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[54] **BREATHABLE, LIQUID INPERVIOUS BACKSHEET FOR ABSORPTIVE DEVICES**

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[52] **U.S. Cl.** **128/287;** 161/112

[51] **Int. Cl.** **A41b 13/02**

[58] **Field of Search** 128/287, 286, 284, 156; 161/112, 113, 410, 250

[56] **References Cited**

UNITED STATES PATENTS

2,119,610	6/1938	Tasker	128/284
3,039,459	6/1962	Scholl	128/156 X
3,156,242	11/1964	Crowe, Jr.	128/156
3,438,371	4/1969	Fischer	128/156
3,439,678	4/1969	Thomas	128/284
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[57] **ABSTRACT**

A backing for a disposable diaper being a combination of two layers. The first layer is a low void volume perforated thermoplastic film. The second layer is a porous high void volume hydrophobic tissue which is adjacent the first layer.

20 Claims, 3 Drawing Figures

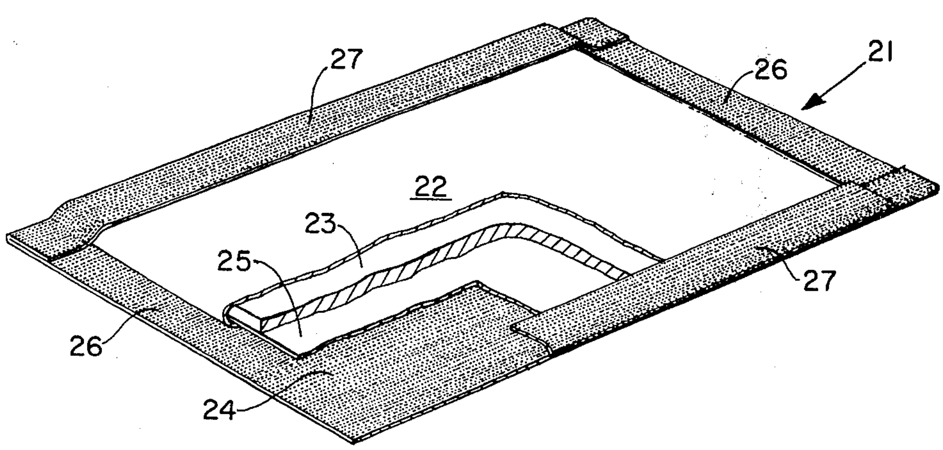


Fig. 1

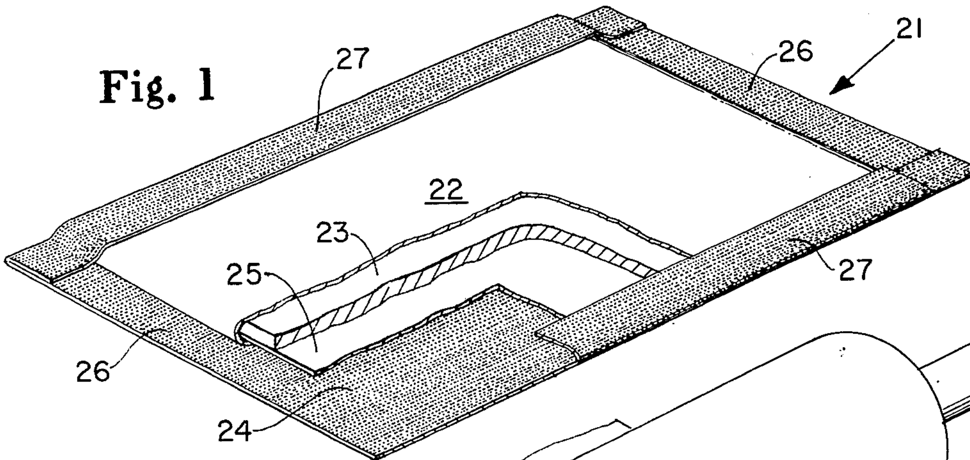
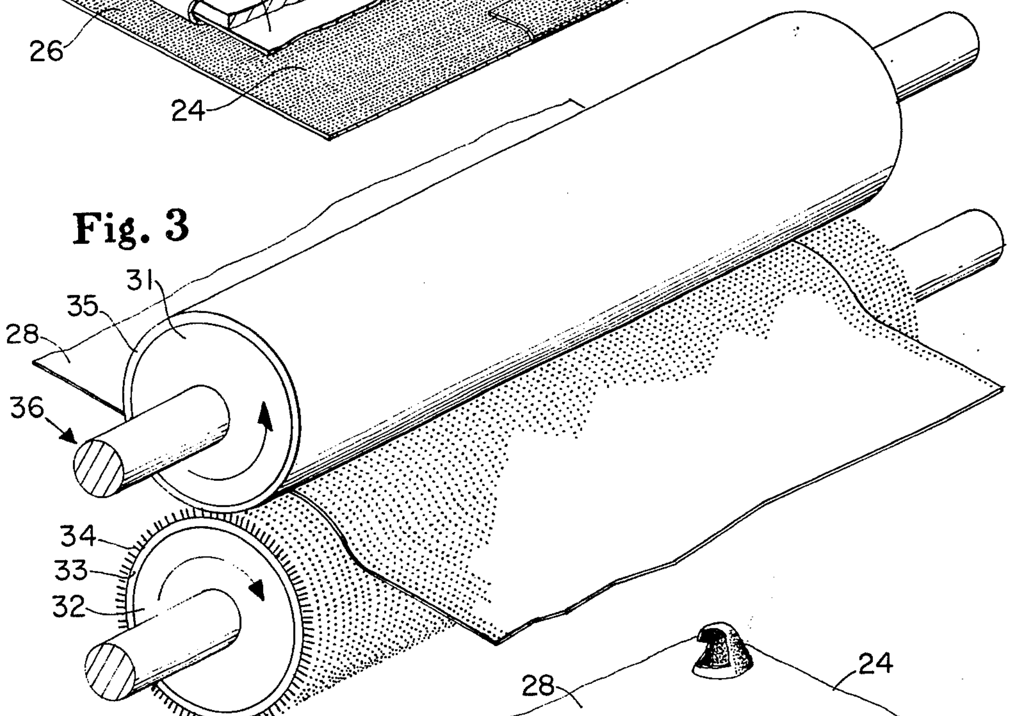


