~~(31)~~.

Claim 7 (Currently Amended): [[An]] The absorbent article according to claim 4 ~~any one of the preceeding claims~~, wherein the average size of the apertures ~~(34)~~ in [[said]] the first perforated polymeric layer ~~(32)~~ is 0.5 - 5 mm.

Claim 8 (Currently Amended): [[An]] The absorbent article according to claim 1 ~~any one of the preceding claims~~, wherein [[the]] open [[area]] areas of [[said]] the first perforated polymeric layer ~~(32) is~~ comprise 5-30% of the first perforated polymeric layer~~, preferably 10-25%~~.

Claim 9 (Currently Amended): [[An]] The absorbent article according to claim 1 ~~any one of the preceding claims~~, wherein said fluid flow control structure ~~(24)~~ is a three-layer structure consisting of [[said]] the non-perforated fibrous polymeric layer ~~(31)~~, [[said]] the first perforated polymeric layer ~~(32)~~ and a second perforated polymeric layer ~~(33)~~, [[said]] the non-perforated fibrous polymeric layer ~~(31)~~ being sandwiched between [[said]] the first perforated polymeric layer ~~(32)~~ and [[said]] the second perforated polymeric layer ~~(33)~~.

Claim 10 (Currently Amended): [[An]] The absorbent article according to claim 9, wherein [[said]] apertures ~~(34)~~ in [[said]] the first perforated polymeric layer and [[said]] the second perforated polymeric layer ~~layers (32,33)~~ are out of register with each other.

Claim 11 (Currently Amended): [[An]] The absorbent article according to claim 9 ~~or 10~~, wherein [[said]] the second perforated polymeric layer ~~(33)~~ has a basis weight of from 50 g/m^2 to 150 g/m^2~~, preferably a basis weight of from 60 g/m^2 to 100 g/m^2~~.

Claim 12 (Currently Amended): [[An]] The absorbent article according to claim 9~~, 10 or 11~~, wherein [[said]] the second perforated polymeric layer ~~(33)~~ is a three-dimensionally formed

layer having apertures ~~(34)~~ extending from a first surface ~~(33')~~ of [[said]] the second perforated polymeric layer towards a second surface ~~(33'')~~ of [[said]] the second perforated polymeric layer and forming protrusions ~~(35)~~ on said second surface of the second perforated polymeric layer ~~(33'')~~.

Claim 13 (Currently Amended): [[An]] The absorbent article according to claim 12, wherein [[said]] the second perforated polymeric layer ~~(33)~~ is arranged with said second surface of the second perforated polymeric layer ~~(33'')~~ facing [[said]] the non-perforated fibrous polymeric layer ~~(31)~~.

Claim 14 (Currently Amended): [[An]] The absorbent article according to claim 12, wherein [[said]] the second perforated polymeric layer ~~(33)~~ is arranged with said second surface of the second perforated polymeric layer ~~(32'')~~ facing away from [[said]] the non-perforated fibrous polymeric layer ~~(31)~~.

Claim 15 (Currently Amended): [[An]] The absorbent article according to claim 12 ~~any one of claims 9-14~~, wherein the average size of the apertures ~~(34)~~ in [[said]] the second perforated polymeric layer ~~(33)~~ is 0.5 - 5 mm.

Claim 16 (Currently Amended): [[An]] The absorbent article according to claim 9 ~~any one of claims 9-15~~, wherein [[the]] open [[area]] areas of the second perforated polymeric layer ~~(33) is~~ comprise 5-30% of the second perforated polymeric layer~~, preferably 10-25%~~.

Claim 17 (Currently Amended): [[An]] The absorbent article according to claim 9 ~~any one of the preceding claims~~, wherein [[said]] the second perforated polymeric layer ~~(33)~~ is a nonwoven, a film or a film/nonwoven laminate~~, said second perforated polymeric layer (33) preferably being a nonwoven material~~.

Claim 18 (Currently Amended): [[An]] The absorbent article according to claim 1 ~~any one of the preceding claims~~, wherein a second absorbent layer ~~(23)~~ is arranged between said fluid flow control structure ~~(24)~~ and said backsheet ~~(4)~~.

Claim 19 (Currently Amended): [[An]] The absorbent article according to claim 1 ~~any one of the preceding claims~~, wherein the thickness of [[the]] said flow control structure ~~(24)~~ at 5 kPa is 60-80% of the thickness at 0.5 KPa at a first , second and third compression performed according to the compression test disclosed herein.

Claim 20 (Currently Amended): [[An]] The absorbent article according to claim 1 ~~any one of the preceding claims~~, wherein the bending stiffness of the laminate material in said fluid flow control structure is 0.5 -5 N~~, preferably 1-4 N,~~ as measured by the modified ASTM D 4032-82 CIRCULAR BEND PROCEDURE.

Claim 21 (Currently Amended): [[An]] The absorbent article according to claim 1 ~~any one of the preceding claims~~, wherein the basis weight of the non-perforated fibrous polymeric layer ~~(31)~~ is from 20-120 gsm~~, preferably from 60-100 gsm~~.

REMARKS

Applicants respectfully request that the Examiner consider the specification, claims, and abstract as amended in this Preliminary Amendment for examination purposes. Entry of this Preliminary Amendment is respectfully requested. Upon entry, claims 1-21 remain pending.

Applicants have amended the claims to, among other things, remove multiple dependencies and reference numbers. The specification has been amended to insert related application data, and to conform the specification to U.S. format. No prohibited new matter has been introduced by these amendments as the amendments are supported by at least the original disclosure.

Should any questions arise in connection with this application, or should the Examiner believe a telephone conference would be helpful in resolving any remaining issues pertaining to this application, it is respectfully requested that the undersigned be contacted at the number indicated below.

EXCEPT for issue fees payable under 37 C.F.R. § 1.18, the Commissioner is hereby authorized by this paper to charge any additional fees during the entire pendency of this application including fees due under 37 C.F.R. §§ 1.16 and 1.17 which may be required, including any required extension of time fees, or credit any overpayment to Deposit Account 50-0573. This paragraph is intended to be a CONSTRUCTIVE PETITION FOR EXTENSION OF TIME in accordance with 37 C.F.R. § 1.136(a)(3).

Respectfully Submitted,

Date: December 26, 2013

By: 

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ABSTRACT:

An absorbent article including a fluid permeable topsheet, a fluid impermeable backsheet and an absorbent core enclosed between the topsheet and the backsheet. The absorbent core includes a first absorbent layer having an opening extending therethrough. A fluid flow control structure is arranged between the first absorbent layer and the backsheet. The fluid flow control structure is a layered structure including a non-perforated fibrous polymeric layer and a first perforated polymeric layer having a basis weight of from 50 g/m^2 to100 g/m^2.

ABSORBENT ARTICLE HAVING INTAKE STRUCTURE

CROSS-REFERENCE TO PRIOR APPLICATION

[0001] This application is a §371 National Stage Application of PCT International Application No. PCT/SE2011/050859 filed June 28, 2011, which is incorporated herein in its entirety.

TECHNICAL FIELD

[0002] The ~~invention~~ disclosure pertains to an absorbent article ~~comprising~~ including a fluid permeable topsheet, a fluid impermeable backsheet and an absorbent core enclosed between the topsheet and the backsheet, the absorbent core ~~comprising~~ including a first absorbent layer and ~~comprising~~ including an opening extending through the first absorbent layer.

BACKGROUND ~~OF THE INVENTION~~

[0003] Absorbent articles of the kind that is worn inside ordinary underpants include incontinence shields and sanitary napkins. As these articles have to be sized and configured to fit in the limited space available in the crotch portion of the underwear, the articles are by necessity designed with a relatively small width. For this reason, a particular problem with such articles is that they may leak at the side edges, before the full absorption capacity of the article has been utilized.

[0004] Side leakage may occur as a consequence of absorbed fluid being dispersed equally fast in all directions from the point where the fluid enters the article. This will lead to the fluid escaping the article at the side edges before being distributed to the end portions of the article. Another cause of side leakage may be when the intake capacity of the article is insufficient to allow all fluid that is exuded onto the article to directly enter inside the article. Instead, the fluid will flow on the topsheet and out over the side edges of the article where it can leak out and soil the wearer's clothing. A further drawback when fluid flows on the outside of the topsheet is that a large portion of the body-contacting topsheet will be

wet. This is of course highly undesirable as it makes the article unhygienic and unpleasant to wear.

[0005] Incontinence shields and sanitary napkins are designed to have a total absorption capacity that is large enough to absorb all fluid that is expected to be released to the absorbent article during a period of wear. However, the fluid is normally not exuded in a steady flow but as sudden gushes of relatively large volume under high pressure and during a very short time period. Accordingly, it would be desirable if the absorbent article was able to receive and contain the emitted fluid with corresponding speed.

[0006] Great efforts have been made in the past in order to overcome the side leakage problem in relation to disposable absorbent articles such as incontinence shields and sanitary napkins. However, to date no such effort has been completely successful.

[0007] International publication WO 2009/105000 discloses a laminate fibrous web having recesses with a diminishing cross-sectional area in a thickness direction of the web. The web can be used as a fluid intake material and is taught to improve fluid flow through the web.

[0008] Although the prior art laminate material may alleviate the side leakage problem to some extent, there is still a great need for further improvements of the side leakage security for the kind of absorbent article that is worn in the crotch portion of an undergarment.

SUMMARY ~~OF THE INVENTION~~

[0009] ~~In accordance with the invention, there is provided~~ It is desired to provide an absorbent article having improved intake capacity, fluid distribution properties and leakage security.

[0010] In a first aspect, an [[The]] absorbent article ~~according to the invention has~~ is provided having a longitudinal direction and a transverse direction, side edges extending in the longitudinal direction and end edges extending in the transverse direction and ~~comprises~~ including a fluid permeable topsheet, a fluid impermeable backsheet and an absorbent core enclosed between the topsheet and the backsheet.[[, the]] The absorbent core ~~comprising~~ includes a first absorbent layer, and the first absorbent layer has ~~having~~ an opening extending therethrough. A fluid flow control structure is arranged between the

first absorbent layer and the backsheet, the fluid flow control structure being a layered structure ~~comprising~~ including a non-perforated fibrous polymeric layer and a first perforated polymeric layer, the first perforated polymeric layer having a basis weight of from 50 g/m^2 to150 g/m^2, ~~preferably~~ or a basis weight of from 60 g/m^2 to 100 g/m^2.

[0011] The fluid flow control structure provides the article with high intake capacity.

[0012] Moreover, the article in accordance with the first aspect can provide ~~of the invention provides~~ a large void volume for temporary storage of fluid. The void volume is created both by the hollow space or well formed at the opening in the absorbent layer and internally in the porous fluid flow control structure. As soon as the fluid has entered into the fluid flow control structure it may run in the open pore structure of the non-perforated layer and be distributed away from the initially wetted area of the absorbent article. The fluid flow control structure not only enhances fluid transport away from the initially wetted area but also promotes fluid distribution throughout the absorbent core both in the length direction and in the thickness direction of the article. The width of the fluid flow control structure may be smaller than the width of the first absorbent layer, whereby the fluid dispersion rate changes at the edge of the fluid flow control structure. In particular embodiments, the [[The]] fluid flow control structure is ~~preferably~~ a highly porous structure with less resistance to fluid flow than the first absorbent layer, implying that fluid will by preference continue to move in the fluid flow control structure. Accordingly, the edges of the fluid flow control structure may act as barriers to fluid distribution transversely to the side edges of the absorbent article, reducing the risk of side failure.

[0013] [[The]] In particular embodiments, the opening through the first absorbent layer is ~~preferably~~ placed in the wetting area of the article. The wetting area of the article is that part of the article which is designed to be initially wetted by emitted fluid when the article is being worn and is located in a crotch area of the absorbent article. By arranging the opening in the first absorbent layer in the wetting area, emitted fluid can flow directly into the opening and be collected and temporarily contained in the space defined by the opening and adjacent layers of the absorbent article.

[0014] The first absorbent layer in an absorbent article ~~of the invention~~ may have one or more openings. The opening or openings may be of any suitable shape or combination of

shapes, such as circular, oval, rectangular, square, star-shaped, flower-shaped, heart-shaped, H-shaped, T-shaped, I-shaped etc. Accordingly, the positioning, shape and size of the opening or openings may be varied within the scope of the invention.

[0015] Due to its high basis weight and the combination of a perforated layer and a non-perforated layer, the fluid flow control structure will preferably have relatively high bending stiffness. A high bending stiffness provides the absorbent article with an improved ability of resisting transverse compression between the thighs of a wearer of the article and counteracts unwanted deformation of the article during wear, such that the opening in the first absorbent layer is kept open for fluid reception throughout use of the article. The bending stiffness or flexure resistance of the laminate material in the fluid flow control structure may be 0.5 -5 N, ~~preferably~~ or 1-4 N, as measured by the modified ASTM D 4032-82 CIRCULAR BEND PROCEDURE. It may be desirable that the bending stiffness of any part of the absorbent article extending laterally outside of the fluid flow control structure has a lower bending stiffness than the fluid flow control structure whereby such less stiff lateral portions of the absorbent article may act as cushioning means between the fluid flow control structure and the wearer's legs.

[0016] The absorbent article ~~according to the invention~~ may ~~comprise~~ include a second absorbent layer being arranged between the fluid flow control structure and the backsheet.

[0017] The first perforated polymeric layer may be a nonwoven, a film or a film/nonwoven laminate. ~~Preferably~~ In certain embodiments, the first perforated polymeric layer is a nonwoven material. Suitable polymers for the first perforated polymeric layer may be polyolefins, polyesters, polyamides and blends and combinations of such polymers with polypropylene being an exemplary polyolefin ~~preferred~~. The nonwoven materials may be carded resin bonded materials, carded through-air bonded materials, spunbond-meltbond-spunbond (SMS) materials, carded hydroentangled materials or carded thermobonded materials.

[0018] The first perforated polymeric layer may be a three-dimensionally formed layer having penetrating apertures, the apertures extending from a first surface of the layer towards a second surface of the layer, forming protrusions on the second surface and, in particular embodiments, ~~preferably being~~ the apertures are funnel-shaped. With a funnel-

shaped aperture as used herein is implied an aperture having a tapering shape in its direction of extension such that the cross-sectional area of the aperture is diminishing when moving along the aperture.

[0019] The first perforated polymeric layer may be arranged with the second surface facing the non-perforated fibrous polymeric layer or may be arranged with the second surface facing away from the non-perforated fibrous polymeric layer.

[0020] The first perforated polymeric layer may be arranged as the first layer of the fluid flow control structure, i.e. as the layer of the structure that is located closest to the topsheet.

[0021] The apertures in the first perforated polymeric layer may have an average size of 0.5 – 5 mm, measured at the smallest diameter of the apertures.

[0022] The open area of the first perforated polymeric layer may be 5-30%, ~~preferably~~ or 10-25%.

[0023] The non-perforated fibrous polymeric layer may be a high loft material of 20-120 gsm, ~~preferably~~ or 60-100 gsm. The polymer for the non-perforated fibrous polymeric layer may be polyester.

[0024] The fluid flow control structure may be a three-layer structure including ~~consisting of~~ the non-perforated fibrous polymeric layer, the first perforated polymeric layer and a second perforated polymeric layer, the non-perforated fibrous polymeric layer being sandwiched between the first perforated polymeric layer and the second perforated polymeric layer.

[0025] The second perforated polymeric layer may be a three-dimensionally formed layer having apertures extending from a first surface of the web towards a second surface of the web and forming protrusions on the second surface.

[0026] The layers in the fluid flow control structure may be attached to each other by means of an adhesive. However, other means of joining of the layers such as thermo-bonding by hot embossing or ultrasonic bonding may be used as well as layers being joined without using any bonding means. The fluid flow control structure ~~of the invention~~ has an overall planar shape. In particular embodiments, the non-perforated fibrous polymer layer ~~should preferably have~~ has uniform thickness and a uniform pore structure. ~~Bonding~~ In further embodiments, bonding between the layers ~~should preferably be~~ is

carried out so as to have minimum impact on the shape and pore structure of the non-perforated fibrous polymer layer.

[0027] The polymer materials of the fluid flow control structure may be non-absorbent materials which do not retain any fluid in the material itself. The function of the fluid flow control structure is to provide the absorbent article with temporary fluid holding capacity and to distribute fluid in the article. As the polymer materials in the fluid flow control structure may be hydrophobic, and may have a wetting angle (θ) of 90° or close to 90° implying that they have no or very low wettability when contacted with aqueous fluids, it is may be an advantage if the components of the fluid flow control structure have been treated to lower the wetting angle and render them hydrophilic, i.e. wettable by body fluids. A perfectly wettable material has a wetting angle (θ) of 0°. Any commonly known method for rendering a hydrophobic material hydrophilic may be used, such as treatment with surfactants, plasma or corona treatment, etc.

[0028] One aspect of an example embodiment concerns a three-layer fluid flow control structure, wherein both the first perforated polymeric layer and the second perforated polymeric layer may be a three-dimensionally formed layer having penetrating, ~~preferably~~ including, for example, funnel-shaped apertures, extending from a first surface of the layer towards a second surface of the layer and forming protrusions on the second surface. Both perforated polymeric layers may be arranged with the second surface facing the non-perforated fibrous polymeric layer arranged between the perforated polymeric layers.

[0029] The apertures in the first and second perforated polymeric layers may be out of register with each other. When the apertures in the first and second perforated polymeric layers are out of register with each other, fluid impinging one of the layers cannot pass directly through the thickness of the fluid flow control structure but is forced to take a more tortuous path through the fluid flow control structure. Moreover, when fluid enters the fluid flow control structure through a first perforated polymeric layer that is arranged facing the topsheet of the article at least some of the fluid travels downward towards the backsheet. When the fluid reaches the second perforated polymeric layer at a non-perforated location, the fluid will run along the second perforated polymeric layer and be distributed inside the fluid flow control structure until it eventually may escape through an

aperture in the second perforated polymeric layer. The second perforated polymeric layer may be a three-dimensionally shaped material with apertures forming protrusions on the side of the second perforated polymeric layer that is facing the non-perforated fibrous polymer layer of the fluid flow control structure. In such case, a network of interconnected channels is formed between the protrusions in which network the fluid may be captured and may flow a long distance away from the initially wetted area before leaving the fluid flow control structure.

[0030] Three-dimensionally shaped first and second perforated polymeric layers may be oriented with the apexes of the apertures, i.e. the protrusions, directed towards the non-perforated fibrous polymer layer or away from the non-perforated fibrous polymer layer. The three-dimensionally shaped first and second perforated polymeric layers and the high-loft non-perforated fibrous polymeric layer together contribute to the void volume of the fluid flow control structure and to the ability of the structure to contain and move fluid therethrough.

[0031] When the fluid flow control structure is a three-layer structure ~~consisting of~~ including a non-perforated fibrous polymeric layer that is sandwiched between a first perforated polymeric layer and a second perforated polymeric layer, the second perforated polymeric layer may be different from the first perforated polymeric layer with regard to chemical composition, physical composition, three-dimensionality, open area, aperture size etc. Alternatively, the second perforated polymeric layer may be identical to the first perforated polymeric layer. The second perforated polymeric layer may thus have a basis weight, open area and aperture size ~~in accordance~~ corresponding to the first perforated polymeric layer.

[0032] Both perforated polymeric layers may be three-dimensionally formed layers as disclosed herein. Each layer may have penetrating apertures that originate in a first surface of the layer and extend towards a second surface of the layer, with the apexes of the apertures forming protrusions at the second surface of the layer. The apertures may be tubular structures, including, for example, ~~and are preferably~~ funnel-shaped with a diminishing cross-sectional area when moving in a direction from the first surface to the second surface of the perforated layer.

[0033] Alternatively, one or both perforated polymer layers may be two-dimensional layers. When at least one of the perforated polymer layers is a three-dimensionally formed layer, such three-dimensionally formed perforated layer may be arranged with the first surface facing away from the non-perforated polymeric layer or with the first surface facing towards the non-perforated polymeric layer. In an absorbent article according to an embodiment of the invention, a three-dimensionally formed perforated polymer layer being oriented with the protrusions facing towards the topsheet of the article will generally promote fluid distribution in the X-Y plane, i.e. in the longitudinal and transverse directions of the article, to a higher extent than a three-dimensionally formed perforated polymer layer being oriented with the protrusions facing towards the backsheet of the article which will generally promote fluid transport in the Z-direction of the article, i.e. in the thickness direction.

[0034] The first and second perforated polymeric layers may pass fluid therethrough but act as protective barriers that prevent particles and fibres from entering the fluid flow control structure and interfering with fluid transport inside the fluid flow control structure. The particles and fibres may be absorbent materials from such as absorbent polymer particles commonly known as "superabsorbents", cellulose fluff pulp fibres, etc.

[0035] The fluid flow control structure may have a high resistance to compression as measured in the Compression Test disclosed herein. Accordingly, the thickness of the flow control structure at 5 kPa may be 60-80% of the thickness at 0.5 KPa at a first, second and third compression performed according to the compression test disclosed herein.

[0036] In an absorbent article according to an embodiment of the invention, the first absorbent layer may have more than one opening extending therethrough. The openings may be placed in the same general area of the absorbent article, such as in a crotch portion of the article or may be placed in different portions of the article such as in two or more of the crotch portion and the end portions. The crotch portion, as used herein, is the portion of the article that is designed to be placed in the crotch of a wearer and to be in contact with the pudendal area of the wearer. The crotch portion includes the wetting area of the article and can be asymmetrically placed in the longitudinal direction of the article. The end portions are placed on either side of the crotch portion in the longitudinal direction of

the article. The article may be designed with end portions that are specifically adapted to be placed towards the front or the rear of a wearer and may then differ in size, shape, etc. to allow a user to apply the article in a correct way inside the underwear.

[0037] The absorbent article ~~of the invention~~ may be provided with means for fastening of the article in ordinary underwear or other supporting pant-garment. The fastening means may be adhesive fasteners, frictional fasteners, mechanical fasteners such as the hook part of a hook-and-loop fastener or combinations of different types of fasteners, as known in the art.

[0038] The absorbent article may be a diaper of the open type that is fastened around the lower torso of a wearer by means of tape fasteners, belts or similar or may be a closed-type pant diaper. The absorbent article may alternatively be of a kind that is worn inside a supporting panty or with a holder, such as a sanitary napkin, a panty liner or an incontinence protector. ~~Preferably~~ In certain embodiments, the absorbent article is an incontinence protector.

[0039] An absorbent article ~~according to the invention~~ may comprise a fluid permeable topsheet, disposed at the surface of the incontinence protector which is intended to be facing a wearer of the incontinence protector, a backsheet disposed at the surface of the incontinence protector that is intended to be facing the undergarment of the wearer, and an absorbent core, enclosed between the topsheet and the backsheet.

[0040] The covering may be of a kind where the topsheet and the backsheet of the incontinence protector extend together laterally outside of the absorbent core along the whole circumference of the absorbent core and are connected to each other in an edge join around the periphery of the absorbent core. An edge join may be formed in any suitable manner as known in the art such as by means of adhesive, ultrasonic bonding, thermobonding, stitching, etc. Alternative covering arrangements such as wrapped-around covers are also conceivable within the scope of the invention.

[0041] The topsheet may ~~consist of~~ include any material which is suitable for the purpose. Examples of commonly found topsheet materials are nonwoven materials, perforated plastic films, plastic or textile mesh, and fluid permeable foam layers. Laminates ~~consisting of~~ include two or more topsheet materials are also commonly employed, as are

topsheets including ~~consisting of~~ different materials within different parts of the fluid permeable wearer-facing surface. [[The]] In certain embodiments, the topsheet is ~~preferably~~ a non-apertured nonwoven web.

[0042] The backsheet is preferably fluid impermeable. However, backsheet materials that are only resistant to fluid penetration may be used particularly in instances where relatively small amounts of urine are expected to be taken up by the incontinence protector. The backsheet may be a thin, flexible, fluid-impermeable plastic film, but fluid-impermeable nonwoven materials, fluid impermeable foams and fluid impermeable laminates are also contemplated within the scope of the invention. The backsheet may be breathable, implying that air and vapor may pass through the backsheet. Furthermore, the backsheet may have an outer, garment-facing surface of a textile material such as nonwoven.

[0043] The absorbent core may be made up of any suitable absorbent or fluid uptake material as known in the art, such as one or more layers of cellulose fluff pulp, foam, fiber waddings, etc. The absorbent core may contain fibers or particles of highly absorbent polymer material, commonly known as superabsorbents, which are materials having the ability to absorb and retain large quantities of fluid upon formation of a hydrogel. The superabsorbents may be mixed with cellulose fluff pulp and/or may be arranged in pockets or layers in the absorbent core. The absorbent core may further incorporate components for improving the properties of the absorbent core. Some examples of such components are binder fibers, fluid-dispersing materials, fluid acquisition materials, etc. as known in the art.

[0044] The absorbent article may ~~comprise~~ include more than one absorbent core. The cores may be an upper larger core and a lower, smaller core.

[0045] The article may further ~~comprise~~ include components such as elastic elements. The elastic elements may be arranged along the side edges of the absorbent article. Elastic elements arranged along the side edges of the absorbent article improve the anatomical fit of the article by inducing longitudinal bending of the article in conformation with the curvature in a wearer's crotch.

[0046] When the absorbent core ~~comprises~~ includes a first absorbent layer and a second absorbent layer the fluid flow control structure may be arranged between the first

absorbent layer and the second absorbent layer. The first absorbent layer may be placed beneath and in direct contact with the topsheet. Alternatively, the first absorbent layer may be placed in indirect contact with the topsheet through one or more intervening components such as tissue layers, acquisition layers or further absorbent layers. Similarly, the second absorbent layer may be placed directly beneath the fluid flow control structure and in direct contact with the fluid flow control structure and the backsheet but may alternatively be in indirect contact with one or both of those components by intervening components.

[0047] The absorbent layers of the core may be homogeneous structures or may in themselves be layered structures such as absorbent laminates of the same or different materials. The absorbent layers may have uniform thickness or may vary in thickness in different parts of the layers. Similarly, the basis weight and composition may vary within the absorbent layers. By way of example, an absorbent layer may ~~comprise~~ include a mixture of absorbent and/or non-absorbent fibres and superabsorbent material, wherein the ratio of superabsorbent material to fibres may vary in the layer.

[0048] The fluid flow control structure may be of rectangular shape and may be surrounded in the longitudinal and lateral directions by portions of the absorbent core. Although other shapes and configurations for the fluid flow control structure may be used, it is generally advantageous if the fluid flow control structure has the same or smaller width than the absorbent core and also the same or shorter length than the absorbent core. The fluid flow control structure has a highly porous internal structure with less resistance to fluid flow than conventional absorption materials. This means that the fluid dispersion rate changes at the edge of the fluid flow control structure so that fluid reaching the edge will continue to move primarily in the fluid flow control structure where the flow resistance is low before being absorbed by the core material. In this way, the edges of the fluid flow control structure act as barriers to fluid distribution transversely to the side edges of the absorbent article, thus reducing the risk of side failure. Conventional absorption materials such as cellulose fluff pulp, and superabsorbents have comparatively smaller capillaries than the fluid flow control structure. A fibrous structure with fine capillaries has a low fluid uptake capacity, but high fluid retention capability once the fluid

has entered the structure. A superabsorbent material has even lower uptake rate and higher retention capability than the fibrous absorbent structures due to fluid uptake in such materials being driven mainly by osmotic pressure.

[0049] The components in the absorbent article may be connected to each other by conventional means such as construction adhesive, heat bonding, ultrasonic bonding, etc. It may not be necessary to bond internal components of the absorbent article to each other by special bonding means. Accordingly, it may suffice that such components are held together by frictional forces.

TEST METHODS

[0050] The modified ASTM D 4032-82 CIRCULAR BEND PROCEDURE

Apparatus:

[0051] The apparatus is a modified Circular Bend Stiffness Tester, having the following parts:

[0052] - A smooth-polished steel plate platform which is 102.0 x 102.0 x 6.35 millimeters having an 18.75 millimeter diameter orifice. The lap edge of the orifice should be at a 45 degree angle to a depth of 4.75 millimeters.

[0053] - A plunger having an overall length of 72.2 millimeters, a diameter of 6.25 millimeters, a ball nose having a radius of 2.97 millimeters and a needle point extending 0.88 millimeter therefrom having a 0.33 millimeter base diameter and a point having a radius of less than 0.5 millimeter, the plunger being mounted concentric with the orifice and having equal clearance on all sides. Note that the needle point is merely to prevent lateral movement of the test specimen during testing. Therefore, if the needle-point significantly adversely affects the test specimen (for example, punctures an inflatable structure), then the needle-point should not be used. The bottom of the plunger should be set well above the top of the orifice plate. From this position, the downward stroke of the ball nose is to the exact bottom of the plate orifice.

[0054] - A force-measurement gauge and more specifically an Instron inverted compression load cell. The load cell has a load range of from 0.0 to 10 N.

[0055] - An actuator, and more specifically an Instron™ tester having an inverted compression load cell. The Instron ™ tester is made by the Instron Engineering Corporation, Canton, Massachusetts.

Number and preparation of specimens:

[0056] In order to perform the procedure for this test, 10 test specimens of 37.5 x 37.5 millimeter are cut from the tested laminate material.

Procedure:

[0057] The procedure for the CIRCULAR BEND PROCEDURE is as follows. The specimens are conditioned by leaving them in a room which is 21 ± 1° and 50 ± 2% relative humidity for a period of two hours. The test plate is leveled. The plunger speed is set at 50.0 centimeters per minute per full stroke length. A specimen is centered on the orifice platform below the plunger such that the body surface of the specimen is facing the plunger and the garment surface is facing the platform. The indicator zero is checked and adjusted, if necessary. The plunger is actuated. Touching the specimen during the testing should be avoided. The maximum force reading to the nearest gram is recorded. The above steps are repeated until all five of the identical specimens have been tested.

Compressibility

Procedure:

[0058] The principle of the method is to slowly compress a material with a metal rod to a force of 5 N while continuously measuring the thickness of the material. The result ~~consists of~~ includes the data points for force and extension. The force translates to a pressure given the contact area of the rod. The metal rod is cylindrical and has a diameter of 10 mm with a flat base. The rod is mounted in a 10N load cell in the upper fixture of an Instron testing apparatus. A flat plate is mounted in the bottom fixture and is centered under the rod [[to]] so that a sample may be placed on top of the plate and be compressed without movement of the plate. The rate of movement of the rod is 5 mm per minute. These settings have been pre-programmed into an Instron Bluehill program called "New Mecano 5 N", but before running a test, the program settings should be checked in order to

make sure that all limits are set to their proper values. Running with a modified version could lead to damage to the equipment, especially the sensitive load cell.

Running a test:

[0059] The first run is an empty run without a sample. This run is used to find the zero thickness position, which is where the steel plate stops the rod. The empty run typically generates forces higher than the maximum limit set before the rod stops, because of the rapid increase in force that occurs when the rod impacts the metal and for which the apparatus cannot compensate sufficiently quickly. Care should be taken to ascertain that the load cell can withstand the impact without being damaged. Special settings can be used for the empty run to lower the limiting maximum force and the speed of the rod.

[0060] When the rod stops, the Instron equipment awaits user input. The extension is then manually reset to zero. This ensures that the extension is set to zero at the exact correct point where the rod touches the base and the extension is measured relative to the bottom plate. The rod may thereafter be manually moved up so that a sample can be placed on the lower plate.

[0061] To test a sample, the rod is moved manually so that it is above the surface of the sample and the program is started. The rod moves down at a speed of 5 mm per minute until the limiting force is reached.

Samples:

[0062] The samples are squares with 50 millimeter sides punched from the tested material. If the material has varying thickness, the samples are taken from the thickest parts of the material. The rod is pressed into the centre of the sample and each sample is tested three times without being moved between runs. Ten samples of each tested material are used, giving thirty measurements in total.

Results:

[0063] The result is the complete set of data points for force versus extension. The force is typically recalculated into pressure using the force measured divided by the bottom area of the rod. The result may be plotted and reported or a specific pressure may be chosen and the thickness noted, so that the result is a thickness for a given pressure.

Open Area and Hole Diameter Measurement

[0064] The following method may be used to determine the open area and hole diameter for an apertured material:

Apparatus:

[0065] - a Nikon microscope

[0066] - a personal computer

[0067] - software NIS-Elements BR 3.10

Procedure:

[0068] - collect a sample of the apertured material

[0069] - position the sample on the reading surface of the microscope

[0070] - start the software

[0071] - catch a representative image of the sample

[0072] - perform the analysis of the properties by contrast technique involving highlighting of the areas occupied by the holes.

[0073] The software calculates the diameters of the highlighted holes as major diagonal and minor diagonal of a rhombus inscribed in the hole. The ratio between the diameters is used to determine the actual average conformation of the holes to a circular shape, wherein a ratio of 1 implies a perfectly circular shape.

[0074] The average hole area value obtained by means of the software is used to calculate the percent open area.

[0075] Alternative methods for determining open area and hole diameter may be used, such as manual methods and methods based on scanning electron microscopy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0076] [[The]] Embodiments of the invention will be described in greater detail below with reference to the figures shown in the appended drawings.

[0077] Figure 1 shows an incontinence protector according to an embodiment of the invention, seen from the side which will be facing the undergarment when the incontinence protector is being worn;

[0078] Figure 2 shows a cross-section through the incontinence protector in Fig. 1, taken along the line II-II;

[0079] Figure 3 shows a section through a fluid flow control structure according to an embodiment of the invention;

[0080] Figure 4 shows an exploded perspective view of a fluid flow control structure according to an embodiment of the invention; and

[0081] Figures 5a-d show absorbent layers having openings therein.

DESCRIPTION OF EMBODIMENTS

[0082] The absorbent article ~~of the invention~~ is exemplified by an incontinence protector as shown in Figs. 1 and 2. It is to be understood that the invention is equally applicable to any type of hygienic absorbent article. Such articles include incontinence protectors, sanitary napkins, panty liners, diapers with tape fasteners, pant diapers or belted diapers.

[0083] Fig. 1 shows a urine incontinence protector 1 seen from the side of the incontinence protector 1 that is intended to be facing towards a wearer's body when the incontinence protector 1 is being worn.

[0084] The incontinence protector 1 ~~comprises~~ includes a fluid permeable topsheet 2, a backsheet 4 and an absorbent core 6, enclosed between the topsheet 2 and the backsheet 4.

[0085] The topsheet 2 and the backsheet 4 of the incontinence protector 1 are shown to extend together laterally outside of the absorbent core 6 along the whole circumference of the absorbent core 6 and are connected to each other in an edge join 7 around the periphery of the absorbent core 6.

[0086] The topsheet 2 and the backsheet 4 may ~~consist of~~ include any material suitable for the particular purpose, as disclosed herein.

[0087] The incontinence protector 1 as shown in Figs. 1 and 2 has elongate, generally rectangular shape when fully extended in all directions. The word "generally" in this context means that, for instance, the corners of the incontinence protector 1 may be rounded, or that the edges of the incontinence protector 1 may not be completely linear as is illustrated in Fig 1. The shape of the incontinence protector 1 shown in Fig. 1 should not be considered limiting to the invention. Accordingly, any other suitable shape may be

used, such as hourglass shape, trapezoidal shape, triangular shape an oval shape, etc. The shape of the article ~~of the invention~~ may be symmetrical about a transverse centre line through the article, as shown in Fig. 1 or may be asymmetrical with end portions having differing shapes and/or differing sizes.

[0088] The incontinence protector 1 in Figs. 1 and 2 has two longitudinal side edges 8, 9 having equal length and extending generally in the same direction as a longitudinal center line 10 through the incontinence protector 1. Front and rear end edges 11, 12 extend transversely to the longitudinal center line 10 at the ends of the incontinence protector. The rear end edge 12 is intended to be orientated rearwards during use of the incontinence protector 1, and the front end edge 11 is intended to be facing forwards towards the abdomen of the wearer.

[0089] The incontinence protector 1 has a front end portion 13, a rear end portion 14 and a crotch portion 15 located intermediate the end portions 13,14. The crotch portion 15 is that portion of the incontinence protector 1 which is intended to be placed against the crotch of a wearer during wearing of the protector 1 and to constitute the main acquisition area for body fluid that reaches the protector 1.

[0090] The incontinence protector 1 further has fastening means 16 for fastening of the incontinence protector 1 inside a supporting pant garment, such as a pair of underpants. The fastening means 16 is in the form of two longitudinally extending bands of pressure sensitive adhesive arranged on the garment-facing surface of the backsheet 4. In Fig. 2, the fastening means 16 is shown to be covered by a releasable protective layer 17. The protective layer may be a siliconized paper, a nonwoven or any other releasable material as is known in the art. Before placing the incontinence protector in the supporting pant garment, the protective layer is removed from the fastening means 16 to expose the adhesive and make it available for fastening to the pant garment.

[0091] The fastening means 16 is optional to the invention and may be omitted, if desired. When using an adhesive fastening means, any suitable adhesive pattern may be used such as full coating of the backsheet, one or more longitudinal adhesive band, transverse bands, dots, circles, curves, stars, etc. Furthermore, the fastening means 16 may be a mechanical fastener such as hook-type fasteners, clips, press studs, etc. or may be a frictional fastener

such as a frictional coating or open-celled foam. Combinations of different types of fasteners are also conceivable.

[0092] The absorbent core 6 of the incontinence protector 1 shown in Figs. 1 and 2 ~~comprises~~ includes a first absorbent layer 22 and a second absorbent layer 23. A fluid flow control structure 24 is arranged between the first absorbent layer 22 and the second absorbent layer 23. In the incontinence protector 1 in Figs. 1 and 2, the first absorbent layer 22 is placed beneath and in direct contact with the topsheet 2. Alternative arrangements may be used, as disclosed herein.

[0093] The first absorbent layer 22 and the second absorbent layer 23 are shown to have generally rectangular shapes. The second absorbent layer 23 is placed beneath the first absorbent layer 22. The second absorbent layer 23 is somewhat smaller than the first absorbent layer 22 so that the first absorbent layer 22 extends beyond the second absorbent layer 23 forward and rearward in the incontinence protector 1. The size and shape of the absorbent layers may be different from those shown in the figures without departing from the invention. Moreover, the second absorbent layer 23 may be omitted in the absorbent article ~~according to the invention~~ or the article may ~~comprise~~ include one or more further absorbent layers.

[0094] The first absorbent layer 22 has an opening 25 extending completely through the layer 22 in the crotch portion 15 of the incontinence protector 1. The opening 25 has elongate shape. Without departing from the invention, the shape, size and location of the opening 25 in the first absorbent layer 22 may be different from what is shown in Fig. 1, as described herein.

[0095] The topsheet 2 is shown to extend down into the cavity 26 that is defined by the opening 25 in the first absorbent layer 22 and the topsheet-facing surface of the fluid flow control structure 24. The cavity 26 is located in the wetting area of the incontinence protector 1 and will in use be placed directly beneath the urethra and the vaginal opening of a female wearer. Any body fluid that is released to the incontinence protector 1 will directly be collected in the cavity 26 and be temporarily contained therein until it is distributed further into and throughout the absorbent core 6.

[0096] A portion of the fluid that is collected in the cavity 26 may be absorbed by the first absorbent layer through the walls of the cavity 26. However, the majority of the fluid will continue downward in the incontinence protector 1, through the bottom of the cavity 26 and into the fluid flow control structure 1 where it is distributed longitudinally and laterally along the flow control structure 24, as described in more detail with reference to Figs 3 and 4.

[0097] The fluid flow control structure 24 is shown in Fig. 1 to be of rectangular shape and to be surrounded in the longitudinal and lateral directions by portions of the absorbent core 6. It is generally advantageous if the fluid flow control structure 24 has smaller width and ~~preferably~~ also is shorter than the absorbent core 6.

[0098] The components in the incontinence protector 1 may be connected to each other by conventional means such as construction adhesive, heat bonding, ultrasonic bonding, etc. It may not be necessary to bond internal components of the incontinence protector to each other by special bonding means. Hence, it may suffice that such components are held together by frictional forces.

[0099] The function of a fluid flow control structure 24 ~~according to the invention~~ and ~~being useful~~ its use in an absorbent article such as the incontinence protector 1 in Figs. 1 and 2 will now be described with reference to Figs. 3 and 4. The fluid flow control structure 24 in Figs. 3 and 4 is a three-layer structure ~~consisting of~~ including a non-perforated fibrous polymeric layer 31 that is sandwiched between a first perforated polymeric layer 32 and a second perforated polymeric layer 33.

[0100] The perforated polymeric layers 32,33 are three-dimensionally formed layers. Each layer 32,33 has penetrating apertures 34 that originate in a first surface 32',33' of the layer and extend towards a second surface 32'',33'' of the layer, with the apexes of the apertures 34 forming protrusions 35 at the second surface 32'',33''. The apertures are tubular structures and can be, for example, ~~are preferably~~ funnel-shaped, as seen in Fig. 3. The distance between the first surface 32',33' and the second surface 32'',33'' is the apparent thickness of the respective layers 32,33.

[0101] When fluid 36 reaches the first surface 32' of the first perforated polymeric layer 32, it spreads slightly on the surface 32' before passing through the apertures 34 into the

non-perforated fibrous polymeric layer 31, as is shown in Fig 3. The non-perforated fibrous polymeric layer 31 offers very little resistance to fluid flow, whereby the fluid runs relatively freely in the layer 31 until it is finally moved by gravity down to the second perforated layer 33 where further downward movement is restricted by the second surface 33'' of the second perforated layer 33. A small amount of fluid may run out of the fluid flow control structure 24 by entering the openings at the apexes of the protrusions 35 on the second perforated layer 33. However, most of the fluid will spread further on the second surface 33'' of the second layer 33 by running in the interconnected channel network 37 that is formed between the protrusions 35, as illustrated in Fig. 4.

[0102] The fluid that is captured in the interconnected channel network 37 will generally not exit the fluid flow control structure 24 until it reaches the edges of the fluid flow control structure 24 or when the channel network 37 is saturated with fluid such that the fluid level raises above the height of the protrusions 35. Accordingly, the fluid 36 will be distributed along the second surface 33'' in all directions from the initial point of fluid impact. The apertures 34 may be distributed in the perforated polymeric layers 32,33 so that fluid dispersion takes place to a greater degree in a direction corresponding to the longitudinal direction of the absorbent article in which the fluid flow control structure 24 is placed than in a direction transverse thereto. As shown in Fig. 4, the perforated polymeric layers 32,33 have apertures 34 arranged in staggered rows, such that generally linear channels are formed between the apertures 34 in a longitudinal direction L of the layers 32,33 and non-linear channels are formed in the transverse direction T. Such an arrangement of the apertures 34 in the second perforated polymeric layer 33 serves to promote longitudinal fluid flow in the fluid flow control structure and limit transverse fluid flow.

[0103] Figs. 5a-5d illustrate that the first absorbent layer in an absorbent article ~~of the invention~~ may have one or more openings of different shapes and configurations. The particular configurations shown in Figs. 5a-d should not be regarded as limiting to the invention but are only offered as examples of the many variations that are possible within the scope of the invention. Fig. 5a shows a first absorbent layer having multiple circular openings in the crotch portion of the layer. Fig. 5b shows a first absorbent layer having

three elongate openings in the front portion of the layer and a single elongate opening in the rear portion of the layer. Fig. 5c shows a first absorbent layer having an opening shaped as a duck's foot and Fig. 5d shows a first absorbent layer having an H-shaped opening. The layer shown in Fig. 5a may, for instance, be suitable when a large total opening area is desired without compromising the wish of having a coherent layer that will not fall apart or otherwise deform during production of the absorbent article ~~according to the invention~~. A layer such as shown in Fig. 5b and 5c and having a large open area positioned to the front, may be particulary useful in sanitary napkins for day-time use. The Fig. 5b layer would additionally work well in absorbent articles intended for night-time use where fluid may run rearward between the wearer's buttocks. The Fig. 5d layer may be particularly suited for incontinence protectors where it may be desired to quickly channel fluid from the crotch portion of the absorbent article towards the ends thereof.

[0104] Figs. 5a-d are also intended to show that the first absorbent layer, as well as the overall absorbent article may have any suitable shape, as known in the art.

PATENT
ATTORNEY DOCKET NO. 049121-0366-00-US-504907

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Patrik ANDERSSON et al.

Application No.: Not Yet Assigned | Confirmation No.: N/A

Filed: December 26, 2013 | Art Unit: N/A

For: ABSORBENT ARTICLE HAVING INTAKE STRUCTURE | Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Madam:

[x] **Under 37 C.F.R. § 1.97(b):** Pursuant to 37 C.F.R. §§ 1.56 and 1.97(b), Applicant brings to the attention of the Examiner the documents listed on the attached PTO Form 1449. To the undersigned's knowledge, this IDS is being filed before the mailing date of a first Office Action on the merits, before the mailing date of a first Office Action on the merits after filing an RCE under § 1.114, or within three months of the application filing date.

[ ] **Under 37 C.F.R. § 1.97(c):** Pursuant to 37 C.F.R. §§ 1.56 and 1.97(c), Applicant brings to the attention of the Examiner the documents listed on the attached PTO Form 1449. This IDS is being filed after the events recited in § 1.97(b) but, to the undersigned's knowledge, before the mailing date of a Final Office Action, a Notice of Allowance, or another action that closes prosecution in the application.

- [ ] The fee of $180.00 set forth in § 1.17(p) is included herein;
- [ ] Applicant submits that each item of information contained in this IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this IDS. 37 C.F.R. § 1.97(e)(1).

☐ Applicant submits that no item of information contained in this IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in this IDS was known to any individual designated in § 1.56(c) more than three months prior to the filing of this IDS. 37 C.F.R. § 1.97(e)(2).

☐ **Under 37 C.F.R. § 1.97(d):** Pursuant to 37 C.F.R. §§ 1.56 and 1.97(d), Applicant brings to the attention of the Examiner the documents listed on the attached PTO Form 1449. This IDS is being filed after the events recited in § 1.97(c) but before payment of the issue fee.

☐ The fee of $180.00 set forth in § 1.17(p) is included herein; and

☐ Applicant submits that each item of information contained in this IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this IDS.

☐ Applicant submits that no item of information contained in this IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in this IDS was known to any individual designated in § 1.56(c) more than three months prior to the filing of this IDS.
37 C.F.R. § 1.97(e)(2).

☐ **Under 37 C.F.R. § 1.97(i):** Pursuant to 37 C.F.R. §§ 1.56 and 1.97(i), Applicant brings to the attention of the Examiner the documents listed on the attached PTO Form 1449. This IDS is being filed after the events recited in § 1.97(d). Applicant requests that the IDS be placed in the file.

☒ A search report or other listing of documents from a counterpart, related, or other application dated February 21, 2012 and having documents cited thereon is attached the Examiner's consideration. Any of these documents not previously cited, and any additional documents are listed on the PTO Form 1449.

☒ Applicant respectfully requests that the Examiner consider the listed documents and evidence that consideration by making appropriate notations on the attached form. As for any document listed on the accompanying PTO-1449 that is in a language other than English, relevance can be understood from an enclosed English abstract or at least partial translation or from mention in the specification or in a search report for a corresponding application.

This submission does not represent that a search has been made or that no better art exists and does not constitute an admission that any of the listed documents are material or constitute "prior art." If it should be determined that any of the listed documents do not constitute "prior art" under United States law, Applicants reserve the right to present to the Office the relevant facts and law regarding the appropriate status of such documents.

Applicants further reserve the right to take appropriate action to establish the patentability of the disclosed invention over the listed documents, should any of the documents be applied against the claims of the present application.

Except for issue fees payable under 37 C.F.R. § 1.18, the Commissioner is hereby authorized by this paper to charge any additional fees during the entire pendency of this Application, including fees due under 37 C.F.R. § 1.16 and 1.17 which may be required and including any required extension of time fees, or credit any overpayment to Deposit Account No. 50-0573. This paragraph is intended to be a CONSTRUCTIVE PETITION FOR EXTENSION OF TIME in accordance with 37 C.F.R. § 1.136(a)(3).

Respectfully submitted,

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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	Not Yet Assigned
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First Named Inventor	Patrik ANDERSSON
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U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	A*	US-4,988,344	01-29-1991	Reising et al.	
	B*	US-5,957,906	09-28-1999	Roe et al.	
	C*	US-6,241,714	06-05-2001	Raidel et al.	
	D*	US-2005/0267429	12-01-2005	Cohen	
	E	US-2010/0291343	11-18-2010	Bocchio	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	F	EP-0336578-A1	10-11-1989	Proctor & Gamble		
	G	EP-1403037-A1	03-31-2004	Japan Absorbent Tech Inst		
	H	FR-2044554-A5	02-19-1971	Wuhrlin, Jean		
	I	WO-97/34559-A1	09-25-1997	Procter & Gamble		
	J	WO-97/47263-A1	12-18-1997	Procter & Gamble		
	K	WO-00/19955-A2	04-13-2000	Kimberly-Clark Worldwide, Inc		
	L	WO-00/59431-A1	10-12-2000	Kimberly-Clark Worldwide, Inc		
	M	WO-01/72251-A1	10-04-2001	Kimberly-Clark Worldwide, Inc		
	N	WO-02/24133-A1	03-28-2002	Tredegar Film Prod Corp		
	O	WO-2005/079542-A2	09-01-2005	Tredegar Film Prod Corp		
	P	WO-2005/084596-A1	09-15-2005	SCA Hygiene Prod AB		
	Q	WO-2009/105000-A1	08-27-2009	SCA Hygiene Prod AB		

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

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(54) Thin, flexible sanitary napkin.

(57) In accordance with the present invention, a sanitary napkin having a body surface and a garment surface and being comprised of an absorbent means underlayed by a liquid barrier means, wherein the sanitary napkin is relatively highly flexible and has a capacity great enough to handle medium to high menstrual flows, is provided. In a preferred embodiment, the sanitary napkin comprises, from the body surface down, an apertured formed film topsheet, an apertured nonwoven wipe acquisition sheet, a wet-laid tissue, a superabsorbent core, and a barrier sheet. Preferably, the central width of the absorbents is at least about 6.5 centimeters and the caliper of the napkin as a whole is less than about 2.6 millimeters. In a preferred embodiment, the napkin has laterally extending flaps which drape over the edges of the wearer's panties in the crotch and are attachable to the garment side of the wearer's panties.

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THIN, FLEXIBLE SANITARY NAPKIN

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to female sanitary napkins. Particularly, the present invention concerns thin, flexible sanitary napkins offering enhanced fit and comfort through a construction which promotes a continuously self-conforming anatomical cooperation of the sanitary napkin to the wearer to yield a highly effective absorbent device.

2. Background Art

All manner and variety of absorbent articles configured for the absorption of body fluids such as menses, urine and feces are, of course, well known. With respect to feminine protection devices, the art has offered two basic types; sanitary napkins have been developed for external wear about the pudendal region while tampons have been developed for internal wear within the vaginal cavity for interruption of menstrual flow therefrom. Such tampon devices are disclosed in U.S. Patent 4,412,833, entitled "Tampon Applicator", which patent issued to Weigner et al. on November 1, 1983, and U.S. Patent 4,413,986, entitled "Tampon Assembly With Means For Sterile Insertion", which patent issued to Jacobs on November 8, 1983.

Hybrid devices which attempt to merge the structural features of the sanitary napkins and the tampons into a single device have also been proposed. Such hybrid devices are disclosed in U.S. Patent 2,092,346, entitled "Catamenial Pad", which patent issued to Arone on September 7, 1937, and U.S. Patent 3,905,372, entitled "Feminine Hygiene Protective Shield", which patent issued to Denkinger on September 16, 1975. Other less intrusive hybrid devices are known as labial or interlabial sanitary napkins and are characterized by having a portion which at least partially resides within the wearer's vestibule and a portion which at least partially resides external of the wearer's vestibule. Such devices are disclosed in U.S. Patent 2,662,527, entitled "Sanitary Pad", which patent issued to Jacks on December 15, 1953, and U.S. Patent 4,631,062, entitled "Labial Sanitary Pad", which patent issued to Lassen et al. on December 23, 1986.

With respect to sanitary napkins, at least two general classes pertinent to the present invention exist. One such class is for the absorption of medium to high menstrual flows. These sanitary napkins offer a fairly high absorptive capacity. Absorptive capacity is commonly achieved by providing the napkin with a fairly thick and bulky absorbent member, commonly fluff pulp. Sanitary napkins of this class are disclosed in U.S. Patent 3,294,091, entitled "Sanitary Napkin", which patent issued to Morse on December 27, 1966, U.S. Patent 4,654,040, entitled "Smooth-Edged Contoured Sanitary Napkin", which patent issued to Luceri on March 31, 1987, and U.S. Patent 4,687,478, entitled "Sanitary Napkin With Flaps", which patent issued to Van Tilburg on August 18, 1987. Such sanitary napkins theoretically have a high absorptive capacity, however, when the sanitary napkin is worn and subjected to the compressive forces of the wearer's thighs and pudendal region, the fluff pulp core simply compacts or bunches into an arbitrary, but generally rope-like shape. Such napkins commonly shift from their original placement so that after only a short wearing time, the napkin might only partially, if at all, be beneath the wearer's vaginal orifice or vestibule. Thus, in use, these sanitary napkins sometimes offer very little absorption. Further, the rolling and twisting of these napkins may create soiling on the wearer's panties and skin surfaces. In addition, the bulkiness of these napkins causes a high degree of wearing awareness and may make them quite obtrusive when worn with tight fitting slacks, body suits or bathing suits.

A second class of sanitary napkins are intended for light or low menstrual flows and are commonly referred to as panty liners or panty shields. Sanitary napkins of this type are disclosed in U.S. Patent 4,681,578, entitled "Pantiliner With Ventilation Areas", which patent issued to Anderson and Brandt on July 21, 1987. Sanitary napkins of this class, as a group, are thinner, somewhat more flexible and generally more comfortable than those of the first class, however, they lack the absorptive capacity of the napkins of the first class.

Therefore, there exists a real consumer need for a sanitary napkin which is thin and flexible, thereby offering enhanced fit and comfort, yet having a fluid capacity great enough for use with medium to high menstrual flows thereby allaying consumer fears of leakage and staining.

Therefore, it is an object of the present invention to provide a sanitary napkin which is thin and flexible and which is absorbent enough to absorb and contain medium to high menstrual flows.

It is an additional object of the present invention to provide a sanitary napkin which will closely conform to the various anatomical shapes of the female urogenital and buttocks region.

It is an additional object of the present invention to provide a sanitary napkin which offers enhanced fit and comfort and a low degree of wearing awareness.

It is an additional object of the present invention to provide a thin and flexible sanitary napkin having laterally extending flaps configured to drape over the side edges of the wearer's panties in the crotch portion thus being disposed between the side edges of the wearer's panties in the crotch portion and the wearer's thighs.

It is an additional object of the present invention to provide the laterally extending flaps with an attachment means on their garment facing surface so that the flaps can wrap around the side edges of the wearer's panties in the crotch portion and be attached to the garment facing side of the wearer's panties in order to provide protection from soiling and so as to keep the napkin properly positioned in the wearer s panties.

SUMMARY OF THE INVENTION

According to the invention, there is provided a sanitary napkin having a body surface and a garment surface, comprising an absorbent means having a first major surface and a second major surface; and a liquid impermeable barrier means forming said garment surface and disposed adjacent said second major surface of said absorbent means, wherein said sanitary napkin has a caliper of less than 5.0 millimeters, a flexure-resistance of less than 400 grams, a test capacity of at least 8.0 grams, and a total capacity of at least 14.0 grams.

In a preferred embodiment, the sanitary napkin comprises, from the body surface down, an apertured formed film topsheet, an apertured nonwoven wipe acquisition sheet, a wet-laid tissue, a superabsorbent core, and a barrier sheet. Preferably, the central width of the absorbents is at least about 7.0 centimeters and the caliper of the napkin as a whole is less than about 2.5 millimeters. In a preferred embodiment, the napkin has laterally extending flaps which drape over the edges of the wearer's panties in the crotch and are attachable to the garment side of the wearer's panties.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a top plan view of a preferred sanitary napkin embodiment of the present invention with portions being torn away to show underlying structure.

Figure 2 is a lateral cross-sectional view of the preferred sanitary napkin embodiment shown in Figure 1 taken along line 2-2 of Figure 1.

Figure 3 is a top plan view of a preferred topsheet and wipe acquisition sheet laminate with portions of the topsheet being torn away to show underlying structure.

Figure 4 is a top plan view of an alternatively preferred sanitary napkin embodiment of the present invention with portions being torn away to show underlying structure.

Figure 5 is a top plan view of another alternatively preferred sanitary napkin embodiment of the present invention with portions being torn away to show underlying structure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention relates to female sanitary napkins and in particular to sanitary napkins which are thin and flexible and offer enhanced fit, comfort, and containment.

As used herein, the term "sanitary napkin" refers to an article which is worn by females adjacent to the pudendal region and which is intended to absorb and contain the various exudates which are discharged from the body (e.g., blood, menses and urine) and which is intended to be discarded after a single use (i.e., it is not intended to be laundered or otherwise restored or reused). Interlabial devices which reside partially within and partially external of the wearer's vestibule are also within the scope of this invention. As used herein, the term "pudendal" refers to the externally visible female genitalia and is limited to the labia majora, the labia minora, the clitoris, and the vestibule.

A preferred embodiment of a sanitary napkin 10 of the present invention is shown in Figures 1 and 2. As can be seen in Figures 1 and 2, a preferred sanitary napkin 10 basically comprises an absorbent means 13 and a liquid impermeable barrier means 16. The absorbent means 13 may be any means which is generally compressible, conformable, non-irritating to the wearer's skin and capable of absorbing and containing body exudates such as menses, blood and urine. Preferably, the absorbent means 13 maintains integrity when wetted, in use. The absorbent means 13 has a first major surface 19 and a second major surface 22. The barrier means 16 is adjacent the second major surface 22 of the absorbent means 13. The barrier means 16 may be any means which is flexible and liquid impervious and which prevents the exudates absorbed and contained in the absorbent means 13 from wetting articles which contact the sanitary

napkin 10 such as panties.

In the preferred embodiment shown in Figures 1 and 2, the absorbent means 13 is comprised of a liquid permeable topsheet 25, a liquid permeable wipe acquisition sheet 28, a wet-laid tissue sheet 31 and an absorbent core 34. In the preferred embodiment shown in Figures 1 and 2, the barrier means 16 is a barrier sheet. The absorbent core 34 is comprised of hydrogel-forming material 37 disposed between two air-laid tissue sheets 40 and 43. The sanitary napkin 10 has side edges 11 and end edges 12 which together form the periphery 15 of the sanitary napkin 10. The sanitary napkin 10 has a body surface 26 which is generally defined by the topsheet 25 and a garment surface 17 which is generally defined by the barrier sheet 16.

Looking at some of the elements of the sanitary napkin 10 more specifically, the absorbent core 34 may be any means which is generally compressible, conformable, non-irritating to the wearer's skin and capable of absorbing and containing body exudates. The absorbent core 34 has a first major surface 46, a second major surface 49, a pair of end edges 52 and a pair of side edges 55. The absorbent core 34 may be manufactured in a wide variety of sizes and shapes (e.g., rectangular, hourglass, etc.). A preferred shape of the absorbent core 34 is the dogbone shape shown in Figure 1. This preferred absorbent core 34 is 22.0 centimeters long (longitudinal dimension along the longitudinal centerline 58), 7.0 centimeters wide across its midportion (lateral dimension along the lateral centerline 61) and 8.0 centimeters wide across its widest portion (lateral dimension). The absorbent core 34 is symmetrically configured for ease of manufacture and so that no conscious effort is required by the wearer to properly place the napkin 10 in the direction it should be worn. The midportion is configured to basically conform to the wearer's thighs and to the thinner crotch portion of the wearer's panties so as to prevent excessive bunching. The size of the absorbent core 34 may be varied to accommodate wearers ranging in size and also ranging in the expected amount of exudate fluid volume. The absorbent core 34 may be attached over the core's first or second major surfaces 46 and 49, respectively, to adjacent members such as the topsheet 25 and barrier sheet 16 by any of the means well known in the art, such as by spray-gluing or lines or spots of adhesive. Such attachment facilitates integrity and recoverability of the absorbent materials in use so as to maintain an optimum degree of absorbency. Preferably, the absorbent core 34 has a wet-tensile strength in the cross-direction of at least about 100.0 grams per centimeter. Wet tensile strength is determinable by ASTM Standard D 829-49.

The absorbent core 34 may be manufactured from a wide variety of liquid absorbent materials commonly used in disposable sanitary napkins, diapers, and other absorbent articles. Examples of suitable absorbent materials include comminuted wood pulp which is generally referred to as airfelt, creped cellulose wadding, absorbent foams, absorbent sponges, synthetic staple fibers, polymeric fibers, hydrogel-forming polymer gelling agents, or any equivalent materials or combinations of materials. A particularly preferred absorbent material are polymeric gelling agents. Polymeric gelling agents are those materials which, upon contact with fluids (i.e., liquids) such as water or body fluids, imbibe such fluids and thereby form hydrogels. In this manner, fluid discharged into the absorbent core 34 can be acquired and held by the polymeric gelling agent, thereby providing the articles herein with enhanced absorbent capacity and/or improved fluid retention performance.

The polymeric gelling agent which is employed in the absorbent core 34 will generally comprise particles of a substantially water-insoluble, slightly cross-linked, partially neutralized, hydrogel-forming polymer material. Such polymer materials can be prepared from polymerizable, unsaturated, acid-containing monomers. Suitable unsaturated acidic monomers for use in preparing the polymeric gelling agents used in this invention include those listed in U.S. Patent 4,654,039, entitled "Hydrogel-Forming Polymer Compositions For Use In Absorbent Structures", which issued to Brandt, Goldman and Inglin on March 31, 1987.

Preferred monomers include acrylic acid, methacrylic acid, and 2-acrylamido-2-methyl propane sulfonic acid. Acrylic acid itself is especially preferred for preparation of the polymeric gelling agent material.

In the hydrogel-forming polymeric gelling agent the polymeric component formed from unsaturated, acid-containing monomers may be grafted onto other types of polymer moieties such as starch or cellulose. Polyacrylate grafted starch materials of this type are especially preferred for use herein.

Preferred polymer gelling agents which can be prepared from conventional types of monomers include hydrolyzed acrylonitrile grafted starch, polyacrylate grafted starch, polyacrylates, maleic anhydride-based copolymers and combinations thereof. Especially preferred are the polyacrylates and polyacrylate grafted starch.

Whatever the nature of the basic polymer components of the hydrogel-forming polymeric gelling agents used in the absorbent core 34 herein, such materials will in general be slightly cross-linked. Cross-linking serves to render the hydrogel-forming polymer gelling agents used in this invention substantially water-insoluble, and cross-linking thus in part determines the gel volume and extractable

polymer characteristics of the hydrogels formed from the polymeric gelling agents employed. Suitable cross-linking agents are well known in the art and include, for example, those described in greater detail in U.S. Patent 4,076,663, which patent issued to Masuda et al. on February 28, 1978.

Preferred cross-linking agents are the di- or polyesters of unsaturated mono- or polycarboxylic acids with polyols, the bisacrylamides and the di- or triallyl amines. Especially preferred cross-linking agents are N,N'-methylenebisacrylamide, trimethylol propane triacrylate and triallyl amine. The cross-linking agent can generally comprise from about 0.001 mole percent to 5.0 mole percent of the resulting hydrogel-forming polymer material. More preferably, the cross-linking agent will comprise from about 0.01 mole percent to 3.0 mole percent of the hydrogel-forming polymeric gelling agent used herein.

The slightly cross-linked, hydrogel-forming polymeric gelling agents which may be used in the articles of the present invention are generally employed in their partially neutralized form. For purposes of this invention, such materials are considered partially neutralized when at least 25.0 mole percent, and preferably at least 50.0 mole percent of monomers used to form the polymer are acid group-containing monomers which have been neutralized with a salt-forming cation. Suitable salt-forming cations include alkali metal, ammonium, substituted ammonium, and amines. This percentage of the total monomer utilized which are neutralized acid group-containing monomers is referred to herein as the "degree of neutralization."

The polymeric gelling agent materials used in the absorbent articles herein must have a relatively high capacity for imbibing fluids encountered in such articles. The absorbent capacity of these materials can be quantified by referencing the "gel volume" of the polymeric gelling agents which are to be selected for use in the present invention.

For purposes of this invention, gel volume can be defined in terms of the amount of synthetic urine absorbed by any given polymeric gelling agent and is specified as grams of synthetic urine per gram of polymeric gelling agent. Gel volume in synthetic urine can be determined by forming a suspension of 0.1-0.2 parts of dried polymeric gelling agent to be tested with 20 parts of synthetic urine. This suspension is maintained at ambient temperature under gentle stirring for a time sufficient, e.g., 1 hour, for swelling equilibrium to be attained. The gel volume of the polymeric gelling agent in grams of synthetic urine per gram of polymeric gelling agent is then calculated from the weight fraction of the polymeric gelling agent in the suspension and the ratio of the liquid volume excluded from the formed hydrogel to the total volume of the suspension.

The gel volume of the gelling agents used in the absorbent core 34 herein will generally be at least 20.0 grams of synthetic urine per gram of polymeric gelling agent. More preferably, the gel volume of the materials employed will range from 20.0 to 60.0, most preferably from 22.0 to 35.0 grams of synthetic urine per gram of polymeric gelling agent.

Within the webs which form the layers of the absorbent core 34, the particles of the polymeric gelling agent should be thoroughly dispersed but may or may not be uniformly distributed. In particular, there may be regions or zones of the core layers which have higher concentrations of gelling agent particles than do other regions or zones of the layers.

In a preferred embodiment, the sanitary napkin 10 of the present invention will have a hydrogel-forming polymeric gelling agent distributed throughout at least 17.0 square centimeters of the napkin, more preferably throughout at least 50.0 square centimeters of the napkin, and most preferably throughout at least 100.0 square centimeters of the napkin. Preferably, the hydrogel-forming polymeric gelling agent will be distributed in an amount of from 0.001 grams per square centimeter to 0.009 grams per square centimeter, more preferably of from 0.003 grams per square centimeter to 0.008 grams per square centimeter, and most preferably from 0.004 grams per square centimeter to 0.007 grams per square centimeter. Preferably, the absorbent core 34 will contain from 5.0% to 85.0% by weight of hydrogel-forming polymeric gelling agent, more preferably from 10.0% to 70.0%, and most preferably from 15.0% to 55.0%.

In the preferred embodiment shown in Figure 2, the absorbent core 34 is a laminate comprised of a layer of superabsorbent polymer material 37 disposed between two air-laid tissues 40 and 43. A suitable laminate is the superabsorbent laminate WATER-LOCK L-535 available from the Grain Processing Corporation of Muscatine, Iowa (WATER-LOCK registered TM by Grain Processing Corporation). Such superabsorbent laminates are disclosed in U.S. Patent 4,467,012, entitled "Composition For Absorbent Film And Method Of Preparation", which patent issued to Pedersen et al. on August 21, 1984, 4,260,443, entitled "Laminated Absorbent Process", which patent issued to Lindsay et al. on April 7, 1981, and which patents are incorporated herein by reference. The WATER-LOCK L-535 has a hydrogel polymer loading of 0.005 grams per square centimeter, however, loadings of 0.001 - 0.009 grams per square centimeter have been found acceptable. The first and second tissue layers 40 and 43 provide containment of the superabsorbent polymer material 37, Improve lateral wic-

king of the absorbed exudates throughout the absorbent core 34 and provide a degree of absorbency. In the case of non-particulate hydrogel-forming polymer gelling agents which can be formed into fibrous sheets, foams or films, the non-particulate gelling agent may comprise from 15% to 100% by weight of the absorbent core 34, more preferably of from 40% to 100%, and most preferably of from 60% to 100%. The basis weight of such non-particulate superabsorbents may be from 0.002 to 0.028 grams per square centimeter, more preferably of from 0.003 to 0.018, and most preferably of from 0.004 to 0.010. Two suitable and commercially available non-particulate absorbent materials for the absorbent core 34 are a double layer acrylic fibrous material available under the tradename Lanseal F from the Choli Company, LTD., of Higashi, Osaka Japan and a carboxymethylcellulose fibrous material available under the tradename Aqualon C from Hercules, Inc. of Wilmington, Delaware.

The total absorbent capacity of the absorbent core 34 should be compatible with the design exudate loading for the intended use of the sanitary napkin 10. Further, the absorbent capacity of the absorbent core 34 may be varied to accommodate wearers ranging in the expected amount of exudate fluid volume. For instance, a different absorbent capacity may be utilized for sanitary napkins intended for daytime use as compared with those intended for nighttime use, or for sanitary napkins intended for use by teenage females as compared with those intended for use by more mature women.

It should be noted that the scope of the present invention is not intended to extend to sanitary napkins which are void of any superabsorbent material and which have a central absorbent member overlayed solely by nonwoven materials, wherein the nonwoven materials have caliper of less than 0.50 millimeters, as determined by the caliper test, as later defined.

Superimposed over the absorbent core 34 and extending 3.0 millimeters beyond the edges 52 and 55 of the absorbent core 34 is the wet-laid tissue 31. The wet-laid tissue 31 is liquid permeable. A satisfactory wet-laid tissue 31 has a basis weight of 15.8 grams per square meter and an air permeability of 30.5 cubic meters per minute per square meter at a pressure differential of 12.8 millimeters of water. Preferably, the wet-laid tissue 31 maintains integrity when wetted, in use. The wet-laid tissue 31 preferably has a wet tensile strength in the cross-direction of at least 15.0 grams per centimeter. Suitable tissues 31 and their manufacture are disclosed In U.S. Patent 3,301,746, entitled "Process For Forming Absorbent Paper By Imprinting A Fabric Knuckle Pattern Thereon Prior To Drying And Paper Thereof", which patent issued to Sanford and Sisson on January 31, 1967. In a preferred embodiment, those parts of the wet-laid tissue 31 which extend beyond the edges 52 and 55 of the absorbent core 34 are associated with the barrier sheet 16. The wet-laid tissue 31 may be associated with the barrier sheet 16 by attachment means as are well known in the art such as by spray-gluing or lines or spots of adhesive. The wet-laid tissue 16 serves a number of purposes. The tissue 31 serves to confine any loose superabsorbent material 37 between the tissue 31 and the barrier sheet 16 thereby preventing the superabsorbent material 37 from coming in contact with the wearer's skin. Also, the tissue 31 improves lateral wicking of the absorbed exudates over the absorbent core 34 thereby providing a more even distribution of the exudates throughout the absorbent core 34. Further, the tissue 31 provides some degree of absorbency and further inhibits exudates which have reached and been absorbed by the absorbent core 34 from rewetting the wearer's skin.

Superimposed over the wet-laid tissue 31 is a liquid permeable wipe acquisition sheet 28. In a preferred embodiment, the wipe acquisition sheet 28 is a nonwoven sheet. In the preferred embodiment shown in Figure 2, the sheet 28 is a spunlaced 70%/30% rayon/polyester fiber sheet. Spunlaced fabrics of this type are manufactured by E.I. DuPont Nemours & Company of Wilmington, Delaware, and are made available under the tradename "SONTARA" (SONTARA registered TN by E.I. DuPont Nemours & Company). These fabrics are available in a number of suitable styles, however, Style 8407 In its apertured form, having a basis weight of 0.005 grams per square centimeter and a thickness of 0.04 millimeters, is preferred. The wipe acquisition sheet 28 extends beyond the edges of the wet-laid tissue 31 where it too is associated with the barrier sheet 16. The wipe acquisition sheet 28 greatly improves lateral wicking of exudates over the absorbent core 34 thereby providing a more even distribution of the exudates throughout the absorbent core 34. The lateral wicking of the wipe acquisition sheet 28 is important for the following reason. Many bulky prior art sanitary napkins rely on a high degree of vertical absorption at the point where exudates are initially deposited. In other words, because the absorbent cores of these napkins are fairly thick, they can absorb a high degree of exudates throughout their thickness while utilizing only a small degree of their surface area or lateral absorption capability. However, the relatively thin napkins 10 of the present invention have a comparatively small degree of vertical absorption. Therefore, for a relatively large amount of exudates to be absorbed, a wipe acquisition sheet 28 which can laterally dis-

perse the exudates over a large surface area of the absorbent core 34 where the exudates can better and faster be vertically absorbed is highly desirable. Further, the wipe acquisition sheet 28 provides a fairly high degree of initial absorption during the time interval between the time exudates are deposited onto the topsheet 25 and the time they are absorbed by the absorbent core 34. This property will be more specifically described later.

Superimposed over the wipe acquisition sheet 28 is the liquid permeable topsheet 25. In a preferred embodiment, the topsheet 25 is associated with the wipe acquisition sheet 28 by spray-gluing the topsheet 25 to the surface of the wipe acquisition sheet 28. The topsheet 25 is compliant, soft feeling, and non-irritating to the wearer's skin. Further, the topsheet 25 is liquid pervious, permitting liquid to readily transfer through its thickness. A suitable topsheet 25 may be manufactured from a wide range of materials such as polymeric materials, formed thermoplastic films, apertured plastic films, porous foams, reticulated foams, natural fibers (e.g., wood or cotton fibers), synthetic fibers (e.g., polyester or polypropylene fibers) or from a combination of natural and synthetic fibers, with apertured formed films being preferred. Formed films are preferred for the topsheet 25 because they are pervious to liquids and yet non-absorbent. 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. Patent 3,929,135, entitled "Absorptive Structure Having Tapered-Capillaries", which patent issued to Thompson on December 30, 1975, U.S. Patent 4,324,246, entitled "Disposable Absorbent Article Having A Stain Resistant Topsheet", which patent issued to Mullane and Smith on April 13, 1982, U.S. Patent 4,342,314, entitled "Resilient Plastic Web Exhibiting Fiber-Like Properties", which patent issued to Radel and Thompson on August 3, 1982, and U.S. Patent 4,463,045, entitled "Macroscopically Expanded Three-Dimensional Plastic Web Exhibiting Non-Glossy Visible Surface and Cloth-Like Tactile Impression", which patent issued to Ahr, Louis, Mullane, and Ouellete on July 31, 1984.

In a preferred embodiment of the present invention, the body surface 26 of the topsheet 25 is hydrophilic. The hydrophilic body surface 26 helps liquid to transfer through the topsheet 25 faster than if the body surface 26 was not hydrophilic. This diminishes the likelihood that menstrual fluid will flow off the topsheet 25 rather than being absorbed by the absorbent core 34. In a preferred embodiment, the body surface 26 of the topsheet 25 is made hydrophilic by treating the body surface 26 with a surfactant. It is preferred that the surfactant be substantially evenly and completely distributed throughout the body surface 26 of the topsheet 25. This can be accomplished by any of the common techniques well known to those skilled in the art. For example, the surfactant can be applied to the topsheet 25 by spraying, by padding, or by the use of transfer rolls. Further, the surfactant can be incorporated into the polymeric materials of a formed film topsheet or between or within the fibers of a nonwoven topsheet.

The barrier means 16 is adjacent the second major surface 22 of the absorbent means 13. In a preferred embodiment, the absorbent means 13 may be affixed over the second major surface 22 of the absorbent means 13 to the barrier means 16. Any of the common techniques well known in the art, such as spray-gluing or lines or spots of adhesive may be used for this purpose. The barrier means 16 generally defines the garment surface 17 of the sanitary napkin 10. The barrier means 16 may be any means which is impervious to liquids and which prevents exudates absorbed and contained in the absorbent means 13 from soiling articles, such as panties, which come in contact with the garment surface 17 of the sanitary napkin 10. In the preferred embodiment of the sanitary napkin 10 illustrated in Figures 1 and 2, the barrier means 16 is a barrier sheet manufactured from a thin plastic film. Other flexible liquid impervious materials may also be used. Preferably, the barrier sheet 16 is a polyethylene film having a thickness of from 0.012 millimeter to about 0.051 millimeter. As used herein, the term "flexible" refers to materials which are compliant and which will readily conform to the general shape and contours of the human body.

A suitable polyethylene film is manufactured by Monsanto Chemical Corporation and marketed in the trade as Film No. 8020. The barrier sheet 16 is preferably embossed and/or matte finished to provide a more clothlike appearance. Further, the barrier sheet 16 may permit vapors to escape from the absorbent means 13 while still preventing exudates from passing through the barrier sheet 16.

Preferably, the topsheet 25 and the barrier sheet 16 have length and width dimensions generally larger than the absorbent core 34 so that they extend beyond the edges 52 and 55 of the absorbent core 34 where they are associated together in a suitable manner. As used herein, the term "associated" encompasses configurations whereby a first member is directly joined to a second member and configurations whereby a first member is indirectly joined to a second member by affixing the first member to intermediate members which in turn are affixed to the second member. The extension of the topsheet 25 and/or the barrier sheet 16 beyond the core end edges 52

and the core side edges 55 of the absorbent core 34 form the end edges 11 and the side edges 12, respectively, of the sanitary napkin 10. In a preferred embodiment, the barrier sheet 16 and the topsheet 25 have an elliptical shape and extend beyond the absorbent core 34 a distance of at least 1.0 centimeter where they are joined directly to each other by attachment means as are well known in the art. The attachment means may be, for example, a uniform continuous layer of adhesive a patterned layer of adhesive, or an array of separate lines or spots of adhesives.

The sanitary napkin 10 of the present invention has a low flexure-resistance. Thus, the sanitary napkin 10 of the present invention is highly flexible and conforms very well to the various shapes of the female urogenital region. Preferably, the sanitary napkin 10 of the present invention has a flexure-resistance of less than 300.0 grams, more preferably less than 250.0 grams, and still more preferably less than about 175.0 grams and most preferably less than 130.0 grams.

The flexure-resistance of a sanitary napkin is measured by peak bending stiffness. Peak bending stiffness is determined by a test which is modeled after the ASTM D 4032-82 CIRCULAR BEND PROCEDURE, the procedure being considerably modified and performed as follows. The CIRCULAR BEND PROCEDURE is a simultaneous multi-directional deformation of a material in which one face of a specimen becomes concave and the other face becomes convex. The CIRCULAR BEND PROCEDURE gives a force value related to flexure-resistance, simultaneously averaging stiffness in all directions.

APPARATUS:

The apparatus necessary for the CIRCULAR BEND PROCEDURE is a modified Circular Bend Stiffness Tester, having the following parts:

A smooth-polished steel plate platform which is 102.0 x 102.0 x 6.35 millimeters having an 18.75 millimeter diameter orifice. The lap edge of the orifice should be at a 45 degree angle to a depth of 4.75 millimeters.

A plunger having an overall length of 72.2 millimeters, a diameter of 6.25 millimeters, a ball nose having a radius of 2.97 millimeters and a needle-point extending 0.88 millimeter therefrom having a 0.33 millimeter base diameter and a point having a radius of less than 0.5 millimeter, the plunger being mounted concentric with the orifice and having equal clearance on all sides. Note that the needle-point is merely to prevent lateral movement of the test specimen during testing. Therefore, if the needle-point significantly adversely affects the test specimen (for example, punctures an inflatable structure), than the needle-point should not be used. The bottom of the plunger should be set well above the top of the orifice plate. From this position, the downward stroke of the ball nose is to the exact bottom of the plate orifice.

A force-measurement gauge and more specifically an Instron inverted compression load cell. The load cell has a load range of from 0.0 to 2000.0 grams.

An actuator, and more specifically the Instron Model No. 1122 having an inverted compression load cell. The Instron 1122 is made by the Instron Engineering Corporation, Canton, Massachusetts.

NUMBER AND PREPARATION OF SPECIMENS

In order to perform the procedure for this test, as explained below, five representative sanitary napkins are necessary. From one of the five napkins to be tested, some number "Y" of 37.5 x 37.5 millimeter test specimens are cut. Specimens having portions in which a topsheet is joined directly to a barrier sheet or which are a laminate of a topsheet, two or less tissue sheets and a barrier sheet, should not be tested. The reason that these specimens are not tested is due to the realization that prior art napkins exist in which a topsheet is joined to a barrier sheet beyond the edges of an absorbent core in the periphery of the napkin, such portions of which are highly flexible. However, the present invention is more concerned with the overall flexibility of the sanitary napkin and not merely the peripheral portions thereof and, therefore, the flexibility of the present invention is more concerned with the flexibility of the significant absorbent portions of the sanitary napkin. If any of these significant absorbent portions of the sanitary napkin meet the parameters of this test, then the sanitary napkin satisfies the test. Therefore, a number of different specimens should be tested from each sanitary napkin. Certainly, the structurally most flexible portion of the sanitary napkin should be tested, excluding those portions excluded above. The test specimens should not be folded or bent by the test person, and the handling of specimens must be kept to a minimum and to the edges to avoid affecting flexural-resistance properties. From the four remaining sanitary napkins, an equal number "Y" of 37.5 x 37.5 millimeter specimens, identical to the specimens cut from the first napkin, are cut. Thus, the test person should have "Y" number of sets of five identical specimens.

PROCEDURE

The procedure for the CIRCULAR BEND PRO-

CEDURE is as follows. The specimens are conditioned by leaving them in a room which is 21 ± 1 °C and 50 ± 2% relative humidity for a period of two hours. The test plate is leveled. The plunger speed is set at 50.0 centimeters per minute per full stroke length. A specimen is centered on the orifice platform below the plunger such that the body surface 26 of the specimen is facing the plunger and the garment surface 17 of the specimen is facing the platform. The indicator zero is checked and adjusted, if necessary. The plunger is actuated. Touching the specimen during the testing should be avoided. The maximum force reading to the nearest gram is recorded. The above steps are repeated until all five of the identical specimens have been tested.

CALCULATIONS

The peak bending stiffness for each specimen is the maximum force reading for that specimen. Remember that "Y" number of sets of five identical specimens were cut. Each set of five identical specimens is tested and the five values received for that set are averaged. Thus, the test person now has an average value for each of the "Y" sets tested. Remember, if any of the significantly absorbent portions of the sanitary napkin have the requisite flexure-resistance, then the napkin satisfies the parameters of this test. Therefore, the flexure-resistance for a particularly designed sanitary napkin is the greatest of these average peak bending stiffnesses.

As alluded to earlier, the combination of topsheet 25 and wipe acquisition sheet 28 imparts some beneficial properties to the sanitary napkin 10. In particular, the combination of an apertured formed film topsheet 25 superimposed over an apertured nonwoven wipe acquisition sheet 28 is beneficial. A preferred wipe acquisition sheet 28 is the previously described SONTARA 8407. An enlarged depiction of such an arrangement is shown in Figure 3. Such a combination is even more beneficial when the nonwoven wipe acquisition sheet 28 is formed or positioned such that no fiber bundles 89 of the sheet 28 are beneath some of the apertures 83 of the formed film topsheet 25 (i.e., the apertures in the two sheets 25 and 28 are aligned) while beneath other apertures 83 of the formed film topsheet 25 fiber bundles 89 of the nonwoven sheet 28 are present (i.e., apertures in the two sheets 25 and 28 are not aligned). Such an arrangement is readily apparent in Figure 3, wherein the apertures 86 of the nonwoven sheet 28 are larger than the apertures 83 of the formed film topsheet 25. Such an arrangement provides the sanitary napkin 10 at least two beneficial properties: enhanced gush acquisition and enhanced wipe acquisition. Gush acquisition is enhanced in those areas where the apertures 83 of the topsheet 25 are aligned with the apertures 86 of the nonwoven wipe acquisition sheet 28. The aligned apertures 83 and 86 provide a direct route for exudates to flow from the body surface 26 of the topsheet 25 to the central absorbent materials of the napkin 10. Further, the apertures 83 and 86 themselves are able to contain a degree of fluid within their walls or boundaries until such fluid is absorbed. Wipe acquisition, which is the ability to pull liquid exudates from the wearer's skin into the absorbent material of the napkin 10, is enhanced in those areas where fiber bundles 89 of the nonwoven wipe acquisition sheet 28 are aligned such that the fiber bundles 89 are beneath the openings of the apertures 83 of the topsheet 25.

As just mentioned, wipe acquisition is critical in those regions where the topsheet 25 is in contact with exudates on the wearer's skin. In such areas, the sanitary napkin 10 is likely under compressive forces from the wearer's body. When such is the case, the fiber bundles 89 of the nonwoven wipe acquisition sheet 28 beneath the apertures 83 of the topsheet 25 are forced somewhat up into the apertures 83 of the topsheet 25, closer to the wearer's skin. Obviously, the spaces between the fiber bundles 89 and the walls of the apertures 83 or between the fibers of the fiber bundles 89 themselves will be less than the spaces which were between only the walls of the apertures 83. These spaces are capillaries. As is well known in the art, as capillary spaces are decreased, capillary or drawing action is increased. Thus, the capillary action in these apertures 83 where fiber bundles 89 are present is increased and the sanitary napkin 10 is better able to draw exudates from the wearer's skin into these capillaries and eventually into the central absorbent materials of the sanitary napkin 10.

Although all of the apertures 83 of the topsheet 25 are referenced by the numeral "83", for the following teaching purposes, specific reference is directed to the aperture of Figure 3 specifically labeled and designated "83". The specific aperture 83 referenced is an example in which an aperture 83 of the topsheet 25 is aligned with an aperture 86 of the nonwoven wipe acquisition sheet 28. Theoretically, such an aperture is useful for gush acquisition since exudates have uninterrupted flow from the body surface 26 of the topsheet 25 to the central absorbent material (not shown). Next, attention is directed to the aperture 83 immediately to the right of the specific aperture 83 just referenced. As seen, this aperture 83 is superimposed over a fiber bundle 89 of the nonwoven wipe acquisition sheet 28. Theoretically, exudates that flow into the

aperture 83 will enter the capillaries of the fiber bundle 89. The exudates will then either be pulled or absorbed into the central absorbent materials or wicked to intersecting fiber bundles 89, then wicked further to other intersecting fiber bundles 89, and so on, until the exudates are absorbed into a more laterally distant portion of the central absorbent materials. Hence, a large portion of the total absorbent capacity of the absorbent materials can be utilized.

As previously mentioned, the sanitary napkin 10 of the present invention has a liquid capacity great enough to absorb medium to high menstrual flows. Two capacities, which, depending on the size of the sanitary napkin may be the same, are determinable: test capacity and total capacity. The napkin 10 of the present invention has a test capacity of at least 8.0 grams, more preferably of at least 15.0 grams, and most preferably of at least 18.0 grams. The napkin 10 of the present invention has a total capacity of at least 14.0 grams, preferably of at least 20.0 grams, more preferably of at least 30.0 grams, and most preferably of at least 40.0 grams.

The test and total capacities of a sanitary napkin are determined as follows. Any panty adhesive release paper is removed from the napkin to be tested. To determine test capacity, a 4.75 x 14.0 centimeters portion, or any other configuration having 66.5 square centimeters, of the sanitary napkin is cut from the portion of the sanitary napkin which would be centered under the vaginal orifice when the sanitary napkin is worn. Total capacity is determined using the entire napkin minus any release paper. The article is weighed to the nearest 0.1 gram. The article is then submerged in a beaker of sterile saline (obtainable from the Baxter Travenol Company of Deerfield, Illinois), such that the article is totally submerged and is not bent or otherwise twisted or folded. The article is submerged for 10 minutes. The article is removed from the saline and suspended for two minutes in a vertical position to allow the saline to drain out of the article. The article is then placed body facing surface down onto an absorbent blotter, such as the filter paper #631 available from the Filtration Science Corp., Eaton-Dikeman Division of Mount Holly Springs, Pennsylvania. A uniform 17.6 grams per square centimeter load is placed over the article to squeeze excess fluid out. The absorbent blotter is replaced every 30 seconds until the amount of fluid transferred to the absorbent blotter is less than 0.5 grams in a 30 second period. Next, the article is weighed to the nearest 0.1 gram and the dry weight of the article is subtracted. The difference in grams is the test or total capacity of the article, whichever the case may be.

The central absorbent width 63 of absorbent material of the sanitary napkin 10 of the present invention is an important parameter. The term "central absorbent width" refers to a specific area of the sanitary napkin 10 determinable as follows, reference being had to Figure 5. A point 64 on the sanitary napkin 10 which is disposed beneath the center of the vaginal orifice, when worn, is located. A plane 65 parallel to the lateral centerline 61 and 3.75 centimeters forward from the point 64 in the direction of the wearer's mons pubis is located. Another plane 66 parallel to the lateral centerline 61 and 5.0 centimeters rearward from the point 64 in the direction of the wearer's buttocks is also located. The greatest flat-out, uncompressed, unmanipulated, lateral width of absorbent material of the sanitary napkin 10 between the planes 65 and 66 is the central absorbent width 63 of the sanitary napkin 10. It matters not whether the absorbent material is a single sheet, overlapping sheets, staggered sheets, etc., and it matters not whether the absorbent material is a nonwoven sheet, an absorbent topsheet, an absorbent core, a tissue, synthetic staple fibers, etc. For example, a sanitary napkin 10 of the present invention might have a wipe acquisition sheet 28 or a wet-laid tissue 31 having a width of about 7.75 centimeters and an absorbent core 34 having a width of 3.8 centimeters. Thus, in this example, the sanitary napkin 10 has a central absorbent width 63 of 7.75 centimeters.

The sanitary napkin 10 should preferably be scaled to the width of the crotch of the underwear of the wearer; A sanitary napkin 10 having a central absorbent width 63 which registers the absorbent 13 with the edges of the underwear crotch is particularly preferred. For relatively narrower underwear crotches, having a width of 3.7 to 6.4 centimeters, a sanitary napkin having a central absorbent width 63 of 3.7 to 6.4 centimeters works well.

The total width of the napkin 10 is scaled to the central absorbent width 63, and should be from 0.6 to 1.0 centimeters greater than the central absorbent width 63, due to the additional margin necessary to join the edges of the topsheet 25 and barrier sheet 16 together. Generally 0.3 to 0.5 centimeters are necessary at each edge of the napkin 10 to join the topsheet 25 to the barrier sheet 16. Thus, a napkin having a central absorbent width 63 of 3.7 to 6.4 centimeters will have a total width ranging from 4.3 to 4.7 centimeters to from 7.0 to 7.4 centimeters.

The sanitary napkin 10 of one embodiment of the present invention intended for underwear having a relatively greater crotch width should have a central absorbent width 63 of at least 6.5 centimeters, more preferably of at least 7.0 centimeters, more preferably of at least 7.75 centimeters, and most preferably of at least 9.0 centimeters.

As the central absorbent width 63 of the sanitary napkin 10 diminishes, the total capacity, as determined by the aforementioned Test Procedure, will proportionally diminish, unless the sanitary napkin 10 is lengthened in the longitudinal direction. Because a pad which is excessively lengthened may not be comfortable to wear, it is acceptable, for a pad having a central absorbent width 63 of 6.2 centimeters or less to have a reduced total capacity. For such an arrangement a sanitary napkin 10 having a total capacity of 14 grams has been found to work well.

The central absorbent width 63 of the sanitary napkin 10 of the present invention is believed important for the following reason. As stated previously, the sanitary napkin 10 of the present invention relies more on the lateral distribution of exudates over or through a relatively large surface area of the absorbent core 34 rather than on a high degree of vertical absorption common to many prior art sanitary napkins. Therefore, because exudates which are distributed onto the topsheet 25 may not be quickly absorbed before they migrate across the topsheet 25, it is important to contain such exudates pending absorption. The specified central absorbent width 63 of the sanitary napkin 10 of the present invention has been determined based on the width of a flexible napkin which will cup around the labia in the region of the vaginal orifice such that at least the edges of the absorbent material are positioned in the uppermost part of the wearer's legs at the crotch. Thus, the sanitary napkin 10 and the absorbent material may be cupped shaped in the surrounding regions of the vaginal orifice and exudates deposited thereon will be contained until absorbed.

Because of the flexibility requirements of the sanitary napkins 10 of the present invention, it is likely that the sanitary napkins 10 of the present invention will be relatively thin. It is preferred to keep the sanitary napkins 10 of the present invention thin so that the sanitary napkins 10 of the present invention will be unobtrusive and the user will have a low awareness of the sanitary napkin 10 of the present invention while it is being worn. The sanitary napkin 10 shown in Figures 1 and 2 has a caliper of 1.9 millimeters. The caliper of a sanitary napkin 10 is determined by the following test.

A comparator gauge, and specifically the Ames, Model 130 with dial indicator Model 482, available from the B.C. Ames, Company of Waltham, Massachusetts is needed. The comparator gauge should have a circular comparator foot made of aluminum and having a weight of 10.0 grams and a contact surface of 5.16 square centimeters. The comparator gauge is zeroed. An 80.0 grams stainless steel weight is placed on the spindle extending above the comparator dial. The comparator foot is raised and the napkin, with any panty adhesive release paper being removed, is placed garment surface down on the base plate. The napkin is positioned on the base plate so that when the foot is lowered it is in the center of the napkin. Try to smooth out or avoid any wrinkles in the napkin. Gently lower the foot onto the napkin. Determine the napkin caliper by reading the comparator dial 30 seconds after the foot comes in contact with the napkin. Repeat the measurement 3.0 centimeters from each of the ends of the absorbent material along the longitudinal centerline 58 of the napkin. The average of the three readings is the caliper of the sanitary napkin. Preferably, the sanitary napkins 10 of the present invention have a caliper of less than 2.6 millimeters, more preferably less than 2.2 millimeters, and most preferably less than 2.0 millimeters. The caliper of the sanitary napkin of the present invention may be increased, in a less preferred embodiment, proportional to an increase in the flexure-resistance. If the flexure-resistance is increased to greater than 400 grams, or even greater than about 500 grams, the calliper may be increased to as much as 4.0 to about 5.0 millimeters, but preferably is not greater than 3.0 millimeters.

An alternative embodiment of a sanitary napkin 10 of the present invention is shown in Figure 4. In this embodiment, the sanitary napkin 10 has two flaps 70 each of which are adjacent to and extend laterally from a side edge 55 of the absorbent core 34. The flaps 70 are configured to drape over the edges of the wearer's panties in the crotch region so that the flaps 70 are disposed between the edges of the wearer's panties and the wearer's thighs. The flaps 70 serve at least two purposes. First, the flaps 70 help serve to prevent soiling of the wearer's body and panties by menstrual fluid. Second, the flaps 70 are preferably provided with attachment means 71 on their garment surface 17 so that the flaps 70 can be folded back under the panty and attached to the garment facing side of the panty. In this way, the flaps 70 serve to keep the napkin 10 properly positioned in the panty. A preferred attachment means 71 is a pressure-sensitive adhesive, as is well known in the art. Alternatively, the flaps 70 may be attached to each other on the underside of the panty by the attachment means 71 without being affixed to the panty.

In the preferred embodiment shown, the flaps 70 are comprised of topsheet 25, tissue 31, and barrier sheet 16. Further, in the embodiment shown, the flaps 70 are unitary with the laminae of the napkin 10. In other words, the topsheet 25, tissue 31 and barrier sheet 16 simply extend laterally beyond the core 34 to form the flaps 70. However, the flaps 70 need not be unitary with the napkin 10 but can be separate elements which are

affixed to the napkin 10. Further, the flaps 70 can be comprised of a single substrate or other laminae configurations. It is recommended, however, that the flaps 70 have a liquid impervious barrier sheet 16. The barrier sheet 16 prevents exudates which reach the flaps 70 from soiling the edges of the wearer's panties. Further, it is preferable that the flaps 70 be provided with an absorbent layer, at least to a point beyond the edges of the wearer's panties. Theoretically, only a relatively small amount of menses should reach the flaps 70, therefore, only a relatively small amount of absorbent material is desirable in the flaps 70. However, at least some absorbent material is recommended in order to prevent any exudates that reach the flaps 70 from being able to flow further to unprotected areas. The absorbent material may be a tissue, such as the tissue 31, or an extension of the absorbent core 34, such as the WATER-LOCK L - 535. However, the absorbent material in the flaps 70 should be relatively highly flexible. A number of sanitary napkins having flaps suitable or adaptable for use with the sanitary napkins 10 of the present invention are known. Such flaps are disclosed in U.S. Patent 4,687,478, entitled "Shaped Sanitary Napkin With Flaps", which patent issued to Van Tilburg on August 18, 1987, U.S. Patent 4,608,047, entitled "Sanitary Napkin Attachment Means", which patent issued to Mattingly on August 26, 1986, U.S. Patent 4,589,876, entitled "Sanitary Napkin", which patent issued to Van Tilburg on May 20, 1986, and U.S. Patent 4,285,343, entitled "Sanitary Napkin", which patent issued to McNair on August 25, 1981

For illustration purposes, the central absorbent width 63 of the napkin 10 shown in Figure 4 would extend laterally from the outer edge 32 of the tissue 31 in the one flap 70 to the outer edge 32 of the tissue 31 in the other flap 70.

Another alternative embodiment of a sanitary napkin 10 of the present invention is shown in Figure 5. Like the napkin 10 shown in Figure 4, this napkin 10 also has flaps 70, only of a different configuration. In this embodiment, the flaps 70 are comprised only of the topsheet 25 and the barrier sheet 55.

For illustration purposes, the central absorbent width 63 of the napkin 10 shown in Figure 5 would extend laterally from one outer edge 32 of the tissue 31 to the other outer edge 32 of the tissue 31.

Claims

1. A sanitary napkin having a body surface and a garment surface, comprising:
an absorbent means having a first major surface and a second major surface; and
a liquid impermeable barrier means forming said garment surface and disposed adjacent said second major surface of said absorbent means, characterised in that said sanitary napkin has a caliper of less than 5.0 millimeters, a flexure-resistance of less than 400 grams, a test capacity of at least 8.0 grams, and a total capacity of at least 14.0 grams.

2. A sanitary napkin according claim 1 characterised in that said sanitary napkin has a total capacity of at least 20.0 grams and a flexure resistance of less than 300.0 grams.

3. A sanitary napkin as claimed in either one of claims 1 and 2, characterised in that said sanitary napkin has a caliper of less than 3.0 millimeters.

4. A sanitary napkin as claimed in any of the preceding claims, characterised in that said sanitary napkin has a central absorbent width of at least 3.7 centimeters.

5. A sanitary napkin as claimed in any of the preceding claims, characterised in that said sanitary napkin has a total pad width of at least 4.3 centimeters.

6. A sanitary napkin as claimed in any of the preceding claims characterised in that said absorbent means comprises a liquid permeable topsheet and an absorbent core.

7. A sanitary napkin as claimed in claim 6, characterised in that said absorbent core contains from 5% to 85% by weight of a particulate hydrogel-forming polymer gelling agent.

8. A sanitary napkin as claimed in any of the preceding claims, characterised in that said barrier means comprises a barrier sheet and said absorbent means comprises a liquid permeable polymeric topsheet overlaying a wipe acquisition sheet overlaying an absorbent core, said topsheet being associated with said barrier sheet.

9. A sanitary napkin as claimed in Claim 8, characterised in that said topsheet is an apertured formed film, said wipe acquisition sheet is an apertured nonwoven sheet comprising fiber bundles and apertures, some of said apertures of said topsheet and said wipe acquisition sheet being aligned, such that no fiber bundles of said wipe acquisition sheet are beneath some of said apertures of said topsheet while others of said apertures of said topsheet and said wipe acquisition sheet are not aligned, such that a fiber bundle of said wipe acquisition sheet is beneath said aperture of said topsheet.

10. A sanitary napkin as claimed in any of the preceding claims, characterised in that said napkin further comprises at least one laterally extending flap.

Fig. 1

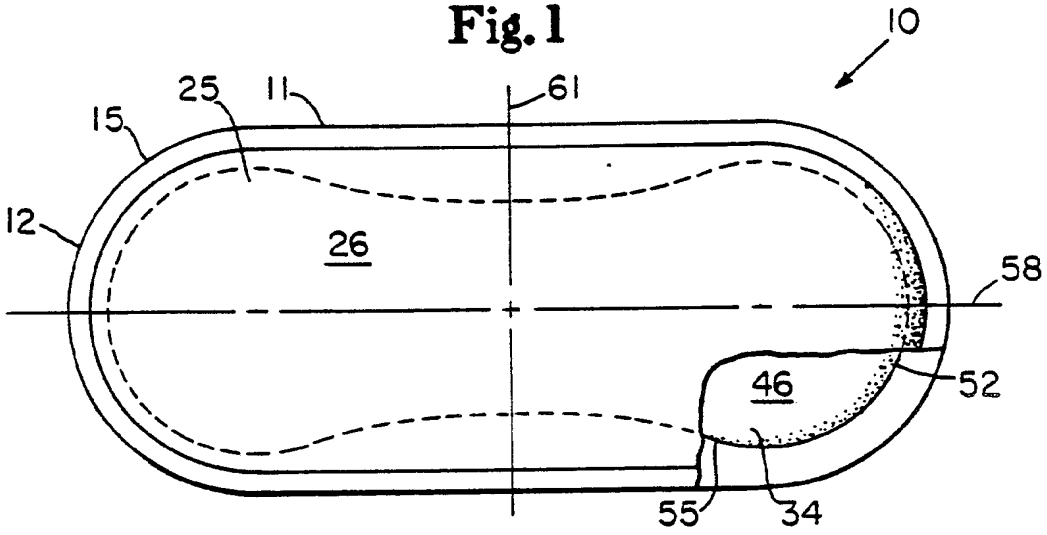


Fig. 2

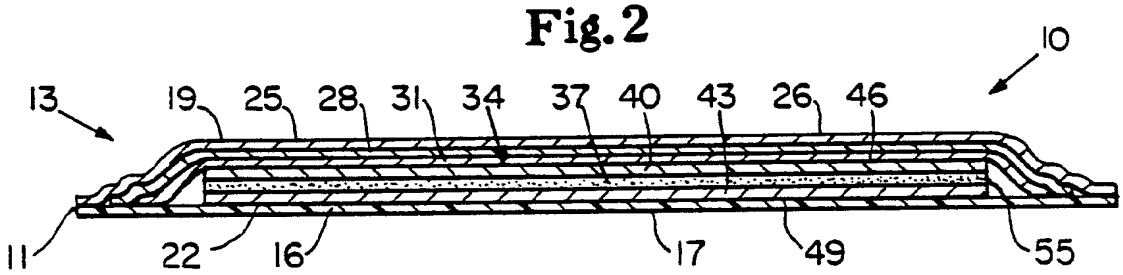


Fig. 3

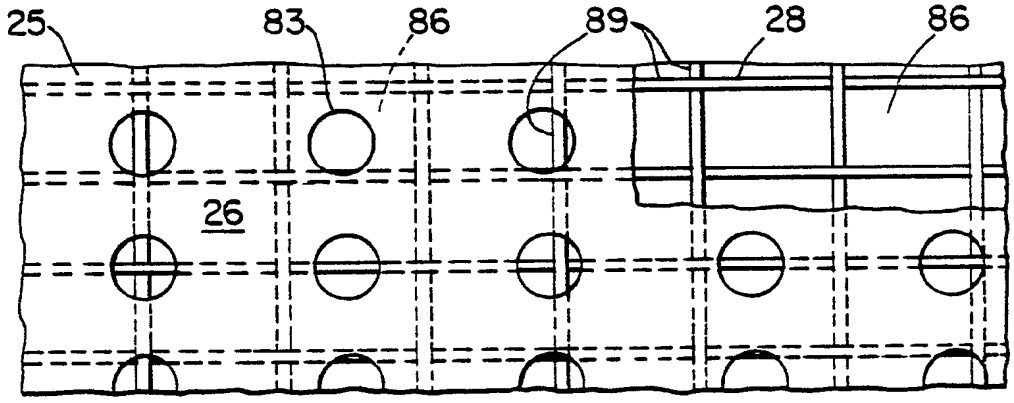


Fig. 4

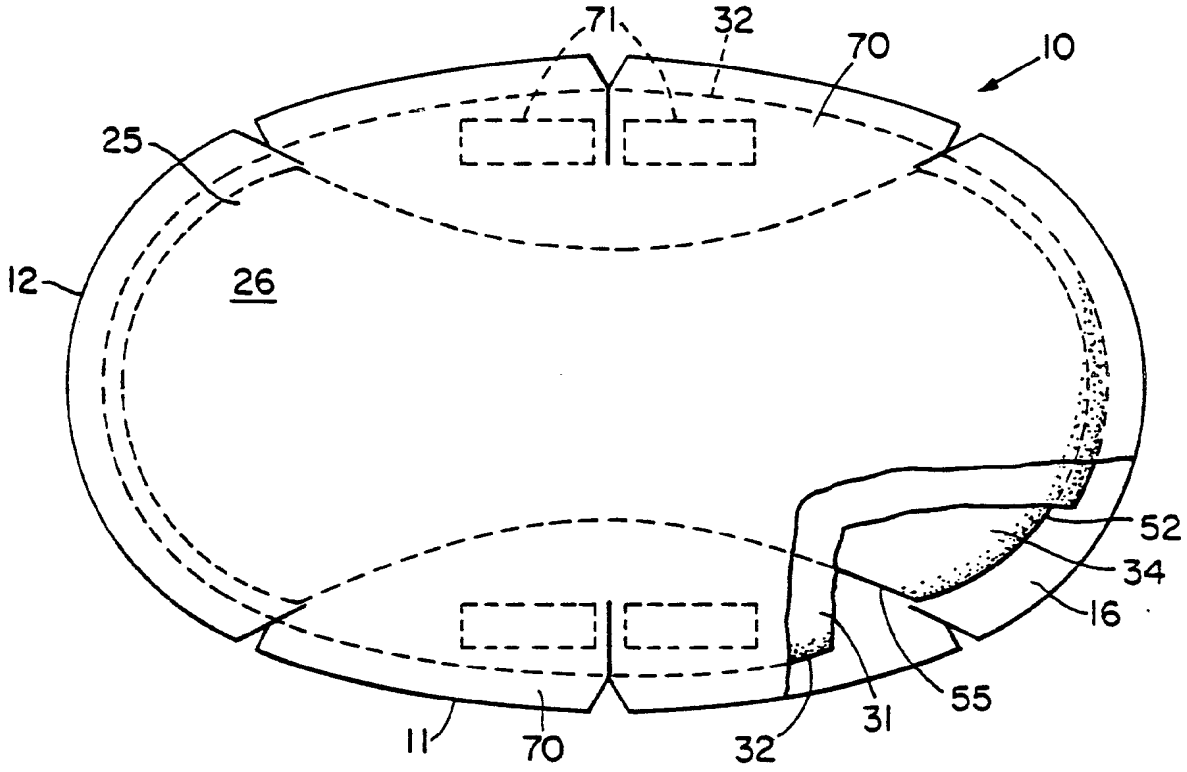
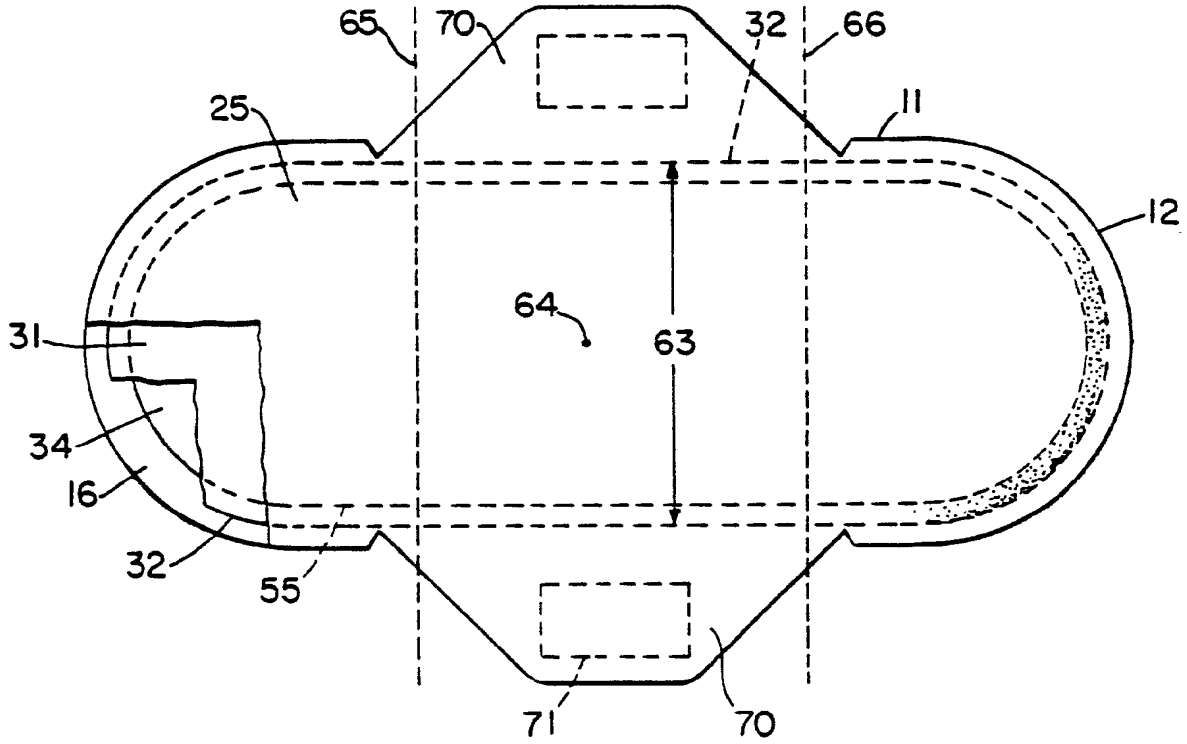

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Fig. 5


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European Patent Office

EUROPEAN SEARCH REPORT

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 89302553.6

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US - A - 4 425 130 (DES MARAIS) * Claims * --	1,3,6	A 61 F 13/16
A	US - A - 4 057 061 (ISHIKAWA) * Claims * --	1,3,6	
A	EP - A1 - 0 215 417 (KIMBERLY-CLARK) * Claims * ----	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

A 61 F
A 61 L
A 41 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	14-06-1989	BECKER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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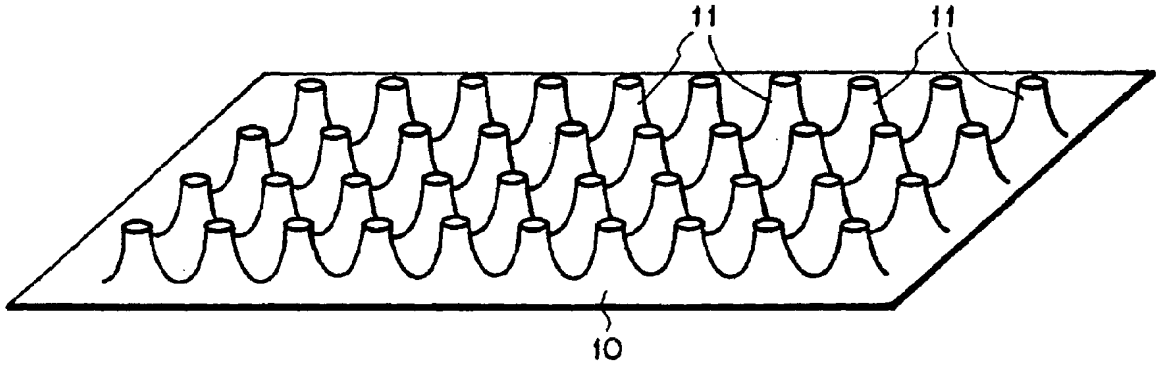
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(54) HIGHLY PERMEABLE AND WATER RESISTANT BARRIER SHEET, AND ABSORBER PRODUCT USING THE BARRIER SHEET

(57) A highly permeable and water resistant barrier sheet, comprising a porous buffer sheet and a water resistant nonwoven cloth of 100 mmH_2O or higher in water resistance connected integrally with each other and combined with a permeable sheet-like absorber to form an absorbing core so as to make an absorber product highly permeable, wherein the porous buffer sheet is a perforated film formed desirably in an irregular structure having funnel-shaped perforated structures with top and bottom parts different in diameter from each other and, when the diameter thereof on the shorter diameter side is 1 mm or shorter when a hole is approximated in a complete round shape and the number of holes is 20/cm^2 or more.

