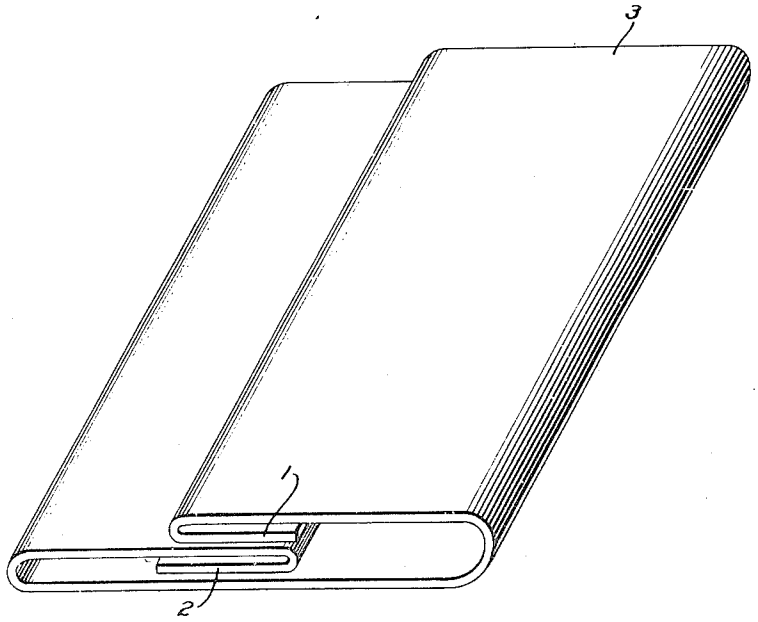
Nov. 1, 1949 R. B. SEYMOUR ET AL 2,486,806

DIAPERS AND LIKE SHEET-LIKE MATERIALS

Filed Oct. 8, 1947



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Patented Nov. 1, 1949 2,486,806

UNITED STATES PATENT OFFICE

2,486,806

DIAPER AND LIKE SHEETLIKE MATERIAL

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Application October 8, 1947, Serial No. 778,718

4 Claims. (Cl. 117—68)

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This invention relates to disposable diapers and sheets and more particularly to an article of this character which has as a base a sheet of unwoven fibers having a random distribution. The invention primarily involves surface coatings for such a fibrous sheet which make it especially suitable for use as a diaper.

The invention concerns both the process of producing the disposable diaper and the resulting product as an article of manufacture.

The coating on both sides of the diaper may be of the same character, both of these coatings transmitting moisture to the interior of the diaper. Because of this either side of the diaper may be applied next to the infant and moveover the diaper may be folded in any manner desired.

As a basis for comparison in this latter respect, it may be pointed out that in an application Serial Number 778,717 filed herewith by the present co-inventors, a diaper is disclosed which has a water-repellent coating on one side and a water-pervious coating on the other side. With such a diaper it is necessary that care be taken in applying it to the infant to make certain that the water-repellent coating is not next to the infant. Although there is a considerable demand for a diaper of the type having a water-repellent coating on one side, principally because they can be used in a thin, single sheet form without folding, many persons prefer to employ a diaper which is folded and used in the same manner that the conventional cloth diaper is used.

The diaper of the present invention meets the demand for this latter type of disposable diaper. Although the diaper has as its base material, a sheet of unwoven fibers having a random distribution, the diaper is thin and can be folded upon itself several times without becoming bulky. Moreover the diaper is highly absorptive, it is very flexible and it has an exceedingly smooth and pleasant texture. Even when wet, the diaper has sufficient strength to resist ordinary tearing stresses.

The fibrous sheeting employed to carry out the invention is preferably that obtained by garnetting picked, woven, knitted or felted materials of virgin cotton or other cellulosic fibrous materials. In this process, an especially designed machine of known type called a picker picks apart the woven, knitted or felted materials and these materials, virgin cotton or other cellulosic fibrous materials, are formed into a batting or felt of substantially uniform thickness on an especially designed machine of known type called a garnet.

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This fibrous sheet is economically produced, particularly if it is made from waste or rejected cellulosic or wool cloth. The cellulosic fibers may be either natural or synthetic.

The resulting sheet of fibrous material has the advantage over felt or batting produced by a carding process because its fibers are distributed in all directions in a random fashion. The fibrous sheet consequently has substantially no tensile strength in any direction, but what strength it does possess is nearly uniform in all directions due to the irregular disposition of the fibers. This would not be true of a carded felt as there the fibers are all lined up in the same direction.

The coating which is applied to both sides of the sheet of loose, unwoven fibers, performs the important function of binding the surface fibers against movement. As a substantially continuous film of the binding material is formed, all, or nearly all of the surface fiber portions are interconnected both at their points of intersection and along their intervening sections. Also, as the binding material penetrates somewhat into the sheet, it binds together the fibers below the surface. It consequently is apparent that the coating material must transmit moisture through it so that the moisture can be absorbed by the fibers.

The coating is a mixture of a solid, high molecular weight polyethylene glycol, and a styrene-maleic anhydride interpolymer. It has been found that ratios of 35 to 60 parts by weight of styrene-maleic anhydride and 40 to 65 parts of solid polyethylene glycol are satisfactory since this material has a good hand and binds the fibers effectively. Also, the coating formed from this material will transmit water therethrough. A preferred proportion is to have the styrene-maleic anhydride constitute 55% of the combined weight.

The hetero-polymer of styrene and maleic acid may be obtained, for example, in accordance with the disclosure of Patent 2,047,398 to Voss et al. and it should have a molecular weight such that a 0.2% aqueous solution will have a viscosity of from 0.5 to 50 centipoises. The ammonium salt of this polymer is used in making up the aqueous solution for application to the fibrous sheet. This aqueous solution also contains a solid polyethylene glycol, and these solid polyethylene glycols may vary in average molecular weight from 1000 to 7000. These materials are very water-soluble and are highly hygroscopic.

Preferably, the solid polyethylene glycol and the styrene-maleic anhydride, in the above range of proportions, are used in an amount to make up a 1% aqueous solution. Excellent results are, however, obtained with an aqueous solution of from 0.5 to 4.0%. This aqueous solution may be applied to the fibrous sheet in any appropriate manner which will form a substantially continuous layer, and one suitable way is by bringing the fibrous sheet into contact with rotating rollers which dip into the solution or upon which the solution is continuously sprayed. A film of the solution is thereby formed upon the rollers and this film is transferred to the fibrous sheet as the sheet continuously comes into contact with the rotating rollers.

In selecting the relative proportions of the ingredients, consideration should be given to the molecular weight of the solid polyethylene glycol. Thus, with the lower molecular weights, it is advisable to use a composition having a greater content of solid polyethylene glycol to make certain that a water-repellent coating is not obtained.

After a film of the aqueous solution is applied to the fibrous sheet, heat is applied to remove the water of solution. This heat is preferably applied by advancing the coated sheet to rotating rollers on opposite sides of the sheet maintained at a temperature of from 250 to 450° F. These heated rollers also serve to drive the coating material into the surface of the fibrous sheet.

The heated rollers not only serve to remove the water of solution, but also serve to drive off the ammonia from its salt of the styrene-maleic anhydride. As a result, a water insoluble coating is produced and it is presumed that this is because the heat causes a reaction between the carboxy groups of the styrene-maleic acid and the hydroxy groups in the solid polyethylene glycols which results in the formation of a water-insoluble cross-linked material when the ammonia is driven off. Since only two hydroxyl groups are present in the molecules of the polyethylene glycol having molecular weights of 1000 to 7000, it is surprising that a soft flexible film which is essentially insoluble results.

This coating of solid polyethylene glycol and styrene-maleic acid on both sides of the fibrous sheet is continuous or substantially continuous. As a consequence, all, or practically all of the fiber portions at the surfaces are retained in these coatings and thereby held against displacement. It is this structure, as distinct from a structure in which the binding material is localized at the intersections of the fibers, which accounts for the high strength of the present product. A strong interconnection exists between the fibers not only at their surface points of intersection but along their intervening portions at the surface of the sheet, as well.

It is preferable that the mixture of the solid polyethylene glycol and the styrene-maleic anhydride be applied in such quantity that it will be present in the range of 0.25 to 2.0 pounds per thousand square feet. A film of corresponding thickness can be readily applied by adjusting the speed of rotation of the applying roller and the quantity delivered by the spray.

As has been noted, the coatings on both sides of the fibrous sheet, serve to transmit moisture to the inner fibers, and this makes it possible to deposit this material as a continuous film and thereby secure a stronger interconnection between the fibers. The coating is highly flexible and will not crack when bent, it is not tacky, and it represents

a smooth surface which has a good feel. Moreover, it has no deleterious effect on the infant's skin.

The accompanying drawing illustrates one manner of folding the diaper for applying it to the infant.

As is apparent from this drawing, the diaper is so folded upon itself as to result in a five layer thickness across the center of the folded diaper. This five layer thickness can be varied in width within the limit of the diaper length. In applying the diaper to an infant the plications are, of course, disposed in a direction generally lengthwise of the child.

The resulting diaper not only possesses this considerable capacity to absorb moisture, but it retains considerable strength even after becoming wet. As a consequence, safety pins used to hold the diaper in place, will not pull through the material after it becomes wet. As has been stated, because the diaper is thin it can easily be folded in place and does not form objectionable creases and wrinkles. It is soft and flexible and is no more annoying to the infant than cloth diapers.

Although the invention has been described with particular reference to diapers, it is to be understood that the product of this invention may be applied to equivalent uses. Thus, the sheet material of the invention may be used in situations where its absorbent properties are desired, such as for bibs, table cloths, surgical sheets, and the like.

The invention may be further illustrated by the following examples:

Example 1.—Rejected cotton cloth is picked apart in a picker and felted in a garnetting machine and the resulting felt having a weight of 1½ to 2 ounces per running yard is sprayed on both sides of the garnetted material with a 2% aqueous solution made up of 0.9 pound of dissolved solid polyethylene glycol having an average molecular weight of 1540, and 1.1 pounds of the ammonium salt of styrene-maleic acid in 98 pounds of water. The treated material is passed through drum rollers to dry the coatings. The rollers were at a temperature of 300 to 450° F. The resulting sheet is cut to a rectangular shape.

Example 2.—Discarded viscose rayon and cotton cloth are picked apart simultaneously on pickers, the materials are conveyed to different garnetting machines and the products from these materials are conveyed to a common apron so that the long, staple, soft rayon forms one surface of the garnetted sheet. This sheet is coated as in Example 1, the water-absorbent coating being applied to both sides.

Example 3.—Virgin cotton is used instead of picked and garnetted cloth as in Example 1.

Diapers made in accordance with this invention possess excellent properties as shown by the following tests:

A piece of felt 1'' in cross section and processed according to Example 1, was placed between clamps and weights were added and the length of time for break was determined, the distance between the clamps being 2''. The untreated felt broke immediately when a 20 gram weight was added. The treated product was not broken in 10 seconds after the addition of a 1500 gram weight. The sample was immersed in water and the test was repeated. Under these conditions the sample did not break in 10 seconds after the addition of the 1500 gram weight. The tests were repeated using strips cut at right angles to the previously described test pieces, and under

these conditions similar results were obtained.

A piece of bonded cotton felt, measuring 3" x 4" and weighing 1 gram, was immersed in water for 10 seconds, placed on blotting paper for 5 seconds and reweighed. The total weight after this procedure was 11 grams, indicating that the material had absorbed 10 times its own weight of water. This test was repeated using a piece of absorbent woven cloth weighing 1 gram and the woven material gained 4 grams in weight due to the absorption of water.

To test the water transmitting properties of the coating, 2 ml. of water in a 2 ml. pipette was allowed to flow freely on the surface of the discs which were supported on the rim of 400 ml. beakers. The time for the water to pass through the coating and be completely absorbed was determined and this was found to be about one minute. However, when a coating was made using a ratio of 70 parts of styrene maleic anhydride heteropolymer to 30 parts of solid polyethylene glycol, no water was absorbed at the end of eight hours.

What is claimed is:

1. A diaper having both sides water pervious comprising a sheet of unwoven fibers having a random distribution, and a substantially continuous, moisture transmitting coating on both sides thereof of a water insolubilized composition consisting of 40 to 65 parts of a solid polyethylene glycol having an average molecular weight of 1000 to 7000 and 35 to 60 parts of a styrene-maleic anhydride interpolymer, the coatings having been subjected to a temperature of from 250 to 450° F.

2. A diaper having both sides water pervious comprising a sheet of unwoven fibers having a random distribution, and a substantially continuous, moisture transmitting coating on both sides thereof of a water insolubilized composition consisting of 40 to 65 parts of a solid polyethylene glycol having an average molecular weight of 1000 to 7000 and 35 to 60 parts of a styrene-maleic anhydride interpolymer, the coatings having been subjected to a temperature of from 250 to 450° F., and said coatings having a thickness corresponding to from .25 to 2.0 pounds per thousand square feet.

3. A diaper having both sides water pervious comprising a sheet of unwoven fibers having a random distribution, and a substantially continuous, moisture transmitting coating on both sides thereof of a water insolubilized composition consisting of 40 to 65 parts of a solid polyethylene glycol and 35 to 60 parts of a styrene-maleic anhydride interpolymer, the coatings having been subjected to a temperature of from 250 to 450° F., said solid polyethylene glycol having an average molecular weight of from 1000 to 7000, and said styrene-maleic anhydride interpolymer having a molecular weight such that a 2% aqueous solution will have a viscosity of from 0.5 to 50 centipoises.

4. A diaper having both sides water pervious comprising a sheet of unwoven fibers having a random distribution, and a substantially continuous, moisture transmitting coating on both sides thereof of a water insolubilized composition consisting of 45 parts of solid polyethylene glycol having an average molecular weight of 1540, and 55 parts of a styrene-maleic anhydride interpolymer, the coatings having been subjected to a temperature of from 250 to 450° F.

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