Fig. 3



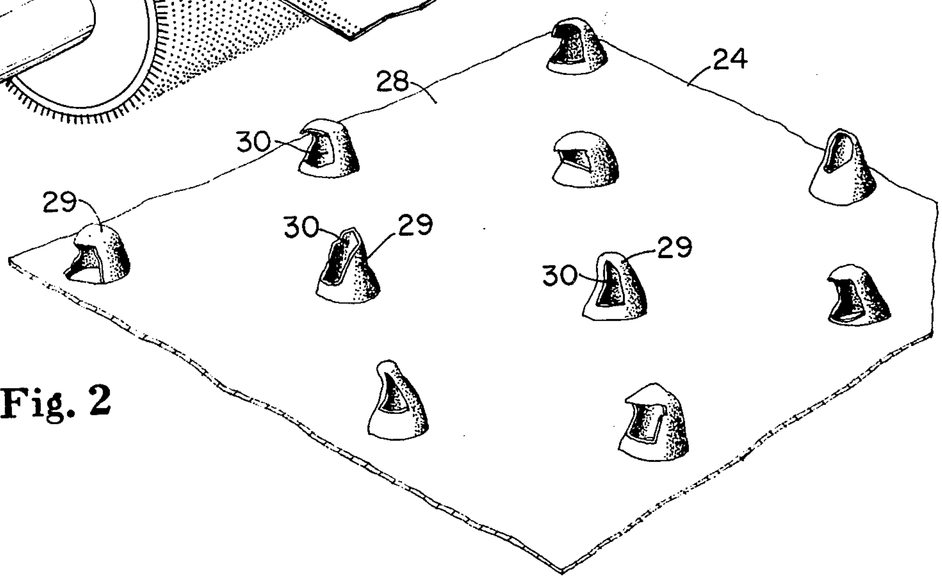


Fig. 2

BREATHABLE, LIQUID INPERVIOUS BACKSHEET FOR ABSORPTIVE DEVICES

FIELD OF THE INVENTION

This invention relates generally to absorptive devices such as disposable diapers, sanitary napkins, disposable bedpads, and incontinent pads; and in particular, relates to a backing for such devices which prevents the passage of liquids while permitting the passage of gasses.

DESCRIPTION OF THE PRIOR ART

Absorptive devices, such as diapers, are well-known. These devices are used to absorb liquid from the human body and retain that liquid. It is also known to cover the exterior of these devices with a flexible, plastic sheet to prevent the liquid absorbed from striking through the absorbtive device and soiling other adjacent clothing, such as bedding and wearing apparel. The waterproof, plastic sheet of the prior art does prevent strikethrough and helps contain the liquid within the absorptive device, but it also makes the absorptive device feel hot and uncomfortable to wear and can create a rash or irritation. In addition, it precludes a self-drying of the absorptive device which can occur through evaporation of the liquid held therein. The breathable backing as herein described is of particular advantage when it is desirable to shield the liquid in the absorbent body thereof from adjacent clothing in that it provides a cooler garment and permits drying of the absorbent body while it is being worn.

Teaching of permeable backings for absorptive devices are present in the prior art. In general, the purpose disclosed in this prior art is to provide communication between the interior and exterior of the absorptive device, thus allowing circulation. U.S. Pat. No. 2,570,011, issued to Stamberger on Oct. 2, 1951, approaches the problem of providing a breathable backing for absorptive devices by teaching a diaper having both absorbent and retarding sections. The retarding section is a chemically treated portion of a paper or cloth diaper and is folded toward the outside thereof. This retarding section is treated to prevent penetration of urine.

U.S. Pat. No. 3,156,242, issued to Crowe, Jr. on Nov. 10, 1964, teaches an absorbent device having an absorbent body covered by a nonabsorbent, flexible film. The film is air pervious so as to permit drying of the absorbent body held thereunder. The air perviousness of the film is achieved by using a microporous film or a film having holes or slits therein.

U.S. Pat. No. 2,119,610, issued to Tasker on June 7, 1938, teaches a combination of a pad holder and a removable disposable absorbent pad. The holder is a sheet of rubber or Jap silk which is perforated and the pad comprises a perforated base portion of inexpensive moistureproof material such as cellophane. The base portion of the pad is adjacent the holder.

U.S. Pat. No. 3,439,678, issued to Thomas on Apr. 22, 1969, teaches baby panties which are suitable for being worn over diapers made from a plied fabric having high water resistance. The fabric comprises at least two layers, each formed from a woven fabric which is resistant to standing water and is air and vapor permeable.

Additional prior art patents relating to porous thermoplastic webs are: U.S. Pat. No. 2,027,810, issued to Cooper on Jan. 14, 1936; U.S. Pat. No. 3,292,619, issued to Egler on Dec. 20, 1966; U.S. Pat. No. 3,426,754, issued to Birenbaum et al. on Feb. 11, 1969; and U.S. Pat. No. 3,446,208, issued to Fukuda on May 27, 1969.

OBJECTS OF THE INVENTION

It is one object of the present invention to provide a backing for an absorbent body which is substantially gas pervious and liquid impervious.

It is another object of this invention to provide a backing for an absorbent body which remains substantially liquid impervious even when the absorbent pad is subjected to pressure.