FIG.3



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Description

Field of art

[0001] The present invention relates to a highly air permeable and water resistant barrier sheet comprising a conjugate of a porous buffer sheet and a water resistant nonwoven fabric.

Background technology

[0002] To an absorbent product, skin rash and irritation poses a big problem as accompanied by the wearing of the absorbent product. Various artifices have been presented to overcome such problem such as providing contrivances to the surface materials of the absorbent product, i.e. providing a air permeable zone in the side portion or the end portion of the product or using as the back sheet various materials in combination. No ultimate solutions have been made so far.

[0003] So as to give the so-called breathable back sheet which is a back sheet imparted permeability, many proposals have already been made such as methods of utilizing a laminated member of a microfibrillated web or a gel blocking behavior. The only commercially available effective means is to use a so-called air permeable PE sheet as the back sheet. The permeability of normally available air permeable film is as low as 3.0 to 5.0 kg/24 hr·m^2 as expressed in terms of WVTR (Water Vapor Transfer Ratio) ASTM E 96-63 F, E 96-80B. This air permeability nearly equals to 500~100 sec/100 ml as expressed in term of the Gurley Method.

[0004] In the meantime, according to certain studies on the skin discomfort due to the stuffiness of underwears worn, gap of 2 mm or more is required between the surface of an underwear and the surface of the skin together with a high permeability to make surface air stream existent by virtue of the bellows effect for preventing such discomfort. A normally worn underwear has such permeability that 100 ml of air is made to pass in less than 1.0 second even if it is of a dense fabric as expressed by the Gurley method (ISO 5636/5). If expressed in terms of the permeability by ASTM D-737 for comparing with air permeable films, the permeability of a normal underwear fabric is usually 1 m^3 or more per min · m^2, and further if it is a thin fabric, its permeability is 10 m^3 or more per min · m^2 and even when it is in a wet condition, the permeability is still at least 0.5 m^3 or more per min · m^2. The permeability of this level is nearly 100~300 times as high as that of a air permeable film discussed above. Hence, it is understandable how it is difficult to have an absorbent product sufficiently air permeable not to cause the skin discomfort due to the stuffiness of an underwear or skin rash.

[0005] Besides, since a typical absorbent product represented by a disposable diaper is today designed to fit the body as less gap in between as possible, it has no such gap in between for having the bellows effect work with little air stream on the surface. In addition, since the absorbent body itself of the absorbent product has a thick layer of pulp/SAP, what permeability the air permeable film has does not work as expected after it has absorbed bodily fluid. This is the case today. It is quite natural that such absorbent product likely to result in such condition is worn, the humidity and the temperature inside the product is increased so that the skin discomfort due to the stuffiness of the product or skin rash are likely to be caused.

[0006] In addition, a proposal has been made to provide ventilation holes on the sides or the front and the back or the end of an absorbent product taking risks of causing possible leakage, and a new problem is caused that the effluvium of body fluids comes out of such holes.

[0007] That is to say, in order to make possible an absorbent product which is highly air permeable and in addition less likely to cause skin discomfort due to the stuffiness of an absorbent product and skin rash, although it is important to have more air permeable back sheet, it is necessary but not sufficient, and it is also necessary to impart a stably air permeable structure to the absorbent body itself of the absorbent product.

Disclosure of the invention

[0008] An object of the present invention is to provide novel highly air permeable and water resistant barrier sheets wherein a high level of permeability and at the same time a high level of prevention of leakage which are conflicting with each other are made to be compatible.

[0009] According to the present invention, a highly air permeable and water resistant barrier sheet characterized in that the barrier sheet is comprised by a porous buffer sheet the diameter of whose pores is 1 mm or less and the number of whose pores is 10 or more per cm^2 and a water resistant nonwoven fabric whose water resistance is 100 mmH_2O or higher as bonded in an integrated form.

[0010] A preferable porous buffer sheet is a highly air permeable foamed sheet having continuous air bubbles whose number of cells is 20 or more per 25 mm and whose thickness is 3 mm or less.

[0011] Another preferable porous buffer sheet is an apertured film with many funnel-shaped hollow juts formed having different diameters in the top portion and the bottom portion, and, when the pore of the top portion of the hollow jut

approximates a perfect round shape, the diameter is 1 mm or less and the number of pores is 10 or more per cm^2.

[0012] Also, a preferable water resistant nonwoven fabric is a multi-layered member of spun-bonded web and melt-blown web formed as a material base of PE, PP, PET or polyurethane or any of their derivatives either alone or mixed in any arbitrary combination. The configuration of the layers of the multi-layered member of spun-bonded web (S) and melt-blown web (M) is SMS, SMMS, SMMM or SMSMS.

[0013] Furthermore, the present invention provides an absorbent product having as an absorbent core including as an absorbent component at least one of SAP and fluff pulp in powder, particulate or fibrous form, wherein an highly air permeable and water resistant barrier sheet is provided as disposed in contact with the layer of said absorbent component, said highly air permeable and water resistant barrier sheet comprising a composite of a porous buffer sheet and a water resistant nonwoven fabric whose water resistance is 100 mmH_2O or higher, said porous buffer sheet being an apertured film with many funnel-shaped hollow juts formed with the diameter of its top portion being different from that of the bottom portion, the diameter of the top portion of the hollow juts being 1 mm or less when the diameter approximates a perfect round shape and the number of pores being 10 or more per cm^2 and the top portion of the hollow juts being disposed in contact with said absorbent core.

[0014] In an absorbent product like this, said buffer sheet is disposed as covering the whole undersurface, a part of the sides and a part of the face of said absorbent core, with the undersurface of said absorbent core bonded as integrated with said water resistant nonwoven fabric.

[0015] Said buffer sheet may cover the whole undersurface and the sides of said absorbent core, bonded in its undersurface as integrated with said water resistant nonwoven fabric. Alternatively, said buffer sheet may be disposed as developed on the undersurface of said absorbent core, bonded in its entire surface as integrated with said water resistant nonwoven fabric so that the buffer sheet may function as a back sheet.

[0016] The portion of the whole absorbing surface of said absorbent core where discharged bodily waste is fed in excess of the water retaining capability or pressure is concentrated locally may be reinforced by means of a non-air permeable film whose water resistance is high or a air permeable film whose water resistance is high.

[0017] In said absorbent product, said water resistant film and said buffer sheet may be bonded as integrated with said water resistant nonwoven fabric as combined with each other only in their respective edges.

[0018] In said absorbent product, the thickness of said absorbent water resistant sheet is 0.5 mm or less, said water resistant nonwoven fabric as its component is SMS or SMMS of 30 g/m^2 to 10 g/m^2, said hydrophilic sheet is tissue mainly comprising wood pulp of 30 g/m^2 to 10 g/m^2 and said SAP includes particle SAP of 80 g/m^2 to 210 g/m^2 whose particle size is 500 μm or less.

[0019] 50% or more of the whole weight of said absorbent core is preferably constituted by SAP. More preferably, said absorbent core is a sheet-like conjugate comprising a nonwoven fabric and SAP as carried by said nonwoven fabric.

[0020] Another preferable absorbent core is a sheet-like absorbent body formed by air laid method into a sheet shape as comprises a mixture of fluff pulp and SAP.

[0021] It should be noted that in a highly air permeable and water resistant barrier sheet according to the present invention the "water resistance" needs to be 100 mmH_2O or higher, or preferably 150 mmH_2O or higher, if expressed in terms of the water resistance as generally used in this field of technology and that the water resistance of normally used film such as 2000 mmH_2O or higher is not required and such level of water resistance as can be said to be water permeability is sufficient.

Brief Description of Drawings

[0022]

Fig. 1 is an oblique perspective drawing showing an example of an apertured film as applied to a highly air permeable and water resistant barrier sheet according to the present invention, the film being convexo-concave.

Fig. 2 is an illustrative drawing showing the behavior of fluids movement in case the convexo-concave film according to Fig. 1 is combined with an absorbent core.

Fig. 3 is an oblique perspective drawing showing the appearance of the convexo-concave apertured film having an opening provided on the top portion as applied to a highly air permeable and water resistant barrier sheet according to the present invention.

Fig. 4 is a partially cutout drawing of the convexo-concave apertured film of Fi. 3.

Fig. 5 is illustrative drawings showing different shapes and distributions of openings formed on the top of the evaginated portion of the convexo-concave film.

Figs. 6 (a), (b) and (c) are oblique perspective drawings showing respectively different positions of openings formed on each evaginated portion of the convexo-concave film.

Fig. 7 is an illustrative drawing exemplifying change of the thickness of polyurethane foam as is compressed

thermally or absorbs water.

Fig. 8 is a drawing showing the configuration wherein an apertured film and a water resistant nonwoven fabric are combined with an absorbent core.

Fig. 9 is a pattern diagram showing two kinds of gaps (A, B) existent in the structures of a water resistant nonwoven fabric and a buffer sheet as combined.

Fig. 10 is a flow diagram showing the cycle of an absorbent core absorbing fluids from its start of absorption to completion in the structures of a buffer sheet according to Fig. 9 and a water resistant nonwoven fabric with the absorbent core.

Fig. 11(a) is a plan view showing a sheet-like absorbent body comprising three components of an absorbent layer mainly comprising a highly absorbent resin, a nonwoven fabric substrate carrying the highly absorbent resin and a binding material component binding the highly absorbent resins with each other and the highly absorbent resin with the nonwoven fabric substrate. Fig. 11 (b) is a cross-sectional view of a sheet-like absorbent body according to Fig. 11 (a).

Fig. 12 (a) is a cross-sectional view showing a product model wherein a buffer sheet covers the whole undersurface and both side portions of an absorbent core and further a part of the face portion of the absorbent core and is made a highly air permeable and water resistant barrier sheet as bound in its undersurface portion in an integrate form with a water resistant nonwoven fabric.

Fig. 12 (b) is a cross-sectional view showing a product model wherein a buffer sheet covers the whole undersurface and both side portions of an absorbent core and is made a highly air permeable and water resistant barrier sheet as bound in its undersurface portion in an integrate form with a water resistant nonwoven fabric.

Fig. 12 (c) is a cross-sectional view showing a product model wherein a highly air permeable and water resistant barrier sheet constituted by a buffer sheet and a water resistant nonwoven fabric as bound in an integrated form with each other is disposed in the undersurface of an absorbent core.

Fig. 13 (a) is an illustrative view showing a structure wherein on both sides of an absorbent core a sheet-like absorbent body is quadruplicated in a bank shape. Fig. 13 (b) is an illustrative view showing an example wherein a liquid imair permeable reinforcing film is disposed on the side portions.

Fig. 14 (a) is an illustrative view showing an absorbent product of a structure wherein in the center portion of an absorbent core a sheet-like absorbent body is tripled. Fig. 14 (b) is an illustrated view showing an absorbent product of a structure wherein a reinforcing film is disposed in the center portion of an absorbent core.

Fig. 15 is a schematic longitudinal sectional view showing an example of an absorbent product wherein, with a buffer sheet omitted for the portion where a reinforcing film exists, a buffer sheet and a film portion are partially overlapped with each other to be bound with a water resistant nonwoven fabric.

Fig. 16 is a schematic longitudinal sectional view showing a back-up sheet as applied to an absorbent product according to the present invention.

Fig. 17 is a schematic longitudinal sectional view showing an example of an absorbent product according to the present invention with a back-up sheet added to the outside of a highly air permeable and water resistant barrier sheet.

Fig. 18 is a schematic longitudinal sectional view showing another example of an absorbent product according to the present invention with a back-up sheet added to this inside of a highly air permeable and water resistant barrier sheet.

Fig. 19 is a side elevation view showing the whole of an apparatus for evaluating water resistance as applied in evaluating water resistance.

Fig. 20 is a side elevation view showing the part of the apparatus of Fig. 19 as enlarged where an evaluation sample is mounted.

Fig. 21 is a cross-section view showing an absorbent product model constituted by liquid distribution unit (LDU) being combined with a highly air permeable and water resistant barrier sheet according to the present invention, which is in turn folded with an absorbent core.

Fig. 22 is an illustrative diagram showing the material balance obtained by analyzing the existential condition of fluids absorbed in an absorbing test of a product model of an absorbent product with no buffer sheet used.

Fig. 23 is an illustrative diagram showing the material balance obtained by analyzing the existential condition of fluids absorbed in an absorbing test of a product model of an absorbent product with a buffer sheet used.

Best Mode of Practicing the Present Invention

[0023] An highly air permeable and water resistant barrier sheet according to the present invention based on a novel concept obtained by binding a porous buffer sheet with an a water resistant nonwoven fabric will be explained first, and then an absorbent product obtained by combining said barrier sheet and an absorbent core will be explained.

Porous Buffer Sheet

[0024] A first constituent component of a highly air permeable and water resistant barrier sheet according to the present invention is a porous buffer sheet. This buffer sheet is used in an absorbent product with one surface thereof being disposed directly under an absorbent core and the other surface being bound with a water resistant nonwoven fabric in an integrated form, so that the following conditions need to be satisfied:

(1) The buffer sheet needs to be sufficiently air permeable not to affect the permeability of the absorbent core above and of the water resistant nonwoven fabric below.

(2) The buffer sheet needs to have the function of trapping temporarily water yet to be absorbed (so-called free water) passing through the absorbent core without being absorbed by SAP.

This trapping function is referred to as a bottom acquisition function (temporary retention in the bottom) so that it is distinguished from a conventional surface acquisition function (temporary retention on the surface) wherein the buffer sheet is disposed on the upper portion of the absorbent core in proximity with the top sheet. Water yet to be absorbed trapped by a buffer sheet having this bottom acquisition function is reabsorbed by the SAP layer of the absorbent core above as time passes, and then made stabilized.

Here, the bottom acquisition function possessed by the buffer sheet is as mentioned above a function of temporarily retaining fluids from the absorbent core yet to be absorbed in the bottom of the absorbent core. SAP which is a main component of the absorbent core leaks temporarily out of the absorbent core since it is slow in the initial absorbing speed, and fluids coming out below as get in contact with a conventional film-like back sheet flow on the surface of the back sheet and build up in the lowest portion by means of the law of gravity so the fluids come out as leak through any gap. Hence, such fluids need to be trapped so that they are made uniformly distributed and not moved.

For example, in case a sheet so formed as to give convexes and concaves as shown in Fig. 1 is disposed as a back sheet in contact with an absorbent core, fluids are divided depending on the depths and the number of concaves as shown in Fig. 2 so that and the convexo-concave sheet gets to have a function of trapping fluids as a result and the fluids are pooled uniformly on the whole surface of the sheet. Such function is generally called as the bottom acquisition function.

It is noted that a convexo-concave sheet as shown in Figs. 1 and 2 has a good bottom acquisition function, but is not air permeable so such sheet is not suitable for the object of the present invention.

(3) The buffer sheet needs to have some degree of water resistance.

It is preferable that the amount to be transferred to the water resistant nonwoven fabric below of water yet to be absorbed as trapped on the buffer sheet or in the gaps of the buffer sheet is made as less as possible. The buffer sheet having such function of stopping water needs to have water resistance of such level as not to hamper the high permeability.

(4) The buffer sheet needs to have a structure of many cells or convexes and concaves for defining and finely segmenting fluids.

It is required that free water (water yet to be absorbed) coming out of the absorbent core and temporarily retained by the buffer sheet is not pooled locally, but retained on the whole portion of the buffer sheet in contact with the fluids so that the fluids are defined and finely segmented in streams by means of a dividing structure possessed by the buffer sheet resulting in no local load imposed on the water resistant nonwoven fabric.

(5) The buffer sheet needs to have a so-called buffer effect, in other words a cushion effect, that load and pressure imposed to the absorbent core are alleviated so water pressure as applied to the water resistant nonwoven fabric below is reduced.

Configuration of Porous Buffer Sheet

[0025] It is preferable that, for a porous buffer sheet to be highly air permeable and to exert a function as the stopper of fluids by means of its water resistance, it is porous and at the same time its pores are very fine. At the same time, the buffer sheet needs to be hydrophobic, or preferably constituted by a hydrophobic material, so that the surface tension is made to operate. The pore size is preferably 1 mm or less, and more preferably 0.5 mm or less. Examples of materials constituting the porous body may be mono-polymers, copolymers and their blends such as PE, PP, PET, synthetic rubber, urethane and EVA or their sheet formed products surface treated with such water repellent agent as silicone and Teflon (registered trademark).

[0026] For the function of trapping free water (water yet to be absorbed), so-called bottom acquisition function, to be fully fulfilled, the buffer sheet needs to have a structure that it is bulky with its inside area being large and has the function of physically retaining fluids sufficiently. For such bottom acquisition function to be great enough, it is preferable if said in the simplest way that the buffer sheet is as bulky as possible with its apparent specific gravity being small.

With such buffer sheet used, however, an absorbent product becomes thicker. It is an indispensable requirement that an absorbent product needs to be compact. Such thick absorbent products do not meet the marketing requirements. Accordingly, there should be inherent limitations on the thickness of the products. Thicker and bulkier buffer sheet fulfills the object of the present invention in some way because such buffer sheet has a cushion effect of preventing weight imposed on an absorbent core from being added to a water resistant nonwoven fabric, but, when considering such extremely thin absorbent product the thickness whose absorbent core is 5 mm or less, the thickness of a buffer sheet to be used for such extremely thin product is at least 3 mm or less and preferably 1 mm or less. A buffer sheet, in order that it has 1 mm or less thickness and its buffer effect as mentioned above is stably exerted, needs to be stiff sufficiently that it does not deform significantly when pressure is applied to it or is required to keep a property that when it is dry before use it is kept thin, 1 mm or less, as compressed and deformed, but its bulkiness is recovered when it absorbs moisture or water.

[0027] Another important function of a buffer sheet is to make uniform the flow of the distribution and diversion of fluids. The porous structure of a buffer sheet as used in the present invention is preferably such that, unlike a uniform bulky nonwoven fabric as obtained by a through air process used very often as an acquisition layer in a usual absorbent product, it has a lot of convexo-concave portions like a plastic film formed as having convexes and concaves or a lot of cells like a foam having continuous air bubbles.

[0028] Typical examples having such structure are a foamed urethane sheet having continuous air bubbles and an apertured plastic film having a convexo-concave structure.

[0029] A representative example of such apertured film having a convexo-concave structure is an apertured film with many convexes and concaves each of a so-called funnel shape having different pore sizes of the top and the bottom portion. This apertured film is generally used as a highly stain-free surface member with its side of larger pore size facing upwards disposed on the side of receiving fluids so that the flowing-in of fluids is made easier and at the same time the back-flow from downwards of fluids is prevented. Also, a composite material as made by conjugating a bulky liquid air permeable nonwoven fabric on its surface is described in Japanese patent application 2000-501883 (of Tredegar) and used as a surface material.

[0030] In the present invention an important feature is that an apertured film is disposed in a reverse direction, i.e. with its side of smaller pore size facing upwards and as supporting an absorbent core from downwards in the bottom of the absorbent core so that some resistance is given against the flow-in of fluids and at the same time the moving of fluids from downwards is made likely to be easy. In other words, this type of configuration is required so that, even if fluids yet to be absorbed leaking from an absorbent core overflow out of a buffer sheet and as a result further leak also to the side of a water resistant nonwoven fabric from the pore, in case the leaking fluids are reabsorbed as the absorbing capacity of SAP is recovered, the fluids are made to flow easily to the absorbent core through the pore.

[0031] Fig. 3 shows the appearance of an apertured film 10 having convexes and concaves as used preferably in the present invention, and Fig. 4 is a cross-sectional view of a part thereof as enlarged. The apertured film 10 as shown has many funnel-shaped evaginated portions 11 as formed in an appropriate distribution density, and on the side of larger diameter (bottom portion) of the evaginated portion 11 a bottom pore 12 having a diameter ϕb is formed and on the side of smaller diameter (top portion) of the evaginated portion 11 a top pore 13 having a smaller diameter ϕt is formed, respectively. The ratio of diameter ϕb to ϕt (ϕb / ϕt) is preferably selected from the range of 1.1 to 3.0. Also, the distance between the adjacent evaginated portions 11 is indicated by L, the height by H and the thickness by T. The preferable height is 3 mm or less. The thickness T is the thickness of a material film and preferably 0.01 to 0.5 mm. It is noted that the thickness and the height were measured using Daiei Kagaku Seiki's FS 60 A under the minimum loading condition of 3 g/cm^2. It was intended to indicate the thickness under a condition as near to no-load as possible.

[0032] What is important with the apertured film is, first of all, the size of the smaller pore formed on the top portion of the funnel-shaped evaginated portion 11. This pore size is preferably as small as possible in the range that no air permeability is injured because, when fluids absorbed by an absorbent core are beyond the capability of the absorbent core, the pore becomes an excretory pore for excreting the fluids overflowing from the pore to the water resistant nonwoven fabric of the back sheet side or the back-up sheet side. A preferable pore size is 2 mm or less, and more preferably 1 mm or less if represented by a diameter when the shape of the pore is made to approximate a complete round shape. Under this condition, fluids (yet to be absorbed) weeping down to the bottom layer through the absorbent core are trapped by the concaves of the convexo-concave apertured film and are, until overflowing from there, prevented by the resistance coming from the surface tension of the pores directly flowing out to the water resistance nonwoven fabric. If the pore is beyond 2 mm, however, fluids transferred downwards from the absorbent core are made to bypass directly to the water resistant nonwoven fabric side through the pores of a buffer sheet without exhibiting its water resistance so that its trapping function, i.e. its bottom acquisition effect is made meaningless.

[0033] The number of the pores per a unit area of an apertured film is also an important factor with the present invention. An apertured film has less pores than a foamed sheet (to be described later), so the number of pores is important. Also, the number of pores has much to do with the number of diversions and distributions of fluids yet to be absorbed overf lowing to the water resistant nonwoven fabric. The number of pores if expressed in terms of the number

of pores per cm^2 is preferably 10 /cm^2 or more and more preferably 20 to 300 /cm^2. If the number is less than 10 /cm^2, the distribution and diversion effect is hard to be uniform and thus the buffer effect becomes lower.

[0034] Fig. 5 shows examples of distribution of pores on the top portion of apertured films. All of apertured films A, B and C are of PE. Apertured film A, which is relatively coarsely apertured, is of Tredegar (USA), apertured film B, which is relatively finely apertured, is of Avgol (Israel) and apertured film C, which is more finely apertured, is of Tredegar.

[0035] In the present invention, no particular restrictions are imposed on the shapes of pores formed on an apertured film, but the position of pores may somewhat influence the bottom acquisition function. In order to obtain better bottom acquisition effect, pores 13 are preferably positioned on the top of an evaginated portion as shown in Fig. 6 (a). In order to have higher water resistance under load, the pores are preferably disposed on the side of an evaginated portion as shown in Fig. 6 (b), in which case, as shown in Fig. 6 (c), two pores 13 may be formed on one evaginated portion and as required three or more pores may be formed on one evaginated portion. In case pores are formed on the side of an evaginated portion, the pores are made flattened in shape when deformed under load, which may sometimes be better.

[0036] On the other hand, a foamed sheet is a sheet of hydrophobic foam such as PE, PP, polyurethane, PET and synthetic rubber and should be air permeable having continuous air bubbles. In general, such foamed sheet has preferably an air permeability of at least 5 $m^3/min \cdot m^2$ (ASTM D-737) and, if expressed in the number of cells and the degree of foaming, the foamed sheet has preferably the following physical properties:

Porosity : 70% to 99%,
Number of cells : 20 cells / 25 mm to 80 cells / 25 mm, and
Degree of foaming : 15 to 50 times.

[0037] The thickness of a foamed sheet is, like an apertured film as above described, 3 mm or less and preferably 1 mm or less. A thicker than 3 mm sheet, however, may be preferably used if it is made thin as compressed under load.

[0038] In other words, a preferable bulky state of a foamed sheet means that it is kept as thin as possible not only when packaged as a absorbent product but also when opened or worn so that as accompanied by the absorbed swelling of an absorbent core as wetted when body fluids are discharged the sheet as a buffer sheet may be made swollen and bulky.

[0039] A buffer sheet may be such as is bulky having resilience under compression as described in Japanese Patent Application 2001-19777, but rather, preferably, is such as is likely to crumple, i.e. to deform to thin state permanently without its structure destroyed. Being made thin like this under compression is relatively easy in the case of materials such as foamed sponge. For example, a foam of a thermoplastic polymer such as PE and PP can be compressed down to a degree of one tenth to one fifth by being pressed at its thermal melting or lower temperature. Even a polyurethane foam whose heat plasticization temperature is high can be compressed down to a degree of one fifth by treating under high pressure as heated. Even a cellulose sponge of no thermoplasticity can be also compressed down to a degree of one fifth by treating under heat and compression as it is wetted. These compressed sponges recover nearly to their original level of bulkiness by means of the hydration of foamed cells if when used water is absorbed under the pressure of body weight.

[0040] Fig. 7 exemplifies change of the thickness of a polyurethane foam in the course of thermal compression and water absorption. In case the thickness P of a polyurethane foam yet to be compressed is for example 8 mm, the thickness is compressed down to 2 mm, i.e. a degree of one fourth of the original thickness, the thickness of the foam as compressed being called Q. The compressed foam stably keeps the 2 mm thickness when it is dry, but, after it is used as a buffer sheet and thus has absorbed water under compression, its thickness is recovered to a degree of 6 mm, the recovered thickness being called S. The thickness as buffer sheet in this case is indicated to be 2 mm as the thickness when it is dry.

Water Resistant Nonwoven Fabric

[0041] Next, the concept and characteristics of a water resistant nonwoven fabric, a second component of a highly air permeable and water resistant barrier sheet, are explained.

[0042] A water resistant nonwoven fabric in combination with a buffer sheet as above described functions for trapping fluids coming out of the pores of the buffer sheet and preventing such fluids from leaking outside the system. Accordingly, materials constituting the water resistant nonwoven fabric are required to have considerably more finely porous than an aperturued film and a sponge. A nonwoven fabric of fine denier constituent fibers and of a dense construction meets such requirements.

[0043] Such nonwoven fabric is preferably a water resistant nonwoven fabric having a property to less wet to water being permeability resistant to some extent and as thin with uniform hydrophobicity and water repellency as possible. Examples of such nonwoven fabric are melt blown nonwoven fabric, spun bond nonwoven fabric and their conjugates

SMS, SMM and SMSMS, of PE, PP, PET, polyurethane and their derivat ives or mixtures. The weight of such nonwoven fabric is preferably in the range of 10 g/m^2 to 30 g/m^2. The water resistance of such nonwoven fabric is preferably high, but, as described later, since it is important that it functions effectively in combination with a buffer sheet, the water resistance of a single layer of such nonwoven fabric is 100 mmH_2O or more and preferably 150 mmH_2O or more. In this sense, a preferable nonwoven fabric is SMS which is a composite of a spun bond (S) and a melt blown web of finer constituent fibers (M), and SMMS, SMMMS and SMSMS which are composites with a higher percentage of a melt blown layer and made uniform, and the denier of filaments constituting a spun bond layer is preferably 2 denir or less.

[0044] In order to stabilize the water resistance of a water resistant nonwoven fabric, the surface of the nonwoven fabric may be treated with a water repellent agent such as silicone and Teflon (registered trademark).

Integration of Water Resistant Nonwoven Fabric with Buffer Sheet

[0045] In a highly air permeable and water resistant barrier sheet according to the present invention, it is necessary to join and integrate a water resistant nonwoven fabric as above described and a buffer sheet in a close contact with each other. For integrating them, a buffer sheet and a water resistant nonwoven fabric may be joined with an adhesive agent or a fusing agent, but it is preferably recommended that, in order not to inhibit the air permeability of a nonwoven fabric and a buffer sheet, they are joined with a bonding agent, a hot melt resin usually used for hygiene products being applied by means of a hot melt applicator such as a spray coater and a curtain coater to them as they are made in a fibrous state.

[0046] Alternatively, an apertured film / a melt blown composite or a foamed sheet / a melt blown composite which are manufactured by a coupled process of a manufacturing process of an apertured film or a foamed sheet and a melt blown process may be used.

[0047] A water resistant nonwoven fabric is used as it is in a composite laminated state of a buffer sheet as described above, and, by means of such laminated structure, becomes to possess such completely different properties from those of a single layer.

[0048] Table 1 below shows measurements of a single layered water resistant nonwoven fabric, a single layered buffer sheet and a barrier sheet comprising laminate structure of such single layers in terms of water resistance. From these results it is seen that, although the water resistance possessed by an apertured film as a buffer sheet is extremely low, the water resistance is made considerably high by lamination.

Table 1

Constituent materials		Water resistance (mmH_2O)
Water resistant nonwoven fabric	SMMS (22 g/m^2)	220
Buffer sheet	Apertured film A	5
	Apertured film B	12
	Apertured film C	25
	Polyurethane foam	30
Barrier sheet	Apertured film A/SMMS	260
	Apertured film B/SMMS	390
	Apertured film C/SMMS	430
	Polyurethanefoam/SMMS	330

[0049] The results shown in Table 1 show that the barrier sheet made by disposing SMMS as a water resistant nonwoven fabric to an apertured film B and to an apertured film C each of relatively fine pores exhibits very high water resistance.

[0050] Next, an absorbent product constituted by combining a high air permeable and water resistant nonwoven barrier sheet with an absorbent core is explained with reference to Fig. 8. Fig. 8 shows a configuration relation among a water resistant nonwoven fabric 20, a apertured film 10 and an absorbent core 30 in combination. In this configuration, as shown in Table 1 for example, in case an apertured film 10 whose water resistance is 25 mmH_2O (an apertured film C of Fig. 5) is combined with a water resistant nonwoven fabric 20 comprising SMMS whose water resistance is 220 mmH_2O, the sum of the water resistances of the individual elements is only 245 mmH_2O, but the measurement of a

joined and integrated composite is 430 mmH_2O, which is nearly two times as high as the former. One reason for this seems to be that, by employing a combined configuration of an apertured film and SMMS, a combined effect of the water resistant structure of the apertured film 10 and the layer of air existent is realized so that some or other water resistance alleviation effect is made to work on the water resistant nonwoven fabric 20.

Mechanism of Trapped Fluids Reabsorbed

[0051] What is further important with a joined structure of a buffer sheet and a water resistant nonwoven fabric is a bottom acquisition effect and a mechanism of trapped fluids yet to be absorbed being reabsorbed by an absorbent core containing SAP.

[0052] Fig. 9 is a pattern diagram showing two kinds of air spaces existent in a structure of a water resistant nonwoven fabric 20 and a buffer sheet of an apertured film 10 as combined, i.e. an air space A existent in a concave portion of a buffer sheet, an apertured film, and an air space B existent between a water resistant nonwoven fabric and a convex portion of a buffer sheet of an apertured film 10.

[0053] In addition, Fig. 10 shows an absorbing cycle example from the start to the end of absorption of fluids by an absorbent core in a configuration shown in Fig. 9. Body fluids discharged are first diffused onto the surface of an absorbent core and then absorbed partly by the SAP layer with fluids remaining not absorbed moving further to the bottom layer. Any fluids left yet to be absorbed resulting from the supply of body fluids in excess of the absorption by SAP are trapped first by portion A of the buffer sheet having many cell-shaped concaves so that it shows a state shown in Fig. 9 (I). If the amount of fluids yet to be absorbed is further more, portion A becomes filled and the fluids as diffusing all over the concaves and convexes overflow from the pores to fill portion B, which is a state as shown in Fig. 9 (II).

[0054] Since, as time passes, however, the SAP layer on the top provides a surplus capacity of absorption, fluids existent in portion A are first reabsorbed by the absorbent core. Then, the fluids in portion B are also reabsorbed after flowing back through the pores. This is as shown in Fig. 9 (III). Further, as time passes, almost all of the fluids in portions A and B are reabsorbed by the absorbent core, and both of portions A and B are recovered to their original spaces so that the portions are made ready to receive next coming discharged fluids. This is as shown in Fig. 9 (IV).

[0055] The load applied to the water resistant nonwoven fabric becomes highest when, as shown in Fig. 9 (II), both of portions A and B are filled and such load is alleviated as time passes. Even when both of the portions are filled as the load is at its maximum, the amount received as the water pressure from the trapped water is low like as 2 mm to 5 mmH_2O as the free water pressure so that the water resistant nonwoven fabric can function to prevent leakage.

[0056] The volume occupied percentages of portions A and B of a buffer sheet in bearing the expected functions are shown in Table 2 in the states of (I) to (IV) in Fig 9. State (I) means the state that 80 to 90 % of portion A alone out of 100 % of the respective capabilities of portions A and B is utilized, state (II) shows the state that 100 % of portions A and B is utilized when they are filled, state (III) means a state that while portion A starts to reabsorption and the half of the fluids has been reabsorbed in portion A, a part of portion B (20%) has been reabsorbed as affected by portion A. In state (IV), a state is shown in a model that almost all fluids have been reabsorbed and portions A and B are ready for the next discharge.

Table 2

	Stages in Absorption Cycle (100% means fully occupied, 0% means nearly vacant state)			
Portion A or B	(I)	(II)	(III)	(IV)
Portion A	80 to 90%	100%	50%	0%
Portion B	0%	100%	80%	0%

[0057] In the above schematic example the leakage prevention effects have been explained of a barrier sheet having a multi-layered of a buffer sheet and a water resistant nonwoven fabric in combination. Below an absorbent product as constituted by such barrier sheet in combination with an absorbent core is explained.

Absorbent Core Preferable in Absorbent Product of Present Invention

[0058] One of preferable absorbent cores as used in absorbent products according to the present invention is an

absorbent core containing a high percentage of SAP and that, for example, as recited in Japanese Patent Application Laid Open Hei 10-168230 and Japanese Patent Application Laid Open 2000-201975, such absorbent sheet as comprises three components of an absorbent layer mainly consisting of a highly absorbent resin, a nonwoven fabric substrate carrying the highly absorbent resin and a bonding agent for bonding the highly absorbent resins and the highly absorbent resin to the nonwoven fabric substrate.

[0059] One example of such absorbent sheet is shown in Fig. 11. In Fig. 11 reference code 31 represents a nonwoven fabric substrate, and reference code 32 indicates SAP layer provided line zone state on the surface of this nonwoven fabric substrate. The zone where SAP layer exists functions as an absorbent zone phase (P phase) and the zone where no SAP layer exists functions as a diffusion/acquisition zone phase (Q phase) which is extremely low in air flow resistance. In this way an absorbent sheet wherein phases mutually different in functions are existent as continuous phases adjacent to each other is suitable to the present invention. The Q phase of this absorbent sheet has an air flow structure where air can pass freely before and after absorbing fluids.

[0060] Also, this absorbent sheet, since it has a SAP content of 80 to 90 %, falls within the concept of absorbent cores of so-called super super thin structure, and an absorbent core like this is very excellent in compactness but has a defect that its initial absorption speed is low. Hence, conventionally an method has been employed that on the top side of an absorbent core a surface acquisition layer of a bulky nonwoven fabric or fluff pulp is provided to trap fluids temporarily and then to supply fluids to the SAP layer. However if fluids are intended to be trapped only by the surface acquisition layer, the utilization of the SAP layer is reduced necessarily resulting in that the acquisition layer needs to be thicker and larger. Consequently, the product cost will be higher and the benefit of compactness will be forfeited. The present invention solves these problems also by providing a buffer sheet having a bottom acquisition function.

[0061] For example, the urinating rate of a healthy baby is approximately 100 ml/30 sec. Thus it is naturally required that any difference between the urinating rate and the absorbing rate of an absorbent core needs to be adjusted and, in such case, the present invention works effectively. One solution for adjusting such difference of the absorbing rate is to use Liquid distribution unit (LDU) and diffuse liquids rapidly all over the surface of an absorbent core so that the utilization of the area space may be increased as proposed by the inventors of the present invention in their Japanese Patent Application 2001-044494. Another solution to solve this problem is to eliminate the above-described absorbing rate difference by trapping fluids yet to be absorbed utilizing the bottom acquisition effect possessed by a buffer sheet. Thus, by combining the first solution of Liquid distribution unit (LDU) and the second solution of the buffer sheet, the absorption rate can be considerably improved. The specific effects of such means will be explained with reference to the embodiment of an absorbent product shown in Fig. 21.

Configuration Relation of Absorbent Core to Barrier Sheet

[0062] An embodiment of combining an absorbent sheet containing a high concentration of SAP as described above and a barrier sheet according to the present invention is explained with reference to Figs. 12.

[0063] In an example shown in Fig. 12 (a), an apertured PE film 10 used as a buffer sheet covers both sides of the under surface of an absorbent core 30 and a part of the surface portion of the absorbent core 30 whereby the apertured PE film 10 also functions so-called core wrapping covering a great part of the absorbent core. The under surface of the apertured film 10 is bonded to and integrated with SMMS of PP constituting a water resistant nonwoven fabric 20 and EVA type hot melt (not shown) to function as a highly air permeable and water resistant barrier sheet. An absorbent product having such absorbent core structure has a buffer sheet whose area of use is large, and the part existent on the top surface of the absorbent core functions as a Liquid distribution unit (LDU) and has multi functions operating as a core wrapping making easier the reabsorption of fluids in the regions from the side portions extending down to the under surface and further working in the under surface region as a back sheet as a highly air permeable and water resistant barrier sheet in a composite with a water resistant nonwoven fabric.

[0064] Fig. 12 (b) shows an example wherein an apertured PE film used as a buffer sheet covers the whole under surface and both sides of an absorbent core 30 and bonded and integrated in its under surface portion with SMMS of PP, a water resistant nonwoven fabric 20, by means of EVA type hot melt (not shown). In an absorbent product having such absorbent core structure, a buffer sheet, i.e. an apertured film 10, exhibits as a core wrapping function making easier the reabsorption of fluids in the regions from the side portions extending down to the under surface of the absorbent core 30 and fullfils in its under surface region the function of a back sheet as a highly air permeable and water resistant barrier sheet in a composite with a water resistant nonwoven fabric 20.

[0065] In an example shown in Fig. 12(c), a highly air permeable and water resistant barrier sheet wherein a buffer sheet comprising an apertured PE film and a water resistant nonwoven fabric comprising SMMS of PP are bonded to each other in an integrated form is disposed as developed widely on the under surface of an absorbent core 30 to function as a back-up sheet.

Countermeasures when Load is Excessive to Highly Air permeable and Water Resistant Barrier Sheet

[0066] In a highly air permeable and water resistant barrier sheet having a structure according to the present invention, the retention of absorbed fluids of SAP, a main component of an absorbent core, is very important. There are such cases where body fluids may be discharged in excess of the retention of SAP, pressures coming from body fluids may be locally concentrated and leakage may take place in a region where SAP is overloaded. As against such cases it is effective to reinforce such regions beforehand with more water resistant non air permeable film or more water resistant highly air permeable film. The positions and the area of such reinforcing may be arbitrarily selected. It should be noted that if the positions are too many or the area is too large, the significance of existence of a barrier sheet according to the present invention is diminished.

[0067] Figs. 13 and 14 show examples of reinforcing with a non-air permeable film or a highly water resistant air permeable film. In an example shown in Fig. 13 (a), the sides of an absorbent core are so structured that absorbent sheets are quadruplicated in the form of a bank. As baby and adult diapers are contemplated, the body weight is concentratedly applied on this quadruplicated portion so that there may be likely leakage on the sides. In such case, as shown in Fig. 13 (b), such leakage may be eliminated by disposing a liquid imair permeable reinforcing film 40 on each side. In the case of this example, a PE film of 15 μm thickness is disposed between a highly air permeable and water resistant barrier sheet 100 and an absorbent core 30. Of course, this film may be placed between an apertured film 10 constituting a highly air permeable and water resistant barrier sheet and a water resistant nonwoven fabric 20.

[0068] In an example shown in Fig. 14 (a), an absorbent core 30 is so structured that an absorbent sheet is trebled in the middle portion of the core. In this case, since the amount of fluids to be absorbed becomes larger and the load is concentrated in the middle portion, as shown in Fig. 14 (b), possible leakage may be eliminated by disposing a reinforcing film 40 in the middle portion. In the case of this example, the reinforcing film 40 is obtained by disposing a PE film of 15 μm thickness between a highly air permeable and water resistant barrier sheet and an absorbent core 30. The reinforcing may be either in a longitudinal direction or in a width direction.

[0069] Some embodiments have thus been explained of adding film to a buffer sheet. It is an effective means that, since if a buffer sheet is folded on a film, the leakage prevention function is duplicated in that particular portion with a resulting increase in the cost, a buffer sheet in the portion where such film is existent is omitted and, as shown in Fig. 15, an apertured film 10 is folded partly on a reinforcing film 40, which are then bonded to a water resistant nonwoven fabric 20 with a hot melt 21, for use.

Highly Air permeable and Water Resistant Barrier Sheet with Leakage Prevention Stability Improved

[0070] In case an adult diaper is used for incontinence applications or a baby diaper is used for nighttime applications where loading is high or in such systems where an absorbent body is pulp rich, since free fluids are always existent in abundance, it is necessary to maintain a stable leakage prevention effect. In this case, reinforcing with film as discussed above is not suitable since the reinforced portion is increased and the air permeability may be injured. In a case like this, the structure becomes complicated with a resulting increased cost, but one layer of an absorbent water resistant sheet is added as a back-up sheet so that, while the air permeability may be maintained, the leakage prevention may be secured. The absorbent water resistant sheet is an absorbent sheet having a coating pattern of SAP as shown in Fig. 11 made thinner and more flexible, which has a structure shown in Fig. 16. In other words, it has a structure where a hydrophilic sheet 22 of tissue having a water diffusing property is thinly coated with SAP 32 in line patterns to which coated surface a water resistant nonwoven fabric 20 is bonded by means of hot melt 21 resulting in a three-layered structure and thus, such structure has absorbency and at the same time has water resistance so that it is called an absorbent water resistant sheet 50. A back-up sheet is intended to work as a back up in an emergency leading to leakage, and thus preferably thin and flexible. The maximum thickness of the back-up sheet is 1 mm and preferably less than 0.5 mm.

[0071] An absorbent water resistant sheet 50 should be as thin and water resistant as possible. SAP used for the sheet is particulate with the particle size being 500 μm or less and preferably 300 μm or less. The amount of SAP to be used for coating is 100 g/m^2 or less and preferably 20 to 80 g/m^2 or less. Thus, a thin and flexible structure is preferable.

[0072] A water resistant nonwoven fabric may be, as explained above, SMS or SMMS comprising hydrophobic fibers, and in this example a relatively thin fabric of 13 g/m^2 is used.

[0073] A hydrophilic sheet is for diffusing leaking fluids uniformly, and a relatively thin sheet made of cellulose fibers such as wood pulp, rayon and cotton is used. The weight is preferably 30 to 10 g/m^2, and in this example tissue of 15 g/m^2 comprising wood pulp is used for constituting the hydrophilic sheet.

[0074] An absorbent water resistant sheet 50 like this is used as a back-up sheet. Embodiments of absorbent products with such back-up sheet added are shown in Figs. 17 and 18.

[0075] First of all, in an example shown in Fig. 17, an absorbent core is a mixture of SAP and pulp, in a so-called

ultra-thin type structure with approximately 35% of SAP and the balance of fluff pulp. In this case, since the amount of free fluids is relatively large, an absorbent water resistant sheet 50 as shown in Fig. 16 is further added as a back-up sheet under a water resistant barrier sheet comprising a buffer sheet and a water resistant nonwoven fabric. By employing a structure like this, the protectiveness against leakage is considerably improved. Incidentally, in Fig. 17, reference code 10 represents an apertured film, reference code 20 indicates a water resistant nonwoven fabric, and reference code 30 indicates an absorbent core, respectively.

[0076] In an example shown in Fig. 18, since an absorbent core 30 is of an absorbent structure mainly consisting of fluff pulp with 10 % of SAP contained, the amount of free fluids is very large. In this case, an absorbent core 30 mainly consisting of fluff pulp is wrapped with an absorbent water resistant sheet 50, and, after free fluids are trapped at a first stage by this absorbent water resistant sheet, the protectiveness against leakage is secured by a highly air permeable and water resistant sheet comprising a buffer sheet and a water resistant nonwoven fabric. The absorbent water resistant sheet used here is excellent in air permeability, so that the high air permeability of an absorbent product, which is a feature of the present invention, is not considerably injured. In Fig. 18, the same or equivalent reference codes are used as and to those used in Fig. 17.

Air Permeability and Evaluation Methods

[0077] In the present invention, an apertured film is a material which is extremely air permeable just like a water resistant nonwoven fabric, and thus its composite of such material, a highly air permeable and water resistant barrier sheet of the present invention, is also extremely air permeable, which is several hundred times as high as that of any conventional air permeable back sheet, which is equivalent to that of any underwear so that the evaluation of its air permeability by WVTR is difficult to perform. Therefore, the air permeability tests were performed by means of air permeability test by ASTM (D-737) and Gurley methods by ISO 5636/5. As a result, almost all examples showed similarly excellent air permeability.

[0078] The air permeability tests by ASTM (D-737) were expressed in terms of the amount of air (m^3) passing through samples of 1 m^2 for one minute and Gurley tests were expressed in terms of the time in sec for air of 100 ml to pass through.

- Air permeability tests (m^3/min, m^2) : 1 m^3 or more
- Gurley tests (sec/100ml) : 1 sec or less

[0079] From the test results, the behavior of highly air permeable and water resistant barrier sheets according to the present invention exhibiting its water resistance while maintaining their air permeability is understood to be entirely different from the mechanism of air permeability means applied to conventional back sheets.

Test Methods of Water Resistance

[0080] Next, the evaluation of water resistance is explained.

[0081] Fig. 19 shows the whole of an evaluation apparatus employed here. Fig. 20 shows an enlargement of the portion where samples for evaluation are mounted of the apparatus.

[0082] The sizes of samples are 5 cm×5 cm or larger. The samples were mounted in the following way:

1) Place 2 pieces as folded of filter paper 63 (model: No.2 and size: 15 cm×15 cm, which details are applicable to the other pieces of filter paper.) on a glass plate 62 on a jack 61.
2) Place a sample 64 in the center of the pieces of filter paper 64 with their SAP coated surface facing upwards.
3) Place a piece of tissue 65 (4 cm×4 cm or larger) smaller than the sample on the sample 64.
4) Then, set an acrylic pipe 66 in the following manner.
5) Attach a cushion packing 68 meeting the size of a hole (20 mm ϕ) on the under surface of an acrylic seat 67 made integrated with the acrylic pipe 66.
6) Hold the acrylic pipe 66 by means of a clump 70 of a stand 69, and adjust so as to have the hole of the bottom of the acrylic pipe 66 meet the center of the sample 64. In this case, hold the acrylic pipe 66 at a right angel to the sample 64.
7) Following the positioning of the acrylic pipe 66, fix the position of the acrylic pipe 66 by tightening the clump 70.
8) Lift the jack 61 so that tightening for prevention of leakage is done by interceding the cushion packing 68 between an acrylic sheet 62 and the acrylic seat 67 of the bottom of the acrylic pipe 66.

[0083] Next, in the following procedure the water resistance pressure tests were performed to evaluate the water resistance:

[0084] First of all, from the top edge of the acrylic pipe, pour gently a small amount (for example, 2 to 3 ml) of measurement fluid (0.9 % NaCl aqueous solution, colored in edible blue No.1) contained in a washing bottle. In this case, make sure that the sample surface has absorbed fluids sufficiently.

[0085] Allow the sample to stand for one minute so that SAP particles on the sample surface are swollen. In this case, too, make sure that no measurement fluid has leaked.

[0086] Next, attach a funnel 72 on the top edge of the acrylic pipe, and add the measurement fluid. Read the indicated graduation of the acrylic pipe when leakage takes place on the filter paper on the glass plate, which is understood to be the water resistance (P). Read the graduation in terms of 10 mmH_2O.

[0087] It is noted that the foregoing evaluation is performed as observation is done appropriately using a mirror 73 disposed under the glass plate 62.

Examples

[0088] (Analysis of absorbing behavior of an absorbent product model made by combining an absorbent core and a highly air permeable and water resistance barrier sheet according to the present invention)

[0089] A highly air permeable and water resistant barrier sheet according to the present invention on which an absorbent core was placed as folded to make an absorbent product model. The configuration of this product model is shown in Fig. 21 with reference code 10 representing an apertured film, 20 indicating water resistant nonwoven fabric, 30 indicating an absorbent core and 60 indicating an elastic element, respectively. In addition, on the center top surface of the absorbent core a top sheet 301 and a Liquid distribution unit (LDU) 302 are disposed as necessary. Liquid distribution unit (LDU) in this case uses an apertured film and the smaller the area of use, the higher the effects comparing the top sheet 301 area.

<Water resistant nonwoven fabric>

[0090] As a water resistant nonwoven fabric, SMMS which is a laminate of PP spun bond web and PP melt blown web (of Avgol) was prepared. In the constitution of SMMS, 6 g of S and 4 g of M were used as laminated in an integrated SMMS. The weight was 20 g/m^2 and the water resistance was 180 mmH_2O.

<Buffer sheet>

[0091] An apertured film sample (B) (prepared by Avgol) as shown in Fig. 5 was used as a buffer sheet. The sheet was so high in air permeability that it showed low resistance to permeability.

<Absorbent core>

[0092] An absorbent core (prepared by Tokushu Paper Ltd.) using MegaThin (registered trademark) wherein a spun lace substrate was coated with SAP was prepared. The absorbent core was manufactured by a process recited in Japanese Patent 3046367, and the constituents of MegaThin were 150 g/m^2 of SAP and 40 g/m^2 of a nonwoven fabric substrate with 7 mm and 3 mm (7/3) of SAP coating width and distance resulting in the total weight of 190 g/m^2. This MegaThin was cut into 100 mm $\times$ 270 mm to constitute the absorbent core 30 where the MegaThin was folded as trebled on both sides and a top sheet 301 and a Liquid distribution unit (LDU) 302 were disposed in the center portion. The amount of absorption of the absorbent core 30 was 4500 ml and the retention was 320 ml. The absorbent core had a high air permeability due to the existence of a portion comprising only a nonwoven fabric.

[0093] A buffer sheet comprising a PE apertured film 10 was disposed for covering the whole under surface of the absorbent core with its top portion made in contact with the under surface of the absorbent core, and further on the under surface of the buffer sheet a water resistant nonwoven fabric (SMMS) was bonded in an integrated manner.

[0094] To this product model 300 ml of physiological saline water was added in an amount of 100 cc at 10-minute intervals to analyze the existence condition of fluids in terms of the amount of absorption and the amount transferred to the buffer sheet and to compare the material balances. The results are given in Figs. 22 and 23.

[0095] In a system shown in Fig. 22 where no porous buffer sheet was used (get rid of buffer sheet 10 from Fig. 21 product), fluids yet to be absorbed not captured by the absorbent core were flowed out to the water resistant nonwoven fabric side (absorbed by back-up sheet). The change between immediately after time the fluids were absorbed and the time when the absorbent core was allowed to stand for 10 minutes thereafter was only that fluids yet to be absorbed as contained by the top sheet were reabsorbed by the absorbent core. The amounts of fluids not absorbed and discharged were 23 ml at a first time, 25 ml at a second time and 30 ml at a third time. 78 ml in total out of 300 ml was discharged at a breath to the side of the back-up sheet. This flow was neither regulated nor distributed and that a large load was imposed on the buck-as a sheet and possible leakage is likely as pressurized under the body weight. There-

fore, a material such as PE film which is highly water resistant and at the same time necessarily less air permeable needed to be employed.

[0096] As against this, if one observed in a system shown in Fig. 23 where a porous buffer sheet is combined with a water resistant nonwoven fabric, immediately after a first 100 ml was supplied, 5 ml of fluids yet to be absorbed was trapped by the top sheet, 75 ml was trapped by the absorbent core and 19 ml was trapped by the buffer sheet, and only 1 ml leaking from these elements was further distributed leaked out of the pores to the back-up sheet. Fluids thus leaking were only those existent in drops on the water resistant nonwoven fabric. Of course, no fluids leaked out of the water resistant nonwoven fabric at all. Until when a next supply was made, SAP of the absorbent core swelled to restore an absorbing capacity and reabsorbed by absorbing fluids yet to be absorbed out of space A and space B as mentioned above which existed around the buffer sheet, thereby the spaces around the buffer sheet became empty to be ready to receive a next supply of fluids. The amounts of fluids not absorbed and discharged were 1ml at a first time, 2ml at a second time and 1ml at a third time.

[0097] As a second supply of fluids started, a cycle similar to that at the first time was repeated. At the time that a third absorption of fluids was finished, 5 ml out of the total of 300 ml was re-divided and became existent in sheets as a load to the water resistant sheet.

[0098] As a result, the following differences were observed depending upon whether a buffer sheet is provided or not:

(1) The load to the buffer sheet side was considerably reduced from 78 ml to 5 ml.
(2) As against the fact that without a buffer sheet used the load of 78 ml was concentrated on a part of the back-up sheet, the use of a buffer sheet according to the present invention re-distributed the load as applied to the back-up sheet of 5 ml further into one of several tenths.
(3) When no buffer sheet was employed, the body weight of a wearer was applied to the back-up sheet as a direct water pressure, but as the pressure was dissipated and alleviated by the use of the porous buffer sheet thereby the pressure was made indirectly uniform, so that the pressure as applied to the back-up sheet was made very little.

[0099] On observation of the leakage of an absorbent product model provided with the above-described buffer sheet and water resistant nonwoven fabric being made to absorbed 300 ml while was worn actually at a sitting position and then allowed to stand for 5 minutes with 50 kg body weight applied, no leakage took place at all.

[0100] A highly air permeable and water resistant barrier sheet according to the present invention has a high air permeability and at the same time a high level of water resistance. Absorbent products having this barrier sheet applied therein as a back sheet such as baby diapers, adult diapers, feminine hygiene products and articles for pets provide an excellent and comfortable feeling of use with much less skin rash and stuffiness.

Industrial Applicability

[0101] A highly air permeable and water resistant barrier sheet has not only a high air permeability but also a good water resistance, and as such is applicable for use as water barrier in baby diapers, adult diapers and any other absorbent products.

Claims

1. A highly air permeable and water resistant barrier sheet comprising a composite obtained by bonding, in an integrated form,
   a porous buffer sheet which has pores having a diameter of 1 mm or less and has a number of 10 pores/cm^2 or more and
   a water resistant nonwoven fabric having a water resistance value of 100 mmH_2O or more.

2. A highly air permeable and water resistant barrier sheet according to claim 1 wherein said porous buffer sheet comprises a highly air permeable foam sheet having continuous air bubbles and having a number of 20 cells/25 mm or more and a thickness of 3 mm or less.

3. A highly air permeable and water resistant barrier sheet according to claim 1 wherein said porous buffer sheet is an apertured film with many funnel-shaped hollow juts,
   the diameter of the top portion of said juts being different from that of the bottom portion of said juts,
   the diameter of the top portion of said juts being 1 mm or less when the shape of the top portion of said juts is approximated to a perfect circle,
   said porous buffer sheet having a number of 10 pores/cm^2 or more.

4. A highly air permeable and water resistant barrier sheet according to either of claims 1 to 3 wherein said water resistant nonwoven fabric is a multi-layered member of a spun bond web and a melt blown web which are formed by using, as a raw material base, PE, PP, PET or polyurethane and their derivatives alone or in any arbitrary combination.

5. A highly air permeable and water resistant barrier sheet according to claim 4 wherein said multi-layered member of spun bond (S) and melt blown (M) has a layer configuration selected from the group consisting of SMS, SMMS, SMMMS and SMSMS.

6. An absorbent product having an absorbent core including at least one of SAP component and fluff pulp component in the form of a powder, particulate or fiber as an absorbent component,
a highly air permeable and water resistant barrier sheet being provided and disposed in contact with the layer of said absorbent component,
said highly air permeable and water resistant barrier sheet comprising a composite obtained by bonding, in an integrated form, a porous buffer sheet which has pores having a diameter of 1 mm or less and has a number of 10 pores/cm^2 or more and
a water resistant nonwoven fabric having a water resistance value of 100 mmH_2O or more.

7. An absorbent product according to claim 6 wherein said buffer sheet is an apertured film with many funnel-shaped hollow juts, the diameter of the top portion of said juts being different from that of the bottom portion of said juts, the diameter of the top portion of said juts being 1 mm or less when the shape of the top portion of said juts is approximated to a perfect circle,
said porous buffer sheet having a number of 10 pores/cm^2 or more, the top portion of said juts being disposed in contact with said absorbent core.

8. An absorbent product according to either of claims 6 and 7 wherein said buffer sheet is disposed to cover the whole undersurface and both sides of said absorbent core and a part of the surface of said absorbent core,
the undersurface of said absorbent core being bonded, in an integrated form, to said water resistant nonwoven fabric.

9. An absorbent product according to either of claims 6 and 7 wherein said buffer sheet covers the whole undersurface and both sides of said absorbent core and is bonded, in an integrated form, to said water resistant nonwoven fabric in the undersurface of said absorbent core.

10. An absorbent product according to either of claims 6 and 7 wherein said buffer sheet is disposed, developed on the undersurface of said absorbent core, and bonded, in an integrated form, to said water resistant nonwoven fabric on the whole surface of said absorbent core so that said buffer sheet and said water resistant nonwoven fabric may function as a back-up sheet.

11. An absorbent product according to either one of claims 6 to 10 wherein a non air permeable film of high water resistance or an air permeable film of high water resistance is added to reinforce the portion of the whole absorbing surface of said absorbent core where discharged body fluids are intensively supplied in excess of the water retaining capability of said absorbent core or pressure is concentrated locally.

12. An absorbent product according to claim 11 wherein said highly water resistant film and said buffer sheet are combined with each other only in their respective edges folded on each other and are bonded in an integrated form.

13. An absorbent product according to either one of claims 6 to 11 wherein an absorbent water resistant sheet is further added to said barrier sheet as a back-up sheet in order to improve the water resistance stability thereof.

14. An absorbent product according to claim 13 wherein said absorbent water resistant sheet has a three-layered structure as composed of said water resistant nonwoven fabric, a hydrophilic sheet having a water dispersibility and a SAP layer as interposed between said water resistant sheet and said hydrophilic sheet.

15. An absorbent product according to claim 14 wherein said absorbent water resistant sheet has a thickness of 0.5 mm or less, said water resistant nonwoven fabric is in the form of SMS or SMMS of 30 g/m^2 to 10 g/m^2, said hydrophilic sheet is a tissue paper mainly comprising wood pulp of 30 g/m^2 to 10 g/m^2 and said SAP layer includes SAP particles of 80 g/m^2 to 210 g/m^2 whose particle size is 500 μm or less.

16. An absorbent product according to either one of claims 6 to 15 wherein 50% or more of the whole weight of said absorbent core is composed of said SAP particles.

17. An absorbent product according to either one of claims 6 to 15 wherein said absorbent core is a sheet-like composite comprising a nonwoven fabric and SAP particles as carried by said nonwoven fabric.

18. An absorbent product according to either one of claims 6 to 15 wherein said absorbent core comprises a mixture of fluff pulp and SAP particles and is a sheet-like absorbent body formed by an air laid method.

Amended claims under Art 19.1 PCT

1. (Amended) A highly air permeable and water resistant barrier sheet comprising a composite obtained by bonding, in an integrated form,
a porous buffer sheet which has pores having a diameter of 1 mm or less and has a number of 10 pores/cm^2 or more and
a water resistant nonwoven fabric having a water resistance value of 100 mmH_2O or more, said water resistant nonwoven fabric comprising a spun bond web and a melt blown web.

2. A highly air permeable and water resistant barrier sheet according to claim 1 wherein said porous buffer sheet comprises a highly air permeable foam sheet having continuous air bubbles and having a number of 20 cells/25 mm or more and a thickness of 3 mm or less.

3. (Amended) A highly air permeable and water resistant barrier sheet according to claim 1 wherein said porous buffer sheet is an apertured film with many funnel-shaped hollow juts,
the diameter of the top portion of said juts being different from that of the bottom portion of said juts,
the diameter of the top portion of said juts being 1 mm or less when the shape of the top portion of said juts is approximated to a perfect circle,
said porous buffer sheet having a number of 10 pores/cm^2 or more, said water resistant nonwoven fabric being bonded to said bottom portion of said hollow juts of said porous buffer sheet.

4. (Amended) A highly air permeable and water resistant barrier sheet according to either of claims 1 to 3 wherein said water resistant nonwoven fabric is formed by using, as a raw material base, PE, PP, PET or polyurethane and their derivatives alone or in any arbitrary combination.

5. A highly air permeable and water resistant barrier sheet according to claim 4 wherein said multi-layered member of spun bond (S) and melt blown (M) has a layer configuration selected from the group consisting of SMS, SMMS, SMMMS and SMSMS.

6. (Amended) An absorbent product having an absorbent core including at least one of SAP component and fluff pulp component in the form of a powder, particulate or fiber as an absorbent component,
a highly air permeable and water resistant barrier sheet being provided and disposed in contact with the layer of said absorbent component,
said highly air permeable and water resistant barrier sheet comprising a composite obtained by bonding, in an integrated form,
a porous buffer sheet which has pores having a diameter of 1 mm or less and has a number of 10 pores/cm^2 or more and
a water resistant nonwoven fabric having a water resistance value of 100 mmH_2O or more,
said water resistant nonwoven fabric comprising a spun bond web and a melt blown web.

7. An absorbent product according to claim 6 wherein said buffer sheet is an apertured film with many funnel-shaped hollow juts,
the diameter of the top portion of said juts being different from that of the bottom portion of said juts,
the diameter of the top portion of said juts being 1 mm or less when the shape of the top portion of said juts is approximated to a perfect circle,
said porous buffer sheet having a number of 10 pores/cm^2 or more, the top portion of said juts being disposed in contact with said absorbent core.

8. An absorbent product according to either of claims 6 and 7 wherein said buffer sheet is disposed to cover the whole undersurface and both sides of said absorbent core and a part of the surface of said absorbent core, the undersurface of said absorbent core being bonded, in an integrated form, to said water resistant nonwoven fabric.

9. An absorbent product according to either of claims 6 and 7 wherein said buffer sheet covers the whole undersurface and both sides of said absorbent core and is bonded, in an integrated form, to said water resistant nonwoven fabric in the undersurface of said absorbent core.

10. (Amended) An absorbent product according to either of claims 6 and 7 wherein said buffer sheet is disposed, developed on the undersurface of said absorbent core, and bonded, in an integrated form, to said water resistant nonwoven fabric on the whole surface of said absorbent core so that said buffer sheet and said water resistant nonwoven fabric may function as a water resistant barrier sheet.

11. An absorbent product according to either one of claims 6 to 10 wherein a non air permeable film of high water resistance or an air permeable film of high water resistance is added to reinforce the portion of the whole absorbing surface of said absorbent core where discharged body fluids are intensively supplied in excess of the water retaining capability of said absorbent core or pressure is concentrated locally.

12. (Amended) An absorbent product according to claim 11 wherein said highly water resistant film and said buffer sheet are combined with each other only in their respective edges folded on each other and are bonded in an integrated form.

13. An absorbent product according to either one of claims 6 to 11 wherein an absorbent water resistant sheet is further added to said barrier sheet as a back-up sheet in order to improve the water resistance stability thereof.

14. An absorbent product according to claim 13 wherein said absorbent water resistant sheet has a three-layered structure as composed of said water resistant nonwoven fabric, a hydrophilic sheet having a water dispersibility and a SAP layer as interposed between said water resistant sheet and said hydrophilic sheet.

15. An absorbent product according to claim 14 wherein said absorbent water resistant sheet has a thickness of 0.5 mm or less, said water resistant nonwoven fabric is in the form of SMS or SMMS of 30 g/m^2 to 10 g/m^2, said hydrophilic sheet is a tissue paper mainly comprising wood pulp of 30 g/m^2 to 10 g/m^2 and said SAP layer includes SAP particles of 80 g/m^2 to 210 g/m^2 whose particle size is 500 μm or less.

16. An absorbent product according to either one of claims 6 to 15 wherein 50% or more of the whole weight of said absorbent core is composed of said SAP particles.

17. An absorbent product according to either one of claims 6 to 15 wherein said absorbent core is a sheet-like composite comprising a nonwoven fabric and SAP particles as carried by said nonwoven fabric.

18. An absorbent product according to either one of claims 6 to 15 wherein said absorbent core comprises a mixture of fluff pulp and SAP particles and is a sheet-like absorbent body formed by an air laid method.

FIG. 1

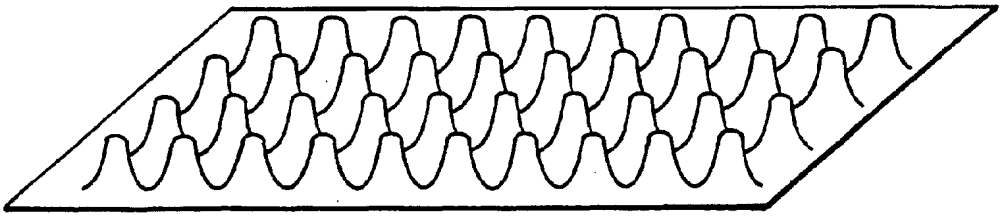


FIG. 2

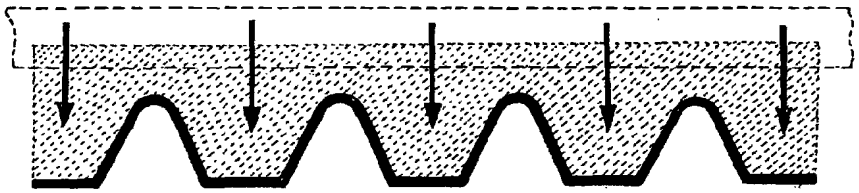


FIG.3

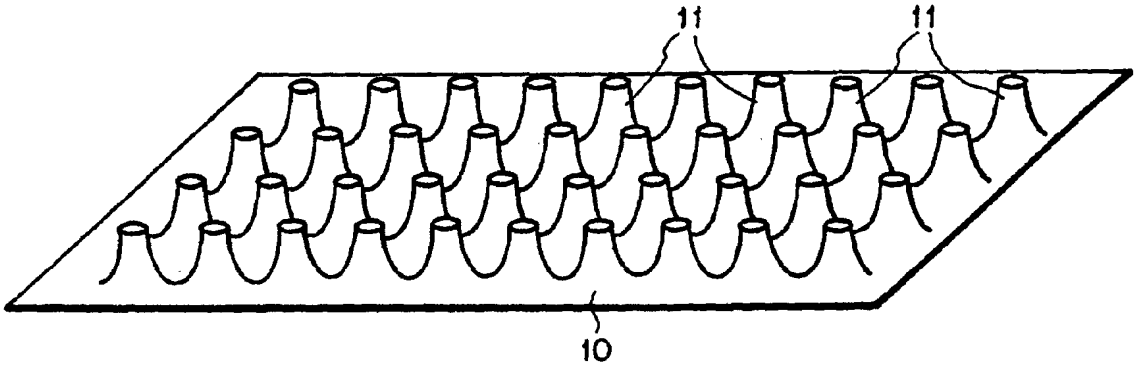


FIG.4

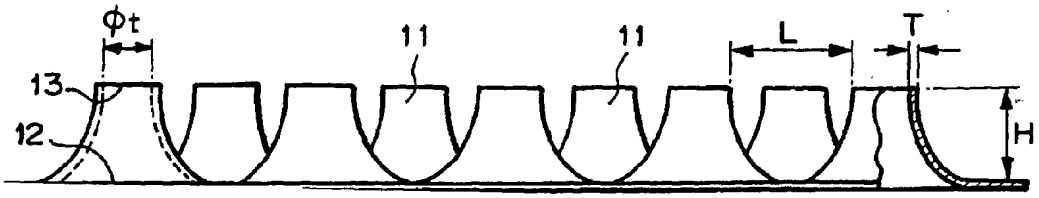
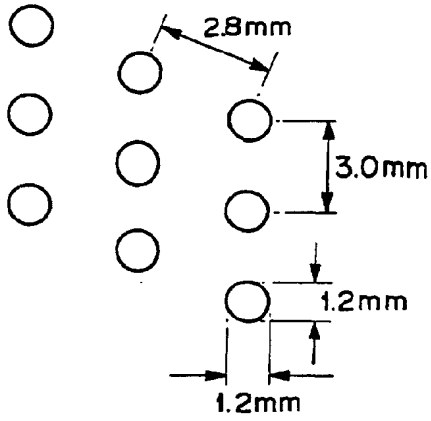


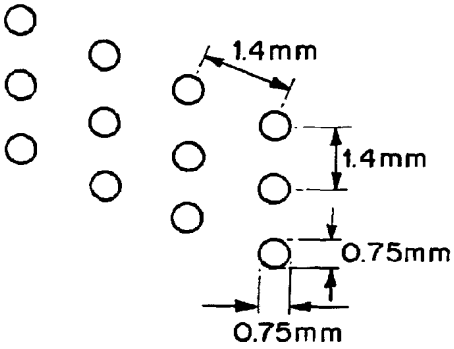
FIG.5

APERTURED FILM-A



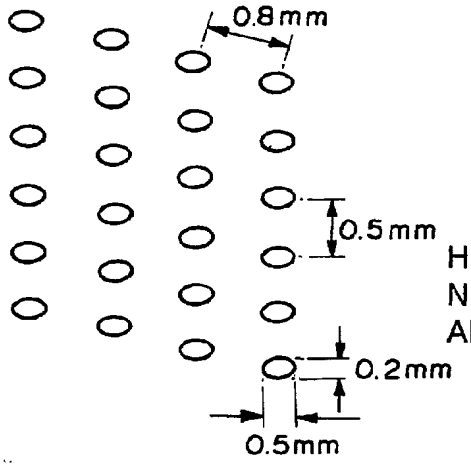
HEIGHT: 1.1mm
NUMBER OF HOLES: 15/cm^2
APERTURED RATIO: 30 %

APERTURED FILM-B



HEIGHT: 0.5mm
NUMBER OF HOLES: 55/cm^2
APERTURED RATIO: 15 %

APERTURED FILM-C



HEIGHT: 0.4mm
NUMBER OF HOLES: 210/cm^2
APERTURED RATIO: 25 %

FIG.6

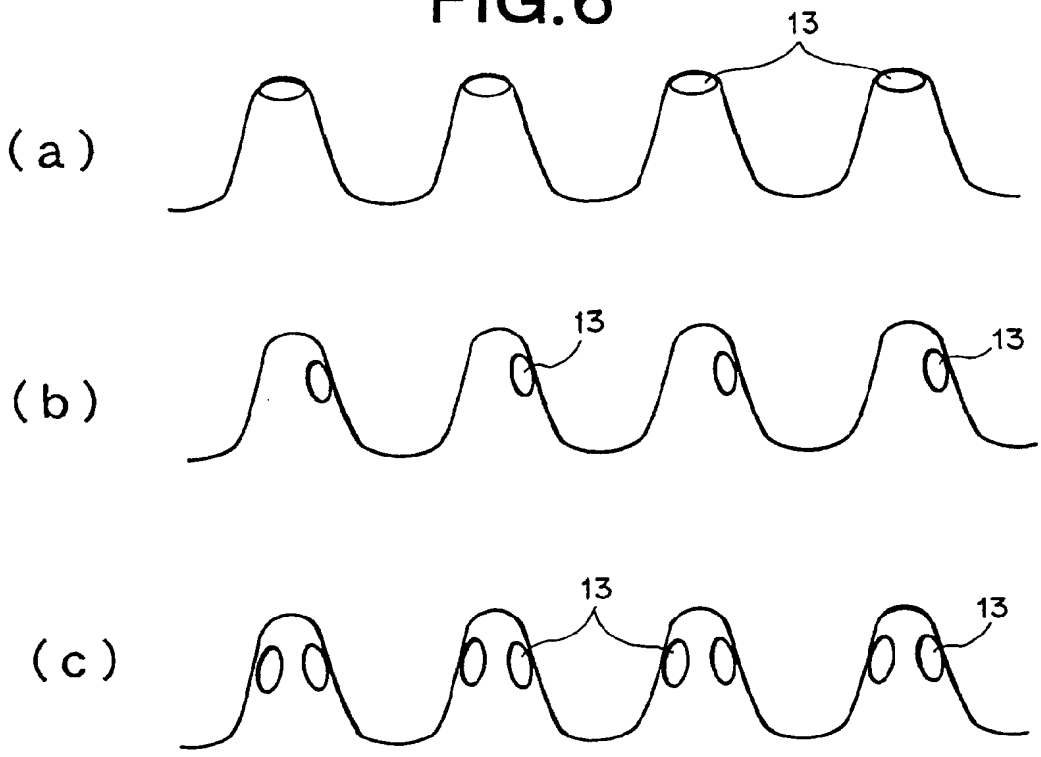

(a)
13
(b)
13
13
(c)
13
13

FIG.7

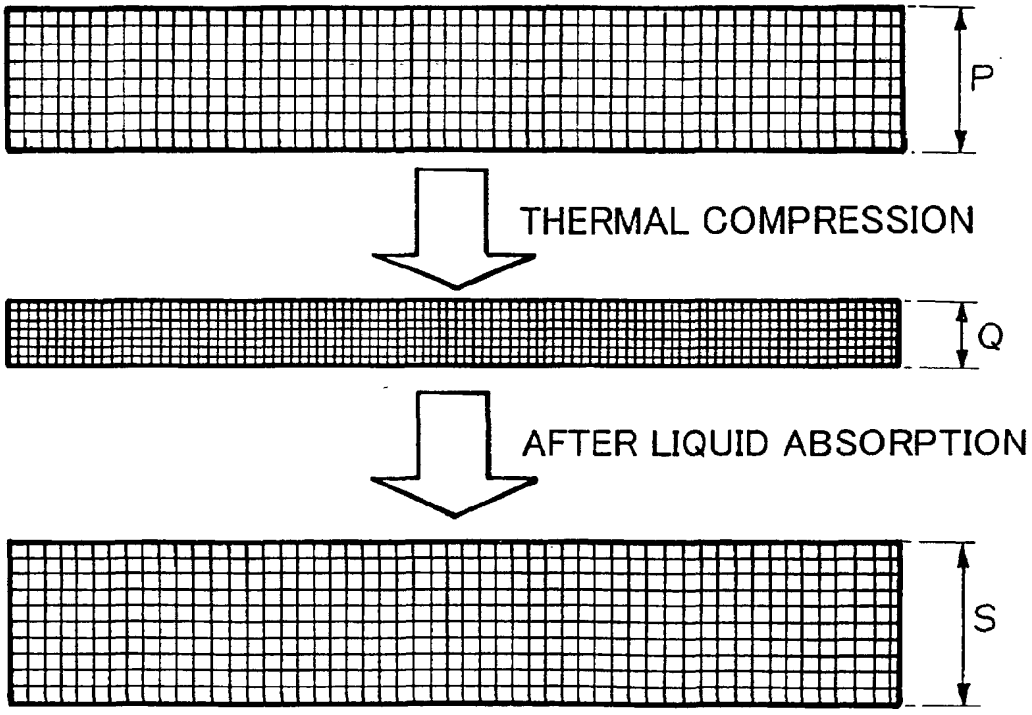

P
THERMAL COMPRESSION
Q
AFTER LIQUID ABSORPTION
S

FIG.8

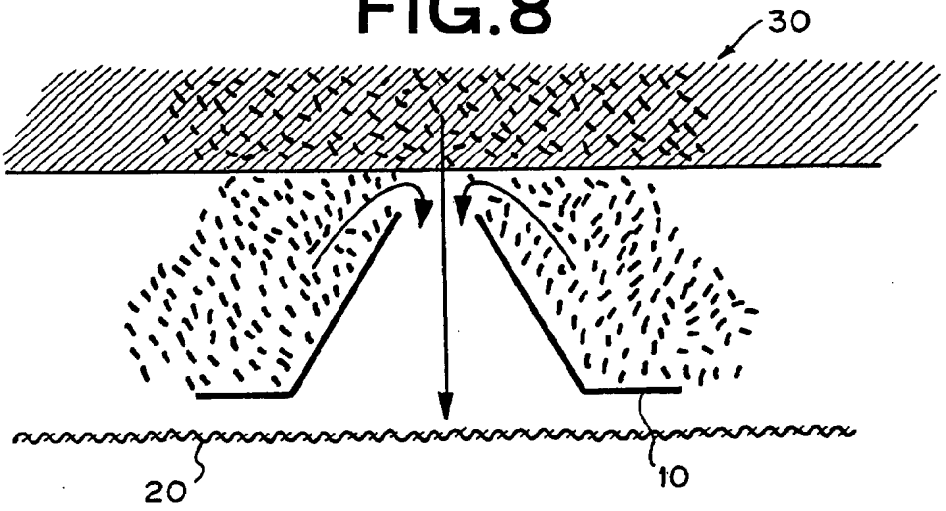


FIG.9

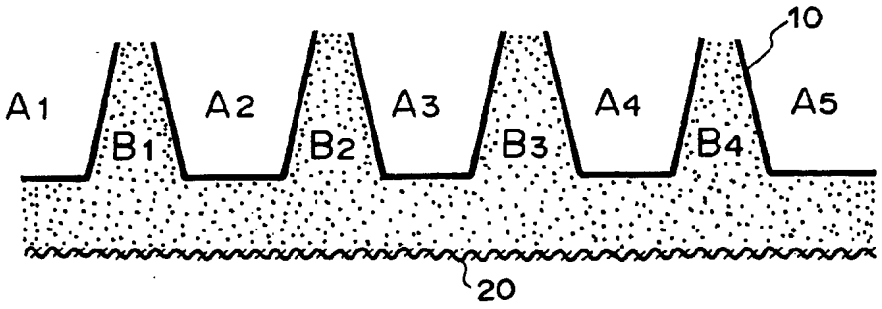


FIG.10

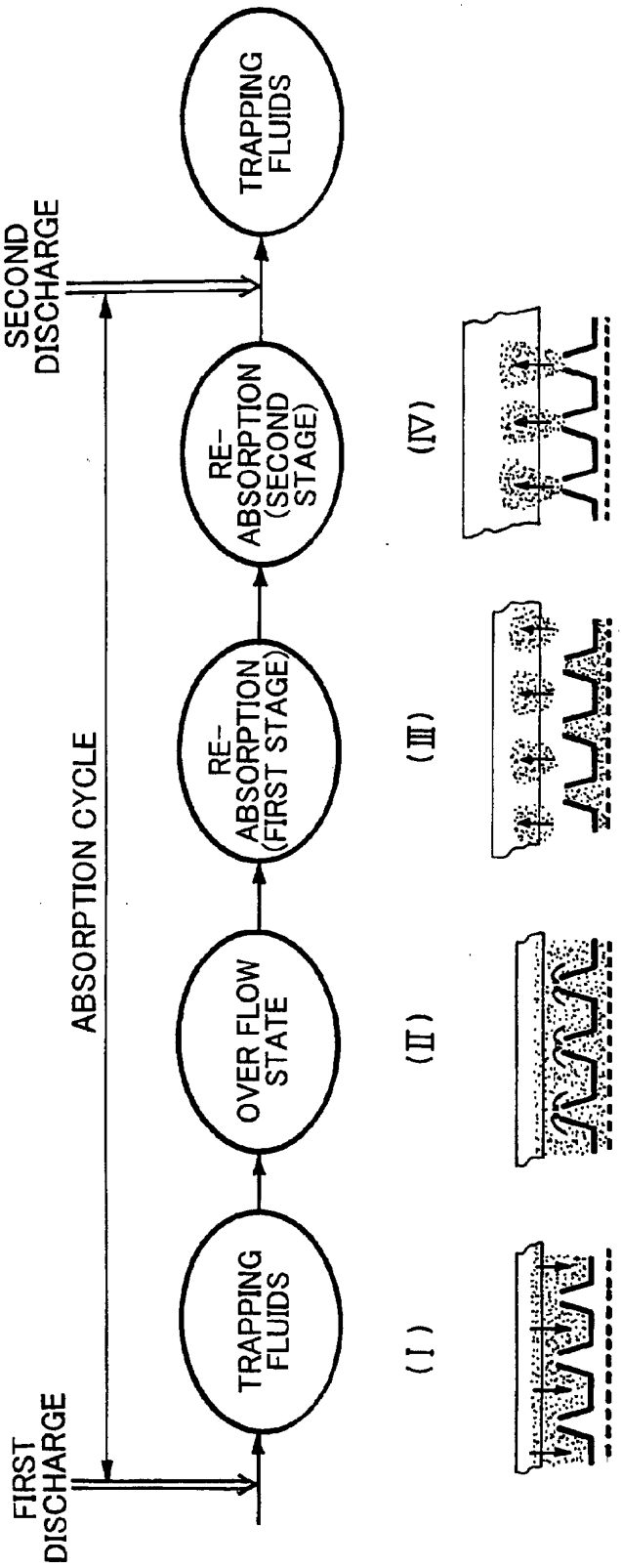
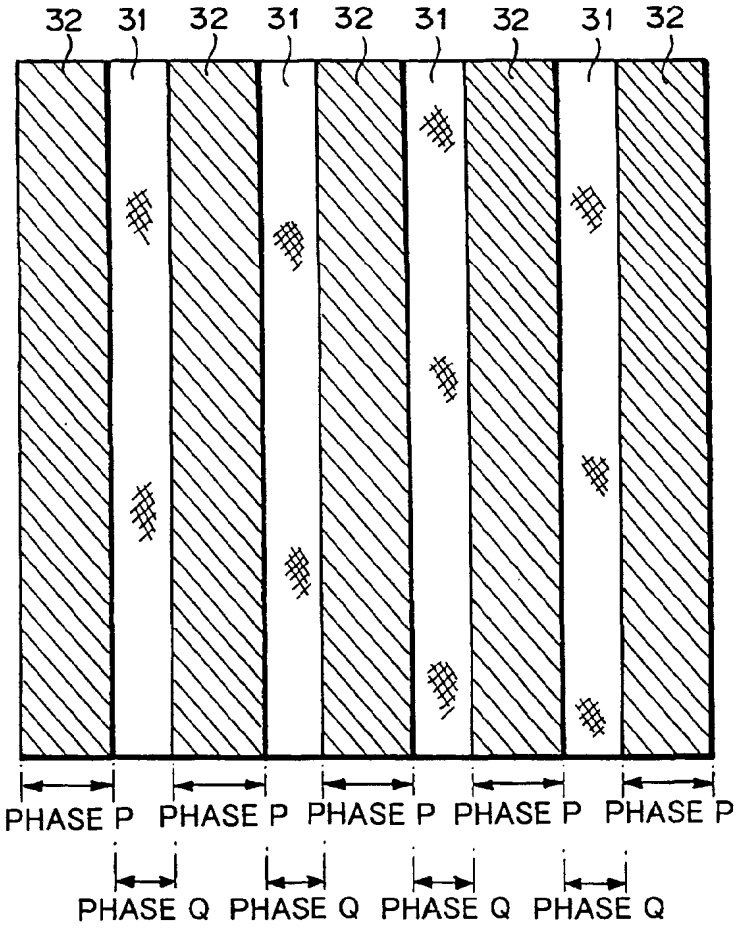

FIRST DISCHARGE
ABSORPTION CYCLE
SECOND DISCHARGE
TRAPPING FLUIDS
OVER FLOW STATE
RE-ABSORPTION (FIRST STAGE)
RE-ABSORPTION (SECOND STAGE)
TRAPPING FLUIDS
(I)
(II)
(III)
(IV)

FIG.11

(a)


32
31
32
31
32
31
32
31
32
PHASE P
PHASE P
PHASE P
PHASE P
PHASE P
PHASE Q
PHASE Q
PHASE Q
PHASE Q

(b)

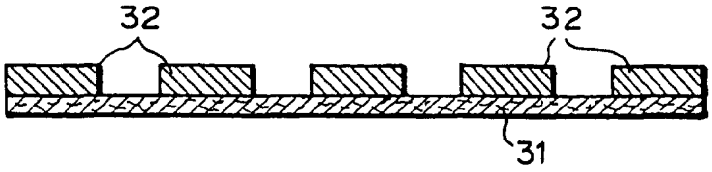

32
32
31

FIG.13

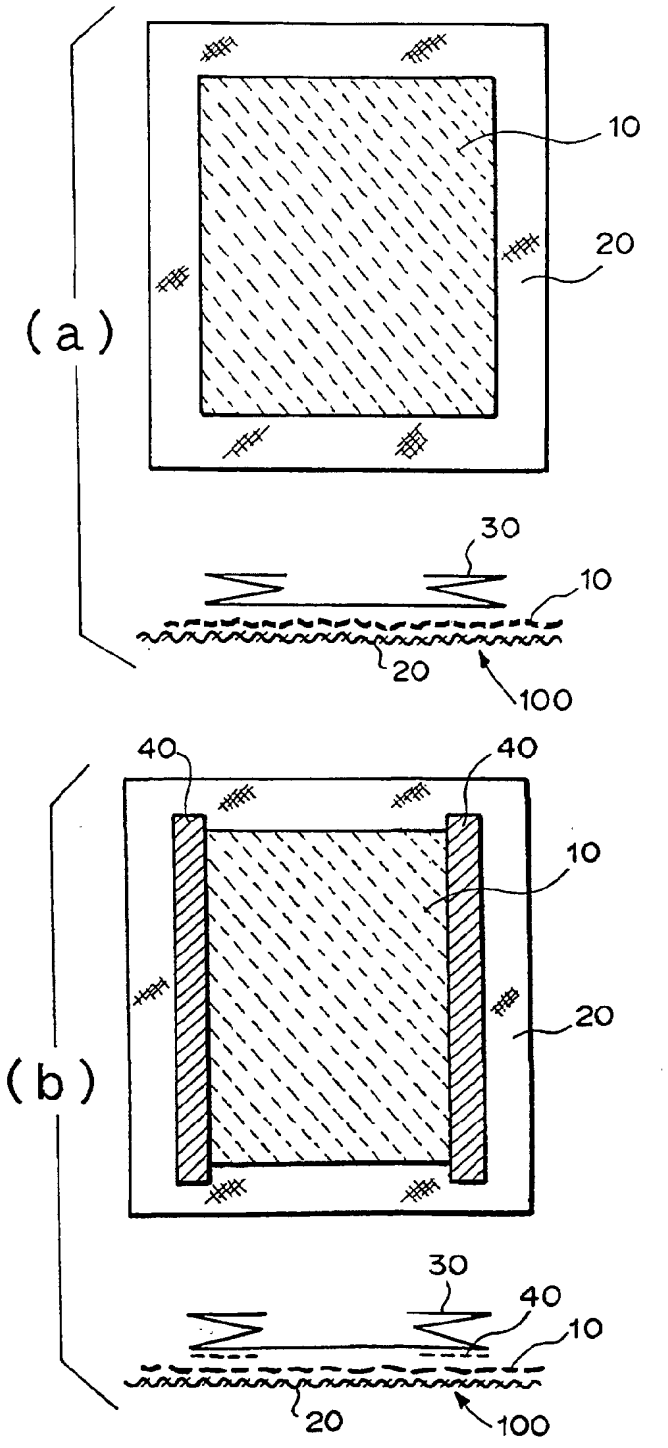


FIG.12

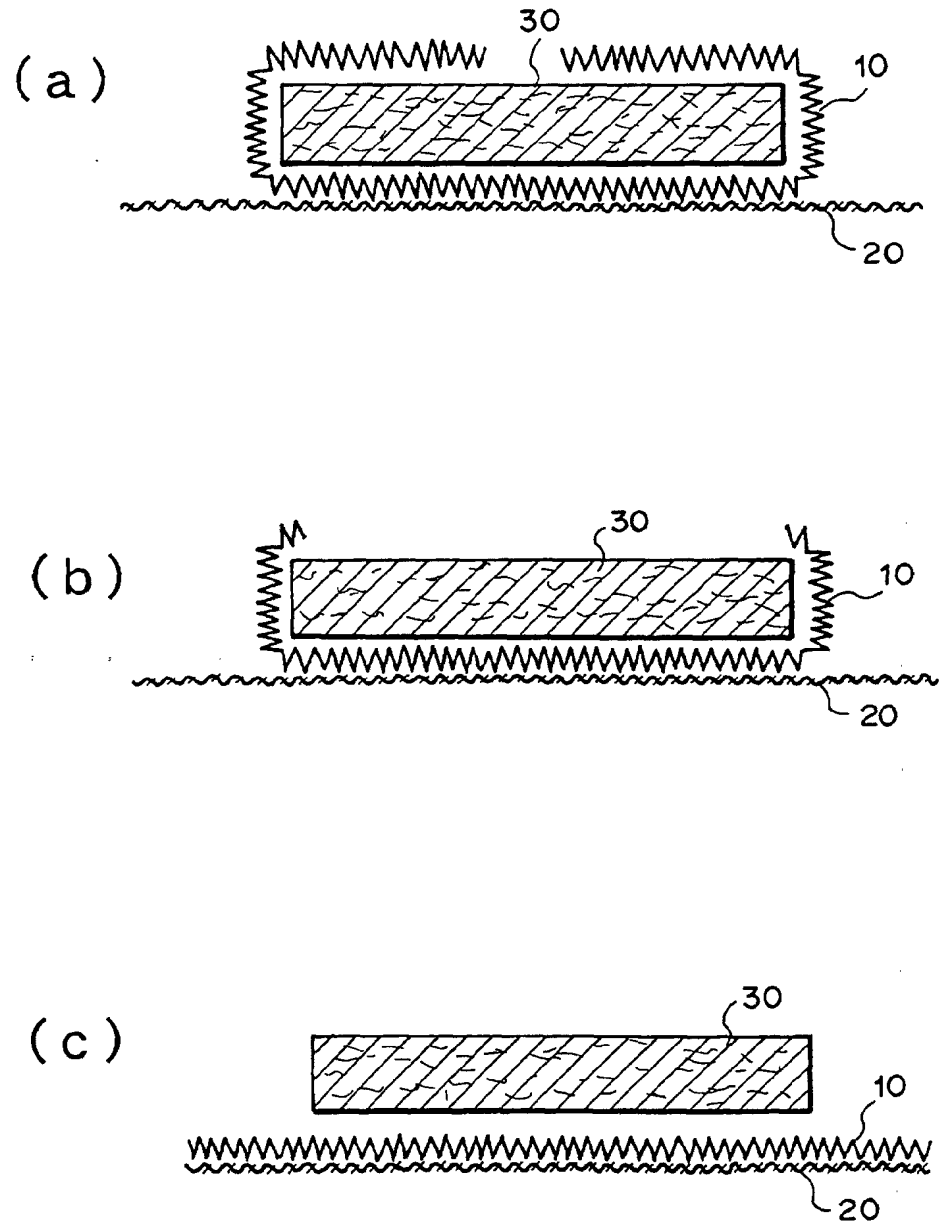


FIG. 14

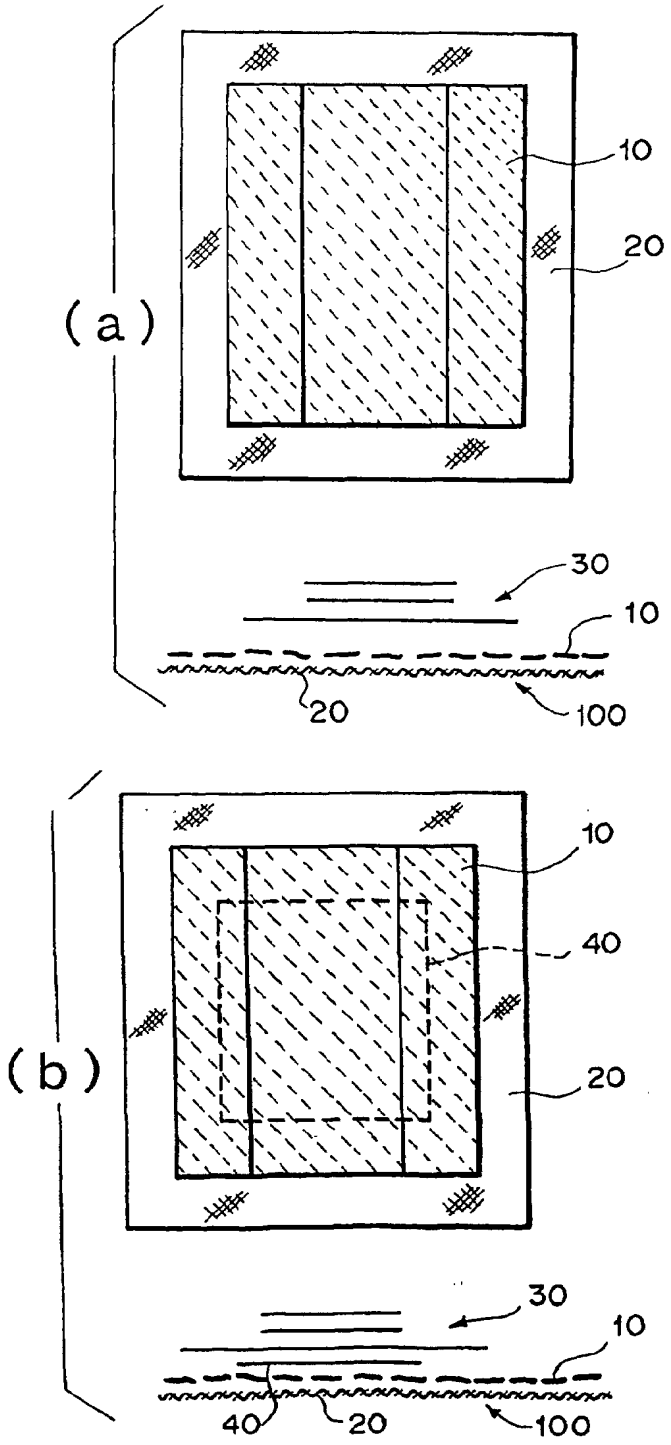


FIG.15

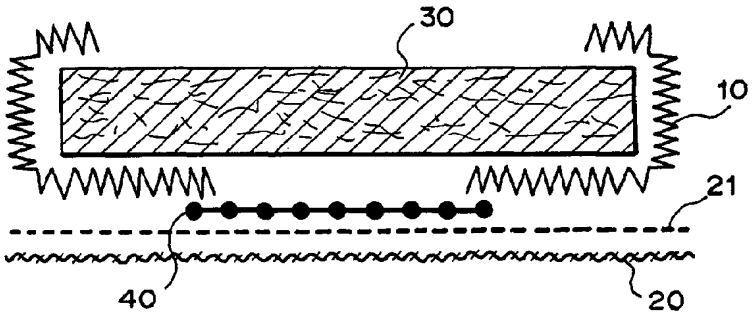


FIG.16

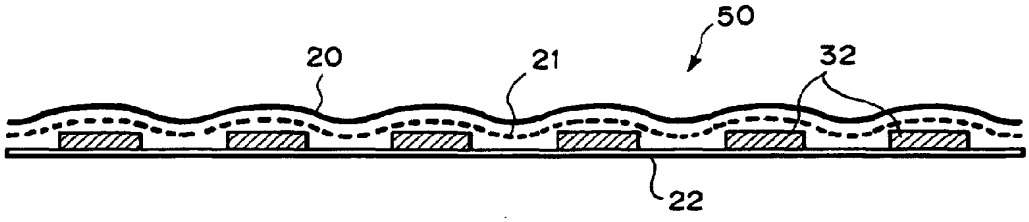


FIG. 17

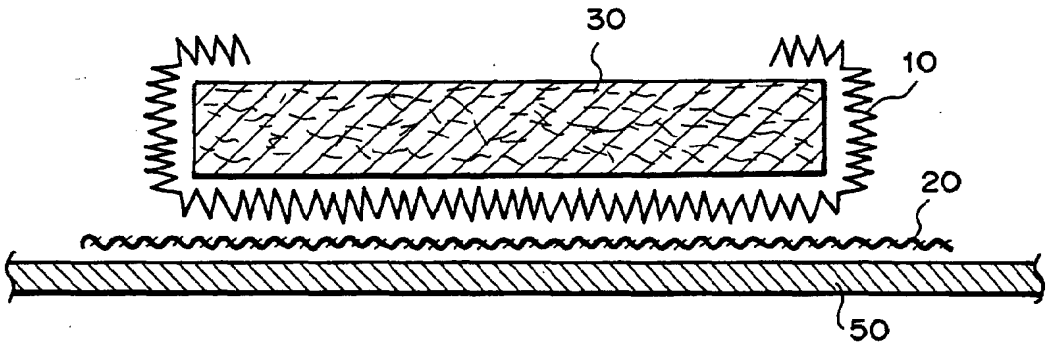


FIG. 18

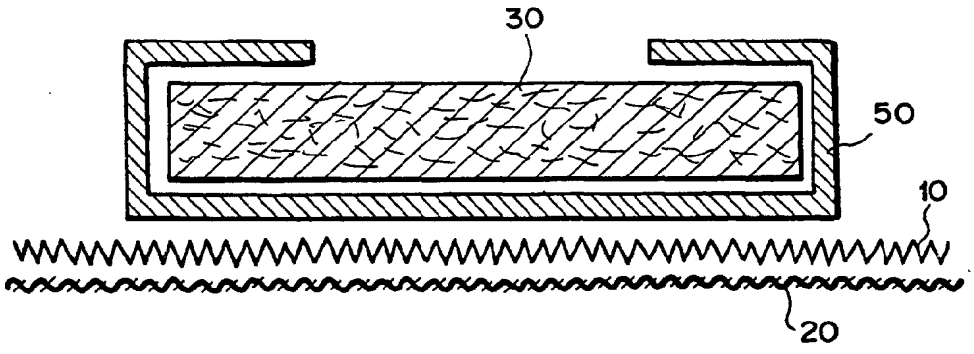


FIG.19

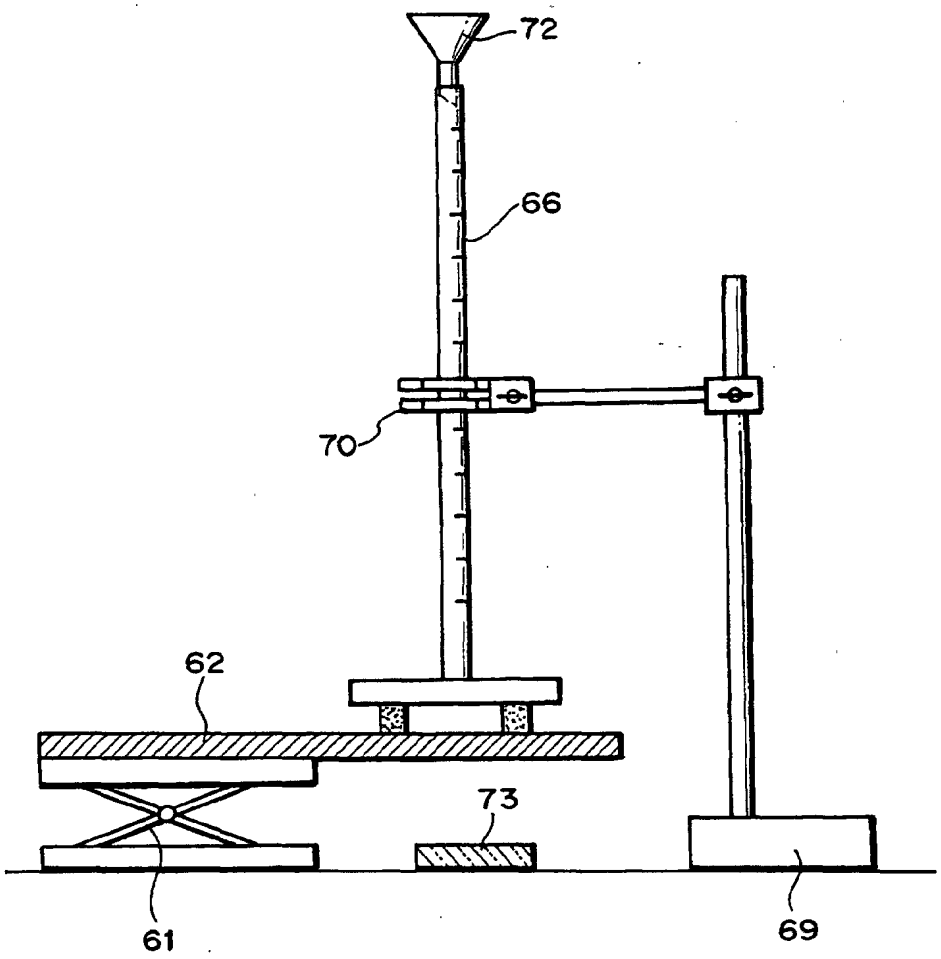


FIG.20

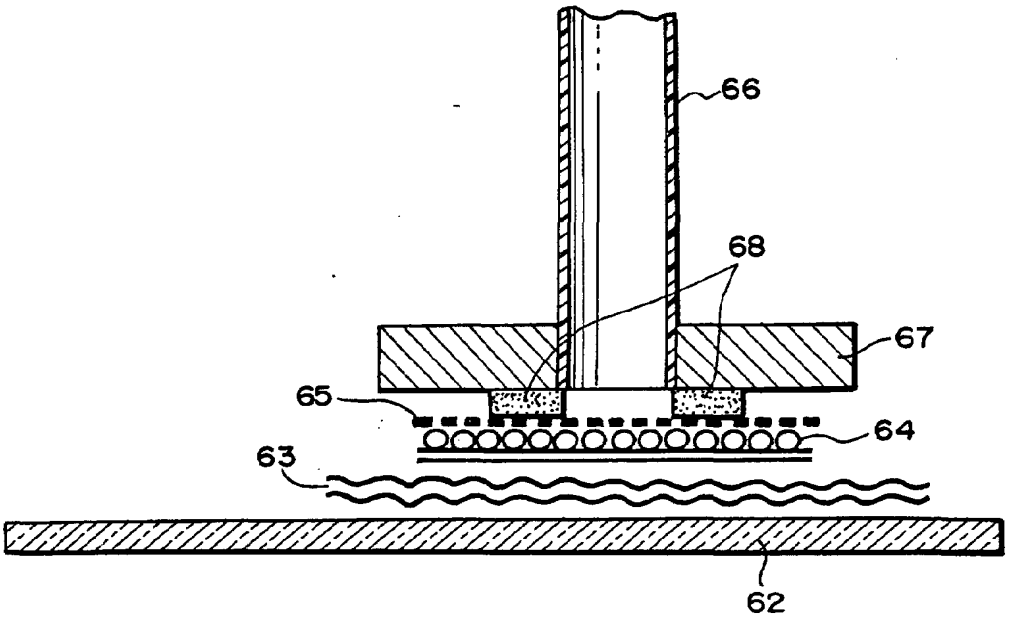


FIG.21

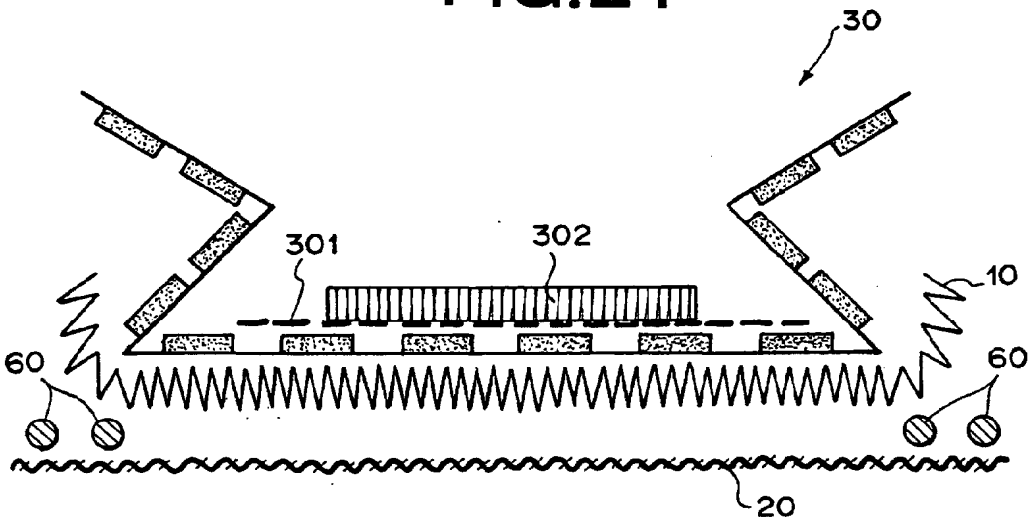


FIG.22

NO POROUS BUFFER SHEET

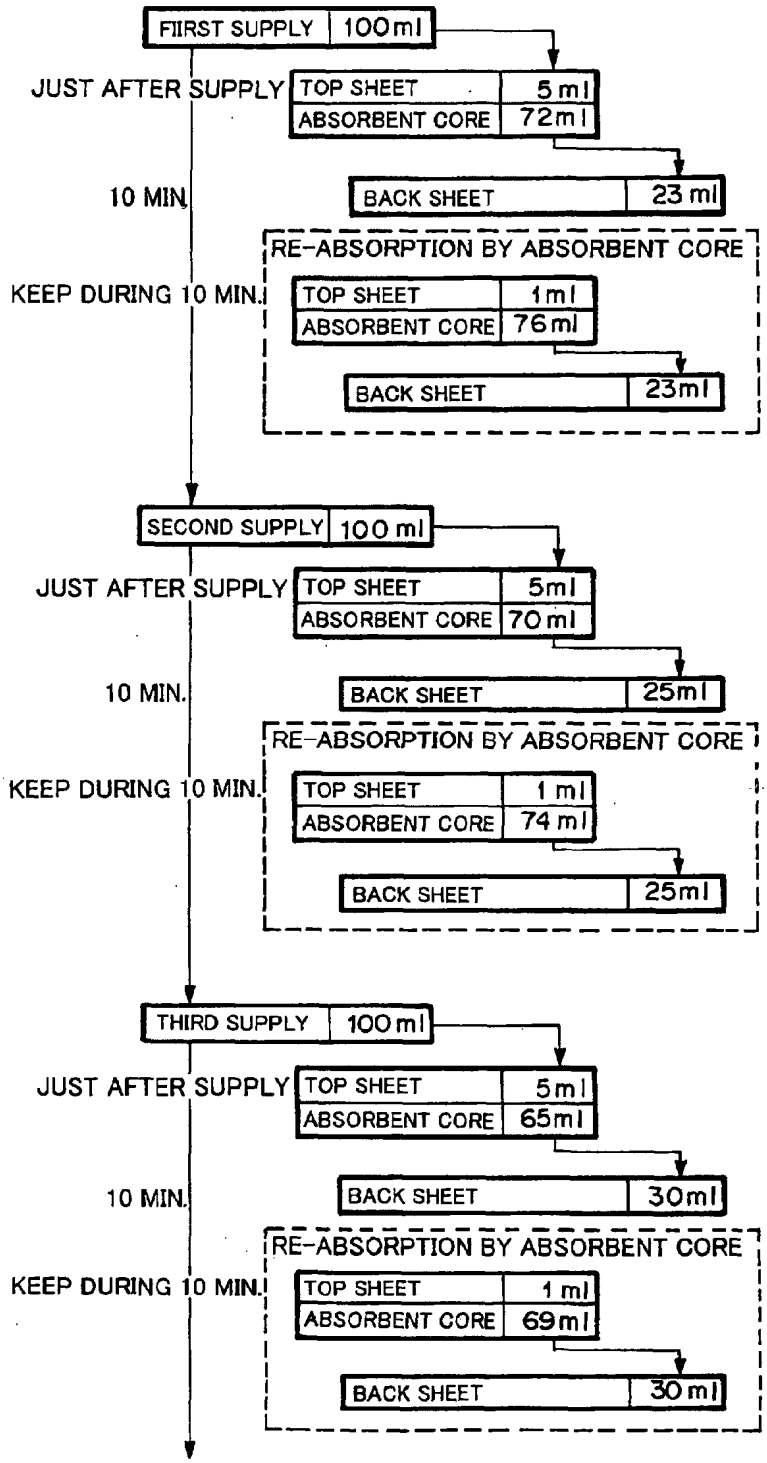
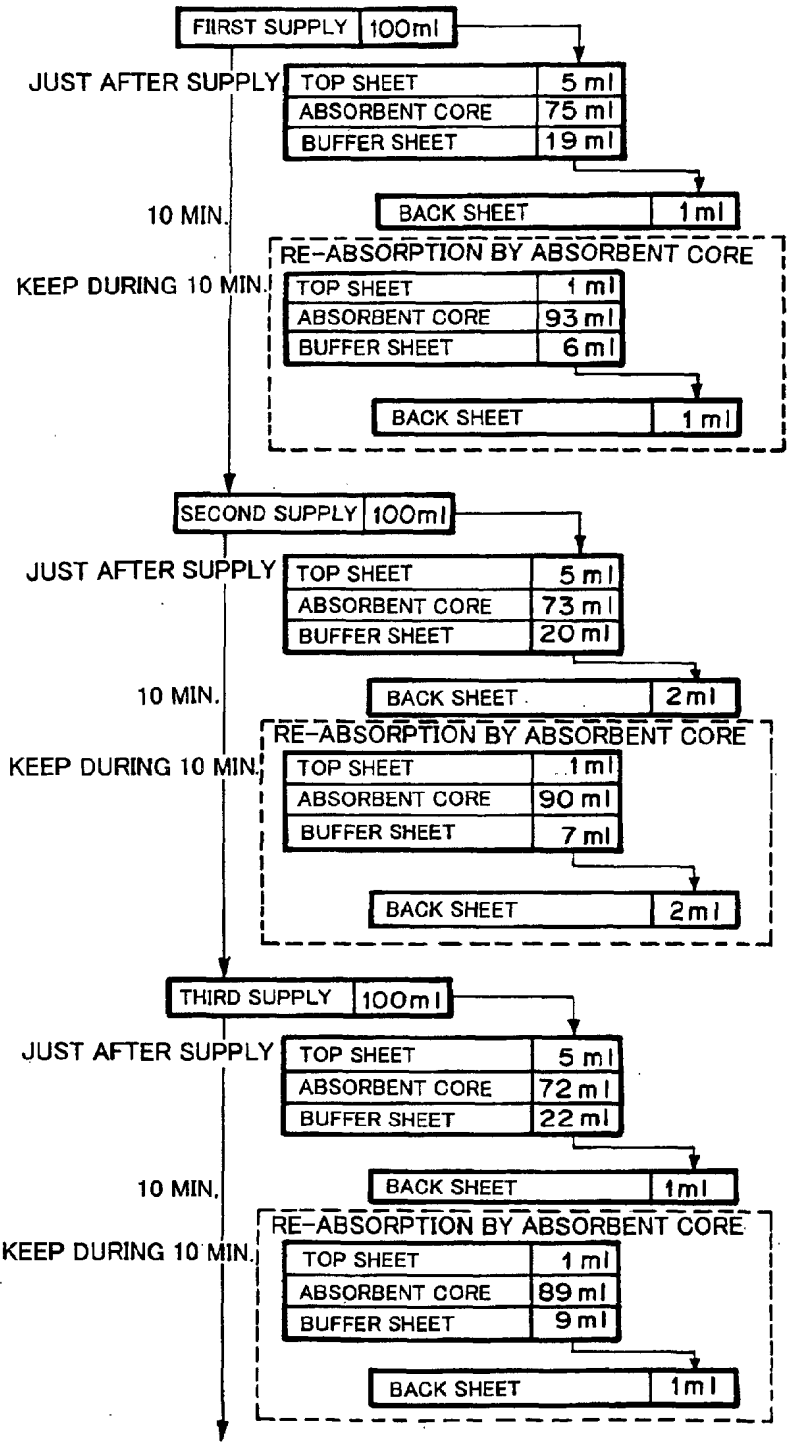


FIG.23

WITH POROUS BUFFER SHEET



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/04401

A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B32B1/00-35/00, A61F13/15-13/84

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-2002
Kokai Jitsuyo Shinan Koho	1971-2002	Jitsuyo Shinan Toroku Koho	1996-2002

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 11-348163 A (Mitsui Chemicals, Ltd.), 21 December, 1999 (21.12.99), (Family: none)	1,3,6-12 2,4,5
X A	JP 10-158909 A (Shinwa Kabushiki Kaisha), 16 June, 1998 (16.06.98), (Family: none)	1 2-12
P,A	JP 2001-233982 A (Tokuyama Corp.), 28 August, 2001 (28.08.01), (Family: none)	1-12
A	WO 99/39673 A (THE PROCTER & GAMBLE CO.), 12 August, 1999 (12.08.99), & JP 2002-502633 A	1-12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
02 August, 2002 (02.08.02)	20 August, 2002 (20.08.02)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
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BREVET D'INVENTION

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Publication de la délivrance..... B.O.P.I. — « Listes » n° 7 du 19-2-1971.

