Jan. 13, 1970 R. C. DUNCAN ET AL 3,489,148

TOPSHEET FOR DISPOSABLE DIAPERS

Filed Dec. 20, 1966 2 Sheets-Sheet 1

Fig. 1

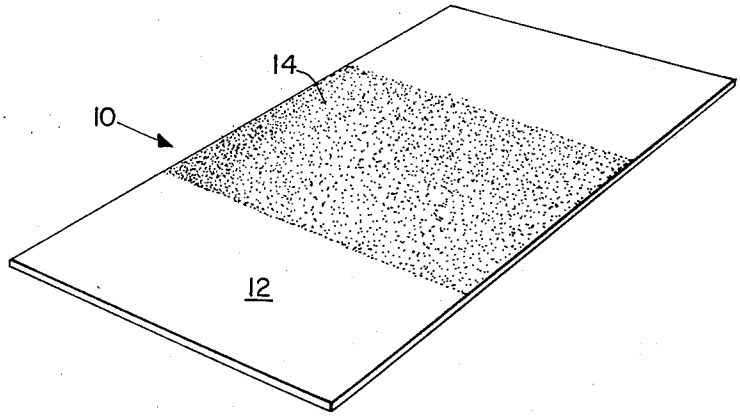



Fig. 1a

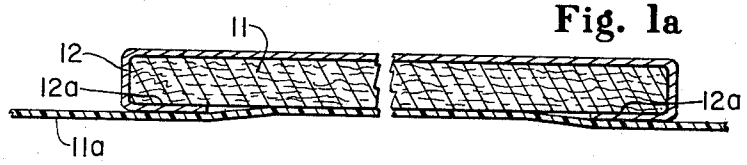
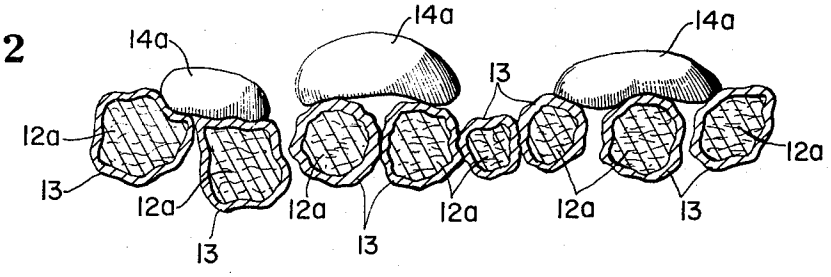



Fig. 2

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TOPSHEET FOR DISPOSABLE DIAPERS