It is a further object of this invention to provide a backing which is the combination of two relatively highly porous layers.

It is an additional object of this invention to provide a liquid impervious, gas pervious backing for an absorbent body which is economical and easy to manufacture.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided for a disposable absorptive device having an absorptive body and a backsheet, an improved breathable liquid impervious backsheet. This improved backsheet comprises the combination of two adjacent hydrophobic layers to form an effective breathing portion of the improved backsheet, the first layer being liquid permeable and having a low void volume, the second layer being liquid permeable and having a high void volume, whereby combination of the two layers prevents the passage of liquid while permitting the passage of gases therethrough.

BRIEF DESCRIPTION OF THE DRAWING

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as forming the present invention, it is believed that the invention will be better understood from the following description taken in connection with the accompanying drawing in which the thickness of some of the materials are exaggerated for clarity and in which:

FIG. **1** is a perspective view of a disposable diaper of this invention in an unfolded condition and having various layers cut away;

FIG. **2** is a perspective view of an enlargement of an area of the backsheet shown in FIG. **1**; and

FIG. **3** is a perspective view of one form of apparatus for perforating a moistureproof web.

While the invention will be described in connection with a preferred embodiment, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawing and in particular to FIG. **1** thereof, a disposable diaper **21** incorporating the present invention is shown. The diaper **21** is fabricated from the usual multiple plies of various materials. A preferred construction of the diaper illustrated in FIG. **1** includes a topsheet **22**, an absorbent core **23**, and a backing which comprises a first layer **24** and a second layer **25**.

The absorbent core **23** is superposed over the backing and the topsheet **22** is superposed over the absorbent core **23**. The topsheet **22** may be longer in a longitudinal dimension than the absorbent core **23** so that it can be folded around and under the longitudinal ends of the absorbent core as is shown in FIG. **1**. Also the combination of the absorbent core **23** and the topsheet **22** are generally attached to the backsheet, which in FIG. **1** is the first layer **24**, adjacent to and parallel to their lateral edges and/or longitudinal ends. Of course, it is also well-known to attach them over substantially their entire interface.

The topsheet **22** may be any of the well-known topsheets, for example, the topsheet described in U.S. Pat. reissue No. 26,151, issued to Duncan et al. on Jan. 31, 1967, this patent being incorporated herein by reference. That particular topsheet is a hydrophobic nonwoven rayon web bonded with a thermoplastic binder.

The absorbent core **23** likewise may be formed from any of the materials well-known in the art for providing good moisture absorbent characteristics. Several examples of such an absorbent core are described in the above cited Duncan et al patent, for example, multiple layers of creped tissue, wadding, cellulose fluff, air-felt materials, absorptive natural sponges, synthetic foamed absorptive materials. The backing of this invention comprises a first layer **24** and a second layer **25**. In this embodiment the first layer **24** is a perforated polyethylene web, which is hydrophobic, and the second layer **25** is a hydrophobic porous creped tissue. Each of these layers is pervious to liquids by itself but when placed together so one is superposed on the other, they cooperate to form a liquid impervious backing. Although FIG. **1** shows first layer **24** exterior to second layer **25**, if so desired, the second layer **25** can be placed exterior to first layer **24**.

The first layer **24** is generally a flexible web of a liquid impervious material which has been perforated to make it liquid pervious. Although polyethylene is used in this embodiment, it is not intended that the first layer be limited to a polyethylene material. In the preferred embodiment, the first layer **24** is a 1.8 mil (46 micrometers (μm)) thick web of polyethylene film, available from Edison Plastic Inc., Metuchen, N.J. made from Alathon 3120 resin supplied by E. I. Du pont de Nemours and Co., which web is perforated as infra. A micrometer is 10^{-6} meters.

The first layer **24** has a low void volume, described infra. The perforated void volume of the first layer is the same as the percent open area in the layer due to perforation of the layer if based on projected perforation diameter, described infra. The perforated open area of the first layer is from about 0.01 to about 5.0 percent of the nominal surface of the unperforated web, more preferably 0.01 to 2.0 percent, and most preferably 0.01 to 1.0 percent. The average projected diameter of the perforations preferably is from about 10 to 300μm, more preferably 10 to 200μm, and most preferably 10 to 100μm.

The second layer **25** of this embodiment is a creped tissue layer, i.e., a fibrous web, having a high void volume and which has been made hydrophobic by impregnating it with a paraffin wax described more completely infra. The porosity of the second layer **24** is high even after the paraffin wax impregnation.

In the diaper illustrated in FIG. **1**, the first layer **24** has lineaments greater than those of the absorbent core **23** to provide longitudinal end margins **26** and lateral edge margins **27** thereof. The lateral edge margins **27** can then be folded around and onto the top of the absorbent core **23** provide what can be termed "side flaps". These side flaps may or may not be attached to a topsheet such as **22**. Also, before applying a diaper **21** to an infant, the longitudinal end margins **26** may also be folded around and onto the top of the absorbent core **23**. This folding over of the end and edge margins can be advantageous in that it places the absorbent core **23** in a basin formed by the first layer **24**.

The edge and end margins **27** and **26** of first layer **24** can be perforated as shown in FIG. **1** or if desired left unperforated. Although FIG. **1** shows essentially the entire first layer **24** perforated, less than the total area of the backing for the absorptive device can be established as the "effective breathing portion" of the backing. The effective breathing portion would be that portion where first layer **24** and second layer **25** are combined to prevent the passage of liquid and permit the passage of gases therethrough. The effective breathing portion of the embodiment shown in FIG. **1** is the entire back surface of the diaper because the two layers are combined over that entire area. If the second layer covered the entire back of the diaper, but only a two inch circular portion in the geometric center of first layer **24** were perforated as herein described, the effective breathing portion would be limited to the two inch circular perforated portion which, in that embodiment, would be the only portion of the first layer **24** working in combination with the second layer.