(51) Classification internationale (Int. Cl.).... **A 61 f 13/00//A 41 b 13/00.**
(71) Déposant : WUHRLIN Jean, résidant en France (Paris).

Mandataire : Simonnot, Rinuy, Santarelli.

(54) **Dispositif répartiteur d'absorption pour articles absorbants à usages hygiénique et thérapeutique.**

(72) Invention de :

(33) (32) (31) Priorité conventionnelle :

La présente invention a pour objet un dispositif répartiteur d'absorption pour articles absorbants à usages hygiénique, comme les couches pour bébé et les serviettes périodiques, et thérapeutique comme les pansements.

On a constaté que,dans un article absorbant, une couche en ouate de cellulose par exemple, l'absorption se localisait dans une zone limitée de l'article et que le liquide absorbé traversait plus facilement l'article qu'il ne se répartissait dans celui-ci.

L'invention remédie à cet inconvénient et vise un dispositif répartiteur d'absorption constitué, de préférence, par une feuille réalisée en une matière étanche , souple, inerte et non putrescible, ladite feuille étant munie de trous et glissée dans l'article absorbant.

Suivant le nombre de trous, leur dimension et leur répartition, le liquide est arrêté plus ou moins longtemps par le dispositif répartiteur, pour se répandre ou s'étaler à son niveau et s'écouler ensuite par les trous situés dans la zone d'étalement.

L'invention vise également, à titre de produits industriels nouveaux, les articles absorbants pourvus dudit dispositif répartiteur.

D'autres caractéristiques et avantages de la présente invention ressortiront de la description qui va suivre faite en regard du dessin annexé sur lequel :

-Figure 1 est une vue en perspective, avec arrachement, d'un article absorbant pourvu d'un dispositif répartiteur conforme à l'invention;

- Figure 2 est une vue en coupe longitudinale et à plus grande échelle de cet article absorbant permettant d'expliquer le comportement du dispositif répartiteur d'absorption.

Dans la forme de réalisation représentée un dispositif répartiteur d'absorption selon l'invention est constitué par une bande en matière plastique mince 1 perforée régulièrement en quinconce de trous ronds 2.

La bande 1 est insérée dans la matière absorbante 3 d'un article absorbant, contenue dans une gaine 4.

Le liquide absorbé(flèches f_1) est dirigé (flèches f_2) par la bande perforée 1 vers les zones mal utilisées de la matière absorbante, en ralentissant son passage au travers de cette matière (figure 2).

Le passage se fait par autant de trous 2 qui se trouvent dans le périmètre d'étalement du liquide ce qui multiplie les zones d'absorption au-delà de la bande (flèches f_3).

Un essai réalisé avec une couche normale constituant un témoin et une couche pourvue d'un dispositif répartiteur d'absorption selon l'invention, a donné les résultats suivants :

Le dispositif répartiteur est une bande en matière plastique de dimensions 320 x 50 mm perforée de trous de diamètre de 5 mm tous les 1 cm.

	Couche témoin	Couche avec répartiteur
Poids total en g	35,5	36,5
Absorption en ml moyenne	184	235
" " maximum	192	246
" " minimum	176	227

L'effet du dispositif répartiteur d'absorption selon l'invention est donc des plus avantageux.

Il est bien entendu que la présente invention n'a été décrite et représentée qu'à titre d'exemple préférentiel et qu'on pourra apporter des équivalences dans ses éléments constitutifs sans, pour autant, sortir du cadre de ladite invention qui est défini dans les revendications qui suivent.

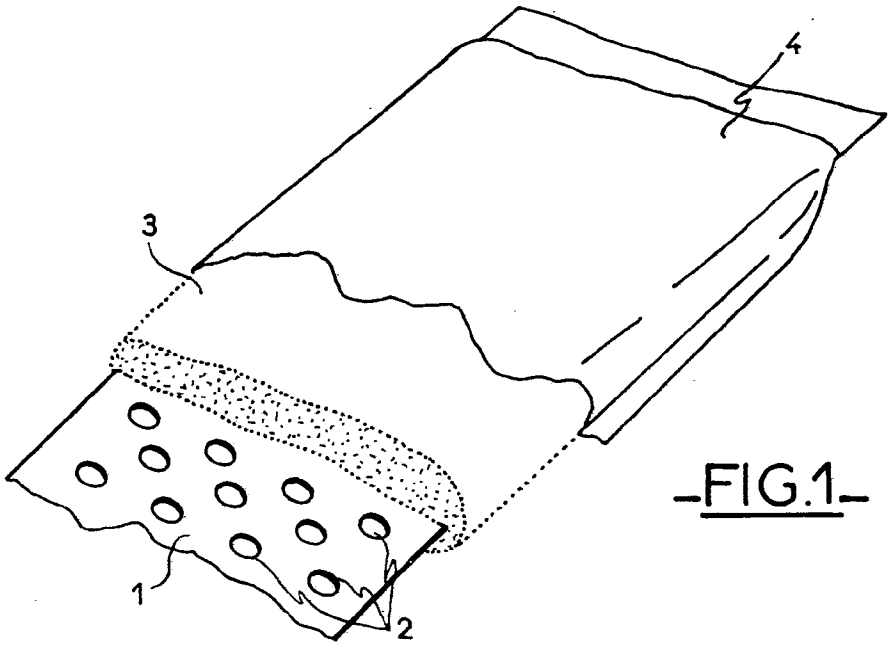
REVENDICATIONS

1 - Dispositif répartiteur d'absorption pour articles absorbants à usages hygiènique et thérapeutique caractérisé en ce qu'il est constitué par une feuille réalisée en une matière étanche, souple, inerte et non putrescible, ladite feuille étant munie de trous et glissée dans l'article absorbant.

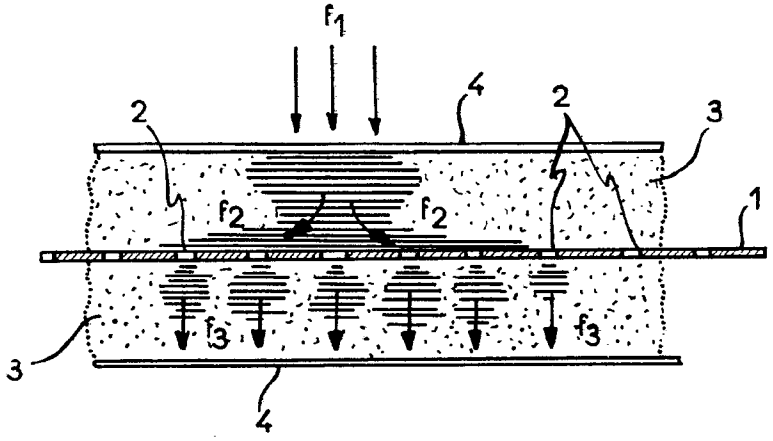
2 - Dispositif répartiteur d'absorption selon la revendication 1 caractérisé en ce que la feuille est réalisée en matière plastique.

3 - Dispositif répartiteur d'absorption selon la revendication 1 caractérisé en ce que le nombre de trous, leur dimension et leur répartition sont variables.

4 - A titre de produits industriels nouveaux les articles absorbants pourvus d'un dispositif répartiteur selon les revendications 1, 2 et 3.



-FIG.1-



-FIG.2-

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(71) Applicant: THE PROCTER & GAMBLE COMPANY [US/US]; One Procter & Gamble Plaza, Cincinnati, OH 45202 (US).

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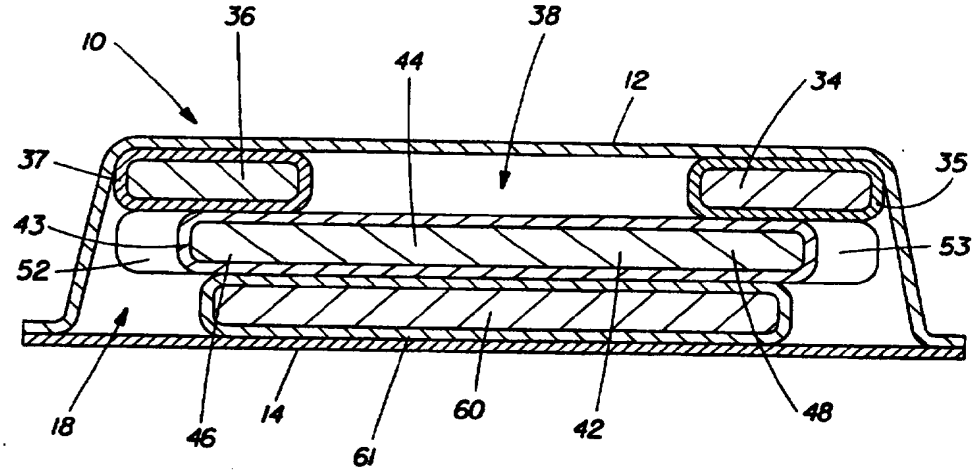
(74) Agents: REED, T., David et al.; The Procter & Gamble Company, 5299 Spring Grove Avenue, Cincinnati, OH 45217 (US).

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(54) Title: ABSORBENT COMPONENTS HAVING A SUSTAINED ACQUISITION RATE CAPABILITY UPON ABSORBING MULTIPLE DISCHARGES OF AQUEOUS BODY FLUIDS

(57) Abstract



In one aspect, the present invention relates to absorbent articles (10) that maintain or increase fluid rates when subjected to successive fluid loads. A test method is described for measuring fluid acquisition rates. In another aspect, the invention relates to an absorbent article (10) useful for absorbing discharged aqueous body fluids that comprises: A) a fluid pervious topsheet (12); B) a backsheet (14); and C) an absorbent core (18) positioned between the topsheet and the backsheet, the absorbent core comprising: (1) at least one upper fluid storage component (34, 36) capable of expanding in the z-direction when contacted with aqueous body fluids, said at least one upper fluid storage component being in direct fluid communication with the topsheet and at least partially forming a fluid acquisition zone (38); (2) a fluid acquisition zone (38) capable of receiving aqueous body fluids, said fluid acquisition zone being at least partially surrounded by said a least one upper fluid storage component and positioned at least partially beneath the fluid discharge region of the absorbent core; (3) a fluid acquisition/distribution component (42) capable of acquiring and transporting aqueous body fluids, at least a portion of this fluid acquisition/distribution component being positioned underneath and in fluid communication with said at least one fluid storage component, and at least a portion of the fluid acquisition/distribution component being positioned underneath, and in fluid communication with the fluid acquisition zone of the absorbent core; and (4) preferably, at least one lower fluid storage component (60) positioned underneath the fluid acquisition/distribution component and in fluid communication therewith, at least a portion of this lower storage component being positioned underneath the fluid acquisition zone.

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ABSORBENT COMPONENTS HAVING A SUSTAINED ACQUISITION RATE CAPABILITY UPON ABSORBING MULTIPLE DISCHARGES OF AQUEOUS BODY FLUIDS

TECHNICAL FIELD

This application relates to absorbent articles such as diapers, adult incontinence pads, sanitary napkins, and the like capable of handling multiple discharges of aqueous body fluids. The application particularly relates to articles comprising an absorbent core having sustained acquisition rate capability. The absorbent core offers sustained acquistion rates by providing a fluid acquistion zone formed by the swelling of a fluid storage material located in direct fluid communication with the article's topsheet.

BACKGROUND OF THE INVENTION

The development of highly absorbent members for use as disposable diapers, adult incontinence pads and briefs, and catamenial products such as sanitary napkins, are the subject of substantial commercial interest. A highly desired characteristic for such products is thinness. For example, thinner diapers are less bulky to wear, fit better under clothing, and are less noticeable. They are also more compact in the package, making the diapers easier for the consumer to carry and store. Compactness in packaging also results in reduced distribution costs for the manufacturer and distributor, including less shelf space required in the store per diaper unit.

The ability to provide thinner absorbent articles such as diapers has been contingent on the ability to develop relatively thin absorbent cores or structures that can acquire and store large quantities of discharged body fluids, in particular urine. In this regard, the use of certain absorbent polymers often referred to as "hydrogels," "superabsorbents" or "hydrocolloid" material has been particularly important. See, for example, U.S. Patent 3,669,103 (Harper et al), issued June 13, 1972, and U.S. Patent 3,670,731 (Harmon), issued June 20, 1972, that disclose the use of such absorbent polymers (hereafter "hydrogel-forming absorbent polymers") in absorbent articles. Indeed, the development of thinner diapers has been the direct consequence of thinner absorbent

cores that take advantage of the ability of these hydrogel-forming absorbent polymers to absorb large quantities of discharged aqueous body fluids, typically when used in combination with a fibrous matrix. See, for example, U.S. Patent 4,673,402 (Weisman et al), issued June 16, 1987 and U.S. Patent 4,935,022 (Lash et al), issued June 19, 1990, that disclose dual-layer core structures comprising a fibrous matrix and hydrogel-forming absorbent polymers useful in fashioning thin, compact, nonbulky diapers.

Prior to the use of these hydrogel-forming absorbent polymers, it was general practice to form absorbent structures, such as those suitable for use in infant diapers, entirely from wood pulp fluff. Given the relatively low amount of fluid absorbed by wood pulp fluff on a gram of fluid absorbed per gram of wood pulp fluff, it was necessary to employ relatively large quantities of wood pulp fluff, thus necessitating the use of relatively bulky, thick absorbent structures. The introduction of these hydrogel-forming absorbent polymers into such structures has allowed the use of less wood pulp fluff. These hydrogel-forming absorbent polymers are superior to fluff in their ability to absorb large volumes of aqueous body fluids, such as urine (i.e., at least about 15 g/g), thus making smaller, thinner absorbent structures feasible.

Prior absorbent structures have generally comprised relatively low amounts (e.g., less than about 50 % by weight) of these hydrogel-forming absorbent polymers. See, for example, U.S. Patent 4,834,735 (Alemany et al), issued May 30, 1989 (preferably from about 9 to about 50% hydrogel-forming absorbent polymer in the fibrous matrix). There are several reasons for this. The hydrogel-forming absorbent polymers employed in prior absorbent structures have generally not had an absorption rate that would allow them to quickly absorb body fluids, especially in "gush" situations. This has necessitated the inclusion of fibers, typically wood pulp fibers, to serve as temporary reservoirs to hold the discharged fluids until absorbed by the hydrogel-forming absorbent polymer.

More importantly, many of the known hydrogel-forming absorbent polymers exhibited gel blocking. "Gel blocking" occurs when particles of the hydrogel-forming absorbent polymer are wetted and the particles swell so as to inhibit fluid transmission to other regions of the absorbent structure. Wetting of these other regions of the absorbent member therefore takes place via a very slow diffusion process. In practical terms, this means acquisition of fluids by the absorbent structure is much slower than the rate at which fluids are discharged, especially in gush situations. Leakage from the absorbent article can take place well before the particles of hydrogel-forming absorbent polymer in the absorbent member are fully saturated or before the fluid can diffuse or wick past the "blocking" particles into the rest of the absorbent member. Gel blocking can be a particularly acute problem if the particles of hydrogel-forming absorbent polymer do not have adequate gel strength and deform or spread under stress once the particles swell with absorbed fluid. See U.S. Patent 4,834,735 (Alemany et al), issued May 30, 1989.

This gel blocking phenomena has typically necessitated the use of a fibrous matrix in which are dispersed the particles of hydrogel-forming absorbent polymer. This fibrous matrix keeps the particles of hydrogel-forming absorbent polymer separated from one another. This fibrous matrix also provides a capillary structure that allows fluid to reach the hydrogel-forming absorbent polymer located in regions remote from the initial fluid discharge point. See U.S. Patent 4,834,735 (Alemany et al), issued May 30, 1989. However, dispersing the hydrogel-forming absorbent polymer in a fibrous matrix at relatively low concentrations in order to minimize or avoid gel blocking can lower the overall fluid storage capacity of thinner absorbent structures. Also, absorbent cores comprising hydrogel-forming absorbent polymers dispersed uniformly throughout the fibrous matrix will typically not have the ability to rapidly acquire and distribute fluids during "gush" situations or when the core has become saturated from prior discharges of body fluids.

The need for rapidly acquiring and distributing discharge body fluids has led to the development of dual-layer core structures noted above. These dual-layer core structures basically comprise: (1) an upper fibrous layer adjacent to the fluid pervious topsheet that is substantially free of hydrogel-forming absorbent polymers that acquires the discharged fluid; and (2) a lower layer that stores this acquired fluid and is typically either a: (a) fibrous matrix having hydrogel-forming absorbent polymers uniformly dispersed therein; or (b) laminate structure where hydrogel-forming absorbent polymers is between two tissue layers. See, for example, U.S. Patent 4,673,402 (Weisman et al), issued June 16, 1987. See also U.S. Patent 4,935,022 (Lash et al), issued June 19, 1990 and U.S. Patent 5,217,445 (Young et al), issued June 8, 1993, where certain chemically stiffened curly, twisted cellulosic fibers are used in this upper layer to provide improved acquisition and distribution performance. Another variation is to "profile" the absorbent core such that there is an acquisition zone substantially free of hydrogel-forming absorbent polymers in the fluid discharge area and a storage area having dispersed therein hydrogel-forming absorbent polymers that is in fluid communication with the acquisition zone. See U.S. Patent 4,834,735 (Alemany et al), issued May 30, 1989 and U.S. Patent 5,047,023 (Berg), issued September 10, 1991.

Even with the fluid handling improvements provided by these prior absorbent designs, it has been found that the ability to rapidly acquire fluid diminishes as the absorbent core becomes saturated with aqueous body fluids. That is, prior absorbent articles exhibit decreased acquisition rates as a result of each successive fluid load. This occurs because the void spaces between fibers and the hydrogel-forming absorbent polymers in the absorbent core become partially filled with fluid during the first "gush" and therefore can not rapidly accept the necessary volume of fluid during subsequent "gushes". Furthermore, the risk of leakage increases as the acquisition rate decreases.

Another problem that can occur with some prior absorbent core designs is a phenomenon referred to as "rewet." Rewet occurs when there is acquired fluid that is freely mobile and available in that portion of the absorbent core adjacent the topsheet. This is typically experienced as the absorbent core becomes saturated with acquired fluid. Under mechanical pressure from the wearer of the article, this mobile fluid is pumped out of the absorbent core and upwards through the topsheet. As a result, the topsheet becomes "rewetted" with this pumped fluid such that there is not adequate topsheet dryness.

Accordingly, it would be desirable to provide an absorbent article that can maintain or increase acquisition rates with successive fluid gushes. It would also be desirable to provide an absorbent article that: (1) has an absorbent material, capable of swelling upon absorbing discharged body fluid to form a fluid acquisition zone, in the absorbent core for desired total fluid capacity and thinness; (2) is able to acquire discharged fluid rapidly during "gush" situations, even when the core has become saturated in the loading area from prior discharges of fluids; and (3) preferably minimizes rewetting of the topsheet.

SUMMARY OF THE INVENTION

The present invention relates to an absorbent article useful for absorbing discharged aqueous body fluids that comprises: A) a fluid pervious topsheet; B) a backsheet; and C) an absorbent core positioned between the topsheet and the backsheet, the absorbent core comprising:

(1) at least one upper fluid storage component capable of expanding in the z-direction when contacted with aqueous body fluids to form a fluid acquisition zone, said at least one upper fluid storage component being in direct fluid communication with the topsheet;

(2) a fluid acquisition zone capable of receiving aqueous body fluids, said fluid acquistion zone being at least partially surrounded by said at least one upper fluid storage component and positioned at least partially beneath the fluid discharge region of the absorbent core;

(3) a fluid acquisition/distribution component capable of acquiring and transporting aqueous body fluids, at least a portion of this fluid acquisition/distribution component being positioned underneath and in fluid communication with said at least one fluid storage component, and at least a portion of the fluid acquisition/distribution component being positioned underneath, and in fluid communication with the fluid acquisition zone of the absorbent core; and

(4) preferably, at least one lower fluid storage component positioned underneath the fluid acquisition/distribution component and in fluid

communication therewith, at least a portion of this lower storage component being positioned underneath the fluid acquisition zone.

In another aspect, the present invention relates to absorbent articles that maintain or increase fluid acquistion rates after being subjected to additional fluid loads.

Certain absorbent articles of the present invention have an improved ability to rapidly acquire, distribute and store discharged body fluids due to the presence of: (1) the fluid acquisition zone in the fluid discharge region of the absorbent core; (2) the fluid acquisition/distribution component that is proximate this acquisition zone; and (3) the proximaty of the upper fluid storage to the article's topsheet. This is especially important during "gush" situations or when portions of the absorbent core become saturated from prior multiple discharges of such fluids. The absorbent articles of the present invention also minimize rewetting of the topsheet, particularly those preferred articles having the storage component adjacent the topsheet. This provides good skin dryness for the wearer of the article.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a top plan view of an absorbent article according to the present invention where the topsheet is transparent so as to more clearly show the absorbent core.

Figure 2 is a cross-sectional view taken along line 2-2 of Figure 1.

Figure 3 is a cross-sectional view of an absorbent article showing an alternative absorbent core according to the present invention.

Figure 4 is a cross-sectional view of an absorbent article showing another alternative absorbent core according to the present invention.

Figure 5 is a cross-sectional view of an absorbent article showing another alternative absorbent core according to the present invention.

Figure 6 is a cross-sectional view of an absorbent article showing yet another alternative absorbent core according to the present invention.

Figure 7 is schematic view of the apparatus for conducting acquisition rates discussed in the Test Method section.

DETAILED DESCRIPTION OF THE INVENTION

A. Definitions

As used herein, the term "aqueous body fluids" includes, e.g., urine, menses and vaginal discharges.

As used herein, "direct communiciation" means that fluid can transfer readily between two absorbent article components (e.g., the topsheet and the upper storage component) without substantial accumulation, transport, or restriction by an interposed layer. For example, tissues, nonwoven webs, construction adhesives, and the like may be

present between the topsheet and upper storage component while maintaining "direct communication" as long as they do not substantially accumulate (store), transport (wick), or restrict the fluid as it passes from the topsheet to the storage layer.

As used herein, the term "Z-dimension" refers to the dimension orthogonal to the length and width of the member, core or article. The Z-dimension usually corresponds to the thickness of the member, core or article.

As used herein, the term "X-Y dimension" refers to the plane orthogonal to the thickness of the member, core or article. The X and Y dimensions usually correspond to the length and width, respectively, of the member, core or article.

As used herein, the term "absorbent core" refers to the component of the absorbent article that is primarily responsible for fluid handling properties of the article, including acquiring, transporting, distributing and storing aqueous body fluids. As such, the absorbent core typically does not include the topsheet or backsheet of the absorbent article.

As used herein, the term "load" or "gush" generally refers to an insult or depostion of urine that would typically result during use. The term load may also refer to the total amount of liquid contained in an absorbent article, but typically refers to one fluid insult.

As used herein, the term "layer" refers to an absorbent member whose primary dimension is X-Y, i.e., along its length and width. It should be understood that the term layer is not necessarily limited to single layers or sheets of material. Thus the layer can comprise laminates or combinations of several sheets or webs of the requisite type of materials. Accordingly, the term "layer" includes the terms "layers" and "layered."

As used herein, the term "maintained fluid acquisition rates" means that the fluid acquisition rates for successive fluid loads are not statisitically significantly different.

As used herein, the term "increased fluid acquisition rates" means that the fluid acquisition rate for each of successive fluid loads is statisitically significantly greater than the preceding fluid load.

For purposes of this invention, it should also be understood that the term "upper" refers to absorbent core components, such as layers, that are nearest to the wearer of the absorbent article, and are typically nearer the topsheet of an absorbent article; conversely, the term "lower" refers to absorbent core components that are furthermost away from the wearer of the absorbent article and are typically nearer the backsheet.

As used herein, the term "comprising" means various components, steps and the like can be conjointly employed according to the present invention. Accordingly, the term "comprising" encompasses the more restrictive terms "consisting essentially of" and "consisting of," these latter, more restrictive terms having their standard meaning as understood in the art.

All percentages, ratios and proportions used herein are by weight unless otherwise specified.

B. Absorbent Article Performance

With repspect to the preferred articles of the present invention, Applicants have discovered the ability to overcome the inverse relationship between fluid loading level (g or ml of fluid) and fluid acquisition rate (ml/sec) previously accepted as the norm for absorbent articles. Thus, in one aspect, the present invention relates to an absorbent article that, in addition to being relatively thin, exhibits the ability to maintain the rate of fluid acquisition for each of two successive fluid loads. In another aspect, the invention relates to an absorbent article that exhibits the ability to increase the rate of fluid acquisition for each of two successive fluid loads. Preferably, the articles will exhibit maintained or increased fluid acquisition rates for each of three successive fluid loads, more preferably for each of four successive fluid loads.

The ability of an absorbent article to meet this criteria is measured as described in detail in the Test Method section, using an Aquisition Test apparatus such as that shown in Figure 7. Briefly, fluid acquisition rates for a given absorbent article are determined for each of four successive loads of 50 ml per load, each load being delivered at a constant rate of about 10 ml/sec) of synthetic urine, with a 5 minute equilibration period between each load. The articles of the present invention exhibit maintained or increased fluid acquistion rates as the number of loads increases.

With respect to those articles that exhibit maintained fluid acquisition rates for at least two successive loads, it is required that these articles (including topsheet, backsheet and absorbent core; but excluding tape, leg cuffs, or other optional components) have a thickness, in the dry state, of no more than about 0.5 inches, preferably no more than about 0.25 inches, more preferably no more than about 0.2 inches. Thickness of the articles is measured with no pressure applied. While not a requirement, with regard to those articles of the present invention that exhibit increased fluid acquisition rates for at least two, three or four successive loads, it is preferred that these absorbent articles also satisfy the above thickness requirements.

In addition to exhibiting maintained/increased acquisition rates for successive fluid loads, preferred absorbent articles acquire fluid at a rate of at least about 2 ml/sec for the first 50 ml load, more preferably at least about 5 ml/sec. Though this is not a criteria that must be satisfied by these article, meeting this criteria will more likely result in an article that is useful for the intended purpose.

C. Absorbent Core Components

Exemplary core components useful in achieving improved acquisition performance are described below.

1. Fluid Storage Components

Fluid storage components useful in the present invention include materials that are capable of absorbing large quantities of aqueous body fluids, with or without other optional components such as fibers, thermoplastic material, etc.; and are capable of swelling in the z-direction upon imbibing fluid so as to form a fluid acquisition zone. Materials capable of performing as the fluid storage component(s) include substantially water-insoluble, water swellable absorbent polymer materials commonly referred to as "hydrogels", "hydrocolloids", or "superabsorbent" materials (for the purposes of the present invention, these materials are collectively referred to as "hydrogel-forming absorbent polymers"); and open-celled foam materials that remain in a collapsed (i.e., unexpanded) state until contacted with aqueous body fluids.

A principle function of these fluid storage components is to absorb the discharged body fluids either directly or from other absorbent core components (e.g., the fluid acquisition/distribution component), and then retain such fluids, even when subjected to pressures normally encountered as a result of the wearer's movements. Another important funtion is the ability of the storage component(s) to swell to form the fluid acquisition zone. (It should be understood that the fluid storage component(s) can serve functions other than fluid storage and formation of a fluid acquisition zone, such as improving body fit.)

Regardless of the material used, it is preferred that the upper storage component be capable of expanding in the z-direction from the dry, compressed state by at least 100% when fully saturated. Such z-directional expansion will effectively increase the volume of the fluid acquisition zone. However, those skilled in the art will recognize that the width and length of the fluid acquisition zone is also important to overall volume, and materials that do not swell in the z-direction by 100% may still be useful herein.

a. Hydrogel-forming Absorbent Polymers

When hydrogel polymers are used, an important aspect of these fluid storage components according to the present invention is that they contain a relatively high concentration of the absorbent polymers. In order to provide relatively thin absorbent articles capable of absorbing and retaining large quantities of body fluids, it is desirable to increase the level of these hydrogel-forming absorbent polymers and to reduce the level of other components, in particular fibrous components. In measuring the concentration of hydrogel-forming absorbent polymer, the percent by weight of the hydrogel-forming polymer relative to the combined weight of hydrogel-forming polymer and any other components (e.g., fibers, thermoplastic material, etc.) that are present in the fluid storage component is used. With this in mind, the concentration of the hydrogel-forming absorbent polymers in a given fluid storage component according to the present invention

can be in the range of from about 50 to 100%, preferably from about 60 to 100%, more preferably from about 70 to 100%, and most preferably from about 80 to 100%, by weight of the storage component.

A wide variety of hydrogel-forming absorbent polymers can be used in the fluid storage components of the present invention. These hydrogel-forming absorbent polymers have a multiplicity of anionic, functional groups, such as sulfonic acid, and more typically carboxy, groups. Examples of absorbent polymers suitable for use herein include those which are prepared from polymerizable, unsaturated, acid-containing monomers, including the olefinically unsaturated acids and anhydrides that contain at least one carbon to carbon olefinic double bond. More specifically, these monomers can be selected from olefinically unsaturated carboxylic acids and acid anhydrides, olefinically unsaturated sulfonic acids, and mixtures thereof. See U.S. Patent 5,324,561 (Rezai et al), issued June 23, 1994 (herein incorporated by reference), which describes suitable absorbent polymers and their preparation.

Preferred hydrogel-forming absorbent polymers for use in the present invention contain carboxy groups. These include hydrolyzed starch-acrylonitrile graft copolymers, partially neutralized starch-acrylonitrile graft copolymers, starch-acrylic acid graft copolymers, partially neutralized starch-acrylic acid graft copolymers, saponified vinyl acetate-acrylic ester copolymers, hydrolyzed acrylonitrile or acrylamide copolymers, slightly network crosslinked polymers of any of the foregoing copolymers, partially neutralized polyacrylic acid, and slightly network crosslinked polymers of partially neutralized polyacrylic acid. These polymers can be used either solely or in the form of a mixture of two or more different polymers. Examples of these polymer materials are disclosed in U.S. Patent 3,661,875, U.S. Patent 4,076,663, U.S. Patent 4,093,776, U.S. Patent 4,666,983, and U.S. Patent 4,734,478.

Most preferred hydrogel-forming absorbent polymers for use in the present invention are slightly network crosslinked polymers of partially neutralized polyacrylic acids and starch derivatives thereof. Most preferably, the absorbent polymers comprise from about 50 to about 95%, preferably about 75%, neutralized, slightly network crosslinked, polyacrylic acid (i.e. poly (sodium acrylate/acrylic acid)). Processes for network crosslinking the polymers and typical network crosslinking agents are described in greater detail in the hereinbefore-referenced U.S. Patent 4,076,663.

The hydrogel-forming absorbent polymers can be formed in any conventional manner. Preferred methods for forming these absorbent polymers are those that involve aqueous solution or other solution polymerization methods. See, for example, U.S. Reissue Patent 32,649 (Brandt et al), reissued April 19, 1988. While it is preferred that the absorbent polymers be manufactured using an aqueous solution polymerization process, it is also possible to carry out the polymerization process using multi-phase polymerization

processing techniques such as inverse emulsion polymerization or inverse suspension polymerization procedures. See U.S. Patent 4,340,706 (Obaysashi et al), issued July 20, 1982, U.S. Patent 4,506,052 (Flesher et al), issued March 19, 1985, and U.S. Patent 4,735,987 (Morita et al), issued April 5, 1988, all of which are incorporated by reference, for processes involving inverse suspension polymerization. These absorbent polymers can synthesized or made in a variety of shapes and sizes, including fibers, granules, flakes or pulverulents. However, these absorbent polymers are most commonly supplied as absorbent particles or particulates.

One preferred class of hydrogel-forming absorbent polymers useful in the present invention are those which exhibit a high absorptive capacity. Absorptive capacity refers to the capacity of a given polymer material to absorb liquids with which it comes into contact. Absorptive capacity can vary significantly with the nature of the liquid being absorbed and with the manner in which the liquid contacts the polymer material. For purposes of this invention, Absorptive Capacity is defined in terms of the amount of Synthetic Urine absorbed by any given polymer material in terms of grams of Synthetic Urine per gram of polymer material in a procedure defined in the Test Methods section of U.S. Patent 5,324,561 (Rezai et al), issued June 23, 1994, which is incorporated by reference. Preferred absorbent polymers having a high absorptive capacity are those which have an Absorptive Capacity of at least about 20 grams, more preferably at least about 25 grams, of Synthetic Urine per gram of polymer material. Typically, these highly absorptive polymers have an Absorptive Capacity of from about 20 grams to about 70 grams of Synthetic Urine per gram of polymer material. Absorbent polymers having this relatively high absorptive capacity characteristic are especially useful in fluid storage components of the present invention since they hold desirably high amounts of discharged body exudates such as urine.

Another preferred class of hydrogel-forming absorbent polymers useful in the present invention are those having relatively high Saline Flow Conductivity (SFC) values and relatively high Performance Under Pressure (PUP) capacity. See copending U.S. application Serial No. 219,574 (Goldman et al), filed March 29, 1994, which is incorporated by reference, where SFC values and PUP capacity are defined and methods for measuring these parameters are provided. Absorbent polymers useful in the present invention can have SFC values of at least about 30 x 10^{-7} cm^3sec/g, preferably at least about 50 x 10^{-7} cm^3sec/g, and most preferably at least about 100 x 10^{-7} cm^3sec/g. Typically, these SFC values are in the range of from about 30 to about 1000 x 10^{-7} cm^3sec/g, more typically from about 50 to about 500 x 10^{-7} cm^3sec/g, and most typically from about 100 to about 350 x 10^{-7} cm^3sec/g. Absorbent polymers useful in the present invention generally have a PUP capacity at least about 23 g/g, preferably at least about 25 g/g, and most preferably at least about 29 g/g. Typically, these PUP capacity values are in

the range of from about 23 to about 35 g/g, more typically from about 25 to about 33 g/g, and most typically from about 29 to about 33 g/g.

Surface crosslinking of the initially formed polymers is a preferred process for obtaining hydrogel-forming absorbent polymers having relatively high SFC and PUP capacity values. A number of processes for introducing surface crosslinks are disclosed in the art. These include those where: (i) a di- or poly-functional reagent(s) (e.g., glycerol, 1,3-dioxolan-2-one, polyvalent metal ions, polyquaternary amines) capable of reacting with existing functional groups within the hydrogel-forming absorbent polymer is applied to the surface of the hydrogel-forming absorbent polymer; (ii) a di- or poly-functional reagent that is capable of reacting with other added reagents and possibly existing functional groups within the hydrogel-forming absorbent polymer such as to increase the level of crosslinking at the surface is applied to the surface (e.g., the addition of monomer plus crosslinker and the initiation of a second polymerization reaction); (iii) no additional polyfunctional reagents are added, but additional reaction(s) is induced amongst existing components within the hydrogel-forming absorbent polymer either during or after the primary polymerization process such as to generate a higher level of crosslinking at or near the surface (e.g., heating to induce the formation of anhydride and or esters crosslinks between existing polymer carboxylic acid and/or hydroxyl groups and suspension polymerization processes wherein the crosslinker is inherently present at higher levels near the surface); and (iv) other materials are added to the surface such as to induce a higher level of crosslinking or otherwise reduce the surface deformability of the resultant hydrogel. Combinations of these surface crosslinking processes either concurrently or in sequence can also be employed. In addition to crosslinking reagents, other components can be added to the surface to aid/control the distribution of crosslinking (e.g., the spreading and penetration of the surface crosslinking reagents.) See copending U.S. application Serial No. 219,574 (Goldman et al), filed March 29, 1994, which is incorporated by reference,

Suitable general methods for carrying out surface crosslinking of hydrogel-forming absorbent polymers according to the present invention are disclosed in U.S. Patent 4,541,871 (Obayashi), issued September 17, 1985; published PCT application WO92/16565 (Stanley), published October 1, 1992, published PCT application WO90/08789 (Tai), published August 9, 1990; published PCT application WO93/05080 (Stanley), published March 18, 1993; U.S. Patent 4,824,901 (Alexander), issued April 25, 1989; U.S. Patent 4,789,861 (Johnson), issued January 17, 1989; U.S. Patent 4,587,308 (Makita), issued May 6, 1986; U.S. Patent 4,734,478 (Tsubakimoto), issued March 29, 1988; U.S. Patent 5,164,459 (Kimura et. al.), issued November 17, 1992; published German patent application 4,020,780 (Dahmen), published August 29, 1991; and published European patent application 509,708 (Gartner), published October 21, 1992; all of which

are incorporated by reference. See also copending U.S. application Serial No. 219,574 (Goldman et al), filed March 29, 1994, which is incorporated by reference, and especially Examples 1 to 4.

While these hydrogel-forming absorbent polymers are preferably formed from the same monomers and have the same properties, this need not be the case. For example, some absorbent polymers can comprise a starch-acrylic acid graft copolymer while other absorbent polymers can comprise a slightly network crosslinked polymer of partially neutralized polyacrylic acid. Further, the absorbent polymers can vary in size, shape, absorptive capacity, or any other property or characteristic. In preferred embodiments of the present invention, the absorbent polymers consist essentially of slightly network crosslinked polymers of partially neutralized polyacrylic acid, each absorbent particle having similar properties.

One preferred fluid storage component according to the present invention having a relatively high concentration of these hydrogel-forming absorbent polymers is in the form of porous, absorbent macrostructures. These macrostructures are formed from a multiplicity of hydrogel-forming absorbent polymer particles. These macrostructures are capable of absorbing large quantities of aqueous body fluids (e.g., urine or menses) and then retaining such liquids under moderate pressures. Because they are formed from particles, these macrostructures have pores between adjacent particles. These pores are interconnected by intercommunicating channels such that the macrostructure is fluid permeable (i.e., has capillary transport channels).

Due to the bonds formed between the particles, the resultant aggregate macrostructures have improved structural integrity, increased fluid acquisition and distribution rates, and minimal gel-blocking characteristics. When wetted with aqueous fluids, the macrostructure swells generally isotropically even under moderate confining pressures, absorbs such fluids into the pores between the particles, and then imbibes such fluids into the particles. The isotropic swelling of the macrostructure allows the particles and the pores to maintain their relative geometry and spatial relationships even when swollen. Thus, the macrostructures are relatively "fluid stable" in that the particles do not dissociate from each other, thereby minimizing the incidence of gel blocking and allowing the capillary channels to be maintained and enlarged when swollen so that the macrostructure can acquire and transport subsequent loadings of liquid, even excess liquid. See U.S. Patent 5,102,597 (Roe et al), issued April 7, 1992, and U.S. Patent 5,324,561 (Rezai et al), issued June 23, 1994, which are incorporated by reference. As referred to herein, these macrostructures of interconnected particles are referred to as "fluid stable macrostuctures" or "fluid stable aggregates".

While these macrostructures can have a number of shapes and sizes, they are typically in the form of sheets, films, cylinders, blocks, spheres, fibers, filaments, or other

shaped elements. These macrostructures will generally have a thickness or diameter between about 0.2 mm and about 10.0 mm. Preferably these macrostructures are in the form of sheets or strips. The terms "sheet" or "strips" as used herein describes macrostructures having a thickness of at least about 0.2 mm. The sheets or strips will preferably have a thickness between about 0.5 mm and about 10 mm, typically from about 1 mm to about 3 mm.

These macrostructures are formed by the joining or adhering together of adjacent particles. The adhesive agent is essentially the polymeric material that is present in the surface of these particles. When these particles are treated with a crosslinking agent and physically associated, the polymer material present in the surface of these particles is sufficiently plastic and cohesive (e.g., sticky) such that adjacent particles are adhered together, typically as discrete linking portions between the particles. The crosslinking reaction between the particles then sets this adhered structure.

In preparing these macrostructures, a crosslinking agent is used to provide crosslinking at the surface of the absorbent precursor particles. This typically occurs as a result of the crosslinking agent by reacting with the polymer material in these particles. Typically, the polymer material of the absorbent precursor particles has anionic, and preferably carboxy, functional groups that form a covalent, ester-type bond with the crosslinking agent. These portions of the absorbent particle that have been effectively crosslinked will swell less in the presence of aqueous (body) fluids relative to the other uncrosslinked portions of the particle.

Suitable crosslinking agents for this purpose can be nonionic and possess at least two functional groups per molecule capable of reacting with the carboxy group. See, for example, U.S. Patent 5,102,597 (Roe et al), issued April 7, 1992, which is incorporated by reference, and which discloses a variety of nonionic crosslinking agents. The particularly preferred nonionic crosslinking agent is glycerol. A preferred crosslinking agent for use in these macrostructures is an adduct of epichlorohydrin with certain types of monomeric or polymeric amines. See U.S. Patent 5,324,561 (Rezai et al), issued June 23, 1994, which is incorporated by reference and which discloses suitable cationic amino-epichlorohydrin adduct crosslinking agents. These amino-epichlorohydrin adducts, and especially the polymeric resin versions of these adducts, are preferred crosslinking agents because they react only with the polymer material at the surface precursor particles. In addition, the cationic functional groups (e.g., azetedinium groups) of these adducts, particularly polymeric resin versions, are believed to react very rapidly with the anionic, typically carboxy, functional groups of the polymer material of the absorbent particles, even at room temperature (e.g., at from about 18° to about 25°C). Most preferred are certain polyamide-polyamine-epichlorohydrin resins particularly commercially marketed by Hercules Inc. under the trade name Kymene®. Especially useful are Kymene® 557H, Kymene® 557LX

and Kymene® 557 Plus, which are the epichlorohydrin adducts of polyamide-polyamines that are the reaction products of diethylenetriamine and adipic acid. They are typically marketed in the form of aqueous solutions of the cationic resin material containing from about 10% to about 33% by weight of the resin active.

In preparing these porous, absorbent macrostructures, the absorbent particles are treated with the crosslinking agent, along with any other components or agents. For example, water is typically used with the crosslinking agent to form an aqueous treatment solution thereof. Water promotes the uniform dispersion of the crosslinking agent on the surface of the absorbent particles and causes permeation of the crosslinking agent into the surface regions of these particles. Water also promotes a stronger physical association between the treated precursor particles, providing greater integrity of the resultant interparticle bonded crosslinked aggregates. See U.S. Patent 5,102,597 (Roe et al), issued April 7, 1992 (nonionic crosslinking agents such as glycerol), and U.S. Patent 5,324,561 (Rezai et al), issued June 23, 1994 (cationic amino-epichlorohydrin adduct crosslinking agents), which are incorporated by reference.

It is particularly preferred that the treatment solution include a plasticizer, especially when cationic amino-epichlorohydrin adducts are used as the crosslinking agent. he preferred plasticizer is a mixture of glycerol and water, particularly when included as part of an aqueous treatment solution of the cationic amino-epichlorohydrin adduct, in a weight ratio of glycerol to water of from about 0.5:1 to about 2:1, preferably from about 0.8:1 to about 1.7:1. See U.S. Patent 5,324,561 (Rezai et al), issued June 23, 1994 which is incorporated by reference. Before, during, or after treatment with crosslinking agent, and optional plasticizer, the particles are physically associated together to form the aggregate macrostructures A preferred method and apparatus for continuously forming these aggregate macrostructures into sheets is described in U.S. Patent 5,324,561 (Rezai et al), issued June 23, 1994 (cationic amino-epichlorohydrin adduct crosslinking agents), which are incorporated by reference. See especially Figure 9 from this patent and its associated description.

Once the particles have been physically associated together to form an aggregate macrostructure, the crosslinking agent is reacted with the polymer material of the precursor particles, while maintaining the physical association of the particles, to provide effective surface crosslinking in the particles in the aggregate macrostructure. See U.S. Patent 5,102,597 (Roe et al), issued April 7, 1992 (nonionic crosslinking agents such as glycerol), and U.S. Patent 5,324,561 (Rezai et al), issued June 23, 1994 (cationic amino-epichlorohydrin adduct crosslinking agents), which are incorporated by reference. When amino-epichlorohydrin adducts are used as the crosslinking agent, this crosslinking reaction can occur at relatively low temperatures, including ambient room temperatures. Such ambient temperature curing is particularly desirable when the absorbent particles are

treated a plasticizer, such as a mixture of water and glycerol. Curing at significantly above ambient temperatures can cause the plasticizer to be driven off due to its volatility, thus necessitating an additional step to plasticize the resulting aggregate macrostructure.

If desired, these macrostructures can include various types of fibers to act as reinforcing members. These include cellulose fibers, modified cellulose fibers, rayon, polypropylene, and polyester fibers such as polyethylene terephthalate (DACRON), hydrophilic nylon (HYDROFIL), and the like. Examples of other fiber materials are hydrophilized hydrophobic fibers, such as surfactant-treated or silica-treated thermoplastic fibers derived, for example, from polyolefins such as polyethylene or polypropylene, polyacrylics, polyamides, polystyrenes, polyurethanes and the like. In fact, hydrophilized hydrophobic fibers that are in and of themselves not very absorbent and which, therefore, do not provide webs of sufficient absorbent capacity to be useful in conventional absorbent structures, are suitable for use in these macrostructures by virtue of their good wicking properties. Synthetic fibers are generally preferred for use herein as the fiber component of the macrostructure. Most preferred are polyolefin fibers, preferably polyethylene fibers.

Other suitable fluid storage components according to the present invention can be in the form of a layer of hydrogel-forming absorbent polymer particles contained between two other fibrous layers, e.g., a laminated fluid storage component. Suitable laminated fluid storage components according to the present invention can be prepared using procedures similar to those described in U.S. Patent 4,260,443 (Lindsay et al); U.S. Patent 4,467,012 (Pedersen et al), issued August 21, 1984; U.S. Patent 4,715,918 (Lang), issued December 29, 1987; U.S. Patent 4,851,069 (Packard et al), issued July 25, 1989; U.S. Patent 4,950,264 (Osborn), issued August 21, 1990; U.S. Patent 4,994,037 (Bernardin), issued February 19, 1991; U.S. Patent 5,009,650 (Bernardin), issued April 23, 1991; U.S. Patent 5,009,653 (Osborn), issued April 23, 1991; U.S. Patent 5,128,082 (Makoui), July 7, 1992; U.S. Patent 5,149,335 (Kellenberger et al), issued September 22, 1992; and U.S. Patent 5,176,668 (Bernardin),issued January 5, 1993 (all of which are incorporated by reference). These laminated fluid storage components can be in the form of thermally bonded fibrous layers, adhesively bonded fibrous layers (e.g., glued bonding between the fibrous layers or between the fibrous layers and the hydrogel-forming absorbent polymer particles), or fibrous layers that are held together by hydrogen bonding (e.g., by spraying the fibrous layers with water followed by compaction).

If desired, the above macrostructures or absorbent particles can be attached to a substrate to form the fluid storage components. The substrate can provide a variety of functions, including: (1) improving the distribution of fluids to be absorbed by the macrostructure/particles; and (2) supporting the macrostructure/particles by providing additional integrity, especially in the situation, where the absorbent particles begin to swell after absorbing fluid. The substrate can be made from various materials known in the art

such as cellulose fibers, nonwoven webs, tissue webs, foams, polyacrylate fibers, apertured polymeric webs, synthetic fibers, metallic foils, elastomers, and the like. Most such substrate materials can distribute fluids to, as well as support, the macrostructure/particles. Preferably, the substrate is comprised of cellulosic material or a material having cellulosic functionality. Preferred substrates for distributing fluids are cellulosic materials, fibrous webs, cellulosic fibrous webs, tissues, solid foams, cellulosic foams, and polyvinyl alcohol foams. Preferred substrates for supporting the macrostructure/particles are tissues, cellulosic materials, fibrous webs, nonwoven webs, fabrics, cellulosic fibrous webs, solid foams, cellulosic foams, and polyvinyl alcohol foams.

The substrate is preferably flexible and pliable to encourage such properties in the resulting absorbent composite with the macrostructure/particles. The substrate can be substantially resilient and non-stretchable, or it can be stretchable or deformable to a varying extent in response to forces exerted normal to and in the plane of the surface of the substrate. The thickness and basis weight (weight per unit area of substrate) of the substrate material can vary depending on the type of substrate and properties desired. The substrate can comprise a plurality of individual sheets, or plies, of a particular substrate material, or a combination of one or more substrate layers in a laminate. One such suitable substrate is a Bounty® sheet having a thickness of from about 0.02 mm to about 1.2 mm, more preferably from about 0.3 mm to about 0.8 mm, and a basis weight of from about 5 gm/m^2 to about 100 gm/m^2, more preferably from about 10 gm/m^2 to about 60 gm/m^2, and most preferably from about 15 gm/m^2 to about 40 gm/m^2. Another suitable substrate is a cellulose foam having a dry compressed thickness of from about 0.5 mm to about 3.0 mm, more preferably from about 0.8 mm to about 2.0 mm, a wet expanded thickness of from about 0.8 mm to about 6.0 mm, more preferably from about 1.0 mm to about 5.0 mm, and a basis weight of from about 50 gm/m^2 to about 2,000 gm/m^2, more preferably from about 100 gm/m^2 to about 1,000 gm/m^2.

Substrates suitable for supporting the macrostructure/particles typically have a dry tensile strength of from about 500 gm/in to about 8,000 gm/in, more preferably from about 1,000 gm/in to about 3,000 gm/in, a wet tensile strength of from about 200 gm/in to about 5,000 gm/in, though more preferably from about 400 gm/in to about 1,000 gm/in, and a wet burst strength of from about 100 gm to about 2,000 gm, though more preferably from about 200 gm to about 1,000 gm. Preferred substrates of this type include cellulosic fibrous webs such as paper towels and tissues such those disclosed in U.S. Patent 3,953,638, issued April 27, 1976, U.S. Patent 4,469,735, issued Sept. 4, 1984, U.S. Patent 4,468,428, issued Aug. 28, 1984, and U.S. Patent 4,986,882, issued Jan. 22, 1991, all of which are incorporated by reference.

The porous absorbent macrostructure/particles can be attached to the substrate by a variety of chemical, physical, and adhesive agents. Adhesive agents for attaching the

macrostructure/particles to substrate include glues and hot melt adhesives. Preferably, the bonding between the substrate and macrostructure/particles is achieved by depositing the precursor absorbent particles on the substrate, treating the deposited particles with the solution comprising a crosslinking agent and then curing the treated particles/substrate as previously. In a preferred embodiment of this method, a cellulosic substrate (e.g., paper towel) is used. The precursor absorbent particles are then deposited on this cellulosic substrate. A treatment solution comprising an amino-epichlorohydrin adduct, preferably a polymeric epichlorohydrin-polyamide/polyamine wet strength resin such Kymene®, is then applied (e.g., sprayed) on the cellulosic substrate and the absorbent particles. The treated substrate/particles are then cured at ambient temperatures such that the particles are bonded to the cellulosic substrate.

To enhance the overall flexibility of the cores of the present invention, the fluid stable macrostructures may be slitted so as to be discontinuous. That is, the macrostructure strips may each be cut at various locations to form slits through the entire thickness (i.e., z-direction) of the structure. Such macrostructures are described in co-pending U.S. applications 08/142,258 (filed October 22, 1993 by Hsueh et al.), 08/550,181 (filed October 30, 1995 by Rezai et al.), and 08/550,185 (filed October 30, 1995 by Dierckes et al.), all of which are incorporated by reference herein. Upon stretching the slitted macrostructures in the y-direction, a "netted" material results. The open spaces between the hydrogel-containing continuous portion permits freer swelling of the hydrogel structure, and also increases permeability through this component.

The porous, absorbent macrostructures useful as fluid storage components according to the present invention can also be enclosed or enveloped within a tissue. Such tissue envelopes can keep loose absorbent particles from migrating within the absorbent core and can provide additional structural integrity to the macrostructure.

Regardless of the nature of the absorbent material utilized, it is important that the storage material be restrained from swelling to a significant degree into the fluid acquisition zone (i.e., in the x- and/or y-directions, particularly toward the interior of the absorbent core), while being free to swell in the z-direction. This will result in a larger acquisition zone to accept fluid gushes. As is discussed with regard to Figures 3 and 4, swelling into the fluid acquistion zone can be prevented by, for example, use of adhesive spot bonds. This may be particularly beneficial when discrete particles of absorbent polymer are used as the upper fluid storage material. In some instances, the arrangement of the various core materials will provide the desired restrained swelling.

b. Foam Materials

As indicated above, foam materials useful as the absorbent storage component of the present invention should, in addition to offering adequate fluid storage capacity, be

capable of existing in a collapsed, or thin, state until contacted with a body fluid. The ability to remain in such as state is important in providing thin diapers that appeal to the consumer. The use of these foam materials provides the added advantage of swelling almost entirely in the z-direction. That is, upon imbibing fluid, the foams swell significantly in the z-direction, while essentially maintaining their length and width dimensions. This is important in that it allows for efficient formation of the fluid acquisition zone.

Representative foam materials that are useful in the present invention are those described in U.S. Patent No. 5,387,207 ("'207 patent"), issued February 7, 1995 to Dyer et al., which is incorporated herein by reference. Briefly, that patent describes polymeric foams derived from emulsions that have a relatively small amount of an oil phase (including the polymerizable monomers) and a relatively large amount of an aqueous phase. (Such emulsions are commonly referred to as high internal phase emulsions, or HIPEs.) These HIPE-derived foams are rendered hydrophilic by agents remaining after polymerization, or by post-polymerization treatment with a surfactant. The foams described in the '207 patent are open-celled. That is, the individual cells (also referred to as pores) that represent the space occupied by individual water droplets in the emulsion are interconnected by numerous small holes. These small holes in the walls of the cells allow fluid to transfer from one cell to another, throughout the entire foam structure.

The ability of the foams to remain in the "thin-until-wet" state is believed to be due to the capillary forces within the foam, particularly the foam's capillary pressure. To remain in the collapsed state until wetted, the capillary pressures within the foam must be equivalent or greater than the forces exerted by the elastic recovery or modulus of the foam polymer, which work to "spring" the foam back to its uncompressed thickness. Parameters that affect capillary pressure include capillary suction specific surface area, foam density, fluid surface tension and average cell size. Parameters that affect the modulus of the foams include monomer content comprising the polymer, as well as residual oil-soluble emulsifiers which tend to plasticize the polymer, thereby reducing polymer modulus. A complete list of preferred ranges for these parameters, as well as a discussion of other important properties of the foams, is set forth in the patent.

Co-pending U.S. Patent applications 08/563,866, which is incorporated by reference herein, was filed November 29, 1995 by DesMarais et al., and also describes expandable foams that are useful in the present invention. Though these foams are also prepared from HIPEs, the preparation of emulsions with higher water-oil ratios provides even higher porosity, lower density structures. The foams are prepared from emulsions having a water phase to oil phase ratio of from about 55:1 to about 100:1. These foams have a specific surface area per foam volume of at least about 0.025 m^2/cc, preferably at least about 0.05 m^2/cc, more preferably at least about 0.07 m^2/cc (the density being

measured in the expanded state). The foams have a capillary suction specific surface area of at least about 3 m^2g, preferably from about 3 to about 15 m^2/g, more preferably from about 4 to about13 m^2/g, and most preferably from about 5 to about 11 m^2/g. The foams have a foam density, as measured in the collapsed state, of from about 0.1 g/cc to about 0.2 g/cc, preferably from about 0.11 g/cc to about 0.15 g/cc, more preferably from about 0.12 g/cc to about 0.14 g/cc. The foams further exhibit a fluid surface tension of from about 15 to about 65 dynes/cm, preferably from about 20 to about 65 dynes/cm, more preferably from about 20 to about 65 dynes/cm. The average cell size of these foams is preferably less than about 50μm, more preferably from about 5μm to about 35 μm. These foams are particularly preferred as the fluid storage material when use of foams are desired. The foams will preferably exhibit a ratio of expanded (wet) to collapsed (dry) thickness of at least about 6:1, more preferably from about 6:1 to about 10:1; and a free absorbent capacity of from about 55 to about 100ml of synthetic urine per gram of dry foam, more preferably from about 55 to 75 ml per gram.

Another important consideration when using a collapsable foam as the upper fluid storage component(s) is it's ability to swell in the z-direction against pressure. The referenced patents discuss the ability to swell against pressure, and the parameters that affect this ability. The skilled artisan can readily determine what characteristics are needed for foams to perform as the storage component herein.

Other foam materials useful as the storage material include compressed cellulosic foams. Such foams are described in European Patent Publication 293,208, published by Lion Corp. Cellulose foams useful herein are commercially available from several companies, including Spontex, Toray and 3M. These cellulose foam materials when supplied as compressed sponges expand rapidly upon wetting, thus creating the fluid acquisition zone.

2. Fluid Acquisition/Distribution Component

The fluid acquisition/distribution component can provide a variety functions in the absorbent cores of the present invention. One is to initially acquire the discharged body fluids. Another key function is to transport and distribute these acquired fluids to other absorbent core components, and in particular the fluid storage components of the absorbent core. In some instances, the fluid acquisition/distribution component according to the present invention can include at least some hydrogel-forming absorbent polymer and thus provide some fluid storage capacity for the absorbent core.

The fluid acquisition/distribution component of the present invention can comprise a variety of fibrous materials that form fibrous webs or fibrous matrices. Fibers useful in the fluid acquisition/distribution component include those that are naturally occurring fibers (modified or unmodified), as well as synthetically made fibers. Examples of

suitable unmodified/modified naturally occurring fibers include cotton, Esparto grass, bagasse, kemp, flax, silk, wool, wood pulp, chemically modified wood pulp, jute, rayon, ethyl cellulose, and cellulose acetate. Suitable synthetic fibers can be made from polyvinyl chloride, polyvinyl fluoride, polytetrafluoroethylene, polyvinylidene chloride, polyacrylics such as ORLON®, polyvinyl acetate, polyethylvinyl acetate, non-soluble or soluble polyvinyl alcohol, polyolefins such as polyethylene (e.g., PULPEX®) and polypropylene, polyamides such as nylon, polyesters such as DACRON® or KODEL®, polyurethanes, polystyrenes, and the like. The fibers used can comprise solely naturally occurring fibers, solely synthetic fibers, or any compatible combination of naturally occurring and synthetic fibers.

The fibers useful in fluid acquisition/distribution components of the present invention can be hydrophilic, hydrophobic fibers that are made hydrophilic, or can be a combination of both hydrophilic and hydrophilized hydrophobic fibers. As used herein, the term "hydrophilic" describes fibers, or surfaces of fibers, that are wettable by aqueous fluids (e.g., aqueous body fluids) deposited on these fibers. Hydrophilicity and wettability are typically defined in terms of contact angle and the surface tension of the fluids and solids involved. This is discussed in detail in the American Chemical Society publication entitled Contact Angle, Wettability and Adhesion, edited by Robert F. Gould (Copyright 1964). A fiber, or surface of a fiber, is said to be wetted by a fluid (i.e., hydrophilic) when either the contact angle between the fluid and the fiber, or its surface, is less than 90°, or when the fluid tends to spread spontaneously across the surface of the fiber, both conditions normally co-existing. Conversely, a fiber or surface is considered to be hydrophobic if the contact angle is greater than 90° and the fluid does not spread spontaneously across the surface of the fiber.

Other fibers useful as the fluid aquistition/distribution component are hydrophobic fibers that are wettable due to their geometry. Such fibers include "capillary channel fibers" such as those described in U.S. Patent No. 5,200,248, to Thompson et al. and U.S. Patent No. U.S. 5,268,229, to Phillips et al, both which are incorporated by reference herein.

Suitable hydrophilic fibers for use in the present invention include cellulosic fibers, modified cellulosic fibers, rayon, polyester fibers such as polyethylene terephthalate (e.g., DACRON®), hydrophilic nylon (HYDROFIL®), and the like. Suitable hydrophilic fibers can also be obtained by hydrophilizing hydrophobic fibers, such as surfactant-treated or silica-treated thermoplastic fibers derived from, for example, polyolefins such as polyethylene or polypropylene, polyacrylics, polyamides, polystyrenes, polyurethanes and the like. For reasons of availability and cost, cellulosic fibers, in particular wood pulp fibers, are preferred for use in the present invention.

Suitable wood pulp fibers can be obtained from well-known chemical processes such as the Kraft and sulfite processes. It is especially preferred to derive these wood pulp fibers from southern soft woods due to their premium absorbency characteristics. These wood pulp fibers can also be obtained from mechanical processes, such as ground wood, refiner mechanical, thermomechanical, chemimechanical, and chemi-thermomechanical pulp processes. Recycled or secondary wood pulp fibers, as well as bleached and unbleached wood pulp fibers, can be used.

A desirable source of hydrophilic fibers for use in the present invention are chemically stiffened cellulosic fibers. As used herein, the term "chemically stiffened cellulosic fibers" means cellulosic fibers that have been stiffened by chemical means to increase the stiffness of the fibers under both dry and aqueous conditions. Such means can include the addition of a chemical stiffening agent that, for example, coats and/or impregnates the fibers. Such means can also include the stiffening of the fibers by altering the chemical structure, e.g., by crosslinking polymer chains.

Polymeric stiffening agents that can coat or impregnate the cellulosic fibers include: cationic modified starches having nitrogen-containing groups (e.g., amino groups) such as those available from National Starch and Chemical Corp., Bridgewater, NJ, USA; latexes; wet strength resins such as polyamide-epichlorohydrin resin (e.g., Kymene® 557H, Hercules, Inc. Wilmington, Delaware, USA), polyacrylamide resins described, for example, in U.S. Patent 3,556,932 (Coscia et al), issued January 19, 1971; commercially available polyacrylamides marketed by American Cyanamid Co., Stamford, CT, USA, under the tradename Parez® 631 NC; urea formaldehyde and melamine formaldehyde resins, and polyethylenimine resins. A general dissertation on wet strength resins utilized in the paper art, and generally applicable herein, can be found in TAPPI monograph series No. 29. "Wet Strength in Paper and Paperboard", Technical Association of the Pulp and Paper Industry (New York, 1965).

These fibers can also be stiffened by chemical reaction. For example, crosslinking agents can be applied to the fibers that, subsequent to application, are caused to chemically form intrafiber crosslink bonds. These crosslink bonds can increase the stiffness of the fibers. While the utilization of intrafiber crosslink bonds to chemically stiffen the fiber is preferred, it is not meant to exclude other types of reactions for chemical stiffening of the fibers. Fibers stiffened by crosslink bonds in individualized form (i.e., the individualized stiffened fibers, as well as processes for their preparation) are disclosed, for example, in U.S. Patent 3,224,926 (Bernardin), issued December 21, 1965; U.S. Patent 3,440,135 (Chung), issued April 22, 1969; U.S. Patent 3,932,209 (Chatterjee), issued January 13, 1976; and U.S. Patent 4,035,147 (Sangenis et al), issued July 12, 1977. More preferred stiffened fibers are disclosed in U.S. Patent 4,822,453 (Dean et al), issued April 18, 1989; U.S. Patent 4,888,093 (Dean et al), issued December 19, 1989; U.S. Patent 4,898,642

(Moore et al), issued February 6, 1990; and U.S. Patent 5,137,537 (Herron et al), issued August 11, 1992, all of which are incorporated by reference. In the more preferred stiffened fibers, chemical processing includes intrafiber crosslinking with crosslinking agents while such fibers are in a relatively dehydrated, defibrated (i.e., individualized), twisted, curled condition. See. for example, U.S. Patent 4,898,642.

These chemically stiffened cellulosic fibers have certain properties that can make them particularly useful in fluid acquisition/distribution components according to the present invention, relative to unstiffened cellulosic fibers. In addition to being hydrophilic, these stiffened fibers have unique combinations of stiffness and resiliency. This allows thermally bonded fluid acquisition/distribution components made with these fibers to maintain high levels of absorptivity, and to exhibit high levels of resiliency and an expansionary responsiveness to wetting. In particular, the resiliency of these stiffened fibers enables the fluid acquisition/distribution component to better maintain its capillary structure in the presence of both fluid and compressive forces normally encountered during use and are thus more resistant to collapse.

In the case of thermally bonded fluid acquisition/distribution components useful in the present invention, a thermoplastic material is included with the fibers. Upon melting, at least a portion of this thermoplastic material migrates to the intersections of the fibers, typically due to interfiber capillary gradients. These intersections become bond sites for the thermoplastic material. When cooled, the thermoplastic materials at these intersections solidify to form the bond sites that hold the matrix or web of fibers together in each of the respective layers.

Amongst its various effects, bonding at these fiber intersections increases the overall compressive modulus and strength of the resulting thermally bonded fluid acquisition/distribution component. In the case of the chemically stiffened cellulosic fibers, the melting and migration of the thermoplastic material also has the effect of increasing the average pore size of the resultant web, while maintaining the density and basis weight of the web as originally formed. This can improve the fluid acquisition properties of the thermally bonded fluid distribution component upon initial discharges, due to improved fluid permeability, and upon subsequent discharges, due to the combined ability of the stiffened fibers to retain their stiffness upon wetting and the ability of the thermoplastic material to remain bonded at the fiber intersections upon wetting and upon wet compression. In net, thermally bonded webs of stiffened fibers retain their original overall volume, but with the volumetric regions previously occupied by the thermoplastic material becoming open to thus increase the average interfiber capillary pore size.

Thermoplastic materials useful in fluid distribution components of the present invention can be in any of a variety of forms including particulates, fibers, or combinations of particulates and fibers. Thermoplastic fibers are a particularly preferred form because

of their ability to form numerous interfiber bond sites. Suitable thermoplastic materials can be made from any thermoplastic polymer that can be melted at temperatures that will not extensively damage the fibers that comprise the primary web or matrix of each layer. Preferably, the melting point of this thermoplastic material will be less than about 190°C, and preferably between about 75°C and about 175°C. In any event, the melting point of this thermoplastic material should be no lower than the temperature at which the thermally bonded absorbent structures, when used in absorbent articles, are likely to be stored. The melting point of the thermoplastic material is typically no lower than about 50°C.

The thermoplastic materials, and in particular the thermoplastic fibers, can be made from a variety of thermoplastic polymers, including polyolefins such as polyethylene (e.g., PULPEX®) and polypropylene, polyesters, copolyesters, polyvinyl acetate, polyethylvinyl acetate, polyvinyl chloride, polyvinylidene chloride, polyacrylics, polyamides, copolyamides, polystyrenes, polyurethanes and copolymers of any of the foregoing such as vinyl chloride/vinyl acetate, and the like. One preferred thermoplastic binder fiber is PLEXAFIL® polyethylene microfibers (made by DuPont) that are also available as an about 20% blend with 80% cellulosic fibers sold under the tradename KITTYHAWK® (made by Weyerhaeuser Co.) Depending upon the desired characteristics for the resulting thermally bonded absorbent member, suitable thermoplastic materials include hydrophobic fibers that have been made hydrophilic, such as surfactant-treated or silica-treated thermoplastic fibers derived from, for example, polyolefins such as polyethylene or polypropylene, polyacrylics, polyamides, polystyrenes, polyurethanes and the like. The surface of the hydrophobic thermoplastic fiber can be rendered hydrophilic by treatment with a surfactant, such as a nonionic or anionic surfactant, e.g., by spraying the fiber with a surfactant, by dipping the fiber into a surfactant or by including the surfactant as part of the polymer melt in producing the thermoplastic fiber. Upon melting and resolidification, the surfactant will tend to remain at the surfaces of the thermoplastic fiber. Suitable surfactants include nonionic surfactants such as Brij® 76 manufactured by ICI Americas, Inc. of Wilmington, Delaware, and various surfactants sold under the Pegosperse® trademark by Glyco Chemical, Inc. of Greenwich, Connecticut. Besides nonionic surfactants, anionic surfactants can also be used. These surfactants can be applied to the thermoplastic fibers at levels of, for example, from about 0.2 to about 1 g. per sq. of centimeter of thermoplastic fiber.

Suitable thermoplastic fibers can be made from a single polymer (monocomponent fibers), or can be made from more than one polymer (e.g., bicomponent fibers). As used herein, "bicomponent fibers" refers to thermoplastic fibers that comprise a core fiber made from one polymer that is encased within a thermoplastic sheath made from a different polymer. The polymer comprising the sheath often melts at a different, typically lower, temperature than the polymer comprising the core. As a result, these bicomponent fibers

provide thermal bonding due to melting of the sheath polymer, while retaining the desirable strength characteristics of the core polymer.

Suitable bicomponent fibers can include sheath/core fibers having the following polymer combinations: polyethylene/polypropylene, polyethylvinyl acetate/polypropylene, polyethylene/polyester, polypropylene/polyester, copolyester/polyester, and the like. Particularly suitable bicomponent thermoplastic fibers for use herein are those having a polypropylene or polyester core, and a lower melting copolyester, polyethylvinyl acetate or polyethylene sheath (e.g., DANAKLON®, CELBOND® or CHISSO® bicomponent fibers). These bicomponent fibers can be concentric or eccentric. As used herein, the terms "concentric" and "eccentric" refer to whether the sheath has a thickness that is even, or uneven, through the cross-sectional area of the bicomponent fiber. Eccentric bicomponent fibers can be desirable in providing more compressive strength at lower fiber thicknesses. Suitable bicomponent fibers for use herein can be either uncrimped (i.e. unbent) or crimped (i.e. bent). Bicomponent fibers can be crimped by typical textile means such as, for example, a stuffer box method or the gear crimp method to achieve a predominantly two-dimensional or "flat" crimp.

In the case of thermoplastic fibers, their length can vary depending upon the particular melt point and other properties desired for these fibers. Typically, these thermoplastic fibers have a length from about 0.3 to about 7.5 cm long, preferably from about 0.4 to about 3.0 cm long, and most preferably from about 0.6 to about 1.2 cm long. The properties, including melt point, of these thermoplastic fibers can also be adjusted by varying the diameter (caliper) of the fibers. The diameter of these thermoplastic fibers is typically defined in terms of either denier (grams per 9000 meters) or decitex (grams per 10,000 meters). Suitable bicomponent thermoplastic fibers can have a decitex in the range from about 1.0 to about 20, preferably from about 1.4 to about 10, and most preferably from about 1.7 to about 3.3.

The compressive modulus of these thermoplastic materials, and especially that of the thermoplastic fibers, can also be important. The compressive modulus of thermoplastic fibers is affected not only by their length and diameter, but also by the composition and properties of the polymer or polymers from which they are made, the shape and configuration of the fibers (e.g., concentric or eccentric, crimped or uncrimped), and like factors. Differences in the compressive modulus of these thermoplastic fibers can be used to alter the properties, and especially the density characteristics, of the respective absorbent members during preparation of the absorbent core.

As noted previously, in some absorbent cores according to the present invention, the fluid acquisition/distribution component can include hydrogel-forming absorbent to provide some fluid storage capacity for the core. In those instances, the fluid acquisition/distribution component can comprise up to about 50%, by weight of the fluid

acquisition/distribution component, hydrogel-forming absorbent polymer. Preferably, the fluid distribution component comprises up to about 30%, by weight of the fluid acquisition/distribution component, hydrogel-forming absorbent polymer. Most preferably, the fluid distribution component comprises up to about 15%, by weight of the fluid acquisition/distribution component, hydrogel-forming absorbent polymer.

The fluid acquisition/distribution component can also or alternatively comprise a polymeric foam material. Particularly suitable absorbent foams have been made from HIPEs. Though they differ with respect to certain properties from those foams discussed as being useful as the fluid storage component, the foams are open-celled, polymeric materials. See, for example, U.S. Patent 5,260,345 (DesMarais et al), issued November 9, 1993 and U.S. Patent 5,268,224 (DesMarais et al), issued December 7, 1993. These absorbent HIPE foams provide desirable fluid handling properties, including: (a) relatively good wicking and fluid distribution characteristics to transport the imbibed urine or other body fluid into the unused portion of the absorbent article to allow for subsequent gushes of fluid to be accommodated; and (b) a relatively high storage capacity with a relatively high fluid capacity under load, i.e. under compressive forces. These HIPE absorbent foams are also sufficiently flexible and soft so as to provide a high degree of comfort to the wearer of the absorbent article. See also U.S. Patent 5,147,345 (Young et al), issued September 15, 1992 and U.S. Patent 5,318,554 (Young et al), issued June 7, 1994, which discloses absorbent cores having a fluid acquisition/distribution component that can be a hydrophilic, flexible, open-celled foam such as a melamine-formaldehyde foam (e.g., BASOTECT made by BASF), and a fluid storage/redistribution component that is a HIPE-based absorbent foam.

These foam-based acquisition/distribution components should allow rapid fluid acquisition, as well as efficient partitioning or distribution of fluid to other components of the absorbent core having higher absorption pressures than the desorption pressure of the acquisition/distribution foam. This property of fluid desorption to other core components is important in enhancing the ability to accept repeated discharges or loadings of fluid and to maintain the skin dryness of the wearer. It also allows the acquisition/distribution foam to serve as a void volume reservoir, or buffer zone, to temporarily hold fluid that can be expressed from the storage components of the core when extraordinarily high pressures are encountered during use of the absorbent article.

In giving this fluid to other core components, these foam-based acquisition/distribution components should do so without densifying or collapsing. Foam-based acquisition/distribution components should also readily accept fluid, with or without the aid of gravity. Foam-based acquisition/distribution components should further provide good aesthetics, be soft and resilient in structure, and have good physical integrity in both wet and dry states.

Other foams useful as such acquisition/distribution components are described and claimed in co-pending U.S.S.N. 08/370,695, filed January 10, 1995, by Stone, et al., which is incorporated by reference herein. These foams offer improved fluid retention and desorption (i.e., ability to relinquish fluid to other absorption components) properties, resulting from the processing conditions described therein. Briefly, the ability to provide these improved foams lies with the use of low shear conditions and a robust emulsifier system during HIPE processing.

Still other foams useful as the acquisition/distribution componenets are described and claimed in co-pending U.S.S.N. 08/520,793, filed August 30, 1995 by DesMarais, which is incorporated herein by reference. These foams offer still better storage and desorption properties, again because of advancements made in the processing (e.g., low shear) and the emulsifier employed.

3. Optional Lower Fluid Storage Component

Certain absorbent core designs according to the present invention may further comprise an optional lower fluid storage component. This lower fluid storage component is positioned underneath the fluid acquisition/distribution component, and is preferably wider than the fluid acquistion zone formed by the upper fluid storage components. A portion of this lower storage component is also positioned underneath the fluid acquisition zone. The lower fluid storage component is in fluid communication with the fluid acquisition/distribution component so as to be able to receive the acquired body fluids. The materials useful as the upper fluid storage component will also be useful as the optional lower fluid storage component. However, it is not necessary that this component be capable of swelling in the z-direction upon imbibing fluid. Thus, the skilled artisan will recognize that any material capable of absorbing a significant amount of fluid can be utilized as this component.

The lower fluid storage component may comprise a fiber/hydrogel composite, or only a hydrogel material. In this case, the lower storage component will preferably have a concentration of hydrogel of from about 30% to 100%, more preferably from about 70% to 100%, by total weight of the lower storage component. The lower storage component may also comprise a hydrophilic polymeric foam, including those discussed above. Foams that remain thin until wetted are preferred, again because they allow the manufacture, transport and store display of very thin absorbent articles.

D. Fluid Acquisition Zone

The fluid acquisition zone, formed in-part by the swollen storage component(s), creates a void space beneath the overlying topsheet. Because of the void space created by the acquisition zone, the absorbent cores according to the present invention can more

easily handle "gushes" of discharged body fluids. This is especially important as portions of the absorbent core become saturated from prior multiple discharges of such fluids.

As can be seen by refering to the drawings, the fluid acquisition zone has three dimensions. The width (y-direction) and length (x-direction) of the acquisition zone is generally defined as the void area created by the upper storage component, with the "bottom" of the zone being the upper surface of the acquisition/distribution material. Where two lateral storage components are spaced apart, the width of the acquisition zone is the gap between these components. The length in this case will be determined by the length of the upper storage components. The depth of the zone will be the height (z-direction) of the swollen storage components.

The fluid acquisition zone may be of irregular shape in the x-y directions, though generally rectangular is preferred. Further, while the volume of the acquisition zone required to obtain the benefit of maintained acquisition rates will vary according to various factors (e.g., the rate of absorbency of the storage material; the absorbency rate and capacity of the acquistion material, etc.), it is preferred that the acquisition zone have a volume, when the storage material is wetted and the article is not subject to external pressure, of at least about 30 cc, preferrably at least about 50 cc, and more preferably at least about 75 cc. Of course, when in the article is in the dry state, the acquisition zone volume will be significantly smaller. Those skilled in the art will recognize that measuring acquisition zone volumes will be imprecise, given the nature of the materials employed as the storage and acquisition/distribution components. As such, the preferred volume ranges listed are illustrative only, and are not intended to limit the scope of the invention.

E. Topsheets

Topsheets useful in absorbent articles of the present invention are compliant, soft feeling, and non-irritating to the wearer's skin. These topsheets are fluid pervious to permit body fluids to readily penetrate through its thickness. A suitable topsheet can 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.

Preferred topsheets for use in the present invention are selected from high loft nonwoven topsheets and aperture formed film topsheets. Apertured formed films are especially preferred for the topsheet because they are pervious to body fluids and yet non-absorbent and have a reduced tendency to allow fluids to pass back through and rewet the

wearer's skin. Thus, the surface of the formed film that 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. Patent 3,929,135 (Thompson), issued December 30, 1975; U.S. Patent 4,324,246 (Mullane, et al), issued April 13, 1982; U.S. Patent 4,342,314 (Radel. et al), issued August 3, 1982; U.S. Patent 4,463,045 (Ahr et al), issued July 31, 1984; and U.S. 5,006,394 (Baird), issued April 9, 1991. Each of these patents are incorporated herein by reference. Particularly preferred microapertured formed film topsheets are disclosed in U.S. Patent 4,609,518 (Curro et al), issue September 2, 1986 and U.S. Patent 4,629,643 (Curro et al), issued December 16, 1986, which are incorporated by reference. The preferred topsheet for use in catamenial products of the present invention is the formed film described in one or more of the above patents and marketed on sanitary napkins by The Procter & Gamble Company of Cincinnati, Ohio as "DRI-WEAVE®."

The body surface of the formed film topsheet can be hydrophilic so as to help body fluids to transfer through the topsheet faster than if the body surface was not hydrophilic so as to diminish the likelihood that fluid will flow off the topsheet rather than flowing into and being absorbed by the absorbent structure. In a preferred embodiment, surfactant is incorporated into the polymeric materials of the formed film topsheet such as is described in U.S. patent Application Serial No. 07/794,745, "Absorbent Article Having A Nonwoven and Apertured Film Coversheet" filed on November 19, 1991 by Aziz, et al., which is incorporated by reference. Alternatively, the body surface of the topsheet can be made hydrophilic by treating it with a surfactant such as is described in the above referenced U.S. 4,950,254, incorporated herein by reference.

F. Backsheets

Backsheets useful in absorbent articles of the present invention are typically impervious to body fluids and are preferably manufactured from a thin plastic film, although other flexible fluid impervious materials may also be used. As used herein, the term "flexible" refers to materials that are compliant and will readily conform to the general shape and contours of the human body. The backsheet prevents body fluids absorbed and contained in the absorbent core from wetting articles that contact the such as pants, pajamas, undergarments, and the like. The backsheet can comprise a woven or nonwoven material, polymeric films such as thermoplastic films of polyethylene or polypropylene, or composite materials such as a film-coated nonwoven material. Preferably, the backsheet is a polyethylene film having a thickness of from about 0.012 mm (0.5 mil) to about 0.051 mm (2.0 mils). Exemplary polyethylene films are manufactured by Clopay Corporation of Cincinnati, Ohio, under the designation P18-0401 and by Ethyl Corporation, Visqueen Division, of Terre Haute, Indiana, under the

designation XP-39385. The backsheet is preferably embossed and/or matte finished to provide a more clothlike appearance. Further, the backsheet can permit vapors to escape from the absorbent core (i.e., breathable) while still preventing body fluids from passing through the backsheet.

Particularly desirable backsheets can be made from 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-path length that 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-path length includes one or more deformations that extend beyond the plane of the other region. The SELF web exhibits at least two significantly different stages of 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-path length 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 are more completely described in the copending, commonly assigned U. S. Patent Application Serial Number 08/203,456 entitled "Absorbent Article with Multiple Zone Structural Elastic–Like Film Web Extensible Waist Feature" filed by Donald C. Roe, et al. on February 24, 1994, which is incorporated herein by reference.

G. Absorbent Articles

The absorbent articles of the present invention generally comprise: (1) a topsheet; (2) a backsheet; and (3) an absorbent core positioned between the topsheet and the backsheet. As used herein, the term "absorbent article" refers to articles that absorb and contain body fluids, and more specifically refers to articles that are placed against or in proximity to the body of the wearer to absorb and contain the various fluids discharged from the body. Additionally, "disposable" absorbent articles are those which are intended to be discarded after a single use (i.e., the original absorbent article in its whole is not intended to be laundered or otherwise restored or reused as an absorbent article, although

certain materials or all of the absorbent article may be recycled, reused, or composted). A preferred embodiment of a disposable absorbent article according to the present invention is a diaper. As used herein, the term "diaper" refers to a garment 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 incontinent briefs, incontinent pads, training pants, diaper inserts, catamenial pads, sanitary napkins, facial tissues, paper towels, and the like.

The absorbent core used in the absorbent articles of the present invention comprises at least one fluid storage component, as previously described, that is essentially adjacent the topsheet. In such a preferred embodiment, a relatively thin fluid pervious layer such as tissue layer can be interposed between the topsheet and the fluid storage component. However, it is important that the fluid storage component be essentially in direct fluid communication with the topsheet. This is so the absorbent core according to the present invention can minimize rewetting of the topsheet and thus provide good skin dryness for the wearer of the absorbent article.

In a preferred embodiment, the absorbent core comprises two upper fluid storage components which are laterally spaced apart. By "laterally spaced apart" is meant that there is a gap between these fluid storage components. When these laterally spaced storage components swell in the z-direction upon absorbing body fluid, the gap between the fluid storage components, together with the acquisition/distribution layer positioned thereunder, defines the fluid acquisition zone for receiving discharged body fluids. At least a portion of this fluid acquisition zone typically comprises a void space underneath the overlying topsheet. Because of the void space in this acquisition zone, the absorbent core according to the present invention can more easily handle "gushes" of discharged body fluids. This is especially important as portions of the absorbent core become saturated from prior multiple discharges of such fluids.

Absorbent cores according to the present invention further comprise a fluid acquisition/distribution component that is capable of transporting the discharged body fluids to other components in the absorbent core. This fluid acquisition/distribution component is at least partially positioned underneath and typically proximate to the acquisition zone so as to be able to receive these discharged body fluids. At least a portion of this fluid acquisition/distribution component is also positioned underneath each the upper storage component(s). These portions of the fluid acquisition/distribution component are in fluid communication with the upper storage component(s) and allow the transfer of fluids from the fluid distribution component to each of the upper storage components so the fluid acquisition/distribution component can receive additional discharges of body fluid.

Where the acquisition/distribution material is fibrous, it is preferred that the basis weight be in the range of from about 0.08 g/sq.in. to about 0.30 g/sq.in., more preferably from about 0.08 g/sq.in to about 0.15 g/sq.in.; and that the density be in the range of from about 0.05 g/cc to about 0.30 g/cc; more preferably from about 0.05 g/cc to about 0.15 g/cc.

Certain absorbent core designs according to the present invention may further comprise an optional lower fluid storage component. This lower fluid storage component is positioned underneath the fluid acquisition/distribution component. A portion of this lower storage component is also positioned underneath the fluid acquisition zone. This lower fluid storage component is in fluid communication with the fluid acquisition/distribution component so as to be able to receive the acquired body fluids. The materials useful as the upper fluid storage component will also be useful as the optional lower fluid storage component. However, it is not necessary that this component be capable of swelling in the z-direction upon imbibing fluid. Thus, the skilled artisan will recognize that any material capable of absorbing a significant amount of fluid can be utilized as this component.

The lower fluid storage component may comprise a fiber/hydrogel composite, or only a hydrogel material. In this case, the lower storage component will preferably have a concentration of hydrogel of from about 30% to 100%, more preferably from about 70% to 100%, by total weight of the lower storage component.

The lower storage component may alternatively comprise a hydrophilic polymeric foam, including those discussed above. Foams that remain thin until wetted are preferred, again because they allow the manufacture, transport and store display of very thin absorbent articles. In addition, since the lower storage component is preferably in proximity to the backsheet, the tactile feel of the material through the backsheet is important to consumers. The material therefore is preferably relatively smooth and flexible. Thin-until-wet foams provide these tactile benefits.

Regardless of the material constituting the optional lower storage core, this component will preferably be at least as wide (i.e., in the y direction) as the fluid acquisition zone, so that swelling of lower layer does not diminish void volume created by swelling of the upper storage component(s). Thus, where there are two lateral upper fluid storage components separated by a gap, the lower storage component will be wider than this gap.

An embodiment of the an absorbent article in the form of a diaper 10 having one such absorbent core according to the present invention is shown in Figure 1. Figure 1 is a top plan view of diaper 10 in a flat-out, uncontracted state (i.e., with any elastic-induced contraction removed) having a topsheet 12, a backsheet 14, and an absorbent core indicated generally as 18 that is positioned between topsheet 12 and backsheet 14.

Topsheet 12 is shown as being transparent so as to better illustrate the various components of absorbent core 18.

As also shown in Figure 1, diaper 10 has a front waistband region 22, a back waistband region 24, a crotch region 26 and a periphery 28 that is defined by the outer edge of backsheet 14 and which has longitudinal edges designated 30 and end edges designated as 32. The longitudinal axis of diaper 10 runs essentially parellel to longitudinal edges 30, while the transverse axis runs essentially parellel to end edges 32. The waistband regions 22 and 24 comprise those upper portions of the diaper 10, which when worn, encircle the waist of the wearer. The crotch region 26 is that portion of the diaper 10 between waistband regions 22 and 24, and comprises that portion of the diaper 10 which when worn, is positioned between the legs of the wearer and covers the lower torso of the wearer. Thus, the crotch region 26 defines the area of typical liquid deposition for a diaper 10 or other disposable absorbent article.

Topsheet 12 and backsheet 14 can be associated together in any suitable manner. As used herein, the term "associated" encompasses configurations where topsheet 12 is directly joined to backsheet 14 by affixing the topsheet directly to the backsheet, and configurations where the topsheet is indirectly joined to the backsheet by affixing the topsheet to intermediate members which in turn are affixed to the backsheet. Preferably, the topsheet 12 and backsheet 14 are affixed directly to each other by attachment means (not shown) such as an adhesive or any other attachment means as known in the art. For example, a uniform continuous layer of adhesive, a patterned layer of adhesive, or an array of separate lines or spots of adhesive may be used to affix topsheet 12 to backsheet 14. As shown in Figure 1, topsheet 12 has a smaller size configuration than backsheet 14. However, topsheet 12 and backsheet 14 can both have the same, or a similar, size configuration (i.e., are coextensive) such they are joined together at periphery 28 of diaper 10. The size of the backsheet 14 is dictated by the size of the absorbent core 18 and the exact diaper design selected. In the embodiment shown in Figure 1, the backsheet 14 has an hourglass-shaped configuration. However, other configuration such as rectangular, I-shaped and the like are also suitable.

Although not shown, diaper 10 can have elastic members that exert a contracting force on the diaper so that it configures more closely and more comfortably to the wearer. These elastic members can be assembled in a variety of well known configurations, such as those described generally in U.S. Patent 3,860,003 (Buell), issued January 14, 1975, which patent is incorporated by reference. The elastic members can be disposed adjacent the periphery 28 of the diaper 10, preferably along each longitudinal edge 30, so that the elastic members tend to draw and hold the diaper 10 against the legs of the wearer. Alternatively, the elastic members can be disposed adjacent either or both of the end edges 32 of diaper 10 to provide a waistband as well as or rather than leg cuffs. See, for

example, U.S. Patent 4,515,595 (Kievit et al), issued May 7, 1985, which is incorporated by reference. The elastic members are secured to the diaper 10 in an elastically contractible condition so that in a normally unrestrained configuration, these elastic members effectively contract or gather the diaper 10. The elastic members can be secured in an elastically contractible condition in at least two ways. For example, the elastic members can be stretched and secured while the diaper 10 is in an uncontracted condition. Alternatively, the diaper 10 can be contracted, for example, by pleating, and the elastic members secured and connected to the diaper 10 while they are in their unrelaxed or unstretched condition. The elastic members can extend essentially the entire length of the diaper 10 in the crotch region 26, or alternatively can extend the entire length of the diaper 10, or any other length suitable to provide an elastically contractible line. The length of these elastic members is typically dictated by the diaper's design.

Referring to Figure 1 and especially Figure 2, absorbent core 18 has two upper fluid storage components 34 and 36 in the form of rectangular strips that comprise hydrogel-forming absorbent polymer and are underneath and adjacent topsheet 12. These fluid storage components are each respectively wrapped in a fluid pervious paper tissue 35 and 37, as shown specifically in Figure 2. These wrapped fluid storage components 34 and 36 are laterally spaced apart and define the fluid acquisition zone identified generally as 38. This fluid acquisition zone 38 is generally in the fluid discharge region of diaper 10.

The absorbent core 18 further comprises a continuous fluid acquisition/distribution component 42 in the form a fibrous web that is also wrapped in a paper tissue 43. The middle portion 44 of this fluid acquisition/distribution component 42 is positioned underneath the fluid acquisition zone 38. This fluid acquisition/distribution component 42 also has lateral portions 46 and 48. Lateral portion 46 is positioned underneath and in fluid communication with fluid storage component 36, while lateral portion 48 is positioned underneath and in fluid communication with fluid storage component 34. As shown in Figure 1, fluid distribution component 42 has arcuate concave edges 52 and 53 in the crotch section 26 of diaper 10 and thus assumes a somewhat hourglass shape.

As shown particularly in Figure 2, absorbent core 18 further includes a lower fluid storage component 60 in the form of a rectangular strip that comprises hydrogel-forming absorbent polymer or an absorbent foam material, and is wrapped in a paper tissue 61. This lower fluid storage component 60 has approximately the same length as fluid storage components 34 and 36, and is positioned underneath and in fluid communication with middle portion 44 of fluid distribution component 42. Lower storage component 60 is wider (in the y-direction) than the fluid acquisition zone 38 that is formed, in part, by the storage components 34 and 36. This lower fluid storage component 60 is positioned underneath the fluid acquisition zone 38.

Upon first exposure to aqueous body fluids, upper storage components 34 and 36 begin to swell, increasing in caliper by at least 2 mm when fully saturated. This increase in caliper increases the void volume of the acquisition zone 38. Consequently, the absorbent article is better able to handle subsequent "gushes" of aqueous body fluids. Preferably, the upper storage components will expand by at least 100% in the z-direction. Of course, because the length and width of the fluid acquisition zone will also affect the core's void volume, 100% z-direction expansion may not be required in such cores.

Figure 3 shows a cross section of an absorbent article 110 having a topsheet 112, a backsheet 114 and an alternative absorbent core 118 positioned between the topsheet and the backsheet. This alternative absorbent core 118 also has to two upper fluid storage components 134 and 136 that comprise hydrogel-forming absorbent polymer or a polymeric foam, and are underneath and adjacent topsheet 112. These fluid storage components 134 and 136 are laterally spaced apart and define, in part, the fluid acquisition zone identified generally as 138. A paper tissue layer 143 is positioned between these upper fluid storage components 134 and 136 and the fluid acquisition/distribution component 142. This fluid acquisition/ distribution component 142 has a middle portion 144 positioned underneath the fluid acquisition zone 138 and has lateral portions 146 and 148. Lateral portion 146 is positioned underneath and in fluid communication with fluid storage component 136, while lateral portion 148 is positioned underneath and in fluid communication with fluid storage component 134.

Absorbent core 118 further includes a lower fluid storage component 160 that comprises hydrogel-forming absorbent polymer or an absorbent polymeric foam. This lower fluid storage component 160 is positioned underneath and in fluid communication with middle portion 144 of fluid distribution component 142. This lower fluid storage component 160 is also positioned underneath the fluid acquisition zone 138, and is wider than the fluid acquistion zone 138. That is, the storage component 160 is wider than the gap between fluid storage components 134 and 136. As shown in Figure 3, the components of absorbent core 118 are wrapped within a paper tissue 164. Tissue 164 is adhesively bonded to tissue 143 at the points indicated by 166 and 168.

Upon first exposure to aqueous body fluids, upper storage components 134 and 136 begin to swell, increasing in caliper by at least 2 mm when fully saturated. Adhesive bonds 166 and 168 prevent lateral expansion of storage components 134 and 136 into acquisition zone 138. The increase in caliper increases the void volume of the acquisition zone 138. Consequently, the absorbent article is better able to handle subsequent "gushes" of aqueous body fluids.

Figure 4 shows a cross section of an absorbent article 210 having a topsheet 212, a backsheet 214 and another alternative absorbent core 218 positioned between the topsheet and the backsheet. This alternative absorbent core 218 also has to two upper fluid storage

components 234 and 236 that comprise hydrogel-forming absorbent polymer and are underneath and adjacent topsheet 212. These fluid storage components 234 and 236 are laterally spaced apart and define the fluid acquisition zone identified generally as 238. A paper tissue layer 243 is positioned under these upper fluid storage components 234 and 236 and over fluid acquisition/distribution component 242 that comprises a fibrous matrix having homogeneously dispersed therein hydrogel-forming absorbent polymer particles. This fluid distribution component 242 has a middle portion 244 positioned underneath the fluid acquisition zone 238 and has lateral portion 246 and 248. Lateral portion 246 is positioned underneath and in fluid communication with fluid storage component 236, while lateral portion 248 is positioned underneath and in fluid communication with fluid storage component 234. As shown in Figure 4, the components of absorbent core 218 are wrapped within a paper tissue 264. Tissue 264 is adhesively bonded to tissue 243 at the points indicated by 266 and 268.

Upon first exposure to aqueous body fluids, upper storage components 234 and 236 begin to swell, increasing in caliper by at least 2 mm when fully saturated. Adhesive bonds 266 and 268 prevent lateral expansion of storage components 234 and 236 into acquisition zone 238. The increase in caliper increases the void volume of the acquisition zone 238. Consequently, the absorbent article is better able to handle subsequent "gushes" of aqueous body fluids.

Figure 5 shows a cross section of an absorbent article 310 having a topsheet 312, a backsheet 314 and yet another alternative absorbent core 318 positioned between the topsheet and the backsheet. This alternative absorbent core 318 has a continuous layer 320 comprising hydrogel-forming absorbent polymer or an absorbent polymeric foam that is partially wrapped around fluid distribution component 342, this continuous layer 320 having the ability to expand in the z-direction upon absrobing body fluids. Continuous layer 320 includes upper fluid storage components or sections 334 and 336 that are underneath and adjacent topsheet 312, and a lower fluid storage component or section 360 that is underneath fluid distribution component 342. The gap between fluid storage components/sections 334 and 336 define the fluid acquisition zone identified generally as 338. Middle portion 344 of fluid distribution component 342 is underneath fluid acquisition zone 338. Lateral portion 346 of fluid distribution component 342 is positioned underneath and in fluid communication with fluid storage component 336, while lateral portion 348 is positioned underneath and in fluid communication with fluid storage component 334. Fluid storage component or section 360 is underneath and in fluid communication with fluid distribution component 342.

Upon first exposure to aqueous body fluids, upper storage components or sections 334 and 336 begin to swell, increasing in caliper by at least 2 mm when fully saturated. The increase in caliper increases the void volume of the acquisition zone 338.

Consequently, the absorbent article is better able to handle subsequent "gushes" of aqueous body fluids.

Figure 6 shows a cross section of an absorbent article 410 having a topsheet 412, a backsheet 414 and an alternative absorbent core 418 positioned between the topsheet and the backsheet. This alternative absorbent core 418 also has to two upper fluid storage components 434 and 436 that comprise hydrogel-forming absorbent polymer or a polymeric absorbent foam, and are underneath and adjacent topsheet 412. These fluid storage components 434 and 436 are laterally spaced apart and define the fluid acquisition zone identified generally as 438. Where comprised of hydrogel-forming absorbent polymer, these fluid storage components 434 and 436 are further bonded to substrates 435 and 437, respectively. Regardless of the material comprising fluid storage components 434 and 436, both are folded in a c-shape as shown in Figure 6.

A paper tissue layer 443 is positioned under these upper fluid storage components 434 and 436 and over fluid distribution component 442. This fluid distribution component 442 is positioned underneath and in fluid communication with fluid storage components 434 and 436 and under fluid acquisition zone 438.

Absorbent core 418 further includes a lower fluid storage component 460 that comprises hydrogel-forming absorbent polymer or an absorbent foam. This lower fluid storage component 460 is positioned underneath and in fluid communication with fluid distribution component 442. This lower fluid storage component 460 is also positioned underneath the fluid acquisition zone 438.

Upon first exposure to aqueous body fluids, upper storage components 434 and 436 begin to swell, increasing in caliper by at least 2 mm when fully saturated. Substrate layers 435 and 437 prevent lateral expansion of storage components 434 and 436 into acquisition zone 438. The c-folding of upper fluid storage components 434 and 436 enhance the ability of these components to swell in the z-direction, thereby increasing the void volume of acquisition zone 438. The increase in caliper increases the void volume of the acquisition zone 438. Consequently, the absorbent article is better able to handle subsequent "gushes" of aqueous body fluids.

H. Test Method -- Fluid Acquistion Rate

The rate at which an absorbent article such as a diaper is able to acquire liquids is measured by the following Acquisition Test which has been developed for this particular purpose. The Acquisition Test should be performed on a minimum of three samples of a given diaper configuration, to provide statistically significant results.

PRINCIPLE

This test simulates the introduction of urine into a diaper under the following conditions:

1) A pressure of 0.4 psi (about 28 g/cm^2) is applied to a diaper sample.

2) A total of 2 or more loadings of synthetic urine at a rate of 10 ml/sec are applied to the diaper sample, with a 5 minute time period (equilibration time) between each loading.

APPARATUS

Conditioned room:	Temperature and humidity controlled within the following limits: Temperature: 73 ± 2°F * Relative Humidity: 50 ± 2%
Acquisition Tester:	Obtain from Concord - Renn Co., 6315 Warrick St., Cincinnati, OH. 45227. Part Test Bed (PLEXIGLAS) Foam Base - 6" x 20" x 1" foam coveredwith polyethylene backsheet material - foam type: Density 1.0 lb/ft^3. IDL 24 psi Nozzle Cover plate
Graduated cylinders: (100 ml) (1,000 ml) equivalent	VWR Scientific, (100 ml) Catalog number: 24711-310 (1,000 ml) Catalog number: 24711-364 or
Erlenmeyer flask: (6,000 ml)	VWR Scientific Catalog number: 29135-307 or equivalent
Digital Pump:	Cole-Parmer Instrument Co.; Tel. No. (800) 323-4340 Catalog number: G-07523-20
Easy Load Pump Head:	Cole-Parmer Instrument Co. Catalog number: g-07518-02
Distilled water:	Convenient source
Dry Synthetic Urine:	Jayco SynUrine

ASSEMBLY OF TEST APPARATUS

The test apparatus should be assembled as shown in Figure 7. The test apparatus is designated by reference number 520. The test apparatus 520 is placed on a suitable table or bench top. The test apparatus 520 comprises a supply of synthetic urine 524, a pump 528, a pair of electrical connectors (or probes) 536, and a sample holder 546.