Filed Dec. 20, 1966 2 Sheets-Sheet 2

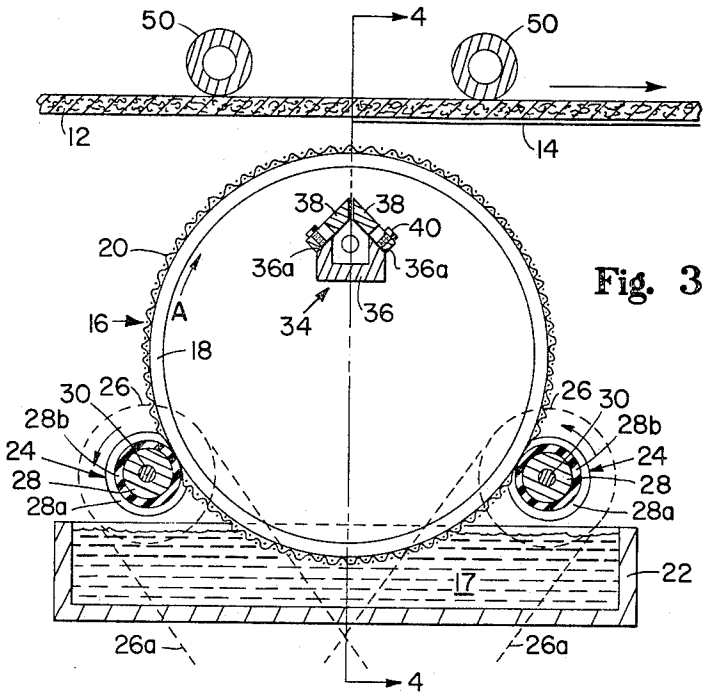


Fig. 3

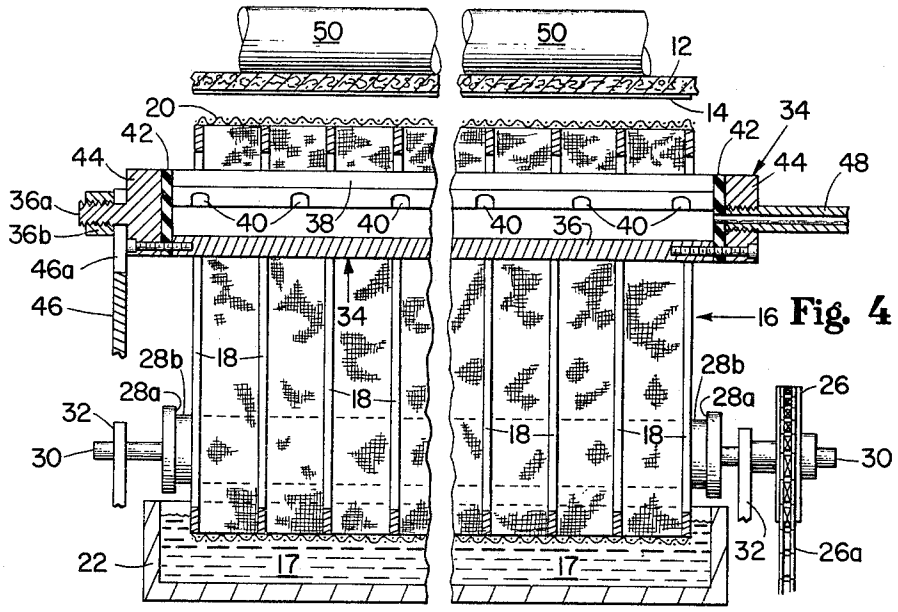


Fig. 4

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3,489,148

# TOPSHEET FOR DISPOSABLE DIAPERS

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Int. Cl. A61f 13/18
U.S. Cl. 128—284 14 Claims

## ABSTRACT OF THE DISCLOSURE

A diaper having an oleophobic-hydrophobic topsheet, the outer face of which is coated with a film of discrete droplets of an oleaginous moisture barrier material suitable for application to an infant's skin.

This invention relates to a topsheet for diapers and more particularly to a disposable diaper topsheet which is treated to alleviate diaper rash on infants. A topsheet is the portion of the disposable diaper which covers the upper face of an absorbent diapering pad and contacts the infant in use.

One of the principal contributing causes of diaper-derived skin rash in maceration of the skin, generaly at the base of the trunk, due to prolonged contact with waste fluids. In order to minimize the effect of prolonged liquid contact with the skin, diapers and diaper liners have been produced with the body-contacting side or member thereof made in part of completely of hydrophobic fibers such as Verel, polyolefin or the like. The described construction is porous and permits the fluid to pass readily therethrough into an underlying absorptive backing and to partition itself preferentially in the hydrophilic substrate, leaving the hydrophobic topsheet or diaper liner relatively dry. This approach is generally disclosed in U.S. Patents Nos. 2,905,176; 3,063,452; 3,113,570; and 3,180,335. While a hydrophobic topsheet will function in the manner intended to an extent dependent upon its thickness (and thus the volume of free space therein under stress) it has been found that in-use stresses exerted on diapers frequently forces fluid out of the absorptive substrate and through the open pores of the hydrophobic topsheet or diaper liner to thereby rewet the skin. The frequency of this rewetting increases as the absorptive capacity of the locally wetted sector of the absorptive substrate is approached. When this absorptive capacity is exceeded the surface of the topsheet or diaper liner remains "flooded" until wicking of moisture from the wetter toward the drier sectors of the absorptive substrate redistributes the moisture concentration or until the compressive stress upon the absorptive substrate is relieved. The result of continued compression and decompression is thus to repeatedly rewet the skin's surface which, unless evaporation is rapid, becomes waterlogged, hydrated and macerated. As a result of the hydration of the stratum corneum, the irritation reaction of the skin even to materials as normally inert as olive oil is markedly increased.

When diaper rash manifests itself on the skin of an infant, parents will frequently apply a protective barrier (for example, baby lotions, mineral oil or the like) thereto so as to prevent further maceration and therefore allow the affected skin area to heal. This procedure usually involves the mother's pouring of the oil or lotion, for example, in one of her hands, rubbing both hands together to distribute the substance thereon and then wiping the same on the skin of the infant. The procedure is wasteful, messy, easily forgotten and, in general, troublesome and aesthetically demanding for the parents.

Discontinuous surface films of a protective barrier material were therefore applied to the topsheet of disposable diapers to eliminate the need for separately applying the protective barrier by the parent at the time of diaper change. In this manner an oily film could be transferred to the infant's skin by contact with skin in its driest condition and thereby maintain a moisture barrier to help prevent the start of the rash rather than acting only after the rash appears. However, it was found that this approach was not effective on diapers which did not have a hydrophobic topsheet. Moreover, while it was found that disposable diapers having hydrophobic topsheets functioned quite well with a freshly applied barrier film on its hydrophobic topsheet, upon aging to the extent that the product would age during the normal range of shelf life expected, the only discernible effect on the film was of a deleterious nature—reduction in the in-use capacity of the diaper. It is believed that the barrier material migrated through the topsheet and into the absorptive pad thereunder, reducing the rate at which the pads' absorbent substrate can absorb the fluid, decreasing its ability to wick moisture from the wet center to the drier extremities of the diaper, and reducing the partitioning effect by which the topsheet is kept relatively dry between reflooding, and thereby actually increases the possibility of infants getting a skin rash due to increased fluid contact.

It is an object of the present invention to obviate the above problems.

Another object of the present invention is to provide a disposable diaper which has a topsheet treated in such a manner as to reduce the possibility of an infant developing diaper rash due to contact with waste fluid and/or fecal matter.