A diaper **21** can be attached to an infant by any of the fastening means well-known to those of ordinary skill in the art. One fastening means, so well-known for attaching diapers that it needs no more than mere mention, is diaper pins.

Another means presently finding great acceptance in the commercial market is pressure sensitive tape fasteners, one embodiment of which is disclosed in the above cited Duncan et al. patent. These diaper fastening means are not shown in the drawing.

Referring now to FIG. **2**, a fragmentary enlargement of first layer **24** is shown to depict typical bosses and perforations formed in the above mentioned polyethylene web. The polyethylene web **28** has bosses **29** formed therein and perforations **30** formed in the bosses **29**.

Web **28**, being the above mentioned Edison web, was perforated and bosses raised in it by running it through the nip **36** of two rolls, see FIG. **3**. Two solid steel rolls, back-up roll **31** and perforating roll **32**, were mounted in frames and bearings, not shown, so that they would form a nip on which pressure could be applied and controlled by suitable air cylinders and a pressure control valve well-known to those of ordinary skill in the art. The perforating roll **32** was spiral wound with card cloth **33** produced by Howard Bros. Mfg. Co., Auburn, Mass. The card cloth **33** was formed by gluing four plies of woven cotton canvas with a rubber base adhesive to form a belt 0.125 inch thick and 1-9/16 inches wide. Into this belt straight staples were inserted vertical to the plane of the belt in a uniform rectilinear pattern. The staple ends extended 0.125 inch beyond the cloth face to provide straight standing pins **34** having a round cross section. The total thickness of card cloth was 0.250 inch. The pin density was 530/inch^2 (82/cm^2). The pins were 0.009 inch (228μm) in diameter and made from tempered carbon steel with a tensile modulus of 260,000 – 290,000 psi.

The perforating roll 32 wound with card cloth 33 was exactly 3 inches in diameter; had a face length greater than 19 inches, and was driven in the direction indicated in FIG. 3.

The back-up roll 31 was encased in a tubular felt sleeve 35 of needled felt manufactured by Rontex America Inc., Lowell, Massachusetts. The fibers in sleeve 35 were a mixture of a minor portion of polyester and a major portion of high tenacity nylon staple fibers in the ranges of 1.5 to 6.0 denier weight and 1 to 2 inches in length. The radial thickness of the sleeve 35 was 0.250 inch, the inside diameter of sleeve 35 was 3 inches and the weight of felt sleeve was 87 grams/ft.^{2} of interior surface. Thus, the back-up roll 31 with sleeve 35 was 3.5 inches in diameter. This back-up roll 31 was not driven.

The web 28 of the above described polyethylene film being about 22000 in.^{2}lb. weight, was pressed through nip 36 having a nip pressure of about 91 pounds per lineal inch and was perforated effectively at about 220 feet per minute.

The height of bosses 29 formed in the above mentioned web by the above process range from about 50 to 150μm above the surface of the web 28. The preferred height is about 150μm, which is about three times the unperforated web thickness, thereby providing an unloaded thickness for the first layer 24 of about four times the unperforated web thickness.

The perforations 30 have a theoretical diameter of about 228μm which is the size of the pins in the card cloth. Diameter as used herein is intended to mean an average of the chords passing through the center of the perforation. The projected diameter of the perforations, i.e., the diameter of the perforations 30 as projected to the plane of the web 28, is less than the 228μm because the perforations 30 are generally in the side of the bosses 29, thus at an angle to the plane of the web, and the perforation diameter retracts due to the film elasticity as the card cloth pins 34 are removed from the perforation.

The perforated Edison film had the following properties. A description of the methods for these measurements is given infra.

Caliper, perforated	0.004 in.
Permeability, air flow	3.9 cc/sec/cm^2 at 10 cm water Δ P
Elmendorf Tear Strength (values given are for 4 plies)	MD-36 CD-46
Ball Impact	15.5 inches
Average Projected perforation diameter	55μm
% bosses punctured	8

Continued

Elasticity, % permanent strain after 30% elongation	MD-3.3 CD-4.5
% permanent strain after 55% elongation	MD-10.5 CD-15.0
Tensile Stress at 30% elongation	MD-740 gr.inch width CD-530
at 55% elongation	MD-880 CD-570
at rupture	MD-1105 CD-640
Open Area (projected)	0.014%

In the first layer 24, the permanent strain after an elongation of 30% should preferably be 15% or less and the air flow permeability should preferably be in the range of about 0.5 to 10 cubic centimeters per second per square centimeter at a pressure differential of 10 centimeters of water.

In this embodiment, the second layer 25 was a creped, wet strength, white tissue made hydrophobic by treating the surface of the fibers therein with paraffin wax. The wax treated tissue remained highly porous.

The tissue was made from bleached chemical wood pulp, that is, 30% bleached sulfite pulp manufactured from aspen species and 70% bleached Kraft from northern spruce and pine species refined, then treated with a wet strength resin such as Parez 631NC (American Cyanamide Company) ½% – 1% resin solids on the weight of dry fiber, and formed into rolls of white creped tissue on a Yankee type Fourdrinier paper machine by means common to the industry. The percent crepe defined by (Yankee speed - roll winding speed) ÷ Yankee speed was 14%.