The pump 528 is a volumetric pump which is equipped with a pump head 530 and digital timer 532. The electrical probes 536 are connected to the pump 528 by wires 538. Tygon® tubing 540 runs from the supply of synthetic urine 524 to the pump 528 and from the pump 528 to the sample holder 546. The tygon® tubing 540 that runs from the pump 528 to the sample holder 546 is preferably held over the sample holder 546 by a ring stand

(not shown). The end of the tygon® tubing 540 that runs to the sample holder 546 also contains a nozzle 542 for directing the synthetic urine onto the test sample.

The sample holder 546 comprises a PLEXIGLAS test bed, a foam base 550, and a cover plate 552. The test bed 548 is shown schematically in Fig. 7 as comprising a PLEXIGLAS base plate for simplicity. The test bed 548 should also have four PLEXIGLAS walls which stand upright from the base and surround the diaper sample 510. This prevents synthetic urine from running out of the test bed 548 during the test. The foam base 550 is placed on top of the PLEXIGLAS base plate 548 so that the pressure on the sample will be equalized during the test. A diaper sample 510 is placed on the foam base with its topsheet facing upward. The cover plate 552 is then placed on top of the diaper sample so that the cylindrical liquid directing column 556 and opening 558 in the cover plate are in the transverse center of the diaper sample. Weights 560 are then placed on the cover plate 552 so that a pressure of 0.4 psi is applied to the diaper sample.

The electrical probes 536 are arranged so that they just touch the topsheet of the diaper sample in the region where synthetic urine is deposited. The electrical probes are located outside, and on opposite sides of the cylindrical liquid directing column 556. The electrical probes 536 detect the presence of synthetic urine on the topsheet of the diaper sample. When all of the synthetic urine has been acquired by the diaper sample, the electrical connection between the electrical probes 536 will be broken. This will provide the time for the test sample to acquire a given gush or load (i.e., 50 ml) of synthetic urine.

SYNTHETIC URINE PREPARATION

Measure four 1,000 ml portions of distilled water into a clean, dry 6,000 ml Erlenmeyer flask. Add a stirring bar to the flask and place the flask on a magnetic stirring plate. Carefully transfer the dry synthetic urine mixture into the flask containing the 4,000 ml of distilled water. A funnel is very helpful in preventing loss of the dry synurine mixture. Rinse the funnel into the Erlenmyer flask with the last 1,000 ml portion of distilled water so that a total of 5,000 ml of distilled water is added to the flask. Allow the solution to stir until all solids are dissolved.

Label and date the flask; discard any solution remaining after 7 days.

Larger volumes of synthetic urine (multiples of 5,000 ml) may be made if greater volumes are required. Use appropriately larger volumes of distilled water (for example, 10,000 ml in a 12,000 ml container) and the appropriate number of dry synurine mixture packages (e.g., 2 packages for 10,000 ml).

PROCEDURE

1) Cut any elastics out of the test diaper so that the diaper will lay flat. Place the diaper on top of the piece of foam in the acquisition tester base. The diaper should be placed with the topsheet of the diaper facing upward, so that the synthetic urine

will be applied to the topsheet. The diaper should be positioned so the urine delivery nozzle is approximately 3 inches from the front edge of the diaper.

2) Place the cover plate assembly on the diaper.

3) Gently place the appropriate weights on the cover plate so that a pressure of 0.4 psi is placed on the diaper.

4) Move the ring stand into position so that the nozzle is directly above the center of the cylindrical liquid directing column. Lower the ring until the nozzle extends 2" (about 5 cm) above the surface of the diaper. Position the nozzle so that it is perpendicular to the bench top.

5) Start the pump.

6) The pump will begin dispensing the specified volume of synthetic urine*, and the timer will run until that volume has been absorbed by the diaper. When all of the fluid has been absorbed by the diaper, the Acquisition Time for the volume of synthetic urine added (50ml) will appear on the digital pump.

7) After a 5 minute equilibration time has elapsed, the test cycle will automatically repeat. The test cycle will run the desired number of times so that a specific volume of synthetic urine is applied to the diaper sample.

8) After completing all of the tests, run distilled water through the tubing. Clean the surface of the small probe contacts located inside the base of the top plate tube with a small brush on a daily basis. If the acquisition tester is being used around the clock and it is not possible to rinse the synthetic urine out of the tubing, replace the tubing monthly. Replace the foam base every 3 months to maintain firmness of support.

*: Where a HIPE-derived, collapsable foam is used as the upper storage component, the Jayco synthetic urine and equipment should be equilibrated to a temperature of 87.8°F. Fluid acquistion rates should be measured at this temperature.

What is claimed is:

1. An absorbent article for absorbing body fluids, the absorbent article comprising a fluid pervious topsheet, a backsheet, and an absorbent core positioned between the topsheet and the backsheet, characterized in that the absorbent article exhibits maintained fluid acquisition rates for two successive fluid loads of synthetic urine; and further characterized in that the absorbent article, when considering only the topsheet, backsheet and absorbent core, has a thickness when dry of not more than 0.5 inches.

2. An absorbent article for absorbing body fluids, the absorbent article comprising a fluid pervious topsheet, a backsheet, and an absorbent core positioned between the topsheet and the backsheet; characterized in that the absorbent article exhibits maintained fluid acquisition rates for each of three, preferably four successive fluid loads of synthetic urine; and further characterized in that the absorbent article, when considering only the topsheet, backsheet and absorbent core, has a thickness when dry of not more than 0.5 inches.

3. The absorbent article of Claim 1 or Claim 2, further characterized in that each of the three successive fluid loads is 50 ml of synthetic urine, each of the loads is dispensed into the article at a rate of 10 ml/sec, and a 5 minute equilibration period is provided between each of the successive loads.

4. The absorbent article of Claim 3, wherein the fluid acquisition rate for the first fluid load of 50 ml of synthetic urine is at least 2 ml/sec.

5. An absorbent article for absorbing body fluids, the absorbent article comprising a fluid pervious topsheet, a backsheet, and an absorbent core positioned between the topsheet and the backsheet; characterized in that the absorbent article exhibits increased fluid acquisition rates for two successive fluid loads of synthetic urine.

6. An absorbent article for absorbing body fluids, the absorbent article comprising a fluid pervious topsheet, a backsheet, and an absorbent core positioned between the topsheet and the backsheet; characterized in that the absorbent article exhibits increased fluid acquisition rates for each of three, preferably four, successive fluid loads of synthetic urine.

7. The absorbent article of Claim 5 or Claim 6, characterized in that each of the successive fluid loads is 50 ml of synthetic urine, each of the loads is dispensed into the article at a rate of 10 ml/sec, and a 5 minute equilibration period is provided between each of the successive loads.

8. An absorbent article useful for absorbing discharged aqueous body fluids, the absorbent article comprising:

A) a fluid pervious topsheet;

B) a backsheet;

C) an absorbent between the topsheet and the backsheet, the absorbent core comprising:

(1) at least one upper fluid storage component capable of expanding in the z-direction when contacted with aqueous body fluids to form a fluid acquisition zone, said at least one upper fluid storage component being in direct fluid communication with the topsheet;

(2) a fluid acquisition zone capable of receiving aqueous body fluids, said fluid acquistion zone being at least partially surrounded by said at least one upper fluid storage component and positioned at least partially beneath the fluid discharge region of the absorbent core; and

(3) a fluid acquisition/distribution component capable of acquiring and transporting aqueous body fluids, at least a portion of this fluid acquisition/distribution component being positioned underneath and in fluid communication with said at least one upper fluid storage component, and at least a portion of the fluid acquisition/distribution component being positioned underneath the fluid acquisition zone.

9. The absorbent article of Claim 8 characterized in that the absorbent core comprises two upper fluid storage components in the form of strips that run longitudinally in the absorbent core, further characterized in that the components are laterally spaced apart so as to form the fluid acquistion zone upon contact with aqueous body fluids.

10. The absorbent article of Claim 8 or Claim 9 characterized in that the absorbent core further comprises at least one lower fluid storage component positioned underneath the fluid acquisition/distribution component, the at least one lower fluid storage component being wider than the fluid acquisition zone formed by the laterally spaced apart upper fluid storage components.

11. The absorbent article of Claim 9 or Claim 10, characterized in that the two upper fluid storage components and the lower fluid storage component each comprise from 70 to 100%, by weight of the respective storage component, of hydrogel-forming absorbent polymer; and wherein the fluid acquisition/distribution layer comprises up to 30%, by weight of the acquisition/distribution layer, of hydrogel-forming absorbent polymer.

12. The absorbent article of Claim 9 or Claim 10, characterized in that the upper fluid storage component(s) of the absorbent core comprises a collapsable polymeric foam material derived from a high internal phase water in oil emulsion.

13. The absorbent article of any of Claims 8, 9, 10, 11, or 12, characterized in that the fluid acquisition/distribution layer of the absorbent core comprises chemically stiffened cellulosic fibers, preferably thermally bonded stiffened fibers.

14. An absorbent article capable of absorbing discharged aqueous body fluids, the absorbent article comprising:

A) a fluid pervious topsheet;

B) a backsheet;

C) an absorbent core positioned between the topsheet and the backsheet, the absorbent core comprising:

(1) two upper fluid storage components capable of expanding in the z-direction when contacted with aqueous body fluids positioned in direct fluid communication with the topsheet, the two upper fluid storage components being in the form of strips that run longitudinally in the absorbent core and being spaced apart so as to form a fluid acquistion zone upon contact with aqueous body fluids, and characterized in that both fluid storage components comprise a fluid stable macrostructure of interconnected, hydrogel-forming absorbent polymer particles;

(2) a fluid acquisition zone capable of receiving aqueous body fluids, said fluid acquistion zone being at least partially surrounded by the two upper fluid storage components and positioned at least partially beneath the fluid discharge region of the absorbent core;

(3) a fluid acquisition/distribution component capable of acquiring and transporting aqueous body fluids, at least a portion of this fluid acquisition/distribution component being positioned underneath and in fluid communication with the two upper fluid storage components, and at least a portion of the fluid acquisition/distribution component being positioned underneath the fluid acquisition zone, characterized in that the fluid acquisition/distribution component comprises chemically stiffened cellulosic fibers that are thermally bonded with a thermoplastic material; and

(4) a lower fluid storage component positioned underneath the fluid acquisition/distribution component and in fluid communication therewith, the lower fluid storage component being wider than the fluid acquisition zone, characterized in that the lower fluid storage component comprises a material selected from the group consisting of a fluid stable macrostructure of interconnected, hydrogel-forming absorbent polymer particles and a polymeric foam material.

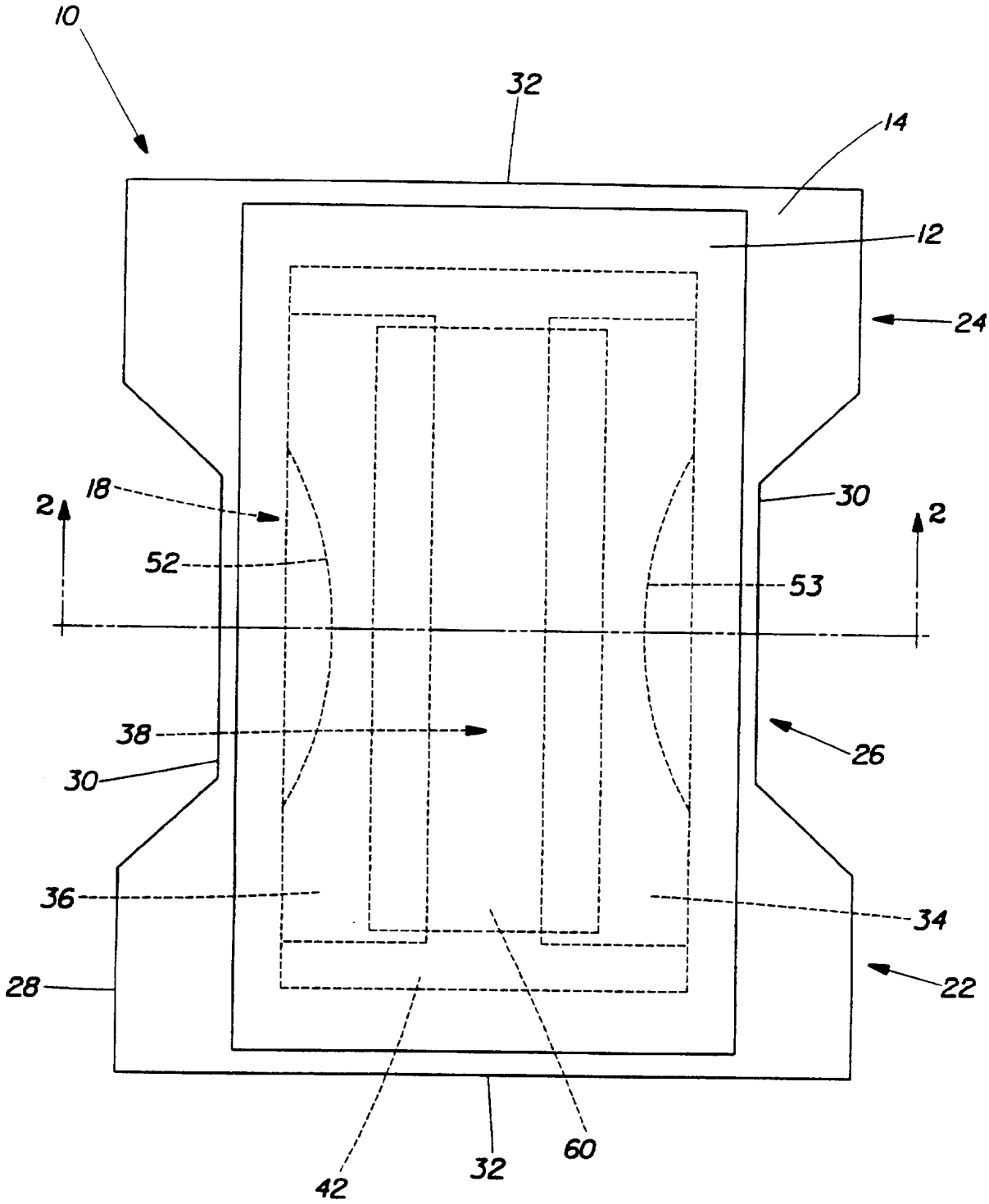


Fig. 1

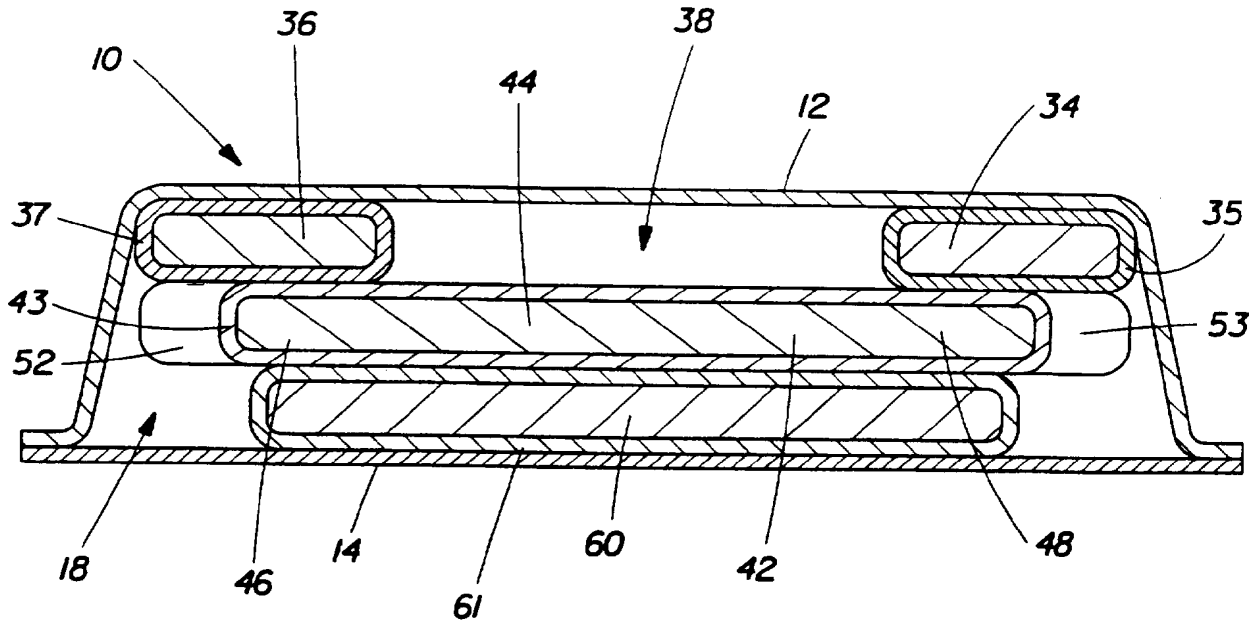

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Fig. 2

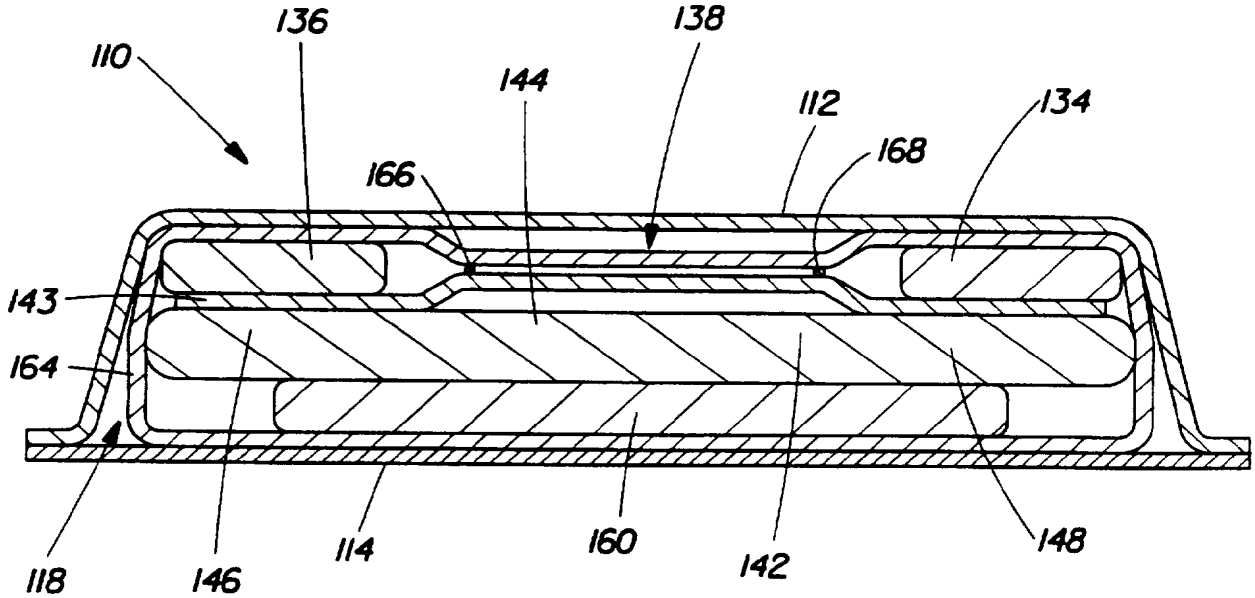

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Fig. 3

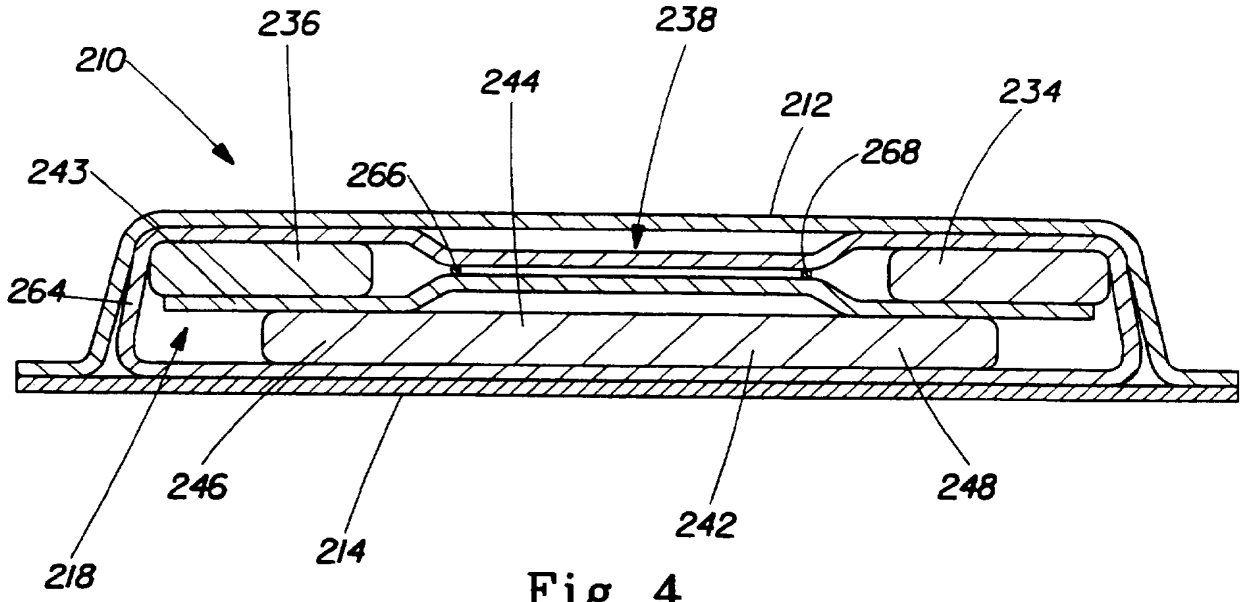

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Fig. 4

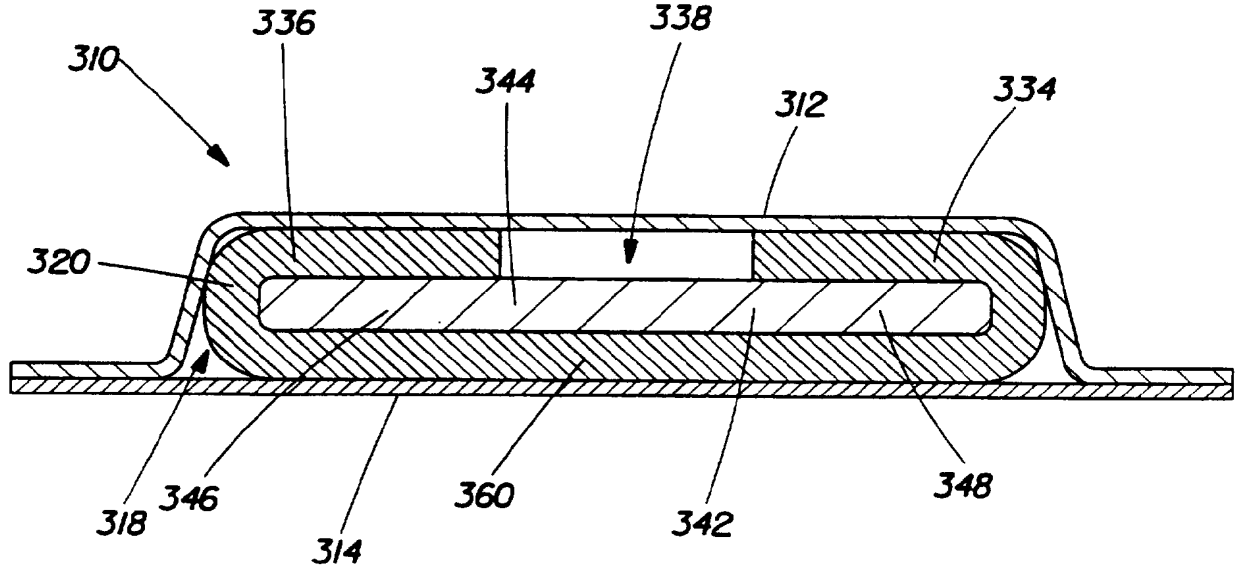

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Fig. 5

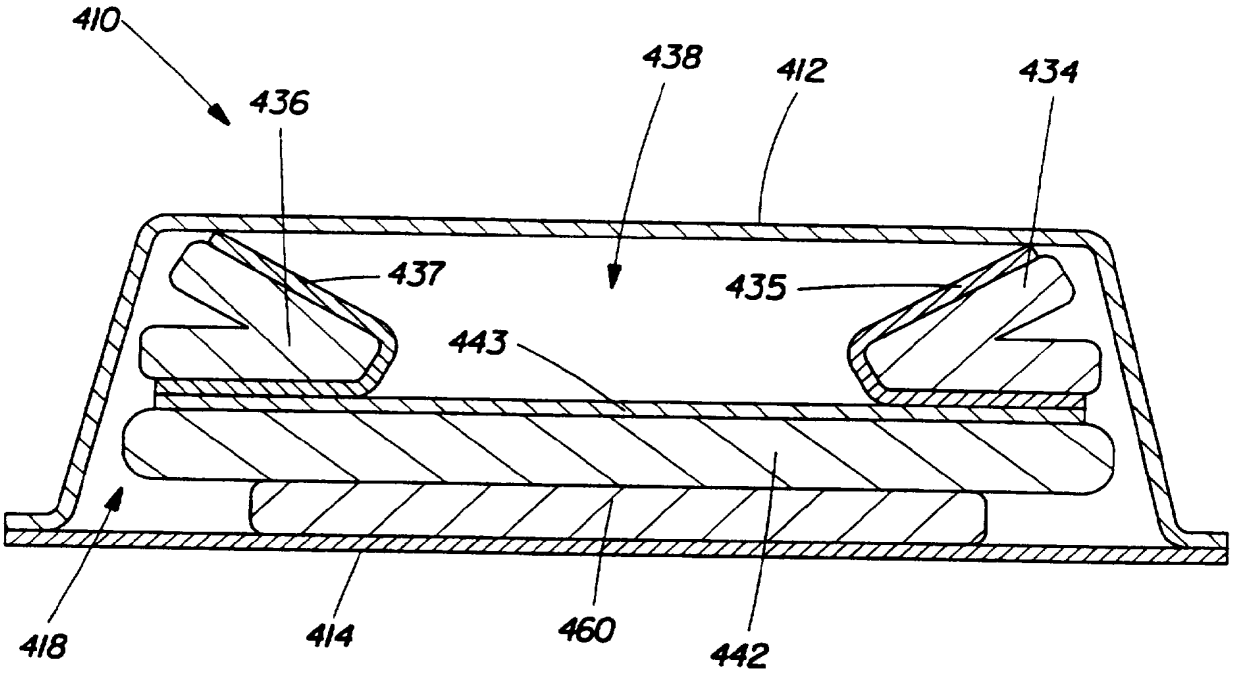


Fig. 6

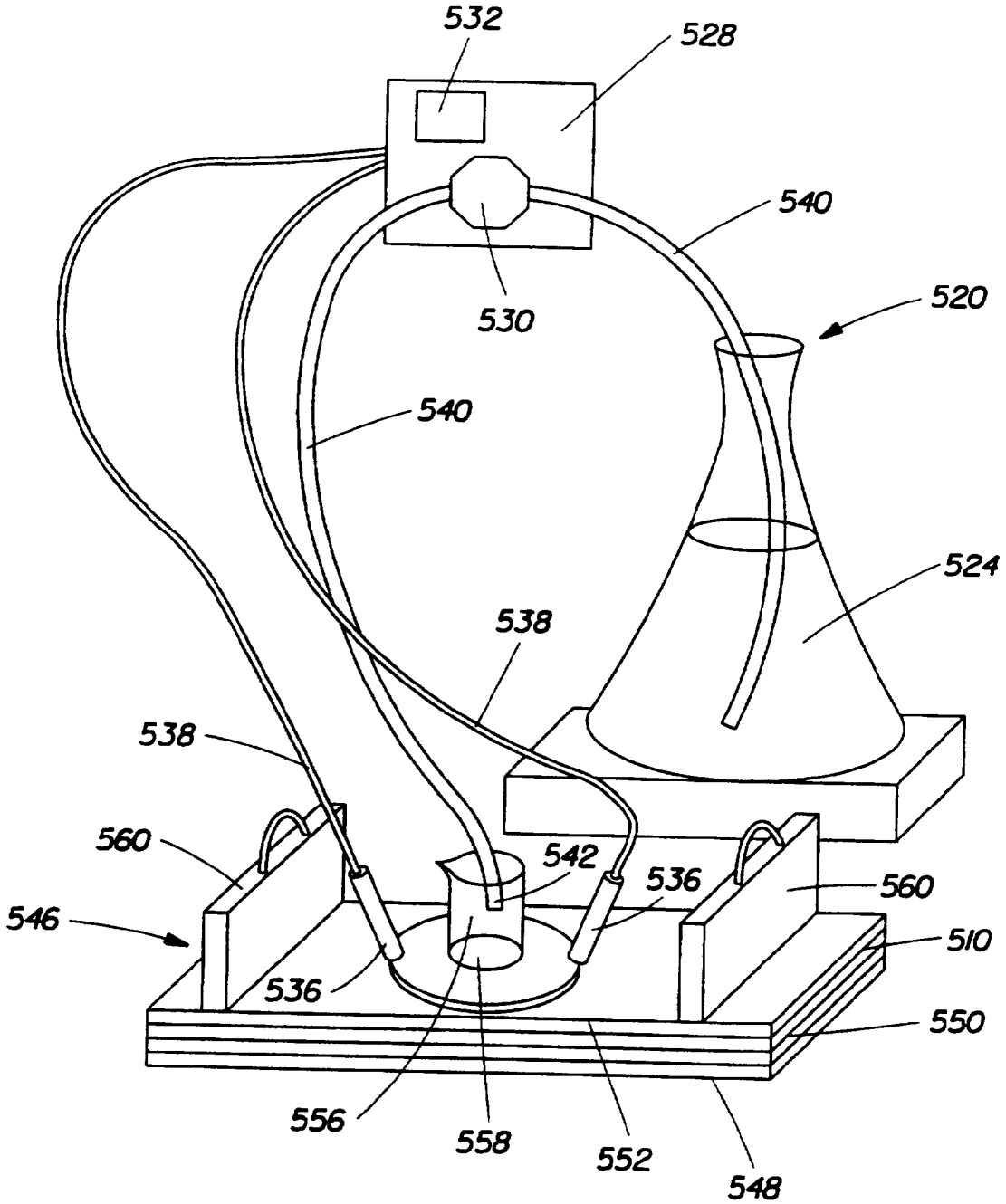

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Fig. 7

INTERNATIONAL SEARCH REPORT

Inten nal Application No PCT/US 97/03287

A. CLASSIFICATION OF SUBJECT MATTER

A 61 F 13/46

According to International Patent Classification (IPC) or to both national classification and IPC 6

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A 61 F, A 61 L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO, A, 92/11 830 (THE PROCTER & GAMBLE COMPANY) 23 July 1992 (23.07.92), claims. --	1-14
A	US, A, 5 318 554 (YOUNG et al.) 07 June 1994 (07.06.94), the whole document. --	1-14
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☐ Further documents are listed in the continuation of box C.

☐ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 July 1997	18.08.97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	BECK e.h.

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ANHANG

zum internationalen Recherchenbericht über die internationale Patentanmeldung Nr.

ANNEX

to the International Search Report to the International Patent Application No.

ANNEXE

au rapport de recherche international relatif à la demande de brevet international n°

PCT/US 97/03287 SAE 157757

In diesem Anhang sind die Mitglieder der Patentfamilien der im obengenannten internationalen Recherchenbericht angeführten Patentdokumente angegeben. Diese Angaben dienen nur zur Unterrichtung und erfolgen ohne Gewähr.

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The Office is in no way liable for these particulars which are given merely for the purpose of information.

La présente annexe indique les membres de la famille de brevets relatifs aux documents de brevets cités dans le rapport de recherche international visée ci-dessus. Les renseignements fournis sont donnés à titre indicatif et n'engagent pas la responsibilité de l'Office.

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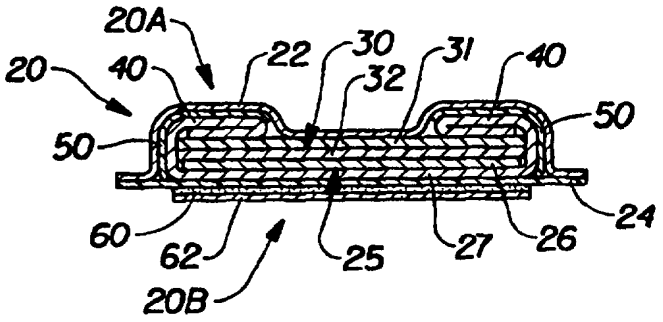
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(57) Abstract

A disposable absorbent article such as an incontinence pad that is both comfortable and suitable for absorbing and containing large volumes of body liquids rapidly without leakage, especially a subsequent gush of liquid. The absorbent article has a pair of end regions, and a central region disposed between the end regions. The central region includes a pair of spaced apart longitudinal side portions and a central portion disposed between the longitudinal side portions. The absorbent article includes a liquid pervious topsheet, a liquid impervious backsheet joined to the topsheet, an absorbent core positioned between the topsheet and backsheet, and an acquisition component positioned between the topsheet and the absorbent core. The acquisition component has a total void volume. The portion of the acquisition component with the central region provides at least about 50 % of the total void volume of the absorbent article. A portion of the absorbent core is folded upon the acquisition component along a first pair of generally parallel longitudinally extending fold lines to form a pair of resilient absorbent members which encapsulate the acquisition component within the longitudinal side portions. The resilient absorbent members are arranged in a longitudinally spaced relation to each other between the acquisition component and the topsheet. The absorbent article has a total absorptive capacity. The central region provides at least about 50 % of the total absorptive capacity and the longitudinal side portions provide at least about 70 % of the central regions absorptive capacity.



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ABSORBENT ARTICLE WITH ACQUISITION ZONE

FIELD OF THE INVENTION

The present invention relates to absorbent articles such as incontinence pads, and more particularly, to absorbent articles which are comfortable yet capable of rapidly accepting and containing large volumes of liquids.

BACKGROUND OF THE INVENTION

There is a growing awareness of the lack of satisfactory products designed for mobile persons with incontinent infirmities. While sanitary napkins, pantiliners, disposable briefs and diapers are available for the mobile incontinent person, such products are not satisfactory from either a comfort or a protection standpoint. Catamenial products such as pantiliners and sanitary napkins are very comfortable to use. However, these products fail to achieve a satisfactory level of containment for high void levels of urine. While diapers and briefs meet the containment needs of the incontinent person, these products lack the comfort and discreteness available from sanitary napkins and pantiliners.

Thus, it is desirable to provide an absorbent article such as an incontinence pad that is comfortable and discrete, yet provides superior protection and containment. In order to achieve the goal of providing such an absorbent article, it is necessary that the absorbent article be capable of rapidly accepting and containing a large volume of liquid within a small surface area; rapidly distributing the liquid efficiently throughout the product; conforming to the body of the wearer; maintaining good body contact (i.e., the maintenance of the absorbent article in close proximity to and in conformity with the body of the wearer); and maintaining its integrity even when wetted so as to be effective to accept and contain a subsequent

discharge or gush of liquid and to prevent rewet (i.e., recontact of liquids contained in the absorbent article with the skin of the wearer due to forces that squeeze the liquid out of the absorbent article).

One of the methods for enhancing the absorptivity of such products is to provide a void space or reservoir that is located near the top surface of the article. Examples of these type of products are disclosed in U. S. Patent 3,364,931 issued January 23, 1968 to W. F. Hirsch; U. S. Patent 4,029,101 issued June 14, 1977 to Chesky et al., and U. S. Patent 4,501,586 issued February 26, 1985 to Holtman. Such articles, while providing some measure of increased ability to accept large volumes of liquid, are often incapable of both effectively accepting a subsequent discharge or gush of liquid and preventing rewet. This is due to the lack of integrity or from retention capacity of the materials after being wetted. Absorbent cores such as those formed of creped wadding or cellulosic fibers have a tendency to split, ball or lump when wetted. They thereby become relatively shapeless and non-form-sustaining. These elements also tend to flatten out and become compacted when subjected to forces. Because an absorbent article is subject to various forces during use, the article will tend to lose its shape when wetted. Thus, it will not conform to the body of the wearer resulting in discomfort for the wearer. In addition, the wetted and compressed absorbent core will have lost its ability to absorb a subsequent discharge or gush of liquid resulting in an increased likelihood of leakage and failure of the product. Further, because the void space or reservoir tends to lose its size and shape, not only is there a decreased ability to contain high volumes, but there is also an increased danger of rewet as the overwrap is no longer spaced away from the absorbent core.

Thus, there is a need to provide an absorbent article wherein the article will retain its shape after being wetted so as both to remain comfortable and to be able to rapidly absorb and contain a subsequent gush of liquid without increasing the likelihood of leakage or rewet. Accordingly, it would be advantageous to provide an absorbent article that retains its shape after being wetted without a loss in comfort or absorbent capacity. It would also be advantageous to provide an article having increased absorption and increased comfort.

Given the geometry of absorbent articles, a width dimension which is smaller than the length dimension, leakage typically occurs along the longitudinal side edges

of the absorbent article as bodily fluid deposited in the center of the absorbent article spreads radially reaching the longitudinal side edges prior to reaching the transverse end edges. Thus, there is a need to provide an absorbent article which reduces the likelihood of side leakage.

Another method for increasing the absorbency of absorbent articles is to provide them with absorbent gelling materials. Absorbent gelling materials are polymeric materials which are capable of absorbing large quantities of liquids and which are further capable of retaining such absorbed liquids under moderate pressures. These absorption characteristics of absorbent gelling materials make such materials especially useful for incorporation into absorbent articles such as incontinence pads.

The effectiveness of absorbent gelling materials in disposable absorbent articles can be quite dependent upon the form, position and/or manner in which the absorbent gelling material is incorporated into the absorbent article. In some cases, for example, the effectiveness of absorbent gelling material absorption in absorbent articles can be adversely affected by a phenomenon called "gel blocking". The term gel blocking describes a situation that occurs when an absorbent gelling material particle, film, fiber, composite, etc. is wetted. Upon wetting, the surface of the absorbent gelling material swells and inhibits liquid transmission to the interior of the absorbent material. Wetting of the interior subsequently takes place via a very slow diffusion process. In practical terms, this means that absorption of liquid by the article is much slower than discharge of liquid to be absorbed, and failure of the absorbent article may take place well before the absorbent gelling material in the absorbent article is fully saturated.

Thus, there is a continuing need to identify absorbent gelling material containing absorbent articles wherein the absorbent gelling material is especially effective and efficient in performing its intended function of holding discharged body liquids without interfering with the acquisition and distribution of body liquids by and within the article. Absorbent gelling materials are generally significantly more expensive than readily available absorbent fiber materials (e.g. cellulose fibers). Accordingly it would be advantageous to provide articles wherein either absorbent capacity of the absorbent gelling material-containing article can be improved or wherein a given absorbent capacity of an article can be maintained

while efficiently utilizing the relatively expensive absorbent gelling material. It would also be advantageous to provide articles wherein the liquid-storing absorbent gelling material does not adversely affect the ability of the absorbent article to quickly acquire discharged body liquids.

Therefore, it is an object of the present invention to provide an absorbent article which is able to rapidly accept and contain a large void of body liquids without leakage.

It is another object of the present invention to provide an absorbent article having improved comfort in both the wet and dry state for the wearer.

It is another object of the present invention to provide an absorbent article which reduces the incidence of side leakage.

These and other objects of the invention will be more readily apparent when considered and referenced to the following description and when taken in conjunction with the accompanying drawings.

SUMMARY OF THE INVENTION

The present invention provides a disposable absorbent article such as an incontinence pad that is both comfortable and suitable for absorbing and containing large volumes of body liquids rapidly without leakage, especially a subsequent gush of liquid. The absorbent articles of the present invention have a pair of end regions, and a central region disposed between the end regions. The central region comprises a pair of spaced apart longitudinal side portions and a central portion disposed between the longitudinal side portions. The absorbent article comprises a liquid pervious topsheet, and a liquid impervious backsheet joined with the topsheet. An acquisition component is positioned between the topsheet and the backsheet. The acquisition component has a total void volume. The portion of the acquisition component with the central region provides at least about 50% of the total void volume of the absorbent article. An absorbent core is positioned between the acquisition component and the backsheet. A portion of the absorbent core is folded upon the acquisition component along a first pair of generally parallel longitudinally extending fold lines to form a pair of resilient absorbent members which encapsulate

the acquisition component within the longitudinal side portions. The resilient absorbent members are arranged in a longitudinally spaced relation to each other between the acquisition component and the topsheet. The absorbent article has a total absorptive capacity. The central region provides at least about 50% of the total absorptive capacity. The longitudinal side portions provide at least about 70% of the central regions absorptive capacity.

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 descriptions which are 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 an incontinence pad of the present invention having portions cut away to reveal the underlying structure;

FIG. 2 is a cross-sectional view of the incontinence pad of the present invention taken along section line 2-2 of Figure 1;

FIG. 3 is a simplified plan view depicting the various regions and portions of the incontinence pad of the present invention;

FIG. 4 is a plan view of the absorbent core shown in its pre-folded condition;

FIG. 5 is a plan view of another embodiment of an incontinence pad of the present invention;

FIG. 6 is a cross-sectional view of another embodiment of an incontinence pad of the present invention; and

FIG. 7 is a sectional view of the incontinence pad of Figure 1 showing the separation of the absorbent core from the acquisition component.

DETAILED DESCRIPTION OF THE INVENTION

As used herein, the term "disposable absorbent article" refers to articles which absorb and contain body liquids and more specifically refers to articles which are placed against or in proximity to the body of the wearer to absorb and contain the various liquids discharged from the body, and which are intended to be discarded after a single use (i.e., they are not intended to be laundered or otherwise restored and reused). A preferred embodiment of the disposable absorbent article of the present invention, incontinence pad 20, is shown in Figure 1 and in cross-sectional view in Figure 2. As used herein, the term "incontinence pad" refers to a garment generally worn by incontinent persons by adhesively attaching the pad directly to the crotch region of the wearer's undergarment. It should be understood, however, that the present invention is also applicable to other disposable absorbent articles such as incontinence briefs, diapers, sanitary napkins, and the like.

Figure 1 is a plan view of the incontinence pad 20 of the present invention with portions of the structure being cut away to more clearly show the construction of the incontinence pad 20 and with the portion of the incontinence pad 20 which faces or contacts the wearer, oriented towards the viewer. As shown in Figure 1, the incontinence pad 20 preferably comprises a liquid pervious topsheet 22, a liquid impervious backsheet 24 joined with the topsheet 22, an absorbent core 25 positioned between the topsheet 22 and the backsheet 24, an acquisition component 30 positioned between the topsheet 22 and the absorbent core 25, and a pair of resilient absorbent members 40 disposed one on each side of the incontinence pad 20 in a spaced relation to one another between the topsheet 22 and the acquisition component 30, and a rewet barrier 50 positioned between the resilient absorbent members 40 and the topsheet 22.

As shown in Figure 2, the absorbent core 25 comprises two distinct layers 26 and 27, respectively. The acquisition component 30, as shown in Figure 2, comprises two distinct layers 31 and 32, respectively. The rewet barriers 50 cover portions of each of the resilient absorbent members 40 to provide a barrier in order to contain liquids within the incontinence pad 20. Secured along the bottom of the incontinence pad 20 on the backsheet 24 is an adhesive attachment means 60 that is covered by a removable release liner 62.

It should be understood for the purposes of this invention that the term "layers" does not necessarily limit the invention to single layers or sheets of material. Thus, each of the layers may actually comprise laminates for combinations of several sheets or webs of the requisite type of the materials as hereinafter described. Thus, as used herein, the term "layer" includes the terms "layers" and "layered".

Figure 3 shows a simplified plan view of the incontinence pad 20 of Figure 1 depicting the various regions and portions of the incontinence pad 20 and their positioning with respect to each other. The incontinence pad 20 comprises a pair of end regions 100 and a central or insult accepting region 102. The central region 102 is disposed between the respective end regions 100. The end regions 100 extend longitudinally outwardly from the central region 102 to form portions of the end edges 108.

While in Figure 3 the central or insult accepting region 102 is shown to be positioned in the center of the incontinence pad 20, the exact location of the insult accepting region 102 is not critical to the performance of the incontinence pad 20. For example, in some embodiments the insult accepting region 102 may be positioned near one of the end edges of the incontinence pad 20. Referring now to Figure 5, the incontinence pad 200 comprises a pair of end regions 202 and a central or insult accepting region 204. The central or insult accepting region 204 comprises a pair of longitudinal side portions 206 and a central portion 208. The central region 204 is disposed between the respective end regions 202. The end regions 202 extend longitudinally outwardly from the central region 204. Alternatively, the central region 204 may be positioned such that it forms a portion of one of the end edges of the incontinence pad.

Referring again to Figure 3, the central region 102 preferably comprises from at least about one-fourth to about two-thirds of the total longitudinal length of the incontinence pad 20. Most preferably, the central region 102 comprises about one-third of the total longitudinal length of the incontinence pad 20.

The central region 102 comprises a pair of spaced apart longitudinal side portions 104 and a central portion 106 disposed between the longitudinal side

portions 104. The longitudinal side portions 104 extend laterally outwardly from the central portion 106 to form portions of the longitudinal side edges 110.

Preferably, each longitudinal side portion 104 comprises from at least about one-eighth to about one-third of the total transverse width of the central region 102. Most preferably, each longitudinal side portion 104 comprises about one-fourth of the total transverse width of the central region 102.

The transverse width of the central portion 106 is critical to the rapid acquisition characteristics of the incontinence pad 20. If the width of the central portion 106 is too small, the incontinence pad 20 will be unable to rapidly collect and contain large gushes of liquid. Preferably, the central portion 106 comprises from at least about one-third to about three-fourths of the total transverse width of the central region 102. Most preferably, the central portion 106 comprises about one-half of the total transverse width of the central region 102.

Referring again to Figures 1 and 2, the incontinence pad 20 has two surfaces, a body-contacting surface or body facing surface 20A and a garment facing surface 20B. The incontinence pad 20 is shown in Figure 1 as viewed from its body facing surface 20A. The body facing surface 20A is intended to be worn adjacent to the body of the wearer while the garment facing surface 20B is on the opposite side and is intended to be placed adjacent to the wearer's undergarments when the incontinence pad 20 is worn.

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

The topsheet 22 is compliant, soft feeling and non-irritating to the wearer's skin. Further, the topsheet 22 is liquid pervious permitting liquids (e.g., menses and/or urine) to readily penetrate through its thickness. A suitable topsheet 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 film; porous foams; reticulated foams; reticulated thermoplastic film; 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, polyethylene fibers or bicomponent fibers) or from a combination of natural and synthetic fibers. A preferred topsheet comprises an apertured formed film. Apertured formed films are preferred for topsheets 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 issued to Thompson on December 30, 1975; U.S. Pat. No. 4,324,246 issued to Mullane et al. on April 13, 1982; U.S. Pat. No. 4,342,314 issued to Radel et al. on August 3, 1982; U.S. Pat. No. 4,463,045 issued to Ahr on July 31, 1984; and U.S. Pat. No. 5,006,394 issued to Baird on April 9, 1991. Each of these patents are incorporated herein by reference. A preferred topsheet for the present invention is the formed film described in one or more of the above patents and marketed on sanitary napkins by The Procter & Gamble Company of Cincinnati, Ohio as "DRI-WEAVE".

In a preferred embodiment of the present invention, the body facing surface of the formed film topsheet is hydrophilic so as to help liquid to transfer through the topsheet faster than if the body facing surface was not hydrophilic so as to diminish the likelihood that bodily fluid will flow off of the topsheet rather than flowing into and being absorbed by the absorbent core. In a preferred embodiment, surfactant is incorporated into the polymeric materials of the formed film topsheet such as is described in U.S. Pat. Application Serial No. 07/794,745, "Absorbent Article Having A Nonwoven And Apertured Film Coversheet" filed on November 19, 1991 by Aziz et al., which is incorporated herein by reference. Alternatively, the body facing surface of the topsheet can be made hydrophilic by treating it with a surfactant such as described in U.S. Pat. No. 4,950,264 issued to Osborn on August 21, 1990, incorporated herein by reference.

Another suitable topsheet is a composite or "hybrid" topsheet structure. The

hybrid topsheet generally comprises a longitudinally oriented central zone and longitudinal side regions located laterally outboard of the central zone. The hybrid topsheet structure preferably comprises an apertured thermoplastic film in the central zone of the hybrid topsheet structure and a less plastic-like outer covering that forms the longitudinal side portions. Such a topsheet is useful for improving the skin feel and comfort of the topsheet made of apertured plastic film. In particular, such a topsheet reduces the tendency for apertured plastic films to feel hot, sweaty and sticky. This is especially useful in the case of larger absorbent articles wherein there is a large portion of the topsheet which is in contact with the wearer's body. Hybrid topsheet structures are described generally in PCT Publication No. 93/09744 assigned to The Procter & Gamble Company which published May 27, 1993, in the name of Sugahara et al., which is incorporated herein by reference.

Another suitable topsheet comprises an upper layer constituted by a nonwoven textile of synthetic fibers, an intermediate layer constituted by a film material and a lower layer constituted by a nonwoven layer of textile of synthetic fibers. An example of such a topsheet is described in U.S. Pat. No. 4,780,352 issued to Palumbo on October 25, 1988, which is incorporated herein by reference.

The backsheet 24 is impervious to liquids (e.g., menses and/or 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 contrast of the human body. The backsheet 24 prevents the exudates absorbed and contained in the absorbent core from wetting articles which contact the incontinence pad 20 such as pants, pajamas, and underpants. The backsheet 24 may thus comprise a woven or nonwoven material, polymeric films such as thermoplastic films of polyethylene or polypropylene, or composite materials such as a film-coated nonwoven material. Preferably, the backsheet 24 is a polyethylene film having a thickness of from about 0.012 mm (0.5 mil) to about 0.051 mm (2.0 mils). Exemplary polyethylene films are manufactured by Clopay Corporation of Cincinnati, Ohio, under the designation P18-0401 and by Tredegar Corporation, of Terre Haute, Indiana, under the designation XP-39385. The backsheet is preferably embossed and/or matte finish to provide a more cloth-like appearance. Further, the backsheet 24 may permit vapors to escape from the absorbent core (i.e., breathable), while still preventing exudates from passing through the backsheet 24.

The backsheet 24 and the topsheet 22 are preferably joined to each other and other components or layers of the incontinence pad 20 by attachment means (not shown) such as those well known in the art. For example, the backsheet 24 and/or the topsheet 22 may be secured to each other or to other components 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, Minnesota under the designation HL-1258 or H-2031. The attachment means will preferably comprise an open pattern network of filaments of adhesives as is disclosed in U.S. Pat. No. 4,573,986 issued to Minetola et al. on March 4, 1986, and which is incorporated herein by reference. An exemplary attachment means of an open patterned network of filaments comprises several lines of adhesive filaments swirled into a spiral pattern such as illustrated by the apparatus and method shown in U.S. Pat. No. 3,911,173 issued to Sprague, Jr. on October 7, 1975; U.S. Pat. No. 4,785,996 issued to Zieker et al. on November 22, 1978; and U.S. Pat. No. 4,842,666 issued to Werenicz on June 7, 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.

The acquisition component 30 serves several functions including accepting a high rate of fluid intake, serving as a temporary reservoir for the fluid, efficiently transporting fluids over and into the absorbent core, and draining substantially completely into the absorbent core in order to remain empty for subsequent fluid loadings. There are several reasons why efficiently transporting bodily fluids is important, including providing a more even distribution of bodily fluids throughout the absorbent core. The transportation referred to herein may encompass the transportation of liquids in one, two, or all directions (i.e., in the X-Y plane and/or in the Z-direction). In addition, the acquisition component 30 must resist collapse when wet so that it maintains its performance through multiple loadings. The acquisition component also preferably provides a resilient form retaining member within the interior of the incontinence pad 20. The acquisition component also allows liquid contact with large surface areas with the underlying absorbent core. This element preferably does all these things while also remaining thin.

The acquisition component 30 serves to drain liquids through the topsheet and provide void volume so that the underlying absorbent core (which has high storage capacity, but relatively slow rate of absorbency) will have time to absorb bodily fluids deposited thereon. Furthermore, since the point of insult typically occurs within the central region 102 of the incontinence pad 20, it is important that the portion of the acquisition component 30 located within the central region 102 provide sufficient void volume to handle and distribute repeated gushes of liquid. Since the point of insult typically does not occur within the end regions 100, the requirements for void volume in the end regions 100 is not as stringent as that required of the central region 102. Thus, the acquisition component within the central region 102 preferably provides from at least about 50% to about 100% of the total void volume of the acquisition component 30, more preferably from at least about 60% to about 80%, with 70% being the most preferred.

As shown in Figures 1 and 2, the acquisition component 30 comprises two distinct layers 31 and 32. Each layer 31 and 32 can be of any desired shape. Suitable shapes include for example, circular, rectangular, triangular, trapezoidal, oblong, dog-boned, hourglass, oval, asymmetric, etc. In the embodiment shown in Figures 1 and 2, the acquisition layer 31 has an hourglass shape and the acquisition layer 32 has a rectangular shape.

The uppermost acquisition layer 31 preferably has a longitudinal length at least equal to that of the central region 102. The uppermost acquisition layer 31 may have a longitudinal length greater than that of the central region 102 such that the uppermost acquisition layer 31 extends into the end regions 100 of the incontinence pad 20. The acquisition layer 31 preferably has a transverse width at least equal to that of the central portion 106. The uppermost acquisition layer 31 may have a transverse width greater than that of the central portion 106 such that the uppermost acquisition layer 31 extends into the longitudinal side regions 104 of the incontinence pad 20.

The lowermost acquisition layer 32 preferably has a longitudinal length at least equal to that of the central region 102. The lowermost acquisition layer 32 may have a longitudinal length greater than that of the central region 102 such that the lowermost acquisition layer 32 extends into the end regions 100 of the incontinence

pad 20. The lowermost acquisition layer 32 preferably has a transverse width at least equal to that of the central portion 106. The lowermost acquisition layer 32 may have a transverse width greater than that of the central portion 106 such that the lowermost acquisition layer 32 extends into the longitudinal side regions 104 of the incontinence pad 20.

The uppermost acquisition layer 31 is shown in Figure 1 to have a longitudinal length greater than that of the lowermost acquisition layer 32. Alternatively, the uppermost acquisition layer 31 may have a longitudinal length less than or equal to that of the lowermost acquisition layer 32.

In the embodiment shown in Figure 2, the acquisition component 30 comprises two acquisition layers 31 and 32, respectively. Alternatively, the acquisition component 30 may comprise a single layer or multiple layers, for example, three, four, five or more layers.

The acquisition components may be comprised of several different materials including nonwoven or woven webs of synthetic fibers including polyester, polypropylene, or polyethylene; natural fibers including cotton or cellulose; blends of such fibers; or any equivalent materials or combinations of materials. Suitable nonwoven webs include bonded carded webs, spunbonded webs, meltblown webs, spunlaced webs, stitch-bonded webs, and thermally bonded air laid webs. The acquisition component may be joined with the topsheet, each other, and the absorbent core by any conventional means for joining webs together such as adhesives, 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.

If the acquisition component is a nonwoven web, the nonwoven web may be a spunbonded web, a meltblown web, a bonded carded web, a spunlaced web, a stitch-bonded web, or a thermally bonded air laid web. The nonwoven web may be made of fiber forming polymers such as, for example, polyesters, polyamines, and polyolefins. Exemplary polyolefins include one or more of polypropylene, polyethylene, ethylene copolymers, propylene copolymers, and butene copolymers. In another embodiment, the acquisition component may be multi-layer material having, for example, at least one layer of a spun bonded web joined to at least one

layer of a meltblown web, a bonded carded web, a thermally bonded air laid web, or other suitable material. Alternatively, the nonwoven layer may be a single layer of material such as, for example, a spunbonded web or a meltblown web. The nonwoven web may also be a composite made up of a mixture of two or more different fibers or a mixture of fibers and particles. Such mixtures may be formed by adding fibers and/or particulates to the gas stream in which the meltblown fibers or spunbonded fibers are carried so that an intimate entangled commingling of fibers and other materials, e.g., wood pulp, staple fibers, superabsorbent materials, and particles corresponding to the collection of the fibers. In another preferred embodiment, the nonwoven web may be comprised of bicomponent fibers. The bicomponent fibers preferably are a thermal bondable bicomponent fiber having an inner core component and an outer sheath component where the inner core component has a higher melting point than the outer sheath component. The ability of the sheath to melt during thermal bonding gives the fiber a heat feasible characteristic. The fiber itself is typically hydrophobic, but can be made hydrophilic by incorporating a surfactant into the sheath of the bicomponent fiber and/or by treating the external surface of the sheath with a surfactant. Exemplary bicomponent fibers and processes for producing the same are described in European Patent Application No. 0 340 763, published November 8, 1989 in the name of Hansen et al. Exemplary acquisition layers having bicomponent fibers are described in U.S. Pat. No. 5,231,122 issued to Palumbo et al. on July 27, 1983; and in International Publication No. WO 94/28838, published December 22, 1994 in the name of Palumbo, et al., each of which is incorporated herein by reference.

The fibrous acquisition component may comprise a composite of bicomponent fibers and other fibers such as rayon, monocomponent synthetic fibers, and tricomponent synthetic fibers. For example the acquisition component may comprise a blend of 75% bicomponent fibers and 25% rayon fibers. Other suitable blends of bicomponent fibers and rayon fibers may also be used. The fibrous acquisition component should also have an operable level of density and basis weight to rapidly acquire and then drain liquid surges into the underlying absorbent core, thus remaining relatively empty to receive subsequent liquid surges. The fibrous acquisition component should have sufficient void volume capacity to temporarily retain the amount of liquids that is typically discharged by a wearer during a surge of liquid into the incontinence pad. Insufficient void volume capacity may result in excessive pooling of liquid against the wearer's skin or excessive run-

off of liquid.

The basis weight of the acquisition component is preferably within the range of from about 10 g/m^2 to about 300 g/m^2, more preferably from about 20 g/m^2 to about 200 g/m^2, and most preferably from about 30 g/m^2 to about 80 g/m^2. The fibrous acquisition component has a thickness of from about 1 mm to about 10 mm, more preferably from about 1.5 mm to about 6 mm, still more preferably from about 1.7 mm to about 4.5 mm, and more preferably from about 2 mm to about 4 mm, as measured under a pressure of 2 kPa.

The fibrous acquisition component has a bulkiness of from about 10 cm^3/g to about 100 cm^3/g, more preferably a bulk mass of from about 15 cm^3/g to about 65 cm^3/g, still more preferably from about 20 cm^3/g to about 60 cm^3/g, and more preferably from about 25 cm^3/g to about 55 cm^3/g.

The absorbent structure 25 for the incontinence pad 20 is shown in greater detail in Figure 4 in its flat out pre-folded configuration. The absorbent core 25 of the preferred embodiment comprises two components or layers 26 and 27. The individual layers 26 and 27 may be comprised of the same absorbent material or may be tailored and comprised of different absorbent materials. In addition, the absorbent core 25 may comprise a single component or layer.

In a preferred embodiment the lower absorbent layer 27 comprises a resilient absorbent material. A suitable resilient absorbent material is a high capacity Thermally Bonded Air Laid (TBAL), nonwoven material fabricated from a blend of cellulose fibers, bicomponent fibers, and absorbent gelling material particles. The TBAL material obtained from Walkisoft of Aarhus, Denmark, preferably comprises a homogeneous blend of about 30% flint river fluff (cellulose), 60% Nalco 1180 absorbent gelling material particles obtained from Nalcoa of Naperville, IL, and 10% Danaklon ES-C 3.3 DTEX X 6 MM bicomponent fibers obtained from Danaklon of Varde, Denmark. The TBAL material is formed into a web having a basis weight of about 350 g/m^2, and a caliper of about 2.7 mm measured under a load of about 0.1 psi. Other suitable resilient absorbent materials for the lower absorbent layer 27 include but are not limited to absorbent foams, and absorbent sponges.

As shown in Figure 4, the absorbent components 26 and 27 are shown to form

a cross-like shape prior to folding. Alternatively, a single absorbent component or layer may be formed into a cross-like shape similar to that shown in Figure 4. In Figure 4, the absorbent layer 26 is shown to be positioned on top of the absorbent layer 27. However, these may be reversed wherein the absorbent layer 27 is placed on top of the absorbent layer 26. The underlying absorbent layer 27 is preferably folded along a series of generally parallel longitudinally extending fold lines 70, 71 and 72, to form a pair of resilient absorbent members 40 disposed in the longitudinal side portions 104. The resilient absorbent members 40 disposed in the longitudinal side portions 104 are arranged in a longitudinally spaced relation to each other between the acquisition component 30 and the topsheet 22. As shown in Figure 2, the absorbent layer 27 is folded along the generally parallel longitudinally extending fold lines 70, 71, and 72 such that it encapsulates the acquisition component 30 within the longitudinal side portions 104 to form resilient absorbent members 40 which are disposed alongside and on top of the acquisition component 30.

Preferably, the resilient absorbent members 40 are contained solely within the longitudinal side portions 104. This allows the bulk of the absorbent material to be concentrated in the side portions 104 of the incontinence pad 20. As mentioned above, this becomes important as the point of insult typically occurs in the central region 102 and spreads radially therefrom. Since the incontinence pad 20 is typically narrower in width or has a width dimension smaller than its length dimension bodily fluid deposited upon the incontinence pad 20 typically reaches the side or longitudinal edges 110 prior to reaching the end edges 108. Therefore, it is important to have additional capacity in the side portions 104 since there is no where else for the fluid to transmit.

In contrast to other prior art absorbent structures, the blended structure of the resilient absorbent members of the present invention resists collapse when wetted via the inclusion of the bicomponent fibers and the absorbent gelling material particles. Thus, the resilient absorbent members 40 retain their shape when wetted thus forming a seal between the user and the absorbent pad to thereby prevent side leakage or leakage of urine along the longitudinal side edges 110 of the incontinence pad 20.

Since most of the liquid insult is concentrated in the central region 102 it is important that the central region 102 provide at least about 50% of the total

absorptive capacity of the incontinence pad 20. In addition, it is important that the longitudinal side portions 104 provide at least about 60% of the central regions 102 absorptive capacity. This configuration allows the incontinence pad 20 to have sufficient capacity within the side portions 104 permitting the acquisition component 30 to fully drain into the resilient absorbent members 40 located within the longitudinal side portions 104. Other executions are suitable wherein the central region 102 provides at least about 60%, more preferably at least about 70%, and most preferably about 80% of the total absorptive capacity of the incontinence pad 20. In addition, in preferred embodiments the longitudinal side portions 104 provide at least about 70% of the central region's absorptive capacity, more preferably about 80%, and most preferably at least about 90% of the central region's total absorptive capacity.

The resilient absorbent members 40 provide an improved incontinence pad design having raised side portions which are pressed up against the skin area around the perineal area by the wearer's undergarment thereby forming a gasketing effect leading to close body contact between the wearer and the incontinence pad 20. Liquid is thereby directed toward the middle of the incontinence pad 20 into the acquisition component 30. Preferably, the resilient absorbent members 40 have a height as measured from acquisition component of at least about 1 mm, preferably, the resilient absorbent members 40 have a height of from about 2 mm to about 3 mm. However, if the resilient absorbent members 40 are too high they may be uncomfortable for the wearer.

In addition to the gasketing effect mentioned above, the resilient absorbent members 40 also provide an improved gasketing effect after the incontinence pad 20 has been subjected to liquid insult. Upon wetting the absorbent gelling material particles within the resilient absorbent members 40 swell thereby causing the resilient absorbent members 40 to expand. This expansion of the resilient absorbent members 40 presses them into closer contact with the wearer's skin thereby improving the gasketing effect of the incontinence pad 20.

In addition, because the properties of the resilient absorbent members 40 in retaining their shape and acquisition characteristics even when wet, the incontinence pad 20 is capable of acquiring a subsequent gush of liquid without increased likelihood of leakage. Because of its physical properties, the resilient absorbent

members 40 also enhance the comfort perceived by the wearer. The resilient absorbent members 40 mainly serve as a storage reservoir in the side regions of the absorbent pad for containing bodily liquids.

The resilient absorbent members 40 of the present invention may be formed in a number of ways. As is shown in Figure 2, the material forming the resilient absorbent members 40 may be folded one layer on top of another to provide the resilient absorbent member 40 with sufficient height. Alternatively, the resilient absorbent members may be formed by rolling the absorbent material into a tubular configuration.

In a preferred embodiment the absorbent layer 26 also comprises a high capacity TBAL nonwoven material fabricated from a blend of cellulose fibers, bicomponent fibers, and absorbent gelling material particles. The TBAL material obtained from Walkisoft of Aarhus, Denmark, preferably comprises a homogeneous blend of about 30% flint river fluff (cellulose), 60% Nalco 1180 absorbent gelling material particles obtained from Nalcoa of Naperville, IL, and 10% Danaklon ES-C 3.3 DTEX X 6 MM bicomponent fibers obtained from Danaklon of Varde, Denmark. The TBAL material is formed into a web having a basis weight of about 350 g/m^2, and a caliper of about 2.7 mm measured under a load of about 0.1 psi.

Since the function of the upper absorbent layer 26, (i.e., to absorb bodily fluids), is different from the lower absorbent layer 27, (i.e., to absorb bodily fluids while providing a resilient structure which can be folded to form the resilient absorbent members 40), the absorbent layer 26 need not be comprised of a resilient material. The absorbent layer 26 may be any absorbent means which is capable of absorbing or retaining liquids (e.g., urine). The absorbent layer 26 may be manufactured from a wide variety of liquid-absorbent materials commonly used in incontinence pads 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; synthetic fibers such as crimped polyester fibers; peat moss; tissue including tissue wraps and tissue laminates; absorbent foams; absorbent sponges; superabsorbent polymers; absorbent gelling materials; or any equivalent material or combinations of materials, or mixtures of these. The configuration and construction of the absorbent layer may

also be varied (e.g., the absorbent core may have varying caliper zones (e.g., profiled so as to be thicker in the center) hydrophilic gradients, superabsorbent gradients, or lower density and lower average basis weight acquisition zones; or may comprise one or more layers or structures). The total absorbent capacity of the absorbent layer should, however, be compatible with the desired loading and the intended use.

Exemplary absorbent structures for use as the absorbent layer 26 are described in U.S. Pat. No. 4,950,264 issued to Osborn on August 21, 1990; U.S. Pat. No. 4,610,678 issued to Weisman et al. on September 9, 1986; U.S. Pat. No. 4,834,735 issued to Alemany et al. on May 30, 1989; European Patent Application No. 0 198 683, The Procter & Gamble Company, published October 22, 1986 in the name of Duenk, et al.; International Publication No. WO 94/28838, published December 22, 1994 in the name of Palumbo, et al.; and International Publication No. WO 94/01069, published January 20, 1994 in the name of Palumbo, et al. Each of these patents are incorporated herein by reference.

To allow liquids to rapidly flow into the acquisition component 30 of the incontinence pad 20, the resilient members 40 must be in a spaced relation to each other. As shown in Figures 1 and 2, the resilient absorbent members 40 are in a longitudinal spaced relation to each other and are located each respectively within the longitudinal side portions 104. (A longitudinal spaced relation is defined as placing the elements lengthwise along the side of the pad so that there is a transverse width dimension separating the elements.) While the resilient absorbent members 40 may be arranged in a number of different ways, a longitudinal spacing arrangement is preferred.

In order to provide an incontinence pad 20 capable of being both comfortable and protective, the resilient absorbent members 40 should be compressible, conformable, and resilient. That is to say, the resilient absorbent members 40 must possess such physical properties so that the forces applied by the action of the wearer will readily cause them to bend, to compress and to conform to a space available for them as the incontinence pad 20 is held adjacent the wearer's body. The resilient absorbent members 40 must be resilient so that each must, without the application of external forces, return to essentially its original size and shape of after the forming forces are removed. Preferably, the material used in the manufacturing the resilient absorbent members 40 possess such a resilience that it will recover at

least about 80% of its original volume after it is compressed to about 20% of its original volume when the compressing forces are removed. Most preferably, the material will recover at least about 90% of its original volume after it is compressed about 50% of its original volume when the compressing forces are removed.

Because the incontinence pad 20 is designed to retain its shape during use, the resilient absorbent members 40 must also be essentially unaffected by the presence of liquids such as urine. The resilient absorbent members 40 must retain sufficient inherent resiliency, even when wet, to impart to the elements sufficient elasticity to resist close packing of the fibers thereof and the retention of the characteristics of the three-dimensional structure during use so that the incontinence pad 20 will retain its shape during subsequent gushes.

Because the absorbent gelling material-containing resilient absorbent members 40 require sufficient void volume to rapidly contain large quantities of liquids, it is desirable that the acquisition component be able to contain acceptable quantities of liquid. The acquisition component 30 should, therefore, be manufactured of a material of relatively low density such that it has sufficient void volume in the interstices or capillaries between fibers to contain practical quantities of urine.

In the embodiment shown in Figure 4, the absorbent core comprises two separate absorptive members 26 and 27. Alternatively, a single material may be used to form the absorbent core. In addition, multiple layers of material, for example, three, four, five or more layer may be used to form the absorbent core.

In the embodiment shown in Figure 2, the absorbent layer 27 is shown to be folded to provide the resilient absorbent members 40 with two layers of material within the longitudinal side portions 104. Alternatively, the folding sequence can be altered such that the absorbent material 27 provides a single layer in the longitudinal side portions 104 or multiple layers such as three, four, five or more layers in the longitudinal side portions 104. However, while the capacity in the longitudinal side portions 104 may be increased by folding the absorbent material 27 multiple times, the comfort of the incontinence pad 20 may be compromised by the bulk of the pad within the longitudinal side portions 104.

A rewet barrier 50 positioned between the topsheet 22 and the resilient absorbent members 40 is liquid pervious, permitting liquids to readily penetrate through its thickness. The rewet barrier may be joined to the resilient absorbent members 40 by any conventional means for joining webs together such as adhesives, 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.

A preferred rewet barrier comprises an apertured, macroscopically expanded three-dimensional, polymeric web. Apertured macroscopically expanded, three-dimensional, polymeric webs are preferred for the rewet barrier 50 because they are pervious to bodily fluids and yet non-absorbent and have a reduced tendency to allow liquids to pass back through and rewet the wearer's skin. Thus, the outer cover of the incontinence pad which is in contact with the body remains dry, thereby reducing body soiling and creating a more comfortable feel for the wearer. Suitable apertured, macroscopically expanded, three-dimensional, polymeric webs are described in U.S. Pat. No. 3,929,135 issued to Thompson on December 30, 1975; U.S. Pat. No. 4,324,246 issued to Mullane et al. on April 13, 1982; U.S. Pat. No. 4,342,314 issued to Radel et al. on August 3, 1982; U.S. Pat. No. 4,463,045 issued to Ahr et al. on July 31, 1984; and U.S. Pat. No. 5,006,394 issued to Baird on April 9, 1991. Each of these patents are incorporated herein by reference.

The incontinence pad 20 is preferably provided with adhesive attachment means 60 as is illustrated in Figure 2. The adhesive attachment means 60 is illustrated as a wide strip of adhesive positioned on the backsheet 24 and running almost the entire length of the incontinence pad 20. This arrangement is selected for convenience; those skilled in the art can readily select a different pattern for the adhesive attachment means 60. The purpose of the adhesive attachment means 60 is to secure the incontinence pad 20 in the crotch region of the wearer's undergarment. Any adhesive or glue used with sanitary napkins for such a purpose can be used with this invention. Pressure sensitive adhesives are preferred. Suitable adhesives include Century A-305-IV manufactured by Century Adhesive Corporation of Columbus, Ohio and Instant Lok 34-2823 manufactured by National Starch and Chemical Company of Bridgewater, NJ. Suitable adhesive fasteners are also described in U.S. Pat. No. 4,917,697.

Before the incontinence pad is placed in use, the pressure sensitive adhesive is typically covered with a removable release liner 62 in order to keep the adhesive 60 from drying out or adhering to a surface other than the crotch portion of the panty prior to use. Suitable release liner 62 are also described in the above-referenced U.S. Pat. No. 4,917,697. Any commercially available release liners commonly used for such purposes can be utilized herein. Non-limiting examples of suitable release liners 34 are BL30 MG-A SILOX E1-0 and BL30 MG-A SILOX 4P/O both of which are manufactured by the Akrosil Corporation of Menasha, WI. The incontinence pad of the present invention is used by removing the release liner 62 and thereafter placing the incontinence pad 20 in a panty so that the adhesive 60 contacts the panty. The adhesive 60 maintains the incontinence pad 20 in its position within the panty during use.

The end regions 100 of the incontinence pad 20 preferably have a caliper less than that of the central region 102. Preferably, the end regions 100 have a caliper of less than about 8 mm, more preferably less than about 6 mm, most preferably less than about 4 mm. The caliper within the end regions 100 is important such that the incontinence pad 20 is not too thick that it becomes irritating and therefore uncomfortable for the wearer.

Referring now to Figure 6, there is shown another embodiment of an incontinence pad 300 of the present invention. The incontinence pad 300 comprises a liquid pervious topsheet 322, a liquid impervious backsheet 324 joined with the topsheet 322, an absorbent core 325 position between the topsheet 322 and the backsheet 324, an acquisition component 330 positioned between the topsheet 322 and the absorbent core 325, a pair of resilient absorbent members 340 disposed one on each side of the incontinence pad 300, and a rewet barrier 350 positioned between the resilient absorbent members 340 and the topsheet 322. The resilient absorbent members 340 are separate and distinct members from the absorbent core 325.

In other preferred alternative embodiments, the incontinence pad 20 can be provided with an absorbent core that is capable of separating from (or decoupling" from) at least a portion of the acquisition component to provide improved fit and performance. The separation or decoupling of theses components refers to a movement of one component apart from another component in a direction generally perpendicular to the longitudinal and transverse axes, (i.e., in the "Z-direction). The

concept of separation of components of an absorbent article is described in greater detail in U.S. Pat. No. 5,077,906 entitled "Decoupled Sanitary Napkin", issued to Osborn, et al. on April 16, 1992; in PCT International Patent Application Publication No. WO 92/07535 entitled "Sanitary Napkin Having Components Capable of Separation in Use" published in the name of Visscher, et al. on May 14, 1992; and in U.S. Pat. Application Serial No. 07/874,872 entitled "Generally Thin, Flexible Sanitary Napkin With Stiffened Center" filed April 28, 1992 in the name of Osborn.

The separation of the absorbent core 25 from the acquisition component 30 may alternatively be thought of as a separation of the topsheet 22 from the absorbent core 25. This is because if the absorbent core 25 separates from the acquisition component 30, the topsheet 22, (being disposed on the other side of the acquisition component 30) will also separate from the absorbent core 25.

The separation or decoupling of the absorbent core 25 from the acquisition component 30 is shown in Figure 7. The drawings are merely intended to be approximate representations of the configuration that the incontinence pad 20 may take when it is worn. Thus, the separation of these components may occur in manners in addition to those shown in the drawings. The scope of the present invention includes all of these other configurations and manners of separation. In addition, it should also be understood that the size of various components of the incontinence pad 20 may be slightly exaggerated in the drawings. This has been done to more clearly show the separation of the components of the incontinence pad 20.

The separation of the absorbent core 25 from the acquisition component 30 is possible because of the way the absorbent core 25 is joined to the acquisition component 30. The upper layer 26 of the absorbent core 25 is joined to the lowermost acquisition component 32 at junctures 80. The acquisition component 30 is otherwise unattached to the absorbent core 25. The unattached portion of the acquisition component 30 may move apart, separate, or decouple from the absorbent core 25.

To further aid in the separation of the absorbent core 25 from the acquisition component 30, the uppermost layer 26 of the absorbent core 25, which may comprise a relatively stiff material, is preferably provided with an embossed

channel, fold or crease. For example, the absorbent layer 26 shown in Figure 7 is provided with an embossed channel 85 which extends along the longitudinal centerline L. When the incontinence pad 20 is subjected to the lateral compressive forces caused by the thighs of the wearer, the portions of the body facing surface of the absorbent layer 26 on either side of the embossed channel 85 are brought closer together. The unattached portion of the acquisition component 30 separates and lifts from the absorbent core such that the incontinence pad 20, and in particular the topsheet 22 and the acquisition component 30, will conform with the wearer's anatomy. Thus, the incontinence pad 20 is in a position to more readily intercept bodily fluids discharged from the wearer.

Alternatively, the absorbent layer 26 may be provided with a low density or lower basis weight channel which extends along the longitudinal centerline L. Since the portions of the absorbent layer 26 on either side of the low density channel will typically be stiffer than the channel, the absorbent layer 26 will tend to bend along the channel when the incontinence pad 20 is subjected to the lateral compressive forces caused by the thighs of the wearer during use.

Additionally, the absorbent layer 26 may be provided with multiple embossed channels, folds or creases allowing the absorbent layer 26 to bend in numerous configurations. Furthermore, if desired, the absorbent layer 27 may also be provided with one or more channels, folds, or creases to assist the absorbent layer 27 in bending in the desired configuration.

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

WHAT IS CLAIMED IS:

1. An absorbent article having a pair of end regions, a central region disposed between said end regions, said central region comprising a pair of spaced apart longitudinal side portions and a central portion disposed between said longitudinal side portions, the absorbent article comprises a liquid pervious topsheet, a liquid impervious backsheet joined with said topsheet, an absorbent core positioned between said topsheet and said backsheet, characterized by

an acquisition component positioned between said topsheet and said absorbent core, said acquisition component having a total void volume, said central region providing at least 50% of said total void volume;

a pair of resilient absorbent members disposed in said longitudinal side portions, said resilient absorbent members arranged in a longitudinally spaced relation to each other between said acquisition component and said topsheet;

said absorbent article having a total absorptive capacity, said central region providing at least 50% of said total absorptive capacity, said longitudinal side portions providing at least 70% of the central regions absorptive capacity.

2. An absorbent article having a pair of end regions, a central region disposed between said end regions, said central region comprising a pair of spaced apart longitudinal side portions and a central portion disposed between said longitudinal side portions, the absorbent article comprises a liquid pervious topsheet, a liquid impervious backsheet joined with said topsheet, characterized in that

an acquisition component positioned between said topsheet and said backsheet, said acquisition component having a total void volume, said central region providing at least 50% of said total void volume;

an absorbent core positioned between said acquisition component and said backsheet, a portion of said absorbent core being folded upon said

acquisition component along a first pair of generally parallel longitudinally extending fold lines to form a pair of resilient absorbent members which encapsulate said acquisition component within said longitudinal side portions, said resilient absorbent members arranged in a longitudinally spaced relation to each other between said acquisition component and said topsheet;

said absorbent article having a total absorptive capacity, said central region providing at least 50% of said total absorptive capacity, said longitudinal side portions providing at least 70% of the central regions absorptive capacity.

3. The absorbent article of either Claim 1 or Claim 2 further comprising a rewet barrier positioned between said resilient absorbent members and said topsheet, said rewet barrier comprising an apertured, macroscopically expanded three-dimensional, polymeric web.

4. The absorbent article of any one of the preceding claims wherein each of said resilient absorbent members is formed from a resilient material that will recover at least 80% of its original volume after it is compressed 20% of its original volume.

5. The absorbent article of any one of the preceding claims wherein each of said resilient absorbent members comprises bicomponent fibers.

6. The absorbent article of Claim 5 wherein each of said resilient absorbent members comprise cellulose fibers and absorbent gelling material particles.

7. The absorbent article of Claim 1 wherein each of said resilient absorbent members has a height of at least 1 mm.

8. The absorbent article of Claim 1 wherein each of said resilient absorbent members has a height of from 1 mm to 2 mm.

9. The absorbent article of Claim 1 wherein the longitudinal length of the central region is from one-fourth to two thirds of the total longitudinal length of the absorbent article.

10. The absorbent article of Claim 1 wherein the transverse width of the central portion is from one-third to three-fourths of the total transverse width of the absorbent article.

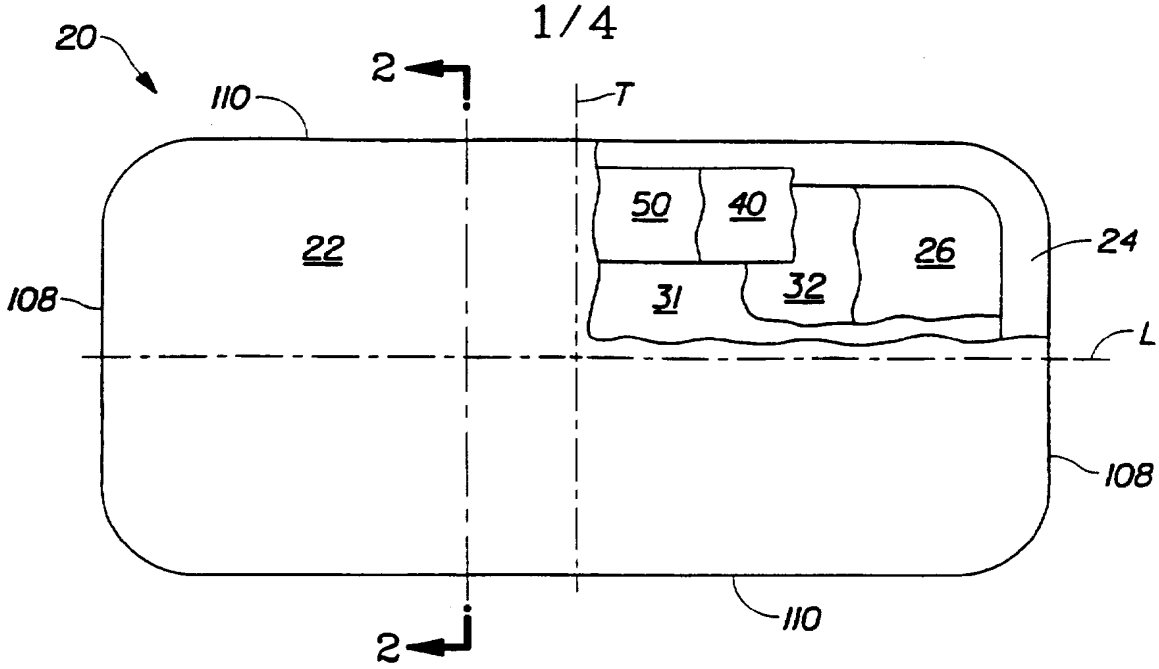


Fig. 1

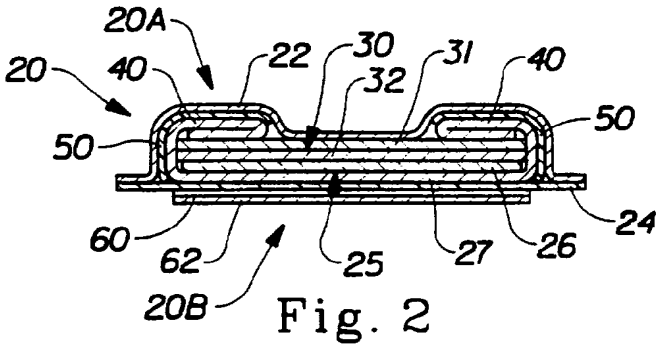


Fig. 2

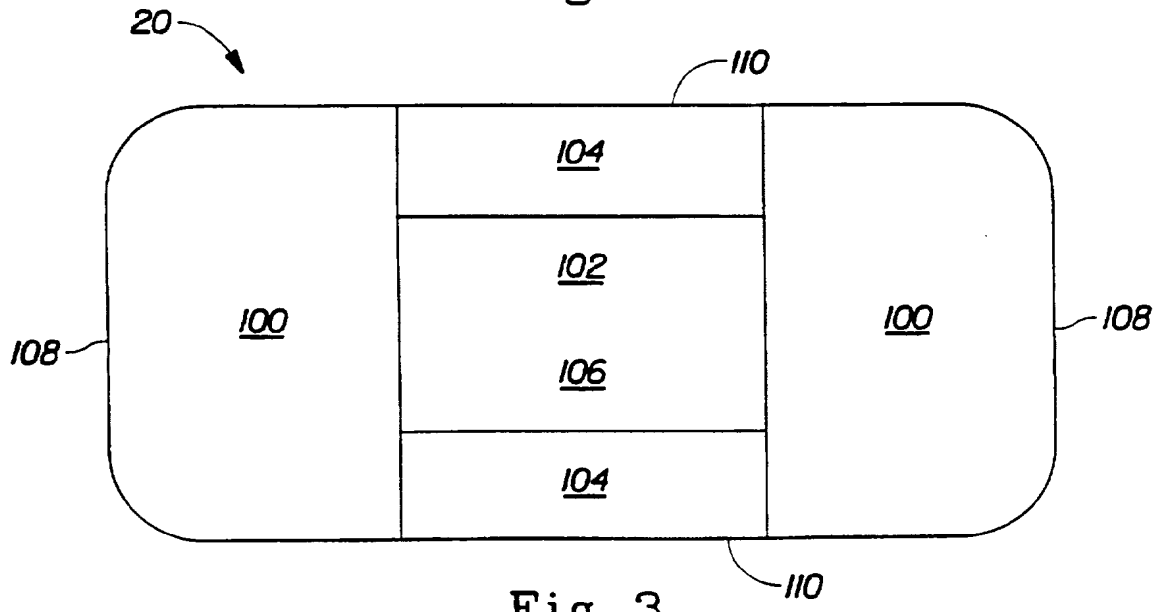


Fig. 3

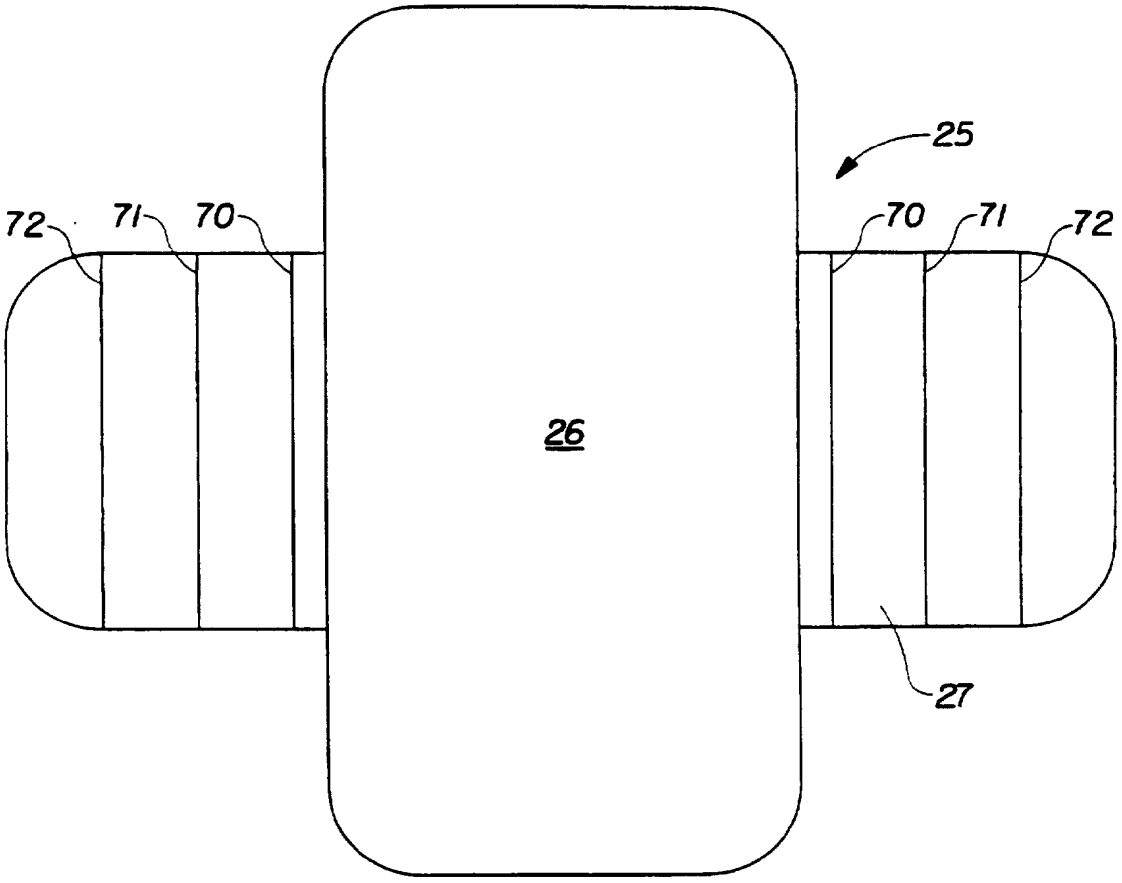


Fig. 4

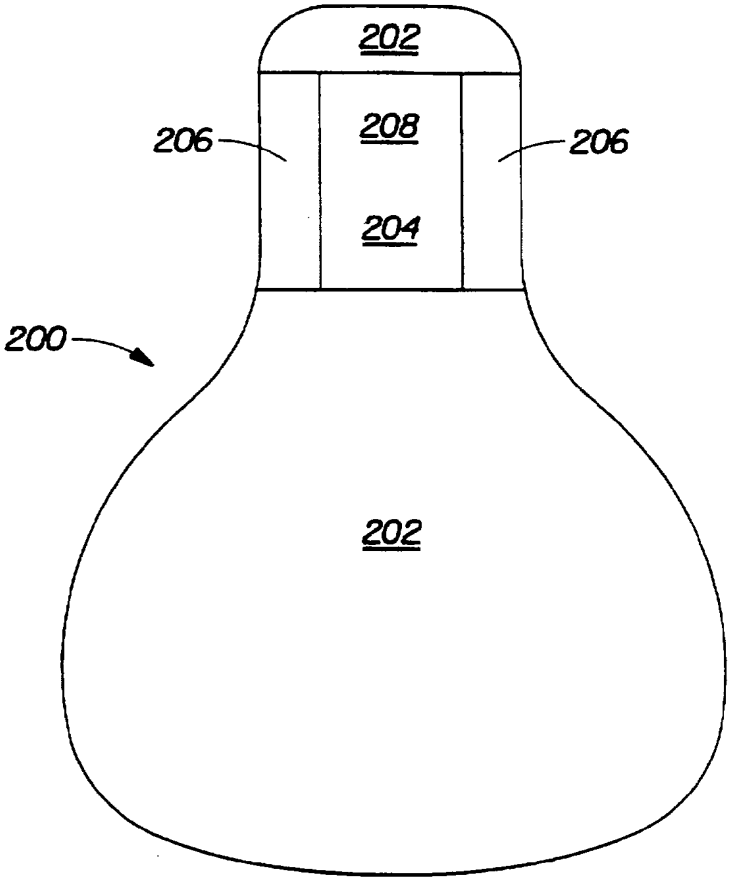


Fig. 5

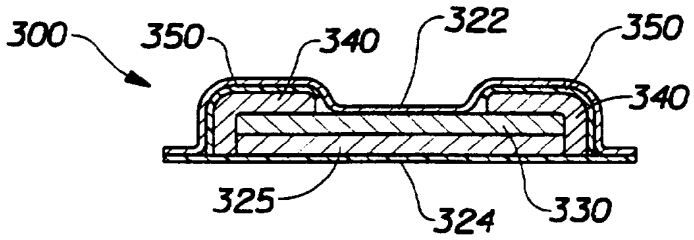

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Fig. 6

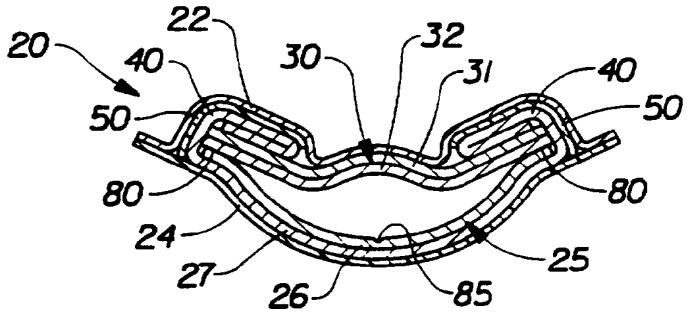

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Fig. 7

INTERNATIONAL SEARCH REPORT

Interna al Application No
PCT/US 97/09976

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61F13/15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	EP 0 222 585 A (PROCTER & GAMBLE) 20 May 1987 see page 6, line 17 - line 22; claim 10; figure 2 see page 18, line 19 - page 19, line 22 see page 20, line 8 - line 15 ---	1,4,7 3
Y	US 5 352 217 A (CURRO JOHN J) 4 October 1994 see column 2, line 27 - line 39 --- -/--	3

[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 92 11830 A (PROCTER & GAMBLE) 23 July 1992 see page 21, line 31 - page 23, line 32 see page 28, line 1 - line 4; claims 1,8; figure 2 see page 30, line 31 - page 31, line 6 see page 32, line 23 - line 26 see page 33, line 29 - line 34 see page 36, line 9 - line 16 see page 37, line 30 - line 36	1,2,4
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Interna al Application No
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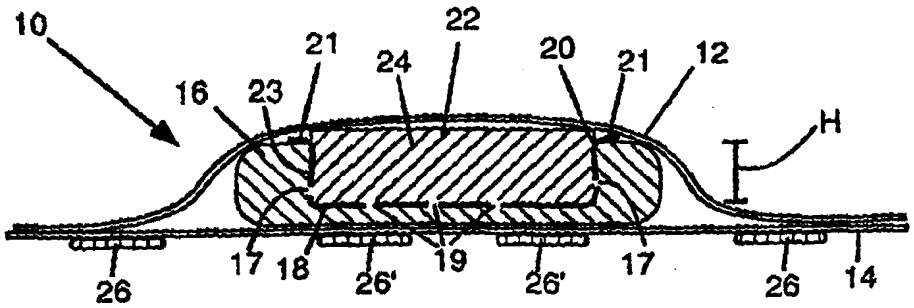
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(54) Title: ABSORBENT ARTICLE HAVING INTEGRAL WICKING BARRIERS



(57) Abstract

An absorbent article comprising a central absorbent member and a lateral wicking barrier for inhibition of wicking from the central regions of the article to an outlying outer absorbent member. The wicking barrier has a vertical component for prevention of radial wicking in the plane of the article and thus promotes center filling of the article with fluid and reduces the likelihood of leaks from the sides of the article. The wicking barrier can also have a horizontal component to prevent leakage, redirect fluid flow, and improve fit and performance of the article. In one embodiment, the central absorbent member is a concentric absorbent structure having alternating rings of barrier material and absorbent material, including a spiral wound composite formed from a layer of barrier material wound with a layer of absorbent material and then sliced to provide a thin absorbent layer having high permeability in the thickness direction but low permeability in the plane due to the barrier material. In a second embodiment the absorbent Core consists out of an outer absorbent member having a central void, open toward the body side of the absorbent article a central absorbent member disposed over and extending into the open void and a wicking barrier disposed between the outer and central absorbent member.

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ABSORBENT ARTICLE HAVING INTEGRAL WICKING BARRIERS

Background of the Invention

To prevent leakage of body exudates from absorbent articles such as feminine care pads or napkins and disposable diapers, it is desirable that the exudates not reach the edges of the absorbent material in the article. A "center fill" strategy is desirable for leakage control, wherein fluids are preferentially held in a central region of the article. Further, absorbent articles with center fill strategies are desirable for the clean appearance they offer and the reduced wetted area in contact with skin. Unfortunately, in traditional absorbent articles, there is generally no barrier to bulk flow or capillary wicking from the target region to the edges of the article.

Efforts to prevent leakage from the sides of absorbent articles include using fluid impervious cuffs and flaps. These added barriers are costly and do not prevent fluid from reaching the edge of the absorbent article, though they can be effective in reducing leakage in some absorbent articles.

Central meltblown strips and other narrow strips of absorbent material have been added to the body side of absorbent articles to promote center filling of the articles. However, meltblown strips interfere with absorption of fluid into the absorbent cellulosic portions of the article and can hold wet fluid near the skin. Other efforts at controlling fluid intake to promote central filling have used narrow strips of cellulosic or other absorbent material with a horizontal barrier between the strip and the underlying absorbent core. The horizontal barrier material for delaying wicking provides vertical isolation of the central strip from the absorbent core, but does not prevent flow out of the sides of the wetted strip or toward the sides of the article. Further, the horizontal fluid barrier often occupies a significant portion of the article's surface area and can result in ineffective use of the underlying absorbent core.

Embossing has also been used to promote longitudinal fluid flow, but embossments generally are not successful in preventing lateral wicking and in promoting true center fill. Furthermore, heavy embossing can be an ineffective use of absorbent material since the embossed regions are typically highly densified, generally having little pore volume for absorption of fluid.

Longitudinal chambers have also been used wherein each channel or chamber of absorbent material is completely isolated from the next by means of impervious or flow

restricting walls. In some cases, however, isolated chambers represent a poor use of absorbent material as one chamber may become overloaded and overflow onto the cover, resulting in smearing and inefficient use of the absorbent material in other chambers. Successful use of isolated chambers requires improvements for prevention of chamber overflow, prevention of undesirable surface transport and smearing, and improved use of the absorbent material in the absorbent article. Further, prior attempts at isolated flow chambers are generally complex in execution, costly, and may suffer from poor product integrity. Improved approaches are needed that can be mass produced for low cost while achieving high levels of performance.

In general, what is needed is an improved means for promoting center fill and reducing flow toward the edges of the absorbent article for leakage reduction that offers improved feel and appearance of the article while also reducing smearing or other forms of failure.

Summary of the Invention

In one aspect, the present invention resides in an absorbent article having a longitudinal direction, a transverse direction, a vertical direction substantially normal to both the longitudinal and transverse directions, and a body side, the absorbent article comprising:

a) an absorbent core having a body side surface, the core comprising an outer absorbent member having a central void open toward the body side of the absorbent article, and a central absorbent member disposed over the central void of the outer absorbent member and extending into the void; and

b) a wicking barrier disposed between the outer absorbent member and the central absorbent member, the wicking barrier comprising a vertical component and a horizontal component, the vertical component spanning a vertical distance between the outer absorbent member and the central absorbent member, and the horizontal component spanning a horizontal distance on the body side surface of the absorbent core.

In another aspect, the invention resides in an absorbent article having a body side, the absorbent article comprising an absorbent core having a body-side surface and comprising an outer absorbent member and a central absorbent member having a perimeter, and a wicking barrier spanning a vertical distance disposed along at least a portion of the perimeter of the central absorbent member, the wicking barrier also

comprising a horizontal component residing on the body-side surface of the absorbent core.

In another aspect, the invention resides in an absorbent article having a longitudinal direction, a transverse direction, and a vertical direction substantially normal to both the longitudinal and transverse directions, a crotch region, and a body side, the absorbent article comprising:

a) an absorbent core having a body side surface, the absorbent core comprising a central absorbent member surrounded by a outer shaping member with a central void for receiving the central absorbent member;

b) a baffle layer beneath the central absorbent member; and

c) a wicking barrier disposed between the outer shaping member and the central absorbent member, the wicking barrier comprising a vertical component and a horizontal component, and the horizontal component spanning a horizontal distance on the body side surface of the outer shaping member.

In another aspect, the invention resides in an absorbent article with a longitudinal direction, a transverse direction, a vertical direction substantially normal to both the longitudinal and transverse directions, a body side, and a garment side, the absorbent article comprising:

a) an absorbent core having a central absorbent member and an outer absorbent member, the outer absorbent member having a central void defined therein for receiving at least a portion of the central absorbent member, whereby an interface is defined between the central absorbent member and the outer absorbent member; and

b) a wicking barrier, desirably a single-ply wicking barrier, disposed along the interface between the central absorbent member and the outer absorbent member, the wicking barrier spanning a vertical distance in the absorbent article and having a variable liquid permeability such that the liquid permeability of the wicking barrier is lower near the body side and higher near the garment side.

The wicking barrier can extend downward from the surface of the absorbent core to span a vertical distance less than the vertical distance of the interface, or, alternatively, can extend substantially along the entire vertical distance of the interface and is provided with apertures or openings away from the body side of the absorbent core such that fluid passing through the wicking barrier must follow an elongated or tortuous path to pass out of the central absorbent member. The wicking barrier can also be provided with a

horizontal component on or near the surface of the absorbent core spanning a horizontal distance to reduce the likelihood of contact between the outer absorbent member and the central absorbent member when the article is laterally compressed or bunched together in use.

In another aspect, the invention resides in an absorbent article with a crotch region, a longitudinal direction, a transverse direction, and a vertical direction substantially normal to both the longitudinal and transverse directions, the absorbent article comprising:

a) an absorbent core having a central absorbent member and an outer shaping member, the outer shaping member having a central void defined therein for receiving at least a portion of the central absorbent member, whereby an interface is defined between the central absorbent member and the outer shaping member, the interface spanning a vertical distance, the outer shaping member suitably having a thickness of at least about 1 mm, an edge width of at least about 2 mm, and a basis weight of at least about 100 gsm; and

b) a wicking barrier disposed along the interface between the central absorbent member and the outer absorbent member.

In another aspect, the invention resides in an absorbent article comprising an absorbent core comprising an outer absorbent member and a central absorbent member, the outer absorbent member having a central void therein for receiving an insert, and the central absorbent member being inserted into the central void, and a wicking barrier between the outer absorbent member and the central absorbent member, the wicking barrier spanning a vertical distance that can be substantially as great as the thickness of the central absorbent member or can be less than the thickness of the central absorbent member. The central void can be a hole that passes completely through the outer absorbent member, or can be a depressed region within a contiguous, uninterrupted outer absorbent member. Desirably, the wicking barrier comprises a horizontal component that serves as a ledge on the surface of the absorbent core. In one embodiment, the central void longitudinally divides the outer absorbent member into two discontiguous sections. In other embodiments, the outer absorbent member is divided by the central void in the crotch region, but the outer absorbent member may be contiguous in the front or back portions of the article (i.e., the central void does not extend substantially beyond the crotch region).

In another aspect, the present invention resides in an absorbent article comprising a composite absorbent core having a center, the absorbent core having a body side surface and comprising a central absorbent member and a surrounding outer absorbent

member, wherein a plurality of vertically oriented segments of hydrophobic material in the central absorbent member define liquid wicking pathways from the center of the central absorbent member to the outer absorbent member.

In another aspect, the invention resides in an absorbent article comprising a backsheet and a concentric absorbent structure attached to the backsheet, the concentric absorbent structure having a thickness and comprising multiple alternating concentric layers of barrier material and absorbent material, wherein the barrier material substantially spans the thickness of the concentric absorbent structure.

In another aspect, the invention resides in a method for producing an absorbent article having a central absorbent member, the method comprising:

a) preparing an outer absorbent member, wherein the outer absorbent member has a central void;

b) deposing a layer of a flexible barrier material over the central void; and

c) inserting a section of absorbent material into the central void and over the barrier material to form a central absorbent member, such that a portion of the barrier material separates the central absorbent member from the outer absorbent member along a vertical distance.

The above method may further comprise deposing a backsheet beneath the absorbent core; deposing a topsheet above the absorbent core; and attaching a portion of the topsheet to a portion of the backsheet.

In another aspect, the invention resides in a method for producing an absorbent article having a central absorbent member, a garment side, and a body side, the method comprising:

a) preparing an outer shaping member having a first portion and a second portion with a central void between the first portion and the second portion, wherein the central void has a vertical depth and the outer shaping member has a surface comprising a wicking barrier that spans at least a portion of the vertical depth of the central void; and

b) inserting an absorbent material into the central void of the outer shaping member to form a central absorbent member.

In yet another aspect, the invention resides in a method of preparing an absorbent article comprising a concentric absorbent structure with multiple vertical wicking barriers interposed between layers of absorbent material, the method comprising:

a) superposing at least one layer of a barrier material onto at least one layer of absorbent material to form a multilayered structure;

b) rolling the multilayered structure about a rolling axis to form a spiral wound roll;

c) slicing a portion of the spiral wound roll substantially normal to the rolling axis to form a substantially concentric absorbent structure; and

d) attaching the substantially concentric absorbent structure to a backsheet.

Brief Description of the Drawings

FIG. 1A and 1B depict a cross-section of a sanitary napkin of the present invention.

FIG. 2 depicts a cross-section of a sanitary napkin of the present invention having two absorbent components in the central absorbent member.

FIG. 3A and 3B depict a cross-section of a sanitary napkin of the present invention having three absorbent components in the central absorbent member.

FIG. 4A and 4B depict a cross-section of a sanitary napkin of the present invention having a contoured central absorbent member.

FIG. 5A and 5B show a diaper having a central absorbent member surrounded by a moat.

FIG. 6 depicts a cross-section of a sanitary napkin wherein barrier material is wrapped around the upper surface of the central absorbent member.

FIG. 7A and 7B and 7C depict a cross-section of an absorbent article with a central absorbent member and an outer absorbent member, with a wicking barrier that does not pass beneath the central absorbent member.

FIG. 8 is a top view of a sanitary napkin having a central absorbent member concentrically surrounded by an outer absorbent member.

FIG. 9 is a top view of a sanitary napkin having a central absorbent member separated from the outer absorbent member by longitudinal barrier zones.

FIG. 10 is a top view of a sanitary napkin comprising a spiral wound composite with barrier material between successive layers.

FIG. 11 shows a layer of a spiral wound composite.

FIG. 12 shows a spiral wound roll from which a spiral wound composite is cut.

FIG. 13 shows a length of heterogeneous barrier material having multiple permeability or wicking zones for use in a spiral wound composite.

FIG. 14 shows a feminine care pad with wings having a shaped spiral wound composite layer.

FIG. 15 shows a top view of a sanitary napkin with multiple wicking barriers arranged to provide a labyrinth-like tortuous pathway for radially outward wicking from the target area of the central absorbent member.

FIG. 16A and 16B show a cross-section of an absorbent article according to the present invention wherein the central absorbent member can expand substantially when wetted.

FIG. 17 shows a cross-section of an absorbent article according to the present invention wherein the central absorbent member comprises multiple longitudinal bands of absorbent material for improved wicking in the longitudinal direction.

FIG. 18A and 18B show cross-sections of an absorbent article comprising a protruding loop of cover material to form a runoff barrier near the periphery of the central absorbent member.

FIG. 19A and 19B show cross-sections of an absorbent article comprising multiple protruding loops of cover material to form runoff barriers on the body-side surface.

FIG. 20A and 20B show two exemplary forms of loops of cover material having multiple folds.

FIG. 21 shows the top view of several sanitary napkins described in the Examples, also showing embossed lines.

FIG. 22A and 22B depict an absorbent article with two layers of film serving as the wicking barrier.

FIG. 23 depicts an absorbent article with two layers of film serving as the wicking barrier, wherein the outer absorbent member is largely encased in impervious material.

FIG. 24A and 24B depict an absorbent article with a single wicking barrier extending to the longitudinal sides of the absorbent core in the crotch region.

FIG. 25A and 25B depict embodiments in which the central absorbent member comprises an absorbent layer wrapped around a second layer of absorbent material.

FIG. 26 depicts an absorbent article in which the topsheet wraps the edges and undersides of the outer absorbent member to permit the outer edges of the absorbent core to flex away from the backsheet.

FIG. 27 depicts an embodiment similar to FIG. 26 in which the topsheet further wraps the edges and underside of the central absorbent member to permit its edges to flex away from the backsheet.

FIG. 28 depicts a cross-section of an absorbent article wherein the wicking barrier wraps around the outer absorbent member and runs along the garment side of the article, serving as a backsheet.

FIG. 29 depicts a cross-section of an absorbent article having a unitary shaping member surrounding a central absorbent member.