A further object of the present invention is the provision of a diaper topsheet which is adapted to be interposed between the absorptive portion of the diaper and the infant and which has a film thereon of a protective barrier material which will not migrate to the absorptive portion and which is adapted to be transferred to the skin of the infant when the diaper is applied whereby to insulate the infant from prolonged contact with body wastes which promote diaper rash.

Briefly stated, in accordance with one aspect of the present invention there is provided a diaper comprising an absorptive pad and a thin diaper topsheet comprising fibrous material. The surfaces of the fibers in at least the central portion of the topsheet are both hydrophobic and oleophobic. One face of the topsheet has at least in the central portion thereof a discontinuous film of an oleaginous moisture barrier material suitable for application to the skin of an infant.

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:

FIGURE 1 is a fragmentary perspective view illustrating a preferred embodiment of a disposable diaper topsheet of the present invention;

FIGURE 1*a* is a fragmentary cross-sectional view of a disposable diaper employing the topsheet of FIGURE 1;

FIGURE 2 is an exaggerated transverse cross-sectional view of fibers of the topsheet of FIGURE 1, showing droplets of oleaginous moisture barrier material thereon;

FIGURE 3 is a fragmentary vertical sectional view of apparatus adapted to apply a moisture barrier material to one face of a disposable diaper topsheet; and

FIGURE 4 is a fragmentary sectional view of the apparatus of FIGURE 3 taken along line 4—4 thereof.

Referring to FIGURE 1 of the drawings, there is illustrated a preferred embodiment of a disposable diaper topsheet **10** of the present invention. The topsheet **10** can comprise any compliant, soft-feeling, porous web **12** hav-

ing the properties of hydrophobicity and oleophobicity to be described. The size of the web **12** is not critical and is governed by the size of the absorptive pad of the diaper and the diaper structure. For example, as shown in FIGURE 1*a*, a web **12** for a topsheet for the diaper of Duncan et al., U.S. Patent 3,180,335 can measure about 14½" wide by about 18" long in connection with an absorbent paid **11** which is 12½" wide by 16" long. The edges **12***a* of the web **12** can be folded underneath the pad **11** and secured to the lower face thereof with adhesive so as to enclose the exposed edges of the absorptive material, which can comprise creped cellulose wadding, an air-laid felt or the like. The lower face of the assembled pad and topsheet can be attached to a moisture impervious backsheet **11***a*, if desired. Along at least the central portion of the web **12** and on only one face thereof is a discontinuous film **14** of an oleaginous moisture barrier material suitable for application to the skin of an infant, i.e., bland and non-toxic.

Such barrier materials can be derived from mineral oils of varying molecular weights and viscosities, as exemplified by medicinal white oils (such as liquid petrolatum, U.S.P. XIV and light liquid petrolatum) and petrolatum, U.S.P. XIV; from animal oils (for example, triglycerides of higher fatty acids such as stearic, palmitic and oleic acids; lanolin and codliver oil); and from vegetable oils such as soybean oil, peanut oil, cottonseed oil, rapeseed oil, olive oil, palm oil and coconut oil. The properties of the oleaginous barrier material can be improved and the possibility of fabric penetration further decreased by admixing the same with an additive capable of increasing its viscosity. For example, a mineral oil of low viscosity can be mixed with a crystalline material such as the above-mentioned triglycerides or with inorganic materials such as zinc oxide or with metal salts of fatty acids having molecules containing between 12 and 22 carbon atoms (for example, calcium, magnesium, potassium or sodium salts of stearic and palmitic acids) to increase its viscosity for use as a barrier material. Such additives can be added to said barrier materials in appropriate quantities dependent upon their effectiveness in increasing viscosity, but preferably in amounts up to about 10% by weight of barrier material.

Preferably, the barrier material has a viscosity in the range of from about 70 to about 280 S.U.S at about 100° F. Preferably, also, in order to avoid a greasy look and feel, the discontinuous film **14** comprises a multiplicity of discrete droplets **14***a* (see FIGURE 2) having diameters in the range of from about 0.05 mm. to about 1.0 mm. and is applied in quantities of from about 0.001 to about 0.020 gram per square inch. Higher concentrations will, however, transfer increased levels of oleaginous materials if it is desired to leave the skin "greasy."

While the embodiment illustrated employs the discontinuous film **14** only along the transversely extending central portion of one face of web **12**, it will be understood that the same can be located along the longitudinal central portion or can be coextensive with the said one face, if desired. Although not critical, a film **14** which has a width of about 8" has been found to be satisfactory. The manner of and means for the application of the discontinuous film **14** on a continuous length of web **12** is described hereinafter.