The above tissue was then submitted to a dry waxing process which is an old and widely practiced process and was performed by The Crystal Tissue Company Middletown, Ohio. In this process food grade paraffin wax, having a melt point of about 140°F. is carried against one face of the rapidly moving tissue web (web speed about 940 feet per minute) by a relatively slow turning heated applicator roll (roll speed about 5% of web speed) partially immersed in a molten bath of the paraffin wax. The molten wax is wiped from the surface of the applicator roll onto the tissue. The wax is caused to wick along the surface of the fibers until all of them are coated by carrying the wax coated web in contact with the surface of additional heated rolls and then winding the web into a roll while still above the melt point of the wax. This dry waxing process coats the surface of the fibers within the tissue with wax, but the quantity of wax applied is restricted so that only the smallest interstices between the fibers are occluded and only a relatively small reduction in rate of air flow through the tissue web takes place.

A tissue thus formed and used as second layer 25 had the following physical properties before and after formation. A description of methods for these measurements is given infra.

	Basis Weight (lbs./3000 ft.^{2})	Thickness* (in.)	Dry Tensile Strength (grams/inch width)		Wet Tensile Strength (grams inch width)		Air Flow at ½" H_2O ΔP (CFM/ft.^{2})
			MD	MD	MD	CD	
unwaxed	12.4	0.005	657	242	—	75	101
waxed	15.4	0.005	720	247	188	80	90

*Measured at 80 gms./inch^2 pressure
MD - Machine Direction
CD - Cross Direction

The above wax treated tissue had an apparent void volume of 88%. The calculation used to determine the void volume is disclosed infra. The void volume of the second layer **25** should be at least 60 percent. The high void volume layer used should preferably have an air flow permeability of at least 10 cubic feet per minute per square foot at a pressure differential of 0.5 inch of water.

An alternate process has been used for wax treating such a tissue to render it hydrophobic. That process comprised preparing a solution of paraffin wax in chlorethene solvent so that the solution had about 5% paraffin wax by volume. The tissue was then passed through the paraffin solution and thoroughly wetted thereby. The wetted tissue was then dried by allowing the solvent to evaporate.

The second layer **25** can also be formed by treating the bottom surface of a high void volume absorbent body with a hydrophobic material, such as mentioned herein, so that the bottom layer of the absorbent pad is rendered hydrophobic to a depth of at least several fibers.

Test pads of this invention were made up in accordance with the following examples to determine the liquid imperviousness and the gas perviousness of the backing. All test pads had the same approximate size, that is, square and about 10 cm. by 10 cm. and were multi-layered. The first four layers of each test pad were identical and were, in sequence, as follows. The first layer, analagous to topsheet **22** of the drawing, was a Kendall Webline 6211 nonwoven fabric having a basis weight of 23.9 gms./sq. meter and being available from the Kendall Corporation. Layer two was a creped wet strength bleached Kraft tissue having a basis weight of 19.9 gms./sq. meter. Layer three was a cellulose fluff, or airfelt as it is sometimes called, made from bleached softwood Kraft. The third layer had a basis weight of 168 gms./sq. meter. The fourth layer was a creped bleached Kraft tissue having a basis weight of 19.9 gms./sq. meter. Layers **2, 3** and **4** are analagous to absorbent core **23** of the drawing. Only the backing was varied among the test pads and is described in the examples.

The test pads were wetted with a "test liquid" which simulated urine, i.e., the test liquid was a 1% aqueous NaCl solution reduced to a surface tension of **45** dynes/cm. with Triton X-100 surfactant available from Rohm and Haas Company, Philadelphia, Pennsylvania. Each test pad was wetted with the test liquid to a level of about 5 gms. of liquid per gm. of absorbent body, i.e., per gm. of the combined weight of layers **2, 3** and **4** (hereinafter referred to as "wetted to 5X").

The liquid imperviousness of the backing was determined in a "wet-through" test, described infra. The gas imperviousness of the backing was determined through an "evaporation" test, described infra.

Wet-through test — Two plies of Whatman No. 4 filter paper (available from W. and R. Balston Ltd., England) were weighed to obtain a dry weight of the filter paper. The backing of the wetted test pad was placed against a filter paper. The wetted pad was subjected to the pressure of either 35.2 or 70.4 gms./sq. cm. through a 5 cm. diameter (19.7 sq. cm. in area) pressure foot centered on the pad and applied on the pad surface opposite the backing. The pressure was maintained for 15 minutes. After 15 minutes, the filter paper was again weighed to determine its wetted weight. The amount of liquid picked up by the filter paper was then determined by subtracting the dry weight of the filter paper from the wetted weight of the filter paper. The amount of liquid passed through the backing was then divided by the pressurized area, i.e., 19.7 sq. cm., to obtain the gms. of liquid/sq. cm. passed through the backing under pressure as a measure of the liquid perviousness of the backing.

Evaporation test — The test pads were wetted to about 5X and "covered" with a sheet of nonperforated polyethylene film. That film covered the test pad in that it was placed over the topsheet and wrapped slightly around the edges of the test pad. The wrapped around edges were attached to the backing with commercially available polyester tape. The exposed, i.e., noncovered, backing area was substantially square and about 9 cm. × 9 cm. The covered, wetted test pad was then weighed to acquire an initial pad weight. Then the test pad was placed on a lab bench with the backing facing upwardly to expose the uncovered backing to ambient room conditions which were about 72° to 75°F. and 60% relative humidity. The test pad was left in this state for about 3 hours and then reweighed to get a final pad weight. The weight loss through evaporation was determined by subtracting the final pad weight from the initial pad weight. This evaporative loss was reduced to an evaporation rate by dividing the weight loss by the time exposed and by the exposed area of the backing. This factor was then reduced to give an evaporation rate in gms./1000 sq. cm./hr.

EXAMPLES I – IV

Test pads were made by combining the first four layers as above described with only a single layer of the above-described perforated polyethylene web as the backing. The polyethylene web was placed next to layer **4** with the bosses **29** toward the interior of the pad. The test pads were wetted with test liquid to about 5X. The wet-through and evaporation tests were run on the test pads and the results are given in Table 1 below.