FIG. 30 depicts a commercial maxipad.

FIG. 31 depicts the modified maxipad of FIG. 30 after a wicking barrier has been added according to the present invention.

FIG. 32 depicts a transverse cross-section of a sanitary napkin according to the present invention.

Detailed Description of the Invention

To fully achieve a center-fill effect for fluid in an absorbent article such as a sanitary napkin or diaper, it has been discovered that excellent results are obtained when a central absorbent member is properly isolated from a surrounding outer absorbent member of the article, such that fluid communication between the absorbent members is reduced, impeded, or prevented. The isolation can be achieved with barrier material spanning a vertical distance between a central absorbent member and a surrounding outer absorbent member to interfere with wicking of fluid (or other forms of flow) from the center of the absorbent article toward the edges of the article. Alternatively, the outer absorbent member may be replaced with a resilient outer shaping member that need not be absorbent. Further, the barrier material desirably can also span a horizontal distance on the surface of the absorbent core of the article for reduced leakage and improved control of fluid flow. The horizontal component of the wicking barrier serves as a ledge on the absorbent core with multiple desirable functions, hereafter described.

The vertical wicking barriers isolate absorbent members of the absorbent core for reduced leakage to the side without the disadvantage offered by horizontal barriers or horizontal transfer delay layers of making absorbent material in the center of the article less accessible to incoming flow. Specifically, the wicking barriers isolate or partially isolate a central absorbent member from the surrounding portions of an outer absorbent member such that in-plane or lateral wicking of fluid is impaired, and thus can be termed "wicking barriers to lateral flow." The term "lateral," as used herein, refers to the in-plane flow directions in an absorbent article, particularly the direction of flow from the central portions of an absorbent core toward the outer edges of the article, particularly the longitudinal edges. More specifically, in-plane flow from the center to the outer regions of an absorbent core can be termed "radially outward flow." The use of vertical wicking barriers permits any desired portions of the body side surface of each absorbent

component to remain available for fluid intake and generally provides for more efficient use of absorbent material.

In most embodiments of the present invention, the flow isolating effect within the absorbent core is achieved at least in part because the wicking barrier spans a vertical distance between the central absorbent member and the surrounding portion of the absorbent core (i.e., the outer absorbent member, which may surround the entire central absorbent member or only surround its edges in the crotch region or other region where lateral leakage is likely), thus giving a vertical component to the barrier. Therefore, the barriers can also be termed "vertical wicking barriers" due to the vertical component of the geometry. The vertical component of the wicking barrier spans a vertical distance that is desirably of at least about 20 percent, more desirably of at least about 50 percent, suitably of at least about 70 percent, and up to about 100 percent of the average thickness of the central absorbent member.

The central absorbent member can lie within a depression or void within a surrounding outer absorbent member or can lie substantially above the outer absorbent member and can also serve as the primary absorbent material of the absorbent article. It has also been discovered that isolation of a central absorbent member can be achieved without promoting overflow of liquid entering the central absorbent member due to excessive saturation and without promoting surface smearing. This can be achieved by providing tortuous pathways for fluid flow from the target area to the surrounding absorbent material, thus permitting fluid to move toward the outer absorbent member when the absorbent capacity of the central absorbent member is approached, but whereby such radially outward flow is delayed or impeded by the tortuous pathways. Wicking barriers with vertical components establish the tortuous or labyrinth-like flow pathways by which fluid in the center of an absorbent core can gradually move toward the outer absorbent member of the pad in a way that reduces leakage and enhances utilization of the absorbent material.

In one class of related embodiments, the wicking barrier does not completely separate the adjacent zones of absorbent material but prevents radially outward flow (flow from the center of the pad to the edges, especially the longitudinal edges of the article) in the upper regions of the absorbent zones near the user's body, while permitting some degree of radially outward flow through tortuous pathways or labyrinth-like pathways, preferably pathways remote from the body side or upper surface of the absorbent core, such that the outer absorbent member or regions of the article can serve a useful absorbent function, such as providing a source of additional absorbent capacity when the main absorbent capacity of the central absorbent member is exceeded, or serving as an

indicator that the article should be replaced. For example, a wicking barrier comprising an impervious film may form a wall around a central absorbent insert placed within a hole in an outer absorbent member, but still permit some radially outward flow away from the body side surface if the lower portions of the film away from the body side surface are provided with apertures through which fluid can flow when the central absorbent member becomes saturated.

While the wicking barriers can interfere with wicking flow, wherein capillary forces move the fluid, the wicking barriers naturally can impede more rapid flow as well, including gushes of flow driven by hydraulic pressure or gravitational force. Thus, the flow isolation effect of the wicking barrier is not limited to wicking flow alone.

One problem known with previous attempts at isolating longitudinal chambers of absorbent material has been surface smearing of the fluid, typically due to a single isolated chamber becoming saturated with fluid and then forcing additional fluid to flow along the surface of the article to other chambers or to the edges of the article. If the primary fluid pathway from one absorbent region or member to the next is along the surface of the article, smearing is likely. Likewise, complete isolation of an absorbent member can keep that member wet and provide discomfort to the user and result in inefficient use of the absorbent material of the article. Accordingly, surface smearing and oversaturation of the target region of the absorbent article can be reduced by any or all of the following: 1) redistributing the mass and/or the absorbent capacity in the absorbent article such that the central absorbent member has substantially greater basis weight and/or absorbent capacity than the outer absorbent member of the absorbent article, and desirably also has a greater thickness to ensure preferential contact of fluid with the central absorbent member; 2) providing flow pathways from the central absorbent member to the surrounding or adjacent outer absorbent member or regions that are remote from the surface of the absorbent article such that fluid flow from one member to the next is possible by a route other than along the surface, such as by openings in the wicking barrier away from the upper surface of the article, and desirably by a tortuous route that delays lateral wicking enough for effective center fill without promoting overflow or oversaturation; 3) providing a horizontal component to the barrier material such that a portion of the barrier material resides on the surface of the absorbent core in addition to the portion spanning a vertical distance between adjacent absorbent members, thus forming "ledges" of barrier material near the surface of the absorbent article (desirably beneath the cover but above the absorbent core).

The development of vertical wicking barriers with horizontal components on the body-side surface of the absorbent core of an absorbent article is believed to offer many

advantages previously unavailable in absorbent articles. First, the horizontal component is especially effective in preventing wicking contact between the central absorbent member and the adjacent outer absorbent member. If a vertical barrier ends abruptly at the surface between two adjacent chambers, there is the possibility that wicking contact between the two chambers will be established at the upper surface of the article, especially if the article is laterally compressed or bunched together in use or if the article experiences in-plane shear that can move the upper layers of one absorbent member toward other absorbent members in the absorbent article. Even a small region of contact between adjacent absorbent members can result in undesired lateral wicking, and since the fluid flow between the two members in that case will be primarily along the surface, surface smearing is a possibility. A horizontal component, or ledge, at the top of the vertical wicking barrier can greatly increase the effectiveness of the wicking barrier and isolate the upper regions of the adjacent absorbent members, thus reducing the chances of surface smearing and preventing undesired flow toward the edges of the article, from whence the fluid may leak and soil the wearer's clothes.

Second, the ledge can redirect flow toward the central absorbent member, increase the center-fill effect, and increase the effective size of the central absorbent member. Particularly desirable is a hydrophobic ledge around or along the central absorbent member extending away from the central absorbent member and toward the edges of the article, spanning a short horizontal distance, and preferably a distance approximately equal to a characteristic drop size of the fluid being absorbed. For many absorbent articles, the horizontal distance spanned is desirably between about 0.3 millimeters (mm) and about 5 mm, and specifically between about 0.5 mm and about 3 mm, more specifically between about 1 mm and about 2.5 mm, and alternatively between about 0.2 mm and about 2 mm. When fluid is deposited on such a ledge, the fluid can be redirected toward the central absorbent member instead of flowing into the underlying outer absorbent member. Desirably, the ledge lies on the outer absorbent member and helps redirect fluid toward the central absorbent member. This is especially effective when the central absorbent member is more elevated than the outer absorbent member, so that fluid on the ledge is likely to contact the elevated, adjacent central absorbent member. However, in one embodiment, the ledge can extend substantially all the way to the longitudinal edges of the crotch region of the outer absorbent member. In a related embodiment, the ledge can substantially cover all of the body side surface of the outer absorbent member outside the perimeter of the central absorbent member. This is particularly helpful when the central absorbent member is sufficiently sized and placed to receive essentially all of the liquid received by the absorbent article so essentially none

falls on the ledge. In this manner, the ledge can provide excellent wicking isolation of the central absorbent member from the outer absorbent member even under extreme bunching of the article during dynamic use.

Third, the ledge can provide increased stability, strength, and resiliency to an absorbent article. This is particularly so when the ledge is adhesively or otherwise attached to the cover or topsheet of an absorbent article and/or to one or more elements of the absorbent core. A problem in some previous attempts at providing isolated chambers in an absorbent article is that a film or other barrier between adjacent chambers eliminates the fiber-fiber bonding or entanglement between fibers that holds an absorbent core together, resulting in an absorbent core which can come apart, separate, or fail either in tension or compression or during bending. In the present invention, the ledge of the wicking barrier is easily attached to the cover and can further be attached to either or both of the central absorbent member and the outer absorbent member adhesively, by thermal or ultrasonic bonds, or by other attachment means known to one skilled in the art. By geometric considerations alone, a wicking barrier with a ledge can effectively hold the central absorbent member in place between the wicking barrier and the cover when the ledge is attached to the cover or to the surface of the outer absorbent member.

Fourth, the ledge of the wicking barrier can serve important visual roles. It can help the wearer with proper placement by clearly marking the intended target zone, particularly if the wicking barrier has a color such as pink or blue that contrasts well with the absorbent material of the core. It can provide an important visual cue to the user that a central absorbent member exists and that the article provides a center fill strategy. The visible "protection zone" can increase user confidence in the article and can provide an improved clean appearance to the article, even after use. Further, if the ledge is at least somewhat opaque, it can mask incipient lateral flow from the central absorbent member to the outer absorbent member. Thus, a desirable wicking barrier material can be a thin, flexible polyolefin film or nonwoven layer, such as a web having a basis weight less than 40 grams per square meter (gsm) and desirably less than 25 gsm, optionally comprising coloring agents and desirably comprising pigments or fillers such as titanium dioxide or calcium carbonate for opacity.

In addition, surface smearing can be reduced with the use of a cover material that is especially well suited for the vertical barriers and vertical barriers with horizontal components of the present invention. Such a cover material comprises an inherently hydrophilic basesheet with a three-dimensional topography, further comprising hydrophobic matter deposited on the uppermost portions of the basesheet. Such covers are disclosed in the commonly owned copending US patent application, Ser.

No. 08/997,287, "Dual-zoned Absorbent Webs," filed Dec. 22, 1997, by Chen et al., herein incorporated by reference in its entirety. A three-dimensional, wet resilient tissue, for example, with a crosslinked silicone material on the uppermost regions of the surface, can provide an excellent dry feel while permitting good fluid entry into an absorbent basesheet. If the upper region of the underlying central absorbent member comprises a densified airlaid strip or other material having higher capillary pressure than the hydrophilic basesheet of a dual-zoned cover, then fluid can be pulled effectively from the basesheet of the cover into the absorbent core, resulting in small stain sizes and exceptionally dry feel.

Tortuous pathways from the central absorbent member to the outer absorbent member can be provided in a variety of ways. A single layer of hydrophobic barrier material between the central absorbent member and the surrounding outer absorbent member can comprise small apertures, slits, or holes remote from the body side of the absorbent article such that fluid entering the central absorbent member must travel downward through a substantial portion of the thickness of the central absorbent member before having access to openings leading to absorbent material outside the central absorbent member. The apertures or flow openings desirably are not present in the crotch region of the article, but can be placed closer to the longitudinal ends of the central absorbent member such that wicking through the apertures only occurs after fluid has been wicked longitudinally in the central absorbent member toward its ends, and then the fluid will still be remote from the crotch region where leakage tends to be more problematic in most absorbent articles. More complex and tortuous pathways can be created through the use of barrier material arranged in a spiral design from the central portions of the absorbent article to the outer regions, such that fluid in the center must wick along a spiral path in the plane of the article to reach the outer regions of the article. Likewise, barrier material may be arranged to define a labyrinth-like pathway from the central portions of the article to the outer regions, such that in-plane wicking can occur but only along a complex route. Combinations of labyrinth-like pathways and apertures or openings in selected portions of the barrier material can be used.

The barrier material may be impervious or may be permeable to liquid or, in one embodiment, has a variable permeability, particularly a vertical gradient in permeability and/or porosity such that the lowest permeability or porosity of the barrier material is found near the body side of the absorbent core or the absorbent article and the highest permeability is near the garment side of the absorbent core or the absorbent article, with the permeability or porosity of the barrier material increasing with vertical distance from

the body side to the garment side such that lateral flow is most strongly hindered near the body side and least hindered near the garment side.

Possible uses of the present invention include absorbent articles for intake, distribution, and retention of human body fluids. Examples include feminine care pads and related catamenial devices or sanitary napkins, including "ultra-thin" pads and pantiliners and maxipads. Examples of ultra-thin sanitary napkins are disclosed in US Pat. Nos. 4,950,264 and 5,009,653 issued to Osborn; and US Patent No. 5,649,916, issued July 22, 1997 to DiPalma et al., each of which are herein incorporated by reference in their entireties. Likewise, the present invention can be applied to diapers, disposable training pants, other disposable garments such as swimming garments, incontinence articles, bed pads, sweat absorbing pads, shoe pads, bandages, helmet liners, wipes and wipers, or other absorbent articles. The present invention can also be incorporated in articles adapted for particular portions of garments to be worn on the human body, gaskets for ostomy bags, and medical absorbents and wound dressings. The articles of the present invention provide significant leakage protection, fluid center-fill absorptive performance, and other desirable attributes for absorbent articles.

For feminine care pads in particular, the present invention offers surprising advantages in terms of comfort and fit. When the central absorbent member and the outer absorbent member are physically separate members, the transverse compressive stiffness of the article is greatly reduced. In other words, the article can bend between the user's thighs more easily and feels less stiff. Placing longitudinal slits in the central absorbent member is also helpful in reducing transverse stiffness. Further, the presence of a wicking barrier between the two absorbent members can enhance the ability of one absorbent member to move relative to another, as by sliding along the wicking barrier during transverse compression, especially if the wicking barrier is not adhesively attached to both absorbent members across the wicking barrier's entire surface, or if the wicking barrier is adhesively attached to no more than one absorbent member. Thus, the wicking barrier can provide additional freedom of movement and freedom of deformation to the absorbent members for reduced stiffness and better body fit. The presence of a wicking barrier with a vertical component in the crotch region, which separates the central absorbent member and outer absorbent member and allows folding or motion therebetween, appears especially useful in promoting a W-shape geometry of sanitary napkins when compressed in use which can rise toward the body for better intake of fluid and better fit in general. Further still, the center-fill strategy made possible by the present invention can be used to generally ensure that the outer absorbent member remains dry

under typical usage conditions, which in turn allows the outer absorbent member to better maintain its shape and to help hold the pad in a comfortable and effective position.

Indeed, recognizing that the primary absorbent material in the central absorbent member can provide substantially all of the absorbent capacity needed for many absorbent articles such as a feminine care pad (typically 7 milliliters (ml) of fluid will be absorbed, with a high end of about 15 ml), the outer absorbent member can be used to achieve several important functions other than absorbency. Either as a ring of material around the central absorbent member or as a pair of longitudinal bands surrounding the central absorbent member longitudinally, the outer member helps define the shape of the article, particularly when attached adequately to the wearer's panties. In conventional sanitary napkins, the article can become excessively bunched or compressed when wetted, but by maintaining the outer absorbent member in a dry state, it can maintain its shaping and body fit functions throughout use. Thus, the outer absorbent member can serve as a shaping and body fit element as well as a "cradle" to hold the central absorbent member and the wicking barrier in place. In fact, these functions can be achieved whether the outer member is absorbent or not, though it is desirable that the outer member be absorbent to take up fluid that might not be successfully held by the central absorbent member. Nevertheless, in one embodiment of an absorbent article such as a feminine care pad designed to maintain good body fit and provide leakage protection, the outer member need not be absorbent at all but can be a flexible frame member capable of holding the wicking barrier and central absorbent member in place. Thus, an outer shaping member can be used instead of an outer absorbent member, though it is preferred that the outer member be absorbent.

The shaping member can be porous, such as a ring of a polyurethane foam; a polyethylene foam such as the product known as VOLARA™ 2a polyethylene foam, obtained from Voltek Corp., of Lawrence, Mass.; or a foam rubber material (e.g., foamed styrene butadiene), foamed silicones, or foamed vinyl plastics. Several such foams can be obtained from Woodbridge Foam Fabricating, Inc., located in Chattanooga, Tennessee, from the E. N. Murray Company, Inc., located in Denver, Colorado, and Astro-Valcour, Inc., located in Glens Falls, New York. Foam materials desirably have a density of about 0.02 grams per cubic centimeter (g/cc) to about 0.1 g/cc. The foam material desirably is treated to be absorbent and/or hydrophilic, but need not be hydrophilic. In the case of a closed-cell foam or a foam with an impervious skin on the outer surface, the surface of the foam itself can serve as a wicking barrier having both a vertical component and a horizontal component on the bodyside surface of the shaping member. Thus, in general, the shaping member can comprise an integral wicking barrier or can have an additional

polymeric barrier provided on its surface, or can be separated from the central absorbent member by a separate layer of barrier material serving as a wicking barrier.

In one related embodiment, the wicking barrier and the outer shaping member are also integral with a backsheet and can be composed from a single piece of impervious material. The backsheet then also can serve as the baffle layer beneath the central absorbent member. For example, a single section of shaped flexible closed cell foam, desirably comprising an external impervious skin, can be shaped to provide a thin central layer under the central absorbent member, expanding away from the longitudinal centerline to provide thicker regions outside the central absorbent member that serve as the outer portions of the outer shaping member. (The thin central portion is a bridging portion between the outer portions.) Since the central absorbent member is contained by the outer shaping member (within the central sides of the outer portions and above the underlying thin bridging region of the foam body), there is no need for an additional backsheet, assuming the foam is truly impervious or comprises an impervious skin.

In general, for embodiments with an impervious or nonabsorbent outer shaping member, a separate backsheet is not necessary. Nevertheless, some form of a baffle layer must exist beneath the central absorbent member to prevent leakage. If a substantially liquid impervious outer shaping member is used and is contiguous, e.g., comprises first and second outer portions joined by a relatively thin (thinner than the outer portions) bridging member, then the outer shaping member itself can serve as the baffle layer and can replace the function of a backsheet, if desired. If a complete hole rather than merely a depression exists in the central portion of the outer shaping member for receiving the central absorbent member, then a separate baffle layer must be used. This can be a liquid impervious backsheet, a portion of which serves as the baffle layer beneath the central absorbent member, or it can be the wicking barrier if it runs beneath the central absorbent member to prevent leakage of fluid toward the garment side of the article, or it can be a separate layer of impervious or hydrophobic material such as a flexible polymer film, including material integrally attached to the central absorbent member such as a thermoplastic film, or an impervious coating or layer of adhesive. In any case, the construction of the article generally serves to isolate fluid in the central absorbent member for a true center-fill effect and prevent or reduce substantial fluid contact with the outer shaping member, while providing a conformable article that can fit against the body in use.

An outer shaping member comprising foam or other materials can be preshaped to conform suitably to the body. Examples of materials and methods for preparing conformable, resilient shaped members are disclosed in US Patent No. 5,591,150, issued

Jan. 7, 1997 to Olsen et al., herein incorporated by reference in its entirety. The outer shaping member can comprise absorbent materials, particularly cellulose, such as a regenerated cellulose foam or stabilized fluff pulp or air laid wood fibers, stabilized with thermoplastic fibers, crosslinkers, or wet strength agents, and may be preshaped or can be planar. Desirably, the outer absorbent member comprises densified fluff pulp, stabilized air laid pulp, or the soft pulp sheets disclosed in US Patent No. 5,562,645, issued Oct. 8, 1996 to Tanzer et al., herein incorporated by reference in its entirety, and desirably has a density less than 0.2 g/cc and more specifically less than 0.1 g/cc, and most specifically less than 0.07 g/cc. Coform, a meltblown air-formed combination of meltblown polymers, such as polypropylene, and absorbent staple fibers, such as cellulose, can also be used. The outer shaping member can be a composite element, such as a layer of cellulosic fibers joined to a polymeric foam layer. In one embodiment, the outer shaping member is extensible such that its size can be adjusted for improved fit. The outer shaping member can also be biodegradable and/or flushable, if desired. Further, the central absorbent member can be detachable to permit disposal and replacement with a new central absorbent member, rather than discarding the entire article.

In one embodiment, the outer shaping member can comprise gas-filled bubbles sealed inside polymeric material, such as air bubbles sealed between two layers of a polymeric film similar to a bubble wrap material commonly used for protection of articles during shipment. The gas-filled bubbles can be optimized in size and shape to conform to the body and provide shaping, cushioning, and gasketing functions, while preventing wicking from the central absorbent member. In such embodiments, the width of the central absorbent member desirably should be no more than 2 to 4 cm, and the shaping member should have a thickness of at least about 2 mm, desirably from about 2.5 mm to 7 mm, with a width (distance from the edge of the outer absorbent member to the outer longitudinal side of the shaping member) of at least 1 mm and desirably at least about 3 mm. The shaping member in such embodiments can comprise one or more gas-filled bubbles having a volume of at least about 0.2 cubic centimeters, desirably at least about 0.5 cubic centimeters, and more desirably at least about 1 cubic centimeter.

As with the outer absorbent member, the outer shaping member desirably promotes good body conformability. When used in sanitary napkins or feminine pads, for example, the outer shaping member desirably promotes a W-fold geometry in the crotch region when the pad is worn. Thus, the size, thickness, stiffness, and geometry of the outer shaping member should be adjusted to permit it to flex in use into a W-fold when combined with the other components of the absorbent article. Design principles given

herein for embodiments comprising an outer absorbent member can generally be applied to embodiments comprising an outer shaping member, in addition to explicit teachings herein for the outer shaping member.

For best comfort, the outer shaping member or outer absorbent member desirably should be soft, resilient and easily compressible. The resiliency should be in the range of about 15 percent to about 60 percent rebound, preferably about 15 percent to about 50 percent and more preferably about 15 percent to about 35 percent, as determined by the ASTM Test Method D3574-91 procedure H. Compressibility should be in the range of about 0.69 kPa (0.1 pounds per square inch (psi)) to about 13.8 kPa (2 psi) at 50% compression, preferably from about 2.1 kPa (0.3 psi) to about 11.7 kPa (1.7 psi) at 50% compression and most preferably from about 3.45 kPa (0.5 psi) to about 10.3 kPa (1.5 psi) at 50% compression, as determined by the ASTM Test Method D3574-91 procedure C.

Generally, the outer shaping member has a thickness of at least about 1 mm, specifically at least about 2 mm, more specifically at least about 3 mm, and most specifically from about 3 mm to about 7 mm. Desirably, the average thickness of the shaping member is at least about 20 percent of the average thickness of the central absorbent member, and more specifically is at least about 30 percent of the average thickness of the central absorbent member. The thickness of the outer shaping member can also be greater than that of the central absorbent member. For example, the average thickness of the central absorbent member can lower by at least about 20 percent or at least about 50 percent than the average thickness of the outer shaping member.

The "edge width" of the outer shaping member, defined herein as the lateral distance along a continuous portion of the outer shaping member along the transverse centerline, specifically from the inner edge (adjacent the central absorbent member) of the outer shaping member to the outer edge thereof, is desirably at least about 2 mm and specifically at least about 3 mm, more specifically at least about 4 mm. For example, a 7 cm wide rectangular foam section with a 5 cm wide central depression therein for receiving a central absorbent member would have an edge width of 1 cm.

In a preferred embodiment, the outer shaping member is also an outer absorbent member comprising cellulosic fibers, the outer absorbent member being substantially surrounded by impervious material (e.g., the wicking barrier and the backsheet) such that the absorbent material remains substantially dry in use. In one embodiment, the wicking barrier completely covers the body-side surface of the outer absorbent member and forms a seal with the backsheet in the region between the outer absorbent member and the central absorbent member and, optionally, is attached to the backsheet adjacent the outer

periphery of the outer absorbent member. Small apertures may be provided in the wicking barrier to permit some fluid intake into the outer absorbent member when the central absorbent member is heavily saturated, but ordinarily the outer absorbent member will remain dry. The apertures may be provided only near the longitudinal ends of the central absorbent member such that fluid cannot wick directly toward the crotch region of the outer absorbent member. Thus, the outer absorbent member primarily serves to provide comfort and body fit, while providing a substrate on which the wicking barrier can rest to resist fluid flowing out of the article.

The absorbent articles of the present invention can comprise a topsheet or a backsheet or both a topsheet and a backsheet, or other means to provide integrity to the article and comfort on the body side surface. An article can be made without a topsheet and/or without a backsheet, particularly if other components are present to provide suitable integrity of the product and liquid barrier functions. For example, a wicking barrier can be attached to the central absorbent member by attachment means including adhesives, ultrasonic bonds, threads, fiber-fiber entanglement, hook and loop structures, embossments, thermal bonds, elastic ligaments, and other means known in the art to hold the central absorbent member in place. The wicking barrier may also be attached to the outer absorbent member or outer shaping member by similar attachment means to hold it in place. Thus, the restraining or integrity-providing effect of the topsheet and backsheet in normal absorbent articles could be replaced by a wicking barrier suitably attached to the other components of the article. The wicking barrier may also wrap the outer absorbent member or outer shaping member to hold it in place and provide a liquid barrier function around or beneath that member. Comfort, softness, and dry feel functions of a conventional topsheet can be replaced by using suitable absorbent materials, particularly those that have been provided with additional hydrophobic material on the surface of the absorbent material to permit fluid intake yet provide a dry feel against the skin. Tufts of hydrophobic fibers attached to the absorbent core or spaced apart, elevated mounds of silicone material or other hydrophobic material on the surface may simulate the function of apertured films or nonwoven webs without necessarily forming a separate topsheet. Densified airlaid webs with sufficient integrity and optionally a portion of hydrophobic fibers on the surface can also be used for direct contact with the skin. Traditional topsheet materials such as nonwoven webs or apertured films can also be used to cover only a portion of the absorbent article, such as covering only the central absorbent member or only the outer absorbent member or outer shaping member. Likewise, backsheet material may be present on only a portion of the garment side of an article, such as beneath the central absorbent member where it can serve as a baffle layer. In many embodiments of

the present invention, however, it is likely that topsheets and backsheets will be used. Useful guidelines for both topsheets and backsheets now follow.

The topsheet has a body-facing side and a core-facing side. The body-facing side of the topsheet generally forms at least a portion of the body surface of the article. The topsheet should permit liquids to readily transfer through its thickness toward the absorbent core. The topsheet can comprise any fluid pervious cover material known in the art, such as nonwoven webs or apertured films, or other materials such as hydrophilic wet laid basesheets treated with portions of hydrophobic matter, including those of Chen et al. in commonly owned copending application, "Dual-zoned Absorbent Webs", Ser. No. 08/997,287, filed Dec. 22, 1997, previously incorporated by reference. Nonwoven webs used to produce a topsheet can include layers of spunbond material, meltblown material, and combinations thereof. The nonwoven webs may be apertured or slitted webs or provided with treatments for improved wettability, including corona discharge treatment, or treatments for improved flow permeability, such as hydroentangling or aperturing or microembossing. Creping of the nonwoven web using methods known in the art can desirably improve softness, appearance, and performance of the topsheet. The topsheet can comprise a layer of a perf-embossed or apertured film on the body side bonded to a layer of a nonwoven web, preferably treated to be hydrophilic, on the core side. Similarly, the topsheet can comprise two or more nonwoven layers or film and nonwoven layers that have been co-apertured to provide apertures suitable for rapid intake of viscous or viscoelastic fluids and to improve wicking contact with underlying absorbent materials. Examples of suitable co-apertured materials are disclosed in US Patent No. 5,188,625, issued Feb. 23, 1993 to Van Iten et al., herein incorporated by reference in its entirety. If apertured, the topsheet can have about 5 to about 60 percent open area and a thickness of about 0.01 to about 0.1 mm for a film or from about 0.03 to 0.5 mm for a fibrous nonwoven web.

The topsheet desirably is flexible and nonirritating to the wearer's skin. As used herein the term "flexible" refers to materials which are compliant and readily conform to the shape of the body or respond by easily deforming in the presence of external forces. Preferably the topsheet is not noisy, to provide discretion for the wearer. The topsheet desirably can be somewhat opaque to hide the bodily discharges collected in and absorbed by the absorbent core. The topsheet can further exhibit good strikethrough and a reduced tendency to rewet, permitting bodily discharges to rapidly penetrate the topsheet to the core, but not allowing such discharges to flow back through the topsheet to the skin of the wearer.

If desired, the topsheet can be sprayed with a surfactant to enhance fluid penetration to the absorbent core. The surfactant should typically be nonionic and should be nonirritating to the skin. A surfactant density of about 0.01 milligrams per square centimeter of topsheet area is suitable. A suitable surfactant is sold by the Glyco Chemical, Inc. of Greenwich, Conn., as PEGOSPERSE™ 200 ML surfactant.

Exemplary topsheets can be made in accordance with US Pat. No. 5,533,991, issued Jul. 9, 1996 to Kirby et al.; US Pat. No. 4,342,314 issued Aug. 3, 1982 to Radel et al. and US Pat. No. 4,463,045 issued Jul. 31, 1984 to Ahr et al., all of which are incorporated herein by reference. The topsheet may comprise an additional transfer layer to help direct fluid into the absorbent core, as disclosed, for example, in US Pat. No. 4,397,644, issued Aug. 9, 1983 to Matthews et al., herein incorporated by reference.

The topsheet need not have uniform properties but can be preferentially more permeable or liquid pervious or wettable over the central absorbent member than it is elsewhere. For example, the topsheet may be substantially porous and wettable over the central absorbent member but substantially nonwetting over the outer absorbent member. Particularly when the topsheet is adhesively attached to the outer absorbent member such that it remains in contact with the body-side surface of the outer absorbent member when in use, an impervious or nonwettable or low permeability section of the topsheet over the outer absorbent member can also serve the role of a horizontal component in the wicking barrier, though it is more desirable that the horizontal component of the wicking barrier be integral with the vertical component.

The topsheet and the backsheet may be adhesively attached to the absorbent core. Useful principles for adhesively attaching topsheets or other lamina to absorbent cores comprising comminuted fibers are disclosed in US Patent No. 4,573,986, issued Mar. 4, 1986 to Minetola et al., herein incorporated by reference in its entirety.

In the embodiments requiring a separate backsheet, the backsheet should strong enough for handling and flexible enough to fit body contours comfortably. The backsheet has a core-facing side and a garment side. At least a portion of the core-facing side of the backsheet will ordinarily face the core. The backsheet may be any flexible, liquid impervious material that prevents discharges collected by the absorbent article, such as a sanitary napkin, from escaping the absorbent article and soiling the undergarments and clothing of the wearer. Preferably, the backsheet is not noisy, to provide discretion for the wearer. The backsheet can also be impervious to malodorous gases generated by bodily discharges, so that the malodors do not escape and become noticed by the wearer and others. The backsheet can comprise any material known in the art of absorbent articles,

including polymeric films, low-permeability nonwoven webs, cloth layers desirably comprising an impervious layer or film, or polymer-tissue composites.

The backsheet can comprise two layers such as a first layer of a lofted material on the garment-facing side of the backsheet bonded to a second layer such as a polymeric film on the core-facing side. The lofted layer provides a comfortable, non-irritating surface against the body of the wearer. The lofted layer may be comprised of any suitable material, such as a nonwoven material. Desirably, the lofted layer comprises a hydrophobic nonwoven material. The second layer on the core-facing side can comprise a fluid impervious film. A low density polyethylene material about 0.01 to about 0.05 millimeters in thickness, such as about 0.02 millimeters in thickness, can work well as this second layer. The backsheet may also be made of a soft, cloth-like material which is hydrophobic relative to the topsheet. An exemplary cloth-like backsheet material is a laminate of a polyester nonwoven material and a film such as is described in US Pat. No. 4,476,180 issued to Wnuk on Oct. 9, 1984, which is herein incorporated by reference. Another exemplary multi-layered backsheet is that of Linman et al. in US Pat. No. 4,681,793, issued July 21, 1987, herein incorporated by reference, wherein an outer layer with a three-dimensional macroscopically expanded surface is used for better comfort. Desirably, the backsheet is a polyethylene film having a thickness of from about 0.012 mm to about 0.051 mm. Exemplary polyethylene films are manufactured by Clopay Corporation of Cincinnati, Ohio, under the designation P18-0401 and by Tredegar Film Products of Terre Haute, Ind., under the designation XP-39385.

The backsheet and other components may be biodegradable and/or flushable. A flushable article is one that can be directly discarded into a toilet and flushed without clogging piping and without harm to septic systems. Thus, in one embodiment, the backsheet is an impermeable sheet material that rapidly dissolves in cold tap water, and is thereby released from the absorbent core to help render the article flushable. Likewise, the topsheet and the wicking barrier can comprise flushable and/or biodegradable materials. Suitable materials for a flushable backsheet can include polyvinyl alcohol (PVA), starches, rice paper, guar gum, or polylactic acid polymers or copolymers. Other materials and methods for construction of a flushable article are disclosed in US Patent No. 5,300,358, issued Apr. 5, 1994 to Evers; US Patent No. 5,509,913, issued Apr. 23, 1996 to Yeo; US Patent No. 5,405,342, issued Apr. 11, 1995 to Roessler et al.; and US Patent No. 4,522,967, issued Jun. 11, 1985 to Sheldon et al.; all of which herein incorporated by reference in their entireties.

Since flushable structures must be small enough or break down in the toilet water to small enough pieces to flush, in larger flushable articles the core may be segmented

into unconnected individual pieces of a flushable size. The division of the absorbent core into a central absorbent member and an outer absorbent member is helpful in achieving such segmentation.

Because an impervious wicking barrier can be beneath the central absorbent member in many embodiments of the present invention, it is not imperative that the backsheet itself be absolutely impervious, at least not over its entire area, for adequate constraint of fluid in the central absorbent member by an impervious wicking barrier may make the primary function of the backsheet to be providing integrity to the article. Nevertheless, for best results, it is desired that the backsheet be substantially impervious, though it can be breathable to permit transmission of water vapor for comfort.

Generally, the topsheet is joined to the core-facing side of the backsheet along the longitudinal edges of the topsheet and can be joined along at least one transverse line such as an end edge.

When a baffle layer beneath the central absorbent member is required, the materials described herein for the backsheet or for the wicking barrier can generally be used, and either the backsheet or wicking barrier can serve as the baffle layer.

The absorbent core comprises two primary sections, a central absorbent member and an outer absorbent member (or, in some embodiments, an outer shaping member, previously described) with a central void or depression therein which can at least partially receive the central absorbent member such that an interface is established between the two sections that spans a finite vertical distance. Desirably, the central absorbent member has at least one in-plane dimension smaller than the corresponding dimension of the outer absorbent member. Generally, the transverse width of the central absorbent member will be less than the transverse width of the outer absorbent member at least in the crotch region. For purposes of the present invention, the absorbent core generally is considered to be a separate component from any flaps or wings added to the article, even if they also comprise absorbent material.

The absorbent materials of the absorbent core, including either the central absorbent member or the central absorbent member or both, can comprise one or more plies of wetlaid or airlaid tissue; cellulosic airlaid webs of comminuted fibers (commonly termed "airfelt"); other dry laid webs; cellulose-superabsorbent mixtures or composites; hydroentangled webs comprising cellulosic fibers; composites of synthetic fibers and papermaking fibers; cellulosic foams including regenerated cellulose foams; hydrophilic flexible foams; fiber-foam composites; absorbent nonwoven webs; the foam-structured fibrous absorbent materials of F.-J. Chen et al. disclosed in the commonly owned, copending US patent application "Fibrous Absorbent Material and Methods of Making the

Same," Serial Number 09/083,873, , filed May 22, 1998, herein incorporated by reference; or absorbent foams produced from high internal phase emulsions (HIPE), such as the foams disclosed in US Patent No. 5,692,939, issued Dec. 2, 1997 to DesMarais, herein incorporated by reference. The absorbent materials of the absorbent core can also comprise corrugated absorbent materials for enhanced longitudinal transport of fluid, such as the materials disclosed in US Patent No. 4,578,070, issued Mar. 25, 1986 to Holtman, herein incorporated by reference in its entirety.

A commercially available air-laid web is AIRTEX™ 395 air-laid web sold by James River Corporation located in Green Bay, Wisconsin . AIRTEX 395 air-laid web is 100% virgin softwood held together by an acrylic binder. Concert Fabrication Ltee, of Ontario, Canada, also produces a variety of densified airlaid webs held together with thermoplastic binder material.

A particularly useful cellulose-polymer composite material is coform, a hydraulically entangled mixture of pulp fibers and polymer, such as the materials disclosed in US Patent No. 4,879,170, issued Nov. 7, 1989 to Radwanski et al.; US Pat. No. 4,100,324 to Anderson et al. and US Pat. No. 5,350,624 to Georger et al., the contents of which are incorporated herein by reference in their entireties.

Any suitable form of cellulosic material can be incorporated in the absorbent materials of the absorbent core, including wood fibers, such as bleached kraft softwood or hardwood, high yield wood fibers, and chemithermomechanical pulp fibers; bagasse; milkweed; wheat straw; kenaf; hemp; or peat moss. The fibers can also be crosslinked, sulfonated, mercerized, heat treated, mixed with thermoplastic stabilizer fibers, or treated with wet strength agents. Mixtures of various fibers can be used, including coform, which comprises thermoplastic fibers and wood fibers deposited together in an airlaying process.

In one embodiment, the absorbent core comprises a molded, three-dimensional high bulk wet laid cellulosic web, such as an uncreped through-air dried web as taught by F.-J. Chen et al. in commonly owned US patent application, Serial Number 08/912,906, "Wet Resilient Webs and Disposable Articles Made Therewith," filed Aug. 15, 1997; US Pat. No. 5,429,686, issued to Chiu et al. on July 4, 1995; US Pat. No. 5,399,412, issued to S.J. Sudall and S.A. Engel on March 21, 1995; US Pat. No. 5,672,248, issued to Wendt et al. on Sept. 30, 1997; and US Pat. No. 5,607,551, issued to Farrington et al. on March 4, 1997; all of which are herein incorporated in their entirety by reference. Such uncreped structures can offer a plurality of flow channels along the surface of the web. When stacked or layered with other planar materials such as a polymer film, void space can still exist adjacent the surface of the tissue web to permit rapid flow of fluid parallel to the plane of the tissue web. Further, the uncreped tissues show excellent wet resiliency

and high bulk under load when wet. Without wishing to be limited by theory, it is believed that the three-dimensional surface structures of such textured webs can maintain their shape and bulk when wet because the hydrogen bonds defining the arrangement of the fibers are formed in the molded, three-dimensional state, so the structure does not relax to a flat state when wetted.

Dimensions of the components of the absorbent article can be suited and optimized for particular functions. For feminine care pads, for example, the outer absorbent member can have a transverse width (distance from one outer longitudinal side to the other across the transverse centerline, not the smaller edge width defined previously) of from about 4 cm to about 8 cm and a length of from about 15 cm to about 30 cm. The central void in the outer absorbent member may have a transverse width of from about 2 cm to about 6 cm, more specifically from about 3 cm to about 5 cm, and can have a length of from about 4 cm to about 30 cm, more specifically from about 6 cm to about 20 cm, resulting in a desirable distance from the longitudinal edge of the central absorbent member to the nearest outer longitudinal edge of the outer absorbent member (which can also be the edge width of the outer absorbent member, assuming no significant gap between the outer absorbent member and the central absorbent member) of from about 0.3 cm to about 2.5 cm, and more specifically from about 0.5 cm to about 2 cm, and more specifically still from about 0.7 cm to about 1.5 cm. Appropriately larger dimensions would be desirable for diapers and many other absorbent articles. For example, the central absorbent member may be from about 4 cm to about 10 cm in width in a diaper.

Basis weights of the components of the absorbent core can be adjusted and optimized for particular purposes over a wide range. Generally, it is desirable that the basis weight of the central absorbent member be greater than the outer absorbent member because the central absorbent member is intended to contain the primary source of absorbent material for the article, and the outer absorbent member can desirably function as a secondary source of absorbent material when the absorbent capacity of the central absorbent member is exceeded. Thus, the basis weight of the central absorbent member can range, for example, from about 100 grams per square meter (gsm) to about 2500 gsm, more specifically from about 200 gsm to about 1200 gsm, and more specifically still from about 300 gsm to about 800 gsm. The basis weight of the outer absorbent member (or, in some embodiments, of the outer shaping member) can range from about 100 gsm to about 2000 gsm, more specifically from about 200 gsm to about 1000 gsm, and most specifically from about 200 gsm to about 600 gsm.

The absorbent capacity of either the central absorbent member or the outer absorbent member can be optimized for the intended use of the article. In diapers, the absorbent capacity of the central absorbent member generally should be greater than 60 ml and can be about 300 ml or less of fluid, more specifically about 200 ml or less, more specifically still about 150 ml or less, with exemplary ranges of from about 80 ml to about 250 ml or from about 100 ml to about 300 ml. For some uses, such as in sanitary napkins, it is desirable that the absorbent capacity of the central absorbent member be at least 7 ml of fluid, specifically at least 10 ml, more specifically at least 16 ml, more specifically still at least 20 ml, and most specifically from about 15 ml to about 35 ml. In one embodiment, the absorbent capacity of the outer absorbent member is less than the absorbent capacity of the central absorbent member. For example, the outer absorbent member can have an absorbent capacity of about 5 to about 100% of the absorbent capacity of the central absorbent member, or the ratio can be about 90% or less, more specifically about 70% or less, and more specifically still about 30% or less. If desired, however, the outer absorbent member can have a higher absorbent capacity than the central absorbent member. In a less preferred embodiment, the outer absorbent member can have relatively little absorbent capacity , such as between about 1 ml to about 5 ml, but can primarily serve to provide a body-fitting shape to the article and to retain the central absorbent member and the wicking barrier. A ring of a flexible polyurethane foam would be an example of a less absorbent outer member that could serve such a purpose, even if it were a closed-cell foam, but it is preferred that the outer member be relatively absorbent to provide additional protection and absorbency to the article, in addition to optionally serving other functions such as body fit, comfort, integrity of the article, and wetness indication.

For ultrathin pads and other absorbent articles, it is desirable that the dry components of the absorbent core have a total thickness between about 2 mm and about 15 mm, and more specifically from about 3 mm to about 8 mm. When wetted, the central absorbent member and/or the outer absorbent member may increase substantially in thickness and void volume, such as a thickness increase of about 100% or greater, more specifically about 200% or greater, and more specifically still about 300% or greater. An example of a low-cost cellulosic component capable of increasing in thickness when wet is the absorbent material of Chen and Lindsay disclosed in commonly owned copending US application Ser. No. 08/848,353, "Self-texturing Absorbent Structure and Absorbent Articles Made Therefrom," filed April 21, 1997, or the densified structures of Hollenberg et al. in US Pat. No. 5,779,860, "High-density Absorbent Structure," issued July 14, 1998, both of which are herein incorporated by reference in their entireties.

Regenerated cellulose sponge materials are also capable of expanding significantly when wet and can be used to enhance body fit and conformability by providing nonuniform basis weights that expand in a three-dimensional shape.

Either the central absorbent member or the outer absorbent member or both, or individual plies thereof, may be embossed for improved control over fluid wicking, if desired. The absorbent members likewise may be apertured, slitted for improved flexibility and body conformability, perf-embossed, calendered, or pleated. A central slit in the central absorbent member can be especially useful in products for feminine care, for the slit can result in deformation of the article in use that enhances contact with the body for better absorption of menses.

Other components may be combined with the cellulosic materials of the absorbent core or added as separate layers or portions of the article. Such other components include odor absorbing components such as baking soda, talc powder, cyclodextrin, ethylenediamine tetra-acetic acid, zeolites, activated silica, and activated carbon granules, fabrics or fibers; superabsorbent particles and fibers; antimicrobial agents including the silver-loaded zeolites of BF Technologies, located in Beverly, Massachusetts, sold under the trademark HEALTHSHIELD™, as well as triclosan products, chitosan or chitin derivatives; polycarboxylic acids; encapsulated perfumes; emollients such as lanolin; or skin wellness agents such as aloe vera extract or vitamin E. Thermoplastic binder fibers may be added, with or without subsequent heat treatment for improved stability. Foam layers, foam shape-defining components, or foam particles may also be present. Plastic inserts to define shape or maintain integrity may also be used.

The central absorbent member generally can be of any shape such as circular, elliptical, rectangular, triangular, polygonal, dog-bone shaped, hourglass shaped, or diamond shaped, and is inset or inserted into a depression or void in an outer absorbent member having either a width or length, or both, greater than the respective width or length of the central absorbent member. The central absorbent member desirably has a longitudinal length greater than the width, with the length extending desirably across 30% or more of the length of the article, more specifically 50% or more, more specifically still 75% or more, and most specifically 90% or more of the length of the absorbent article, including 100% of the length of said article. The maximum width of the central absorbent member can be 100% of the width of the absorbent article but desirably is no more than about 90%, more specifically no more than about 75%, and more specifically still no more than about 60% of the width of the absorbent article.

The central depression or void of the outer absorbent member is desirably a region of reduced basis weight relative to the other regions of the outer absorbent member, but

can also be a region which has been compressed in thickness substantially such that a depression is defined which can receive an absorbent insert to serve as a central absorbent member.

The center strip or strips that replace a portion of the surrounding outer absorbent member, or are inset into a depression or void in the outer absorbent member, can offer a z-direction gradient in material properties to achieve desired objectives in fluid transport, dryness, odor control, and/or fluid retention. For example, the central absorbent material may be two or more strips of cellulosic material, such as an upper strip of an airlaid or wetlaid material having a first density or mean pore size and a second lower strip of an airlaid or wetlaid material having a second density or mean pore size. Desirably, the mean pore size of the lower strip is smaller than that of the upper strip such that capillary forces will preferentially remove fluid from the upper strip into the lower strip for an improved dry feel. In one embodiment, the lower strip is a wet laid material such as a through-dried tissue having a density greater than 0.1 grams per cubic centimeter (g/cc) and suitably greater than about 0.15 g/cc, while the upper strip is an air laid material having a density less than about 0.15 g/cc and specifically less than about 0.1 g/cc. The combined basis weight of the central absorbent strip or strips can be greater than, less than, or about the same as that of the surrounding outer absorbent member, with characteristic values between about 50 and 500 gsm, specifically between about 100 and 400 gsm, and more specifically between about 150 and 300 gsm. Desirably, though, the central absorbent member has a substantially higher basis weight than the outer absorbent member for better efficiency in material usage.

If two or more strips are present in the central absorbent member, the basis weight of the lower strip can be about the same, less than, or greater than that of the upper strip. Two or three layers with differing wicking capacities can be used, as disclosed in US Patent No. 5,401,267, issued Mar. 28, 1995 to Couture-Dorschner et al., herein incorporated by reference in its entirety. The strips can be textured or three-dimensional webs, such as webs that have been wet-molded, dry-molded, embossed, apertured, co-apertured, folded, pleated, scored, perforated, perf-embossed, or spot bonded. For sanitary napkins, the central absorbent member desirably comprises at least one layer with a longitudinal slit therein to promote a W-shape fold in the pad when it is laterally compressed between the thighs of the user, such that the central absorbent member folds upward toward the body for improved fit and fluid intake. Alternatively, "brick slits" can be used wherein a series of short slits are spaced apart and staggered on two or more parallel longitudinal lines, or other slit patterns can be used, desirably with a

predominantly longitudinal orientation. Score marks or embossing lines can also be applied to promote proper bending of the article in use.

The central inserts for placement in the central depression or void of the outer absorbent member can also be fully wrapped in nonwoven or other material, with the proviso that a portion of the wrap must serve to delay wicking relatively significantly more than does the horizontal surface of the wrapped insert to reduce edge wicking. In many embodiments, the sides of the wrapped insert desirably are substantially impermeable. For some absorbent articles, the central inserts desirably rise above the plane of the surrounding outer absorbent member to provide an elevated central region for improved body fit. The stiffness of elements in the central absorbent member can be adjusted relative to the outer absorbent member such that good body fit is maintained in use and that undesirable bunching of the article is prevented. Densified zones for improved bending can be included in the present invention, as well as wings, tabs, extensible components, cuffs or flaps.

The outer absorbent member can comprise the same absorbent materials as the central absorbent member or other absorbent materials known in the art, with cellulosic fibers being desirable for their low cost, good visual and tactile properties, good absorbent capacity, and biodegradability. Desirably, the outer absorbent member is fibrous with fibers that are essentially discontiguous with the central absorbent member (i.e., the central absorbent member and the outer absorbent member do not share fibers that join the two members). The outer absorbent member desirably has a lower basis weight than the central absorbent member but still provides several important functions. Generally, it is intended that the outer absorbent member remain unwetted except in cases of heavy flow. The unwetted structure of the outer absorbent member does not collapse but maintains high integrity in the dry state, which helps maintain the shape and fit of the article. When it does become wetted, the outer absorbent member can serve as an indicator that the absorbent article needs to be replaced. The indicator function can be visual (e.g., the user sees that flow has reached the outer absorbent member, indicating the need to replace the article), tactile (e.g., fluid reaching the outer absorbent member can react with an agent that produces cold or heat in the outer absorbent member, or the decreased stiffness of the outer absorbent member when wetted may result in a noticeable change in the feel of the article when compressed by the user's legs), olfactory (e.g., microencapsulated perfumes in the outer absorbent member may be released upon wetting to provide a pleasant smell as a cue for changing the article), or auditory (dry particles may swell and emit a crackling sound when wetted, analogous to puffed rice

cereal, or a small electronic circuit may emit a beep when conductive fluid contacts one or more electrodes).

In one embodiment, the outer absorbent member is replaced with an outer shaping member whose primary function is not to absorb fluid but to provide shape and stability to the article as it cradles or holds in place the wicking barrier and the central absorbent member. These functions are desirably achieved with an absorbent material such as cellulose fibers or a hydrophilic foam, but when the absorbent capacity of the central absorbent member is adequate, the outer absorbent member will generally not be needed for its liquid absorbent capacity and thus can be replaced with a material such as a less absorbent polymeric foam (e.g., foam rubber) for comfort, fit, shape, and product integrity.

The wicking barrier can comprise any barrier material between two segments of material that reduces lateral wicking of fluid from the central absorbent member to the surrounding outer absorbent member. The barrier spans a finite vertical distance in the absorbent article, such as about 2 mm or greater, specifically about 3 mm or greater, more specifically about 5 mm or greater, and most specifically from about 4 mm to about 15 mm. The barrier material can be a polymeric film or plastic film; a nonwoven web; a layer of rubber, silicone, or other non-absorbent materials; or a less pervious paper sheet including, for example, glassine, wax paper, impregnated papers, paper-polymer composites, densified tissue, tissue containing internal sizing to render it less hydrophilic or tissue treated with hydrophobic matter such as wax, silicone, thermoplastic material, or polyolefins. Flexible hydrophobic foams may also be used, such as a closed-cell polyurethane foam or a silicone foam. A low density hydrophobic web such as a bonded carded web of a polyolefin (such as materials commonly used for surge layers in diapers, but without surfactants or other hydrophilic treatments) can also be used, including the transfer delay barrier materials disclosed in the commonly owned US patent application Ser. No. 60/079,657, "An Absorbent System for Personal Care Products Having Controlled Placement of Visco-Elastic Fluids" by A.S. Burnes et al., herein incorporated by reference in its entirety. Desirably, the barrier material will have a porosity less than 90%, specifically less than 50%, more specifically less than 30%, and more specifically the barrier material will be substantially nonporous or substantially impermeable, though a small number of apertures or small openings can be provided in selected portions of the barrier material to prevent oversaturation of the central absorbent member. With apertures added, it is still desirable that the average open area of the barrier material be less than 20% and more specifically less than about 10%. Suitably, the thickness of the wicking barrier can be about 5 mm or less, specifically about 2 mm or less, more

specifically about 1 mm or less, and most specifically about 0.5 mm or less. In some cases, such as when a barrier material in the form of a flexible polymer sheet is used, including a polypropylene or polyethylene web, the barrier material can have a thickness of about 0.2 mm or less, more specifically about 0.1 mm or less, and most specifically about 0.08 mm or less, with an exemplary range of from about 0.02 mm to about 0.3 mm.

The barrier material can also comprise hydrophobic matter that is used to impregnate a portion of the outer absorbent member or a portion of the central absorbent member to reduce lateral wicking. Such hydrophobic matter can include adhesives and particularly hot melt adhesives added to the absorbent article while molten; wax; pastes or emulsions comprising waxes; silicone-based fluids, gels, pastes, or caulk; phenolic resins or other resins which are cured after impregnating the fibrous material of the central absorbent member or outer absorbent member; polyolefins or other plastic or hydrophobic material added as powder, particularly sintered powder, or held in place by adhesives, or by thermal bonding. In addition to the impregnating material, which helps prevent lateral fluid flow in the article, it is also desirable that there be a distinct break, gap, or slit between the central absorbent member and the outer absorbent member in the crotch region to further impede fluid communication, especially by removing or severing fibrous pathways between the central absorbent member and the outer absorbent member.

Desirably, the Intrinsic Absorbent Capacity of the barrier material is about 1 or less, more specifically less than about 0.5, more specifically still less than about 0.3, and most specifically less than about 0.1.

The barrier material can be placed along a portion of the perimeter of a central absorbent member to reduce or prevent wicking to the surrounding outer absorbent member. In such an embodiment, the wicking barrier desirably can comprise a thin layer of a hydrophobic material such as a polymeric film, a nonwoven web, a thermoplastic material, a layer of hot melt adhesive, or a flexible material such as a wax impregnated in the fibers adjacent the perimeter of the central absorbent member. When the wicking barrier is a polymeric film or nonwoven web, it desirably has radial dimensions when set in place slightly greater than the radial dimensions of the central absorbent member such that a strip of the material rests on the surface of the absorbent core to define a visible barrier along at least a portion of the perimeter of the central absorbent member.

The barrier can also comprise material from the backsheet of the absorbent article which is embossed, deformed, pleated, or stretched so as to rise above the conventional plane of the backsheet into the barrier zone between the central absorbent member and the surrounding absorbent material. Likewise, the wicking barrier can comprise material from the topsheet that penetrates into the absorbent core to separate the central

absorbent member from the outer absorbent member or from an outer shaping member, particularly when the topsheet material is rendered impervious or hydrophobic by chemical treatment, impregnation of adhesive or thermoplastic material, or heat sealing.

The barrier material can also be an adhesive such as a hot melt, a fluoropolymer, a wax, latex, or other known hydrophobic materials which are added or deposited on at least one side and preferably both longitudinal sides of a central absorbent member to hinder lateral wicking, particularly wicking normal to the longitudinal direction of the absorbent article.

In one embodiment, the wicking barrier is integral or unitary with the backsheet, and comprises an extended portion of the backsheet which wraps a portion of the outer absorbent member and penetrates into the absorbent core, separating the outer absorbent member from the central absorbent member and desirably becoming attached to itself under the central absorbent member. In one embodiment, the horizontal component of the wicking barrier comprises a portion of the backsheet that is wrapped around the outer absorbent member. The vertical component of the backsheet may also comprise a portion of the backsheet that is wrapped around the outer absorbent member.

In a related embodiment, the effect of the wicking barrier is augmented with a moat, wherein a strip or ring of finite thickness essentially void of absorbent material separates two or more zones of absorbent material to reduce lateral wicking from one zone to the other, and optionally to provide a channel or channels to redirect macroscopic flow of fluid acting under the influence of gravity, inertia, or hydraulic pressure. For example, a central absorbent member of a diaper with an hourglass or rectangular shape can be physically separated from the surrounding outer absorbent member by a moat-like void region having a desirable gap width of from about 0.3 mm to about 15 mm, more specifically at least about 1 mm. The moat-like void region can form a concentric ring around the central absorbent member or can isolate the central absorbent member from the outer absorbent member by one or more strait or curved elongated separation zones.

In another embodiment, the vertical component of the wicking barrier can be substantially above the outer absorbent member, covering a portion of the longitudinal sides of a central absorbent member that resides above the outer absorbent member. In one such embodiment, for example, the outer absorbent member may comprise a substantially flat layer of absorbent material having a first width. A central absorbent member having a second width less than the first width resides above the outer absorbent member, with a layer of wicking barrier material sandwiched therebetween, the wicking barrier material having a width intermediate the first and second widths. A portion of the wicking barrier rises vertically along a portion of the longitudinal sides of the central

absorbent member to prevent lateral flow therefrom, and may optionally further wrap a portion of the upper surface of the central absorbent member to form a more complete barrier to hinder fluid communication from the sides of the central absorbent member to the underlying outer absorbent member (or an underlying outer shaping member).

The central absorbent member can comprise the same material as the surrounding outer absorbent member or can be a multi-ply assembly of wet laid tissue or a mixture of wet laid and air laid components, desirably also comprising superabsorbent material which may be laminated in pockets, adhesively attached to the plies, embedded in an airlaid layer, or present as fibers or films.

Optionally, a surge layer can be disposed between the topsheet and the absorbent core, specifically above the central absorbent member, to enhance intake of fluid, particularly urine and particularly in absorbent articles intended for urine management such as diapers, training pants, or incontinence pads. The surge layer is typically a non-absorbent or marginally absorbent (e.g., having an Intrinsic Absorbent Capacity less than about 0.9 and specifically less than about 0.3) high-loft nonwoven web, such as a bonded carded web, of synthetic materials such as polyethylene or polypropylene, which does not retain liquid but helps to distribute it into the underlying absorbent core. Basis weights for such a surge layer are desirably between about 15 gsm and about 100 gsm, with porosities above about 96%. Exemplary surge layers are described in US Patent No. 5,562,650, issued Oct. 8, 1996 to Everett et al.; US Patent No. 5,527,300, issued Jun. 18, 1996 to Sauer; US Patent No. 5,490,846, issued Feb. 13, 1996 to Ellis et al.; and US Patent No. 5,429,629, issued July 4, 1995 to Latimer; all of which are herein incorporated by reference in their entireties.

In one embodiment, an absorbent article according to the present invention can be created by placing a central absorbent strip into a depression in an outer absorbent member wherein a substantially vertical barrier material is at the edges of the central absorbent strip to reduce lateral flow. For example, a depression or stamped out region can be formed in an absorbent pad and the depression or stamped out region is lined with a meltblown barrier layer, a polymeric film, or other barrier material, whereafter a central absorbent strip is placed in the depression or stamped out region to serve as a central absorbent member having barrier to lateral leakage toward the surrounding outer absorbent member. The barrier material may permit z-direction transport toward the outer absorbent member more readily than it permits lateral flow, as can be achieved, for example, by providing perforation in the middle of an impervious film whose unapertured sides block lateral flow into the surrounding outer absorbent member.

Related embodiments can be produced by simply stamping out the region of the absorbent core that lies underneath the air laid strips (thus forming an outer absorbent member with a void therein) and placing a meltblown barrier layer, which is slightly wider than the airlaid strips, over the resulting hole such that most of the meltblown barrier layer is in contact with the backsheet and a recess is defined in the outer absorbent member. The air laid strips, optionally with other absorbent materials, are then pressed into the recess in the outer absorbent member. The meltblown barrier layer deforms around the air laid strips to form a substantially vertical barrier between the strips and the surrounding core. Excess width of the meltblown barrier layer will result in a band of meltblown material around the center strips, which may offer a visual cue (especially if the meltblown is colored) of a protective ring around the central absorbent area. The band can form a complete ring around the central absorbent zone, or can form longitudinal bands separating the sides of the article from the central target region.

Numerous other embodiments of the present invention are possible wherein a web, film, or sheet of limited or relatively reduced fluid permeability serves as a barrier for flow of fluid from a central absorbent member to a surrounding absorbent member. The barrier need not be completely liquid impervious, but can offer substantial flow resistance by virtue of pore size or flow path tortuosity, or can offer capillary resistance by virtue of surface chemistry, such that wicking of fluid from the central absorbent member is substantially reduced in rate relative to a similar absorbent article without the barrier material. For example, the barrier material can be a polymeric apertured film or nonwoven web such as a meltblown web, which can permit fluid flow under gradients of hydraulic pressure but which limits spontaneous wicking out of the central absorbent member. Importantly, the barrier material provides a barrier effect across a finite vertical distance in the absorbent article such that the barrier material acts as a barrier for lateral flow rather than solely as a barrier for vertical flow from one superposed layer to another.

In embodiments using an apertured film for the wicking barrier, the film should be oriented to hinder flow from the central absorbent member toward the outer absorbent member. Many apertured films provide flow directionality, wherein flow passes through the film most easily when fluid is deposited on one side of the film. For example, many films have tapered or conical apertures with large openings on one side and narrow openings on the other, wherein fluid on the side with the large openings passes readily through the film, whereas fluid on the side with the narrow openings is more likely to be hindered from passing through the film. When a film provides such directionality, it is desirable that the side most likely to hinder fluid flow be placed toward the central absorbent member. In this manner, wicking flow from the central absorbent member to

the outer absorbent member may be delayed until the central absorbent member is substantially saturated.

Leakage prevention in sanitary napkins and related absorbent articles for feminine care pose particular problems due to the wide range of forces the article will experience in actual use. In particular, transverse compression of the pad by the legs of the user can result in lateral "bunching" with a wide variety of possible deformations in the product. While the use of vertical barriers between absorbent zones according to the present invention yields excellent center fill results and leakage reduction in lab tests and in theory, the dynamic conditions of actual use can sometimes interfere with the effectiveness of the vertical barriers between absorbent zones. Most importantly, if transverse compression or bunching of the absorbent article causes the edges of the outer absorbent member to fold into contact with the central absorbent member, then wicking contact can be established between the two zones in spite of the vertical wicking barrier, resulting in fluid transport to the outer absorbent member and possible leakage out the side of the article. To maintain a center fill strategy in sanitary napkins under the dynamic conditions of actual product use, it is desirable to implement strategies to prevent bypassing of the wicking barrier and to maintain isolation of the absorbent members.

The presence of a horizontal component or ledge on the body surface of the absorbent material attached to the vertical component of the wicking barrier is one useful means of preventing contact of the central absorbent member with the outer absorbent member during transverse compression. In one embodiment, the ledge has increased width in the crotch region of the article such that the horizontal component of the wicking barrier along the transverse axis of the article covers about 30% or more, specifically about 50% or more and most specifically about 80% or more of the surface of the outer absorbent member along the transverse axis of the article, with essentially 100% coverage in the crotch region being desirable in some embodiments. In some embodiments, it is desirable that the ledge be relatively narrow (e.g., less than 4 mm or less than 3 mm) except in the crotch region, where the ledge can expand to cover a significant portion (about 30% or more, about 50% or more, or about 80% or more) of the distance between the central absorbent member and the longitudinal edges of the outer absorbent member, such that complete folding of the edges of the article into contact with the central absorbent member will not result in wicking contact between the absorbent material of the outer absorbent member with that of the central absorbent member.

Other means can also be employed to prevent wicking contact during bunching of the absorbent article. The topsheet or cover itself can play an important role. In one embodiment, the cover can be rendered substantially impervious over the outer absorbent

member in the crotch region such that wicking between absorbent members is impeded even when the outer absorbent member is folded into contact with the central absorbent member. An apertured film, for example, can simply be made free of apertures in regions where imperviousness is desired such as over the outer absorbent member in the crotch region or over the entire outer absorbent member. To selectively render an otherwise pervious nonwoven material impervious, it can be coated or sprayed with water repellent materials, including those which form a film or can occlude openings. Waxes, acrylic coating materials, and silicone compounds that form gels or films, for example, may be used.

In one embodiment, the topsheet is provided with loops, folds or pleats on the surface to provide regions that are elevated above the absorbent material of the absorbent core, no longer in direct contact with the absorbent material of the core and desirably running in a longitudinal direction, as disclosed by U. Hagrud et al. in PCT publication WO 98/24389, "Absorbent Article with Improved Leakage Security," published June 11, 1998. Hagrud et al. disclose air-filled material folds on the surface of an absorbent article having a longitudinal direction which serve as barriers to fluid flow on the surface of the article and which are said to provide improved comfort to the wearer. The folds can be provided by an impervious fabric applied to the edges of the article or can be formed from the liquid-pervious cover material. The material used to make the folds must be adhered or otherwise attached to an underlying layer, such as a tissue or airlaid strip, at a number of discrete points or along parallel discrete lines or bands between which the folds are formed from material having a length greater than the distance between adjoining points or bands of contact. Such loops, folds or pleats of material, for purposes of the present invention, can be adapted to also help prevent wicking contact of the central absorbent member with the outer absorbent member during conditions of dynamic use.

Desirably, the loops, pleats, or folds are given increased bulk and body by bunching a larger quantity of material together than is necessary to make a single loop. More particularly, it is desirable to have multiple folds or a spiral winding pattern to take up additional material in the fold, pleat, or loop, to increase the body thereof and provide more wet stable resistance to fluid leakage. Thus, the cover material can be wound with multiple turns, or provided with multiple folds and pleats within a small area to increase the bulk of the section, and then stabilized or sealed into place with heat, ultrasound, mechanical pressure, or application of adhesive. The loop or fold can also be provided with additional matter therein to increase its thickness and flow restraining or comfort properties. For example, a length of a fibrous tow or yarn with a diameter of about 0.5 to

about 3 mm may be enclosed in a loop or fold of a nonwoven topsheet along the perimeter of the central absorbent member or superposed over the outer absorbent member to help provide a gasketing function against the body of the wearer, particularly if the loop or fold is treated to be impervious or hydrophobic. Further, the loop or fold filled with fibrous material can better conform to the body and provide a cushiony feel for improved comfort, while serving as a flow controlling agent that prevent wicking contact between the central absorbent member and the outer absorbent member.

In one embodiment, the cover or topsheet of the article is provided with an air-filled or hydrophobic fiber-filled loop or fold of material substantially centered along or running over the boundary between the outer absorbent member and the central absorbent member, particularly in the crotch region. Desirably, the wicking barrier in the boundary also has a horizontal component serving as a ledge residing over a portion of the outer absorbent member, and the cover is adhesively attached just outside the ledge toward the nearest longitudinal edge of the article and is also adhesively attached a distance inside the central absorbent member to define a loop of unattached material substantially over the boundary between the two segregated members of absorbent material. The unattached portion of the fold or pleat over the boundary can buckle away from the boundary as the outer absorbent member is folded toward the central absorbent member with the boundary zone acting approximately as a hinge or hinge region. The outwardly buckled unattached material of the cover provides two additional layers of cover material which can interfere with wicking between the two segregated members, extending the protection offered by the ledge to a greater distance to more fully interfere with wicking to the edges even when the article is severely bunched or transversely compressed during use.

Additionally or alternatively, a loop of material over the central absorbent member slightly inside the boundary can act to help prevent wicking contact of the outer absorbent member with the central absorbent member when the two members are folded toward each other.

The loops, folds, or pleats in the cover material or other material added to the cover to form pleats can be treated to be hydrophobic or impervious in the regions not in contact with the absorbent core to further enhance the ability of the loops, folds, or pleats to prevent undesired fluid transport to the outer absorbent member.

Means can also be applied to reduce the tendency of a pad or sanitary napkin to bunch or fold over onto itself during transverse compression. Wings and tabs that fold over the edge of undergarments are useful in helping to maintain the shape of a pad and can reduce undesirable bunching of the article. Even without tabs or wings, related

advantages can be obtained with proper placement of adhesives on the backsheet of the absorbent article. In many commercial articles, the articles are provided with adhesive strips on the backsheet protected with a layer of release paper that can be removed to permit adhesive attachment of the article to the user's panties. The adhesive strips or zones are typically near the center of the article, permitting the use of narrow strips of release paper. However, placement of the adhesive strips nearer to the edge of the pad or napkin can be more effective in holding the edges of the article in place and reducing the tendency of the article to fold over on itself, and particularly in preventing the outer absorbent member from contacting the central absorbent member. Wider release paper may be needed, or two narrow strips of release paper may be used to cover adhesive strips on the longitudinal sides of the article, but the improved placement and stability of the article attached to the edges of the user's undergarments is believed to offer significant performance advantages.

Preshaping of a pad can be useful, including the means disclosed in US Patent No. 5,545,156, issued Aug. 13, 1996 to DiPalma et al., herein incorporated by reference in its entirety.

It is also desirable to provide the absorbent core of the article with cuts, embossments, or score lines to direct the manner in which the article bends or buckles when in use such that good body fit is achieved. Examples of such an approach are disclosed in US Patent No. 5,514,104, issued May. 7, 1996 to Cole et al., herein incorporated by reference in its entirety. Embossments in the central absorbent member are desirable to promote a fold along the longitudinal centerline in sanitary napkins. Desirably, the embossments (densified areas) should rise toward the body rather than descend away from the body to encourage the central absorbent member to fold up toward the body when compressed from the sides in use.

One embodiment of the central absorbent member of the present invention comprises multiple layers of barrier material sandwiched between regions of absorbent material to form a composite structure wherein multiple barrier regions interfere with radial or lateral wicking (i.e., with horizontal fluid transport) either by imposing impervious barriers or by directing flow in tortuous pathways. As such, in one embodiment, the barrier material of a composite structure may be a wicking barrier as previously discussed herein. The composite structure forms a primary or central absorbent member which need not be surrounded by additional absorbent material but which may comprise substantially all of or a major portion of the absorbent material in an absorbent article, or can comprise an entire layer of absorbent material in such an article. Desirably, the composite structure is a concentric absorbent structure wherein multiple layers of vertically oriented barrier

material alternate between multiple layers of absorbent material either in complete loops such as circles or ellipses, or in a spiral structure. The spiral embodiment of the concentric absorbent structure is analogous to a thinly sliced portion of the "jelly roll" of cake and fruit filling that is well known among bakers and confectioners in the United States and Switzerland, wherein a sheet of flexible cake is coated with the filling and then rolled into a spiral wound structure with concentric bands of cake and filling. The similarity to a jelly roll is due to the concentric absorbent structure comprising a plurality of concentric bands of absorbent material, preferably spiral wound, with each band of absorbent material being adjacent to a thin barrier layer. The resulting composite structure with multiple barrier layers intrinsically offers the highest permeability in the z-direction (the thickness direction of the structure, also the direction substantially parallel to the plane of the wound barrier material), while permeability in the radial direction is relatively lower due in part to the orientation of fibers in the concentric bands and due to the presence of wicking barrier material between the bands to restrict flow. If the barrier material is impermeable, which it can be, then the barriers define a labyrinth-like spiral path for fluid being wicked from central regions of the composite structure to outer regions of the structure. The labyrinth-like pathway restricts the radial expansion of fluid and helps prevent leakage out of the sides of the article.

The multiple regions of barrier material provide multiple vertical barriers to isolate successive zones of the central absorbent member from the longitudinal sides of the article and from any outer absorbent member. The presence of such multiple barriers of generally hydrophobic material or nonabsorbent material reduces the need for a horizontal component or ledge on the surface of the absorbent core, though the wicking barrier can still desirably be provided with a horizontal component for improved protection against leakage or surface smearing. Desirably, a horizontal component or ledge is provided only on the radially outermost section of the wicking barriers, and particularly at the boundary of the central absorbent member and the outer absorbent member. Thus, the wicking barrier between the composite central absorbent member and the outer absorbent member can be provided with both a vertical component and a horizontal component, the latter forming a ledge on the body-side surface of the absorbent core.

A spiral-wound absorbent structure can be formed from any layer of absorbent material placed adjacent to a layer of barrier material, followed by rolling of the absorbent material and barrier material about a rolling axis (e.g., rolled in a specified direction) to form a parent roll, whereupon the parent roll is sliced substantially normal to the rolling axis to give a disk-like layer having a spiral characteristic with alternating concentric bands of absorbent material and barrier material similar to a jelly roll.

The absorbent material of concentric absorbent structures of the present invention can be any of the materials previously mentioned for use in the absorbent core or other materials known by those skilled in the art. The absorbent material can comprise one of more layers that can be overlapped. Alternatively, two or more layers of absorbent material can be butted or spliced prior to forming the concentric absorbent structure such that the absorbent material varies in composition or properties from the center toward the outer edges of the concentric absorbent structure. Likewise, one or more layers of absorbent material may be treated to have spatial gradients in properties such as density, contact angle or wettability, superabsorbent content, or the content of other additives, such that material properties in the absorbent vary with position in the concentric absorbent structure. Further, non-layered materials such as lengths of yarn, bands of absorbent tow, or other materials may be combined with the absorbent material at various locations as it is wound and incorporated into the concentric absorbent structure.

When a molded, three-dimensional sheet is used to form the concentric absorbent structure of the present invention, and particularly uncreped through-dried tissues, substantial flow channels exist for enhanced fluid flow in the thickness direction, thus permitting rapid intake of fluid from urine insults or menses gushes, while also providing absorbency and fluid retention capacity due to the absorbency of the tissue itself.

The concentric absorbent structure can be formed by rolling absorbent material and barrier material around itself, or can be wrapped around a central absorbent member. For example, a roll of cotton material, fluff pulp, or other absorbent material could serve as a central core around which additional absorbent material and barrier material could be wrapped to form a concentric absorbent structure surrounding a first central absorbent member. In this manner, the concentric absorbent structure could serve as an extension of the first concentric absorbent structure, thus being a second central absorbent member which, together with the absorbent central core, forms a composite central absorbent member, or the concentric absorbent structure could comprise an outer absorbent member around the central absorbent member.

The barrier material is a thin layer of material such as a polymeric film or hydrophobic matter which can serve to reduce liquid transport from one absorbent layer to another, as can a polymer film or hydrophobic material placed on a surface of the absorbent material before it is wound into a parent roll. Desirably, the barrier material is flexible to permit winding with the adjacent absorbent material without significant damage to the barrier material. The structure is useful as an intake component in an absorbent article, or as a portion of a primary absorbent core, or as a multifunctional component offering both intake and fluid retention capabilities. The structure is especially well suited

for enhancing transport of fluids in the thickness direction (z-direction) of the structure and reducing fluid leakage to the edges of the absorbent article.

The barrier material may be impervious or may be permeable to liquid or, in one embodiment, has an in-plane gradient in permeability and/or porosity such that the highest permeability or porosity is found in the center portions of the concentric absorbent structure, with the permeability or porosity decreasing with radial distance from the center of the absorbent structure such that lateral flow is most strongly hindered as the edges of the absorbent structure are approached, thus reducing the tendency for wetted absorbent articles to leak toward the edges of the article.

In one embodiment, the barrier material serves to reduce friction between adjacent layers of absorbent material such that the coils or layers of the spiral-like material can move relative to one another in the z-direction of the absorbent structure, resulting, for example, in a telescoping type of action. The possibility for out-of-plane motion of the bands in the concentric absorbent structure permits improved body conformability and reduced stiffness. The barrier material itself can comprise multiple plies.

In one embodiment, the barrier material is a web or film having a first surface that is fixedly attached by adhesive or thermal bonding to a first surface of a tissue web prior to forming a parent roll, and further having a small quantity of adhesive material at discrete and widely separated points or lines on the opposing second surface of the barrier material, such that the resulting concentric absorbent structure can still flex and exhibit a degree of telescoping motion, but wherein the degree of telescoping or z-direction deformation is restrained by the discrete spots of bonding between the second surface of the barrier material and the adjacent second surface of the tissue web in the wound structure.

For example, a polymer film having a basis weight less than 10 grams per square meter (gsm) and preferably less than 3 gsm may be adhesively bonded on its lower surface with a uniform application of adhesive to the upper surface of an underlying through-dried tissue web, desirably uncreped, having a basis weight of about 20 gsm to about 100 gsm, preferably from about 35 gsm to about 60 gsm, and having a bulk at 0.344 kPa (0.05 pounds per square inch) measured by a 7.62-centimeter (3-inch) diameter platen of from about 6 cc/g to about 40 cc/g, and specifically from about 10 cc/g to about 25 cc/g. The upper surface of the polymer film may be printed with discrete lines of contact adhesive running parallel to the axis of winding of the polymer-tissue composite. The thin lines of contact adhesive may be spaced apart by about 0.5 cm to about 2.5 cm. The wound structure, when sliced, yields concentric absorbent structures wherein the barrier material is fixedly attached to one surface of the wound tissue web

and loosely attached by the spaced apart adhesive lines to small portions of the opposing surface of the tissue web, still permitting some z-direction deformation for improved body conformability but restraining the telescoping motion to maintain high integrity of the concentric absorbent structure under shear and compressive stresses.

In another embodiment, the barrier material may comprise two plies of polymeric material with low friction between the two. Such a structure could be formed by laminating a polymeric web or adding other hydrophobic material to both sides of a tissue ply or both the upper and lower surfaces of a multi-ply tissue or cellulosic structure and then rolling or folding the composite to form a parent roll from which the concentric absorbent structure may be sliced. Likewise, simply two layers of a polymeric web could be laid adjacent a cellulosic structure and then rolled or folded to create the parent roll in whatever shape is desired. In this manner, improved mobility of the bands may be achieved by virtue of the low friction between the adjacent barrier material plies. Alternatively, a second ply or layer of barrier material may be added to only selected regions of an already present barrier material ply or layer in contact with tissue before formation of the parent roll to provide increased barrier function or mobility in selected zones of the concentric absorbent structure.

The shape of the concentric absorbent structure can be customized to correspond to the shape of the absorbent article. In one embodiment, the parent roll is formed by folding the tissue-barrier composite about a flat length of the composite to form non-circular parent roll which can then be compressed near the middle region to have an hourglass shape.

In addition to multilayered concentric absorbent structures, central absorbent members can comprise other absorbent structures with multiple vertical layers of barrier material. For example, a stack of multiple layers of absorbent material alternating with layers of barrier material can be assembled without rolling the structure and sliced normal to the plane of the individual layers to create a stratified composite having absorbent zones separate by wicking barriers. Such a stratified composite can be used as a central absorbent member, desirably lined with an additional layer of barrier material to reduce fluid escape from the ends of the layers of absorbent material.

The absorbent articles of the present invention can be combined with other functional materials internally (as by adding material into the absorbent material or on the barrier material) or externally (as by joining with additional layers), including but not limited to odor absorbents, activated carbon fibers and particles, baby powder, zeolites, perfumes, fire retardants, superabsorbent particles, nonwoven materials, plastic films or apertured films, extruded webs, closed cell foams, adhesive strips and tapes, tissue webs,

electronic devices such as alarms indicating wetness or leakage and other wetness indicators, opacifiers, fillers, aerogels, sizing agents, antimicrobial agents, enzymes such as those capable of modifying and particularly reducing the viscosity of menses, ion exchange material, or enzyme inhibitors for prevention of damage to skin by digestive enzymes.

Skin comfort can be enhanced with the addition to the topsheet or body side surface of the absorbent core of other desirable materials such as aloe vera derivatives, lotions, emollients, silicone compounds, vitamin E, or derivatives of tallow and vegetable oils for softness and lubricity. Agents to reduce or prevent itching and skin redness can be included on the topsheet, backsheet, or absorbent members of the present invention, and can include the product sold as ENTELINE 2® by Persperse, Inc. (Piscataway, NJ) which comprises butylene colycol, glycerin, and enteromorpha compressa extract. In general, additional layers, films, particulates, and chemicals can be added through the articles of the present invention.

Shape enhancing elements may be added to improve body fit, including contoured foams, regenerated cellulose structures that expand when wetted, air-filled pouches (including an air filled pouch formed by the wicking barrier and backsheet joined together beneath the central absorbent member), elasticized gathers and other elastic elements. Fluid control elements may be added such as cuffs, waist bands, leg gathers, or surge layers. Additional tissue layers may be added to restrain particulates (e.g., forming a multilayer laminate with superabsorbent particles), improve wicking, or provide integrity for the absorbent core. Adhesives such as construction adhesive or latex, including hydrophobic and hydrophilic varieties, may be used to attach adjoining layers and provide improved integrity and functionality. Fiber-foam composites can be included and can be a component of the outer absorbent member and/or the central absorbent member.

In one embodiment, the absorbent structure comprises a portion of activated carbon fibers to yield a fibrous structure having excellent odor absorbing abilities due to the high permeability of the structure to gas and due to the high fraction of accessible surface area of the fibers. The surface chemistry of the activated carbon fibers should be tailored for optimum absorption or wicking of the target fluids or gases of the fibrous structure and can be rendered hydrophilic. For example, acidic groups on the activated carbon fibers can be desirable for absorbing basic compounds comprising ammonium moieties. Acidic groups can be added by treating the fibers at elevated temperature in the presence of steam, carbon dioxide, or nitric acid. Basic groups, useful for absorbing acidic compounds such as hydrochloric acid, can be introduced by treatment with ammonia at elevated temperatures or by other treatments known in the art. Suitable fibers and fiber

treatment methods include those disclosed in PCT patent application, "Coated Absorbent Fibers," by James Economy and Michael Daley of the University of Illinois, published as WO 96/38232, Dec. 5, 1996, and on the Univ. of Illinois Web site at "http://www.students.uiuc.edu/~ahall/activated carbon fabrics.html" as of January 1998, which discloses a variety of gas treatments at elevated temperature to activate the fibers and control the surface chemistry.

In embodiments comprising fibrous cellulosic absorbent materials, other additional additives and agents commonly known in the papermaking arts can be used. Wet strength agents, dry strength agents, crosslinking agents, surface chemistry modifiers, biocides or antimicrobials, or softeners can be present. When recycled fibers or other papermaking fibers are used, a quantity of filler materials such as calcium carbonate or titanium dioxide can be present. For absorbent articles intended to absorb body fluids, it is desirable that post-consumer recycled fibers not be used, though opacifiers, fillers, and other agents can be present or deliberately added. In most cases, virgin papermaking fibers are desirable for their mechanical properties and lack of contaminants. For example, odor-removing additives can be desirably present in the structures of the present invention, including activated carbon granules or fibers, activated silica particulates, ethylenediamine tetra-acetic acid, zeolites, polycarboxylic acids, anti-bacterial agents, talc powder, sodium bicarbonate, encapsulated perfumes, cyclodextrin, chitosan or chitin.

The absorbent core and particularly the absorbent material of the central absorbent member can comprise cellulosic fibers stabilized with a binder material. Likewise, the multiple layers that can be used in the outer absorbent member or the central absorbent member can be joined together with a binder material, or a binder material can attach the topsheet and/or the backsheet to the adjoining outer absorbent member or central absorbent member to improve pad integrity. The binder material may be water swellable or not water swellable. For best results in absorbent articles, the binder material desirably is substantially water insoluble, even when the binder material is water swellable. Preferably, the binder material provides not only good dry stability but also good wet stability and wet resiliency to the absorbent fibrous structure when wetted with liquid water. For applications where wet resiliency is needed to maintain high void volume even under compressive loads, the binder material desirably is not water swellable, is desirably water insoluble, and desirably has a binder wet strength to dry strength ratio of about 10% or greater, specifically about 20% or greater, more specifically about 40% or greater, and most specifically about 50% or greater. The same desirable ranges for binder wet strength to dry strength ratio apply to swellable binder materials as well.

For swellable binder materials, carboxymethylcellulose is a useful material capable of binding fibers and absorbing water. Aside from carboxymethylcellulose, polymers which are also suitable for use, particularly for freeze drying and other embodiments of the present invention, include a wide variety of anionic, cationic, and nonionic materials. Suitable polymers include polyacrylamides, polyvinyl alcohols, ethylene maleic anhydride copolymer, polyvinylethers, polyacrylic acids, polyvinylpyrrolidones, polyvinylmorpholines, polyamines, polyethyleneimines, polyacrylamides, polyquaternary ammoniums, natural based polysaccharide polymers such as carboxymethyl celluloses, carboxymethyl starches, hydroxypropyl celluloses, algins, alginates, carrageenans, acrylic grafted starches, acrylic grafted celluloses, chitin, and chitosan, and synthetic polypeptides such as polyaspartic acid, polyglutamic acid, polyasparagins, polyglutamines, polylysines, and polyarginines, as well as the salts, copolymers, and mixtures of any of the foregoing polymers. Polyglucan succinate or glutarate, for example, can also be used, particularly when cross-linked to form diester-crosslinks.

Other polymeric materials useful as binder materials include anionic and cationic latexes, wet strength agents, hydrocolloids, pectin, sodium carboxymethylcellulose, thrombin, collagen, amylose derivatives, algin, guar gum, or synthetic gums.

The absorbent core and particularly the central absorbent member fibrous structure can have gradients in material properties extending in the thickness direction or in directions in the plane of the article. Gradients or variations in basis weight and thickness can readily be provided, but other material properties such as fiber composition, pore size, or wettability can have gradients as well. For example, a planar absorbent member suitable for use in an absorbent article may have large pores and large open cells near a top surface, with cells that become progressively smaller near the opposing back surface, optionally terminating in a skin on the back surface which can be partially or substantially liquid impervious. Such a structure with a porosity gradient may be suitable for liquid intake on the top surface but can prevent liquid leakage from the back surface. Articles may be provided with gradients in hydrophilicity as well, with more hydrophilic binder material and fibers in one region (e.g., a top surface) than elsewhere (e.g., a back surface). Gradients may extend in the plane, giving, for example, an article with large cells or pores in a central target region but with more closed cells or smaller pores near the side edges of the absorbent fibrous structure to prevent lateral leakage of fluid.

For feminine care articles, tabs and wings can be added to the sides of the absorbent article. The wicking barrier can extend to the beginning of the tab or wing or beyond, though desirably the wicking barrier prevents lateral wicking of fluid into the region of the tab or wing. In one embodiment, the wicking barrier comprises a transverse

section which extends laterally past the absorbent core to form a component of wings or tabs. Such a section can be an integral part of the wicking barrier or can be a second wicking barrier member in addition to a first wicking barrier member contained within the absorbent core.

The absorbent article can also be provided with densified zones or embossments that permit bending or folding of the article for improved fit or attachment to undergarments, or can be provided with elastic bands, cuffs, leg barriers, waist barriers, pockets for retaining feces, and other structural elements well known to those skilled in the art.

A variety of shaping elements can be added to control the folding or contours of the article in use, and to help maintain body fit. Elasticized regions and bands, for example, can be applied within the absorbent core or in longitudinal cuffs or along the backsheet to help direct curvature and contours of the article for improved fit.

Beneath the central absorbent member, it is possible to add soft, resilient or gas-filled shaping elements to raise the central absorbent member into contact with a body during use. For example, conformable foam or other material may be inserted underneath the central absorbent member, either in contact with the central absorbent member or between a layer of barrier material (i.e., the wicking barrier) and the backsheet. In one embodiment, the wicking barrier passes under the central absorbent member and contacts the backsheet, and is sealed against the backsheet around a periphery in a manner that encloses a volume of air to act as an air cushion beneath the central absorbent member for improved fit and comfort. Alternatively, a layer of material such as bubble wrap may be added to provide a cushion effect for comfort and fit.

As used herein, a material is said to be "absorbent" if it can retain an amount of water equal to at least 100% of its dry weight as measured by the test for Intrinsic Absorbent Capacity given below (i.e., the material has an Intrinsic Absorbent Capacity of at about 1 or greater). Desirably, the absorbent materials used in the absorbent members of the present invention have an Intrinsic Absorbent Capacity of about 2 or greater, more specifically about 4 or greater, more specifically still about 7 or greater, and more specifically still about 10 or greater, with exemplary ranges of from about 3 to about 30 or from about 4 to about 25 or from about 12 to about 40.

As used herein, "Intrinsic Absorbent Capacity" refers to the amount of water that a saturated sample can hold relative to the dry weight of the sample and is reported as a dimensionless number (mass divided by mass). The test is performed according to Federal Government Specification UU-T-595b. It is made by cutting a 10.16 cm long by 10.16 cm wide (4 inch long by 4 inch wide) test sample, weighing it, and then saturating it

with water for three minutes by soaking. The sample is then removed from the water and hung by one corner for 30 seconds to allow excess water to be drained off. The sample is then re-weighed, and the difference between the wet and dry weights is the water pickup of the sample expressed in grams per 10.16 cm long by 10.16 cm wide sample. The Intrinsic Absorbent Capacity value is obtained by dividing the total water pick-up by the dry weight of the sample. If the material lacks adequate integrity when wet to perform the test without sample disintegration, the test method may be modified to provide improved integrity to the sample without substantially modifying its absorbent properties. Specifically, the material may be reinforced with up to 6 lines of hot melt adhesive having a diameter of about 1 mm applied to the outer surface of the article to encircle the material with a water-resistant band. The hot melt should be applied to avoid penetration of the adhesive into the body of the material being tested. The corner on which the sample is hung in particular should be reinforced with external hot melt adhesive to increase integrity if the untreated sample cannot be hung for 30 seconds when wet.

As used herein, "absorbent capacity" refers to the total mass of water that a specified quantity of absorbent material can hold, and is simply the Intrinsic Absorbent Capacity multiplied by the dry mass of the absorbent material. Thus 10 g of material having an Intrinsic Absorbent Capacity of 5 has an absorbent capacity of 50 g (or about 50 ml of fluid).

"Absorbency Under Load" (AUL) is a measure of the liquid retention capacity of a material under a mechanical load. It is determined by a test which measures the amount in grams of an aqueous solution, containing 0.9 weight percent sodium chloride, a gram of a material can absorb in 1 hour under an applied load or restraining force of about 2 kPa (0.3 pound per square inch).

The AUL apparatus comprises a Demand Absorbency Tester (DAT) as described in US Patent No. 5,147,343, issued Sept. 15, 1992 to Kellenberger, herein incorporated by reference, which is similar to a GATS (Gravimetric Absorbency Test System), available from M/K Systems, Danners, Mass. A level porous plate is used having ports confined within a 2.5 cm. diameter area to provide liquid saline solution, 0.9 (w/w)% sodium chloride, delivered from a reservoir to the porous plate such that there is no hydraulic head (neither positive pressure nor suction) at the top of the porous plate. Thus, fluid can be absorbed into the absorbent without overcoming a significant capillary pressure barrier to move liquid out of the porous plate. Fluid absorbed from the plate is replaced with liquid from the reservoir, which resides on an electronic balance that measures the amount of liquid removed from the reservoir and absorbed into the absorbent. The sample on the porous plate resides within a section of 2.54 cm (one-inch) inside diameter thermoplastic

tubing machined-out slightly to be sure of concentricity. Stainless steel wire cloth with 0.15 mm openings (100 mesh) is fused on the bottom of the cylinder to restrain the sample and any particulates therein. Care must be taken to maintain a flat smooth bottom and not distort the inside of the cylinder. A 4.4 g piston is made from 2.54 cm (one inch) diameter solid material (e.g., a clear plastic) and is machined to closely fit without binding in the cylinder. A standard 100 gm weight placed on the piston is used to provide a 21,000 dyne/sq.cm. (about 0.3 psi) restraining load which is commonly experienced in infant diapers. To carry out the test with a foam-like fibrous material or a foam, a material sample is cut into circular discs with a diameter slightly smaller than 2.54 cm (one inch) to freely fit within the sample tube. The sample mass should be from about 0.05 g to about 0.16 g.

This test is initiated by placing a 3 cm diameter GF/A glass filter paper onto the porous plate (the paper is sized to be larger than the inner diameter and smaller than the outer diameter of the cylinder), to insure good contact while eliminating evaporation over the ports of the DAT and then allowing saturation to occur. The material to be tested is placed on the wire cloth at the bottom of the AUL apparatus. The sample is then covered with a plastic spacer disc, weighing 4.4 grams and having a diameter of about 2.527 cm (0.995 inch), which serves to protect the sample from being disturbed during the test and also to uniformly apply a load on the entire sample. After carefully placing the piston and weight on the sample in the cylinder, the AUL apparatus is placed on the glass filter paper. The amount of fluid pick-up is monitored as a function of time either directly by hand, with a strip chart recorder or directly into a data acquisition system.

The amount of fluid pickup measured after one hour is the AUL value, expressed as grams of liquid per dry gram of the tested material.

The AUL of the materials of the present invention can be above 6 grams/gram, more specifically about 10 grams/gram or greater, still more specifically about 15 grams/gram or greater, and most specifically about 25 grams/gram or greater, with an exemplary range of from about 9 to about 40 grams/gram. While high AUL values can be achieved without the additional of superabsorbent material or swellable binder material, especially high values of AUL are possible through incorporation of superabsorbent material into the absorbent structure. Superabsorbent material can be incorporated as loose particulates, particles bound to the hydrophilic fibers, superabsorbent fibers, or as a component of the binder material or structuring composition.

As used herein, "Free Swell Capacity" (FS) is the result of a test which measures the amount in grams of an aqueous solution, containing 0.9 weight percent sodium chloride, that a gram of a material can absorb in 1 hour under negligible applied load. The

test is done as described above for the AUL test, except that the 100 gm weight is not placed on the sample.

The Free Swell Capacity of the materials of the present invention can be above 8, more specifically above 10, more specifically above 20, and most specifically above 30 grams/gram.

As used herein, "Free Swell:AUL Ratio" is the ratio of Free Swell Capacity to AUL. It will generally be greater than one. The higher the value, the more sensitive the material is to compressive load, meaning that the sample is less able to maintain its potential pore volume and capillary suction potential under load. Desirably, the materials of the present invention have "Free Swell:AUL Ratio" of about 4 or less, more specifically about 2 or less, more specifically still about 1.5 or less, and more specifically about 1.3 or less, with an exemplary range of from about 1.2 to about 2.5.

"Water retention value" (WRV) is a measure that can be used to characterize some fibers useful for purposes of this invention. WRV is measured by dispersing 0.5 gram of fibers in deionized water, soaking overnight, then centrifuging the fibers in a 4.83 cm (1.9 inch) diameter tube with an 0.15 mm (100 mesh) screen at the bottom at 1000 gravities for 20 minutes. The samples are weighed, then dried at 105° C. for two hours and then weighed again. WRV is (wet weight - dry weight)/dry weight. Fibers useful for purposes of this invention can have a WRV of about 0.7 or greater, more specifically from about 1 to about 2. High yield pulp fibers typically have a WRV of about 1 or greater.

As used herein, a "flexible film" is one that a bulk material (e.g., the absorbent components of the article or materials used to provide shape in an outer shaping member) is considered "flexible" if a straight, TAPPI-conditioned (50 percent relative humidity at 22.7°C) strip of the material 25 cm long with a cross-section of 1cm x 1 cm can be bent 180° around a 5-cm diameter rod without breaking and without requiring application of more than about 6 Newtons of force to the ends of the strip to cause the bending over a 3-second span of time. The same material is "shape retaining," as used herein, if the strip is held in place on the rod for 5 seconds and then remains bent to an angle of at least 30° after the strip is removed from the rod (i.e., the strip is deformed such that the straight portions at the ends of the strip are at an angle relative to each other of at least 30°).

As used herein, "flexure resistance" is another means of expressing the flexibility of a material or article and is measured according to the Circular Bend Procedure described in detail in US Patent No. 5,624,423, issued Apr. 29, 1997 to Anjur et al., herein incorporated by reference in its entirety. Flexure resistance is actually a measurement of peak bending stiffness modeled after the ASTM D4032-82 Circular Bend Procedure. The Circular Bend Procedure of Anjur et al. is a simultaneous multidirectional deformation of a

material in which one face of a specimen becomes concave and the other face becomes convex. The Circular Bend Procedure gives a force value related to flexure-resistance, simultaneously averaging stiffness in all directions. Desirably, the absorbent article has a flexure-resistance of less than or equal to about 1,500 grams, more specifically about 1000 grams or less, more specifically still about 700 grams or less and most specifically about 600 grams or less.

As used herein, the term "horizontal," refers to directions in the plane of the article that are substantially parallel to the body-side surface of the article, or, equivalently, substantially normal to the vertical direction of the article, and comprises the transverse direction and the longitudinal direction of the article, as well as intermediate directions.

As used herein, the "absorbent core" of an absorbent article refers to the combination of the central absorbent member and the outer absorbent member which together form substantially all of or a major portion of the absorbent material in the absorbent article. Generally, the absorbent core is held in a facing relationship with the region of the user's body that produces fluid exudates to be absorbed. While additional absorbent material may be incorporated in optional tabs, flaps, or wings that are generally folded away from the exudate-producing surfaces of the body and wrapped around undergarments on the absorbent article, such absorbent material is not considered as part of the absorbent core, as the term is used herein. It is particularly desired that flow from the target region (the insult point adjacent the user's body) toward the longitudinal sides of the absorbent core of the article be hindered by the wicking barrier. Additional means for hindering flow from the longitudinal sides of the absorbent core toward optional flaps, tabs, or wings can also be incorporated in the articles of the present invention, including the use of additional barrier material spanning a vertical distance in the article.

The term "sanitary napkin", as used herein, refers to an article which is worn by females adjacent to the pudendal region that is intended to absorb and contain the various exudates which are discharged from the body (e.g., blood, menses, and urine). While the present invention is shown and described in the form of a sanitary napkin, it should be understood that the present invention is also applicable to other feminine hygiene or catamenial pads such as panty liners, or other absorbent articles such as diapers or incontinence pads. The term "feminine care pad" as used herein is synonymous with sanitary napkin.

As used herein, the "crotch region" of an absorbent article refers to the generally central region that will be in contact with the crotch of the user, near the lowermost part of the torso, and resides between the front and rear portions of the article. Typically the

crotch region contains the transverse centerline of the article and generally spans approximately 7 to 10 cm in the longitudinal direction.

"Papermaking fibers," as used herein, include all known cellulosic fibers or fiber mixes comprising cellulosic fibers. Fibers suitable for making the webs of this invention comprise any natural or synthetic cellulosic fibers including, but not limited to nonwoody fibers, such as cotton, abaca, kenaf, sabai grass, flax, esparto grass, straw, jute hemp, bagasse, milkweed floss fibers, and pineapple leaf fibers; and woody fibers such as those obtained from deciduous and coniferous trees, including softwood fibers, such as northern and southern softwood kraft fibers; hardwood fibers, such as eucalyptus, maple, birch, and aspen. Woody fibers can be prepared in high-yield or low-yield forms and can be pulped in any known method, including kraft, sulfite, high-yield pulping methods and other known pulping methods. If bleached, any known bleaching method can be used. Synthetic cellulose fiber types include rayon in all its varieties and other fibers derived from viscose or chemically modified cellulose. Chemically treated natural cellulosic fibers can be used such as mercerized pulps, chemically stiffened or crosslinked fibers, or sulfonated fibers. For good mechanical properties in using papermaking fibers, it is often desirable that the fibers be relatively undamaged and largely unrefined or only lightly refined. While recycled fibers can be used, virgin fibers are generally desirable for their mechanical properties and lack of contaminants. Mercerized fibers, regenerated cellulosic fibers, cellulose produced by microbes, rayon, and other cellulosic material or cellulosic derivatives can be used. Suitable papermaking fibers can also include recycled fibers, virgin fibers, or mixes thereof. In certain embodiments capable of high bulk and good compressive properties, the fibers can have a Canadian Standard Freeness of at least 200, more specifically at least 300, more specifically still at least 400, and most specifically at least 500.

As used herein, "high yield pulp fibers" are those papermaking fibers of pulps produced by pulping processes providing a yield of about 65 percent or greater, more specifically about 75 percent or greater, and still more specifically from about 75 to about 95 percent. Yield is the resulting amount of processed fiber expressed as a percentage of the initial wood mass. High yield pulps include bleached chemithermomechanical pulp (BCTMP), chemithermomechanical pulp (CTMP), pressure/pressure thermomechanical pulp (PTMP), thermomechanical pulp (TMP), thermomechanical chemical pulp (TMCP), high yield sulfite pulps, and high yield Kraft pulps, all of which contain fibers having high levels of lignin. Characteristic high-yield fibers can have lignin content by mass of about 1% or greater, more specifically about 3% or greater, and still more specifically from about 2% to about 25%. Likewise, high yield fibers can have a kappa number greater than 20, for example. The preferred high yield pulp fibers, after being prepared by pulping and

optional bleaching steps and prior to being formed into dry bales or webs, in one embodiment can also be characterized by being comprised of comparatively whole, relatively undamaged fibers, high freeness (200 Canadian Standard Freeness (CSF) or greater, more specifically 250 CSF or greater, and still more specifically 400 CSF or greater), and low fines content (less than 25 percent, more specifically less than 20 percent, still more specifically less that 15 percent, and still more specifically less than 10 percent by the Britt jar test known to those skilled in the art of papermaking). In one embodiment, the high-yield fibers are preferably predominately softwood, more preferably northern softwood, and most preferably northern softwood BCTMP.

As used herein, the term "cellulosic" is meant to include any material having cellulose as a major constituent, and specifically comprising at least 50 percent by weight cellulose or a cellulose derivative. Thus, the term includes cotton, typical wood pulps, nonwoody cellulosic fibers, cellulose acetate, cellulose triacetate, rayon, thermomechanical wood pulp, chemical wood pulp, debonded chemical wood pulp, milkweed, or bacterial cellulose.

As used herein, the term "polymeric web" refers to a porous or nonporous layer primarily composed of polymeric material, and can be a nonwoven web, a plastic film, a polymeric film, an apertured film, or a layer of foam. Polymeric webs can be used as wicking barriers, baffle layers, backsheets, and, if sufficiently liquid pervious, as topsheets of absorbent articles. A polymeric web can consist of about 50 weight percent or more polymeric material, more specifically about 80 weight percent or more polymeric material, and most specifically about 90 weight percent or more polymeric material. Exemplary materials include polyolefins, polyesters, polyvinyl compounds, and polyamides.

As used herein, "bulk" and "density," unless otherwise specified, are based on an oven-dry mass of a sample and a thickness measurement made at a load of 0.34 kPa (0.05 psi) with a 7.62-cm (three-inch) diameter circular platen. Thickness measurements of samples are made in a TAPPI-conditioned room (50% relative humidity and 22.7°C) after conditioning for at least four hours. Samples should be essentially flat and uniform under the area of the contacting platen. Bulk is expressed as volume per mass of fiber in cc/g and density is the inverse, g/cc.

As used herein, "Wet Bulk" is based on a caliper measurement of a sample according to the definition of "bulk" above (at 0.344 kPa), except that the conditioned sample is uniformly misted with deionized water until the moistened mass of the sample is approximately 250% of the dry mass of the sample (i.e., the added mass of the moisture is 150% of the dry sample weight). If the sample cannot absorb and retain enough moisture from misting to increase the mass by 150%, then the highest level of achievable

moisture add-on below 150% but still above 100% moisture add on should be used. The Wet Bulk is calculated as the thickness of the substantially planar moistened sample under a load of 0.344 kPa (0.05 psi) divided by the oven-dry sample basis weight in g/cc. Absorbent materials in the absorbent members of the present invention can have a Wet Bulk of about 4 cc/g or greater, more specifically about 6 cc/g or greater, more specifically still about 10 cc/g or greater, more specifically still about 10 cc/g or greater, and most specifically about 15 cc/g or greater, with an exemplary range of from about 5 cc/g to about 20 cc/g.

As used herein, a material will be considered to be "water soluble" when it substantially dissolves in excess water to form a solution, thereby losing its initial form and becoming essentially molecularly dispersed throughout the water solution. As a general rule, a water-soluble material will be free from a substantial degree of crosslinking, as crosslinking tends to render a material water insoluble. A material that is "water insoluble" is one that is not water soluble according to the above definition.

As used herein, the term "extensible" refers to articles that can increase in at least one of their dimensions in the x-y plane. The x-y plane is a plane generally parallel to the faces of the article. The term extensible includes articles that are stretchable and elastically stretchable (defined below). In the case of a sanitary napkin comprising an absorbent core, for example, the article and the absorbent core are desirably extensible both in length and width. The absorbent article, however, may only be extensible in one of these directions. Preferably, the article is extensible at least in the longitudinal direction. Examples of extensible materials and articles, and their methods of preparation, are disclosed in US Patent No. 5,611,790, issued Mar. 18, 1997 to Osborn, herein incorporated by reference in its entirety.

The absorbent article comprising an absorbent core can, in addition to being extensible, also be stretchable. The term "stretchable", as used herein, refers to articles that are extensible when stretching forces are applied to the article and offer some resistance to stretching. The terms "elastically stretchable" or "elastically extensible" are intended to be synonymous. These terms, as used herein, mean that when in-plane stretching forces are removed, the article or absorbent fibrous structure will tend to return toward its unextended or unstretched dimensions (or original dimensions). It need not return all the way to its unstretched dimensions, however. It may return to relaxed dimensions between its unstretched dimensions and extended (or stretched dimensions).

As used herein, "critical density" refers to the density at which a fibrous mat or pad will neither collapse nor expand when fully saturated with deionized water at 25°C. For papermaking fibers, the critical density is generally quoted as 0.2 grams/cc but actually

ranges from about 0.17 to about 0.25 grams/cc. Wet-laid paper sheets tend to have densities near the critical density. The absorbent materials for the absorbent members of the present invention can be produced at an initial density well below the critical density, such that the critical density is at least 2, 4, 6, 10, 20, or 30 times greater than the dry absorbent structure density. However, after calendering or other forms of mechanical compression, the density of the absorbent fibrous structure can approach the critical density or be above it, such that the density of the central absorbent member or the outer absorbent member can be greater than the critical density by a factor of about 1.2 or greater, more specifically 1.5 or greater, and more specifically still about 2 or greater. The outer absorbent member can have a density significantly below the critical density, such as below about 0.1 g/cc. Desirably, at least one layer of the central absorbent member has a density near or below the critical density, such as about 0.2 g/cc.

As used herein, "biodegradable" refers to the ability of a compound to ultimately be degraded completely into carbon dioxide and water or biomass by microorganisms and/or natural environmental factors. In one embodiment, the outer absorbent member and central absorbent member are substantially biodegradable. In another embodiment, the outer absorbent member, the central absorbent member, and the wicking barrier all comprises biodegradable materials or are substantially biodegradable.

As used herein, the term "hydrophobic" refers to a material having a contact angle of water in air of at least 90 degrees. In contrast, as used herein, the term "hydrophilic" refers to a material having a contact angle of water in air of less than 90 degrees.

As used herein, the term "surfactant" includes a single surfactant or a mixture of two or more surfactants. If a mixture of two or more surfactants is employed, the surfactants may be selected from the same or different classes, provided only that the surfactants present in the mixture are compatible with each other. In general, the surfactant can be any surfactant known to those having ordinary skill in the art, including anionic, cationic, nonionic and amphoteric surfactants. Examples of anionic surfactants include, among others, linear and branched-chain sodium alkylbenzenesulfonates; linear and branched-chain alkyl sulfates; linear and branched-chain alkyl ethoxy sulfates; and silicone phosphate esters, silicone sulfates, and silicone carboxylates such as those manufactured by Lambent Technologies, located in Norcross, Georgia. Cationic surfactants include, by way of illustration, tallow trimethylammonium chloride and, more generally, silicone amides, silicone amido quaternary amines, and silicone imidazoline quaternary amines. Examples of nonionic surfactants, include, again by way of illustration only, alkyl polyethoxylates; polyethoxylated alkylphenols; fatty acid ethanol amides; dimethicone copolyol esters, dimethiconol esters, and dimethicone copolyols such as

those manufactured by Lambent Technologies ; and complex polymers of ethylene oxide, propylene oxide, and alcohols. One exemplary class of amphoteric surfactants are the silicone amphoterics manufactured by Lambent Technologies (Norcross, Georgia).