As used herein, a web **12** is oleophobic and hydrophobic when the critical surface tension thereof is sufficiently low, in contrast with the surface tension of oleaginous moisture barrier material and with that of waste fluids, to prevent a drop of either from spreading on the web. Generally speaking, the contact angle of these materials on the web **12** substrate (i.e., the included angle between the substrate-liquid interface and a line, in a vertical plane, which is tangent to the liquid-air interface and extends through a point on the periphery of the substrate-liquid interface) should exceed about 90° to prevent the oleaginous liquid from spreading on the fibers of the web **12**. Also, generally speaking, the greater the differential between the critical surface tension of the web **12** and the surface tensions of these materials, the greater the contact angle and therefore the less the possibility of wetting the substrate under imposed stresses. The critical surface tension of the web **12** should be in the range of from about 7 to 25 dynes per centimeter at 20° C., preferably less than about 20 dynes per centimeter, and at least about 5 dynes per centimeter lower than the surface tension of the oleaginous moisture barrier material comprising the discontinuous film **14**. Critical surface tension values given above are in terms of the critical surface tension of similar surface systems measured on a flat plane since it is difficult, if not impossible, to accurately measure such values in irregular or rough surfaces such as a fabric. Thus, as used herein, the critical surface tension of a topsheet the fibers of which are coated with a fluorochemical compound, for example, would be that of such compound as measured from a coating thereof applied to a smooth, flat surface.

The web **12** can be constructed of any desired porous material such as paper or a woven, knitted or non-woven fabric. As a specific example, the web can be a non-woven fabric sheet which is constructed from 1.5 to 3 denier rayon fibers 1.3–1.6" long and contains approximately 10–35% of binder (as for example, cross-linked polymers of ethyl acrylate such as is sold by Rohm & Haas Company and identified as HA–8), and having a weight of from about 15 to about 19 grams per square yard. In processing such a sheet, surfactants should be minimal in the binder emulsion and generally avoided in the saturation bath or printing fluid. This is the preferred porous topsheet referred to in the examples.

The described exemplary non-woven sheet can be coated or sized by a substance adapted to reduce the critical surface tension of the web **12** if it appears that the same is not sufficiently low, i.e., does not conform to the preferred limits given above. Any type of coating material capable of such reduction and which is not harmful or an irritant to an infant's skin may be used. Such coating or treating material can, for example, comprise fluorochemicals, silicones and fatty wax-like derivatives (such as a pyridinium acid chloride derivative of stearamide). However, due to the very low critical surface tensions which can be imparted to the fibers of a web by coating or sizing the same with an oil and water-repelling fluorochemical compound, such compounds are preferred agents for use in connection with treating materials for web **12**.

These preferred fluorochemical compounds can have chemical structures of great variety; for example, acrylates and methacrylates of hydroxyl compounds containing a highly fluorinated residue and their polymers and copolymers can be used. Such compounds are described in detail in U.S. Patents 2,642,416; 2,826,564; 2,839,513 and 2,803,615. Other fluorochemical compounds which can be employed include the chromium coordination complexes of saturated perfluoromonocarboxylic acids of which the chromium complexes of perfluorobutyric acid and perfluorooctanoic acid are representative. Fluorochemical compounds are available commercially, for example, those marketed under the trademark "Scotchgard" by the Minnesota Mining and Manufacturing Company. Still further examples of suitable fluorochemical compounds include perfluoronated ethers; fluorocarbon acrylic-type amides (fluorocarbonsulfonyl acrylamides and methylacrylamides) and their polymers such as described in U.S. Patent 2,995,542; phosphorus-containing fluorocarbon compounds and polymers thereof such as perfluoroalkylsulfonamidoalkyl esters of phosphorus acids described in U.S. Patent 3,094,547; perfluoroalkanoic acids such as perfluorolauric acid, $F_3C(CF_2)_{10}COOH$, and compounds containing fluoroalkyl carbamato chains interconnected by methylene bridges as disclosed in U.S. Patent 2,958,613. If desired, the fluorochemical can be combined with other re-

pellent compounds as, for example, Quarpel (developed by the U.S. Army Quartermaster Corps) which combines a pyridinium fatty water-repellant with a fluorochemical, "Scotchgard FC208" (product of Minnesota Mining and Manufacturing Co.).

The following examples illustrate the treatment of the web **12** of the present invention with compounds adapted to impart hydrophobic-oleophobic properties to the surfaces of the fibers thereof. In each case the resulting treated topsheet has a critical surface tension in the range of from about 7 to about 30 dynes per centimeter. Following preparation as described in the examples, a discontinuous film of oleaginous moisture barrier material is applied to the central portion of each topsheet in the manner hereinafter set forth and the film-bearing topsheet is applied to the absorptive pad as described above. The film in each case comprises a multiplicity of discrete droplets ranging in size from about 0.05 mm. to about 1.0 mm. in diameter and has a cumulative weight per unit area of from about 0.001 to about 0.020 gram per square inch.

Example I

A sample of the porous topsheet described above is saturated with a 1% by weight solution of N-methyl, N-perfluorooctane-sulfonyl acrylamide polymer (prepared in accordance with the method of U.S. Patent 2,995,542) in xylenehexafluoride solvent and passed through the nip of squeeze rolls to remove excess solution. The topsheet is then dried by placement in an oven for 10 minutes at 150° C. The result is a treated topsheet which is hydrophobic and oleophobic whereby discrete droplets of waste fluids and of mineral oil deposited on the web surface will remain or run off rather than spread and wet the surface. Alternatively, the topsheet can be sized with the polymer in an aqueous latex dispersion.