EXAMPLES V – VIII

Test pads were made by combining the first four layers as above described with a single layer of the above-described paraffin wax treated tissue as the backing. The wax treated tissue was placed next to layer **4.** The test pads were wetted with test liquid to about 5X. The wet-through and evaporation tests were run on the test pads and the results are given in Table 1 below.

EXAMPLES IX – XII

Test pads were formed by combining the first four layers as above described with a backing which was a combination of one layer of the above-described paraffin wax treated tissue and one layer of the above-described perforated polyethylene film. The wax treated tissue was adjacent layer **4,** thus being analagous to second layer **25** of the drawing. The perforated polyethylene film was adjacent the wax treated tissue, thus being analagous to exterior layer **24** of the drawing, and the bosses were pointed toward the tissue. The test pads were wetted with test liquid to about 5X. The wet-through and evaporation tests were run on the test pads and the results are given in Table 1 below.

EXAMPLE XIII

A test pad was made combining the first four layers as above described with no backing next to layer **4**. The test pad was wetted with test liquid to about 5X. The evaporation test was run on the test pad and the result is given in Table 1 below.

EXAMPLES XIV – XV

Test pads similar to those of Examples IX – XII were made except the wax treated tissue was replaced by a high void volume silica treated tissue. The silica treated tissue was a creped tissue as above described, dipped in a 10% volume chlorothene suspension of silicone coated fumed silica (Silanox 101, Cabot Corporation, Boston, Massachusetts) to obtain a pick-up of 0.45 gms./ft.^{2} (0.05 gm./on 4 × 4 inch tissue) dry solids. The test pads were wetted with test liquid to about 6X. Wet-through and evaporation tests were run on the test pads and the results are given in Table 1 below.

EXAMPLES XVI – XVII

Test pads similar to those of Examples IX – XIV were made except the wax treated tissue was replaced by a high void volume nonwoven fabric. This fabric was a sheet of melt blown polypropylene nonwoven fabric supplied by the Beloit Corporation, Beloit, Wisconsin and was used as a ply of material adjacent to a card cloth perforated polyethylene film. The fabric exhibits a contact angle to water of 100°, has a thickness at 50 gm./in.^{2} gage load of 0.013 inches, has an air porosity of 105 cfm./ft.^{2} at 0.5 inch $H_2O\Delta P$, and has a basis weight of 30 gm./m.^{2} to give a void volume of 88.9%. The test pads were wetted with test liquid to about 6X. Wet-through and evaporation tests were run on the test pads and the results are given in Table 1 below.

EXAMPLES XVIII – XIX

Test pads similar to those of Examples IX – XII were made except that the conically embossed perforated film was replaced by a polyethylene film perforated by the Poruolation process of the Allied Synthetics Corporation, St. Louis, Missouri, wherein the pores are produced by a means which leaves the pore essentially cylindrical with a slightly raised rim. This film had a measured thickness of 1.8 mils (46μm), a weight of 29,000 m^2 per pound, a pore frequency of 309in^2 and a pore diameter of 178μm. The test pads were wetted with test liquid to about 6X. Wet-through and evaporation tests were run on the test pads and the results are given in Table 1 below.

EXAMPLES XX – XXI

Test pads similar to those of Examples I –IV were made except that the conically embossed perforated film was replaced by the perforated polyethylene film described in Examples XVIII – XIX. The test pads were wetted with test liquid to about 6X. Wet-through and evaporation tests were run on the test pads and the results are given in Table 1 below.

From the results in Table 1, it can be seen that the perforated polyethylene film by itself was not liquid impervious, that the wax treated tissue by itself was not liquid impervious, but that the combination of the perforated polyethylene film and the wax treated tissue was substantially liquid impervious. It is also seen that the combination of perforated polyethylene and wax treated tissue is gas permeable. Therefore, the combination functions as a liquid impervious, gas permeable backing.

The data also shows (Examples XIV – XVII) that hydrophobic high void volume layers other than the wax treated tissue function effectively in the backing to provide a liquid impervious, gas permeable backing.

It will be apparent to those of ordinary skill in the art that other high void volume, porous materials that are normally hydrophilic may be rendered hydrophobic by the use of a wide variety of coating agents coming from chemical classes such as fatty acids and their salts, vegetable waxes, silicones, fluororganic resins and olefin resins, and can be used as the high void volume layer of this invention.

Porous hydrophilic materials with relatively high void volumes are exemplified by natural and artificial open cell foams and sponges, textiles both nonwoven and woven, as well as a wide variety of paper products. Such materials may be formed directly from open cell foams or fiber assemblies derived typically from innately hydrophobic polymers such as the fluororganic and olefin resins aforementioned.

Although olefin films, particularly those of polyethylene, are preferred for reasons of availability and cost for the perforated web of this invention, many other materials including the polymers of vinyl chloride, polyvinylidene chloride, propylene and butylene could be employed. Further, these films may be formed in layers from more than one resin or coated with hydrophobic coatings made from such materials as are listed for the high void volume structures to achieve the most effective combinations of strength and repellency after perforation.

TABLE 1

Example	Backing	Wet Through (grams of liquid in 15 minutes) Pressure Exerted (g./cm.^{2}) 35.2	70.4	Evaporation Rates (g./1000 cm.^{2}/hr.)
I	perforated PE* web	0.97	—	—
II		—	0.70	—
III		—	—	6.3
IV		—	—	5.1
V	waxed tissue	0.44	—	—
VI		—	1.37	—
VII		—	—	12.3
VIII		—	—	12.5

TABLE 1 – Continued

Example	Backing	Wet Through (grams of liquid in 15 minutes) Pressure Exerted (g./cm.^{2}) 35.2	70.4	Evaporation Rates (g./1000 cm.^{2}/hr.)
IX	waxed tissue and perforated PE web	0.03	—	—
X		—	0.02	—
XI		—	—	5.6
XII		—	—	5.1
XIII	none	—	—	16.6
XIV	silica treated tissue and perforated PE*	—	0.00	—
XV		—	—	5.26
XVI	nonwoven and perforated PE	—	0.03	—
XVII		—	—	3.2
XVIII	cylindrically perforated PE and waxed tissue	—	0.07	—
XIX		—	—	4.5
XX	cylindrically perforated PE	—	3.37	—
XXI		—	—	4.8

*PE = polethylene

Certain other measurements have been made and referred to herein and are described below.