As used herein, "wet strength agents" are materials used to immobilize the bonds between fibers in the wet state. Typically, the means by which fibers are held together in paper and tissue products involve hydrogen bonds and sometimes combinations of hydrogen bonds and covalent and/or ionic bonds. In the present invention, it is desirable to provide a material that will allow bonding of fibers in such a way as to immobilize the fiber to fiber bond points and make them resistant to disruption in the wet state. In this instance, the wet state usually will mean when the product is largely saturated with water or other aqueous solutions, but could also mean significant saturation with body fluids such as urine, blood, mucus, menses, runny bowel movement, lymph and other body exudates.

There are a number of materials commonly used in the paper industry to impart wet strength to paper and board that are applicable to this invention. These materials are known in the art as "wet strength agents" and are commercially available from a wide variety of sources. Any material that when added to a paper web or sheet results in providing the sheet with a wet geometric tensile strength:dry geometric tensile strength ratio in excess of 0.1 will, for purposes of this invention, be termed a wet strength agent. Typically these materials are termed either as permanent wet strength agents or as "temporary" wet strength agents. For the purposes of differentiating permanent from temporary wet strength, permanent will be defined as those resins which, when incorporated into paper or tissue products, will provide a product that retains more than 50% of its original wet strength after exposure to water for a period of at least five minutes. Temporary wet strength agents are those which show less than 50% of their original wet strength after being saturated with water for five minutes. Both classes of material find application in the present invention. The amount of wet strength agent added to the pulp fibers can be at least about 0.1 dry weight percent, more specifically about 0.2 dry weight percent or greater, and still more specifically from about 0.1 to about 3 dry weight percent, based on the dry weight of the fibers.

Permanent wet strength agents will provide a more or less long-term wet resilience to the structure. In contrast, the temporary wet strength agents would provide structures that had low density and high resilience, but would not provide a structure that had long-term resistance to exposure to water or body fluids. The mechanism by which the wet strength is generated has little influence on the products of this invention as long as the

essential property of generating water-resistant bonding at the fiber/fiber bond points is obtained.

Suitable permanent wet strength agents are typically water soluble, cationic oligomeric or polymeric resins that are capable of either crosslinking with themselves (homocrosslinking) or with the cellulose or other constituent of the wood fiber. The most widely-used materials for this purpose are the class of polymer known as polyamide-polyamine-epichlorohydrin type resins. These materials have been described in patents issued to Keim (US Patent 3,700,623 and US Patent 3,772,076) and are sold by Hercules, Inc., located in Wilmington, Delaware, as KYMENE 557H polyamine-epichlorohydrin resins. Related materials are marketed by Henkel Chemical Co., located in Charlotte, North Carolina, and Georgia-Pacific Resins, Inc., located in Atlanta, Georgia.

Polyamide-epichlorohydrin resins are also useful as bonding resins in this invention. Materials developed by Monsanto and marketed under the SANTO RES™ label are base-activated polyamide-epichlorohydrin resins that can be used in the present invention. These materials are described in patents issued to Petrovich (US Patent 3,885,158; US Patent 3,899,388; US Patent 4,129,528 and US Patent 4,147,586) and van Eenam (US Patent 4,222,921). Although they are not as commonly used in consumer products, polyethylenimine resins are also suitable for immobilizing the bond points in the products of this invention. Another class of permanent-type wet strength agents are exemplified by the aminoplast resins obtained by reaction of formaldehyde with melamine or urea.

Suitable temporary wet strength resins include, but are not limited to, those resins that have been developed by American Cyanamid and are marketed under the name PAREZ™ 631 NC wet strength resin (now available from Cytec Industries, located in West Paterson, New Jersey). This and similar resins are described in US Patent 3,556,932 to Coscia et al. and US Patent 3,556,933 to Williams et al. Other temporary wet strength agents that should find application in this invention include modified starches such as those available from National Starch and marketed as CO-BOND™ 1000 modified starch. It is believed that these and related starches are disclosed in US Patent 4,675,394 to Solarek et al. Derivatized dialdehyde starches may also provide temporary wet strength. It is also expected that other temporary wet strength materials such as those described in US Patent 4,981,557; US Patent 5,008,344 and US Patent 5,085,736 to Bjorkquist would be of use in this invention. With respect to the classes and the types of wet strength resins listed, it should be understood that this listing is simply to provide examples and that this is neither meant to exclude other types of wet strength resins, nor is it meant to limit the scope of this invention.

Although wet strength agents as described above find particular advantage for use in connection with this invention, other types of bonding agents can also be used to provide the necessary wet resiliency. They can be applied at the wet end of the basesheet manufacturing process or applied by spraying or printing after the basesheet is formed or after it is dried.

A cross section of one embodiment of an absorbent article of the present invention is depicted in FIGS. 1A and 1B. The absorbent article, labeled generally as 10, comprises a liquid pervious topsheet 12 on the body-side surface of the article, a liquid impervious backsheet 14 on the opposing garment-side surface of the article, an outer absorbent member 16 having a region of reduced basis weight or thickness having a surface 18 which defines the boundary of a central depression or void. The surface of the depression or void 18 is adjacent (i.e., is in contact with or is lined by) a wicking barrier 20 which serves to prevent or reduce lateral liquid flow, particularly wicking, from the central absorbent member 22 to the surrounding outer absorbent member 16 and which can also prevent or reduce wicking in the z-direction from the central absorbent member to the underlying region of the outer absorbent member. The wicking barrier spans a vertical distance H between the elevation of the body-side surface of the outer absorbent member and the elevation of the lowest portion of the surface of the central depression or void 18 in the outer absorbent member 16. The wicking barrier has a vertical component 23 (which need not be substantially vertical in orientation as shown but spans a vertical distance) and has a horizontal component 21 acting as a ledge and spanning a horizontal distance on the body-side surface of either the outer absorbent member 16 or the central absorbent member 22. (The absorbent core comprises the outer absorbent member 16 and the central absorbent member 22). In FIG. 1A, the horizontal component 21 of the wicking barrier 20 resides primarily on the body-side surface of the outer absorbent member 16, which is generally the more desirable configuration. In FIG. 1B, the horizontal component 21 of the wicking barrier 20 resides primarily on the body-side surface of the central absorbent member 22, which is also within the scope of the present invention.

In FIG. 1A, the horizontal component 21 of the wicking barrier 20 may cover only a fraction of the exposed body-side surface of the outer absorbent member, as shown (e.g., less than 50% or less than 20% of the linear distance from the central absorbent member to the longitudinal edge of the outer absorbent member), or it can cover substantially all of the body-side surface of the outer absorbent member in any particular cross section, particularly in the crotch region of the article, to prevent wicking contact of the central absorbent member with the outer absorbent member when the article is bunched up in use. In both FIG. 1A and 1B, the central absorbent member 22 comprises

an absorbent strip or section 24 which may be a rectangular or other shaped insert suitably comprising hydrophilic fibers such as airlaid or wet laid cellulose, including a pad of fluff pulp, multiple layers of creped or uncreped tissue, peat moss, cotton, mixtures of absorbent fibers and superabsorbent particles or fibers, or layers of fluff separated by tissue layers. The absorbent section 24 may also comprise absorbent foams or foam-fiber composites. Desirably, the AUL value of the absorbent section 24 is about 10 grams/gram or greater. In use, the central absorbent member will tend to fill first with fluid, after which wicking or bulk flow of fluid to the surrounding or underlying regions of the outer absorbent member can take place if sufficient fluid enters the absorbent article.

Entry of fluid from the central absorbent member 22 to the outer absorbent member 16 is made possible by the presence of optional apertures or openings 17, 19 in the wicking barrier 20 remote from the body-side surface of the article. It is intended that body fluid will primarily enter the absorbent article in or immediately above the central absorbent member 22, passing through topsheet 12 into the central absorbent member 22. If fluid spreads radially from the central absorbent member 22 to the outer absorbent member 16, it is intended that such movement of fluid will occur by a tortuous pathway rather than by directly wicking from the body-side surface of the central absorbent member 22 to the body-side surface of the outer absorbent member 16. A tortuous path is established by the optional apertures or openings 17 and 19 in the wicking barrier 20 such that fluid entering the central absorbent member 20 must first migrate downward into the central absorbent member 20 through the openings in the wicking barrier and from thence into the radially outward sections of the outer absorbent member 16, still submerged beneath the body-side surface of the outer absorbent member 16, thus keeping fluid away from the exposed surfaces of the outer absorbent member 16. The depth, size, and number of the openings 17 and 19 can be adjusted to provide the proper balance between hindering radially outward or lateral flow toward the edges of the article and preventing oversaturation or overflowing of fluid from the central absorbent member 22. The openings 17 and 19 are not needed if the absorbent capacity of the central absorbent member 22 is adequate for the anticipated fluid loadings the absorbent article 10 will receive.

The topsheet 12 is liquid permeable and, when the article 10 is in use, is in close proximity to the skin of the user. Desirably, the topsheet 12 is compliant, soft and nonirritating to the user's skin. It can be made from any of the conventional materials for this type of use. Nonlimiting examples of suitable materials include woven and nonwoven polyester, polypropylene, nylon, rayon or the like, particularly in the form of formed or apertured thermoplastic films, including those described in US Pat. No. 4,324,246 issued

to Mullane and Smith on Apr. 13, 1982 and US Pat. No. 4,342,314 issued to Radel and Thompson on Aug. 3, 1982, both of which are incorporated herein in their entirety by reference. Mechanically apertured forms can also be used. Other known cover materials can be employed, including those made from textured cellulosic basesheets with hydrophobic matter added to selected portions of the basesheet, particularly the most elevated portions of the basesheet, as described in commonly owned copending US application, "Dual-zoned Absorbent Webs", Ser. No. 08/997,287, filed Dec. 22, 1997, previously incorporated by reference.

The outer surface of topsheet 12 can be treated with a surfactant to improve liquid penetration, and can have gradients in wettability created having different chemical treatments on the two surfaces of the topsheet 12 or by having different regions in the plane of the topsheet 12 having differing surface chemistry, such that fluid is preferentially absorbed in targeted intake regions and repelled by other regions. Surfactant treatment can be accomplished by any of the common techniques known to those skilled in the art, including, for example, by spraying, by padding or by the use of transfer rolls.

Desirably, the inner surface of the topsheet 12 is secured in contacting relation to the absorbent core which comprises the central absorbent member 22 and the outer absorbent member 16. The topsheet 12 can be maintained in contact with the absorbent core by tensional forces, by ultrasonic or thermal bonding, by needling entanglement, or by application of adhesive, preferably in spaced limited areas, to the inner surface of the topsheet 12. Adhesives can be applied by the same methods as the surfactant can be applied to the outer surface of the topsheet 12, but desirably are applied in a spiral pattern or other fine pattern for good adhesion but low interference with fluid intake. Adhesives or other bonding methods can also join the horizontal component 21 of the wicking barrier 20 to the topsheet 12.

The outer absorbent member 16 is positioned between the topsheet 12 and the backsheet 14. The outer absorbent member 16 is generally compressible, conformable and nonirritating to the user's skin, comprising materials discussed herein.

The backsheet 14 is impervious to liquids and, thus, prevents menstrual fluid or other body exudates which may be released from the absorbent core (comprising the outer absorbent member 16 and the central absorbent member 22) from soiling the body or clothing of the user. Any backsheet material used in the art for such purpose can be utilized herein. Suitable materials are embossed or nonembossed polyethylene films and laminated tissue, desirably treated with sizing agents and wet strength agents. Breathable films that permit moisture transpiration to occur without significant condensation can also

be used. The outer cover 13 may be embossed or provided with odor-controlling materials.

The outer surface of backsheet 14 can be coated with adhesive such as the pressure-sensitive adhesive strips 26,26' shown in FIGS. 1A and 1B. The adhesive, for example, can provide a means for securing the pad in the crotch portion of a panty. Any adhesive or glue used in the art for such purposes can be used herein, with pressure sensitive adhesives being preferred. Also, before sanitary napkin 10 is placed in use, the pressure sensitive adhesive should be covered with one or more removable release liners (not shown). Any commercially available release liners commonly used for such purposes can be utilized. In several embodiments, it is desirable that outer adhesive strips 26 be disposed as close as possible to the longitudinal sides of the article to provide better attachment of the article to the user's undergarments, thus reducing the tendency of side portions of the article to bunch and come into liquid communication with the surface of the central absorbent member 22. One or more additional inner adhesive strips 26' can also be used for improved security. The outer adhesive strips 26 can be any useful width, such as from about 1 mm to about 15 mm, and more specifically from about 3 mm to about 10 mm.

It is desirable that the width of the central absorbent member 22 be from about 1 to about 12 centimeters, more specifically from about 2 to about 7 centimeters, and most specifically from about 2 to about 5 centimeters.

FIG. 2 shows a related embodiment for an absorbent article 30 similar to that of FIG. 1. The central absorbent member 42 comprises two layers of material, an upper layer 44 and a lower layer 46, wherein the lower layer desirably comprises at least one ply of wet laid tissue of higher density than the upper layer. The outer absorbent member 36 has a region of reduced thickness defining a central depression or void 38 in the outer absorbent member. The upper layer 44 can be smaller, larger, or identical in lateral dimensions than the lower layer, but is pictured as having a greater width. The upper layer 44 can fit into the depression or void of the outer absorbent member 36 on top of the lower layer 46 such that its upper surface is coplanar or aligned with the body side (upper) surface of the surrounding outer absorbent member 36, but as depicted in FIG. 2 rises above the surface of the outer absorbent member. A film of barrier material 40, which can comprise an impermeable, flexible polymeric film, a meltblown film, an apertured film, a hydrophobically treated tissue, a nonwoven web, or other wicking inhibiting layer, separates the lower layer 46 of the central absorbent member 42 from the outer absorbent member 36, particularly hindering lateral flow from the vertical sides of the lower layer 46 to the approximately vertical sides of the outer absorbent member 36 that

define the depression 38. The permeability or porosity or surface chemistry of the barrier material 40 can vary with position along the barrier material such that wicking is delayed or hindered to differing extents at different locations. For example, the barrier material may deter lateral wicking but not deter or even promote wicking in the z-direction (from the lower layer 46 to the underlying portion of the outer absorbent member 36). This may be achieved, for example, by providing large apertures 37, 39 in the barrier material 40 in contact with the lower surface of the lower layer 46 of the central absorbent member 42, while the barrier material adjacent the sides of the central absorbent member 42 lacks apertures or has smaller or fewer apertures relative to the horizontal portion underneath said lower layer 46. The horizontal component 41 of the wicking barrier 40 desirably lacks substantial fluid permeability and desirably is impermeable or has a Darcian permeability less than $1x10^{-15}$ m^2, more specifically less than $1x10^{-16}$ m^2 as measured by standard permeability measurement techniques based on Darcy's law with steady-state water flow through a film of known thickness under a pressure differential of 1 kPa. (See, for example, *Porous Media: Fluid Transport and Pore Structure*, by F.A.L. Dullien, Academic Press, New York, 1979, pp. 78-83, and *Absorbency*, ed. by P. K. Chatterjee, Elsevier, 1985, pp. 42-44).

FIGS. 3A and 3B depict a related embodiment of a sanitary napkin 50 in which the central void 58 extends across the entire thickness of the outer absorbent member 56, as can be formed by stamping or cutting out the central portion of the outer absorbent member 56. The central void 58 is lined by a polymeric film, a meltblown layer or other suitable barrier material serving as a wicking barrier 60. The wicking barrier 60 has a vertical component 63 and a horizontal component 61 running on the body-side surface of the outer absorbent member 56 serving as a ledge between absorbent members 56, 62. In FIG. 3A, the entry of fluid from the central absorbent member 62 to the outer absorbent member 56 is made possible by the presence of optional apertures or openings 57. In FIG. 3A, the vertical extent of the vertical component 63 of the wicking barrier 60 is substantially the same as the thickness of the outer absorbent member 56. In FIG. 3B, an alternative form is shown in which the wicking barrier comprises two strips of material 60', 60", one on each longitudinal side of the central absorbent member 62, both with vertical components 63', 63" traversing only a portion of the vertical thickness of the absorbent core. In both FIG. 3A and FIG. 3B, the wicking barrier comprises a horizontal component 61 and a vertical component 63, and the horizontal component 61 overlaps a portion of the body-side surface of the outer absorbent member 56 to define a ledge encircling the central absorbent member 62 when the outer absorbent member 56 encircles the central absorbent member 62. The horizontal component 61 defines

longitudinal side bands when the central absorbent member 62 extends along the full longitudinal length of the outer absorbent member 56. The ledge 60 of the wicking barrier is attached by adhesives 59 or other known means to the topsheet 52 for improved stability and flow control. In FIG. 3A, the wicking barrier 60 can also be attached by adhesives or other bonding methods to the backsheet 54.

In one embodiment, the wicking barrier 60 is colored, such as a peach or blue color to provide a distinctive indication of the barrier effect that results from having a central absorbent member 62 in partial fluid isolation from the surrounding outer absorbent member 56.

The central absorbent member 62 comprises three layers of material, desirably having decreasing density toward the bottom (remote from the body side) of the central absorbent member 62 for improved retention of absorbed fluid. In particular, the middle layer 66 desirably has a higher density or lower mean pore size or higher capillary pressure than the upper layer 68. Further, the bottom layer 64 desirably has a higher density or lower mean pore size or higher capillary pressure than the middle layer 66. The bottom layer 64 can be a wet-laid tissue having a density of about 0.2 g/cc or greater, while the middle layer 66 and the top layer 68 may be airlaid or wet laid materials or absorbent foams or fiber-foam composites, such as those disclosed in the commonly owned, copending US patent application of F.-J. Chen et al., "Fibrous Absorbent Material and Methods of Making the Same," Serial Number 09/083,873 , filed May 22, 1998, previously incorporated by reference. Wet-laid and/or foam-formed composites of fibers and superabsorbent materials can be used. Any of the layers 64, 66, and 68 as well as the outer absorbent member 56 can be embossed or can comprise superabsorbents, menses viscosity modifiers such as enzymes and surfactants, or odor absorbents. Additionally, an apertured film (not shown) may be interposed between any two of the layers 64, 66, or 68 to further control flow, including delaying transfer or providing preferentially one-way flow from top to bottom, wherein the apertured film resists upward fluid flow from one layer to the superposed layer while permitting downward flow.

The topsheet 52 may be an apertured film, a nonwoven web, or a dual-zoned film wherein a textured hydrophilic basesheet is provided with hydrophobic matter on the uppermost regions, as disclosed in commonly owned, copending US patent application of Chen et al., Ser. No. 08/997,287, filed Dec. 22, 1997. The backsheet 54 can be a breathable film, cloth, or a fiber-polymer composite and desirably is substantially impervious to liquid. It may also be provided with adhesives (not shown) on its outer surface for attachment to undergarments.

FIGS. 4A and 4B depict a related embodiment for a sanitary napkin or feminine pad 70 wherein the central depression or void 78 in the outer absorbent member 76 is not rectilinear but has contoured sides without a distinct vertical precipice along the boundaries of the depression or void 78. The depression penetrates into the outer absorbent member 76, relative to the maximum height of the side regions of the outer absorbent member, by at least about 10% of said maximum height, more specifically by at least about 25%, more specifically still by at least 50%, and most specifically from about 30% to 100% of the maximum height of the outer absorbent member along a cross-section of the absorbent article. In FIG. 4A the penetration of the central void 78 into the outer absorbent member 76 is partial, while in FIG. 4B the central void 78 extends completely through the outer absorbent member 76. A wicking barrier 80 comprising a nonabsorbent barrier material impedes fluid communication between the central absorbent layer 84 of the central absorbent member 82 and the outer absorbent member 76 such that lateral wicking to the surrounding outer absorbent member 76 is delayed or substantially prevented, resulting in center-fill performance and reduce leakage from the sides of the absorbent article 70. The central absorbent member 82 comprises a contoured layer 84 with a contoured profile adapted to provide improved body fit and comfort. Desirably, the contoured layer 84 comprises a wet resilient material with a wet bulk of about 8 cc/g or higher. As depicted, the wicking barrier 80 extends slightly beyond the edges of the central absorbent layer, though it can substantially cover the body-side surface of the outer absorbent member 76 or can be coextensive with the central layer 84 of the central absorbent member 82. Wicking barrier 80 can be provided with apertures 77 remote from the body-side surface of the central absorbent member. The wicking barrier 80 may be attached to the topsheet 72 for improved stability and integrity in use.

In FIG. 4B, an optional additional intake layer 85 such as a layer of tissue is attached to the backsheet 74 to provide fluid communication between the two divided portions 76', 76" of the outer absorbent member and to help retain or distribute fluid passing thought apertures 77 of the wicking barrier 80 into the void region below the wicking barrier.

FIG. 5 depicts certain components of a diaper 90 according to the present invention. In FIG. 5A, a shaped outer absorbent member 98 has a central region that has been cut out, defining a void with side edges 102. The outer absorbent member 98 resides on a liquid impervious backsheet 106. In the central void in the outer absorbent member 98 is a central absorbent member 92 comprising a central absorbent insert 94 slightly smaller in lateral dimensions than the central void and substantially concentric with the surrounding outer absorbent member 98. The central absorbent insert 94 has side

edges 100. The finite gap between the side edges 100 of the central absorbent insert 94 and the side edges 102 of the outer absorbent member 98 serves as a moat to impede lateral wicking from the central absorbent member 92 to the surrounding outer absorbent member, thus promoting center fill of the central absorbent member rather than wicking throughout the diaper. The moat can also serve to channel runoff or fast-moving liquid urine, for example, to other portions of the outer absorbent member 98 and the central absorbent member 92 to reduce leakage during an insult. While a moat can reduce wicking, it still permits easy radial spreading of bulk fluid once fluid enters the channel. Therefore, it is desirable for effective center fill performance that an additional wicking barrier be present (not shown), such as a polymeric web, which spans a vertical distance. Further, the wicking barrier should desirably have a horizontal component (not shown) as well on the surface of the outer absorbent member to prevent fluid communications between the outer absorbent member and the central absorbent member when the diaper is bunched together in use.

The central absorbent insert 94 may comprise the same material as the outer absorbent member but desirably has a density gradient and more than one layer (not shown) to retain fluid away from the body of the wearer. For example, a high-bulk layer of airlaid material or tissue could serve as an upper layer for effective fluid intake. An underlying lower layer of densified airlaid material or wet laid material, either being optionally combined with superabsorbent material, could then serve to retain fluid by virtue of its higher capillary suction away from the body of the wearer. The more porous upper layer could serve in effect as a surge layer or could be a surge layer of synthetic polymeric material in nonwoven form.

The central absorbent member 92 need not extend into the back portions of the diaper where collection of feces rather than urine may be the objective. The region most likely to receive feces, particularly runny bowel movement, may be provided with additional voids and gaps in the outer absorbent member 98 to provide space for receiving bowel movement and holding it away from the skin of the user.

FIG. 5B depicts the same components as FIG. 5A except that instead of a moat, a polymeric film is used as the wicking barrier 103, having a horizontal component visible on the surface of the outer absorbent member 98. The horizontal component traverses a greater distance normal to the periphery of the central absorbent member 92 in the crotch region of the article 90 for additional leakage protection. The wicking barrier 103 also passes under the central absorbent member 92 and contacts the backsheet 106, where it may be fixedly attached or may be unattached and able to slidably move relative to the

backsheet for reduced stiffness. The wicking barrier 103 may be adhesively attached to the topsheet (not shown).

FIG. 6 depicts an embodiment of an absorbent article 130 in which a portion of an upper layer 144 of the central absorbent member 142 rises above the body-side surface of the surrounding or adjoining outer absorbent member 136 and is partially wrapped by an upper portion 137 of the wicking barrier 140 that lines the surface of the central void or depression 138 in the outer absorbent member 136 for receiving an insert. The upper portion 137 of the wicking barrier 140 can be attached to the topsheet 132. Said upper portion 137 includes a horizontal component spanning a horizontal distance on the body-side surface of the upper layer 144 of the central absorbent member 142. The upper portion of the barrier material 137 which wraps the edge of the upper layer 144 of the central absorbent member prevents liquid from spreading laterally onto the surface or top portions of the outer absorbent member 136 and promotes liquid flow downward into the lower layer 138 of the central absorbent member 142. The central void 138 may extend to the backsheet 134, but as depicted only extends a portion of the thickness of the outer absorbent member 136. If desired, additional barrier material (not shown) could be disposed on the exposed body-side surface of the outer absorbent member 136 to further prevent fluid communication with the central absorbent member 142.

The wicking barrier 140 need not be completely impervious but suitably permits liquid flow from the central absorbent member 142 to the surrounding outer absorbent member 136 when the central absorbent member 142 is nearly saturated. Thus, the wicking barrier 140 can be a polymeric film provided with apertures or small pores, or may be a meltblown web or other porous, desirably hydrophobic material. It can also be a hotmelt or thermoplastic material introduced between or onto the absorbent members of the absorbent core after their formation to provide fluid isolation between members.

FIGS. 7A-7C depict embodiments of an absorbent article 170 in which the wicking barrier 180 is divided into two longitudinal strips that longitudinally separate the edges of a central absorbent member 184 from the outer absorbent member 176. An absorbent core comprising the central absorbent member 184 and the outer absorbent member 176 is disposed between a backsheet 174 and a topsheet 172, and the separate strips of the wicking barrier 180 at least partially separate the two members of the absorbent core. As shown here, the wicking barrier 180 comprises two strips 180 that do not extend substantially underneath the central absorbent member 172 (i.e., on the side away from the body-side surface). Each wicking barrier strip comprises a vertical component 178 and a horizontal component 181 on the body-side surface of the absorbent core. In FIG. 7A the wicking barrier strips 180 extend over the full thickness of the outer absorbent

member 176 and wrap it on each side, forming a C-shape around each portion of the outer absorbent member 176. The wicking barrier 180 is optionally provided with apertures 179 substantially away from the body-side surface of the central absorbent member 184 to permit delayed fluid flow from the central absorbent member 184 to the outer absorbent member 176 but only by a significantly more tortuous route than would be available were the wicking barrier not present. In an alternative embodiment (not shown), the two portions of the wicking barrier 180 may substantially completely encase the outer absorbent member 176 such that the absorbent material of the outer absorbent member 176 is essentially completely isolated from all fluid communication with the central absorbent member 184. In that case, the outer absorbent member 176 may also function primarily as an outer shaping member, providing comfort and fit against the body of the wearer, particularly if the material encased therein is bulky, soft, and suitably deformable, such as high loft fluff pulp, a carded web, or a sponge.

In FIG. 7B, the vertical components 178 of the wicking barrier 180 extend downward from the body-side surface of the absorbent core for only a portion of the thickness of the outer absorbent member (e.g., 30% or more of the thickness of the outer absorbent member, alternatively 50% or more or 70% or more) to prevent lateral wicking transport of fluid from the upper portions of the central absorbent member 184 to the upper portions of the outer absorbent member 176, forcing any transport of fluid from the center of the article toward the longitudinal sides to occur by a more tortuous route beneath the wicking barrier 180. The horizontal component 181 and the vertical component 178 of the wicking barrier 180 are still present. In FIG. 7C, the configuration of the wicking barrier 180 is the same as in FIG. 7B, except here it is depicted that that central absorbent member 184 is substantially contiguous with the outer absorbent member 176, being formed from a single mat of absorbent material with partial flow isolation between the two regions provided by insertion of the strips of material forming the wicking barrier 180 between the central region 184 and the outer regions of the absorbent material. Such a configuration could be achieved by forming a fluff mat with strips of barrier material already present, or by inserting sections of barrier material into an already formed or partially formed fluff mat or mat of other absorbent material.

When viewed from above with the topsheet removed or translucent, as in FIG. 8, an absorbent article 190 such as a feminine pad or other absorbent article of the present invention can show a loop of wicking barrier material 200 surrounding the central absorbent member 202 and lying within the bounds of a surrounding outer absorbent member 196. The outer absorbent member 196 in this case is said to surround the central absorbent member 202 because, when viewed from above, the outer absorbent

member 196 has portions lying outside of the longitudinal edges 204 of the central absorbent member 202. Additionally, as shown in FIG. 8, it can be said that all sides of the central absorbent member 202 are surrounded by the outer absorbent member 196 when viewed from above, but the fact that the outer absorbent member 196 extends beyond the central absorbent member in the transverse direction of the absorbent article when viewed from above is sufficient to meet the requirements of the term "surrounding" as used herein. Indeed, the outer absorbent member need not surround the outer absorbent member along any transverse cross-section, but should surround the central absorbent member in the crotch region of the absorbent article, where leakage is most problematic and where it is most desirable to have an outer absorbent member with a wicking barrier to reduce or prevent fluid transport from the central absorbent member to the outer absorbent member.

The absorbent core of the article 190 in FIG. 8 comprises the central absorbent member 202 and the outer absorbent member 196 and the wicking barrier 200. Beneath the absorbent core is the backsheet 192, which is connected to the topsheet (not shown) and which is larger than the absorbent core to form a rim around the absorbent article.

When viewed from above, as in FIG. 8, the visible portion of the wicking barrier 200 primarily is the horizontal component of the wicking barrier which extends a distance along the body-side surface of the absorbent core. The horizontal component in the crotch region 201 extends to a greater horizontal distance than elsewhere in the wicking barrier, such that the crotch region of the outer absorbent member 196 is substantially covered by the horizontal component of the wicking barrier 200.

To achieve the desired reduction in lateral wicking to the edges of the article, it is obviously not necessary for the barrier to form a complete loop around the central absorbent member, as shown in FIG. 9, where a top view of another absorbent article 210 according to the present invention is depicted with the topsheet removed for clarity. The absorbent article 210 in the form of a feminine pad comprises a central absorbent member 212 having longitudinal edges 214, depicted as linear though they can be curved or contoured. The edges 214 of the central absorbent member 212 are separated from the edges of the surrounding outer absorbent member 216 by longitudinal bands of barrier material forming the wicking barrier 220, whose visible horizontal component traverses horizontal distance on the body-side surface of the outer absorbent member 216, and whose vertical component (not shown) spans a vertical distance along the edges of the central absorbent member 212 to reduce lateral wicking flow. The backsheet 222 can extend beyond the outer edges of the outer absorbent member 216, as depicted in FIG. 9,

where it is bonded to the topsheet (not shown) and forms a rim around the absorbent core.

FIG. 10 shows an embodiment of the present invention wherein an absorbent article 230 comprises an outer absorbent member 236 and a central absorbent member comprising concentric absorbent structure 232 in the form of a spiral wound composite. The spiral wound composite 232 lies inside the outer absorbent member 236 and may reside in a depression therein or on the surface thereof, and has an outer perimeter 234. The spiral wound composite 232 comprises at least one layer of barrier material 248 rolled in spiral form with at least one layer of absorbent material 246. A backsheet 242 is connected to the topsheet (not shown) at the outer periphery of the article 230 and passes under the absorbent core.

Details of a spiral wound composite are shown in FIG. 11. The spiral wound composite 252 comprises substantially concentric alternating rings or windings of barrier material 256 and absorbent material 254. The barrier material 256 can be a continuous strip, as can be the absorbent material 254. The spiral wound composite as depicted in FIG. 11 has a characteristic thickness (z-direction dimension) C, a width A and a length B which can be substantially greater than width A. The z-direction dimension C may be greater than about 1 mm, preferably between about 3 mm and 20 mm, and more preferably between about 4 mm and 15 mm. The in-plane distances A and B may both independently be greater than about 20 mm, preferably greater than about 30 mm, and most preferably between about 25 mm and 100 mm. The concentric absorbent structure can serve as an outer absorbent member or as a component of an outer absorbent member in an absorbent article. In one embodiment, at least one side of the barrier material is not adhesively bonded to any adjacent web, film, or other layer such that the unbonded side of the barrier material can move under physical force relative to the adjacent cellulosic layer to which it is not bonded, thus permitting portions of the concentric absorbent structure to flex out of the plane, similar to a telescoping effect. The "telescoping" ability of the wound layers in the concentric absorbent structure to move in the z-direction relative to one another enables the concentric absorbent structure to conform to the human body when used as a component of an absorbent article for absorbing body fluids. The "telescoping" ability of the concentric absorbent structure also reduces the bending stiffness of the structure because it can yield and flex more easily when subjected to a bending moment or lateral compressive stress. This can be particularly valuable in sanitary napkins for feminine care, where conformability to the body is required for best absorbent performance and protection against leakage.

The absorbent material 254 of the concentric absorbent structure 252 can comprise a cellulosic web that can be formed from any cellulosic papermaking fibers known in the art, including hardwood and softwood, chemically pulped fibers and mechanically or chemimechanically pulped fibers, wood fibers and nonwood fibers such as bagasse, or kenaf. The cellulosic web can be a composite material such as a mixture of cellulose fibers with other materials such as superabsorbent particles, zeolites, activated silica, alumina, baking soda, chitin or chitosan, activated carbon in the form of fibers or granules, anti-microbial agents, thermosetting polymer fibers, latex binder, wet strength agents, surfactants or agents to modify the viscosity of menses or other fluids. Addition of solid particles and fibers into the cellulosic structure is often practical and feasible when airlaying of fiberized pulp and particles is performed. Non-cellulosic fibers can also be added to the aqueous fiber slurry that is used to form a wet laid structure, and some chemical agents such as strength agents can be added to the fiber slurry. Particles can also be added to wet-laid tissue by air entrainment to add particles to the web when it is relatively dry (e.g., over 30% solids and preferably over 60% solids) or particles can be added by other processes known in the art. In one embodiment, materials are coated or printed on a dry tissue web to serve as the absorbent material 254. Desirably, the tissue web is a three-dimensional structure such as a molded uncreped through-dried web, and superabsorbents or others particles or materials can be added adhesively or deposited in pockets of the three-dimensional tissue structure. Exemplary three-dimensional structures suitable for the present invention are disclosed in US Pat. No. 5,429,686 issued to Chiu et al.; US Pat. No. 5,672,248 issued to Wendt et al.; US Pat. No. 5,607,551 issued to Farrington et al.; and US Pat. No. 5,048,589 issued to Cook and Westbrook.

The barrier material between successive layers of absorbent material in the multi-layered structure (layered with respect to the radial direction) can have a low coefficient of friction to permit easy flexing and deformation of the spiral wound composite in the thickness direction to enhance the previously mentioned telescoping effect in which the centermost portions become more elevated than the surrounding regions.

The spiral wound composite can function in an absorbent article as an absorbent layer, as a central absorbent member in a void or depression of a surrounding outer absorbent member, or as an outer absorbent member.

FIG. 12 illustrates one aspect of a method of producing a spiral wound composite 252, which is cut from a roll 260 formed by rolling a layer of barrier material 264 on which an absorbent web 262 of desirably cellulosic material has been placed. When wound, the barrier material desirably forms the outer surface of the roll.

Cutting or slicing a slice from the roll substantially normal to the axis of the roll yields a spiral wound composite layer.

The slicing or cutting can be performed with high speed circular saws, including diamond saws and the rotating-arm circular saws commonly used to slice logs of wound bath tissue into individual rolls of bath tissue. Cutting by means of high velocity water jets, band saws, guillotine cutters, or wire saws can be done as well.

More than one layer of tissue can be used. For example, a parent roll can be formed by placing two or more plies of tissue on top of a barrier material in the form of a web or film and then rolling said two or more plies of tissue and said barrier material to form a single roll from which concentric absorbent structures can be cut or sliced. Multiple plies of tissue in each band disposed between bands of barrier material can enhance the absorptive properties of the concentric absorbent structure by providing additional interply pore space for wicking and fluid intake. Particularly when wet resilient uncreped, through air dried structures are used with a high degree of molding, the interply contribution to fluid permeability can be significant, as disclosed by Chen et al. in the copending US application of Chen et al., Serial Number 08/912,906, "Wet Resilient Webs and Disposable Articles Made Therewith," filed Aug. 15, 1997.

The barrier material can be any material which can be used to hinder wicking from one absorbent layer to the next in the wound spiral structure (i.e., it reduces radial wicking of fluid); alternatively, the barrier material may be selected primarily for its ability to reduce friction between adjacent cellulosic layers to enable a telescoping effect for good body conformability. Preferably, the barrier material provides both reduced radial wicking and reduced friction between neighboring cellulosic layers. Materials suitable as barrier materials include smooth polymeric films such as polyolefins, cellophane, or vinyl, preferably having adhesive on one side to attach to the cellulose.

The barrier material can also comprise waxes, adhesives, latexes, sealants, hydrophobic powders, and other hydrophobic materials applied to one surface of the tissue web to provide the desired barrier function. For example, waxes may be applied to selected portions of a tissue web to provide the desired gradient effect, with a partially permeable wax coating applied to regions of the web that will comprise the center of the concentric absorbent structure, and a more impermeable coating applied to regions of the tissue that will be near the outer edge (outer bands) of the concentric absorbent structure. In one embodiment, the application of hydrophobic matter to a three-dimensional tissue web can be practiced according to any of the methods disclosed in the commonly owned copending US application, Ser. No. 08/997,287, "Dual-zoned Absorbent Webs," filed Dec. 22, 1997, by Chen et al.

The spiral-wound parent roll can be shaped into a variety of forms other than circles or ovals. For example, it can be shaped to be substantially rectangular or triangular in cross-section. For effective shaping, the central portion of the parent roll may need to be hollow to provide void space for collapse of portions of the concentric absorbent structure to assume the desired shape. Providing a central space in the parent roll can be done by winding the tissue and barrier material about a roll or shaped bar having relatively low friction, such as a bar coated with polytetrafluoroethylene, and then removing the bar from the parent roll after winding is complete. The parent roll may then be shaped by compression of the sides to yield the desired shape.

The barrier material can vary in its properties with radial distance from the center of the spiral wound composite by using a heterogeneous web of barrier material as illustrated in FIG. 13. The length of barrier material 270 comprises three zones having different properties, a first zone 272, a second zone 274, and a third zone 276. The length of barrier material 270 will be wound while adjacent to a layer of absorbent material (not shown) in the direction shown by arrow 280, resulting in a roll with the first zone 272 at the most central portion of the roll, the second zone 272 in the intermediate portion of the roll, and the third zone 276 at the outermost portion of the roll. The first zone 272 can be substantially permeable or apertured to permit radial flow of fluid in the concentric absorbent structure formed by the spiral wound composite. Desirably, the second zone 274 provides increased resistance to radial fluid flow in a spiral wound composite and the third zone 276 can be substantially impermeable or have a permeability or porosity or degree of wettability substantially less than that of the second zone 274 to provide increased impedance to lateral flow, especially radial wicking, in the spiral wound composite as used in an absorbent article.

A heterogeneous film or web used as a barrier material need not have step changes in material properties, as shown in FIG. 13, but may have gradual gradients, or may have less than or more than the three distinct zones shown.

Such gradients or changes in material properties along the length of a barrier material can be made by adding holes or pores in the material, particularly when it is a film, in varying degree over a finite length. For example, pores or holes of varying size or number density may be provided in a film by punching, stamping, perf-embossing, chemically etching, laser drilling, needling, slitting, or ultrasonically perforating. Desirably, any holes or perforations added to the film have dimensions smaller than the z-direction thickness of the concentric absorbent structure (thickness C in FIG. 11) such that the barrier material remains continuous in the concentric absorbent structure after it has been sliced or cut off of the wound parent roll. Alternatively, the barrier material need not be

continuous in the concentric absorbent structure if it is fixedly attached to the cellulosic web, such as by adhesively joining the film or other barrier material to a tissue web or airfelt layer prior to cutting or slicing off concentric absorbent structures.

FIG. 14 depicts a cutaway view of sanitary napkin 290 for feminine care as an exemplary absorbent article comprising a shaped concentric absorbent structure 292, which is a spiral wound composite in this embodiment. As with many absorbent articles for absorbing body fluids known in the art, sanitary napkin 290 comprises an impervious backsheet 302 and a soft, liquid pervious topsheet 300. The topsheet 300 can be a thin nonwoven web comprising polyolefin fibers or an apertured film or a composite topsheet such as those of Chen et al. in commonly owned US patent application Ser. No. 08/997,287. Topsheet 300 is depicted in a cutaway view to reveal the absorbent internal layer comprising a concentric absorbent structure 292 deposed between said impervious backsheet 302 and said topsheet 300. The concentric absorbent structure 292 comprises a spiral wound composite located in the main target area of the absorbent article 290 where the highest influx of body fluids are expected. The absorbent internal layer may further comprise multiple layers or portions of other absorbent material, including fluff pulp, air laid strips, meltblown strips, or superabsorbent particles.

When fluid contacts the concentric absorbent structure 292 near its center, it is preferentially wicked in the z-direction, with relatively less wicking occurring in the radial direction. If the barrier material 296 is desirably porous near the center of the concentric absorbent structure 292 and relatively impervious near the outer edges of the structure, then radial wicking from one layer of the absorbent material 294 to the next in the spiral wound composite 292 can occur in the central regions of the structure for effective distribution of the fluid but radial wicking is impaired for fluid near the edges of the structure to reduce the risk of leakage.

FIG. 14 also depicts the presence of wings 298 on the sides of the absorbent article 290 for attachment of the article to the wearer's undergarments. The concentric absorbent structure 292 may extend to the bending lines 306 where the wings 298 fold. In this embodiment, the concentric absorbent structure 292 is shown to be shaped to more fully correspond to the shape and size of the absorbent article 290, resulting in more efficient use of space. Essentially all of the central absorbent member or outer absorbent member can be comprised by the spiral wound composite 292 when so shaped. To form the shaped spiral wound composite as shown, the absorbent material 294 and the barrier material 296 would not be wound into a circular structure, but would be folded successively over a flat length of the composite that forms the first band 304 in the center of the concentric absorbent structure.

FIG. 15 shows a top view of a sanitary napkin 310 having a central absorbent member 312 surrounded by an outer absorbent member 316 with multiple wicking barriers 317, 318 arranged therebetween to provide a labyrinth-like tortuous pathway in the plane of the article for fluid from wicking out from the target area of the central absorbent member 312. Both wicking barriers 317, 318 comprise a vertical component (not shown) extending vertically into the thickness of the absorbent article and a horizontal component (the visible part of wicking barriers 317, 318) extending a horizontal distance along the body-side surface of the outer absorbent member 316. The wicking barriers 317, 318 may be attached to the topsheet (not shown for clarity), which in turn is attached to the backsheet 320 at the periphery of the article 310. The inner wicking barrier 317 forms a ring around the inner portion 313 of the central absorbent member 312. Fluid can flow in the plane of the article from the inner portion 313 to the outer portion 314 of the central absorbent member 312 via a first opening 322 in the inner wicking barrier 317 located at a transverse edge of the inner portion 313 of the central absorbent member 312. From the outer portion 314 of the central absorbent member 312, fluid can further flow to the outer absorbent member 316 via a second opening 324 in the outer wicking barrier 318. The tortuous in-plane pathway from the center of the inner portion 313 of the central absorbent member 312 to the outer absorbent member 316 permits the absorbency of the outer absorbent member 316 to be available to fluid in the absorbent article 310, but only when the central absorbent member 312 has been sufficiently wetted to permit wicking flow across the long, tortuous pathway so established. Additional pathways may be provided by apertures (not shown) in the wicking barriers 317, 318 remote from the body-side surface of the article.

FIGS. 16A and 16B show a cross-section of an absorbent article 330 according to the present invention wherein the central absorbent member 332 can expand substantially when wetted. As in several other embodiments, the central absorbent member 332 resides in a hole defined within an outer absorbent member 336. The central absorbent member 332 comprises two layers, and upper intake layer 338 and a swelling layer 340 which can expand substantially in the vertical direction upon being wetted. The central absorbent member 332 is lined by a wicking barrier 346, desirably a flexible, substantially impervious polymeric film, comprising a vertical component 350, a horizontal component 348 on the surface of the outer absorbent member 336, and a lower portion 352 beneath the central absorbent member 332 and in contact with the backsheet 344. The wicking barrier 346 is attached to the topsheet 342 by adhesive 354. FIG. 16A depicts the article 330 prior to being wetted. FIG. 16B depicts the article 330 after wetting, when the swelling layer 340 has taken in enough fluid to expand significantly

and modify the fit of the article 330 against the wearer's body. The central absorbent member 332 has been elevated by virtue of the expanding layer 340, resulting in improved contact with the body at a time when the absorbent material might otherwise be collapsing and providing less fit against the body. Sections or cubes cut from compressed chemithermomechanical pulp (CTMP), such as compressed flash-dried bales of softwood bleached chemithermomechanical pulp (BCTMP), are capable of expanding five to eight times their initial thickness when wetted and can be useful in the absorbent article 330. Superabsorbents or mixtures of superabsorbents and cellulose, compressed chemically crosslinked fibers, calendered uncreped through-air dried sheets, compressed sponges of regenerated cellulose, or other materials can also be used to form the expanding layer 340.

FIG. 17 shows a cross-section of an absorbent article 370 according to the present invention with a central absorbent member 372 deposed in a central void of an outer absorbent member 390 between a topsheet 392 and a backsheet 394. The central void of the outer absorbent member 390 passes completely through the outer absorbent member 390. A wicking barrier 380 separates the two absorbent members 372, 390. The wicking barrier 380 comprises a vertical component 384, a horizontal component 382, and a backsheet-contacting component 386 between the central absorbent member 372 and the backsheet 394. The central absorbent member 372 comprises a top intake layer 374, which may be a tissue layer or other absorbent material adapted for rapid intake of fluid, a longitudinal wicking layer 376, and a lower fluid retention layer 378, which may comprise superabsorbent material, densified pulp fibers, microstrained pulp sheets, tissue, coform, or peat moss. The longitudinal wicking layer 376 comprises a plurality of absorbent strips or filaments 378. The strips or filaments can comprise elongated sponge elements, such as those of US Patent No. 4,490,147, issued Dec. 25, 1984 to Pierce et al., herein incorporated by reference, or absorbent fibers, desirably in tow form or in twisted or braided form having a preferential fiber orientation in the longitudinal direction of the article to promote wicking and fluid transport in the longitudinal direction. The elements can have cross-sectional dimensions less than about 10 mm, desirably less than about 5 mm, and can have a length of 50 mm or greater, more specifically 100 mm or greater. The longitudinal wicking layer 376 can also provide low stiffness and good conformability due to deformation or motion of the filaments 378 relative to each other during compression or bending. In one embodiment, the longitudinal wicking layer 376 can be prepared from a wet resilient material such as uncreped through-air dried tissue or meltblown webs treated for hydrophilicity, which has been cut into longitudinal strips or sufficiently provided with slits to serve as individual filaments or strips running in the

longitudinal direction. Desirably, the material used in the longitudinal wicking layer 376 has a fiber orientation that is distinctly preferential in the longitudinal direction.

The horizontal component 382 of the wicking barrier 380 may completely cover the body-side surface of the outer absorbent member 390 or may cooperate with the backsheet 394 to completely wrap or encase the outer absorbent member 390 with substantially impervious material.

FIGS. 18A and 18B show cross-sections of an absorbent article 400 comprising a central absorbent member 402 with an upper layer 406 and a lower layer 408, surrounded by an outer absorbent member 404 split into two segments by a central void. A nonwoven or apertured film topsheet 410 also serves as a wicking barrier. A downward loop 416 of the topsheet 410 separates the central absorbent member 402 from the outer absorbent member 404 and desirably extends to contact the backsheet 412, as depicted, where it is attached for good integrity. On the body-side surface, a protruding loop 418 of the topsheet 410 forms a runoff barrier near the periphery of the central absorbent member 402. In FIG. 18A, the protruding loop 418 is air filled, while in FIG. 18B, the protruding loop 418 is filled with a soft, pliable material 420 such as a strip of a lofty nonwoven web, loose hydrophobic fibers, a yarn, or a pliable foam. A filled protruding loop can improve the gasketing effect of the runoff barrier and improve conformability to the body. Desirably, the topsheet 410 is treated to be less wettable and/or less permeable in the loop regions 416, 418 than elsewhere on the topsheet 410. Such treatment can be achieved by coating with water repellents, heat treating to seal pores in the topsheet, or by addition of impervious material to the loop regions 416, 418.

FIGS. 19A and 19B show cross-sections of an absorbent article 430 comprising multiple protruding loops 441, 443, 445 of cover material from the topsheet 436 to form runoff barriers on the body-side surface of the article. The article 430 comprises a central absorbent member 432 occupying a complete central void within an outer absorbent member 434 such that the outer absorbent member 434 is completely segregated into two sections, at least when viewed in transverse cross-sections as shown near within the crotch region of the article. The central absorbent member 432 is segregated from the outer absorbent member 434 by a wicking barrier 440 comprising a horizontal component defining a ledge 442, a vertical component 444, and an optional underlying component 446 beneath the central absorbent member facing the backsheet 438. Longitudinal folds in the topsheet 436 create longitudinal protruding loops 441, 443, 445 that act as runoff barriers, one of which runoff barrier 445 is within the perimeter of the central absorbent member 432, another of which runoff barriers 443 at least partially overlaps the boundary between the central absorbent member 432 and the outer

absorbent member 434, and another of which runoff barrier 441 is disposed above the outer absorbent member 434 towards the longitudinal sides 450 of the article. In FIG. 19A, the loops 441, 443, 445 are air-filled, while in FIG. 19B loop 443 is filled with a soft, pliable material 447 such as a strip of a lofty nonwoven web or a pliable foam to better serve as a gasket and body fit element. Loop 443 could also comprise multiple folds of the topsheet 436 material to provide a structure of increased bulk, thickness, and resiliency. Examples of loops comprising multiple folds of material are shown in FIGS. 20A and 20B, respectively, where a spiral-wound loop 450 is shown as well as pleated loop 452. Many other geometrical configurations could be used, with or without additional materials enclosed within the loops for softness, resiliency, and comfort.

In embodiments with a runoff barrier formed by a pleat or fold of material from the topsheet, it is desirable that there be at least two longitudinal runoff barriers superposed over at least a portion of the boundary between the central absorbent member and the outer absorbent member. The runoff barrier can be considered to be superposed over the boundary if any portion of the runoff barrier is within about 4 mm of the boundary.

FIGS. 21-32 are discussed in the Examples below.

EXAMPLES

Several examples of absorbent articles were made with the materials listed in Table 1 below:

Table 1. Basic materials used in construction of absorbent articles for the Examples.

Component	Manufacturer	Description
Topsheet		
Spunbond material	Kimberly-Clark Corp.	0.6 osy polypropylene spunbond web, "Delta" version, treated with 0.3% add-on of surfactant (described below)
Surfactant treatment	ICI Americas, Inc.	45% (w) polyethoxlated hydrogenated ethoxylated castor oil; 55% (w) sorbitan monooleate
Adhesive	National Starch and Chemical Co.	NS-34-5610: slot-coated, pinstripe pattern, applied at a level of about 5 gsm or less.
Fluff	Kimberly-Clark Corp.	Coosa River CR56 debonded softwood pulp comminuted with a hammermill
Densified airlaid webs		
Completed web	Concert Fabrication, Ltee	90% softwood fibers and 10% binder fibers with overall densities of 0.1-0.2 g/cc.
Fibers	Weyerhaeuser Co.	NB-416: bleached southern softwood kraft
Binder fibers	Hoechst Celanese Corp. (Trevira Company)	Celbond #255: PET core, activated co-polyethylene sheath, 50/50 core/sheath ratio, concentric, 2.8 dpf, with T-255 fiber finish
Impervious wicking barrier		
Polyolefin film, colored	Edison Plastics Co.	A low density polyethylene, 20 gsm, rose color, 1 mil initially, 2 mil gauge after embossed with pattern MFST (male fine square taffeta), contact adhesive on one side
Polyolefin film, white		Low density polyethylene, 18 gsm, opaque with added white pigment, about 1 mil
Pervious wicking barrier		
Spunbond web	Kimberly-Clark Corp	0.8 osy 2.7 denier, rose color, no surfactant
Backsheet		
Polyolefin film	Edison Plastics Co.	A low density polyethylene, 20 gsm, rose color, 2 mil gauge after embossed with pattern MFST (male fine square taffeta), coated with contact adhesive on one side
Adhesive	National Starch and Chemical Co.	NS-34-5610, less than 15 gsm added, slot-coated, pinstripe pattern
Garment adhesive	National Starch and Chemical Co.	NS-34-5602, less than 45 gsm applied, slot coated, two 15mm side lines of adhesive with a 19 mm space between them
Release paper	Akrosil Inc.	White base sheet, one side coated with silicone release agent, other side printed

EXAMPLES 1-7

Example 1 and other examples described herein were made to have a top view appearance according to FIG. 21. FIG. 21 depicts a central absorbent member 462 surrounded by a hydrophobic ledge 470 and a larger absorbent member 466, which may be an outer absorbent member having a central void or depression or an underlying absorbent member without a central void or depression. The absorbent core comprising the central absorbent member 462 and the outer or underlying absorbent member 466 are enclosed by an underlying backsheet 468, with larger dimensions than the absorbent core to form a rim therearound, and a topsheet (not shown) which is attached to the backsheet 468 at the rim. Optionally, the central absorbent member 462 can be provided with embossed lines as shown in FIG. 21 comprising three long lines 472 and four short lines 474 each about 2 mm wide and approximately 0.4 mm deep.

Example 1 was a control pad made without a vertical wicking barrier but with a horizontal wicking barrier; i.e., with a polymeric film disposed horizontally between two superposed absorbent layers. Thus, in Example 1, the horizontal ledge 470 is the exposed horizontal component of a purely horizontal wicking barrier (the impervious wicking barrier of Table 1) which lies in a plane between an upper central absorbent member 462 and an underlying outer absorbent member 466, which is merely a planar absorbent member which lies beneath the central absorbent member (in other examples according to the present invention, the outer absorbent member has a central void into which the central absorbent member is inserted).

In Example 1, a 175 gsm airlaid densified web (as described in Table 1) served as the lower layer of the absorbent core, i.e., as the outer absorbent member 466 but without a central void or depression. The 175 gsm airlaid outer absorbent member was cut to a dumbbell shape with a length of about 21.5 cm and a width at the transverse centerline of about 6 cm. The dumbbell-shaped outer absorbent member was placed on the backsheet (as described in Table 1) comprising a polymer film provided with contact adhesive. Over the central portion of the outer absorbent member of the control samples was placed a cut rounded rectangular section of spunbond film (the same material as the pervious wicking barrier of Table 1) to serve as a horizontal wicking barrier. The horizontal wicking barrier had a length of 20.3 cm and a width of 4.7 cm. Above the horizontal wicking barrier was placed a rectangular rounded central strip of a densified airlaid web having dimensions smaller than the cut spunbond film (18.7 cm long and 3.7 cm wide). The densified airlaid

strip was as described in Table 1, with a density of about 0.1 g/cc and a basis weight of about 175 gsm. This central strip was provided with the curved embossing lines depicted in FIG. 21 while the underlying outer absorbent member remained unembossed. A slit about 10 cm long was provided through the longitudinal center of the central strip in the longitudinal axis. The spunbond topsheet as described in Table 1 was then placed over the entire article, with edges extending well beyond the outer absorbent member. The laminated structure was then cut with a dumbbell-shaped die having dimensions greater than the outer absorbent member (24.4 cm long, 8 cm wide at the transverse centerline) to provide a rim of backsheet material and cover material around the outer absorbent member in an absorbent article having good integrity provided in part by the contact adhesive on the polymeric film. After cutting, the pad was heat-embossed to provide several embossing lines in the central strip of the pad as shown in FIG. 21.

For Examples 2 to 5, feminine pads according to the present invention were made generally following the procedures above for Example 1, with the exceptions that 1) a central region of the outer absorbent member was removed by a die cutting operation to provide a central void in the outer absorbent member having substantially the same dimensions as the central absorbent member (about 18.7 cm long and 3.7 cm wide); 2) a cut polymer film (the rose-colored impervious wicking barrier of Table 1) die cut to be a rounded rectangle 20.3 cm long by 4.7 cm in width was placed over the central void, replacing the similarly shaped spunbond web of Example 1, thus serving as a barrier material for a wicking barrier; and 3) an absorbent insert having a shape and dimensions essentially the same as the central void was placed over the cut polymer film to define a central absorbent member in the void surrounded by the remaining portions of the outer absorbent member.

After the topsheet was attached and the entire article was die cut to provide a sealed article having a rim of backsheet and topsheet material surrounding the outer absorbent member, a ring of the colored barrier material was visible through the translucent topsheet (the horizontal component of a vertical wicking barrier). The articles were also heat embossed as with the control to provide several substantially longitudinal embossment lines in the central absorbent member.

Several different combinations of material were used to produce the central absorbent member. For most examples, the lower layer of the central absorbent member consisted of the 175 gsm outer absorbent member material that was cut out of the outer absorbent member while providing a central void therein.

In Example 2, the central absorbent member comprised an upper layer consisting of a 250-gsm densified airlaid mat (as described in Table 1) having a density of 0.14 g/cc

and a lower layer consisting of the cut-out portion from the 175-gsm airlaid material of the outer absorbent member having a density of about 0.1 g/cc which was previously removed to provide a central void. As with the control sample (Example 1), the upper layer of the central absorbent member was embossed and provided with a longitudinal slit.

In Example 3, the upper portions of the central absorbent member comprised two layers of an uncreped through-air dried tissue of spruce BCTMP pulp each having a basis weight of 30 gsm and added permanent wet strength agent (Kymene added at about 50 pounds per ton of fiber), molded onto a Lindsay Wire T-116-3 through-air drying fabric and produced with about 27% rush transfer onto a Lindsay Wire T-216-3 transfer fabric (i.e., 27% differential velocity in going from a forming fabric to the textured transfer fabric, from which it was then transferred to the through-drying fabric), according to the teachings of Chen et al. in commonly owned US patent application, Serial Number 08/912,906, "Wet Resilient Webs and Disposable Articles Made Therewith," filed Aug. 15, 1997. The tissue has a bulk of about 33 cc/g (density of 0.03 g/cc) and a wet:dry tensile strength ratio of 43%. Beneath the uncreped tissue layers was the 175 gsm densified airlaid web of the outer absorbent member (0.1 g/cc density) which had been previously cut out from the outer absorbent member.

Example 4 followed Example 3 except that three layers of the uncreped tissue were used in place of the two layers from Example 3 to create the upper layers of the central absorbent member above the 175 gsm airlaid lower layer. The three layers were calendered to provide the same thickness together as the two layers did in Example 3.

In Example 5 a 200-gsm layer of softwood fluff pulp (described in Table 1) with a diamond embossment thereon was placed above the 175 gsm densified airlaid material of the outer absorbent member to form the central absorbent member. No central longitudinal slit was provided in the upper layer of the central absorbent member. The fluff pulp was prepared by splitting a 400-gsm pad of fluff. The formerly interior portion of the 400 gsm appeared substantially uniform, while the opposing surface (formerly an exterior surface of the 400 gsm pad) showed the diamond embossing pattern clearly. The latter side was placed downward, toward the backsheet, in assembling the pad.

In Example 6 a maxipad was prepared with an unembossed 600 gsm fluff pulp pad (described in Table 1) as the absorbent material for both the outer absorbent member and the central absorbent member. The cut out portion from the central void (same dimensions as in previous Examples) was lined with polymeric film (the colored impervious wicking barrier of Table 1) having a width of about 5.5 cm instead of 4.7 cm as in previous Examples, and then replaced in the void, with the polymeric film defining a vertical wicking barrier between the central absorbent member and the surrounding outer

absorbent member. In this case, the central absorbent member consisted essentially of the same material as the surrounding outer absorbent member.

In Example 7, a control maxi pad was produced using an unembossed 600 gsm fluff pulp mat with no wicking barrier and with no central void provided therein.

Testing of Examples 1-5 was done using insults of saline solution containing a small quantity of blue dye. In one group of tests, a 15 ml insult of the blue fluid were added to the center portion. In another group of tests, the insult was 7 ml. In both cases, some of the blue fluid escaped from the edges of the central strip in the control pad of Example 1, wetting the surrounding outer absorbent member. For both the 7 ml and 15 ml insult tests, the pads of the present invention held the fluid in the central absorbent member without substantial spread of the blue liquid into the surrounding outer absorbent member, thus achieving center- fill performance.

Testing with the maxipads of Example 6 and 7 by insulting blue saline solution into the center of the pad showed that the wicking barrier in Example 6 was successful in preventing fluid from migrating toward the longitudinal sides of the sides compared to Example 7.

Under light compression by hand (estimated at about 0.1 psi) of the wetted pads, the pads of the present invention also showed improved ability to retain their fluid in the central absorbent member compared to the control pad of Example 1.

EXAMPLES 8-10

Examples 8 to 10 were made according to Examples 3 to 5, respectively, except that the central absorbent member was inverted in each case. Thus, in Example 8, the upper layer of the central absorbent member was the cut-out portion of the 175-gsm densified airlaid web, while the lower two layers were the uncreped through-dried tissue layers, with the airlaid strip still isolated from the outer absorbent member by the vertical wicking barrier with its vertical component (the vertical wall between the members) and its horizontal component (the ledge resting on a portion of the body-side surface of the outer absorbent member). In Example 9, three layers of uncreped tissue were below the airlaid web in the central absorbent member. In Example 10, the central strip of densified airlaid web rested above a section of 200-gsm fluff pulp.

EXAMPLES 11-13

Examples 11 to 13 were made according to Examples 1, 2, and 4 above, respectively, with the exception that a dogbone-shaped 175-gsm densified airlaid web

prior to cutting out a central void was provided with 5 equidistantly spaced apart parallel embossing lines running about 80% of the length of the pad, having a width of about 2 mm each. Further, the central absorbent member was not provided with the curved embossing lines of FIG. 21 or any other form of embossment, except for the embossments present in the cut-out central densified airlaid strip which was used to form part of the central absorbent member in each case. Thus, Example 11 is identical to Example 1 except for embossment in the lower layer (the underlying outer absorbent member) and lack of embossment in the upper layers (central absorbent member). Example 12 is likewise identical to Example 2 except for embossing differences. Example 13 has a central absorbent member with three unembossed layers of uncreped tissue superposed on a cut-out section of the 175-gsm densified airlaid web with longitudinal embossing lines therein.

EXAMPLE 14

Example 14 is identical to Example 2 except that a clear polyethylene film of about 1 mil thickness was used to form the vertical wicking barrier instead of the rose film of Example 2.

EXAMPLE 15

Example 15 is a maxipad with fluff pulp as the primary absorbent material made according to Example 6, with the exception that the central absorbent member comprises a strip of a dual-zoned web made according to the principles taught by Chen et al. in Ser. No. 08/997,287, "Dual-zoned Absorbent Webs," filed Dec. 22, 1997. Specifically, a 40 gsm web of uncreped through-air dried tissue made from bleached kraft eucalyptus fibers (Aracruz, Brazil) was textured on a three-dimensional Lindsay Wire T-116-1 through-drying fabric with about 15% rush transfer, resulting in a bulk of about 14 cc/g, largely due to the three-dimensional texture of the web. Kymene 557H wet strength agent (Hercules, Wilmington, Delaware) was added at a level of about 7 kg/ton dry fiber. The uppermost portions of the dried web that had contacted the through-drying fabric (the wire-side) were coated with Dow Corning DAP® Silicone Auto/Marine Sealant applied at a total area-averaged level of 5 gsm (estimated to be about 12 gsm on the peaks that received the material). After curing, the coated side of the tissue had a soft, rubbery feel due to the rubbery silicone material being on the highest portions. Though the silicone is impervious and hydrophobic, the coated web is still hydrophilic and able to take liquid in readily due to the untreated lower portions of the web.

The dual-zoned web was provided with an array of spaced apart apertures, each about 0.5 cm apart from its nearest neighbor, each aperture having a diameter of about 0.5 mm. The apertures were stamped by hand into the web, with stamping occurring from the coated side toward the uncoated side. Based on tests with egg white solution as a menses simulant, the apertures were found to be helpful in transporting viscoelastic material through the dual-zoned web to the underlying absorbent material for an improved dry feel on the surface of the article.

A strip of the silicone-treated textured uncreped tissue web was cut to the same size as the central absorbent members of previous examples and placed over the cut-out section of 600 gsm fluff pulp within the central void lined with the wicking barrier (rose-colored impervious wicking barrier as in Table 1). The coated side of the treated web was facing up (toward the body side). To permit the treated dual-zoned web to serve as a cover material as well as an intake layer, a rounded rectangle 3.3 cm wide and 10.5 cm long was cut out of the spunbond web normally used as a topsheet, such that the rounded rectangular hole in the topsheet was centered over the dual-zoned web of the central absorbent member, thus providing direct access to permit the dual-zoned web to touch the body of the wearer and serve as a dry-feel cover material and intake material. The dual-zoned web cover materials of the aforementioned patent application of Chen et al. permit a cover to provide the dry feel of a hydrophobic plastic film while also providing intrinsic hydrophilicity and softness.

The resulting maxipad was thus composed of 600 gsm fluff pulp with a rose-colored wicking barrier surrounding a cut-out section of the fluff pulp, providing a vertical barrier and a visible horizontal ledge around the central absorbent member. The ledge and longitudinal sides of the dual-zoned web were covered by the spunbond topsheet, but most of the area of the dual-zoned web was exposed through the hole cut in the topsheet. Adhesive on the topsheet held the edges of the hole in place on the dual-zoned web.

EXAMPLE 16

Example 16 was made according to Example 12 except that the central absorbent member was entirely replaced with about 3.3 grams of lose "nits" made of bleached kraft eucalyptus fibers which had been mechanically curled and dispersed to form small dense flocs about 1 mm in diameter. The nits were prepared by taking about 20 grams of dry eucalyptus pulp that had been curled in a Maule disperser, than moistening the pulp to a consistency of 20% and beating in a Hobart mixer for 1.5 hours to create dense nits. The moist nits were then spread out on a surface and air dried. The dry, loose nits were

placed over the wicking barrier film inside the void of the outer absorbent member and covered with the topsheet, which served to hold them in place.

EXAMPLE 17

Example 17 was made according to Example 2 except that the topsheet was pleated to provide longitudinal loops of cover material directly over the edge of the central absorbent member. The air-filled loops were heat sealed with an Impulse Sealer by American Electronics, designed for sealing plastic bags. The heat-sealed loops were thus rendered largely impervious and slightly glossy in appearance, though not uncomfortably stiff. The longitudinal loops raised about 0.4 cm from the surface of the absorbent article.

EXAMPLE 18

A pad was made according to Example 2 except that an additional rectangular section of barrier material was superposed over the rounded rectangular cut-out section of barrier material in Example 2 to ensure that a portion of the horizontal component of the wicking barrier extended to the longitudinal sides of the absorbent core. The resulting design is depicted in FIG. 22, where the top view is shown in FIG. 22A and the transverse cross-section (minus the topsheet) is shown in FIG. 22B. A strip of white impervious wicking barrier material 502 (as in Table 1), 100 mm in length and wide enough to extend from one longitudinal side of the absorbent core to the other, was placed over the rounded rectangular wicking barrier 500 lining the central void in the outer absorbent member 496 before inserting the densified airlaid layers that formed the central absorbent member 492. In the central absorbent member 492, the lower layer 514 was a 175 gsm densified airlaid web with a density of 0.1 g/cc (the same material used in the outer absorbent member 496, as in Table 1). The upper layer 493 was a densified airlaid web having a density of 0.14 gsm and basis weight of 250 gsm, further comprising a longitudinal slit 512 that was 100 mm in length through the longitudinal centerline. Both layers in the central absorbent member 492 were embossed with longitudinal embossing lines 504. An impervious backsheet 498 and a spunbond topsheet (not shown), both as described in Table 1, were used.

In this embodiment, the extended horizontal component of the upper ply 502 of the wicking barrier spanned the transverse width of the absorbent core in the crotch region, having a length of 100 mm.

EXAMPLE 19

A cross-section (minus the topsheet) for Example 19 is shown in FIG. 23. Example 19 followed Example 18 except that the upper ply of wicking barrier material 502 in the crotch region was long enough to wrap the longitudinal sides of the article and make sealing contact with the backsheet 498. Thus, the outer absorbent member 496 is largely encased in impervious material (the backsheet 498 and the upper ply of wicking barrier material 502) such that it remains dry and able to provide a shaping function.

Additionally, two 10-cm long strips of two-sided adhesive tape 536 were used to join the lower ply 500 of wicking barrier material to the upper ply 502 in the crotch region, as shown in FIG. 23.

This embodiment was tested by menstruating adult users. Examination of the wetted pads showed excellent center fill performance and improved leakage reduction compared to other commercial products. It is believed that in addition to prevent wicking of fluid toward the longitudinal sides, the present design also helps direct flow toward the central absorbent member 492, preventing surface leakage or surface smearing. Further, it is believed that the discrete central absorbent member 492 and outer absorbent member 496 with a wicking barrier therebetween naturally promotes a W-shaped fold in the article when attached to the wearer's panties and compressed between the thighs of the user. The W-shape fold, which is also facilitated by the central slit 512 in the upper layer of the central absorbent member 492, provides an elevated central portion of the article to contact the wearer's body to directly receive menses and prevent flow along the user's body.

EXAMPLE 20

Example 20 is a hypothetical example depicted in FIG. 24, where a top view is shown in FIG. 24A and a transverse cross-section in FIG. 24B. This example follows the geometry of Example 18 and FIG. 22, with the exceptions that the lower layer of wicking barrier material 500 in FIG. 22 has been removed, and the longitudinal length of the crotch-section wicking barrier 502 was extended to about 160 mm.

Related embodiments are possible wherein the wicking barrier does not completely surround the central absorbent member, but is only present in or near the crotch region where leakage to the sides tends to be most problematic. Indeed, the outer absorbent member need not surround the central absorbent member everywhere, but may be present only near the transverse centerline or in the crotch region, where the

outer absorbent member is largely separated from the central absorbent member by a wicking barrier.

EXAMPLE 21

Example 21 is a feminine care maxipad that followed the geometry of FIG. 21, as described for Example 2, except that no embossing was performed and the horizontal component of the wicking barrier was extended to cover substantially all of the body-side surface of the outer absorbent member. Further, the absorbent material in both the central absorbent member and the outer absorbent member was 620 gsm fluff pulp. A white impervious wicking barrier of unembossed 1 mil polyethylene film was used. A central void in the outer absorbent member was formed by stamping a hole through the outer absorbent member. The cut-out fluff pulp was replaced after the hole was lined with the wicking barrier. No slit was made in the central absorbent member. This sample was tested with menstruating users and resulted in unexpected leakage, apparently because the central absorbent member did not come close to the body but deflected away from the body in use. It is believed that the better performance observed in other embodiments is due to various factors that promote a W-fold shape or elevate the central absorbent member toward the body. Such factors include slits in the central absorbent member, a raised central absorbent member relative to the outer absorbent member, and lower thickness of the absorbent members than was found with 620 gsm fluff pulp.

EXAMPLE 22

Example 22 is a feminine care "ultra-thin" pad that followed the geometry of FIG. 24, except that the horizontal component of the wicking barrier was extended to cover substantially all of the body-side surface of the outer absorbent member. The upper layer 493 of the central absorbent member 492 was a densified airlaid web with a basis weight of 250 gsm and a density of 0.14 g/cc, with a 100-mm long central slit 512, while the lower layer 514 was a densified airlaid web with a basis weight of 175 gsm and a density of 0.1 g/cc, the same as the material used to form the outer absorbent member 496. The wicking barrier 502 was a white 1 mil polyethylene web. A central void in the outer absorbent member was formed by stamping a hole through the outer absorbent member. The cut-out densified airlaid web was replaced in the void after the hole was lined with the wicking barrier. This sample was tested with menstruating users and resulted in excellent center-fill performance and leakage prevention relative to other commercial products and relative to the control sample of Example 1.

EXAMPLE 23

Example 23 followed that of Example 22 except the 228 gsm coform comprising 70% southern softwood and 30% polypropylene was used as the absorbent material for the outer absorbent member, the lower layer of the central absorbent member, and the slit upper layer of the central absorbent member.

EXAMPLE 24

Example 24 is a hypothetical example depicted in two alternative forms in FIGS. 25A and 25B, showing a transverse cross-section of a sanitary napkin. Here a central absorbent member 522 comprises a first layer 542 folded around a second layer 544 in a C-fold configuration, with the C-fold being away from the body side in FIG. 25A and toward the body-side in FIG. 25B. The central absorbent member 522 is lined beneath by a wicking barrier 532 and above by a topsheet 530, which is attached to a backsheet 528 at the periphery of the absorbent article. The outer absorbent member 526 surrounds the central absorbent member 522. The second layer 544 of the central absorbent member can be a densified material with higher capillary pressure (smaller pore size) than the first layer 542, such that it preferentially absorbs fluids from the body. Exemplary materials for the second layer 544 include peat moss, a densified airlaid web, a regenerated cellulose sponge, coform, densified fluff pulp, one or more layers of wet laid paper or tissue, optionally combined with shaping elements such that the central absorbent member folds along the longitudinal centerline in use to rise toward the body. Thus, the second layer 544 may be slit or scored, for example, to enhance folding along the longitudinal centerline in use. The first layer 542 may be fluff, an airlaid web, coform, wet laid tissue, or a nonwoven surge layer preferably treated to be hydrophilic.

EXAMPLE 25

Example 25 was made according to Example 2, only the central absorbent member and outer absorbent member were made of Coosa River 1654 softwood pulp in fluff pulp form having a basis weight of 250 gsm and densified to 0.14 g/cc. Two layers of the densified fluff pulp were used to form the central absorbent member, and were provided with a central longitudinal slit 10 comprises in length. The central absorbent member, being thicker and stiffer than the outer absorbent member by virtue of having twice as much material, appeared to readily yield a useful w-fold geometry when compressed from the sides.

EXAMPLE 26

Example 26 followed Example 25 except that the two layers of the central absorbent member were embossed together with longitudinal flare lines, similar to the lines shown in FIG. 22A.

EXAMPLE 27

Example 27 followed Example 26 except that a layer of 20-gsm softwood creped tissue comprising wet strength agents was placed underneath each layer of fluff pulp in the central absorbent member, thus helping to maintain separation of the two layers in use. Thus, when the central absorbent member is bunched together by the legs of the user in use, the tissue layers help prevent interlocking or entanglement of fibers in the two adjacent fluff pulp payers and thus help prevent wadding of the central absorbent member. The central absorbent member thus becomes more resilient or capable of resisting collapse and maintaining its form. Desirably, tissue layers separating adjacent absorbent layers in the central absorbent member will have a wet strength to dry strength ratio of at least 0.1.

EXAMPLE 28

Example 28 was made according to article 548 shown in FIG. 26, following the structure and materials given in Example 2. The central absorbent member 550 comprised a top layer 554 of 250 gsm densified airlaid web at a density of 0.1 g/cc, and a bottom layer 552 comprising a layer of 175-gsm densified airlaid web at a density of 0.14 g/cc. The two layers of the central absorbent member 550 were provided with a longitudinal slit to encourage a W-fold shape when compressed laterally by the legs of the user. A single layer of 175-gsm densified airlaid web at a density of 0.14 g/cc was used to form the outer absorbent member 556. A clear polymer film was used to form the wicking barrier 562, comprising a vertical component 566, a horizontal component 568 on the body side surface of the outer absorbent member 556, and an underlying portion 564 beneath the central absorbent member 550. The wicking barrier 562 was cut when the outer perimeter of the outer absorbent member 556 was cut to have approximately the same surface area and shape, when viewed from above. A distinct feature of the embodiment in Example 28 is the configuration of the topsheet 558, which wraps the outer edges of the outer absorbent member 556 and runs along the bottom thereof before folding back on itself at a hinge point 559, where the topsheet 558 is doubled, one layer in

adhesive contact with the backsheet 560 and the other layer in contact with the lower side of the outer absorbent member 556. This configuration allows the outer absorbent member 556, which can be relatively thinner than FIG. 26 indicates (not being drawn to scale), to be able to serve as a barrier, cuff, or flap, which can rise upward toward the body or into the fold between the crotch and the user's legs, independently of the position of the backsheet 560. For example, the backsheet 560 may be further attached to wings or tabs (not shown) which wrap around the edges of the user's panties, folding away from the body, yet the hinged structure created with the topsheet 558 wrapping around the outer absorbent member 556 creates an added level of flexibility in the article 548 to permit the outer absorbent member 556 to remain close to the body.

The wicking barrier 562 in this embodiment does not wrap the outer absorbent member 556. Thus, the outer longitudinal sides and bottom side of the outer absorbent member 556 can absorb any fluid that may contact the topsheet 558 in those regions. Thus, if a gush of fluid bypasses the central absorbent member 550 and flows toward the longitudinal sides of the article 548, it can be adsorbed by the surfaces of the outer absorbent member that are not covered with the wicking barrier 562. Particularly when the article 548 is compressed from the sides and the article assumes a W-fold shape, the surfaces of the outer absorbent member 556 that are not covered by the wicking barrier 562 can serve to absorb fluid in unusual circumstances that might otherwise leak or flow past the edges of the article 548. But under normal conditions of use, fluid absorption into the central absorbent member 550 with shielding from the outer absorbent member 556 by means of the wicking barrier 562 should be adequate for good center fill performance and leakage control.

The backsheet 560 was adhesively attached to the underlying portion 564 of the wicking barrier 562 beneath the central absorbent member 550.

EXAMPLE 29

Example 29 is depicted in FIG. 27 and was made according to Example 27, except that the topsheet 576 of article 570 also wrapped around the edges and lower surface 575 of the central absorbent member 571, approaching the longitudinal centerline where the topsheet material 576 then folded back upon itself at hinge points 578 before extending toward the outer absorbent member 574. Thus, the central absorbent member 571, comprising a first layer 572 and a second layer 573 of densified airlaid web material, could fold away from the central restraints formed by the adhesive attachment to hinge points 578 such that the longitudinal sides of the central absorbent member 571 could

move upward toward the body in the shape of a V. As in Example 27, a wicking barrier 584 prevented wicking of fluid from the central absorbent member 571 to the outer absorbent member 574. The topsheet 576 rose from underneath the central absorbent member 571, following the wicking barrier 584, to cover the outer absorbent member 574. The topsheet 576 further wrapped the outer longitudinal edges 584 and underside 586 of the outer absorbent member 574, contacting the backsheet 582 at hinge points 580 where the topsheet folded back upon itself to extend to the outer edges of backsheet 582, to which the topsheet 576 was adhesively attached.

In this embodiment, the outer edges of both the central absorbent member 571 and the outer absorbent member 574 were free to move up toward the body independently of the position of the backsheet 582, thus providing more flexibility, more opportunities for body conformability, especially if wings or tabs were affixed (not shown), and also providing additional surfaces not covered with wicking barrier material 584 for absorbing gushes or fluid that might not effectively reach the central absorbent member 571.

It is envisioned that many related embodiments could be made with multiple zones of absorbent material wrapped with the topsheet or other porous material such as tissue to permit the outer edges of the absorbent zones to deflect upward, away from the backsheet, thus providing flap-like or cuff-like structures formed from absorbent material, yet with the wicking barrier defining central and outer absorbent members and promoting central fill of the article. The flap-like structures, nevertheless, can serve to prevent leakage during gushes or fluid insults and can provide additional surface area for absorption of fluid.

Gaps between the central absorbent member and the outer absorbent member in such embodiments may be created to provide open channels for flow into the space between the members. Such gaps can be created by making the outer longitudinal sides of the central absorbent member to have a wavy shape, while the inner sides of the outer absorbent member could be relatively straight, thus providing imperfect fit with resulting periodic gaps or openings, desirably on the order of 0.1 to 2 mm. Either or both edges could be made irregular to provide occasional openings or gaps between the members, such that even when the article is lying flat, not in a W-folded shape, fluid could still reach the underside of the central absorbent member.

Embossments along the longitudinal centerline of the central absorbent member 571 can be helpful in causing the outer edges of the central absorbent member 571 to naturally deflect upward toward the body.

EXAMPLE 30

Example 30 was made according to Example 29 as shown in FIG. 27 except that the topsheet did not wrap the underside of the outer absorbent member 574, but directly contacted the backsheet 582 after descending down the outer longitudinal sides of the outer absorbent member 574, as in FIG. 3.

EXAMPLE 31

Example 31, as depicted in FIG. 28, is a hypothetical example of an article 600 according to the present invention wherein the wicking barrier 602 also serves as a backsheet, or visa versa, because a sheet of polymeric material covers the garment side of the article, providing a backsheet component 607, then wraps around the longitudinal sides and body side of the outer absorbent members 604, serving the function of a horizontal component 603 in the wicking barrier 602, and further penetrates or descends into the absorbent core (between the outer absorbent members 604 and the central absorbent member 606) to provide a vertical component 605 of the wicking barrier 602. Desirably, the wicking barrier 602 also passes beneath the central absorbent member 606, as shown. The topsheet 608 can be attached to the wicking barrier at the longitudinal sides of the article. Obviously, the topsheet should be more permeable and wettable than the backsheet or wicking barrier.

In FIG. 28 and other figures herein, the garment side of the absorbent core is generally depicted as planar with any nonuniformity in thickness in the members of the absorbent core resulting in height variations on the body side surface of the article. However, for some embodiments, it is possible to assemble the components to maintain a more planar body side surface with thickness variations resulting in height variations or contours on the garment side of the article. Such configurations may be considered in optimizing body fit and the geometrical response of the article when worn.

EXAMPLE 32

Example 32, as depicted in FIG. 29, is a hypothetical example of an article 630 according to the present invention comprising a topsheet 648, a unitary shaping member 634 comprising an outer shaping member 636 with a first portion 636' and a second portion 636" and a relatively thinner bridging portion 638 joining the first portion 636' and second portion 636" of the outer shaping member. Above the bridging portion 638 is a void or depression defined within the shaping member 634 which receives

the central absorbent member 632, which may be provided with multiple slits and may comprise multiple layers (not shown). The body-side surface of the unitary shaping member 634 is provided with a substantially impervious or low permeability wicking barrier 640, which may be integral with the unitary shaping member 634, such as the outer skin on a shaped foamed article or the surface layer of a closed-cell foam, or a layer of thermoplastic film which has been adhered onto the surface of the shaping member 634. The wicking barrier 640 comprises a vertical component 641 and a horizontal component 642, which serve to prevent fluid wicking from the central absorbent member 632 and serve to direct fluid toward the central absorbent member 632. In one embodiment, no backsheet is necessary, or, as shown, an outer backsheet 644, desirably a liquid impervious layer, may be provided by the outer surface of the shaping member 634, which surface can be the skin on a foam, a polymeric coating, an adjoining film, a section of topsheet material wrapped around the article 630, or a film adhered to the shaping member 634.

EXAMPLE 33

Example 33 was made using a commercially available maxipad, the ALWAYS® Maxi with Wings with a DRI-WEAVE™ apertured film cover, manufactured by Procter and Gamble (Cincinnati, Ohio) and taken from a package of 20. This product also features "side channels" which are crescent-shaped, highly densified regions along the longitudinal sides in the crotch region joined to the central high bulk, high thickness fluff pad that extends across the longitudinal length of the article. According to the package, the product was made under one of more of the following US patents: 4,342,314 and 4,463,045, previously incorporated by reference, and 4,556,146; 4,573,986; 4,589,876; 4,687,478; and 5,267,992, all of which are herein incorporated by reference in their entireties. FIG. 30 depicts the original pad 650 as purchased, showing a central high-bulk fluff pad region 652, densified outer zones 654 having a lower basis weight than the central region 652, with highly densified embossment lines 655 joining the central region 652 to the densified outer zone 654. The topsheet (not shown) joins the backsheet to form an outer rim 656, which is also attached to wings 658.

To convert the commercial article into a pad according to the present invention, the apertured film topsheet was slit near the outer perimeter of the wings 658 of the article, and by hand the densified outer zones 654 were separated from the central high-bulk region 652 by tearing along the embossment lines 655. Then a 20 gsm 1-mil pink poly film with a width of 5 cm was pulled into the slit and placed under the central high-

bulk region 652 such that it covered the top surfaces of both of the densified outer zones 654 but went completely beneath the central high-bulk region 652 in the crotch region. The poly film was trimmed to just slightly extend past the outer perimeter of the densified outer zones 654, as depicted in FIG. 31, which follows the numbering scheme of FIG. 30 but shows a wicking barrier 660 comprising the poly film resting on the body-side surface 662 of the densified outer zones 654. In this embodiment, the densified outer zones 654 now serve collectively as the outer absorbent member having first and second portions with a void therebetween which has received a central absorbent member 653 comprising the central high-bulk region 652. The wicking barrier 660 has a horizontal component 662 on the outer absorbent member 654 and spans a vertical distance of about 5 mm from the top of the densified outer zones 654 to the backsheet (not shown) beneath the central high-bulk region 652 in the crotch region.

This modification of a commercial product, according to the present invention, can effectively reduce leaking to occur as fluid is wicked or otherwise transported from the high-bulk region 652 to the densified outer zones 654, and can reduce bending stiffness and enhance the folding geometry of the article when worn. Similar modifications may be made with other commercial articles, such as pantiliners.

EXAMPLE 34

Example 34 is a hypothetical example depicted in FIG. 32, which shows a cross-section of a sanitary napkin 700 along the transverse centerline adapted generally following the embodiment depicted in FIG. 4B. The same numbering scheme as in FIG. 4B is used, except for modified elements. In this embodiment, an abbreviated topsheet 702 extends primarily over the central absorbent member 82 but not completely over the outer absorbent member 76. Instead, the topsheet 702 is attached to an extended wicking barrier 708 which spans the underside of the central absorbent member 82 and wraps around the body-side surfaces of the outer absorbent member 76, which has a first portion 76' and a second portion 76". The extended wicking barrier 708 extends past the outer absorbent member 76 and joins to the backsheet 74. The wicking barrier 708 is also attached to the topsheet 702 at junctures 704. Thus, while the topsheet 708 is not directly attached to the backsheet 74, it can be considered to be indirectly attached to the backsheet 74 by means of a portion of the wicking barrier 708 serving as a joining element.

The abbreviated topsheet 702 permits fluid to readily enter the central absorbent member 84, while the wicking barrier 708 on the exposed surfaces of the outer absorbent

member 76 will resist fluid intake and, more importantly, resist fluid transfer from the central absorbent member 82 to the outer absorbent member 76. Fluid can still pass from the absorbent material 84 of the central absorbent member 82 by means of a tortuous pathway comprising apertures or openings 77 in the wicking barrier 708 and an absorbent strip of material 85 that helps provide fluid communication between the region near the apertures 77 and the outer absorbent member 76.

Of course, one could define the combination of the abbreviated topsheet 702 and the portions of the wicking barrier 708 on the exposed body-side surfaces of the outer absorbent member 76 as the topsheet, which would then be a composite topsheet attached to a wicking barrier having a vertical component and a horizontal component (the ledge just outside the central absorbent member 82).

It will be appreciated that the foregoing examples, given for purposes of illustration, are not to be construed as limiting the scope of this invention. Although only a few exemplary embodiments of this invention have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention, which is defined in the following claims and all equivalents thereto. Further, it is recognized that many embodiments may be conceived that do not achieve all of the advantages of some embodiments, particularly of the preferred embodiments, yet the absence of a particular advantage shall not be construed to necessarily mean that such an embodiment is outside the scope of the present invention.

We claim:

1. An absorbent article having a longitudinal direction, a transverse direction, a vertical direction substantially normal to both the longitudinal and transverse directions, and a body side, the absorbent article comprising:
    a) an absorbent core having a body side surface, the absorbent core comprising an outer absorbent member having a central void open toward the body side of the absorbent article, and a central absorbent member disposed over the central void of the outer absorbent member and extending into the void; and
    b) a wicking barrier disposed between the outer absorbent member and the central absorbent member, the wicking barrier comprising a vertical component and a horizontal component, the vertical component spanning a vertical distance between the outer absorbent member and the central absorbent member, and the horizontal component spanning a horizontal distance on the body side surface of the absorbent core.

2. The absorbent article of Claim 1 further comprising a backsheet attached to the absorbent core.

3. The absorbent article of Claim 2 further comprising a topsheet attached to the backsheet.

4. The absorbent article of Claim 1 further comprising a topsheet attached to the absorbent core.

5. The absorbent article of Claim 1 wherein the absorbent article further comprises a crotch region and wherein the horizontal component of the wicking barrier spans a horizontal distance in the crotch region that is substantially greater than the horizontal distance spanned by the wicking barrier outside of the crotch region.

6. The absorbent article of Claim 1 wherein the absorbent article further comprises a crotch region and wherein the wicking barrier covers a majority of the body-side surface of the outer absorbent member in the crotch region.

7. The absorbent article of Claim 1, wherein the absorbent article further comprises a crotch region, the absorbent core further comprises longitudinal sides, and the

horizontal component of the wicking barrier extends across the body side surface of the outer absorbent member to the longitudinal sides of the absorbent core in the crotch region.

8. The absorbent article of Claim 1, wherein the central void of the outer absorbent member is a hole extending completely through the outer absorbent member.

9. The absorbent article of Claim 8 wherein the absorbent article further comprises a crotch region, the absorbent core further comprises longitudinal sides, and the horizontal component of the wicking barrier extends across the body side surface of the outer absorbent member to the longitudinal sides of the absorbent core in the crotch region.

10. The absorbent article of Claim 9, further comprising a backsheet attached to the absorbent core, wherein the outer absorbent member in the crotch region is substantially enclosed by the wicking barrier and the backsheet.

11. The absorbent article of Claim 1 wherein the wicking barrier is liquid impervious.

12. The absorbent article of Claim 1 wherein the wicking barrier is liquid pervious.

13. The absorbent article of Claim 1, wherein the central void of the outer absorbent member longitudinally divides the outer absorbent member into two discontiguous sections.

14. The absorbent article of Claim 1, wherein the central void of the outer absorbent member is a depression extending only partially through the outer absorbent member.

15. The absorbent article of Claim 1, wherein the wicking barrier is a polymeric web that lines the central void beneath the central absorbent member and extends horizontally beyond the central absorbent member to form a ledge on the surface of the absorbent core.

16. The absorbent article of Claim 1, further comprising wings for attachment of the absorbent article to a wearer's panties.

17. The absorbent article of Claim 1, the absorbent article further comprising a garment side remote from the body side, wherein the wicking barrier extends to the garment side.

18. The absorbent article of Claim 1, wherein the central void of the outer absorbent member has a width and the central absorbent member has a width greater than the width of the central void.

19. The absorbent article of Claim 1, wherein the central void of the outer absorbent member has a width and the central absorbent member has a width less than or equal to the width of the central void.

20. The absorbent article of Claim 1, wherein the horizontal component of the wicking barrier substantially resides on the outer absorbent member.

21. The absorbent article of Claim 1, wherein the horizontal component of the wicking barrier substantially resides on the central absorbent member.

22. The absorbent article of Claim 1, wherein the central absorbent member comprises an upper layer and a lower layer, the upper layer having longitudinal sides, and the wicking barrier wraps at least a portion of the longitudinal sides of the upper layer.

23. The absorbent article of Claim 1, wherein the vertical component of the wicking barrier spans a vertical distance of at least about 20 percent of the average thickness of the central absorbent member.

24. The absorbent article of Claim 1, wherein the central void has a depth and wherein the vertical component of the wicking barrier spans a vertical distance of at least about 50 percent of the depth of the central void in the outer absorbent member.

25. The absorbent article of Claim 1, wherein the central void has a depth and wherein the vertical component of the wicking barrier substantially spans the entire depth of the central void in the outer absorbent member.

26. The absorbent article of Claim 1, wherein the central void has a depth and the wicking barrier extends downward from the surface of the absorbent core to span a vertical distance substantially less than the depth of the central void.

27. The absorbent article of Claim 1, wherein the vertical component of the wicking barrier spans a vertical distance of at least about 1 mm.

28. The absorbent article of Claim 1, wherein the horizontal component of the wicking barrier spans a horizontal distance of at least about 1 mm.

29. The absorbent article of Claim 1 further comprising a transverse axis, wherein the horizontal component of the wicking barrier along the transverse axis covers at least about 30 percent of the surface of the outer absorbent member along the transverse axis.

30. The absorbent article of Claim 1 further comprising a transverse axis, wherein the horizontal component of the wicking barrier along the transverse axis covers at least about 50 percent of the surface of the outer absorbent member along the transverse axis.

31. The absorbent article of Claim 1, wherein the wicking barrier has a liquid permeability gradient such that the wicking barrier is more liquid permeable away from the body side of the article.

32. The absorbent article of Claim 1, wherein the wicking barrier has a wettability gradient such that the wicking barrier is more wettable away from the body side of the article.

33. The absorbent article of Claim 1, wherein the wicking barrier is a fluid impervious film provided with fluid pervious pores remote from the body side surface of the absorbent core.

34. The absorbent article of Claim 33, wherein the pores in the wicking barrier are about 1 mm or greater below the surface of the outer absorbent member.

35. The absorbent article of Claim 1, wherein the central absorbent member further comprises an outer perimeter and a center, and the wicking barrier is adapted to establish a pathway for fluid flow from the center of the central absorbent member to the outer perimeter of the central absorbent member.

36. The absorbent article of Claim 1, wherein the wicking barrier comprises multiple vertical layers of barrier material.

37. The absorbent article of Claim 1, further comprising a backsheet attached to the absorbent core, wherein the wicking barrier is integral with the backsheet.

38. The absorbent article of Claim 1, further comprising a backsheet attached to the absorbent core, wherein the horizontal component of the wicking barrier comprises a portion of the backsheet that is wrapped around the outer absorbent member.

39. The absorbent article of Claim 1, wherein the wicking barrier comprises a hydrophobic barrier material.

40. The absorbent article of Claim 39, wherein the barrier material is selected from the group consisting of a polymeric film, a nonwoven web, a flexible foam, a silicone layer, and a tissue comprising hydrophobic matter.

41. The absorbent article of Claim 39, wherein the barrier material is selected from the group consisting of an impervious polymeric film, an apertured polymeric film, and a spunbond web.

42. The absorbent article of Claim 39, wherein the barrier material is selected from the group consisting of a wax, an adhesive, and a thermoplastic wherein the barrier material impregnates at least one of the central absorbent member and the outer absorbent member.

43. The absorbent article of Claim 1, further comprising a vertical void space between the central absorbent member and the outer absorbent member.

44. The absorbent article of Claim 1, wherein the wicking barrier defines two substantially longitudinal bands separating the central absorbent member from the outer absorbent member.

45. The absorbent article of Claim 1, further comprising a topsheet, wherein the topsheet is provided with at least one fold to form an elevated runoff barrier.

46. The absorbent article of Claim 1, wherein the central absorbent member comprises multiple concentric layers of alternating absorbent material and barrier material spanning a vertical distance.

47. The absorbent article of Claim 1, wherein the central absorbent member comprises about 50 percent or more papermaking fibers by weight.

48. The absorbent article of Claim 1, wherein the central absorbent member comprises high yield papermaking fibers.

49. The absorbent article of Claim 1, wherein the central absorbent member comprises a plurality of layers of cellulosic material.

50. The absorbent article of Claim 49, wherein at least one layer below the uppermost layer of cellulosic material has a density greater than the density of the uppermost layer.

51. The absorbent article of Claim 1, wherein the central absorbent member comprises at least one layer of wet laid tissue.

52. The absorbent article of Claim 1, wherein the central absorbent member comprises at least one layer of cellulosic air laid material.

53. The absorbent article of Claim 1, wherein the outer absorbent member comprises a resilient foam.

54. The absorbent article of Claim 1, wherein the central absorbent member comprises a plurality of vertically oriented layers of nonabsorbent material.

55. The absorbent article of Claim 54, wherein the central absorbent member further comprises an outer edge and a centermost region, and wherein lateral wicking flow from the centermost region of the central absorbent member to the outer edge of the central absorbent member is possible via a path between the plurality of vertically oriented layers of nonabsorbent material.

56. The absorbent article of Claim 1 wherein the central absorbent member comprises a spiral wound composite having at least one layer of absorbent material and at least one layer of barrier material wound together in a spiral form.

57. The absorbent article of Claim 1 wherein the central absorbent member comprises a composite having multiple vertical layers of barrier material alternating with layers of absorbent material.

58. An absorbent article having a body side, the absorbent article comprising an absorbent core having a body side surface and comprising an outer absorbent member and a central absorbent member having a perimeter, and a wicking

barrier spanning a vertical distance disposed along at least a portion of the perimeter of the central absorbent member, the wicking barrier also comprising a horizontal component residing on the body-side surface of the absorbent core.

59. The absorbent article of Claim 58, wherein the central absorbent member and the outer absorbent member comprise comminuted cellulose fibers.

60. The absorbent article of Claim 58, further comprising a backsheet attached to the absorbent core.

61. The absorbent article of Claim 58, further comprising a topsheet attached to the absorbent core.

62. An absorbent article having a longitudinal direction, a transverse direction, and a vertical direction substantially normal to both the longitudinal and transverse directions, a crotch region, and a body side, the absorbent article comprising:

a) an absorbent core having a body side surface, the absorbent core comprising a central absorbent member surrounded by an outer shaping member with a central void for receiving the central absorbent member;
b) a baffle layer beneath the central absorbent member; and
c) a wicking barrier disposed between the outer shaping member and the central absorbent member, the wicking barrier comprising a vertical component and a horizontal component, and the horizontal component spanning a horizontal distance on the body side surface of the outer shaping member.

63. The absorbent article of Claim 62, further comprising a liquid pervious topsheet attached to the body side surface of the absorbent core.

64. The absorbent article of Claim 62, wherein the outer shaping member is substantially nonabsorbent.

65. The absorbent article of Claim 62, further comprising a garment side and a liquid impervious backsheet attached to the garment side of the article, wherein the baffle layer comprises a portion of the backsheet.

66. The absorbent article of Claim 62, wherein the wicking barrier runs beneath the central absorbent member to also serve as the baffle layer.

67. The absorbent article of Claim 62, wherein the wicking barrier comprises at least one surface integral to the outer shaping member.

68. The absorbent article of Claim 62, wherein the outer shaping member comprises a first portion and a second portion joined by a bridging portion.

69. The absorbent article of Claim 62, wherein the wicking barrier comprises a portion of the surface of the outer shaping member.

70. The absorbent article of Claim 62, wherein the baffle layer comprises a portion of the surface of the outer shaping member.

71. The absorbent article of Claim 62, wherein the baffle layer comprises at least one surface integral to the outer shaping member.

72. The absorbent article of Claim 62, wherein the outer shaping member is a foam.

73. The absorbent article of Claim 62, wherein the outer shaping member is a foam having a liquid impervious skin.

74. The absorbent article of Claim 62, wherein the outer shaping member further comprises outer longitudinal sides and wherein the horizontal component of the wicking barrier covers from about 50% to about 100% of the body-side surface of the outer shaping member in the crotch region of the absorbent article.

75. The absorbent article of Claim 62, further comprising a garment side and a liquid impervious backsheet attached to the garment side of the article, wherein the outer shaping member is substantially encircled by the wicking barrier and the backsheet in the crotch region.

76. The absorbent article of Claim 62, wherein the outer shaping member comprises at least about 50 percent cellulosic fibers.

77. The absorbent article of Claim 62, wherein the absorbent capacity of the central absorbent member is at least about 20 milliliters of fluid.

78. The absorbent article of Claim 62, wherein the central absorbent member comprises a composite having multiple vertical layers of barrier material alternating with layers of absorbent material.

79. An absorbent article with a longitudinal direction, a transverse direction, a vertical direction substantially normal to both the longitudinal and transverse directions, a body side, and a garment side, the absorbent article comprising:

a) an absorbent core having a central absorbent member and an outer absorbent member, the outer absorbent member having a central void for receiving at least a portion of the central absorbent member, whereby an interface is defined between the central absorbent member and the outer absorbent member; and

b) a wicking barrier disposed along the interface between the central absorbent member and the outer absorbent member, the wicking barrier spanning a vertical distance in the absorbent article and having a variable liquid permeability such that the liquid permeability of the wicking barrier is lower near the body side and higher near the garment side.

80. An absorbent article with a longitudinal direction, a transverse direction, and a vertical direction substantially normal to both the longitudinal and transverse directions, the absorbent article comprising:

a) an absorbent core having a central absorbent member and an outer absorbent member, the outer absorbent member having a central void defined therein for receiving at least a portion of the central absorbent member, whereby an interface is defined between the central absorbent member and the outer absorbent member, the interface spanning a vertical distance; and

b) a single ply of a wicking barrier disposed along the interface between the central absorbent member and the outer absorbent member.

81. The absorbent article of Claim 80, wherein the single ply of barrier material is adhesively attached to both the central absorbent member and the outer absorbent member.

82. The absorbent article of Claim 80, wherein the absorbent core further comprises a body side surface and the wicking barrier further comprises a horizontal component on the body side surface of the absorbent core spanning a horizontal distance of at least 1 millimeter.

83. An absorbent article with a crotch region, a longitudinal direction, a transverse direction, and a vertical direction substantially normal to both the longitudinal and transverse directions, the absorbent article comprising:

a) an absorbent core having a body side surface, the absorbent core comprising a central absorbent member and an outer shaping member, the outer shaping member having a central void defined therein for receiving at least a portion of the central absorbent member, whereby an interface is defined between the central absorbent member and the outer shaping member, the interface spanning a vertical distance; and

b) a wicking barrier disposed along a vertical distance of the interface between the central absorbent member and the outer absorbent member, wherein the wicking barrier comprises a horizontal component spanning a horizontal distance on the body side surface of the absorbent core.

84. The absorbent article of Claim 83, wherein the outer shaping member comprises a thickness, an edge width, and a basis weight, and the outer shaping member has a thickness of at least about 1 millimeter, an edge width of at least about 2 millimeters, and a basis weight of at least about 100 grams per square meter.

85. The absorbent article of Claim 83, wherein the wicking barrier further comprises a horizontal component spanning a distance of at least about 1 millimeter on the surface of the absorbent core.

86. An absorbent article comprising a composite absorbent core having a center, the absorbent core having a body side surface and comprising a central absorbent member and a surrounding outer absorbent member, wherein a plurality of vertically oriented segments of hydrophobic material in the central absorbent member define liquid wicking pathways from the center of the central absorbent member to the outer absorbent member.

87. The absorbent article of Claim 86, wherein the central absorbent member comprises a spiral wound composite having at least one layer of absorbent material and at least one layer of barrier material wound together in a spiral form.

88. An absorbent article comprising a backsheet and a concentric absorbent structure attached to the backsheet, the concentric absorbent structure having a thickness and comprising multiple alternating concentric layers of barrier material and

absorbent material, wherein the barrier material substantially spans the thickness of the concentric absorbent structure.

89. The absorbent article of Claim 88, wherein the absorbent article further comprises a liquid pervious topsheet attached to the backsheet.

90. The absorbent article of Claim 88, wherein the absorbent material comprises cellulosic fibers.

91. The absorbent article of Claim 88, wherein the concentric absorbent structure comprises a spiral wound composite formed by cutting a slice from a spiral wound roll formed from an absorbent web and a barrier layer wound together.

92. The absorbent article of Claim 88, wherein the concentric absorbent structure comprises two or more adjacent layers of barrier material adapted to slide relative to each other under shearing stress or lateral compression such that the concentric absorbent structure can deform in the thickness direction by sliding action of one layer relative to the other.

93. The absorbent article of Claim 88, wherein the concentric absorbent structure comprises a continuous strip of barrier material spirally wound about a layer of an absorbent cellulosic web.

94. The absorbent article of Claim 88, wherein the barrier material comprises a strip selected from the group consisting of a polymeric film, an apertured film, and a nonwoven web.

95. The absorbent article of Claim 88, wherein the barrier material comprises a thermoplastic hydrophobic material deposited on the absorbent material to provide a wicking barrier between successive layers of the absorbent material.

96. The absorbent article of Claim 88, wherein the absorbent material of the concentric absorbent structure comprises at least one of a layer of airlaid comminuted cellulosic fibers, a wet laid tissue, a dry laid tissue, and a cotton web.

97. A method for producing an absorbent article having a central absorbent member, the method comprising:

a) preparing an outer absorbent member, wherein the outer absorbent member has a central void;

b) deposing a layer of a flexible barrier material over the central void; and

c) inserting a section of absorbent material into the central void and over the barrier material to form a central absorbent member, such that a portion of the barrier material separates the central absorbent member from the outer absorbent member along a vertical distance.

98. The method of Claim 97, the method further comprising:

d) deposing a backsheet beneath the absorbent core;

e) deposing a topsheet above the absorbent core; and

f) attaching a portion of the topsheet to a portion of the backsheet.

99. The method of Claim 97, wherein preparing the outer absorbent member with a central void comprises forming a layer of cellulosic fibers and forming the central void in a central portion of the layer.

100. The method of Claim 97, wherein the central absorbent member comprises a cellulosic absorbent material.

101. The method of Claim 97, wherein the central void in the outer absorbent member is formed by cutting out a section from the outer absorbent member, and wherein the central absorbent member comprises the cut-out section from the outer absorbent member.

102. A method for producing an absorbent article having a central absorbent member, a garment side, and a body side, the method comprising:

a) preparing an outer shaping member having a first portion and a second portion with a central void between the first portion and the second portion, wherein the central void has a vertical depth and the outer shaping member has a surface comprising a wicking barrier that spans at least a portion of the vertical depth of the central void; and

b) inserting an absorbent material into the central void of the outer shaping member to form a central absorbent member.

103. The method of Claim 102, wherein the wicking barrier is a polymeric web attached to the outer shaping member.

104. The method of Claim 102, wherein the wicking barrier also traverses a horizontal distance on the surface of the outer shaping member.

105. The method of Claim 102, wherein the central void is a hole passing completely through the outer shaping member.

106. The method of Claim 102, wherein the method further comprises deposing a backsheet on the garment side of the absorbent article.

107. The method of Claim 102, wherein the method further comprises attaching a topsheet to the body side of the article.

108. The method of Claim 102, further comprising the step of deposing a baffle layer beneath the central absorbent member.

109. A method of preparing an absorbent article comprising a concentric absorbent structure with multiple vertical wicking barriers interposed between layers of absorbent material, the method comprising:

a) superposing at least one layer of a barrier material onto at least one layer of absorbent material to form a multilayered structure;
b) rolling the multilayered structure about a rolling axis to form a spiral wound roll;
c) slicing a portion of the spiral wound roll substantially normal to the rolling axis to form a substantially concentric absorbent structure; and
d) attaching the substantially concentric absorbent structure to a backsheet.