The oleaginous moisture barrier material which is applied to the resulting topsheet is liquid petrolatum, U.S.P. XIV, of a droplet size of from about 0.20 mm. to about 0.80 mm. and an average weight of about .010 gram per square inch. The absorptive pad-topsheet unit is found to be effective in a disposable diaper for at least several months following assembly.

Substantially similar successful results are achieved when the following barrier materials are substituted for the liquid petrolatum, U.S.P. XIV, material described in the above example: lanolin, codliver oil, triglycerides of stearic, palmitic and oleic acids, soybean oil, peanut oil, cottonseed oil, rapeseed oil, olive oil, palm oil and coconut oil.

Example II

A sample of the porous topsheet described above is padded with a 5% by weight solution of N,N'-methylene-di-(methylene-bis-1,1-dihydro - perfluorooctyl carbamate) in acetone and then dried and heated in an air oven at 150° C. for three minutes. The treated topsheet on which is deposited about 4% by weight of the fluorochemical is highly hydrophobic and oleophobic.

The oleaginous moisture barrier material which is applied to the resulting topsheet is light liquid petrolatum having a viscosity of 85 S.U.S. at 100° F. admixed with an additive comprising the sodium salt of stearic acid in a quantity of 5% by weight of the petrolatum. The mixture is found to be very effective as a moisture barrier material and highly resistant to penetration of the treated fabric for considerable periods of time.

The above example is repeated and similarly successful results are achieved substituting the following additives in amounts ranging from 0.5% to about 5% by weight of barrier material for the sodium salt of stearic acid: zinc oxide, sodium salt of palmitic acid and triglycerides of stearic, palmitic and oleic acids.

Example III

Samples of the porous topsheet described above were saturated with a fluorocarbon polymer emulsion known as "Scotchgard FC208" (product of the Minnesota Mining and Manufacturing Co.) at polymer levels of .18, .46 and .5% by weight of solution whereby to effectively coat the fibers of the topsheets with fluorocarbon at levels ranging from about 0.2 to about 0.5% by weight of solids/weight of fabric. The topsheets were then dried by heating them to a temperature of 180° F. for 10 minutes and upon testing each was found to be highly hydrophobic-oleophobic.

It is found that each of the resulting topsheets of this example has a critical surface tension of less than about 20 dynes per centimeter. When each of the oleoginous moisture barrier materials mentioned in Example II is applied in the manner therein described, the critical surface tension of each of the topsheets of this example is at least about 5 dynes per centimeter lower than the surface tension of the said barrier materials and the said barrier materials do not spread out and do not wet the surfaces of the topsheets.

Example IV

An 18" wide continuous web of the porous topsheet described was drawn at a speed of 22 feet per minute through a set of nip rolls, one of which is covered by an 8" wide felt material saturated by a spray delivering an emulsion comprising .056% by weight of the fluorocarbon polymer of "Scotchgard FC208." The web was saturated by said emulsion along an 8" wide central area, dried on a heated roll supplied with steam at about 295° F. and cut transversely to result in a plurality of the above-mentioned 14½" wide by 18" long topsheets. The fluorocarbon polymer solids deposited in said 8" wide central area amounted to about .23% by weight of the dried fabric substrate and was found to be satisfactorily hydrophobic-oleophobic for the purpose of this invention.

Example V

The process of Example IV was repeated using an emulsion comprising .5% by weight of the fluorocarbon polymer of "Scotchgard FC208" and the solids deposited in said 8" wide central area amounted to 2.13% by weight of the dried fabric substrate. The polymer coated portion of the topsheets made from the treated web was found to be highly hydrophobic-oleophobic and well suited for use in the present invention.

Example VI

The following solution composition was prepared:

| | Parts by wt. |
|---|---|
| Water | 88.5 |
| HA–8 (an acrylic bonding material distributed by Rohm & Haas Co. and containing 45% solids) | 7.5 |
| Emulsion containing 99% by weight of water and 1% by weight of the fluorocarbon polymer emulsion known as "Scotchgard FX813" (distributed by Minnesota Mining and Manufacturing Co.) | 4.0 |

The solution was applied to an unbonded web of rayon fibers saturating the web, and the web then blotted to remove excess moisture and dried by heating the same to a temperature of 200° C. for 30 minutes. The fluorocarbon polymer solids content in the solution was .13% by weight and was found to amount to .1% of the total dry fabric weight. The web was a well-bonded highly hydrophobic-oleophobic web well adapted for use as the disposable diaper topsheet in the present invention.

Example VII

A solution similar to that of Example VI was prepared, but using 89.5 parts by weight of water and 3.0 parts by weight of the emulsion. After application to an unbonded web of rayon fiber and drying as indicated, the dry web was found to contain approximately .05% by weight

fluorocarbon polymer solids. Here, too, the web was well-bonded and found to possess the hydrophobic-oleophobic properties required for a topsheet of the present invention.

Example VIII

A perfluoroalkylsulfoamidoalkyl ester of phosphoric acid is prepared as follows: 200 grams of N-ethyl perfluorooctanesulfoamidoethyl alcohol is admixed with 100 ml. benzene and 150 ml. of benzotrifluoride. Then 40 grams of pyridine is added, after which 16.7 grams of phosphorus oxytrichloride is added with stirring. The mixture is refluxed for 16 hours, cooled and filtered. The residue is slurried with water, filtered and dried under vacuum at 60° C.

The prepared phosphate is applied to the porous topsheet described in a 1% solution in acetone-methyl chloroform (10:90 weight percent) by the well-known padding technique. The topsheet is dried at 150° C. for ten minutes and found to be well-adapted for use as the topsheet of this invention.

Example IX

A Werner-type chromium complex of the acid

$$CF_3(CF_2)_6COOH$$

is prepared as follows: 2.59 parts by weight of acid is dissolved in 51 parts by weight of isopropyl alcohol. Then a 34% by weight solution of chromylchloride in carbon tetrachloride is added below the surface of the alcohol solution with stirring, the amount being 8.24 parts by weight. The resulting solution has a ratio of chromium to acid of 2.88 chromium atoms to each molecule of acid. The rate of addition of the chromylchloride solution to the alcohol solution of the acid is adjusted to maintain the temperature of the mixture at 43° C. After addition of the chromylchloride solution is completed, the reaction mixture is distilled to remove carbon tetrachloride, the amount of distillate removed being 19 parts by weight. The mixture is then cooled and .26 parts by weight of water and 1.6 parts by weight of isopropyl alcohol are added to provide a solution containing approximately 30% by weight of solids. The 30% stock solution is diluted to 1% total solids by adding 3.3 volumes of solids solution to 50 volumes of distilled water and then adding to this solution 12.2 volumes of a 30% aqueous solution of urea as a buffer and HCl scavenger. The solution is then diluted to a total of 100 volumes with distilled water.

The 1% solution is applied to the porous topsheet described by the well-known padding technique to obtain a wet pickup sufficient to result in a final solids concentration of about 0.6% by weight of the topsheet and cured at 157° C. for 6 minutes. The cured fabric is washed thoroughly with water to remove excess urea and dried. The dried fabric is highly hydrophobic and oleophobic.

Example X

1,1-dihydroperfluorooctyl acrylate polymer is prepared as described in U.S. Patent 2,642,416 and is incorporated in an emulsion containing the polymer at a level of about 1% by weight of solution. The emulsion is applied to the above-described porous topsheet by known padding techniques whereby polymer is deposited thereon in quantities of about 0.6% by weight of the topsheet. Then the topsheet is dried by heating the same to 170° F. for 15 minutes. The treated dried fabric is hydrophobic-oleophobic and useful in connection with the present invention.

Another sample of the porous topsheet is similarly treated by like quantities of 1,1-dihydroperfluorooctyl methacrylate, i.e., $CH_2{:}C(CH_3)COOCH_2C_7F_{15}$, and a substantially similarly satisfactory result is achieved with respect to hydrophobic-oleophobic properties.

Although the minimum quantity of treating material required to impart the desired hydrophobic-oleophobic properties to the web **12** will vary, it has been found that fluorochemical compounds in quantities of at least about .05% by weight of fabric are required. The upper limit of the quantity of fluorochemical compound can range as high as about 10% by weight of the fabric, although for economy it is preferred to limit the same to less than 2%.

FIGURE 2 shows fibers **12***a* of topsheet **12** coated completely with a treating material **13** whereby droplets **14***a* of oleaginous moisture barrier materials will not wet the surfaces of the fibers. Apparatus for applying the discontinuous film **14** of oleaginous moisture barrier material is illustrated in FIGURES 3 and 4, in which cylindrically-shaped screen member **16** is rotated through a pool **17** of such material and delivers the material to an application position A at a substantially constant rate. The screen member **16** comprises a multiplicity of rings **18** which are axially aligned and spaced from one another and has a covering of wire fabric **20** of about U.S. Standard 40 mesh. Preferably, the cross-section of the ring is as small as possible while retaining sufficient rigidity to support the screen member in a radial direction. In this connection, such rings **18** constructed of 20 gauge stainless steel can have a radial thickness of about ⅛" when the outside diameter of the member **16** is about 12". The rings **18** and the fabric **20** are united, as by spot welding, whereby to form an integral assembly having an axial length equal to the desired width of film **14**.

The pool **17** of oleaginous moisture barrier material is contained by a tray **22**. The tray **22** can be made of sheet metal, plastic or the like and is of sufficient height to contain the required depth of barrier material. The tray **22** has a length greater than the axial length of the screen member **16** and a width which permits it to accept the portion of the periphery of the member **16** which is to be rotated therethrough.

The screen member **16** is freely supported on two spaced driving rolls **24** of similar construction which span the length of tray **22**. The rolls each comprise a steel body **28** having an outwardly projecting shoulder **28***a* at each end. The length of the body **28** between the shoulders **28***a* is slightly greater than the length of screen member **16** and is preferably covered by a layer **28***b* of elastomeric material such as neoprene or other oil-resistant substance. A shaft **30** is affixed within the axial bore extending through the body **28** by means of a key or set screws or the like. The shaft is suitably rotatably supported by bearings (not shown) in standards **32** and by means of which the rolls **24** are held in position above the tray **22** and spaced by an amount sufficient to permit the screen member **16** to extend into the pool **17** by a predetermined amount. For example, if it is desired to have the member **16** dip 1" below the surface of the pool **17** and the diameters of the member **16** and rolls **24** are respectively 12" and 2.75", the axes of the rolls **24** can be spaced 13" from one another and 1$\frac{9}{16}$" above the level of pool **17**. The rolls **24** are rotated at constant speed through a drive arrangement including sprocket **26** and chain **26***a*. The rotation of the rolls **24** causes the screen member **16** supported thereby to rotate at approximately the same speed.

Extending axially within the screen member **16** in a position adjacent the application position A thereof is an air nozzle **34** which presents a slot extending full length of the screen member **16**. The nozzle can be of any form of construction but in the embodiment illustrated comprises a body **36** of substantially U-shaped cross-section, to the inclined edges **36***a* of which are adjustably affixed nozzle plates **38**. Adjustability of the plates permits the adjacent lips thereof to be spaced as desired to form the slot whereby to control the velocity and flow rate of pressurized air therebetween and may be accomplished by a plurality of spaced machine screw-slot arrangements **40**.

The ends of the body **36**-nozzle plate **38** assembly are closed by gaskets **42** of resilient material and end plates **44** fastened to body **36** by machine screws or the like. A threaded stud **36***a* projects outwardly from one end plate

44 and the nozzle 34 is therewith adjustably secured within a vertical slot 46*a* in a support 46 by means of nut 36*b*. An air supply pipe 48 is engaged within a threaded bore in the other end plate 44 and establishes communication between the interior of nozzle 34 (through an aperture in the contiguous gasket 42) and a source of pressurized air. The pipe 48 is suspended by an adjustable hanger (not shown) whereby each side of the nozzle 34 is vertically adjustable.

A continuous length of the hydrophobic-oleophobic treated web 12 of the desired width is located above the screen member 16, moving at constant speed and passing adjacent the application station A. The web is supported and guided by idlers 50, only two of which are shown in the drawing. Means to feed, guide and collect such webs are well known in the art and therefore not described in detail. The same is true of suitable framing for support of the tray 22, a sprocket-equipped drive motor or the like for driving sprockets 26 and details of support 46, standards 32 and other such items, the use and arrangement of which would be obvious to those of ordinary skill in the art.

As the screen member 16 revolves, a film of the material comprising pool 17 is picked up on the fabric 20 and carried to the application station A at which point the airjet from the nozzle 34 blows the material from the fabric onto the adjacent surface of the web 12, thereby forming the discontinuous film 14. With the apparatus sized as described above and using an air nozzle with a slot having a width of .005" located ¼" below the level of the fabric 20, and an air pressure of 3 to 7 p.s.i.g., the web 12 being 10" above the fabric 20 at the application station, the screen member 16 and web 12 moving at the same speed and employing mineral oil as the oleaginous moisture barrier material, the jet of air emanating from the slot applies the film of mineral oil carried by the fabric 20 to the web 12. The mineral oil on the web 12 is in the form of droplets having diameters in the size ranges given above, thus presenting the desired continuous film 14 which contains from about 0.003 to about 0.006 gram of mineral oil per square inch and has a width approximately equal to the length of screen member 16. If an increase in the quantity of mineral oil per unit area is required, then the speed of the screen member 16 is increased relative to that of the web 12. On the other hand, the quantity of mineral oil per unit area can be reduced by decreasing the speed of screen member 16 relative to the speed of web 12.

The velocity of gas driving the oleaginous material from the fabric 20 to web 12 at application station A should be sufficient to transport the droplets, yet not so great as to drive the droplets deeply into or through the web 12 since in-use subsequent transfer of deeply embedded droplets to the infant's skin is inhibited. To this end,, the gas velocity is adjusted depending upon the size spectrum of the droplets, the porosity and depth of the web 12, the distance between fabric 20 and the web 12 and the like parameters for the specific equipment and materials employed in use.

Following the application of the film 14 to the continuous web 12, individual topsheets 10 of the proper width are cut therefrom. The topsheets 10 are employed as the body-contacting portion of disposable diapers and can, for example, be combined with the balance of the disposable diaper as described in Duncan et al., U.S. Patent 3,180,335. Whatever the specific form of construction might be, the topsheet is applied to one side of an absorptive pad, oriented with the face thereof carrying the film 14 of oleaginous moisture barrier material outermost. Preferably, following the manufacture of a disposable diaper having a topsheet 10 of the present invention, the diaper is folded wallet-fashion so that the topsheet is within the interior of the folded device and therefore only contacts itself.

Such disposable diapers can be stored for extended periods of time without loss of the film 14 therefrom and without migration of the oleaginous moisture barrier material into the absorbent pad. When diapers employing the topsheet 10 of this invention are applied to an infant, the film 14 transfers to the infant's skin upon contact therewith and establishes a barrier which insulates and therefore protects the skin from maceration caused by waste fluids and irritants which may be present in the fecal matter trapped by the diaper. In this manner the possibility of an infant developing diaper rash is substantially reduced, under equal conditions of use, relative to the use of other diapers which do not employ the topsheet 10 of the present invention. On the other hand, it is possible with this approach to increase the time between diaper changes while holding diaper rash levels substantially constant an alternative preferred by many parents.

The terms and expressions which have been employed are used as terms of description and not of limitation, and it is not intended in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. A diaper comprising an absorptive pad covered on one face by a topsheet made of a thin, porous web of fibrous material, wherein the improvement comprises employing fibers the surfaces of which are hydrophobic and oleophobic, said hydrophobic-oleophobic surfaced fibers comprising at least the central portion of said topsheet, said topsheet having on at least the central portion of and substantially only on its outer face, prior to application of the diaper to an infant, a discontinuous film of an oleaginous moisture barrier material suitable for application to the skin of an infant.

2. The diaper of claim 1 in which the critical surface tension of said topsheet in at least the central portion thereof is less than about 25 dynes per centimeter at 20° C. and at least about 5 dynes per centimeter lower than the surface tension of said oleaginous moisture barrier material.

3. The diaper of claim 2 in which the quantity of said oleaginous moisture barrier material contained in said film is in the range of from about 0.001 gram to about 0.020 gram per square inch.

4. The diaper of claim 2 in which said oleaginous barrier material is in the form of discrete droplets having diameters in the range of from about 0.05 mm. to about 1.0 mm.

5. The diaper of claim 2 in which said oleaginous barrier material is selected from the group consisting of: mineral oils, vegetable oils, animal oils and mixtures thereof.

6. The diaper of claim 5 in which said mineral oil is selected from the class consisting of: liquid petrolatum, light liquid petrolatum, petrolatum and mixtures thereof.

7. The diaper of claim 5 in which said vegetable oil is selected from the class consisting of: soybean oil, peanut oil, cottonseed oil, rapeseed oil, olive oil, palm oil, coconut oil and mixtures thereof.

8. The diaper of claim 5 in which said animal oil is selected from the class consisting of: lanolin, codliver oil, triglycerides of stearic, palmitic and oleic acids and mixtures thereof.

9. The diaper of claim 5 in which said barrier material contains an additive for increasing its viscosity, said additive being selected from the class consisting of: triglycerides of stearic, palmitic and oleic acids; zinc oxide; calcium, magnesium, potassium and sodium salts of fatty acids having molecules containing between 12 and 22 carbon atoms and mixtures thereof.

10. A diaper comprising an absorptive pad covered on one face by a topsheet made of a thin porous web of fibrous material, wherein the improvement comprises em-

ploying fibers the surfaces of which are hydrophobic and oleophobic, said hydrophobic-oleophobic surfaced fibers comprising at least the central portion of said topsheet and imparting thereto a critical surface tension of less than about 25 dynes per centimeter at 20° C., said topsheet having on at least the central portion of its outer face a discontinuous film of an oleaginous moisture barrier material suitable for application to the skin of an infant, said critical surface tension of said central portion of said topsheet being at least about 5 dynes per centimeter lower than the surface tension of said oleaginous moisture barrier material, the said hydrophobic and oleophobic surfaces of said fibers resulting from the application of a coating of an oil and water-repelling fluorochemical compound to the fibers.

**11.** The diaper of claim **10** in which the said fluorochemical compound is selected from the class consisting of (a) acrylates and methacrylates of hydroxyl compounds containing a highly fluorinated residue and their polymers and copolymers, (b) chromium coordination complexes of saturated perfluoromonocarboxylic acids, (c) perfluoronated ethers, (d) perfluoroalkanoic acids, (e) fluorocarbonsulfonyl acrylamides and methacrylamides and their polymers, (f) perfluoroalkylsulfoamidoalkyl esters of phosphorus acids, and (g) compounds containing fluoroalkyl carbamato chains interconnected by methylene bridges.

**12.** The diaper of claim **10** in which the quantity of oleaginous moisture barrier material contained in said film is in the range of from about .001 to about .020 gram per square inch.



**13.** The diaper of claim **10** in which said oleaginous barrier material is in the form of discrete droplets having diameters in the range of from about 0.5 mm. to about 1.0 mm.

**14.** A disposable diaper having an absorbent pad and a porous fibrous topsheet overlying one surface of the pad, wherein the improvement comprises the fibers in at least the central portion of said topsheet being coated with a fluorochemical compound having a critical surface tension of less than 20 dynes per centimeter at 20° C., the outer face of said topsheet having on at least the central portion thereof a discontinuous film comprising discrete droplets of an oleaginous material suitable for application to the skin of an infant, said oleaginous material having a surface tension at least 5 dynes per centimeter higher than that of the coated portion of the topsheet.

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