Boss Height Measurement — The boss height of perforations was measured optically by means of a microscope equipped with a vernier lens elevator screw graduated in microns. The plane of the upper surface of the film at the base of the boss was brought into sharp focus; the vernier reading was recorded; the vernier screw was then rotated to bring the tip of the boss into focus; and the vernier again read. The difference in vernier readings was the height of the boss in microns.

Elmendorf Tear Strength — Tappi Method T414M-49.

Ball Impact — Similar to ASTM D1709, except that in place of the dart, a three-fourths inch diameter steel ball weighing 28.16 grams was used. The film clamping ring was 3 inches in diameter. The force adjustment was made by adjusting the height from which the ball dropped. The height at which 50% of the drops caused an open split in the film was reported.

Elasticity — A strain gage type tensile tester acceptable to ASTM Standard D-882-67 was used. The tensile tester used was a Model TM manufactured by the Instron Company, Canton, Massachusetts. The sample used had a width of 1 inch and a length of 2 inches. The cross head speed of the Instron machine was 20 inches/min. for both extension and return. The sample was elongated to either 30% or 55% and then returned to zero load. The % permanent strain after return to zero load was recorded.

Projected Diameter of Perforations — A sample of the perforated web was placed under a microscope having an eyepiece with a calibrated grid therein. The size of the perforations were measured therefrom.

Air Flow Permeability-Perforated Film — A sample holder having a 1-13/32 inch diameter hole (10 square centimeters in area) therein and having an air tight chamber attached beneath was used. An air source was connected to the chamber and was regulated by an air regulator (Fairchild Hiller - Kendall, Range 0–10 psig, Model 10). An air flow meter (Brooks, Setting 0–150, air flow 0–6500 cc/min.) was installed between the regulator and the chamber. A water manometer was also connected to the chamber and vented to atmosphere to measure the pressure differential between the chamber and the atmosphere.

A sample about 1.75 inch wide was cut from the perforated web and placed within the sample holder over the hole therein with the bosses oriented away from the chamber. The air source was turned on and regulated to a pressure drop (ΔP) across the sample as read on the manometer. The air flow through the flow meter was recorded and converted to volume of air/time period/exposed area of sample.

Air Flow Permeability of Tissue — ASTM D-737-69 (cfm./ft.^{2} at 0.5 inch $H_2O\Delta P$).

VOID VOLUME OF TISSUE - SAMPLE CALCULATION

Tissue Weight unwaxed - **12.4** lbs./**3000** ft.^{2}

Waxed Tissue Weight - **15.4** lbs./**3000** ft.^{2} Thickness (caliper) - 0.005 inch at 80 gm./in.^{2} measuring pressure. Gross Volume of 3000 ft.^{2} of tissue at 80 gm./in.^{2}

$$= \text{area} \times \text{thickness}$$

$$= 3000 \times \frac{0.005}{12} = 1.250 \text{ ft.}^3$$

$$\text{Cellulose Volume} = \frac{\text{cellulose weight}}{\text{cellulose density from literature}}$$

$$= \frac{12.4 \text{ lb.}}{1.54 \text{ gm./cc.}} \div 62.4 = .1290 \text{ ft.}^3$$

$$\text{Wax Volume} = \frac{\text{wax weight}}{\text{wax density from literature}}$$

$$= \frac{(15.4-12.4=3.0)\text{lb.}}{0.8 \text{ g./cc.}} \div 62.4 = 0.0601 \text{ ft.}^3$$

Total solid volume = cellulose volume + wax volume = 0.1891 ft.^{3}

$$\% \text{ void volume} = [(\text{gross volume} - \text{solid volume}) \div \text{gross volume}]100$$
$$= [(1.25 - 0.189) \div 1.25] \times 100$$
$$= \frac{1.061}{1.25} \times 100 = 85\%$$

Void Volume of Perforated Polyethylene Film - Sample Calculation: A polyethylene film has a density calculated from its weight and optically measured thickness closely approaching the density measured by classical liquid displacement means. It has, for the purposes of this invention, essentially all of the properties of a zero void volume solid.

Such a film, if perforated with a card cloth having 530 wires/in.^{2} — each wire being 0.009 inches in diameter — in a manner such that it was possible to create (punch out) perfect holes, would have an increase in void volume due to perforations which is proportional to the cross section area of the holes.

Perforation void volume = area of holes ÷ surface area

$$= \frac{530 \times \pi \times \frac{(0.009)^2}{4}}{1}$$

$$= 0.0337 \text{ in.}^2 \div 1 \text{ in.}^2$$

$$= 3.37\% \text{ void volume}$$

Due to the elastic nature of the film, the film contracts after perforation thereby reducing the diameter of the perforation. Therefore, the perforation void volume is less than indicated by this calculation, and a perforated polyethylene film as described above has a low void volume.

Thus, it is apparent that there has been provided, in accordance with this invention, an improved breathable, liquid impervious backsheet that fully satisfies the objects, aims, and advantages set forth above. While the invention has been described in conjunction with the specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications, and variations as fall within the spirit and broad scope of the appended claims.