110. The method of Claim 109, the method further comprising attaching a liquid pervious topsheet to the backsheet.

111. The method of Claim 109, wherein the wicking barrier is a polymeric film.

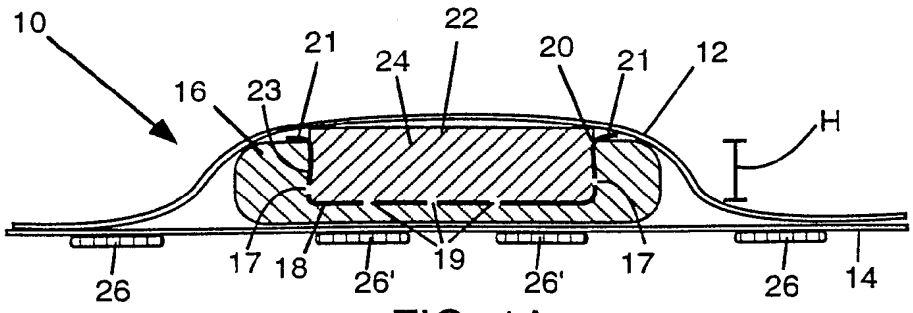


FIG. 1A

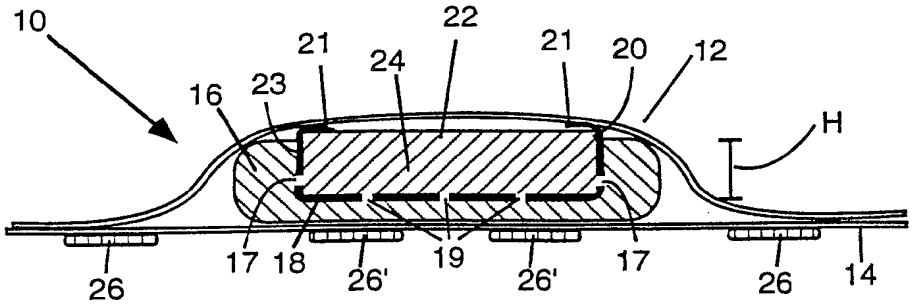


FIG. 1B

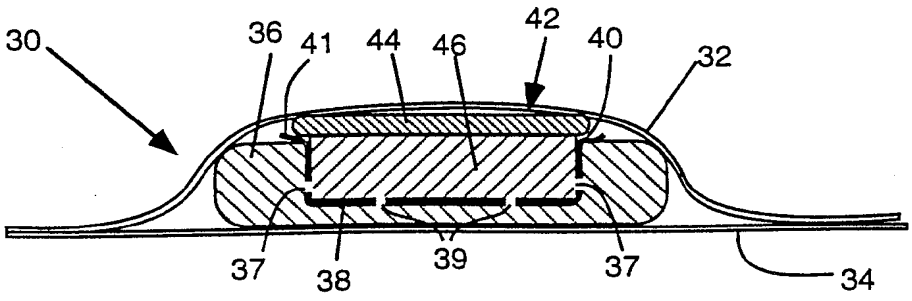


FIG. 2

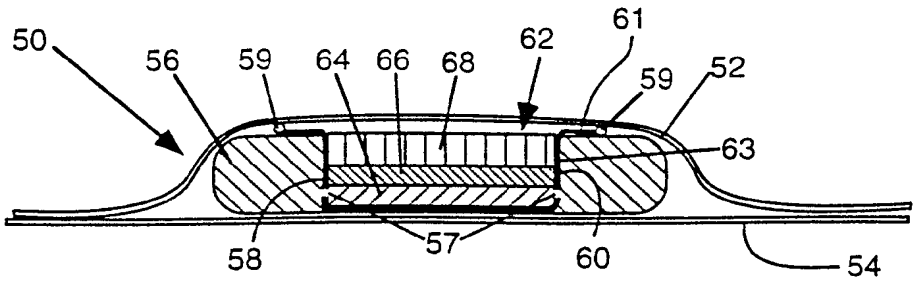

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FIG. 3A

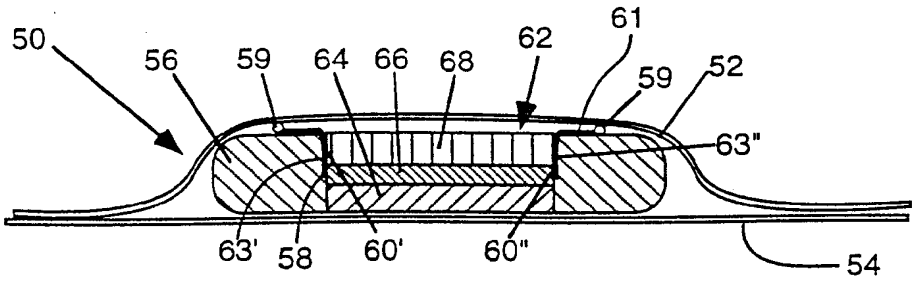

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FIG. 3B

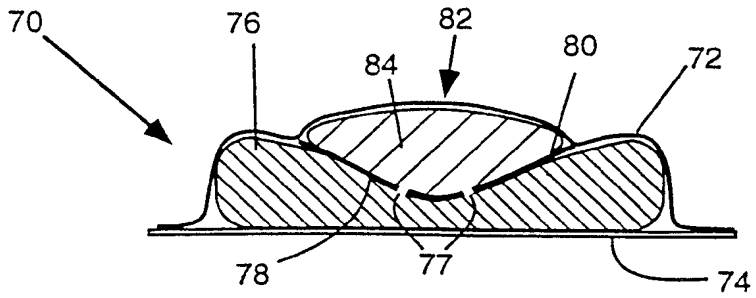


FIG. 4A

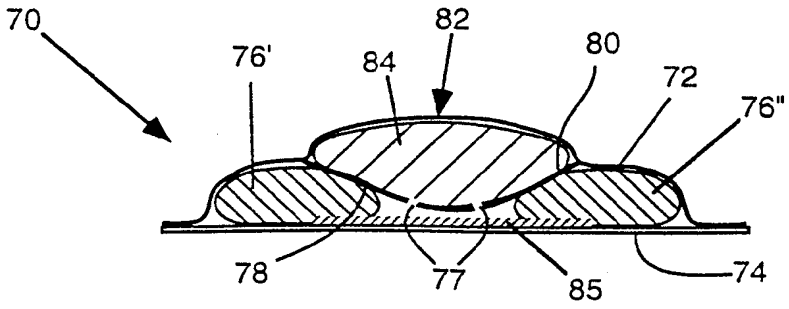


FIG. 4B

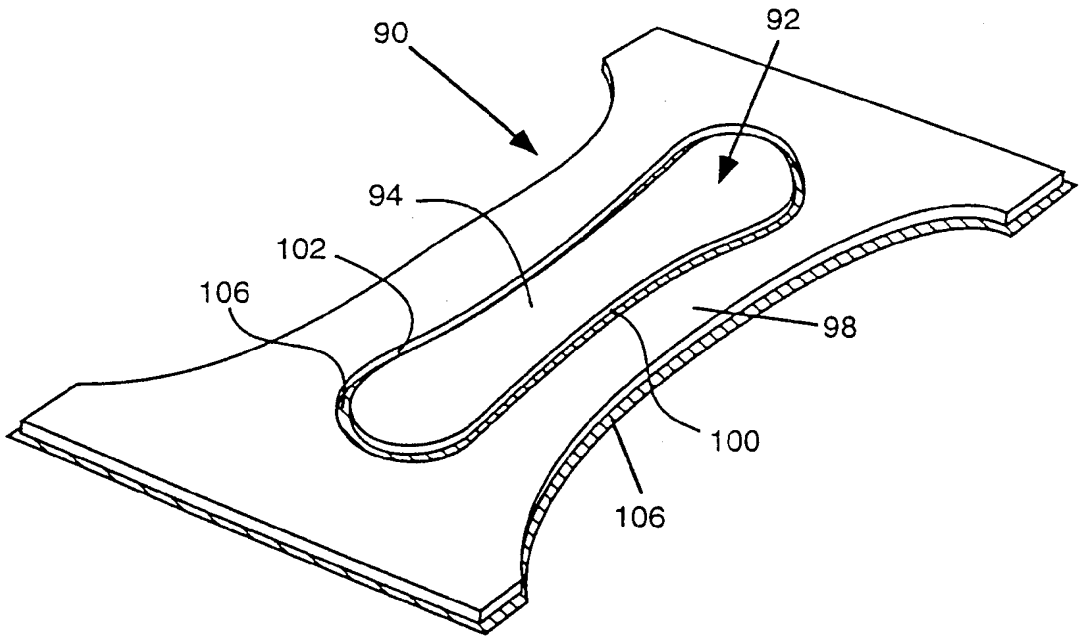


FIG. 5A

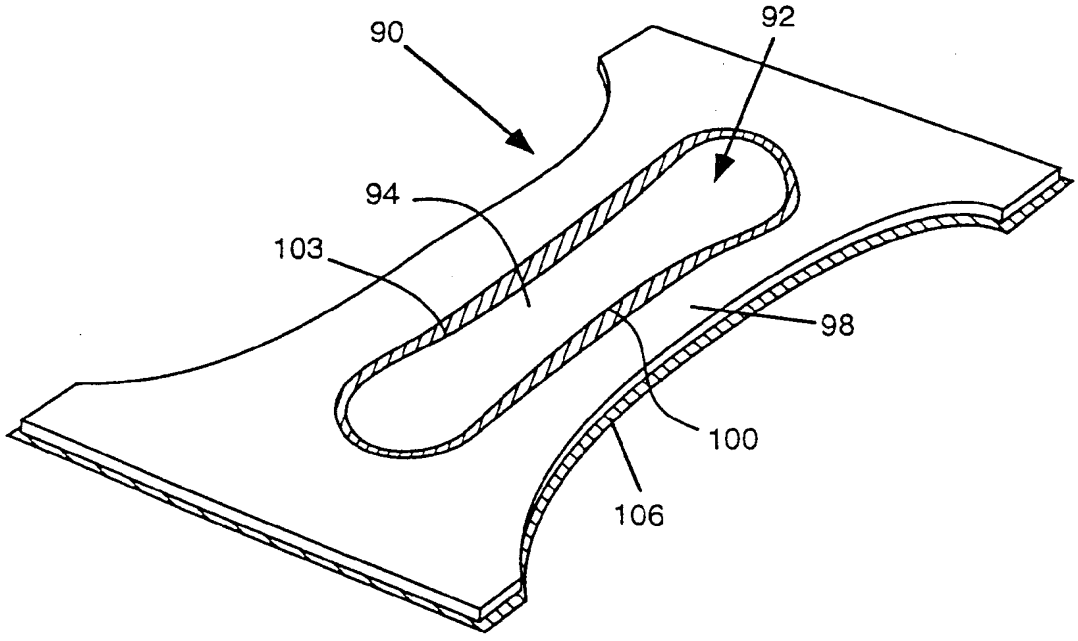


FIG. 5B

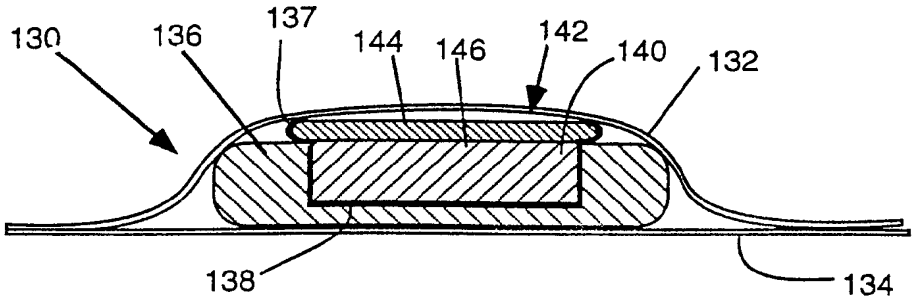


FIG. 6

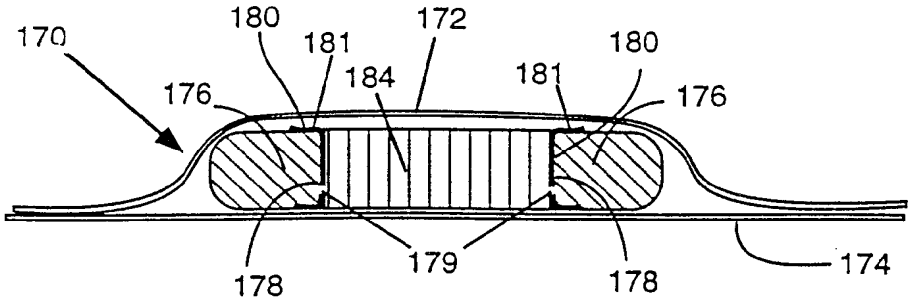


FIG. 7A

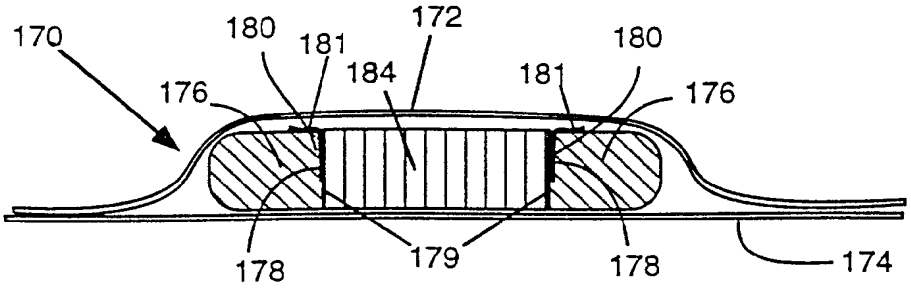


FIG. 7B

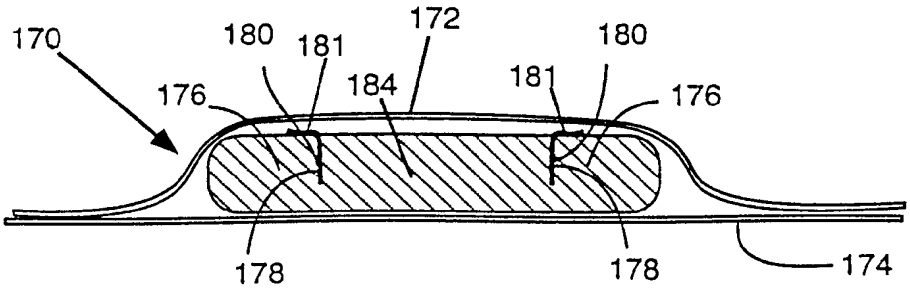


FIG. 7C

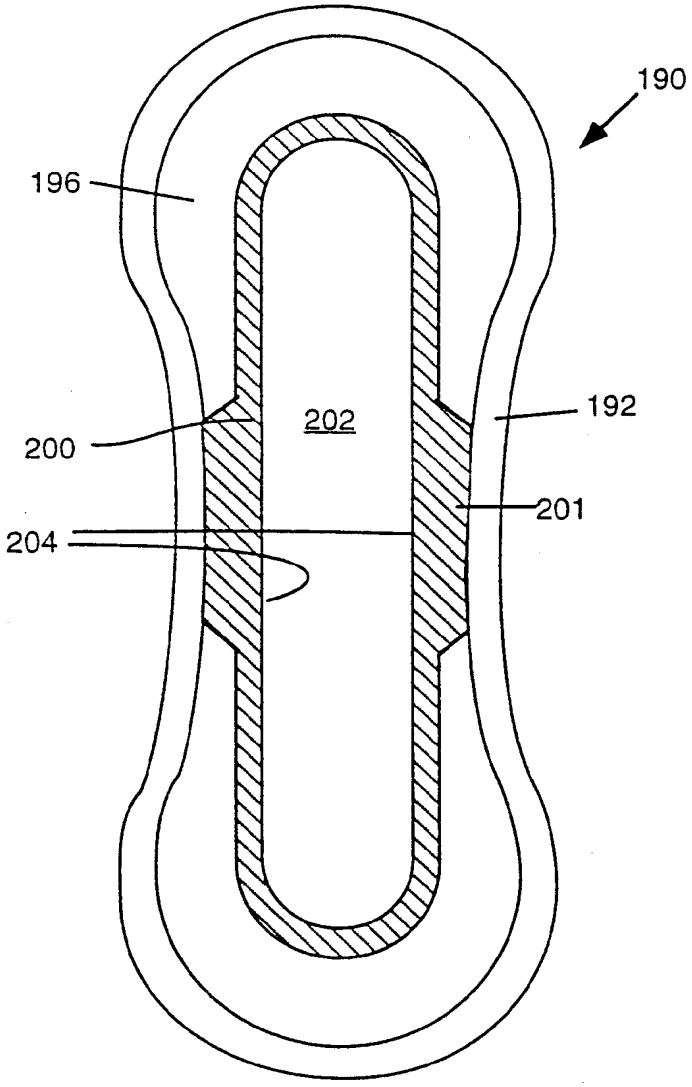


FIG. 8

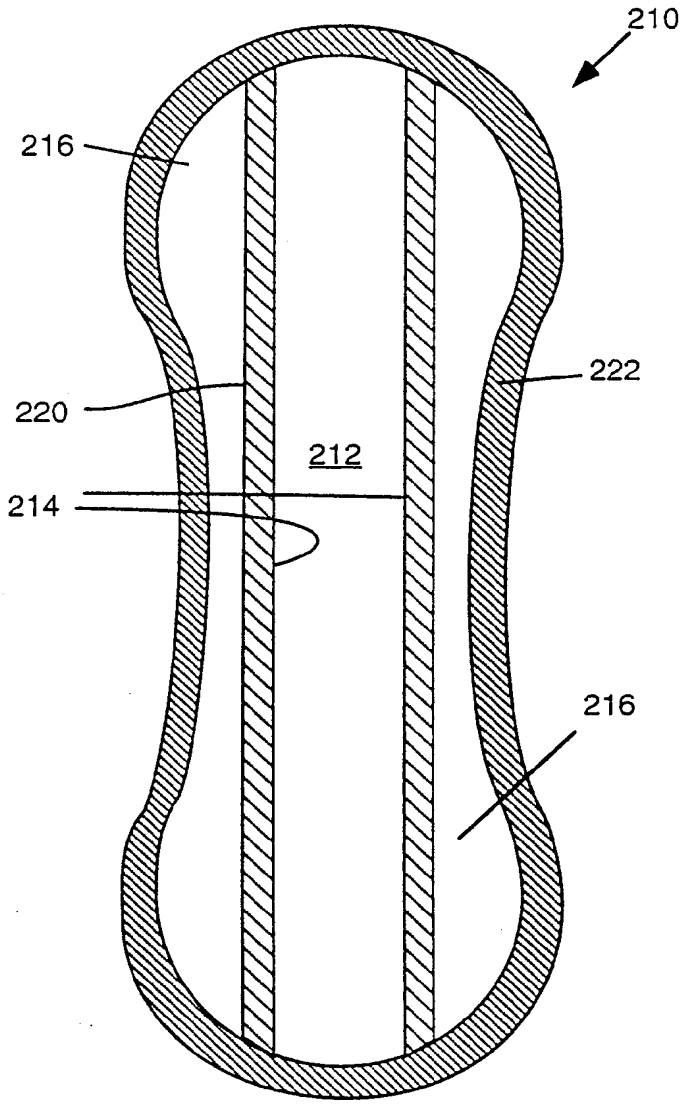


FIG. 9

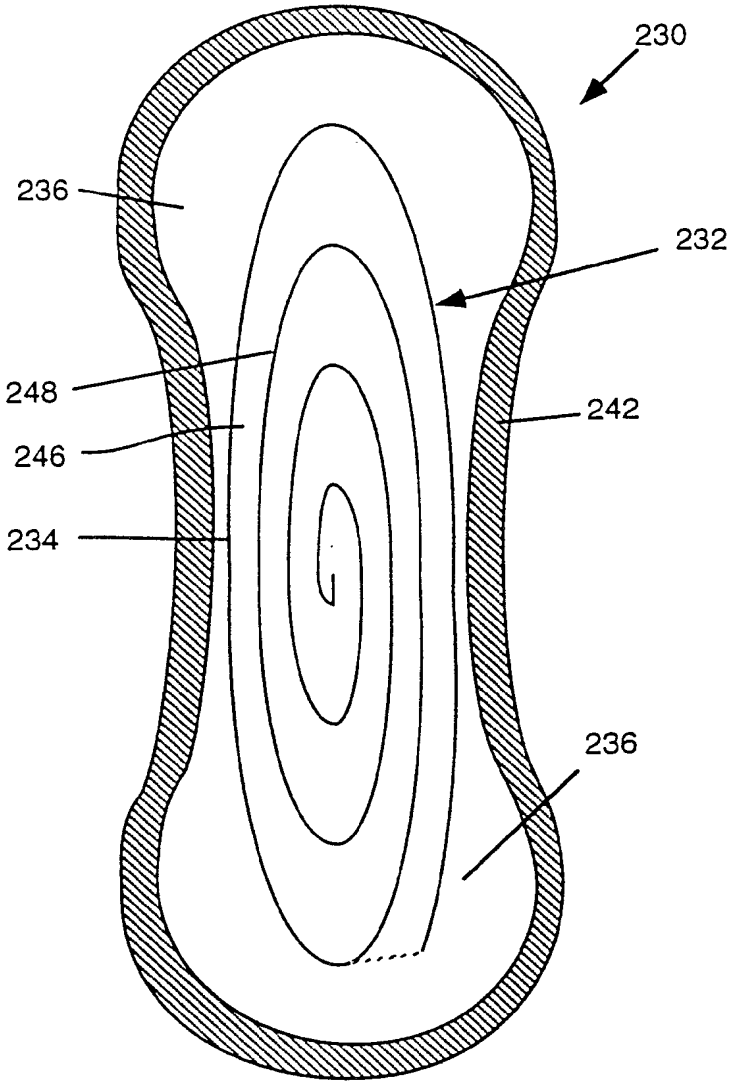


FIG. 10

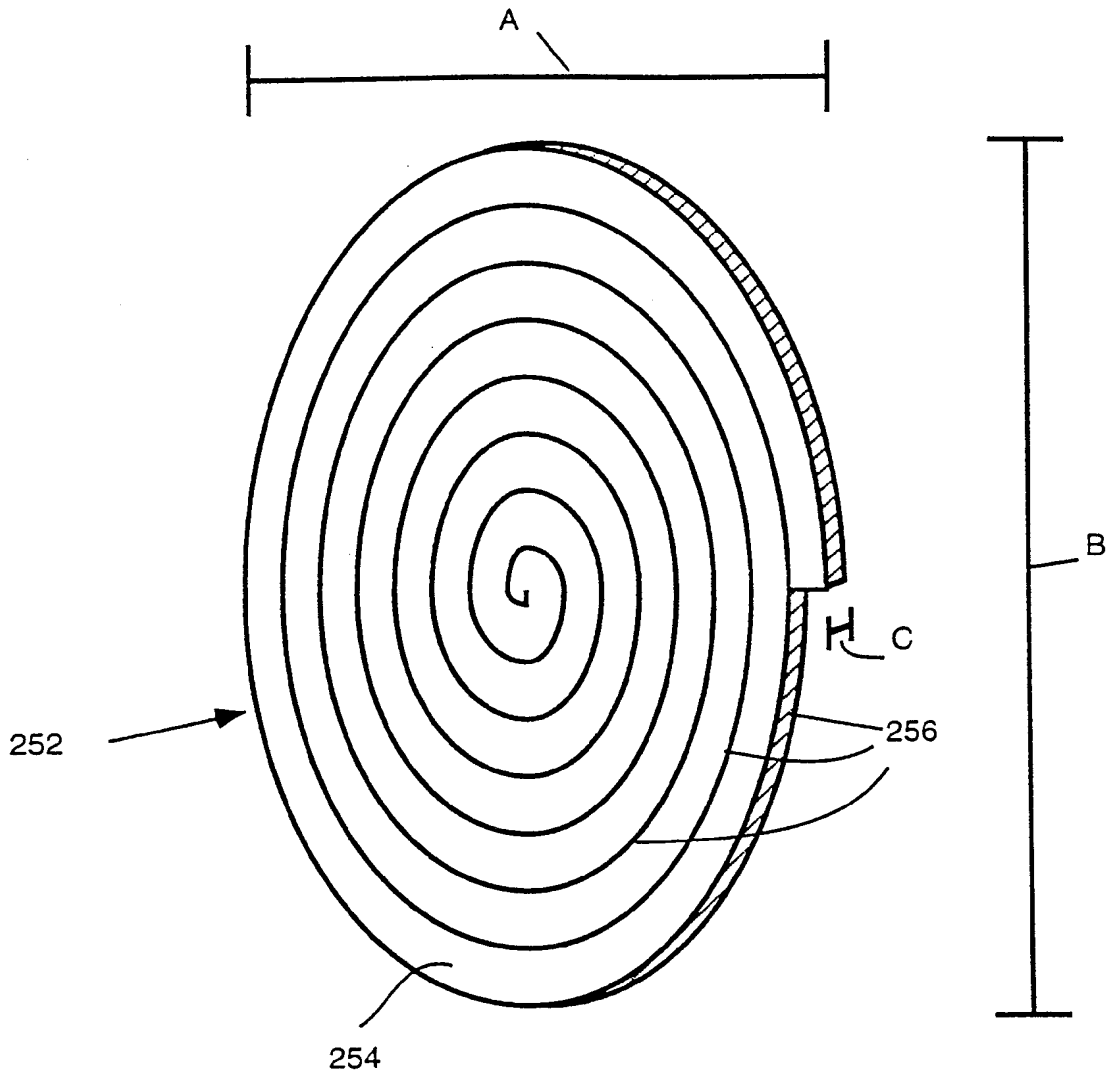


FIG. 11

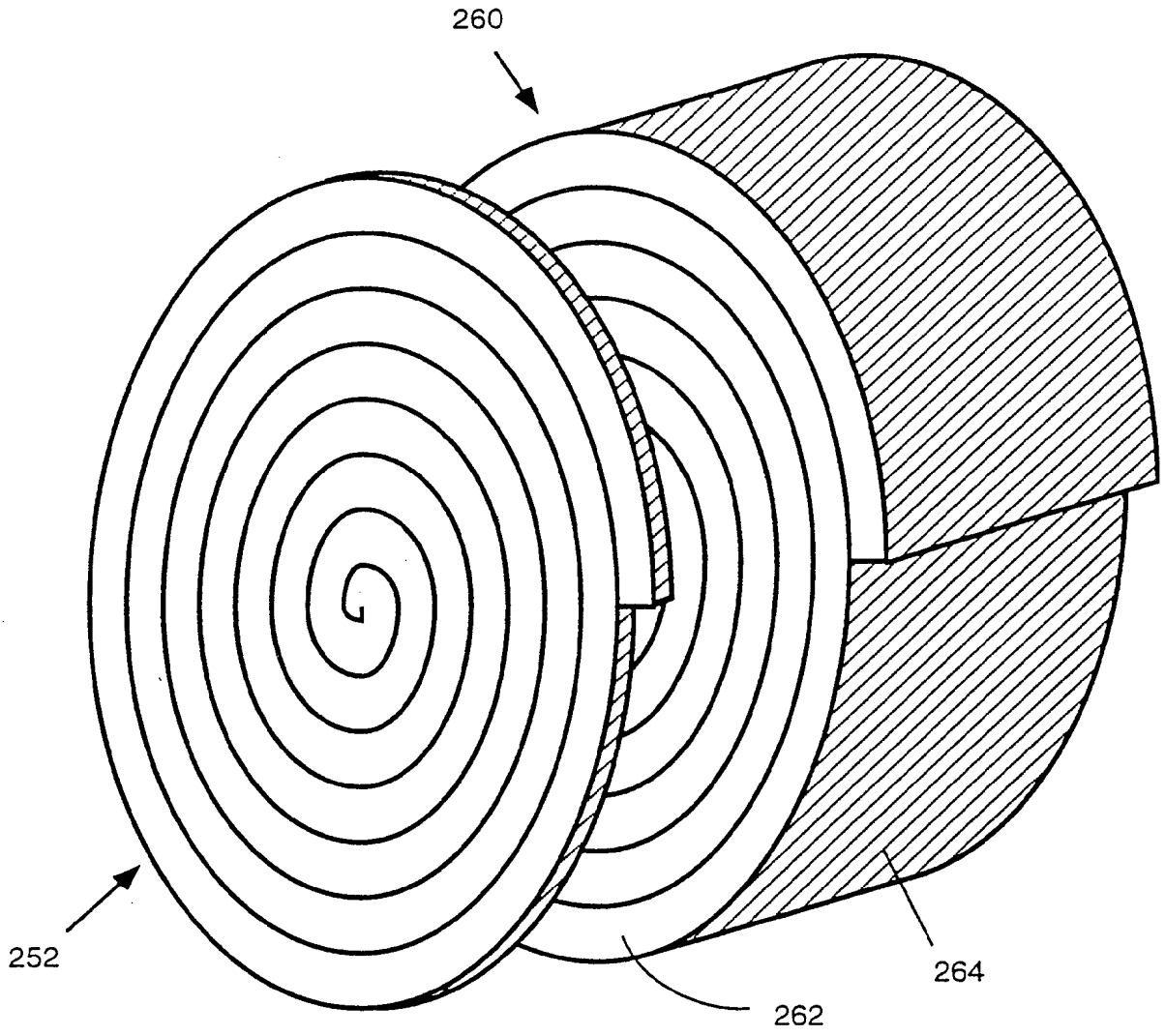


FIG. 12

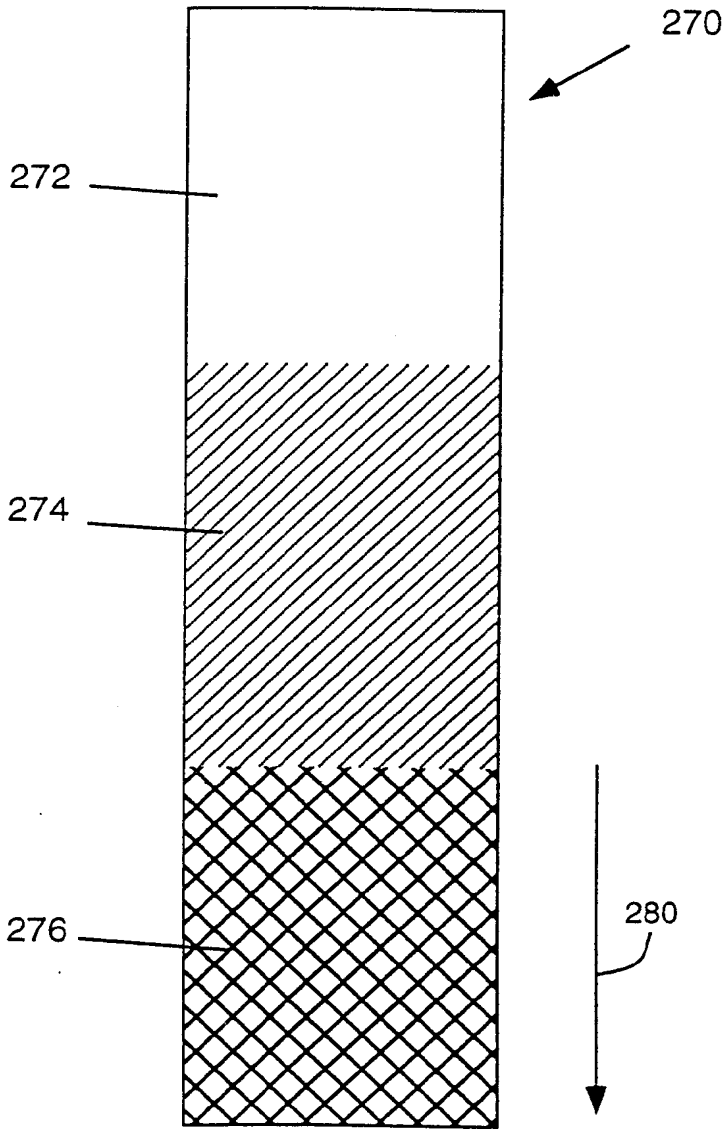


FIG. 13

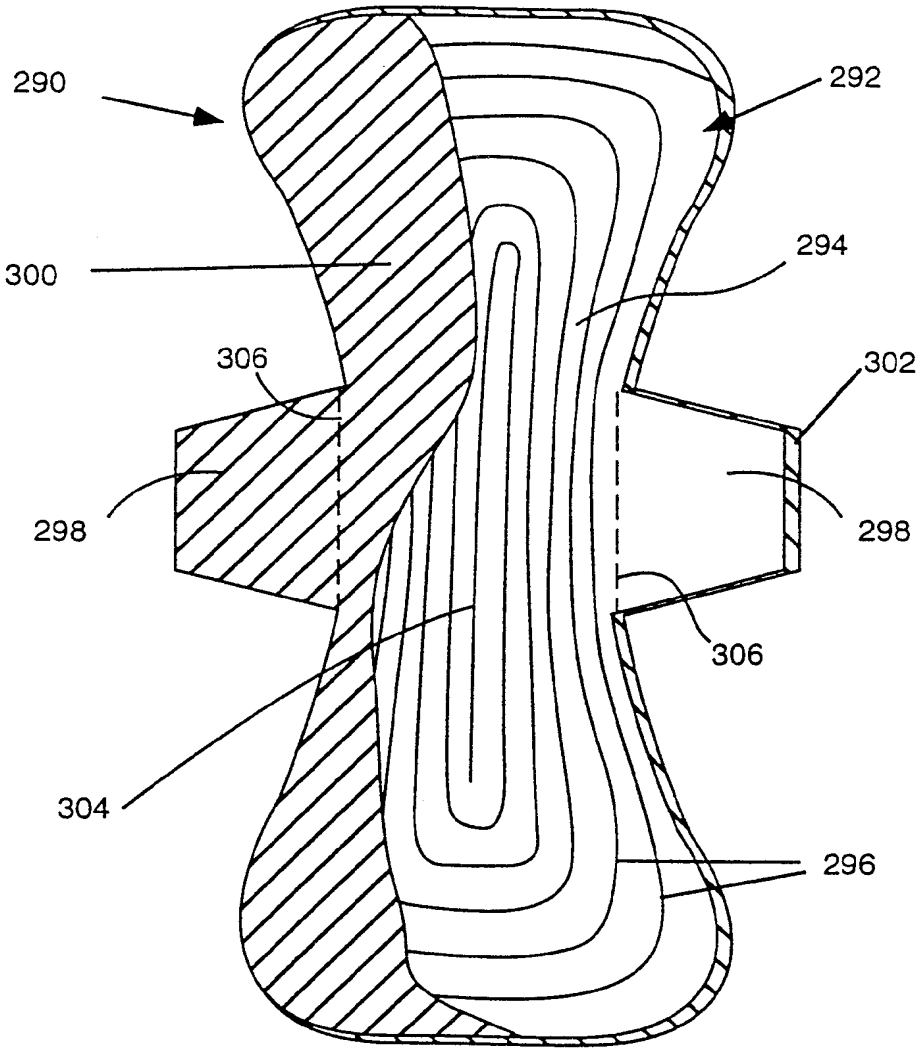


FIG. 14

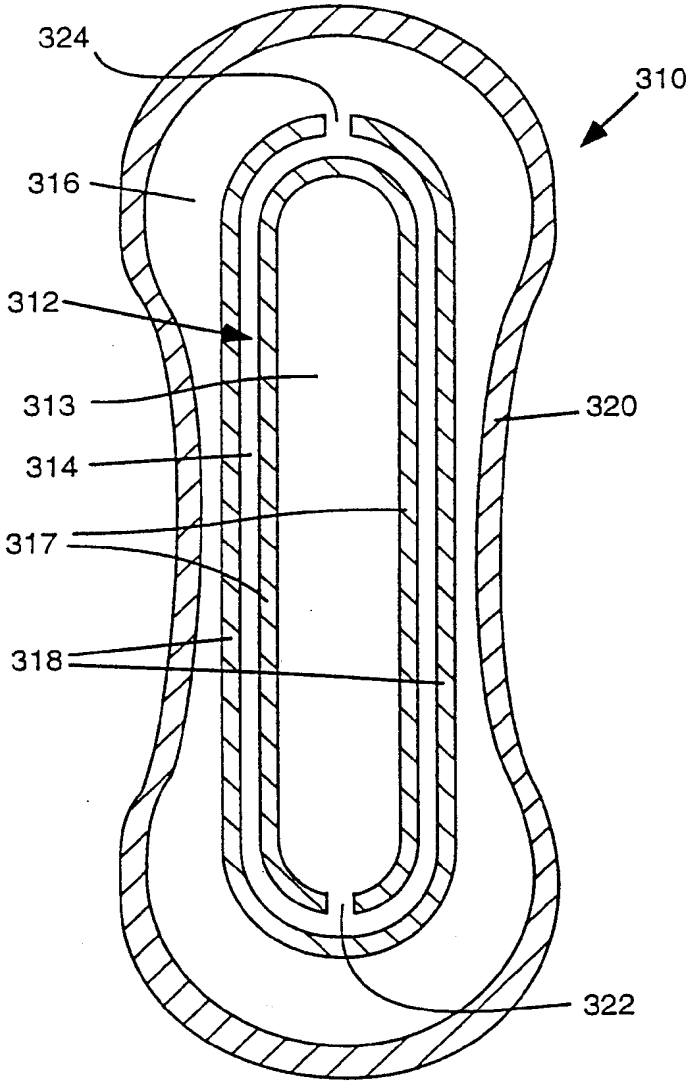


FIG. 15

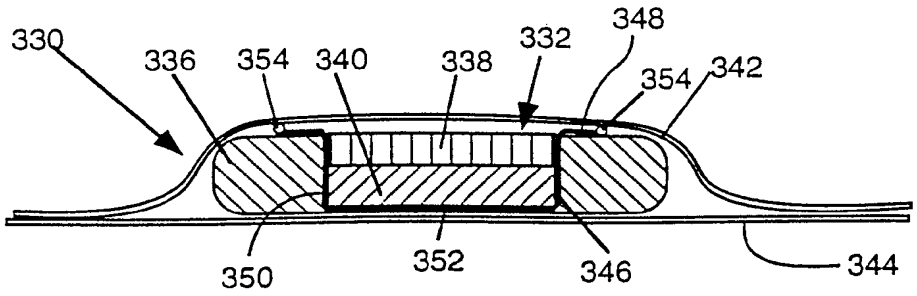


FIG. 16A

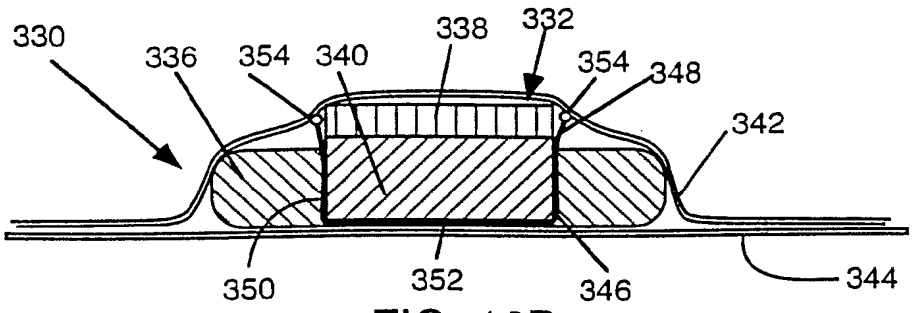


FIG. 16B

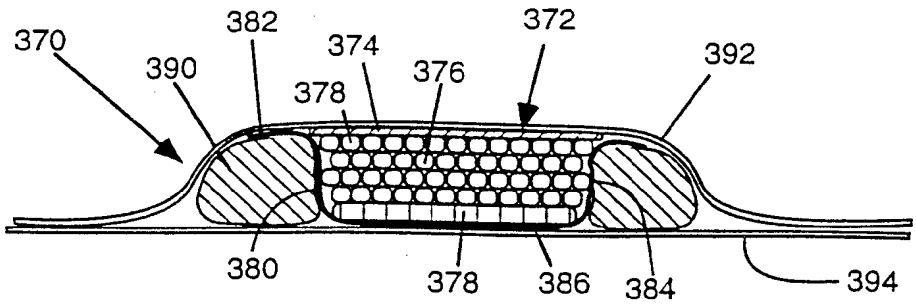


FIG. 17

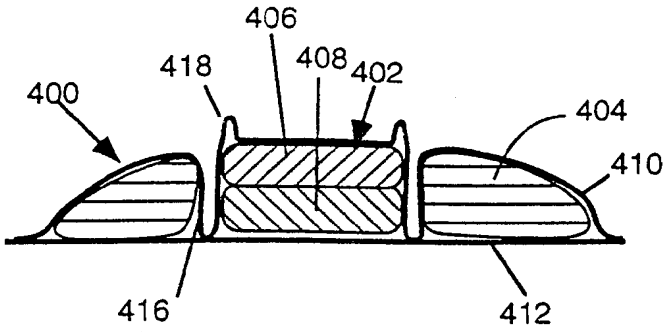


FIG. 18A

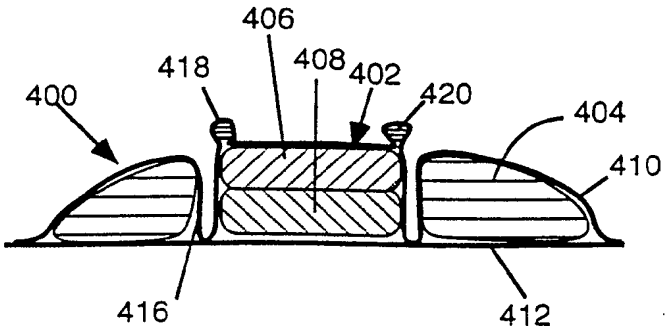


FIG. 18B

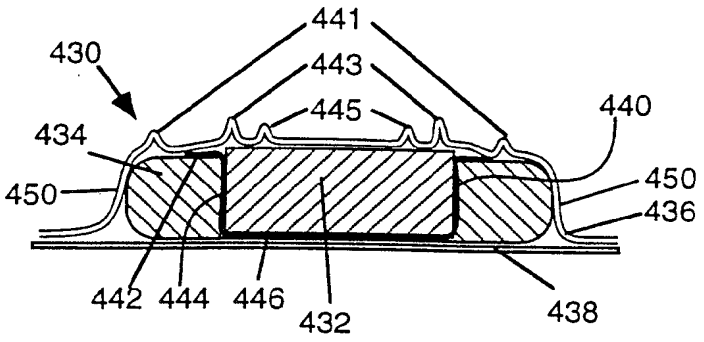


FIG. 19A

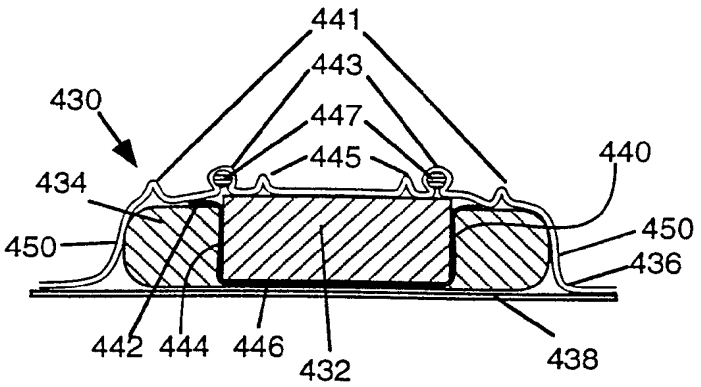


FIG. 19B

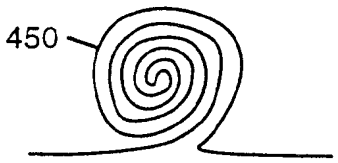


FIG. 20A



FIG. 20B

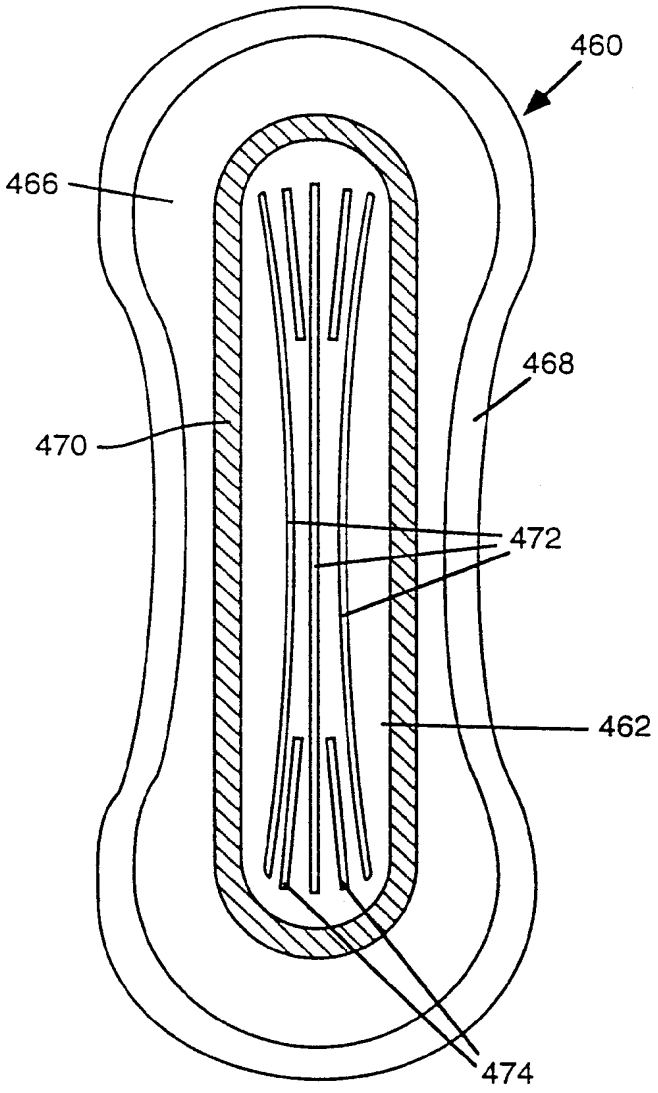


FIG. 21

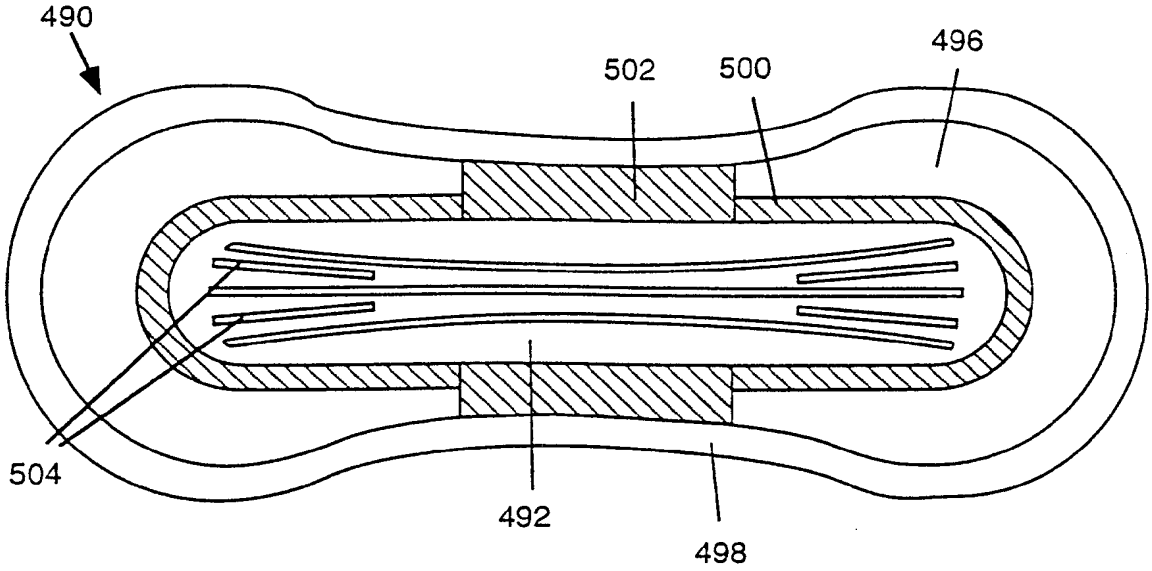


FIG. 22A

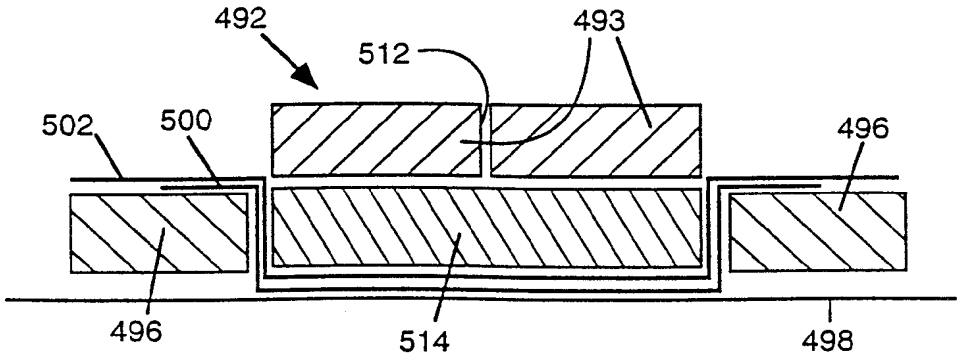


FIG. 22B

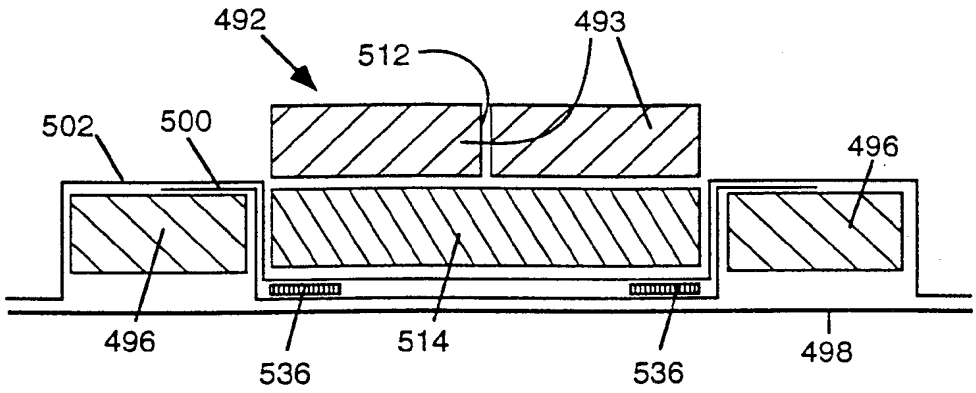


FIG. 23

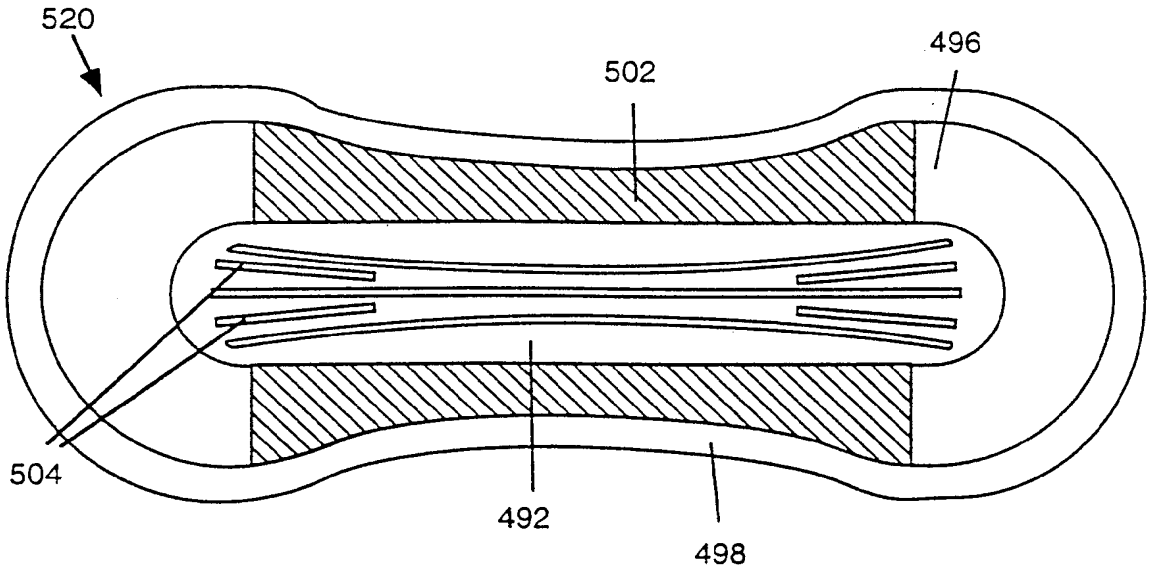


FIG. 24A

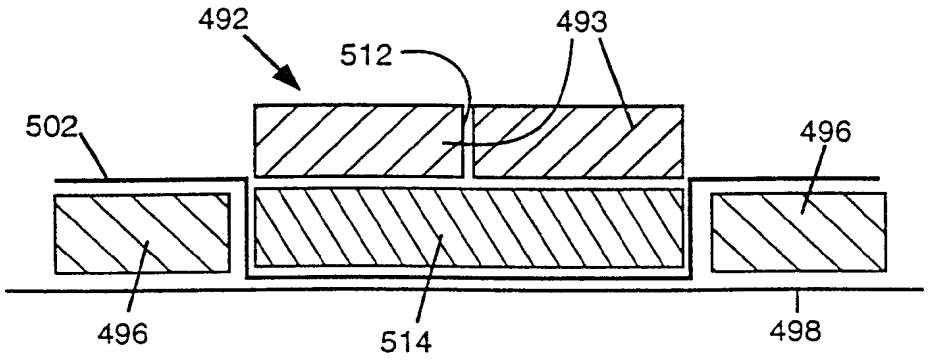


FIG. 24B

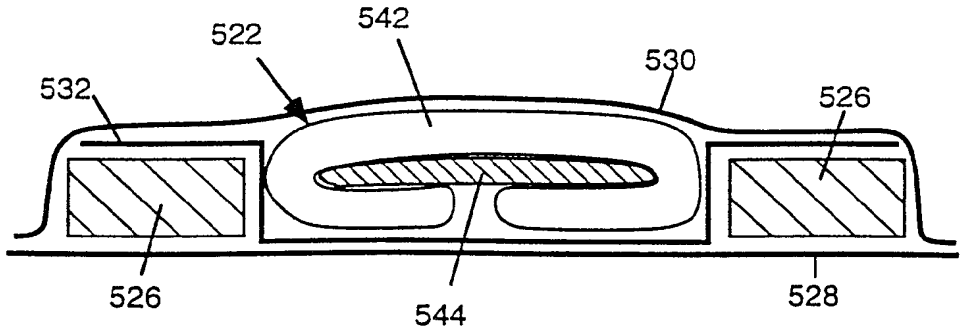


FIG. 25A

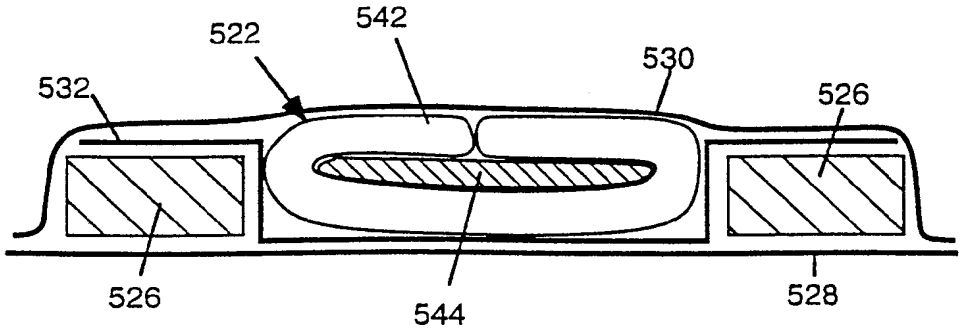


FIG. 25B

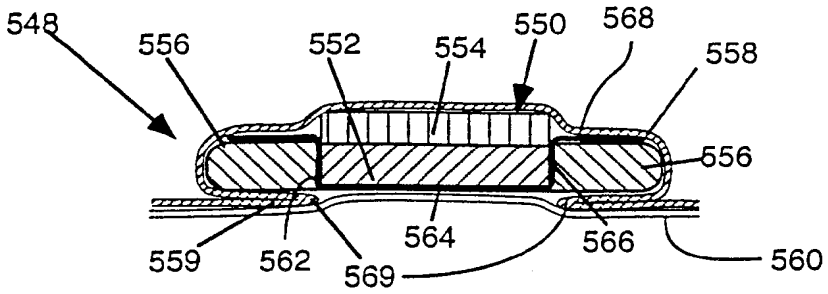

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FIG. 26

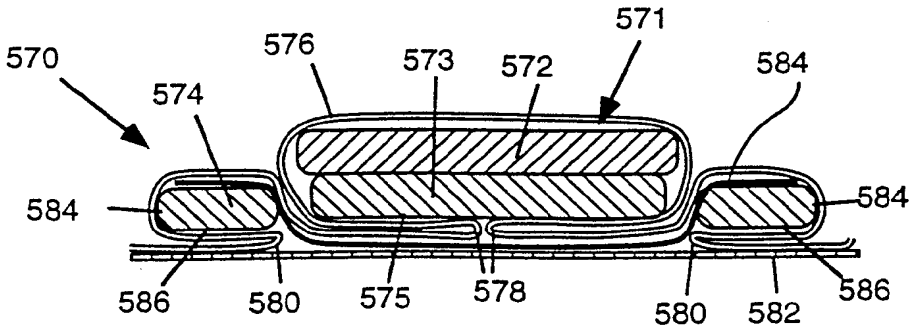

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FIG. 27

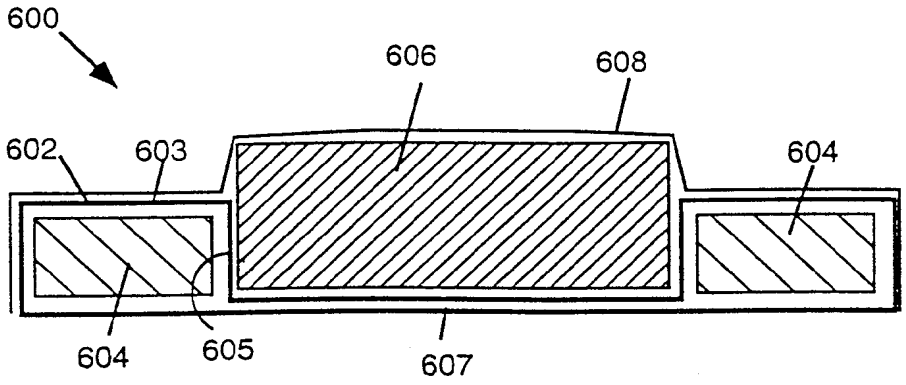

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FIG. 28

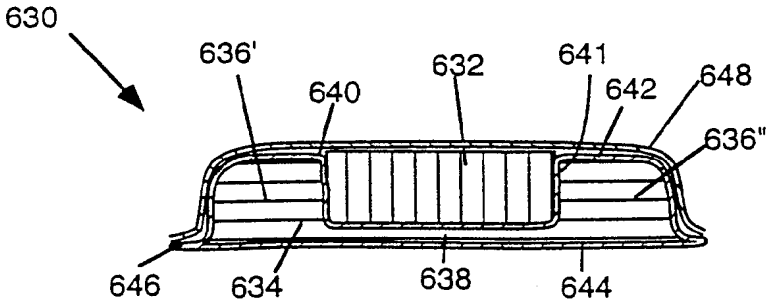

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FIG. 29

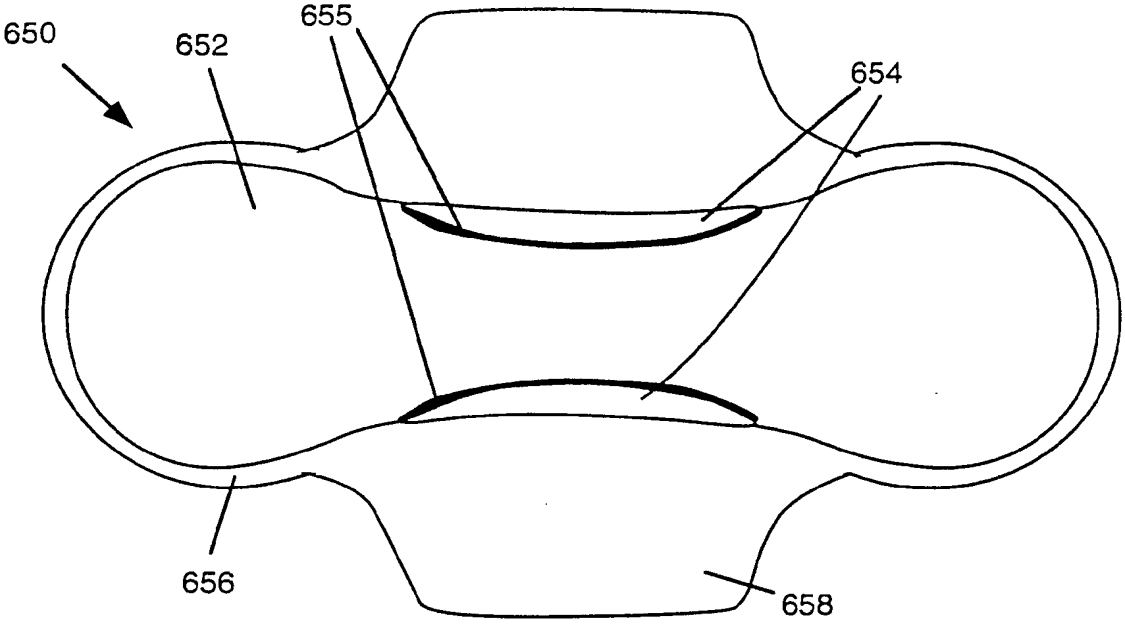


FIG. 30

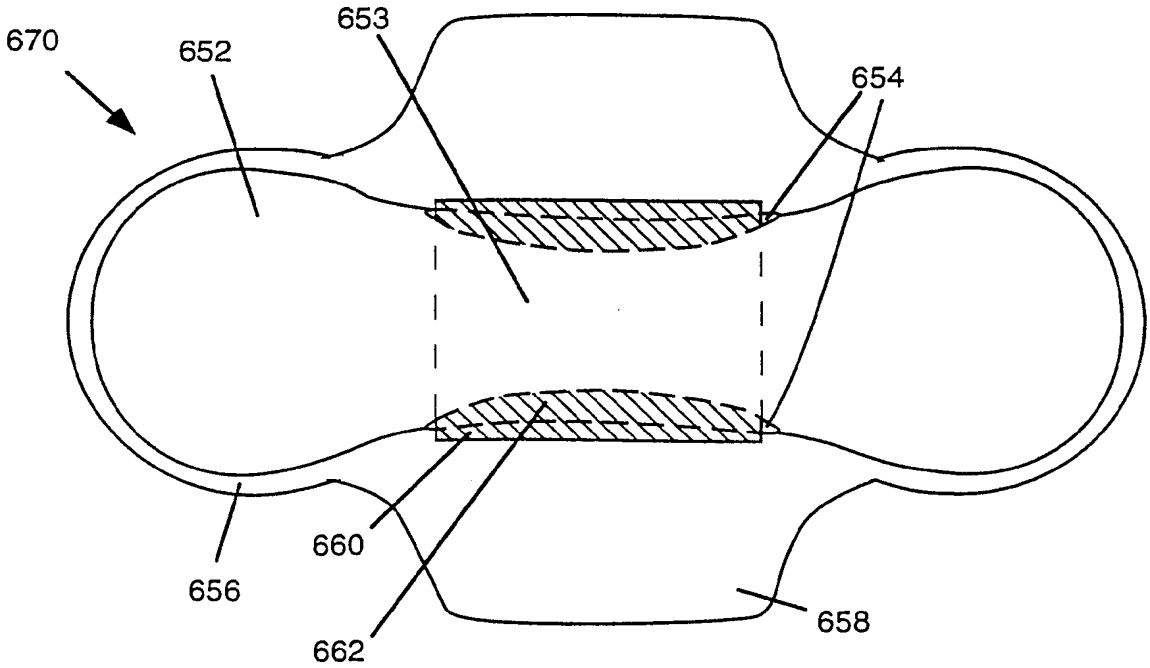


FIG. 31

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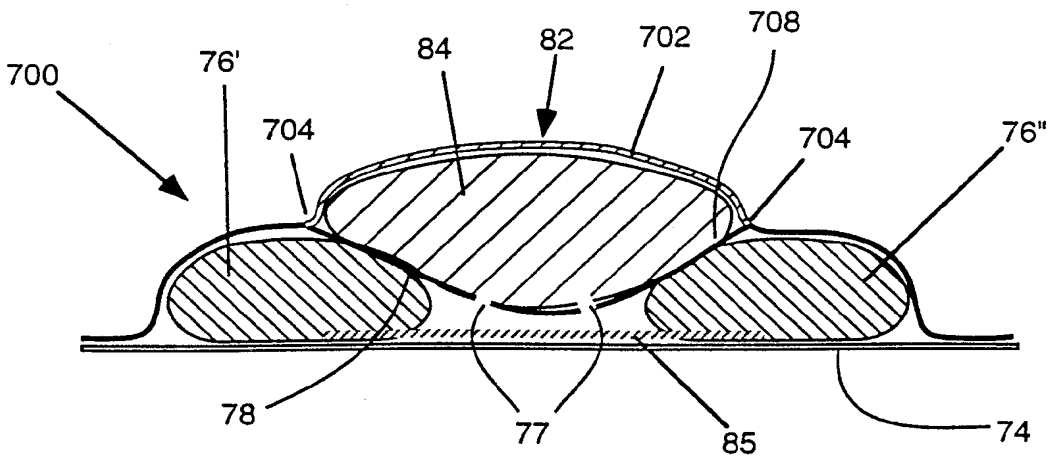


FIG. 32

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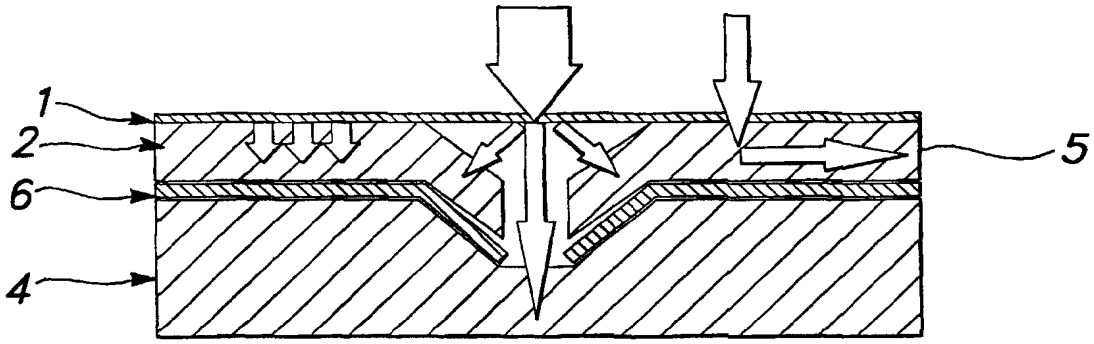
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(54) Title: SANITARY PAD FOR VARIABLE FLOW MANAGEMENT



(57) Abstract

There is provided a feminine hygiene pad comprising a cover adjacent a capillarity fabric having regions of high and low capillarity, which is adjacent a retention layer. In a preferred embodiment, a creped spunbond layer is used as the cover material and a co–apertured intake/distribution layer and transfer delay layer are the capillarity fabric. Combining these improvements into an integrated absorbent system allows the successful achievement of variable flow management and a successful balance between intake and cover desorption properties. The result is improved multiple intake performance and a clean and dry cover surface during use.

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SANITARY PAD FOR VARIABLE FLOW MANAGEMENT

This application claims priority from U.S. Provisional Patent Application 60/127,685 filed April 3, 1999.

FIELD OF THE INVENTION

The present invention is an absorbent article for personal care, particularly feminine hygiene products, which can accept liquid, distribute it and retain it.

BACKGROUND OF THE INVENTION

Personal care articles include such items as diapers, training pants, feminine hygiene products such as sanitary napkins, panty-liners and tampons, incontinence garments and devices, bandages and the like. The most basic design of all such articles typically includes a bodyside liner, an outercover (also referred to as a baffle) and an absorbent core disposed between the bodyside liner and the outercover.

Personal care products must accept fluids quickly and hold them to reduce the possibility of leakage outside the product. The product must be flexible and have a pleasing feel on the skin, and even after liquid insult, must not become tight or bind the user. Unfortunately, while previous products have met many of these criteria to varying degrees, a number have not.

In particular, feminine hygiene products for longer term (i.e. overnight) usage are subject to higher and more variable flow rates and fluid loads than are those intended for regular or shorter term usage. Products for overnight usage, therefore, must have the ability to absorb and contain continuous and light flow as well as gushes and sudden heavy flow over the life of the product. It has been found that continuous flow insults in feminine hygiene products average 1 ml/hr, but may be higher, and are not literally

continuous or constant, but rather variable in rate and may even pause during a cycle. "Gush flow" is defined as a sudden heavy flow condition and occurs at flow rates of up to 1ml/sec. During a gush, 1-5 ml of fluid is released from the body onto the product. The term "continuous flow" is used to define any flow which falls outside of the definition of gush flow.

Combining continuous and gush flow conditions results in variable flow. Essentially, "variable flow" is defined as continuous flow with intermittent gush flow occurrences. Figure 1 is a graph which illustrates the differences between variable flow (diamonds) and continuous flow (squares) over the life of a single product where flow rate volume is on the y-axis in g/hr and time is on the x-axis in hours. This problem of handling gush and continuous flows is termed variable flow management and is defined as the ability to absorb and contain continuous and light flow (1-2 ml/hr) as well as multiple gushes or sudden heavy flow insults (1 ml/sec with a total volume of 1-5 ml) over the life of the product. It is obvious that the challenge of variable flow management is more difficult as the wear time of the product is lengthened, such as in overnight use conditions.

Many feminine care cover materials have low z-directional conductivity, low surface energy, low void volume, and provide little separation between the absorbent core and the user due to their two dimensional structure. Consequently, these covers result in slow and incomplete intake, high rewet, and large surface stains. In addition, typical intake or acquisition layers are low density, high void volume structures which are ideal for fast fluid intake, but because these structures typically have low capillarity, fluid is not adequately desorbed from the cover material, resulting in smearing and surface wetness. Materials which enhance cover desorption are typically high density, high capillarity materials, but because these materials have low void volume and low z-directional permeability, they inherently retard fluid intake.

There remains a need to address variable flow management from the overall product form standpoint, developing a system in which the components are optimized to function together. In such a system, the liner is designed to promote rapid intake and remain clean and dry, there is an intake/distribution material which has the void volume necessary for fast intake and the high capillarity desired for sufficient cover desorption while maintaining an appropriate capillary structure for fluid intake/distribution and the absorbent (retention) layer accepts fluids at the appropriate speed.

An objective of this invention is, therefore, to provide an overall design for a feminine hygiene product, particularly for overnight use, to manage a wide variety of flow conditions including sudden heavy flow insults, or gushes.

SUMMARY OF THE INVENTION

The objects of the invention are achieved by a creped spunbond nonwoven fabric for use as the liner or outer cover, an improved absorbent core using a co-apertured airlaid fabric layer and spunbond nonwoven fabric transfer delay layer, over a fluff retention layer. Combining these improvements into an integrated absorbent system allows the successful achievement of variable flow management and a successful balance between intake and cover desorption properties. The result is improved multiple intake performance and a clean and dry cover surface during use. The material technology developments regarding variable flow management focus on attaining the proper material structure and property balance necessary to achieve fast intake and improve cover desorption, cover staining, and rewet characteristics. These functional properties are provided through improved material technologies and product construction.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a graph of variable flow (diamonds) and continuous flow (squares) over the life of a single product where flow rate volume is on the y-axis in g/hr and time is on the x-axis in hours.

Figure 2 illustrates the tri-modal pore structure of the co-apertured material .

Figures 3, 4, and 5 display SEM images of the apertures. Figure 3 displays an aperture on the airlaid side of the composite. Figure 4 displays a close-up of an aperture on the airlaid side of the composite and Figure 5 displays an aperture from the spunbond (transfer delay) side of the composite.

Figure 6 compares the pore size distribution of an apertured airlaid material to a un-apertured airlaid material.

Figure 7 illustrates the detail of a single aperture and the flow through the material.

Figure 8 is a graph of the pore size distribution for creped and uncreped spunbond cover materials.

Figure 9 shows the three dimensional structure of the creped spunbond fabric cover in an SEM image.

Figure 10 depicts one example of a product form for a feminine hygiene product for overnight use.

Figure 11 illustrates the theoretical fluid loading profile for the feminine hygiene product of Figure 10.

Figure 12 shows a pin aperturing pattern at 7.4 pins/cm^2 using 2.06 mm diameter pins.

Figure 13 shows a pin aperturing pattern at 2.5 pins/cm^2 with the same pin diameter as Figure 12.

Figure 14 is a graph the measured capacity for airlaid fabrics with and without apertures where capacity is on the Y-axis and fabric density (cc/g) on the X-axis.

Figure 15 is a graph of horizontal wicking distance (Y-axis) in mm versus time in minutes for two apertured and two un-apertured airlaid fabrics.

Figure 16 is a graph of saturation in g/g (Y-axis) versus horizontal wicking distance in inches.

Figure 17 is a graph of saturation in g/g (Y-axis) versus the pad section as divided according to the flat system fluid distribution test.

Figure 18 is a graph of saturation in g/g (Y-axis) versus the pad section as divided according to the flat system fluid distribution test.

Figures 19, 20 and 21 are bar charts of triple gush insult results on various parts of a pad.

DEFINITIONS

"Disposable" includes being disposed of after use and not intended to be washed and reused.

"Layer" when used in the singular can have the dual meaning of a single element or a plurality of elements.

"Liquid" means a non-particulate substance and/or material that flows and can assume the interior shape of a container into which it is poured or placed.

"Liquid communication" means that liquid is able to travel from one layer to another layer, or one location to another within a layer.

"Longitudinal" means having the longitudinal axis in the plane of the article and is generally parallel to a vertical plane that bisects a standing wearer into left and right body halves when the article is worn. The "transverse" axis lies in the plane of the article

generally perpendicular to the longitudinal axis, i.e., so that a vertical plane bisects a standing wearer into front and back body halves when the article is worn.

"Conjugate fibers" refers to fibers that have been formed from at least two polymers extruded from separate extruders but spun together to form one fiber. Conjugate fibers are also sometimes referred to as multicomponent or bicomponent fibers. The polymers are usually different from each other though conjugate fibers may be monocomponent fibers. The polymers are arranged in substantially constantly positioned distinct zones across the cross-section of the conjugate fibers and extend continuously along the length of the conjugate fibers. The configuration of such a conjugate fiber may be, for example, a sheath/core arrangement wherein one polymer is surrounded by another or may be a side by side arrangement, a pie arrangement or an "islands-in-the-sea" arrangement. Conjugate fibers are taught in US Patent 5,108,820 to Kaneko et al., US Patent 5,336,552 to Strack et al., and US Patent 5,382,400 to Pike et al. For two component fibers, the polymers may be present in ratios of 75/25, 50/50, 25/75 or any other desired ratios. The fibers may also have shapes such as those described in US Patents 5,277,976 to Hogle et al., and 5,069,970 and 5,057,368 to Largman et al., hereby incorporated by reference in their entirety, which describe fibers with unconventional shapes.

"Biconstituent fibers" refers to fibers that have been formed from at least two polymers extruded from the same extruder as a blend. Biconstituent fibers do not have the various polymer components arranged in relatively constantly positioned distinct zones across the cross-sectional area of the fiber and the various polymers are usually not continuous along the entire length of the fiber, instead usually forming fibrils or protofibrils which start and end at random. Biconstituent fibers are sometimes also referred to as multiconstituent fibers. Fibers of this general type are discussed in, for example, US Patent 5,108,827 to Gessner. Bicomponent and biconstituent fibers are also discussed in the textbook Polymer Blends and Composites by John A. Manson and Leslie H. Sperling,

copyright 1976 by Plenum Press, a division of Plenum Publishing Corporation of New York, IBSN 0-306-30831-2, at pages 273 through 277.

As used herein, the term "machine direction" or MD means the length of a fabric in the direction in which it is produced. The term "cross machine direction" or CD means the width of fabric, i.e. a direction generally perpendicular to the MD.

As used herein the term "spunbonded fibers" refers to small diameter fibers which are formed by extruding molten thermoplastic material as filaments from a plurality of fine, usually circular capillaries of a spinneret with the diameter of the extruded filaments then being rapidly reduced as by, for example, in US Patent 4,340,563 to Appel et al., and US Patent 3,692,618 to Dorschner et al., US Patent 3,802,817 to Matsuki et al., US Patents 3,338,992 and 3,341,394 to Kinney, US Patent 3,502,763 to Hartman, and US Patent 3,542,615 to Dobo et al. Spunbond fibers are generally not tacky when they are deposited onto a collecting surface. Spunbond fibers are generally continuous and have average diameters (from a sample of at least 10) larger than 7 microns, more particularly, between about 10 and 35 microns. The fibers may also have shapes such as those described in US Patents 5,277,976 to Hogle et al., US Patent 5,466,410 to Hills and 5,069,970 and 5,057,368 to Largman et al., which describe fibers with unconventional shapes.

As used herein the term "meltblown fibers" means fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into converging high velocity, usually hot, gas (e.g. air) streams which attenuate the filaments of molten thermoplastic material to reduce their diameter, which may be to microfiber diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly dispersed meltblown fibers. Such a process is disclosed, for example, in US Patent 3,849,241 to Butin et al. Meltblown fibers are microfibers that may be continuous or discontinuous, are generally smaller than 10 microns in average diameter, and are generally tacky when deposited onto a collecting surface.

"Airlaying" is a well-known process by which a fibrous nonwoven layer can be formed. In the airlaying process, bundles of small fibers having typical lengths ranging from about 3 to about 52 millimeters are separated and entrained in an air supply and then deposited onto a forming screen, usually with the assistance of a vacuum supply. The randomly deposited fibers then are bonded to one another using, for example, hot air or a spray adhesive. Examples of airlaying technology can be found in US Patents 4,494,278, 5,527,171, 3,375,448 and 4,640,810.

As used herein, the term "coform" means a process in which at least one meltblown diehead is arranged near a chute through which other materials are added to the web while it is forming. Such other materials may be pulp, superabsorbent or other particles, natural polymers (for example, rayon or cotton fibers) and/or synthetic polymers (for example, polypropylene or polyester) fibers, for example, where the fibers may be of staple length. Coform processes are shown in commonly assigned US Patents 4,818,464 to Lau and 4,100,324 to Anderson et al. Webs produced by the coform process are generally referred to as coform materials.

"Bonded carded web" refers to webs that are made from staple fibers that are sent through a combing or carding unit, which opens and aligns the staple fibers in the machine direction to form a generally machine direction-oriented fibrous nonwoven web. The web is bonded by one or more of several known bonding methods.

Bonding of nonwoven webs may be achieved by a number of methods; powder bonding, wherein a powdered adhesive is distributed through the web and then activated, usually by heating the web and adhesive with hot air; pattern bonding, wherein heated calender rolls or ultrasonic bonding equipment are used to bond the fibers together, usually in a localized bond pattern, though the web can be bonded across its entire surface if so desired; through-air bonding, wherein air which is sufficiently hot to soften at least one component of the web is directed through the web; chemical bonding using, for

example, latex adhesives that are deposited onto the web by, for example, spraying; and consolidation by mechanical methods such as needling and hydroentanglement.

An intake/distribution layer is a material which can wick menstrual fluid a distance of 1.2 cm to about 15.25 cm (0.5 to 6 inches) in one hour when one end of the material is placed in an infinite reservoir of menstrual simulant.

"Co-aperture" refers to a material which has been apertured, as well as a process of aperturing, wherein two or more materials are apertured together. The apertures extend from top to bottom of the material and are essentially aligned with each other. Co-aperturing can join the materials either temporarily or permanently through entanglement, physical bonding or chemical bonding. It is preferred that co-aperturing be carried out at ambient temperatures, not at elevated temperatures.

"Personal care product" means diapers, training pants, absorbent underpants, adult incontinence products, swim wear, bandages and other wound dressings, and feminine hygiene products.

"Feminine hygiene products" means sanitary napkins and pads.

"Target area" refers to the area or position on a personal care product where an insult is normally delivered by a wearer.

TEST METHODS

Material caliper (thickness):

The caliper of a material is a measure of thickness and is measured at 0.05 psi (3.5 g/cm^2) with a Starret-type bulk tester, in units of millimeters.

Density:

The density of the materials is calculated by dividing the weight per unit area of a sample in grams per square meter (gsm) by the material caliper in millimeters (mm) at 0.05 psi (3.5

g/cm^2) and multiplying the result by 0.001 to convert the value to grams per cubic centimeter (g/cc). A total of three samples would be evaluated and averaged for the density values.

Triple Intake Test Procedure:

The objective of this test is to determine differences between materials and/ or materials, composites or systems of material composites in the rate of intake when 3 fluid insults are applied, with time allowed for fluid to distribute in the material(s) between insults.

Equipment needed:

2 acrylic rate blocks.

P-5000 pipette with RC-5000 tips and foam pipette insert.

Small beaker

Menses simulant (made according to directions below), warmed in bath for 30 minutes or more

Small spatula (stirrer)

Bench liner

2 stopwatches

1-2 timers

Gauze squares for cleaning simulant

Procedure: Lay out sample composites according to materials testing plan.

Components are as follows:

Top: Cover

Middle : Capillarity fabric

Bottom: Retention Layer

Weigh each layer dry, record weight. Put materials back in 3-layer composite.

Weigh a dry blotter, record weight and also mark weight on blotter.

Place acrylic rate block in middle of sample composite.

Calibrate pipette:

Weigh a small empty beaker on the balance.

Set pipette to 2 mls.

Draw simulant into pipette.

Deliver simulant from pipette into beaker.

If balance indicates 2 grams of simulant was delivered, setting is correct.

If more or less than 2 grams was delivered, decrease or increase the setting and repeat adjusting pipette and weighing the amount of simulant delivered until 2 grams is delivered.

Simulant handling:

Remove simulant from the refrigerator 30 minutes to 1 hour before using and warm in water bath. Before cutting bag nozzle, massage the bag between hands for a few minutes to mix the simulant, which will have separated in the bag. Cut the bag tubing and pour simulant needed into a small beaker. Stir slowly with a small spatula to mix thoroughly. Return bag to the refrigerator if you do not anticipate using all of it. Return bag to water bath if more will be used during the day.

Test:

Step 1: Center acrylic rate block with funnel on sample. Insult sample composite with 2 mls. simulant, using stopwatch to measure the time from the start of the insult until the fluid is absorbed beneath the cover material. Leave rate block in place for 9 minutes, (use timer). For first sample, after 9 minutes remove the rate block and weigh each layer of the sample. Record the weight. (After 3 minutes timing of the first sample, start testing a second sample going through the same steps.)

Step 2: For the first sample, repeat Step 1 a second time.

Step 3: For the first sample, repeat Step 1 a third time.

Analysis: The fluid loading in each component is calculated as weight after insult subtracted from the weight before insult. The insult time is a direct measurement of time

for absorption. Smaller values of intake time refer to a more absorbent sample with larger values of intake time refer to a less absorbent sample.

Capacity

Capacity was measured using the dunk and drip capacity test method. Menses simulant was used as the test fluid. The sample size was modified to a 5.7 cm (2.25") diameter circle. The weight of each sample was recorded. The sample was immersed in a bath of simulant until equilibration, in this case 9 minutes. The sample was removed from the bath and hung vertically at a height of 10.5 cm (12 inches) using a small clip for 10 minutes. The sample was weighed and the weight was recorded. The capacity was determined by subtracting the before weight from the after weight. The capacity in grams/gram was determined by dividing the capacity in grams by the dry weight of the sample.

Horizontal Capillary Wicking Test Procedure:

The objective of this test it to determine the horizontal wicking capability of a material as it pulls fluid from a infinite reservoir.

Equipment needed: Horizontal wicking stand, menses simulant prepared as described below, ruler, timer.

Procedure:

Cut materials to 1" (2.54 cm) width and desired length.

Fill reservoir in horizontal wicking apparatus with menses simulant.

Place one end of the material in the simulant and lay the rest of the material on the wicking apparatus.

Start the timer.

Measure the distance wicked at a given time, or the time to wick to a given distance.

Flat System Testing Procedure

The purpose of this procedure is to determine the fluid handling characteristics of various absorbent systems through analysis of stain length, saturation capacity, and the

fluid loading of the system components. The equipment required includes hourglass-shaped acrylic plates (with a 0.25 inch hole in the center) weighing approximately 330 grams, syringes, one-eighth inch I.D. Tygon tubing, pipette pump, menses simulant, and a laboratory balance (accurate to 0.00g).

Samples to be tested are cut to a desired shape (currently 1.5 inches by 5.5 inches for fluid intake/distribution layers or capillarity fabrics, 1.75 inches by 5.5 inches for transfer delay layers, and 200 mm long hourglass shape for retention layers). The 5.5 inch layers are marked into 1.1 inch sections and the pad layer is marked into sections corresponding to the marks on the 5.5 inch layers when they are centered on the pad layer. Each component is weighed and the weight recorded. The individual components are assembled into a desired component system maintaining the marked sections aligned and one end is labeled as the top. Syringes are filled with menses simulant and Tygon tubing attached to the syringes. The syringes are placed in a pipette pump which is programmed to deliver a given amount of simulant, currently 30 cc syringes dispensing a specified amount of simulant (usually 10 ml) in one hour. With the open ends of the tubing placed in a beaker, the tubing is primed by running the pump until all air is out of the tubing and simulant is exiting the tubing at the insult end. The component systems to be tested are placed near the pipette pump and a two inch by six inch piece of 25 gsm, 10d BCW is placed on top of the center of the system over which an acrylic plate is placed, also centered on top of the system. The free end of one tubing is inserted into the hole in the acrylic plate and the pipette pump started to begin the insults. At the end of the insult period, the tubing and acrylic plates are removed. The BCW is then carefully removed without moving the underlying layers and discarded. Each layer is then individually weighed and the weight recorded. Then, beginning at the end labeled as the top, each marked section is cut and weighed. The stain length for each layer is measured and recorded and the data entered into a spreadsheet for graphing and analysis. The fluid loading (g/g) is calculated by dividing the amount of fluid absorbed in a material by

the dry weight of the material. The fluid saturation is calculated by dividing the fluid loading by the stain length.

Demand Absorbency Wicking Capability:

The objective of this test is to determine the fluid handling characteristics of various absorbent systems through analysis of stain length, saturation capacity, and fluid loadings of the system components.

Equipment needed: Hourglass-shaped acrylic plates (with 0.25" (6.35 mm) hole in the center) weighing approximately 330 grams; syringes; 1/8 inch (3.175 mm) internal diameter (ID) tubing (e.g. Tygon®); pipette pump; menses simulant prepared as described below; laboratory balance (accurate to 0.00 g).

Procedure:

1. Cut components to desired shape; 1.5 inches (3.8 cm) by 6.0 inches (15.2 cm) for intake/distribution layers, 3.0 inches (7.6 cm) by 6.0 inches for spunbond nonwoven fabric transfer delay and perimeter layers.
2. Mark 6.0 inch layers into 1.2 inch (3 cm) sections. If the perimeter layer is oval, mark into sections corresponding to the marks on the intake/distribution strip when centered on the perimeter layer.
3. Weigh each component and record the weight.
4. Assemble the individual components into the desired absorbent system keeping the marked sections aligned. Label one end as the top.
5. Fill the syringes with menses simulant and attach tubing to syringes.
6. Place the syringes in the syringe pump.
7. Program the size of the syringe into the syringe pump.
8. Program the pump (currently using 30 cc syringes dispensing at a rate of 10 ml. per hour.
9. With the open ends of the tubing placed in a beaker, prime tubing by running pump until all air is out of tubing and simulant is exiting the tubing at the open end.

10. Place the component systems to be tested near the syringe pump, place a 2 inch (5.1 cm) by 6 inch (approximately) piece of 25 gsm, 10 denier bonded carded web material on the top layer of the absorbent system to prevent wicking on the acrylic plate, and place an acrylic plate centered on the top of the system.
11. Insert the open end of one tubing into the hole in the acrylic plate. Repeat for the remaining systems to be tested.

Testing:

1. Start the pipette pump to begin the insult.
2. Ad 3 mls. of menses simulant at a rate of 10 mls per hour.
3. After 3 mls have been insulted into the product, add weights to the acrylic plate to achieve a pressure of 0.08 psi.
4. Continue the insults for another 5 mls, so that a TOTAL of 8 mls is insulted.
5. At the end of the insult period, remove the tubing and acrylic plates. Carefully remove the bonded carded web without moving the underlying layers and discard it.
6. Take photos of the component system and layers and print them.
7. Weigh each layer individually and record the weight.
8. Beginning at the end labeled as the top, cut and weigh the first marked sections and the weight. Repeat for remaining sections and layers.
9. Measure and record the stain length for each layer.
10. Enter the data in a spreadsheet for graphing and analysis.

Preparation of menses simulant:

In order to prepare the fluid, blood, in this case defibrinated swine blood, was separated by centrifugation at 3000 rpm for 30 minutes, though other methods or speeds and times may be used if effective. The plasma was separated and stored separately, the buffy coat removed and discarded and the packed red blood cells stored separately as well.

Eggs, in this case jumbo chicken eggs, were separated, the yolk and chalazae discarded and the egg white retained. The egg white was separated into thick and thin portions by straining the white through a 1000 micron nylon mesh for about 3 minutes, and the thinner portion discarded. Note that alternative mesh sizes may be used and the time or method may be varied provided the viscosity is at least that required. The thick portion of egg white which was retained on the mesh was collected and drawn into a 60 cc syringe which was then placed on a programmable syringe pump and homogenized by expelling and refilling the contents five times. In this example, the amount of homogenization was controlled by the syringe pump rate of about 100 ml/min, and the tubing inside diameter of about 0.12 inches. After homogenizing the thick egg white had a viscosity of about 20 centipoise at 150 sec^{-1} and it was then placed in the centrifuge and spun to remove debris and air bubbles at about 3000 rpm for about 10 minutes, though any effective method to remove debris and bubbles may be used.

After centrifuging, the thick, homogenized egg white, which contains ovamucin, was added to a 300 cc Fenwal® Transfer pack using a syringe. Then 60 cc of the swine plasma was added to the transfer pack. The transfer pack was clamped, all air bubbles removed, and placed in a Stomacher lab blender where it was blended at normal (or medium) speed for about 2 minutes. The transfer pack was then removed from the blender, 60 cc of swine red blood cells were added, and the contents mixed by hand kneading for about 2 minutes or until the contents appeared homogenous. A hematocrit of the final mixture showed a red blood cell content of about 30 weight percent and generally should be at least within a range of 28-32 weight percent for artificial menses made according to this example. The amount of egg white was about 40 weight percent.

The ingredients and equipment used in the preparation of this artificial menses are readily available. Below is a listing of sources for the items used in the example, though of course other sources may be used providing they are approximately equivalent.

Blood (swine): Cocalico Biologicals, Inc., 449 Stevens Rd., Reamstown, PA 17567, (717) 336-1990.

Fenwal® Transfer pack container, 300 ml, with coupler, sample 4R2014: Baxter Healthcare Corporation, Fenwal Division, Deerfield, IL 60015.

Harvard Apparatus Programmable Syringe Pump model no. 55-4143: Harvard Apparatus, South Natick, MA 01760.

Stomacher 400 laboratory blender model no. BA 7021, serial no. 31968: Seward Medical, London, England, UK.

1000 micron mesh, item no. CMN-1000-B: Small Parts, Inc., PO Box 4650, Miami Lakes, FL 33014-0650, 1-800-220-4242.

Hemata Stat-II device to measure hemocrits, serial no. 1194Z03127: Separation Technology, Inc., 1096 Rainer Drive, Altamont Springs, FL 32714.

Rate Block Intake Test

This test is used to determine the intake time of a known quantity of fluid into a material and/or material system. The test apparatus consists of a rate block 10 as shown in Fig. 1. A 4" x 4" piece of absorbent 14 and cover 13 are die cut. The specific covers are described in the specific examples. The absorbent used for these studies was standard and consisted of 250 g/m^2 airlaid made of 90% Coosa 0054 and 10% HC T-255 binder. The total density for this system was 0.10 g/cc. The cover 13 was placed over the absorbent 14 and the rate block 10 was placed on top of the two materials. 2 mL of a menses simulant was delivered into the test apparatus funnel 11 and a timer started. The fluid moved from the funnel 11 into a channel 12 where it was delivered to the material or material system. The timer was stopped when all the fluid was absorbed into the material or material system as observed from the chamber in the test apparatus. The intake time for a known quantity of known fluid was recorded for a given material or material system. This value is a measure of a material or material systems absorbency. Typically, five to ten repetitions were performed, and average intake time was determined.

Rewet Test

This test is used to determine the amount of fluid that will come back to the surface when a load is applied. The amount of fluid that comes back through the surface is called the "rewet" value. The more fluid that comes to the surface, the larger the "rewet" value. Lower rewet values are associated with a dryer material and, thus, a dryer product. In considering rewet, three properties are important: (1) intake, if the material/system does not have good intake then fluid can rewet, (2) ability of absorbent to hold fluid (the more the absorbent holds on to the fluid, the less is available for rewet), and (3) flowback, the more the cover prohibits fluid from coming back through the cover, the lower the rewet. In our case, we evaluated cover systems where the absorbent was maintained constant and, thus, we were only concerned with properties (1) and (3), intake and flowback, respectively.

A 4" x 4" piece of absorbent and cover was die cut. The absorbent used for these studies was standard and consisted of a 250 g/m^2 airlaid made of 90% Coosa 0054 and 10% HC T-255 binder. The total density for this system was 0.10 g/cc. The cover was placed over the absorbent and the rate block was placed on top of the two materials. In this test, 2 mL of menses simulant are insulted into the rate block apparatus and are allowed to absorb into a 4" x 4" sample of the cover material which is placed on top of a 4" x 4" absorbent piece. The fluid is allowed to interact with the system for one minute and the rate block rests on top of the materials. The material system cover and absorbent are placed onto a bag filled with fluid. A piece of blotter paper is weighed and placed on top of the material system. The bag is traversed vertically until it comes into contact with an acrylic plate above it, thus pressing the whole material system against the plate blotter paper side first. The system is pressed against the acrylic plate until a total pressure of 1 psi is applied. The pressure is held fixed for three minutes, after which the pressure is removed and the blotter paper is weighed. The blotter paper retains any fluid that was transferred to it from the cover/absorbent system. The difference in weight between the

original blotter and the blotter after the experiment is known as the "rewet" value. Typically, five to ten repetitions of this test were performed, and average rewet was determined.

Intake/Staining Test

An intake/staining test was developed which enables the stain size, intensity, and fluid retention in components to be observed with fluid flow rate and pressure. Menses simulant was used as the test fluid. A 4" x 4" piece of absorbent and cover were die cut. The absorbent used for these tests was standard and consisted of a 250 g/m^2 airlaid made of 90% of Coosa 0054 and 10% HC T-255 binder. The total density for this system was 0.10 g/cc. A material system, cover and core measuring 4" x 4", was placed underneath an acrylic plate with an 1/8 inch diameter hole bored into the center. A piece of 1/8 inch tubing was connected to the hole with a fitting. Menses simulant was delivered to the sample using a syringe pump at a specified rate and for a specified volume. The pump was programmed to deliver a total volume of 1 mL to the samples, where the samples were under pressures of 0 psi, 0.0078 psi, and 0.078 psi. These pressures were applied using a weight which was placed on top of the acrylic plates and distributed evenly. The flow rate of the pump was programmed to deliver fluid at a rate of 1mL/sec. The stain size for the cover materials was measured manually, and the amount of fluid in each component of the system was measured by weight before and after absorption of the fluid. The stain intensity was evaluated qualitatively by comparison of samples. Staining information was recorded using a digital camera and could be further analyzed with image analysis.

Permeability

Permeability is obtained from a measurement of the resistance by the material to the flow of liquid. A liquid of known viscosity is forced through the material of a given thickness at a constant flow rate and the resistance to flow, measured as a pressure drop is monitored. Darcy's Law is used to determine permeability as follows:

Permeability=[flow rate x thickness x viscosity/pressure drop] Equation (1)

where the units are:

permeability: cm^2 or darcy 1 darcy = 9.87×10^{-9} cm^2

flow rate: cm/sec

viscosity: pascal-sec

pressure drop: pascals

The apparatus consists of an arrangement wherein a piston within a cylinder pushes liquid through the sample to be measured. The sample is clamped between two aluminum cylinders with the cylinders oriented vertically. Both cylinders have an outside diameter of 3.5", an inside diameter of 2.5" and a length of about 6". The 3" diameter web sample is held in place by its outer edges and hence is completely contained within the apparatus. The bottom cylinder has a piston that is capable of moving vertically within the cylinder at a constant velocity and is connected to a pressure transducer that capable of monitoring the pressure of encountered by a column of liquid supported by the piston. The transducer is positioned to travel with the piston such that there is no additional pressure measured until the liquid column contacts the sample and is pushed through it. At this point, the additional pressure measured is due to the resistance of the material to liquid flow through it.

The piston is moved by a slide assembly that is driven by a stepper motor. The test starts by moving the piston at a constant velocity until the liquid is pushed through the sample. The piston is then halted and the baseline pressure is noted. This corrects for sample buoyancy effects. The movement is then resumed for a time adequate to measure the new pressure. The difference between the two pressures is the pressure due to the resistance of the material to liquid flow and is the pressure drop used in Equation (1). The velocity of the piston is the flow rate. Any liquid whose viscosity is known can be used, although a liquid that wets the material is preferred since this ensures that saturated flow is achieved. The measurements disclosed herein were carried out

using a piston velocity of 20 cm/min, mineral oil (Peneteck Technical Mineral Oil manufactured by Penreco of Los Angeles, California) of a viscosity of 6 centipoise.

Alternatively, permeability can be calculated from the following equation:

$$\text{Permeability} = 0.051 * R * (1-\text{Porosity}) * (\text{Porosity}/(1-\text{Porosity}))^{2.75} \quad \text{Equation (2)}$$

where R = fiber radius and

$$\text{Porosity} = 1 - (\text{web density}/\text{fiber density}) \quad \text{Equation (3)}$$

Reference for Equation (2) can be found in the article "Quantification of Unidirectional Fiber Bed Permeability" by J. Westhuizen and J.P. Du Plessis in the Journal of Composite Materials, 28(7), 1994. Note that the equations show that permeability can be determined if fiber radius, web density and fiber density are known.

Conductance is calculated as permeability per unit thickness and gives measure of the openness of a particular structure and, thus, an indication of the relative ease at which a material will pass liquid. The units are darcies/mil.

DETAILED DESCRIPTION OF THE INVENTION

In its broadest embodiment, the invention is feminine hygiene pad comprising a rapid intake cover adjacent a capillarity fabric having regions of varying capillarity which allows the passage of fluids in particular areas, and which is adjacent an absorbent core retention layer. The fabrics used in the practice of this invention may be made by a variety of processes including airlaying, spunbonding, meltblowing, carding, coform and foaming processes, though airlaying for the intake/distribution layer and spunbonding for the transfer delay layer are preferred. The various layers may be made from synthetic polymer and natural fibers. Particularly preferred because of cost are polyolefins like polyethylene and polypropylene.

It is important that the cover rapidly draw insults into the product. A number of materials provide such intake properties. These include pin apertured films, vacuum

apertured films, apertured nonwovens and co-apertured film/nonwoven laminates, conjugate fiber spunbond fabrics, creped spunbond fabrics, airlaid fabrics, bonded carded webs, spunlace fabrics, etc. A number of fabric types which may be unsuitable initially may be made acceptable through the use of topical chemical treatments and mechanical processing. Any material which, when combined with an absorbent core, permits rapid intake, low staining, low rewet and low fluid retention under all flow conditions would be suitable.

The capillarity fabric is an intake/distribution layer which may be made from a variety of fibers and mixtures of fibers including synthetic fibers, natural fibers including, mechanically and chemically softened pulp, staple fibers, slivers, meltblown and spunbond fibers, superabsorbents and the like. The fibers in such a web may be made from the same or varying diameter fibers and may be of different shapes such as pentalobal, trilobal, elliptical, round, etc. The intake/distribution layer may be made by a number of methods, including airlaying, hydroentangling, bonding and carding, and coforming, though airlaying is preferred.

The transfer delay layer may also be made from a variety of fibers in a variety of shapes and sizes. The transfer delay layer may be made according to a number of processes such as spunbonding, carding, meltblowing and film forming, though spunbonding is preferred.

The retention layer materials may be made from materials or substances known in the art to absorb liquid as well as any others that may be developed for that purpose. Examples include fast and slow superabsorbents, pulps, and mixtures thereof. Mixtures of superabsorbents and pulp used as retention materials may be used in ratios of between about 100/0 and 0/100 by weight, more particularly between about 80/20 and 20/80.

Synthetic fibers include those made from polyamides, polyesters, rayon, polyolefins, acrylics, superabsorbents, Lyocel regenerated cellulose and any other

suitable synthetic fibers known to those skilled in the art. Synthetic fibers may also include kosmotropes for product degradation.

Many polyolefins are available for fiber production, for example polyethylenes such as Dow Chemical's ASPUN® 6811A linear low density polyethylene, 2553 LLDPE and 25355 and 12350 high density polyethylene are such suitable polymers. The polyethylenes have melt flow rates, respectively, of about 26, 40, 25 and 12. Fiber forming polypropylenes include Exxon Chemical Company's Escorene® PD 3445 polypropylene and Montell Chemical Co.'s PF-304. Many other polyolefins are commercially available.

Natural fibers include wool, cotton, flax, hemp and wood pulp. Pulps include standard soft-wood fluffing grade such as CR-1654 from Coosa Mills of Coosa, Alabama, high bulk additive formaldehyde free pulp (HBAFF) available from the Weyerhaeuser Corporation of Tacoma, WA, and is a which is a crosslinked southern softwood pulp fiber with enhanced wet modulus, and a chemically cross-linked pulp fiber such as Weyerhaeuser NHB-416. HBAFF has a chemical treatment that sets in a curl and twist, in addition to imparting added dry and wet stiffness and resilience to the fiber. Another suitable pulp is Buckeye HP2 pulp and still another is IP Supersoft from International Paper Corporation. Suitable rayon fibers are 1.5 denier Merge 18453 fibers from Courtaulds Fibers Incorporated of Axis, Alabama.

Various superabsorbents in a number of forms are available. Commercially available examples include FAVOR® 870 superabsorbent spheres from the Stockhausen Company of Greensboro, NC 27406 which is a highly crosslinked surface superabsorbent, XL AFA 94-21-5 and XL AFA-126-15, which are 850 to 1400 micron suspensions of polymerized polyacrylate particles from The Dow Chemical Company of Midland, MI, and SANWET® IM 1500 superabsorbent granules supplied by KoSA Inc. (formerly Trevira Inc. and formerly Hoechst-Celanese), PO Box 4, Salisbury, NC 28145-0004.

Binders may also be included in the spunbond or airlaid layers in order to provide mechanical integrity to the web. Binders include fiber, liquid or other binder means which

may be thermally activated. Preferred fibers for inclusion are those having a relatively low melting point such as polyolefin fibers. Lower melting polymers provide the ability to bond the fabric together at fiber cross over points upon the application of heat. In addition, fibers having as at least one component a lower melting polymer, like conjugate and biconstituent fibers, are suitable for the practice of this invention. Fibers having a lower melting polymer are generally referred to as "fusible fibers." By "lower melting polymers" what is meant are those having a glass transition temperature less than about 175 °C. Exemplary binder fibers include conjugate fibers of polyolefins and/or polyamides, and liquid adhesives. Two such suitable binders are sheath core conjugate fibers available from KoSA Inc. under the designation T-255 and T-256, though many suitable binder fibers are known to those skilled in the art, and are made by many manufacturers such as Chisso and Fibervisions LLC of Wilmington, DE. A suitable liquid binder is Kymene® 557LX binder available from Fibervisions LLC.

Once produced, the web must be adequately stabilized and consolidated in order to retain its shape. The inclusion of a sufficient amount of fusible fibers and subsequent thermal bonding is the preferred method for obtaining adequate stabilization. It's believed that this method allows adequate bonding in the center of a thick material as well as on the surface.

One example of a product form for a feminine hygiene product for overnight use, as depicted in Figure 10; it has an absorbent system composed of a creped spunbond fabric cover 10, a co-apertured airlaid intake/distribution layer 11 and a spunbond fabric transfer delay layer 12, a fluff retention layer 13, and a shaped fluff perimeter layer 14.

A specific example would be a 13.6 gsm (0.4 osy) spunbond cover, creped 30 percent to a basis weight of 20.3 gsm (0.6 osy) and treated with 0.3 weight percent AHCOVEL® Base N-62 surfactant and a capillarity fabric made of a co-apertured 175 gsm, 90 weight percent Weyerhaeuser NF-405 and 10 weight percent KoSa T-255 fiber airlaid fabric at 0.12 g/cc and a 27 gsm (0.8 osy) spunbond transfer delay layer made of

polypropylene. A retention layer made of 500 gsm fluff, 0.06-0.09 g/cc, of Weyerhaeuser NF-405 is included. A second retention layer made of 600 gsm fluff, 0.06-0.09 g/cc, of Weyerhaeuser NF-405 is also included.

Under continuous flow conditions, fluid is rapidly absorbed into the airlaid intake/distribution layer through the wettable and highly permeable creped spunbond cover. The spunbond fabric transfer delay layer, which is co-apertured to the airlaid intake/distribution layer, prevents premature fluid transfer to the underlying retention layer and forces fluid to distribute lengthwise in the product.

Its believed by the inventors that Initial insults are absorbed by and remain in the airlaid intake/distribution layer until 30-40% saturation levels are achieved (approximately 3-4 grams of fluid). At this point of saturation in the airlaid intake/distribution layer, fluid begins to transfer from the intake/distribution layer, through the transfer delay layer to the underlying fluff retention layer. The fluff retention layer, centered below the transfer delay layer, absorbs fluid that passes through the transfer delay layer as the product is insulted. The transfer delay layer controls the amount of fluid that is passed to the absorbent below and facilitates intake/distribution. As the amount of fluid in the airlaid intake/distribution layer increases, the amount of fluid transferred through the transfer delay layer to the underlying fluff increases. By transferring fluid based on the fluid saturation level, the transfer delay prevents high fluid saturation levels (>80%) from occurring in the airlaid intake/distribution layer. This function allows the airlaid intake/distribution layer to maintain void volume for additional insults. The airlaid intake/distribution layer returns toward an equilibrium level of 30-40% fluid saturation during use between insults.

While the shape of the various layers is not considered critical to the success of the invention, it should be noted that the airlaid intake/distribution and fluff retention layers may also incorporate a reduced dimension rectangular strip geometry which prevents fluid from wicking to the pad edges. The combination of intake/distribution and transfer delay technology, aided to some degree by the specific material geometry, forces the fluid to

remain in the center of the product in the x, y, and z directions. The asymmetrical (e.g. hourglass shaped) perimeter layer is also available to hold fluid under medium to high product fluid loads (greater than 5 g), but primarily serves as a product shaping component. It should be noted that the retention layer shape may be the same as or different from that of the perimeter layer and that either may have a rectangular, hourglass, racetrack or other shape. In addition, embossing may be added to the retention and/or perimeter layer to enhance the integrity of the layer.

The theoretical fluid loading profile for this feminine hygiene product is illustrated in Figure 11. Figure 11 is a graph of the component liquid content (or loading) in grams on the Y-axis and total product loading in grams on the X-axis. The airlaid intake/distribution is depicted by diamonds on the graph, the retention layer by squares, and the perimeter layer as triangles. At low loadings (0-3 ml), the fluid is mainly absorbed into the airlaid intake/distribution layer. As fluid loading increases (3-5 ml), the fluid begins to transfer through the transfer delay layer into the retention layer and slightly into the perimeter layer. At this time, very little fluid from additional insults is held in the airlaid intake/distribution layer. The airlaid intake/distribution layer continually regenerates its void volume by transferring fluid to the retention layer so subsequent insults can be accommodated. At higher loadings (>5 ml), the retention layer holds the majority of the fluid due to its high void volume. The perimeter layer has the capacity to retain any residual fluid which is passed through the retention layer because of localized saturation. The perimeter layer also provides further coverage for insults outside of the target area.

Under gush situations (>1ml/sec and 1-5ml/insult), the feminine hygiene product performs similarly to the theoretical filling profile described above but also demonstrates several additional functional characteristics. When a gush occurs, it is absorbed into the void volume of the highly permeable creped cover and into the airlaid intake/distribution layer. Under gush situations, the apertures in the airlaid intake/distribution layer provide internal void volume and increased permeability which assist intake and storage of fluid.

The apertures assist in storage of fluid by providing an immediate internal reservoir for fluid until it is absorbed into the surrounding airlaid structure. This functionality is critical since a gush insult happens so fast that momentary localized saturation occurs in the un-apertured portions of the airlaid fabric. During gush insults, the apertures also provide a direct pathway to the underlying fluff retention layer so that fluid can be immediately transferred to the fluff layer and void volume can be quickly regenerated in the airlaid layer. By regenerating void volume, the airlaid layer is available for future insults.

Immediately after the gush is absorbed, the intake/distribution and transfer characteristics of the co-apertured intake/distribution/transfer delay system take over. The fluid distributes in the airlaid intake/distribution layer and transfers through the transfer delay layer until the equilibrium level of 30-40% fluid saturation is achieved in the airlaid intake/distribution layer. This equilibration process again helps in regenerating the void volume in the intake/distribution layer so that it is available to take additional insults. A suitable intake/distribution layer horizontally wicks menses a distance of from about 1.2 cm to about 15.25 cm.

Cover Material Properties:

It is important that the cover rapidly draw insults into the product. A number of materials provide such intake properties. These include pin apertured films, vacuum apertured films, apertured nonwovens and co-apertured film/nonwoven laminates, conjugate fiber spunbond fabrics, creped spunbond fabrics, airlaid fabrics, bonded carded webs, spunlace fabrics, etc. A number of fabric types which may be unsuitable initially may be made acceptable through the use of topical chemical treatments and mechanical processing. Any material which, when combined with an absorbent core, permits rapid intake, low staining, low rewet and low fluid retention under all flow conditions would be suitable.

Creped spunbond nonwoven fabric is preferred as the feminine care product cover material since it creates benefits that can be leveraged in the design of a gush

management absorbent core. These benefits are a result of the fundamental property changes that occur during the creping process. In order to characterize the structural differences that exist between standard spunbond fabric and creped spunbond fabric and identify the impact of creping the spunbond fabric on gush management, two samples are compared. One sample was a 3.5 dpf, 20.3 gsm (0.6 osy) polypropylene spunbond and the other was a 3.5 dpf, 13.6 gsm (0.4 osy) polypropylene spunbond creped 30% to an effective 20.3 gsm basis weight. Both materials were treated with 0.30 weight percent AHCOVEL surfactant. Structural differences can be best characterized by comparing the pore size distributions of the base material to the creped material. Figure 8 is a graph of the pore size distribution for these two samples. In Figure 8, the Y-axis is the pore volume in cc/g and the X-axis is pore radius in microns. The creped spunbond fabric is denoted by the line which peaks first on the left.

The peak pore size for the standard spunbond fabric is 80 microns while the creped spunbond fabric peak pore size is 170 microns. The peak pore size increases with creping because, its believed, primary bonds are deformed and z-directional pores are formed, thereby creating a three dimensional pore structure. The overall increase in caliper results in an increase in total pore volume and a corresponding shift to a larger pore size. For comparison, the pore structure of standard spunbond fabric is two dimensional due to its relatively flat surface structure. The increased permeability and larger pore size of the creped spunbond fabric allows fluid to enter the product more easily. In addition, the large pores are better suited for handling the variety of menstrual fluid types that are associated with heavy and/or gush flow.

The breadth of the pore size distribution also increases with creping. The area under each of the curves in Figure 8 represents a measure of the pore volume for the material. As illustrated by the curves, the pore volume is much higher for the creped spunbond fabric compared to the standard spunbond fabric. The increase in total pore volume facilitates fluid intake and allows the product to accommodate a variety of flow

types without failure. Figure 9 shows the three dimensional structure of the creped spunbond fabric cover in an SEM image at a magnification of one inch equals 2 mm.

Additional structural differences between standard and creped spunbond fabrics are outlined in Table 1. As can be seen from Table 1, the thickness of the creped spunbond fabric is about 2.5 times that of the uncreped spunbond fabric. The thickness creates a barrier between the product and the woman's body and promotes skin dryness by reducing wetness typically caused by rewet. Second, the permeability of the creped spunbond fabric is significantly higher than that of the standard spunbond fabric. This increase in permeability is believed to be due to two factors: the decrease in spunbond fabric density produced by creping and the partial orientation of fibers out of the plane of the fabric. Both of these factors decrease the amount of fiber surface that is in contact with the testing media and thus provide lower resistance to flow, again facilitating fast intake.

Table 1: Comparison of Structural Properties for Spunbond fabric and Creped Spunbond fabric

	Spunbond (20.3 gsm, 3.5 dpf)	Creped Spunbond (20.3 gsm, 3.5 dpf)
Thickness (mm)	0.254	0.66
Permeability (Darcies)	511	3953

The differences in structural properties of the fabrics have a profound effect on the functional properties that these fabric exhibit, as described above. Table 2 displays how several functional properties improve dramatically for the creped spunbond cover fabric compared to standard uncreped spunbond fabric. Results are indicative of the contributions of the creped cover alone when tested over a standard airlaid absorbent core.

Table 2: Comparison of Functional Properties for Spunbond and Creped Spunbond fabric

	Average Intake Time (seconds)	Average Rewet (grams)	Average Stain Size (mm^2)	Average Fluid Retention (grams)
Spunbond (20.3 gsm, 3.5 dpf	32	0.45	751	0.043
Creped Spunbond (20.3 gsm, 3.5 dpf)	17	0.07	619	0.015

The intake time is cut in half due to the increase in permeability and void volume that is introduced by creping. The creped spunbond fabric cover results in rewet that is 16% of the rewet that occurs with the standard spunbond fabric cover. This reduction occurs due to the increase in permeability, pore size, and thickness of the creped spunbond fabric cover. The increase in permeability promotes fluid transport to the absorbent core and the large average pore size ensures that fluid is not held tightly within the inter-fiber spacing of the cover, thus being easily desorbed by the absorbent core. This reduces fluid retention in the cover which reduces rewet and staining by reducing the amount of fluid that is in contact with or in close proximity to the top surface of the cover. The increased loft of the structure provides separation from the absorbent core and thus provides a barrier to fluid flowback. Some reduction in stain intensity also occurs due to masking which occurs as a result of the material thickness.

The functional improvements of faster intake and reduced rewet, retention, and stain size make the creped spunbond cover an ideal candidate for incorporation into a gush management absorbent system. The creped spunbond cover should be light weight, preferably between about 10 and 30 gsm, more particularly between about 15 and 25 gsm, with between about 20 and 50 percent creping, more particularly between about 25 and 40 percent.

Co-apertured Intake/distribution Layer / Transfer Delay:

The intake/distribution layer and the transfer delay layer are co-apertured using mechanical pin aperturing, though holes may also be provided by die cutting or forming the materials in such a way that they are produced with holes in place. The objective is the production of a material which has regions of high and low capillarity so as to produce a "capillarity fabric" which preferentially allows the movement of fluid in some areas but restricts of prohibits it in others. The fluid transfer delay layer for personal care absorbent products in accordance with this invention is designed to enhance distribution in the x-y plane by delaying the transfer of fluid from the intake/distribution layer to the retention layer. The preferred form of capillarity fabric is produced by the co-aperturing of an airlaid fabric and spunbond fabric, though an apertured nonwoven fabric or an embossed nonwoven fabric may also function well. The co-aperturing of the intake/distribution and transfer delay layers provides unique characteristics for the management of gush insults. A unique material is created with a tri-modal pore structure consisting of 1) pores in the bulk of the airlaid which are characteristic of the original structure in the case of airlaid materials, 2) large void spaces defined by the pins of the aperturing process, and 3) small interfacial pores surrounding the perimeter of the apertures. The apertures are typically characterized by an open structure which tapers into a rounded cone-like structure as observed from the airlaid side of the composite. The interfacial pores are smaller than the surrounding pores due to densification and fiber relocation which results from the aperturing process.

The transfer delay layer provides a permeability and wettability gradient between the intake/distribution layer and the underlying retention layer by preventing intimate contact between the two layers. The transfer delay layer should have relatively low permeability and wettability so it will promote lateral fluid distribution in the intake/distribution layer under continuous flow conditions and so control fluid movement in the Z-direction. The wettability of the transfer delay layer may be modified by topical

chemical treatments known to those skilled in the art to affect the hydrophobicity of a material. Some suitable chemicals for modification of wettability are marketed under the tradenames AHCOVEL®, Glucopon®, Pluronics®, Triton®, and Masil SF-19®. The transfer delay promotes lateral (X-Y) distribution in the intake/distribution layer resulting in fluid accumulation in the intake/distribution layer, and then allows fluid transfer to the retention layer when high pressures or high saturation levels occur. It is believed by the inventors that fluid does not preferentially move into the apertures under continuous flow conditions. This controlled transfer mechanism results in an elongated stain pattern in the retention layer and prevents over-saturation in the insult area and provides a visual signal for the wearer indicating product life remaining.

Under gush flow conditions, the apertures in the transfer delay layer allow fluid to immediately pass through to the underlying retention layer.

Figure 2 illustrates the tri-modal pore structure of the co-apertured material. In Figure 2, three classes of pores are illustrated. Large pores 1 are located at the point where the fabric was apertured. Smaller pores 2 exist in the original airlaid fabric 4. Yet another class of pores 3 may be found in the area surrounding the point where the fabric was apertured due to densification of the fabric and fiber relocation during the aperturing process.

Figures 3, 4, and 5 display SEM images of the apertures. Figure 3 displays an aperture on the airlaid side of the composite at a magnification of one inch (2.54 cm) equals 1 mm. Figure 4 displays a close-up of an aperture on the airlaid side of the composite at a magnification of one inch equals 200 microns and Figure 5 displays an aperture from the spunbond side of the composite at a magnification of one inch equals 2 mm.

Figure 6 compares the pore size distribution of an apertured airlaid material to a un-apertured airlaid material. In Figure 6 the un-apertured airlaid material is signified by the large dark squares and the apertured (at a pin density of about 2.5 pins/cm^2) airlaid

material by the lighter colored diamonds. The pore volume (cc/g) is on the Y-axis and the pore radius (microns) on the X-axis. This graph indicates that there is a slight shift toward smaller pores with the apertured material. This is due to a slight densification of the material around the apertures. The large pores which are created by the apertures are not represented in the graph due to their large size. They do, however, provide additional void volume for the material.

Figure 7 illustrates the detail of a single aperture in relation to the functionality of the absorbent composite. In Figure 7 an insult (noted by arrows) is delivered to a cover 1. The insult flows through the cover 1 to the co-apertured laminate of the invention where it passes though the intake/distribution layer 2 either at the aperture 3 or through the layer 2 itself. The insult may also be distributed laterally along its length to other areas 5 within the intake/distribution layer 2. Much of the insult eventually passes through the intake/distribution layer 2 and transfer delay layer 6 to the absorbent retention core 4.

The functionality of the co-apertured system can be broken down into five areas: cover desorption, increased surface area, aperture void volume, access to fluff, and wicking capability. Each of these functionality benefits is discussed individually below.

1. Cover Desorption

The un-apertured areas of the intake/distribution layer material maintain a high degree of capillarity after insult and are well suited for desorbing the liner. The small pores of the preferred airlaid material provide the capillarity necessary to desorb the large pores of the cover, thereby removing a majority of fluid from the surface of the product. Improved cover desorption results in low smearing and cover staining levels.

2. Increased Surface Area

The apertured areas of the intake/distribution layer material provide increased surface area for the absorption of fluid. During gush insults, fluid that contacts an aperture can be absorbed in the x, y, and z directions through the wall of the aperture, rather than strictly in the z-direction through the top surface. Therefore, the increased surface area

provided by the walls of the apertures enhances the intake characteristics of the airlaid absorbent layer. Additionally, the apertures increase the overall permeability of the intake/distribution layer.

3. Aperture Void Volume

The open areas and void volume created by the apertures allow fluid to be accumulated internally in the product before absorption into the intake/distribution layer material itself. This prevents pooling on the pad surface and facilitates intake when localized saturation of the intake/distribution layer prohibits immediate fluid intake.

4. Access to retention layer

The apertures in the intake/distribution layer material provide a direct fluid pathway to the fluff in the apertured areas. Under gush flow conditions, fluid passes directly through the aperture and into the retention layer. By providing immediate access to retention capacity under these conditions, the void volume of the intake/distribution layer is maintained and intake times for multiple insults are reduced.

5. Wicking Capability

When the intake/distribution layer material is the preferred airlaid fabric, its stability and high degree of wet integrity do not allow the pores to collapse to an appreciable degree when the product is insulted. The stable pore structure allows capillary wicking to laterally transport the fluid out of the insult area and into other regions of the product. The un-apertured areas of the airlaid material maintain this functionality and capillary wicking prevents high saturation from occurring in the insult area. Capillary wicking in combination with the stability of the material allows void volume to be regenerated after an insult so that additional insults can be accepted.

Experiments were undertaken to examine preferred forms of the invention. Three different basis weights of airlaid fabrics were evaluated: 100, 175, and 250 gsm. Comparisons were made between the three apertured airlaid fabric samples and an un-

apertured control sample. The aperturing pattern in Figure 12 was used initially and had 48 pins/inch^2 (7.4 pins/cm^2) using 0.081" (2.06 mm) diameter pins.

These materials were tested over a fluff absorbent core using the flat system fluid distribution test. Key measurements included stain size, whether the saturation profile was even or skewed, and the amount of fluid retention and transfer in the airlaid layer. These results are summarized in Table 3.

Table 3: Flat System Fluid distribution test - Co-apertured Material Matrix

	Apertured* 100gsm, 0.06g/cc, 80/20	Apertured* 175gsm, 0.08g/cc, 88/12	Apertured* 250gsm, 0.14g/cc, 90/10	Control 250gsm, 0.14g/cc, 90/10
Stain Size	12.7 cm	10.2 cm	10.2 cm	15.2 cm
Saturation	Even Profile	Even Profile	Even Profile	Even Profile
Retention	3.5 g	3.8 g	3.0 g	4.5 g
Transfer	2.5 g	2.3 g	3.0 g	1.5 g

*The densities reflected above are pre-apertured densities, the densities of the apertured materials are higher.

This testing showed a decrease in stain length as well as fluid retention in the apertured samples, compared to the control, indicating that aperturing the airlaid fabric increases the density of the airlaid fabric dramatically because the pin density of the initial aperturing pattern (Figure 12) was so high. This is most noticeable on high basis weight, high original density samples. As the density increases, the pore size and void volume of the fibrous regions of the airlaid materials decrease.

As a result of this sample testing, it was determined that aperturing had the potential to impact product performance. Further testing was performed at a pin density

of 16 pins/inch^2 (2.5 pins/cm^2) (shown in Figure 13) to minimize increases in post-aperturing material density. The pin diameter remained at 0.081". The range of fabric density studied was narrowed to 175 to 200 gsm and the airlaid fabric was co-apertured to a spunbond fabric transfer delay layer to maintain the intake/distribution functionality.

Tables 4 and 5 display the additional material matrices that were evaluated. The transfer delay layers were spunbond polypropylene fabrics except where film is indicated. The spunbond transfer delay layers had a density and basis weight as indicated. The spunbond fabrics were not treated with surfactants so remained naturally non-wettable. The film was a 1 mil thick polyethylene film.

Table 4: Co-apertured Airlaid Material / Transfer Delay Layer

Basis Weight	Density	Transfer Delay Layer
175gsm	0.08 g/cc	27 gsm
175gsm	0.08 g/cc	33.9 gsm
175gsm	0.10 g/cc	27 gsm
175gsm	0.10 g/cc	33.9 gsm

Table 5 : Co-apertured Airlaid Material / Transfer Delay Layer

Basis Weight	Density	Transfer Delay Layer
175gsm	0.12g/cc	27 gsm
175gsm	0.14g/cc	33.9 gsm
200gsm	0.12g/cc	27 gsm
200gsm	0.12g/cc	33.9 gsm
200gsm	0.12g/cc	Film
200gsm	0.14g/cc	27 gsm
200gsm	0.14g/cc	33.9 gsm
200gsm	1.14g/cc	Film

The materials described in Tables 4 and 5 represent materials which were believed to have better performance characteristics potential due to lower aperturing pin

density and lower basis weight and/or starting densities. These materials were tested for capacity, horizontal wicking capability, saturation capacity, fluid partitioning characteristics, and triple intake gush capability. Each of these areas is discussed individually below. As a result of this testing, its believed that the pin density should be between about 10 and 40 pins/inch^2 (1.6 and 6.2 pins/cm^2) for good performance.

Capacity

Figure 14 shows the measured capacity for airlaid fabrics with and without apertures. In Figure 14, the top line represents the 175 and 200 gsm, un-apertured airlaid fabrics, the middle line a 200 gsm co-apertured airlaid fabric, and the bottom line a 175 gsm co-apertured fabric. Capacity decreases with increasing density as expected. Capacity is also slightly reduced for the apertured samples. This data reveals that an apertured airlaid fabric at 200 gsm and 0.14 g/cc has an equivalent capacity to an un-apertured 175 gsm, 0.14g/cc fabric.

Horizontal Capillary Wicking - Infinite Reservoir

Horizontal capillary wicking testing was completed to assess the effect of the aperturing process on horizontal wicking distance. Horizontal wicking distance is important to maintain a visual signal which alerts the wearer that the product is nearing capacity and should be replaced. Without appropriate wicking functionality, the visual signal is not present to the desired degree.

The horizontal capillary wicking results of the 175 gsm low density airlaid samples of Table 4 indicate that aperturing the airlaid material reduces capillary wicking distance. Its believed that the aperturing process creates apertures which disrupt the fluid pathway for wicking and creates density gradients around each aperture. The apertured materials wicked between 17 and 30 mm less than the un-apertured samples, depending on original density. A larger difference existed for materials which had a higher starting density. These results are shown in Figure 15 where wicking distance in mm is shown on the y-axis and time in minutes on the x-axis. In Figure 15, the 33.9 gsm un-apertured fabric is

the highest line, immediately below it is the line for the 27 gsm un-apertured fabric, followed by the 27 gsm apertured fabric and the 33.9 gsm apertured fabric.

Figure 15 also indicates that the wicking path disruption associated with aperturing has more impact on horizontal wicking performance than the effect of increased airlaid density. This indicates that the aperturing effect is not a simple densification effect. The horizontal wicking results indicate that there is capillary discontinuity in the apertured samples which results in a significant wicking path disruption.

In an effort to improve wicking distance, higher density airlaid fabric samples were apertured and their capillary wicking performance evaluated. Again the results indicate that the higher density apertured samples do not wick as far as the un-apertured control material. This further showed that capillary disruption is a result of the aperturing process and indicates that capillary wicking distance cannot be controlled by density in the apertured materials.

Wicking Saturation Capacity

To assess the saturation level that results after the capillary wicking process, the saturated materials were sectioned and weighed. The gram per gram saturation level was then calculated to determine how the aperturing process affects the overall gram per gram capacity level of the materials. Note that these saturation levels are based on capillary wicking and not on a dunk and drip protocol.

Figure 16 displays the effect of aperturing on saturation level for the 175 gsm low density airlaid samples of Table 4. The results indicate that not only does horizontal wicking distance decrease as a result of the aperturing process, but wicking saturation capacity decreases also. The apertured samples are much less saturated than the un-apertured samples regardless of starting density though no significant differences were noted between samples that had different starting densities. The effect of aperturing was appeared to be more dominant than the effect of starting density. In Figure 16, the saturation in g/g is indicated on the y-axis and the wicking distance in inches on the x-

axis. The upper most line represents the un-apertured 0.1 g/cc sample, the line below the 0.08 g/cc un-apertured sample, the next line down represents the 0.08 g/cc co-apertured sample and the lowest line the 0.1 g/cc co-apertured sample. All samples are 175 gsm.

The effect of aperturing on the capillary wicking saturation of higher density airlaid materials was also assessed. Again, the apertured samples had lower gram per gram saturation levels than the un-apertured control. It thus appears that basis weight had a minimal effect on horizontal wicking distance or saturation level of the co-apertured samples. The 175 and 200 gsm samples perform similarly and only slight differences were noticed between densities. Overall wicking distance was the same for 0.12 and 0.14 g/cc samples, but the saturation level of the 0.12 g/cc samples was higher, believed to be attributable to the higher void volume of the 0.12 g/cc samples.

Horizontal Capillary Wicking - Demand Absorbency

The objective of aperturing and/or co-aperturing is to increase fluid handling of gush flow while maintaining appropriate fluid intake/distribution and wicking characteristics. Infinite reservoir horizontal wicking tests discussed above have shown that capillary wicking capability and saturation capacity are affected by the aperturing process. Since products experience a variety of pressures and flow conditions in use, wicking potential under demand absorbency was also studied. In the demand absorbency horizontal wicking test, the flat system fluid distribution test method is used and fluid is introduced into the product at a rate of 10 ml/hr.

The results showed that the materials are evenly saturated throughout their length, indicating that wicking is not decreased by aperturing in a demand absorbency wicking setting. Its believed that the stable structure of the airlaid fabric allows the apertured airlaid fabric to be fully utilized even though it does not have the continuous capillary fluid paths that are found in an un-apertured airlaid fabric.

Fluid Partitioning Characteristics under Demand Absorbency Conditions

Figures 17 and 18 show the results of a test of the fluid partitioning characteristics of the material. In Figures 17 and 18, the cover layer is indicated by a light colored vertical bar, the intake/distribution layer by a dark bar and the fluff perimeter layer by a white bar. In these Figures, the y-axis is the saturation in g/g and the x-axis is the pad section distance from the front edge. The test was carried out at by delivering 5 ml at a rate of 10 mls/hr and under a pressure of 0.25 psi. Fluid partitioning is important in assessing how co-aperturing the airlaid and transfer delay layers changes the fluid transfer characteristics of the product. Ideally, fluid should distribute throughout the entire length of the airlaid layer and transfer though the transfer delay layer simultaneously.

Figure 17 shows that the control system (un-apertured 175 gsm, 0.14 g/cc airlaid layer using 27 gsm spunbond transfer delay layer) does not allow any fluid transfer to the fluff perimeter layer of the product. Figure 18 shows that the co-apertured sample (co-apertured 175 gsm, 0.14 g/cc airlaid layer using 0.8 osy spunbond transfer delay layer) does allow transfer to the perimeter fluff layer.

Triple Intake Times

Triple intake testing was completed on a number of airlaid materials to assess the effects of co-aperturing on the intake rates of materials with different starting densities and different transfer delay layers. Testing was done using 3, 2 ml insults, 9 minutes apart. In all of the bar graphs of triple intake testing, the first insult is indicated by a light colored bar, the second in a dark bar and the third in a white bar. The airlaid fabric used in the samples for Figures 19 and 20 were made from 90 weight percent NB416 pulp and 10 weight percent Hoescht-Celanese T-255 binder fiber. In Figures 19, 20 and 21, the y-axis is the intake time in seconds.

In Figure 19, the samples, moving from left to right are 175 gsm, 0.10 g/cc apertured airlaid fabric over fluff, 175 gsm, 0.10 g/cc un-apertured airlaid fabric with a 27 gsm spunbond transfer delay layer over fluff, 175 gsm 0.08 g/cc co-apertured airlaid fabric

with a 27 gsm spunbond transfer delay layer over fluff, 175 gsm 0.08 g/cc co-apertured airlaid fabric with a 33.9 gsm spunbond transfer delay layer over fluff, 175 gsm 0.10 g/cc co-apertured airlaid fabric with a 27 gsm spunbond transfer delay layer over fluff, 175 gsm 0.10 g/cc co-apertured airlaid fabric with a 33.9 gsm spunbond transfer delay layer over fluff.

In Figure 20, the samples, moving from left to right are 200 gsm, 0.14 g/cc apertured airlaid fabric over fluff, 200 gsm, 0.14 g/cc un-apertured airlaid fabric with a 27 gsm spunbond transfer delay layer over fluff, 200 gsm 0.14 g/cc co-apertured airlaid fabric with a 33.9 gsm spunbond transfer delay layer over fluff, 200 gsm 0.14 g/cc co-apertured airlaid fabric with a 27 gsm spunbond transfer delay layer over fluff, 200 gsm 0.14 g/cc co-apertured airlaid fabric with a 1 mil film delay layer over fluff, 200 gsm 0.12 g/cc co-apertured airlaid fabric with a 1 mil film transfer delay layer over fluff, 200 gsm 0.12 g/cc co-apertured airlaid fabric with a 27 gsm spunbond transfer delay layer over fluff and 200 gsm 0.12 g/cc co-apertured airlaid fabric with a 33.9 gsm spunbond transfer delay layer over fluff.

Figures 19 and 20 below show that triple intake times are similar for all of the co-apertured materials tested regardless of which transfer delay layer was used and what density the airlaid fabric was. Triple intake times are higher than a standard airlaid/fluff system and are lower than the same system with a transfer delay but without aperturing. These results indicate that the immediate access to the underlying fluff layer has been greatly improved by co-aperturing.

Triple Intake Testing on a complete gush management absorbent system with a creped cover and co-apertured absorbent system indicate the individual effects of each component.

Figure 21 displays the triple gush intake results. In Figure 21, the samples, moving from left to right are creped spunbond fabric cover with 175 gsm 0.12 g/cc co-apertured airlaid fabric with a 27 gsm spunbond transfer delay layer over fluff, un-creped spunbond

fabric cover with 175 gsm 0.12 g/cc co-apertured airlaid fabric with a 27 gsm spunbond transfer delay layer over fluff, creped spunbond fabric cover with 175 gsm 0.12 g/cc un-apertured airlaid fabric with a 27 gsm spunbond transfer delay layer over fluff, and un-creped spunbond fabric cover with 175 gsm 0.12 g/cc un-apertured airlaid fabric with a 27 gsm spunbond transfer delay layer over fluff.

The results indicate that combining the creped spunbond cover with a co-apertured intake/distribution/transfer delay layer decreases the intake times and facilitates quicker intake than all of the other samples. It can also be seen from this data that the samples with the creped spunbond cover performed better than the samples with the regular spunbond cover. Co-aperturing made a smaller contribution than did the choice of cover but additional improvements were seen when the creped cover and the co-apertured system were combined. The faster intake times are believed to be a result of the increased fluid transfer to the fluff layer and the void volume that is generated in the intake/distribution layer as a result of this.

The results reveal that the intake/distribution layer should be an airlaid fabric between about 150 and 300 gsm, more particularly between about 175 and 225 gsm, with a density between about 0.05 and 0.18 g/cc, more particularly between about 0.08 and 0.14 g/cc. The transfer delay should be a film, meltblown fabric or spunbond fabric, more particularly a spunbond fabric with a basis weight between about 15 and 50 gsm, still more particularly between about 25 and 35 gsm.

Although only a few exemplary embodiments of this invention have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the following claims. In the claims, means plus function claims are intended to cover the structures described herein as performing the recited function and not only structural equivalents but

also equivalent structures. Thus although a nail and a screw may not be structural equivalents in that a nail employs a cylindrical surface to secure wooden parts together, whereas a screw employs a helical surface, in the environment of fastening wooden parts, a nail and a screw may be equivalent structures.

It should further be noted that any patents, applications or publications referred to herein are incorporated by reference in their entirety.

What is claimed is:

1) A feminine hygiene pad comprising a rapid intake cover adjacent a capillarity fabric having regions of varying capillarity which allows the passage of fluids in particular areas, which is adjacent an absorbent core retention layer.

2) The pad of claim 1 wherein said cover is made from a process selected from the group consisting of spunbonding, meltblowing, spunlacing, creping, film aperturing, foaming, airlaying, coforming, bonding and carding, and combinations thereof.

3) The pad of claim 2 wherein said cover is made by a spunbond process and has a basis weight between about 10 and 30 gsm and is creped an amount between 20 and 50 percent.

4) The pad of claim 1 wherein said capillarity fabric is an apertured nonwoven fabric.

5) The pad of claim 1 wherein said capillarity fabric is an embossed nonwoven fabric.

6) The pad of claim 1 wherein said capillarity fabric comprises a intake/distribution layer and a transfer delay layer.

7) The layer of claim 1 wherein said intake/distribution layer horizontally wicks menses a distance of from about 1.2 cm to about 15.25 cm.

8) The pad of claim 6 wherein said transfer delay layer is adjacent said absorbent core.

9) The pad of claim 8 wherein said transfer delay layer is a material selected from the group consisting of spunbond fabric, meltblown fabric, carded fabric and films.

10) The pad of claim 6 wherein said transfer delay layer is a spunbond fabric with a basis weight between about 15 and 50 gsm.

11) The pad of claim 6 wherein said intake/distribution layer is a material selected from the group consisting of airlaid fabric, bonded carded webs, coform materials, hydroentangled pulp fabrics and meltblown fabrics.

12) The pad of claim 11 wherein said intake/distribution layer is an airlaid fabric having a basis weight between about 100 and 300 gsm and a density between about 0.05 and 0.18 g/cc.

13) The pad of claim 6 wherein said intake/distribution and transfer delay layers are co-apertured with pins at a density of between about 1.6 and 6.2 pins/cm^2.

14) The pad of claim 6 wherein said intake/distribution and transfer delay layers are co-apertured with pins at a density of about 2.5 pins/cm^2.

15) The layer of claim 1 wherein said absorbent core comprises pulp and superabsorbent.

16) The pad of claim 4 wherein said superabsorbent is in a form selected from the group consisting of flakes, particles, spheres, foams and fibers.

17) An feminine hygiene pad comprising a creped spunbond nonwoven fabric outer cover adjacent a polyolefin fiber airlaid fabric intake/distribution layer having a basis weight

between about 175 and 225 gsm and a density between about 0.08 and 0.14 g/cc, co-apertured at a pin density of between about 1.6 and 6.2 pins/cm^2 to a polyolefin spunbond nonwoven fabric transfer delay layer having a basis weight between about 25 and 35 gsm, adjacent a retention layer comprising pulp and superabsorbent material.

18) The pad of claim 17 wherein said cover is creped an amount between about 25 and 40 percent and has a basis weight between about 15 and 25 gsm.

19) The pad of claim 17 wherein said airlaid fabric is made from pulp and thermoplastic fibers.

20) The pad of claim 17 wherein said spunbond fabric is made from polypropylene fibers.

21) The pad of claim 17 wherein said creped cover is made from polypropylene fibers.

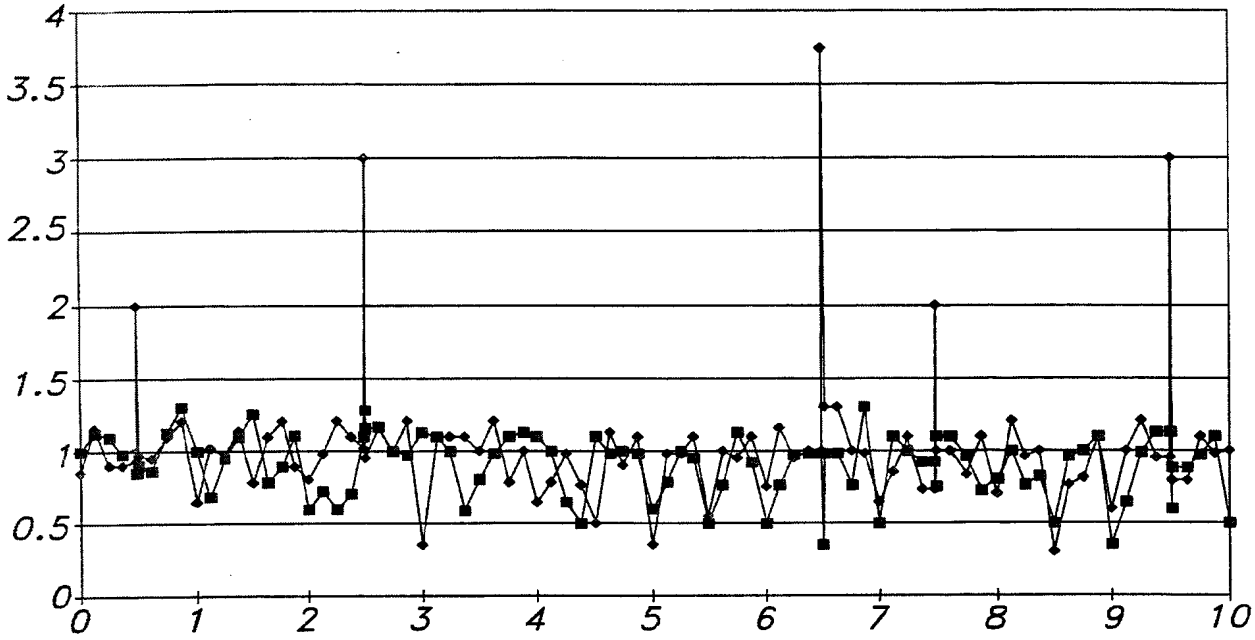


FIG 1

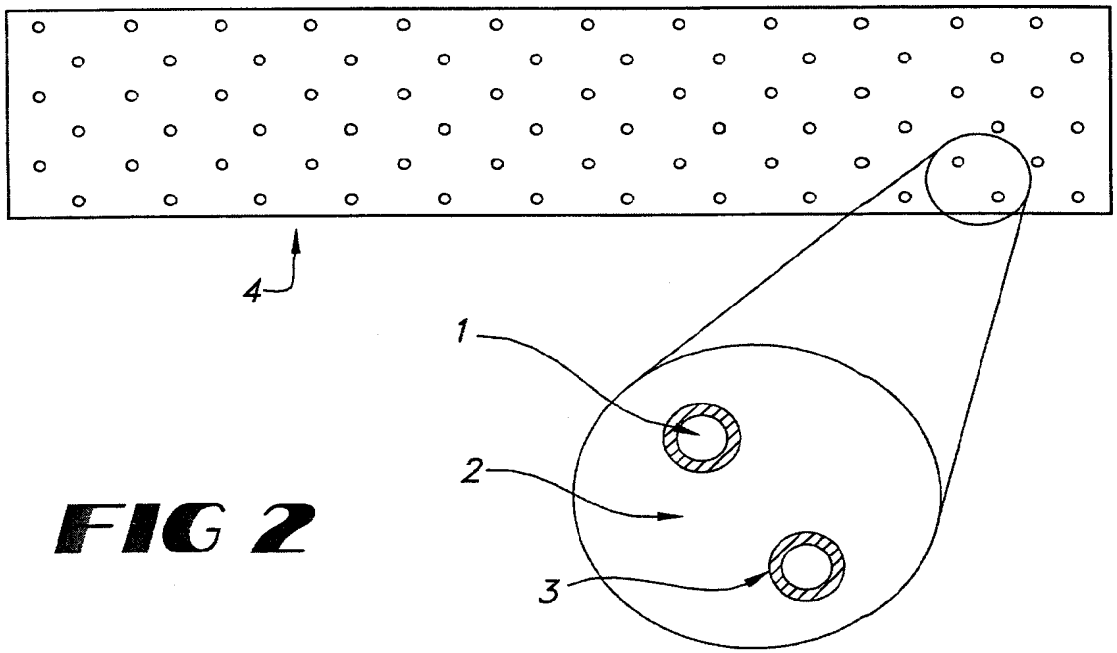


FIG 2

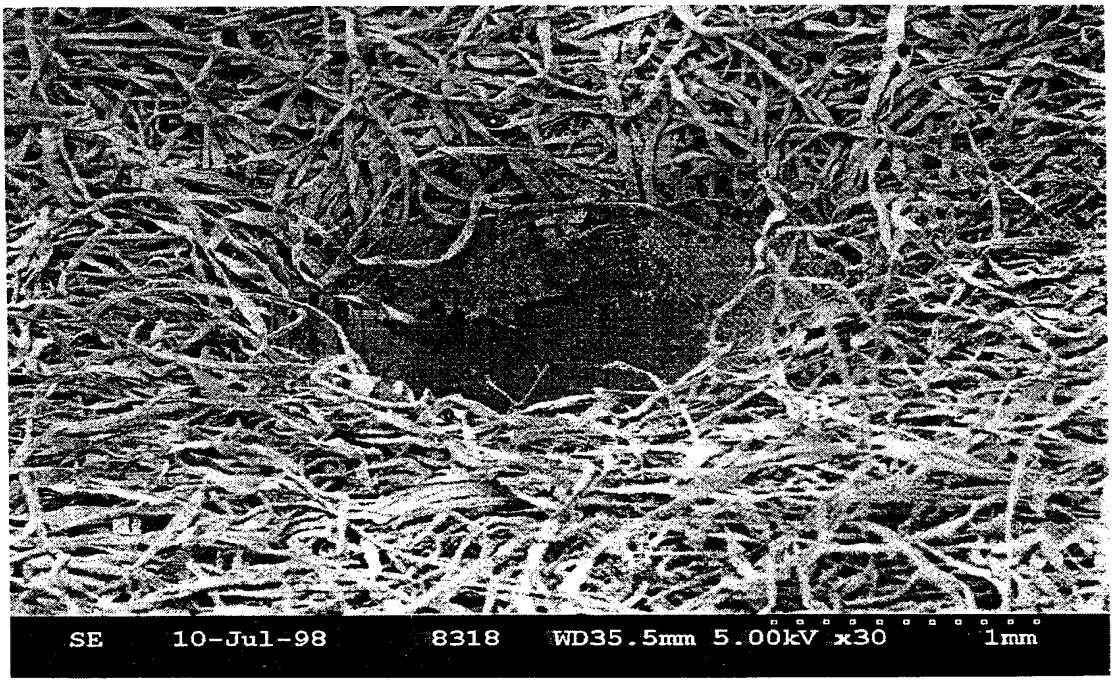

SE 10-Jul-98 8318 WD35.5mm 5.00kV x30 1mm

FIG 3

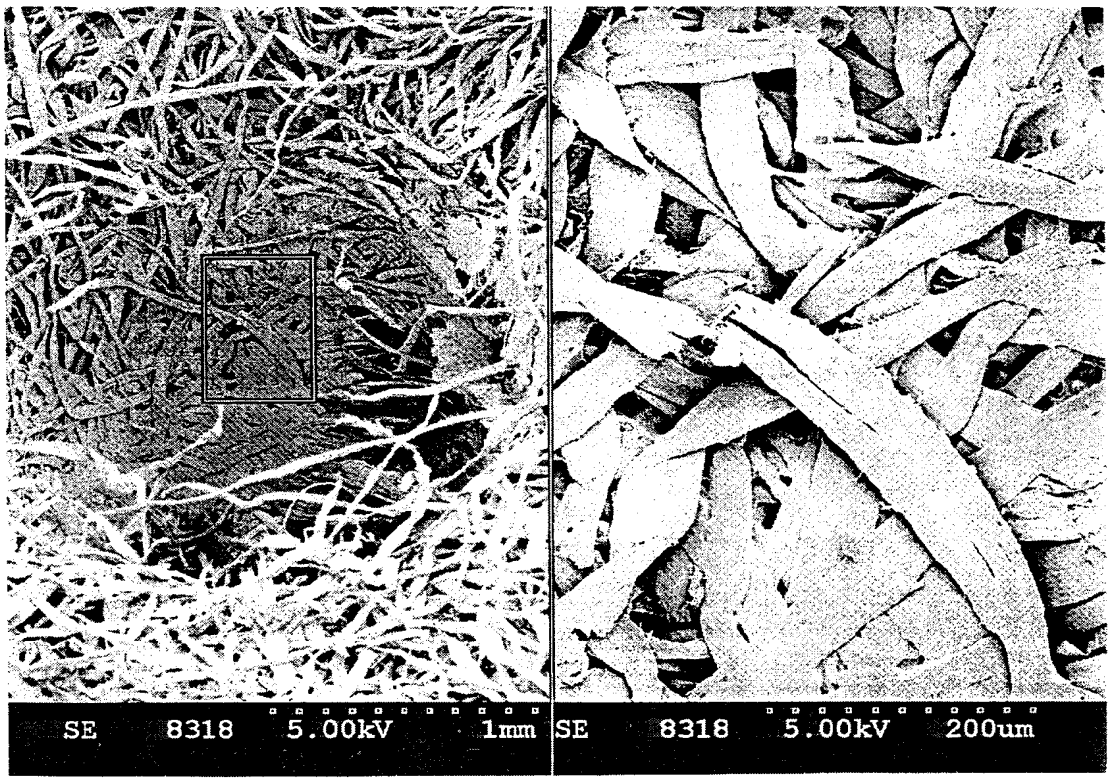

SE 8318 5.00kV 1mm
SE 8318 5.00kV 200um

FIG 4

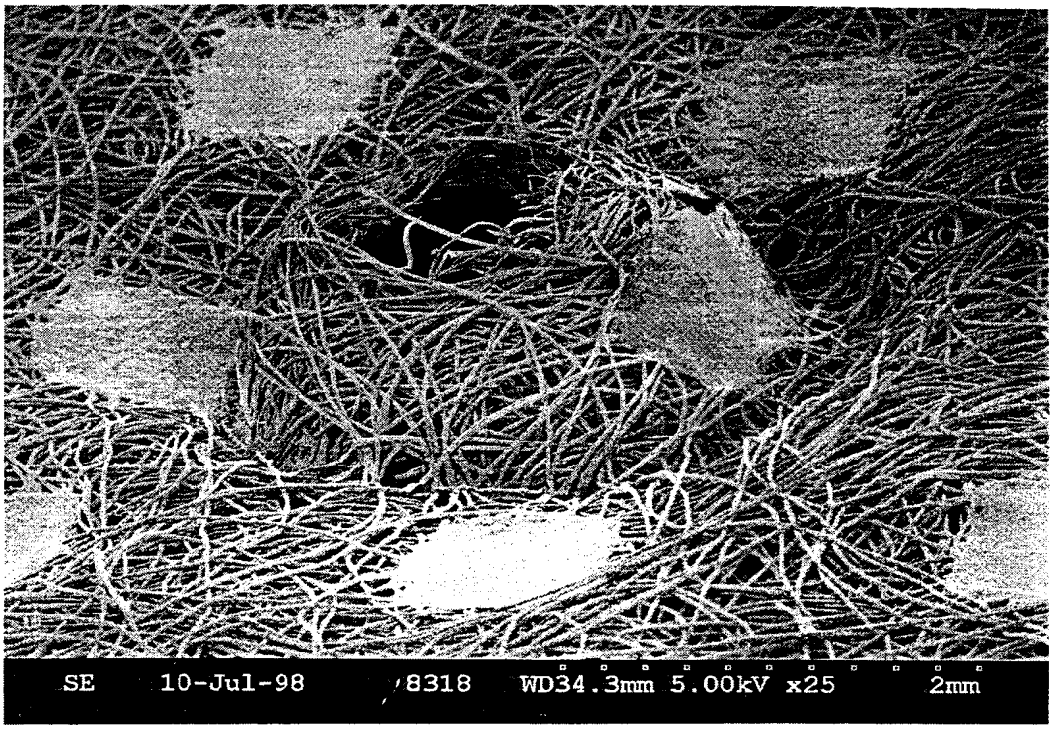

SE 10-Jul-98 8318 WD34.3mm 5.00kV x25 2mm

FIG 5

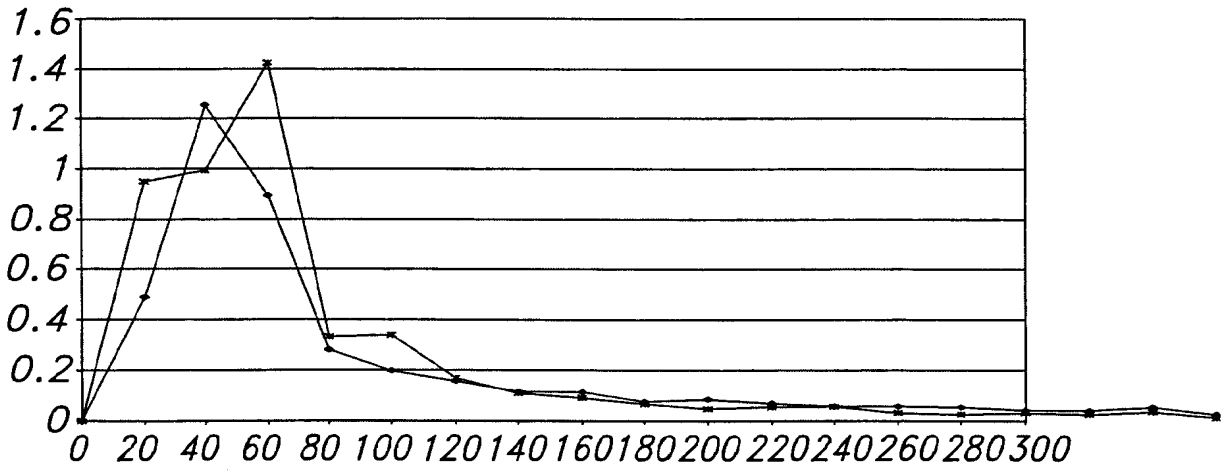

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FIG 6

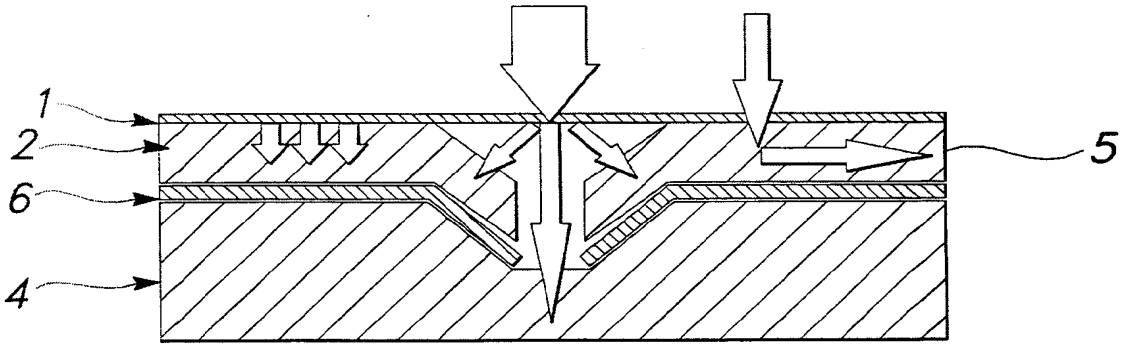

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FIG 7

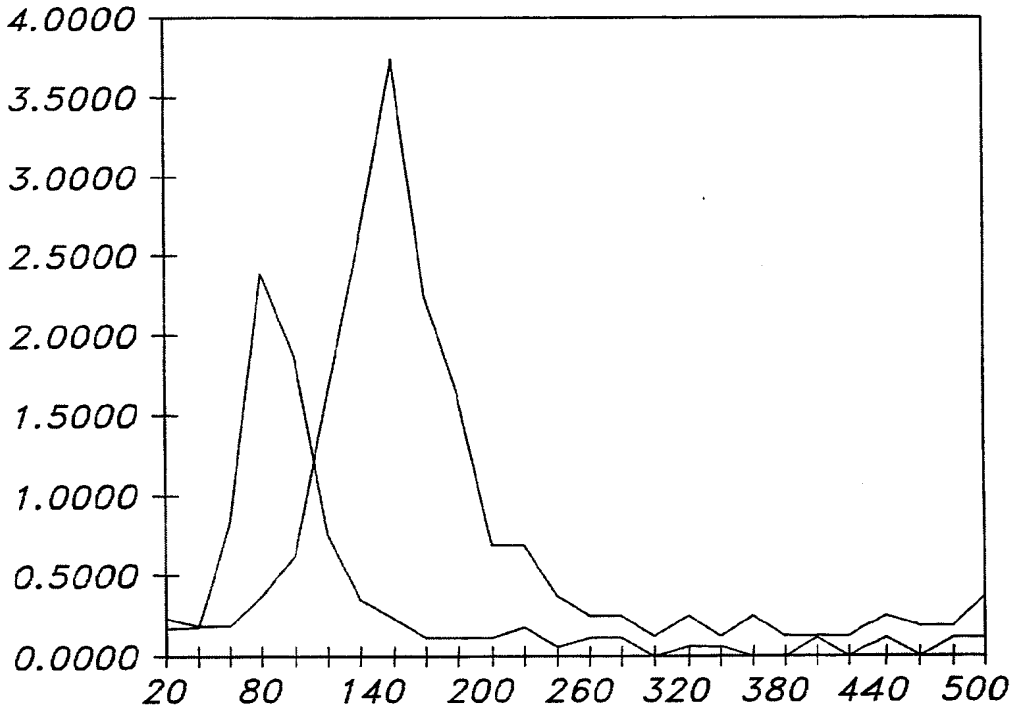

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FIG 8

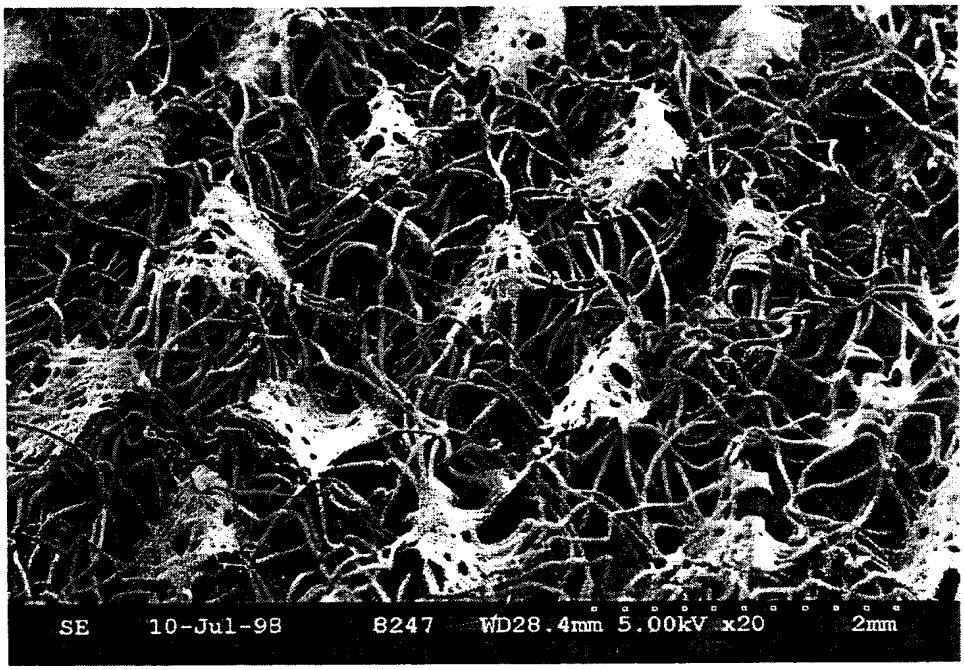


FIG 9

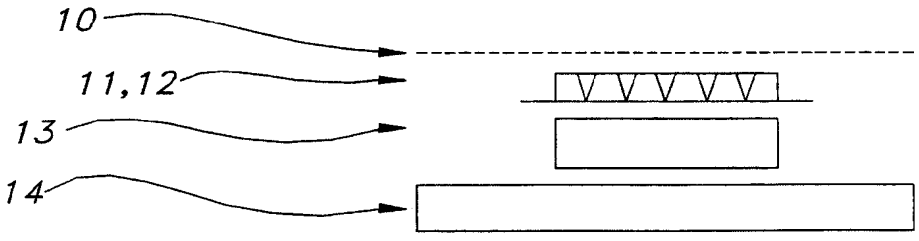


FIG 10

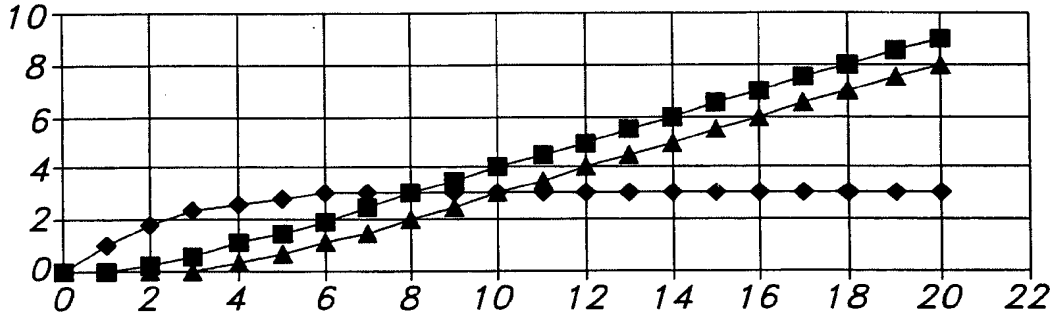


FIG 11

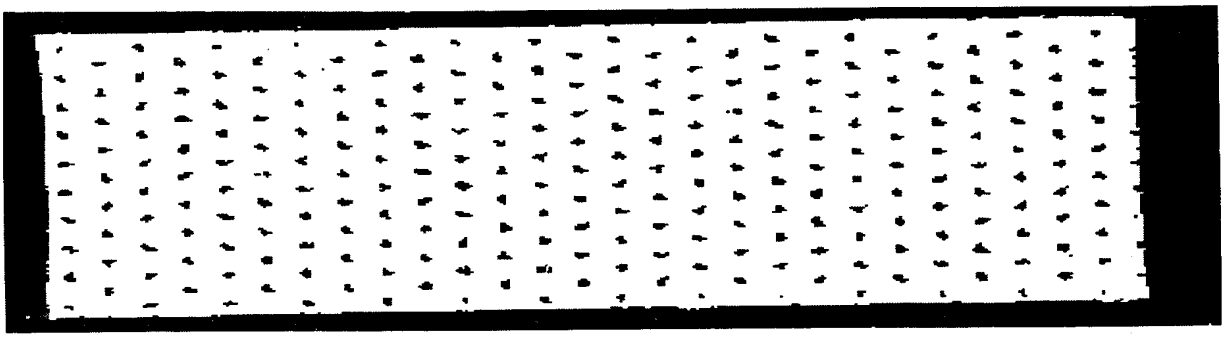


FIG 12

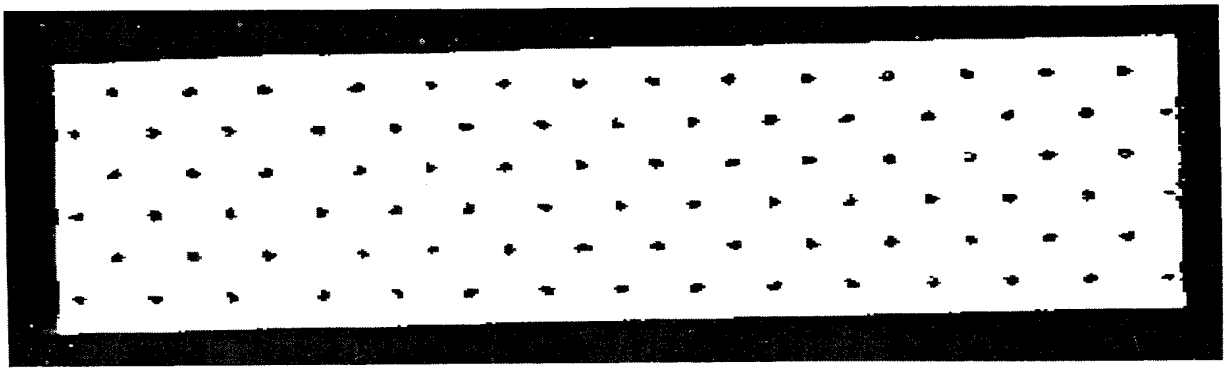


FIG 13

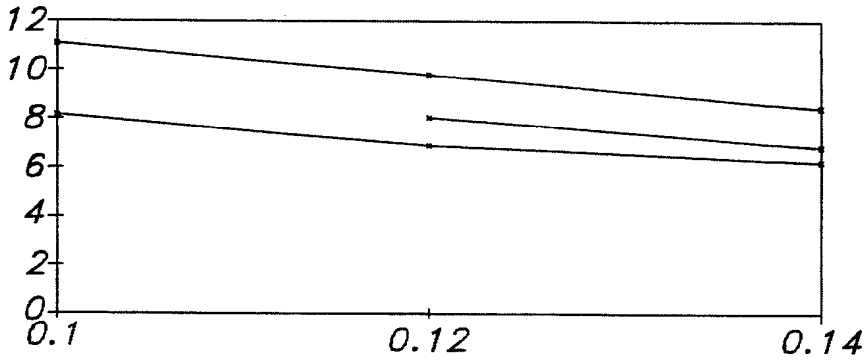


FIG 14

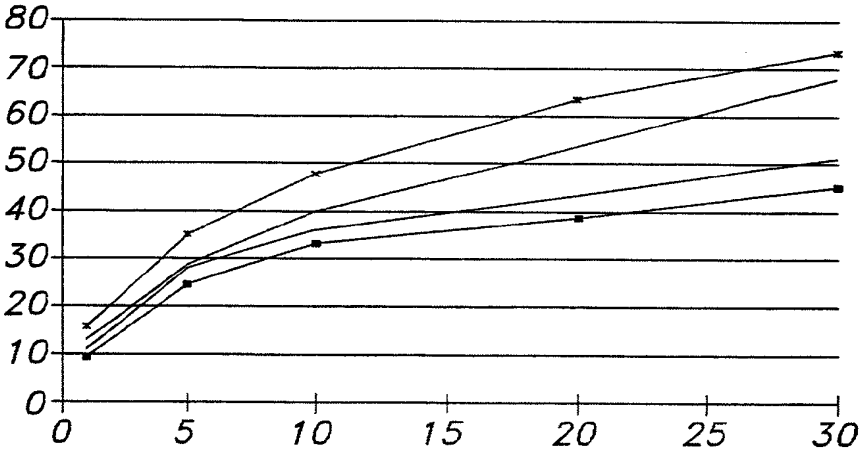


FIG 15

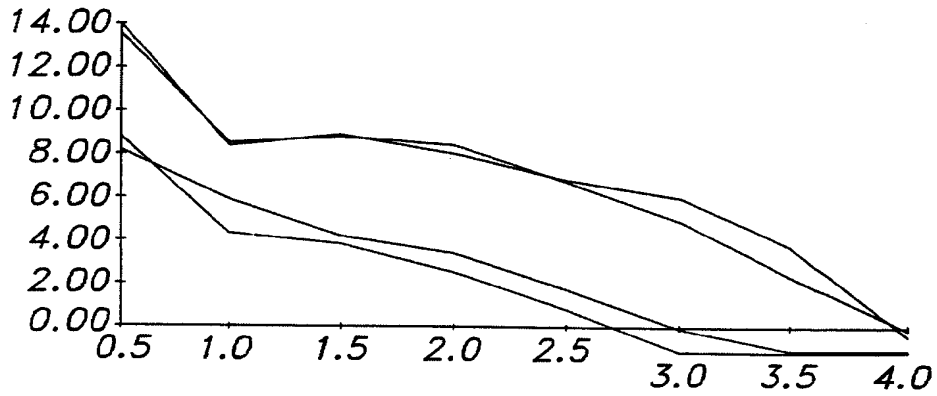

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FIG 16

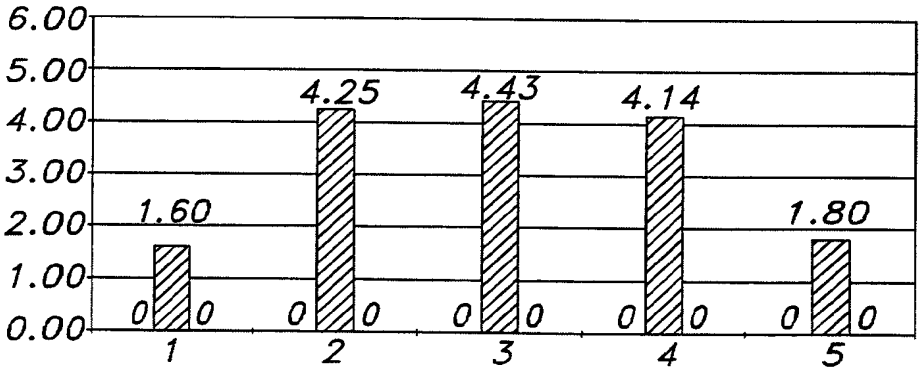

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FIG 17

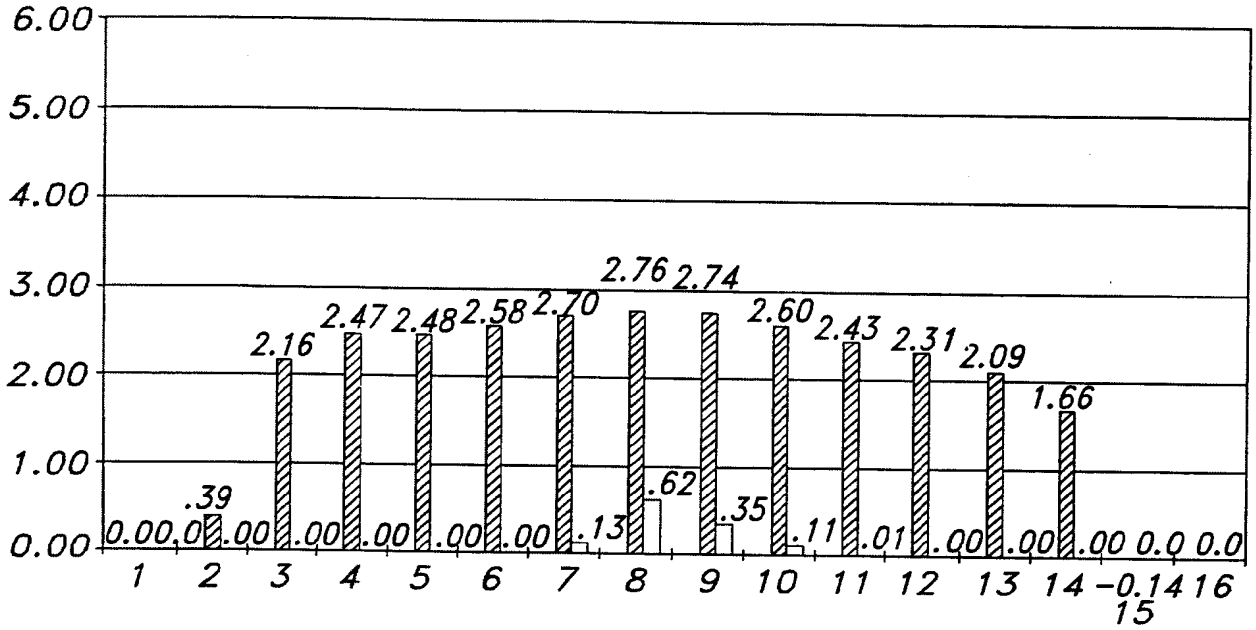

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FIG 18

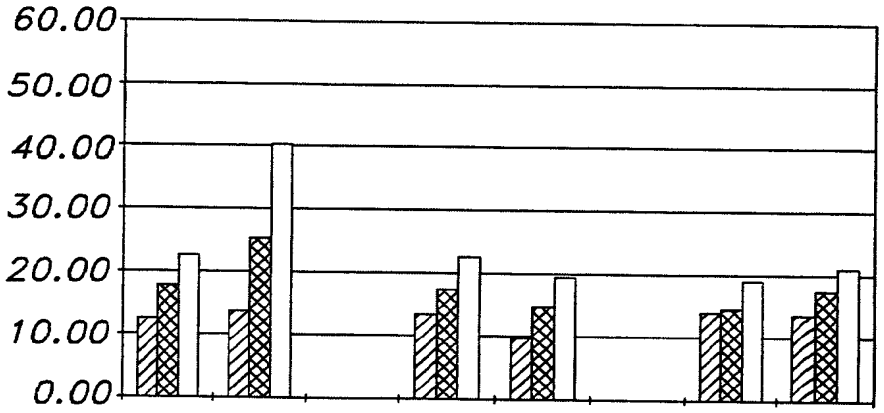

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FIG 19

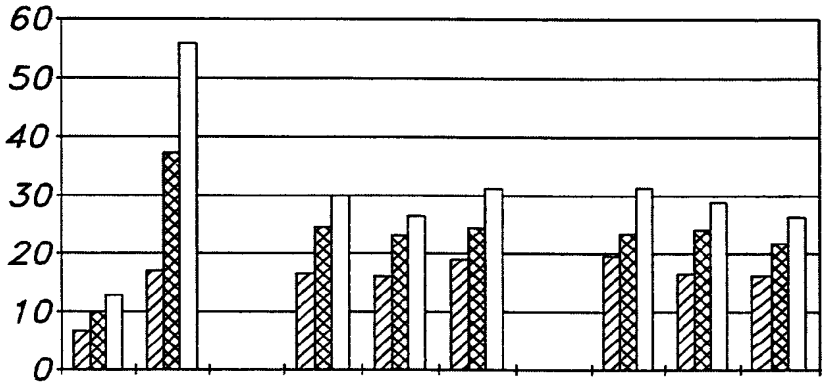

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FIG 20

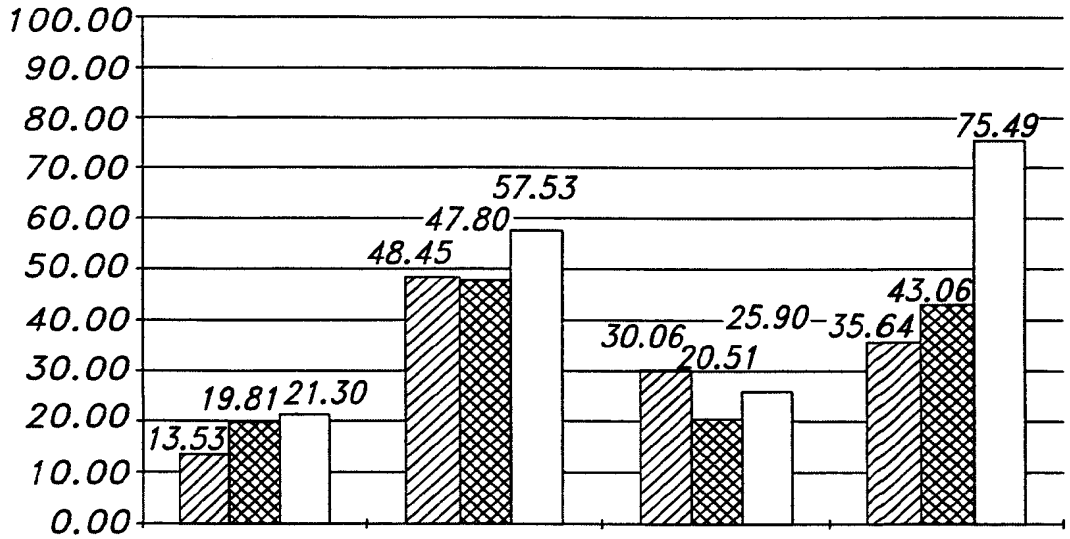

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30.06
20.51
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75.49

FIG 21

INTERNATIONAL SEARCH REPORT

Int. ional Application No
PCT/US 00/08805

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61F13/15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 817 394 A (ALIKHAN MIR INAYETH ET AL) 6 October 1998 (1998-10-06) column 3, line 18 -column 5, line 63 column 12, line 37 -column 14, line 23; claims; figures	1-21
A	US 5 846 232 A (SERBIAK PAUL JOHN ET AL) 8 December 1998 (1998-12-08) claims 8,29	1-3,17
X	WO 93 09745 A (PROCTER & GAMBLE) 27 May 1993 (1993-05-27) claims; figures	1,2,5
X	WO 97 02133 A (KIMBERLY CLARK CO) 23 January 1997 (1997-01-23) claims; figures	1,2,4,5

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
12 July 2000	21/07/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Douskas, K

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INTERNATIONAL SEARCH REPORT

Int. ional Application No
PCT/US 00/08805

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 613 962 A (KENMOCHI YASUHIKO ET AL) 25 March 1997 (1997-03-25) column 4, line 3 - line 45; claims; figures	1,2,5
X	US 3 046 986 A (HARWOOD) 31 July 1962 (1962-07-31) the whole document	1,2,5
X	WO 97 18783 A (DUNI AB ;ROVANIEMI ROLF (SE); HANSEN TORBJOERN (SE)) 29 May 1997 (1997-05-29) claims; figures	1,2,5
A	FR 2 044 554 A (WUHRLIN JEAN) 19 February 1971 (1971-02-19) the whole document	1,3

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. ional Application No
PCT/US 00/08805

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int\ Jonal Application No
PCT/US 00/08805

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2044554 A	19-02-1971	NONE	

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(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 October 2001 (04.10.2001)

PCT

(10) International Publication Number
WO 01/72251 A1

(51) International Patent Classification[7]: A61F 13/15, 13/537, 13/512

(21) International Application Number: PCT/US01/09104

(22) International Filing Date: 21 March 2001 (21.03.2001)

(25) Filing Language: English

(26) Publication Language: English

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09/535,024 24 March 2000 (24.03.2000) US

(71) Applicant: KIMBERLY-CLARK WORLDWIDE, INC. [US/US]; 401 N. Lake Street, Neenah, WI 54956 (US).

(72) Inventors: BRAVERMAN, Jaime; 211 Colonial Home Drive, Apt 2301, Atlanta, GA 30309 (US). COLMAN, Charles, Wilson; 2611 Shadow Woods Circle, Marietta, GA 30062 (US). DALEY, Michael, Allen; 5865 Haterleigh Drive, Alpharetta, GA 30005 (US). EDENS, Ronald, Lee; 201 E. Evergreen Drive, Appleton, WI 54913 (US). GARAVAGLIA, Arthur, Edward; 2560 Runic Way, Alpharetta, GA 30022 (US). GIENCKE, Ann, Marie; 1325 Lucerne Drive, Apartment 17, Menasha, WI 54952 (US). HAMMONDS, Yvette, Lynn; 3033 Rosewood Lane, Oshkosh, WI 54904 (US). KOLLIN, Nancy, Donaldson; 315 Woodchuck Court, Roswell, GA 30076 (US). KOTTEK, Michael, Brent; 516 Emerson Street, Neenah, WI 54956 (US). MACE, Tamara, Lee; 3388 Colquitt Drive, Doraville, GA 30340 (US). MATELA, David, Michael; 1280 Mayfield Manor Drive, Alpharetta, GA 30004 (US). MODER, Susan, Jean; 290 South Kools Street, Appleton, WI 54914 (US). BRAMSTEDT NELSON, Jayne, Ann; 635 Appleton Road, Menasha, WI 54952 (US). RASMUSSEN, Shelley, Rae; 3297 Creek Side Drive, Oshkosh, WI 54904 (US). ROESSLER, Thomas, Harold; 1034 Greendale Court, Menasha, WI 54952 (US). WALKER, Laura, Jane; 2209 Cloudview Court, Appleton, WI 54914 (US).

(74) Agents: ROBINSON, James, B. et al.; Kimberly-Clark Worldwide, Inc., 401 N. Lake Street, Neenah, WI 54956 (US).

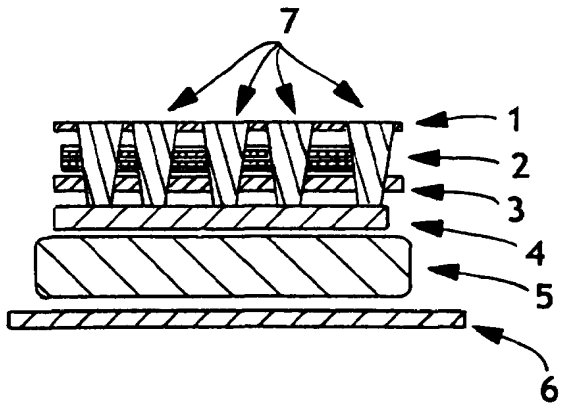
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: CO-APERTURED SYSTEMS FOR HYGIENIC PRODUCTS



(57) Abstract: There is provided a system for a hygienic product having a cover layer, an intake/distribution layer and an absorbent core, in which at least the cover and intake/distribution layers are co-apertured. Combining these improvements into an integrated absorbent system allows the successful achievement of variable flow management and a successful balance between intake and cover desorption properties. The result is improved multiple intake performance and a clean and dry cover surface during use.

WO 01/72251 A1

CO-APERTURED SYSTEMS FOR HYGIENIC PRODUCTS

FIELD OF THE INVENTION

The present invention is a system for an absorbent, hygienic, personal care article, particularly feminine hygiene products. Such products must rapidly accept viscous fluid and retain it so that it does not spread outside the product where it may stain the wearer's garments.

BACKGROUND OF THE INVENTION

Personal care articles include such items as diapers, training pants, feminine hygiene products such as sanitary napkins, panty-liners and tampons, incontinence garments and devices, bandages and the like. The most basic design of all such articles typically includes a bodyside liner (cover material), an outercover (also referred to as a baffle) and an absorbent core disposed between the bodyside liner and the outercover.

Personal care products must accept fluids quickly and hold them to reduce the possibility of leakage outside the product. The product should be flexible and have a pleasing feel on the skin, and even after liquid insult, should not bunch, twist or bind the user making this uncomfortable for the wearer. Unfortunately, while previous products have met many of these criteria to varying degrees, a number have not.

In particular, feminine hygiene products for longer-term (i.e. overnight) usage are subject to higher and more variable flow rates and fluid loads than are those intended for regular or shorter term usage. Products for overnight usage, therefore, must have the ability to absorb and contain continuous and light flow as well as gushes and sudden heavy flow over the life of the product. It has been found that continuous flow insults in

feminine hygiene products average 1 ml/hr, but may be higher, and are not literally continuous or constant, but rather variable in rate and may even pause during a cycle. "Gush flow" is defined as a sudden heavy flow condition and occurs at flow rates of up to 1ml/sec. During a gush, 1-5 ml of fluid is released from the body onto the product. The term "continuous flow" is used to define any flow which falls outside of the definition of gush flow.

Combining continuous and gush flow condition, results in variable flow. Essentially, "variable flow" is defined as continuous flow with intermittent gush flow occurrences. Figure 1 is a graph which illustrates the differences between variable flow (diamonds) and continuous flow (squares) over the life of a single product where flow rate is on the y-axis in g/hr and time is on the x-axis in hours. This problem of handling gush and continuous flows is termed variable flow management and is defined as the ability to absorb and contain continuous and light flow (1-2 ml/hr) as well as multiple gushes or sudden heavy flow insults (1 ml/sec with a total volume of 1-5 ml) over the life of the product.

The ultimate challenge for a product is to be capable of handling a gush (sudden flow) after the product has been insulted and the absorbent system is partially or completely saturated.

Many feminine care cover materials have low z-directional conductivity, low surface energy, low void volume, and provide little separation between the absorbent core and the user due to their two dimensional structure. Consequently, these covers result in slow and incomplete intake, high rewet, and large surface stains. In addition, typical intake or acquisition layers are low density, high void volume structures which are ideal for fast fluid intake, but because these structures typically have low capillarity and because of their generally fibrous nature, fluid is not adequately desorbed from the cover material, resulting in smearing and surface wetness. Materials which enhance cover desorption are

typically high density, high capillarity materials, but because these materials have low void volume and low z-directional permeability, they inherently retard fluid intake.

There remains a need for a system, which is designed to promote rapid intake and remain clean and dry, and which accepts fluids at the appropriate speed. There also remains a need for a system which further allows fluid to be absorbed in particular absorbent layers.

An objective of this invention is, therefore, to provide such a system. It is a further object of this invention to provide a design for a feminine hygiene product incorporating such a system, particularly for medium to high fluid loads.

SUMMARY OF THE INVENTION

The objectives of the invention are achieved by a system having a cover layer, an intake/distribution layer and an absorbent core, in which at least the cover and intake/distribution layers are co-apertured. Other layers may be present as well, including surge and transfer delay layers. The cover may be a film or nonwoven fabric made from thermoplastic polymers. The intake/distribution layer is preferably a nonwoven fabric, and more preferably made by the airlaying process. Surge layers and transfer delay layers are generally nonwoven fabrics of varying wettability, pore size, permeability and fiber denier. The absorbent core may be made from pulp, superabsorbent or a variety of other absorbent materials. The system of this invention results in improved absorption of multiple insults allowing fluid storage in particular layers, providing a clean and dry cover surface during use. These functional properties are provided through improved material technologies and product construction.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a graph of variable flow (diamonds) and continuous flow (squares) over the life of a single product where flow rate volume is on the y-axis in g/hr and time is on the x-axis in hours.

Figure 2 shows a pin aperturing pattern at 7.4 apertures/cm^2 using 2.06 mm diameter pins.

Figure 3 shows a pin aperturing pattern at 2.5 apertures/cm^2 with the same pin diameter as Figure 2.

Figure 4 is a schematic diagram of a rate block apparatus suitable for use in determining fluid intake time of a material or material system.

Figure 5 is a schematic diagram of an absorbent system which has apertures throughout the cover and intake/distribution layer.

Figure 6 is a schematic of a similar coapertured absorbent system as Figure 5 but incorporates an additional material layer between the cover and the intake /distribution layer.

Figures 7, 8, 9, 10, 11, 12, and 13 are examples of zoned co-aperturing patterns that may be used in the practice of this invention.

DEFINITIONS

As used herein the term "nonwoven fabric or web" means a matrix of individual fibers or threads which are interlaid, but not in an identifiable manner as in a knitted fabric. Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes, spunbonding processes, and bonded carded web processes. The basis weight of nonwoven fabrics is usually expressed in ounces of material per square yard

(osy) or grams per square meter (gsm) and the fiber diameters useful are usually expressed in microns. (Note that to convert from osy to gsm, multiply osy by 33.91).

"Spunbonded fibers" refers to small diameter fibers that are formed by extruding molten thermoplastic material as filaments from a plurality of fine capillaries of a spinneret. Such a process is disclosed in, for example, US Patent 4,340,563 to Appel et al. The fibers may also have shapes such as those described, for example, in US Patents 5,277,976 to Hogle et al. which describes fibers with unconventional shapes.

"Bonded carded web" refers to webs that are made from staple fibers which are sent through a combing or carding unit, which separates or breaks apart and aligns the staple fibers in the machine direction to form a generally machine direction-oriented fibrous nonwoven web. This material may be bonded together by methods that include point bonding, through air bonding, etc.

"Airlaying" is a well-known process by which a fibrous nonwoven layer can be formed. In the airlaying process, bundles of small fibers having typical lengths ranging from about 3 to about 19 millimeters (mm) are separated and entrained in an air supply and then deposited onto a forming screen, usually with the assistance of a vacuum supply. The randomly deposited fibers then are bonded to one another using, for example, hot air or a spray adhesive. Airlaying is taught in, for example, US Patent 4,640,810 to Laursen et al.

As used herein, the term "coform" means a process in which at least one meltblown diehead is arranged near a chute through which other materials are added to the web while it is forming. Such other materials may be pulp, superabsorbent or other particles, natural polymers (for example, rayon or cotton fibers) and/or synthetic polymers (for example, polypropylene or polyester) fibers, for example, where the fibers may be of staple length. Coform processes are shown in commonly assigned US Patents 4,818,464 to Lau and

4,100,324 to Anderson et al. Webs produced by the coform process are generally referred to as coform materials.

"Co-aperture" refers to a material that has been apertured, as well as a process of aperturing, wherein two or more materials are apertured together. The apertures extend from top to bottom of the material and are essentially aligned with each other. Co-aperturing can join the materials either temporarily or permanently through entanglement, physical bonding or chemical bonding. Co-aperturing layers may be carried out at ambient or elevated temperatures. Higher temperatures aid the material bonding and create a cleaner pore. One process of co-aperturing is by forcing pins through the various layers by feeding them together through a nip formed by two counter-rotating rollers, one of which has pins to produce the apertures. The apertures may, for example, have a dimension of from 0.5 mm to 5 mm using a pin density of from 1 to 15 apertuers/cm^2 and resulting in apertures having an area of less than 19.6 mm^2 and an open area ranging from about 2 to about 25 percent. Co-aperturing may be performed as a separate "off-line" operation or as part of a larger converting operation (in-line) depending on process economics and equipment availability. Examples of some co-aperturing patterns for feminine hygiene pads may be seen in Figures 7 –13.

"Transfer delay layer" refers to a material which slows down fluid transfer between other adjacent layers but which does not retain substantial amounts of fluid itself.

"Personal care product" means diapers, training pants, disposable swimwear, absorbent underpants, adult incontinence products, feminine hygiene products, wound care items like bandages, and other articles.

"Feminine hygiene products" means sanitary napkins or pads, and panty-liners.

"Target area" refers to the area of a personal care product where a wearer normally delivers an insult while the product is being worn.

TEST METHODS

Material caliper (thickness):

The caliper of a material is a measure of thickness and is measured at 0.05 psi (3.5 g/cm^2) with a STARRET®-type bulk tester, in units of millimeters. Samples are cut to 4" by 4" (10.2 cm by 10.2 cm) squares and five samples are tested and the results averaged.

Density:

The density of the materials is calculated by dividing the weight per unit area of a sample in grams per square meter (gsm) by the material caliper in millimeters (mm) at 0.05 psi (3.5 g/cm^2) and multiplying the result by 0.001 to convert the value to grams per cubic centimeter (g/cc). A total of three samples would be evaluated and averaged for the density values.

Preparation of menses simulant:

The artificial menses fluid used in the testing was made according to US Patent 5,883,231 from blood and egg white by separating the blood into plasma and red cells and separating the white into thick and thin portions, where "thick" means it has a viscosity after homogenization above about 20 centipoise at 150 sec^{-1}, combining the thick egg white with the plasma and thoroughly mixing, and finally adding the red cells and again thoroughly mixing. A more detailed procedure follows:

Blood, in this Example defibrinated swine blood, is separated by centrifuging at 3000 rpm for 30 minutes, though other methods or speeds and times may be used if effective. The plasma is separated and stored separately, the buffy coat removed and discarded and the packed red blood cells stored separately as well. It should be noted that the blood must be treated in some manner so that it may be processed without coagulating. Various methods are known to those skilled in the art, such as defibrinating the blood to remove the clotting fibrous materials, the addition or anti-coagulant chemicals

and others. The blood must be non-coagulating in order to be useful and any method that accomplishes this without damaging the plasma and red cells is acceptable.

Jumbo chicken eggs are separated, the yolk and chalazae discarded and the egg white retained. The egg white is separated into thick and thin portions by straining the white through a 1000-micron nylon mesh for about 3 minutes, and the thinner portion discarded. The thick portion of egg white, which is retained on the mesh, is collected and drawn into a 60 cc syringe, which is then placed on a programmable syringe pump and homogenized by expelling and refilling the contents five times. The amount of homogenization is controlled by the syringe pump rate of about 100 ml/min, and the tubing inside diameter of about 0.12 inches. After homogenizing the thick egg white has a viscosity of about 20 centipoise at 150 sec^{-1} and is then placed in the centrifuge and spun to remove debris and air bubbles at about 3000 rpm for about 10 minutes

After centrifuging, the thick, homogenized egg white, which contains ovamucin, is added to a 300 cc FENWAL® Transfer pack container using a syringe. Then 60 cc of the swine plasma is added to the FENWAL® Transfer pack container. The FENWAL® Transfer pack container is clamped, all air bubbles removed, and placed in a Stomacher lab blender where it is blended at normal (or medium) speed for about 2 minutes. The FENWAL® transfer pack container is then removed from the blender, 60 cc of swine red blood cells are added, and the contents mixed by hand kneading for about 2 minutes or until the contents appeared homogenous. A hematocrit of the final mixture should show a red blood cell content of about 30 weight percent and generally should be at least within a range of 28-32 weight percent for artificial menses made according to this Example. The amount of egg white is about 40 weight percent.

The ingredients and equipment used in the preparation of artificial menses are readily available. Below is a listing of sources for the items used, though of course other sources may be used providing they are approximately equivalent.

Blood (swine): Cocalico Biologicals, Inc., 449 Stevens Rd., Reamstown, PA 17567, (717) 336-1990.

FENWAL® Transfer pack container, 300 ml, with coupler, code 4R2014: Baxter HealthCare Corporation, Fenwal Division, Deerfield, IL 60015.

Harvard Apparatus Programmable Syringe Pump model no. 55-4143: Harvard Apparatus, South Natick, MA 01760.

Stomacher 400 laboratory blender models no. BA 7021, serial no. 31968: Seward Medical, London, England, UK.

1000 micron mesh, item no. CMN-1000-B: Small Parts, Inc., PO Box 4650, Miami Lakes, FL 33014-0650, 1-800-220-4242.

Hemata Stat-II device to measure hemocrits, serial no. 1194Z03127: Separation Technology, Inc., 1096 Rainer Drive, Altamont Springs, FL 32714.

Rate Block Intake Test

This test is used to determine the intake time of a known quantity of fluid into a material and/or material system. The test apparatus consists of a clear, preferably acrylic, rate block 10 as shown in Figure 4. The rate block 10 is 3 inches (76.2 mm) wide and 2.87 inches (72.9 mm) deep (into the page) and has an overall height of 1.125 inches (28.6 mm) which includes a center area 19 on the bottom of the rate block 10 that projects farther from the main body of the rate block 10 and has a height of 0.125 inches (3.2 mm) and a width of 0.886 inches (22.5 mm). The rate block 10 has a capillary 12 with an inside diameter of 0.186 inches (4.7 mm) that extends diagonally downward from one side 15 to the center line 16 at an angle of 21.8 degrees from the horizontal. The capillary 12 may be made by drilling the appropriately sized hole from the side 15 of the rate block 10 at the proper angle beginning at a point 0.726 inches (18.4 mm) above the bottom of the rate block 10; provided, however, that the starting point of the drill hole in the side 15 must be subsequently plugged so that test fluid will not escape there. The top hole 17 has a

diameter of 0.312 inches (7.9 mm), and a depth of 0.625 inches (15.9 mm) so that it intersects the capillary 12. The top hole 17 is perpendicular to the top of the rate block 10 and is centered 0.28 inches (7.1 mm) from the side 15. The top hole 17 is the aperture into which the funnel 11 is placed. The center hole 18 is for the purpose of viewing the progression of the test fluid and is actually of an oval shape into the plane of Figure 4. The center hole 18 is centered width-wise on the rate block 10 and has a bottom hole width of 0.315 inches (8 mm) and length of 1.50 inches (38.1 mm) from center to center of 0.315 inch (8 mm) diameter semi-circles making up the ends of the oval. The oval enlarges in size above 0.44 inches (11.2 mm) from the bottom of the rate block 10, for ease of viewing, to a width of 0.395 inches (10 mm) and a length of 1.930 inches (49 mm). Drilling may also make the top hole 17 and center hole 18.

A 10.2 cm by 10.2 cm (4" x 4") piece of absorbent 14 and cover 13 are die cut. The specific covers are described in the specific examples. The absorbent used for these studies was standard and consisted of 250 g/m^2 airlaid made of 90% CR-0054 (US Alliance Pulp Mills, Coosa, Alabama) and 10% KoSa T-255 binder unless otherwise specified. The total density for this system was 0.14 g/cc. The cover 13 was placed over the absorbent 14 and the rate block 10 was placed on top of the two materials. 2 mL of a menses simulant was delivered into the test apparatus funnel 11 and a timer started. The fluid moved from the funnel 11 into a channel 12 where it was delivered to the material or material system. The timer was stopped when all the fluid was absorbed into the material or material system as observed from the chamber in the test apparatus. The intake time for a known quantity of known fluid was recorded for a given material or material system. This value is a measure of a material or material systems absorbency. Typically, five to ten repetitions were performed, and average intake time was determined.

Rewet Test

This test is used to determine the amount of fluid that will come back to the

surface when a load is applied. The amount of fluid that comes back through the surface is called the "rewet" value. The more fluid that comes to the surface, the larger the "rewet" value. Lower rewet values are associated with a drier material and, thus, a drier product. In considering rewet, three properties are important: (1) intake rate, since if the material/system does not have a good intake rate then fluid can rewet, (2) ability of absorbent to hold fluid (the more the absorbent holds onto the fluid, the less is available for rewet), and (3) flowback, the more the cover prohibits fluid from coming back through the cover, the lower the rewet.

Cover systems were evaluated in which the absorbent was maintained constant, removing the variable (2) from consideration. This left for consideration only variables (1) and (3), intake and flowback, respectively.

A 10.2 cm by 10.2 cm (4" x 4") piece of absorbent and cover was die cut. The absorbent used for these studies was standard and consisted of a 250 gsm airlaid made of 90% CR-0054 (US Alliance Pulp Mills, Coosa, Alabama) and 10% KoSa T-255 binder. The total density for this system was 0.14 g/cc unless otherwise specified. The cover was placed over the absorbent and the rate block was placed on top of the two materials. Two mL of menses simulant are delivered to the rate block apparatus and are allowed to absorb into a 4" x 4" sample of the cover material which is placed on top of a 4" x 4" absorbent piece. The fluid is allowed to interact with the system for one minute with rate block resting on top of the materials. The material system cover and absorbent are placed onto a bag filled with fluid. A piece of blotter paper is weighed and placed on top of the material system. The bag is traversed vertically until it comes into contact with an acrylic plate above it, thus pressing the whole material system against the plate blotter paper side first. The system is pressed against the acrylic plate until a total pressure of 1 psi is applied. The pressure is held fixed for three minutes, after which the pressure is removed and the blotter paper is weighed. The blotter paper retains any fluid that was transferred

to it from the cover/absorbent system. The difference in weight between the original blotter and the blotter after the experiment is known as the "rewet" value. Typically, five to ten repetitions of this test were performed, and average rewet was determined.

Triple Intake Test Procedure:

The objective of this test is to determine differences between materials and/ or materials, composites or systems of material composites in the intake rate when 3 sudden fluid insults (gushes) are applied, with time allowed for fluid to distribute in the material(s) between insults. The materials to be tested are prepared in the same manner as for the Rate Block Intake test described above. Two 2 mL of menses simulant is delivered to the materials via the rate block. The rate block is removed after 9 minutes and each layer is weighed and the weight recorded. This step is repeated for a total of 3 insults, after which a re-wet test as described above is performed and its value is recorded. The fluid loading in each component is calculated as weight after insult subtracted from the weight before insult. The insult time is a direct measurement of time for absorption. Smaller values of intake time refer to a more absorbent sample with larger values of intake time refer to a less absorbent sample. Three samples should be evaluated for each material

Fluid Distribution Test:

This test is designed to measure the fluid distribution in the various layers that make up a personal care product, particularly a feminine hygiene product. Each layer of material in the sample to be tested should be weighed and the weight recorded before testing. The materials to be tested are placed flat and an hourglass shaped plate is placed on the material. The plate is preferably acrylic and is 21.5 cm in length, 8.7 cm in width, weighs 230 grams and has a 3 mm wide hole in its center. The plate is loaded with an additional 800 grams of weight distributed as uniformly as possible over its surface. Once the samples are ready for testing, 7 ml of menses simulant is delivered to the

sample through the hole at a uniform rate over a one hour period. One method of providing the simulant to the sample is with a Harvard Apparatus Model 55-4143 pump and plastic tubing, though comparable methods known to those skilled in the art may be used. After the hour, the plate is removed and the layers weighed. The difference in weight of the dry and wet layers is the amount of simulant absorbed in each layer. A percentage of fluid retained in each layer may then be calculated. Three samples should be evaluated for each material

DETAILED DESCRIPTION OF THE INVENTION

In one, the invention is a composite for use in a feminine hygiene pad wherein the cover and intake/distribution layers of the composite are co-apertured. The layers are a cover, an intake/distribution layer, an optional surge layer, an optional transfer delay layer and an absorbent core. The fabrics used in the practice of this invention may be made by a variety of processes including airlaying, spunbonding, meltblowing, carding, coform and foaming processes, though airlaying for the intake/distribution layer and spunbonding for the transfer delay layer are preferred. The various layers may be made from synthetic polymer and natural fibers. Particularly preferred because of cost are polyolefins like polyethylene and polypropylene.

Figure 5 shows one embodiment of the invention. In Figure 5, the outercover 5 is the outermost part of the product. The absorbent core 4 is positioned near the outercover 5. Adjacent the absorbent core 4 is an optional transfer delay layer 3. The cover 1 and intake/distribution layer 2 are co-apertured as indicated by cones 6.

Figure 6 shows another embodiment of the invention, similar to Figure 5, wherein another layer(s) 7 has been interposed between the cover 1 and intake/distribution 2 layers. This additional layer 7 may be, for example, a surge layer.

It is important that a cover rapidly draw insults into the product and have a soft surface. A number of materials provide such intake properties. These include films, nonwovens and film/nonwoven laminates, nonwoven/nonwoven laminates, conjugate fiber spunbond fabrics, creped spunbond fabrics, airlaid fabrics, bonded carded webs, spunlace fabrics, embossed nonwoven fabrics, etc. A number of cover materials that may be unsuitable initially may be made acceptable through the use of topical chemical treatments and mechanical processing. Any material which, when combined with an absorbent core, permits rapid intake, low staining, low rewet and low fluid retention under all flow conditions would be suitable for use in the practice of this invention. These materials could also comprise different additives to improve softness or to deliver a skin wellness benefit.

The intake/distribution layer may be made from a variety of fibers and mixtures of fibers including synthetic fibers and natural fibers including mechanically and chemically softened pulp, staple fibers, slivers, meltblown and spunbond fibers, superabsorbents and the like. The fibers in such a web may be made from the same or varying diameter fibers and may be of different shapes such as pentalobal, trilobal, elliptical, round, etc. The intake/distribution layer may be made by a number of methods, including airlaying, hydroentangling, bonding and carding, and coforming, though airlaying is preferred. The intake/distribution layer may have a density between about 0.06 and 0.19 g/cc and a basis weight of between about 100 and 300 gsm.

The optional surge layer serves to absorb large sudden flows of liquid. Surge control materials, are provided to quickly accept the incoming insult and either absorb, hold, channel or otherwise manage the liquid so that it does not leak outside the article. Surge control is typically provided by a fluff pulp in an absorbent product or by a high permeability nonwoven layer, like spunbond fabric or bonded carded webs.

The optional transfer delay layer may also be made from a variety of fibers in a variety of shapes and sizes and may alternatively be a film. The transfer delay layer may be made according to a number of processes such as spunbonding, carding, meltblowing and film forming, though spunbonding is preferred. The purpose of the transfer delay layer is to slow the passing of fluid from the intake/distribution layer to the absorbent layer which are adjacent the transfer delay layer on either side.

The absorbent core or retention layer materials may be made from materials or substances known in the art to absorb liquid as well as any others that may be developed for that purpose. Examples include fast and slow superabsorbents, pulps, and mixtures thereof. Mixtures of superabsorbents and pulp used as retention materials may be used in ratios of between about 100/0 and 0/100 by weight, more particularly between about 80/20 and 20/80. The absorbent cores suitable for use in this invention typically have a density between about 0.05 and 0.20 g/cc and a basis weight between 150 and 500 gsm. There may be more than one layer comprising the absorbent core. Absorbent cores also usually have some type of binder to hold the components together. Typical binders include conjugate fibers, adhesive powders which may be heat activated, and liquid binders.

Synthetic fibers include those made from polyamides, polyesters, rayon, acrylics, superabsorbents, LYOCELL® regenerated cellulose and any other suitable synthetic fibers known to those skilled in the art. Synthetic fibers may also include kosmotropes for product degradation.

Many polyolefins are available for fiber production, for example polyethylenes such as Dow Chemical's ASPUN® 6811A linear low-density polyethylene, 2553 LLDPE and 25355 and 12350 high-density polyethylene are such suitable polymers. The polyethylenes have melt flow rates, respectively, of about 26, 40, 25 and 12. Fiber forming polypropylenes

include Exxon Chemical Company's ESCORENE® PD 3445 polypropylene and Montell Chemical Co.'s PF-304. Many other polyolefins are commercially available.

Natural fibers include wool, cotton, flax, hemp and wood pulp. Wood pulps include standard softwood fluffing grade such as CR-1654 (US Alliance Pulp Mills, Coosa, Alabama). Pulp may be modified in order to enhance the inherent characteristics of the fibers and their processability. Curl may be imparted to the fibers by methods including chemical treatment or mechanical twisting. Curl is typically imparted before crosslinking or stiffening. Pulps may be stiffened by the use of crosslinking agents such as formaldehyde or its derivatives, glutaraldehyde, epichlorohydrin, methylolated compounds such as urea or urea derivatives, dialdehydes such as maleic anhydride, non-methylolated urea derivatives, citric acid or other polycarboxylic acids. Some of these agents are less preferable than others due to environmental and health concerns. Pulp may also be stiffened by the use of heat or caustic treatments such as mercerization. Examples of these types of fibers include NHB416 which is a chemically crosslinked southern softwood pulp fibers which enhances wet modulus, available from the Weyerhaeuser Corporation of Tacoma, WA. Other useful pulps are debonded pulp (NF405) and non-debonded pulp (NB416) also from Weyerhaeuser. HPZ3 from Buckeye Technologies, Inc of Memphis, TN, has a chemical treatment that sets in a curl and twist, in addition to imparting added dry and wet stiffness and resilience to the fiber. Another suitable pulp is Buckeye HP2 pulp and still another is IP Supersoft from International Paper Corporation. Suitable rayon fibers are 1.5 denier Merge 18453 fibers from Acordis Cellulose Fibers Incorporated of Axis, Alabama.

Superabsorbents that are useful in the present inventions can be chosen from classes based on chemical structure as well as physical form. These include superabsorbents with low gel strength, high gel strength, surface cross-linked superabsorbents, uniformly cross-linked superabsorbents, or superabsorbents with varied

cross-link density throughout the structure. Superabsorbents may be based on chemistries that include but are not limited to acrylic acid, iso-butylene/maleic anhydride, polyethylene oxide, carboxy-methyl cellulose, poly vinyl pyrrollidone, and poly vinyl alcohol. The superabsorbents may range in rate from slow to fast. The superabsorbents may be in the form of foams, macroporous or microporous particles or fibers, may have fuzzy or fibrous coatings or morphology. The superabsorbents may be in the shape of ribbons, particles, fibers, sheets or films. Superabsorbents may be in various length and diameter sizes and distributions. The superabsorbents may be in various degrees of neutralization. Neutralization occurs through use of counter ions such as Li, Na, K, Ca.

Materials of this invention may include superabsorbents of the types mentioned above. An Example of these types of superabsorbents may be obtained from the Stockhausen Company (of Greensboro, NC) and is designated as FAVOR® 880. Examples of these types of superabsorbents obtained from Camelot Technologies Ltd. (of Alberta, Canada) are designated as FIBERDRI® 1241 and FIBERDRI® 1161. Examples of these types of superabsorbents obtained from Technical Absorbents, Ltd. (of Grimsby, UK) are designated as OASIS® 101 and OASIS® 111. Another Example included in these types of superabsorbents is obtained from Chemdall International (of Arlington Heights, Ill) and is designated FLOSROB® 60 LADY®. Still another Example included in these types of superabsorbents is obtained from Sumitomo Seika of Japan and is designated as SA60N Type 2.

Binders typically used in these structures help provide mechanical integrity and stabilization. Binders include fibers, liquids or other binder means which may thermally activated. Preferred fibers for inclusion are those having a relative melting point such as polyolefin fibers. Lower melting point polymers provide the ability to bond the fabric together at fiber crossover points upon the application of heat. In addition, fibers having a lower melting polymer, like conjugate and biconstituent fibers are suitable for practice of

this invention. Fibers having a lower melting polymer are generally referred to as "fusible fibers". By "lower melting polymers" what is meant are those having a glass transition temperature less than about 175 C. It should be noted that the texture of the absorbent web could be modified from soft to stiff through selection of the glass transition temperature of the polymer. Exemplary binder fibers include conjugate fibers of polyolefins, polyamides and polyesters. Three suitable binder fibers are sheath core conjugate fibers available from KoSa Inc. (Charlotte, North Carolina) under the designation T-255 and T-256 or Copolyester designation, though many suitable binder fibers are known to those skilled in the art, and are available by many manufacturers such as Chisso and Fibervisions LLC of Wilmington, DE. KoSa has developed a suitable co-polyester binder fiber as a sheath core application and is known by designation T254 (low melt CoPET). A suitable liquid binder is KYMENE® 557LX available from Fibervisions LLC. Other suitable liquid binders include ethylene vinyl acetate emulsion polymers sold by National Starch and Chemical Company (Bridgewater, New Jersey) under the tradename Dur-O-Set® ELITE® series (including ELITE® 33 and ELITE® 22). Air Products Polymers and Chemicals sells other suitable binder fibers under the name AIRFLEX®.

Once produced, the web must be adequately stabilized and consolidated in order to retain its shape. The inclusion of a sufficient amount of fusible fibers and subsequent thermal bonding is the preferred method for obtaining adequate stabilization. It's believed that this method allows adequate bonding in the center of a thick material as well as on the surface.

As mentioned above, at least the cover and intake/distribution layers of this system are co-apertured, thus creating a structure that allows rapid intake of fluid and its absorption on the designed absorbent layers. Other layers may optionally be co-apertured to each other or co-apertured with the cover and intake/distribution layers, or

not apertured at all. Co-aperturing the cover with the absorbent system improves the material permeability, thereby reducing fluid intake rate. Making pores through all the layers also creates the necessary passageways for the fluid in order for it to be absorbed in the preferred layers under high or gush flow conditions. This provides balance for fluid absorption in the X-Y and Z directions where the Y-direction is the direction from to back of a product, the Z-direction is perpendicular to the Z-direction and is into the product, and the X direction is perpendicular to both the Y and Z directions. Co-aperturing the layer simultaneously also provides a greater degree of structural integrity to the system.

The shape of the various layers is not considered critical to the success of the invention. It should be noted, however, that the airlaid intake/distribution and absorbent core or retention layers may also incorporate a reduced dimension rectangular strip geometry which prevents fluid from wicking to the pad edges when used, for example, in feminine hygiene products. The retention layer shape may be the same as or different from that of the other layers and any may have a rectangular, hourglass, racetrack or other shape. In addition, embossing may be added to the retention and/or other layers to enhance the integrity of the layer. Co-aperturing may be done in the center of the product only, to enhance the functionality of the product at the target area and to provide a visual cue to the user of the product's remaining life. Alternatively, the product could be co-apertured over its entire dimension or in other localized areas.

The cover may be treated with a surfactant to improve its wettability. This surfactant can be placed across the whole pad, in particular areas or zones or mixed internally into the fibers. For this last embodiment, if the material is pin apertured with hot pins, sufficient heat may be applied so that the surfactant "blooms" or moves toward the outer surface of the fiber, creating wettability regions surrounding the apertures and thereby improving the intake characteristics of the material. Examples of chemicals that could be used on this material could include but not limited to those marketed under the

tradenames AHCOVEL® (from ICI Surfactants, Wilmington, Delaware), GLUCOPON® (from the Henkel Corporation, Chemical's Group, Cincinnati, Ohio), PLURONICS® (from BASF of Germany), TRITON® X-102 (from the Union Carbide Corporation, Danbury, Connecticut), and MASIL SF-19® (from PPG Industries, Inc., Gurnee, Illinois.) or a combination of them.

The optional fluid transfer delay layer in accordance with this invention is designed to enhance distribution in the x-y plane by delaying the transfer of fluid from the intake/distribution layer to the retention layer. A transfer delay layer allows fluid transfer to the retention layer when high pressures, high flow rates or saturation levels occur. This controlled transfer mechanism results in an elongated stain pattern in the retention layer, helps prevent over-saturation in the insult area and may provide a visual signal for the wearer indicating reduced product life remaining.

A transfer delay layer provides a permeability and wettability gradient between the intake/distribution layer and the underlying retention layer by preventing intimate contact between the two layers. A transfer delay layer should therefore have relatively low permeability and wettability so it will promote lateral fluid distribution within the intake/distribution layer under continuous flow conditions and so control fluid movement in the Z-direction. Under gush flow conditions, however, the apertures in the transfer delay layer allow fluid to immediately pass through to the underlying retention layer. The wettability of a transfer delay layer may be modified by topical chemical treatments as described above for the cover layer.

Another embodiment of this invention may include the co-aperturing of multiple layers that could make up the absorbent core, thereby allowing fluid to be moved and absorbed to the preferred product layers and improving fluid absorption. This increases the absorbent material utilization efficiency and creates a different absorption pattern.

The following examples were produced and tested in order to determine the amount of improvement provided by examples of systems according to the invention.

Example 1:

The layers described below were cut into 4" by 4" pieces and placed on top of each other in the order in which they are described, without the use of adhesive.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with fibers of 3.5 dpf. Treated with 0.3 volume percent AHCOVEL® surfactant topically applied.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm and 0.10 g/cc.

Example 2:

The layers described below were cut into 4" by 4" pieces and placed on top of each other in the order in which they are described, without the use of adhesive.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with fibers of 3.5 dpf. Treated with 0.5 volume percent AHCOVEL® surfactant topically applied.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm and 0.10 g/cc.

Example 3:

The layers described below were cut into 4" by 4" pieces and placed on top of each other in the order in which they are described, without the use of adhesive. The cover layer and intake/distribution layer only were co-apertured using a pin aperturing process using a pin roller and another (female) roller, resulting in an aperture open area of 14 percent having 8 holes /cm^2. The temperatures used were 280° F (138° C) on the pin roll and 170° F (77° C) on the female roll at a speed of 40 feet/minute.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with fibers of 3.5 dpf. Treated with 0.3 volume percent AHCOVEL® surfactant topically applied.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm and 0.10 g/cc.

Example 4:

The layers described below were cut into 4" by 4" pieces and placed on top of each other in the order in which they are described, without the use of adhesive. The cover layer and intake/distribution layer only were co-apertured using a pin aperturing process using a pin roller and another (female) roller, resulting in an aperture open area of 14 percent having 8 holes /cm^2. The temperatures used were 280° F (138° C) on the pin roll and 170° F (77° C) on the female roll at a speed of 40 feet/minute.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with fibers of 3.5 dpf. Treated with 0.5 volume percent AHCOVEL® surfactant topically applied.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm and 0.10 g/cc.

Table 1

Example	Intake Time (Seconds)	Re-Wet (Grams)
1	103	0.11
2	75	0.13
3	50.5	0.12
4	33.5	0.23

As seen in Table 1 above, increasing the surfactant content on the nonwoven decreases the intake time of the absorption system. Furthermore, co-aperturing the layer reduces intake time even more. Having the combination of high surfactant levels and layers co-apertured enhances this effect.

Example 5:

These Absorbent prototypes were assembled with cover adhesive with an add-on level of 2-3 gsm forming a Kotex® Ultrathin Maxi product with Safety Zone® as currently sold in the US market.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric, 3.5 dpf. Treated with 0.3 volume percent AHCOVEL® surfactant topically applied. The cover layer was 8 cm x 24.2 cm.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc. This layer was 10.2 cm by 19 cm.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant. This layer was 5 cm by 20.5 cm.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm and 0.10 g/cc. This layer was 6.4 cm wide by 21.5 cm long.

Example 6:

These Absorbent prototypes were assembled with cover adhesive with an add-on level of 2-3 gsm forming a Kotex® Ultrathin Maxi product with Safety Zone® as currently sold in the US market. The cover layer and intake/distribution layer only were co-apertured using a pin aperturing process using a pin roller and another (female) roller, resulting in an aperture open area of 14 percent having 8 holes /cm^2. The temperatures used were 280° F (138° C) on the pin roll and 170° F (77° C) on the female roll at a speed of 40 feet/minute.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric, 3.5 dpf. Treated with 0.5 volume percent AHCOVEL® surfactant topically applied. The cover layer was 8 cm x 24.2 cm.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc. This layer was 10.2 cm by 19 cm.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant. This layer was 5 cm by 20.5 cm.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm and 0.10 g/cc. This layer was 6.4 cm by 21.5 cm .

The product backing was a polyethylene film layer of 0.6 mils used as a fluid containment device. This layer is attached to the absorbent layer using 20 gsm of a hotmelt adhesive. The backing layer was 8 cm wide x 24.2 cm long.

Example 7:

These Absorbent prototypes were assembled with cover adhesive with an add-on level of 2-3 gsm forming a KOTEX® MAXI® product with SAFETY ZONE® as currently sold in the US market by the Kimberly-Clark Corporation.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric, 3.5 dpf. Treated with 0.3 volume percent AHCOVEL® surfactant topically applied. The cover had a width of 8 cm in the target area and 9 cm on the lobes with a length of 22.0 cm.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc. This layer was 9.4 cm cm by 15.6 cm.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant. This layer was 4.8 cm wide with a length of 20.0 cm