What is claimed is:

1. In a disposable absorbtive device having an absorbent body and a backsheet, an improved breathable, liquid impervious backsheet, comprising: the combination of two adjacent hydrophobic layers to form an effective breathing portion of the improved backsheet; the first layer being liquid permeable under pressure and having a low void volume; the second layer being liquid permeable and having a high void volume, whereby the combination of the two layers prevents the passage of liquid while permitting the passage of vapors and gasses.

2. The improved backsheet claimed in claim **1** wherein the first layer is a liquid impervious film having perforations therein, whereby the first layer is made liquid permeable under pressure.

3. The improved backsheet claimed in claim **2** wherein the average projected diameter of the perforations is in the range of from about 10 to about 300 micrometers and the open area of the first layer in the effective breathing portion is from about 0.01 to about 5.0 percent of the nominal area of the first layer coextensive with the effective breathing portion.

4. The improved backsheet claimed in claim **2** wherein the average projected diameter of the perforations is in the range of from about 10 to about 200 micrometers and the open area of the first layer in the effective breathing portion is from about 0.01 to about 2.0 percent of the nominal area of the first layer coextensive with the effective breathing portion.

5. The improved backsheet claimed in claim **2** wherein the average projected diameter of the perforations is in the range of from about 10 to about 100 micrometers and the open area of the first layer in the effective breathing portion is from about 0.01 to about 1.0 percent of the nominal area of the first layer coextensive with the effective breathing portion.

6. The improved backsheet claimed in claim **2** wherein the first layer has a permanent strain of 15% or less after an elongation of 30%.

7. The improved backsheet claimed in claim **6** wherein the average projected diameter of the perforations is in the range of from about 10 to about 100 micrometers and the open area of the first layer in the effective breathing portion is from about 0.01 to about 1.0 percent of the nominal area of the first layer coextensive with the effective breathing portion.

8. In a disposable absorptive device having an absorbent body and a backsheet, an improved breathable, liquid impervious backsheet, comprising: the combination of two adjacent hydrophobic layers to form an effective breathing portion of the improved backsheet; the first layer being liquid permeable and having a low void volume; the second layer being liquid permeable and having a high void volume; whereby the combination of the two layers prevents the passage of liquid while permitting the passage of vapors and gases; wherein said first layer is a liquid impervious film which has a permanent strain of 15% or less after an elongation of 30% and which has a plurality of bosses therein, said bosses being provided with perforations, whereby said first layer is made liquid permeable under pressure, and wherein the projected diameter of said perforations is in the range of from about 10 to about 100 micrometers and the open area of said first layer in said effective breathing portion is from about 0.01 to about 1.0 percent of the nominal area of said first layer coextensive with said effective breathing portion.

9. The improved backsheet claimed in claim **8** wherein the average height of the bosses is at least 50 micrometers.

10. The improved backsheet claimed in claim **8** wherein the bosses are oriented toward the absorbent body.

11. The improved backsheet claimed in claim **8** wherein the second layer is intermediate the first layer and the absorbent body.

12. The improved backsheet claimed in claim **11** wherein the bosses are oriented toward the absorbent body.

13. The improved backsheet claimed in claim **1** wherein the air permeability of the second layer is at least 10 cfm./sq. ft. at a pressure differential of 0.5 inches water.

14. The improved backsheet claimed in claim **1** wherein the void volume of second layer is at least 60 percent.

15. The improved backsheet claimed in claim **14** wherein the second layer comprises a fibrous web.

16. The improved backsheet claimed in claim **15** wherein the second layer comprises a creped tissue and a hydrophobic material, the surfaces of the fibers comprising the tissue being coated with the hydrophobic material.

17. The improved backsheet claimed in claim 14 wherein the second layer is foam-like having a series of interconnecting channels therethrough.

18. The improved backsheet claimed in claim 17 wherein the second layer is a flexible, open-celled, polymeric, foam material.

19. The improved backsheet claimed in claim 1 wherein the second layer is intermediate the first layer and the absorbent body.

20. In a disposable absorptive device having an absorbent body and a backsheet, an improved breathable, liquid impervious backsheet, comprising: a combination of a first and a second layer to form an effective breathing portion of the improved backsheet, the second layer being interposed between the first layer and the absorbent body; the first layer comprising:

A. a liquid-impervious, hydrophobic, polymeric film, the film having a permanent strain of 15% or less after an elongation of 30%;

B. a plurality of bosses in the film; the height of the bosses being at least 50 micrometers;

C. a plurality of perforations in the film, the perforations being located within the bosses, the average projected diameter of the perforations being from about 10 to about 100 micrometers, the perforations being substantially uniformly distributed in the portion of the first layer coextensive with the effective breathing portion such that the open area of that portion of the first layer is from about 0.01 to about 1.0 percent of the effective breathing portion;

the second layer comprising:

a fibrous web and a hydrophobic material, the surfaces of the fibers comprising the web being coated with the hydrophobic material, the coated web having a void volume of at least 60 percent, and the hydrophobic fibrous structure having an air permeability of at least 10 cfm./sq. ft. at a pressure differential of 0.5 inch of water;

whereby the passage of liquid through the effective breathing portion is substantially prevented and the transmission of vapors and gasses therethrough can occur.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,881,489

DATED : May 6, 1975

INVENTOR(S) : Edward Wallace Hartwell

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 22, "22000 in.^{2}lb." should read -- 22000 in.^{2}/lb. --.

Column 5, line 22, "pressed" should be -- passed --.

Column 6, line 8, "MD-740 gr.inch width" should read -- MD-740 gr./inch width --.

Column 6, line 66, "MD MD MD CD" should be -- MD CD MD CD --.

Column 7, line 55, "imperviousness" should be -- perviousness --.

Signed and Sealed this

Twenty-first **Day of** December 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks