Oct. 22, 1968 R. B. CUBITT 3,406,688

DIAPER WITH PAPER FACE

Filed May 21, 1965

FIG. 1

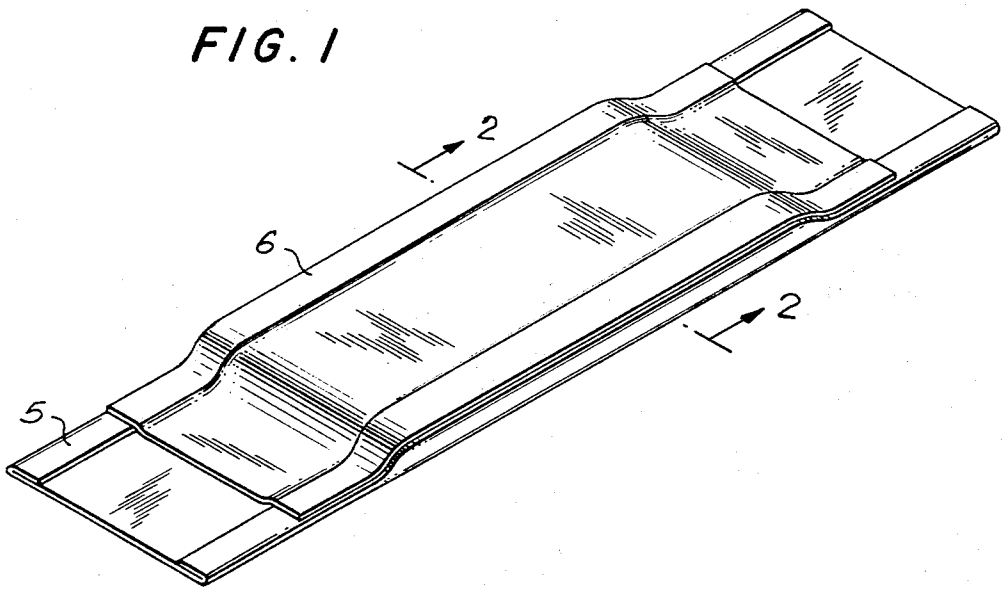
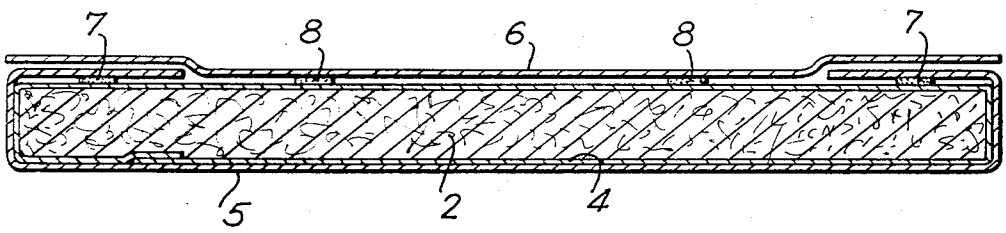


FIG. 2



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3,406,688

DIAPER WITH PAPER FACE

Robert Bruce Cubitt, Bound Brook, N.J., assignor to Colgate-Palmolive Company, New York, N.Y., a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

Wet-strength paper of improved softness containing as a softening agent a mixture of lithium chloride and an organic plasticizer such as sorbitol, sorbitol ethers, polyethylene glycols, urea and glycerol. This paper is particularly adapted for use in connection with disposable diapers and other similar articles of a highly absorbent nature which are intended to be placed in contact with the skin.

The present invention relates to softened paper as well as to disposable diapers and paper suitable for use as the inner surface layer of a disposable diaper, that is, the surface layer intended to be placed in contact with the skin. In a broader sense the invention also relates to other absorbent articles, particularly suitable for absorbing body wastes (e.g., sanitary napkins and bed pads) using a core of highly absorbent material covered with a surface layer of paper.

Disposable diapers may be produced from an absorbent material such as layers of cellulose wadding, absorbent tissue, blotter stock, or loose cellulose pulp, such as "wood fluff," of suitable thickness (e.g., about ½ inch) surfaced with a layer of a wet-strength paper. While wet-strength papers of sufficient softness to be placed in contact with a baby's skin, in the use of the diaper, are known to the art (as shown, for example, in U.S. Patent 2,046,763 of July 7, 1936), such papers have been found to be deficient in use. For example, on storage of disposable diapers having this surface layer of wet-strength paper, it has been found that the initially soft paper becomes rattly and harsh and irritating to the skin.

It is therefore an object of this invention to provide a disposable diaper having a surface layer of wet-strength paper which retains its softness on prolonged periods of storage under the varying conditions generally encountered during the shipment and stocking of products of this type.

Other objects of this invention will be apparent from the following detailed description and claims. In this description and claims, all proportions are by weight unless otherwise specified.

It has now been found that the change in the softness of the wet-strength paper on storage is due, in large part, to the migration of the softener from the surface layer of the diaper into the highly absorbent body of the diaper. When this occurs, the amount of softener in the wet-strength paper is diminished, making the paper harsher. This migration has now been found to be characteristic of such common paper-softening agents as glycerine and diethylene glycol, both of which are liquid, and urea, which is a crystalline solid, as well as mixtures of urea and sodium nitrate. Certain softening agents, such as sorbitol and derivatives thereof, are non-migrating but lose some of their softening effect at low humidities (e.g., below 40% R.H.) and are therefore not entirely satisfactory.

In accordance with one aspect of this invention the softness of plasticized paper at low humidities is substantially improved by the addition of minor amounts of lithium chloride to the principal softening agent used in the paper.

For use in diapers, the paper can be made of bleached cellulose stock, and may be of softwood or hardwood pulp. Papers made of cellulose fibers other than wood fibers have given excellent results; an example is a paper, similar to that used commercially for tea-bags, made of hemp fibers. The wet-strength of the paper is generally attained, in a manner well known to the art, by the use of a small amount of a water-insoluble bonding agent, such as glue (as in U.S. Patents 2,035,024 and 2,046,763) or regenerated cellulose (as in U.S. Patent 2,048,293). The use of synthetic resins (e.g., cationic melamine-formaldehyde, modified urea-formaldehyde and polyamide resins) for imparting wet strength to paper is also well known in the paper art; the wet-strength papers made with these resins are usually resistant to biodegradation in septic tank systems. The papers previously mentioned are therefore more desirable, than those containing these synthetic resins, for making disposable diapers which are intended to be flushed down a toilet. They are also more desirable in that they show considerably better response to plasticiation than the papers made with the more hydrophobic synthetic resins. Parchmentized papers made by treating paper with strong acid (e.g., strong sulfuric acid) have good wet strength, but usually do not have the porosity needed for use as an inner surface layer of a disposable diaper. The porosity and thus the desired permeability to liquids can be increased appreciably by perforating the parchmentized paper, e.g., with 6–10 perforations, of $\frac{1}{50}$ inch diameter, per square inch. More desirably, the necessary porosity can be attained by the use of an initially very porous paper, which retains much of its initial porosity on parchmentizing.

The porosity of the paper can be measured conveniently by a standard conventional Gurley PP porosity tester (which measures the rate of flow of air through porous paper). The porosity, so measured, should be such that no more than about 2 seconds, and preferably much less, is needed for 100 cc. of air to pass through the plasticized paper, when the paper is to be used as the surface of a disposable diaper.

For diaper use, the wet-strength paper, before plasticization, is preferably not too stiff. When tested with the Handle-O-Meter, a device widely used in the textile and tissue paper industries for measuring the hand of fabric or paper, the total hand of the unplasticized paper should preferably be at most 100 (as measured in standard manner using a Thwing Albert Handle-O-Meter with a 10 mm. slot width on a 4" x 4" sample conditioned at 70° F. and 65% R.H., the value of "hand" being the sum of the four readings taken on both sides and in both directions of the sample). Best results thus far have been attained with papers thinner than 5 mils in thickness.

When the paper is to be used as the surface of a disposable diaper, the wet strength of the plasticized paper after thorough soaking in water should preferably be at least ¼ pound/in. when measured in the weaker direction (cross-machine direction) under standard TAPPI conditions, but more preferably about one pound/in. or more, in the weaker direction. It is preferred that the wet strength in the machine direction be at least 2 pounds/in. The presence of the plasticizer generally has little, if any, effect on the wet strength.

It is convenient to apply the plasticizer to the wet-strength paper by saturating the paper with an aqueous solution of the softening agent and then evaporating the water. This provides maximum penetration into the fibers with minimum surface coating.

The amount of plasticizer used in the paper may be varied in accordance with the degree of softening desired and the particular type of paper used. Generally, the percent pickup, i.e. the increase in weight (measured after conditioning at 70° F. and 65% R.H.) as a result of the

addition of the plasticizer will be above about 5% and well below 50%. It will be understood that variations in the type of furnish, type of pulp, porosity of the paper, etc. will affect the hand of the paper and its response to plasticization. With some papers, such as very thin paper made of hemp fibers and regenerated cellulose binder, the amount of softener needed to attain a given hand is much less than that required to attain the same hand with thicker woodpulp cellulose papers.

For the production of disposable diapers having a paper surface layer which retains its softness on long periods of storage the lithium chloride finds its greatest utility when used in minor amounts, in combination with a major proportion of another plasticizer, such as a non-crystallizing grade of sorbitol or a sorbitol derivative. One example is the material known as "Arlex" (from Atlas Powder Co.) which is an industrial grade of sorbitol supplied as an aqueous solution containing minor amounts of sorbitol anhydrides. Among the sorbitol derivatives which may be used are the ethers such as the hydroxyalkyl ethers, e.g. the hydroxypropyl ether sold as "Atlas G–2401." Other such ethers are the hydroxyethyl ether, the hydroxyethoxyethyl ether, and the hydroxypolyethoxyethyl ether of sorbitol. The use of the various sorbitol compounds in admixtures with each other is of course within the scope of this invention. As little as 1% of lithium chloride based on the weight of the principal plasticizer may be employed.

Another plasticizer which, like the sorbitol or sorbitol derivative, does not migrate from the paper when in contact with absorbent cellulose is a polyethylene glycol having a number average of about 6 to 18 oxyethylene units and containing less than about 10% of polyethylene glycols of less than 6 oxyethylene units, such as the liquid polyethylene glycol known as "Carbowax 600" having an average molecular weight in the range of 570–630; paper softened with this plasticizer retains its softness to a large extent at low humidities, even without the lithium chloride, but it may also be employed with minor amounts of lithium chloride.

It is also within the broader aspects of this invention to employ the lithium chloride alone, as the only softener, or in combination with other softeners such as mannitol, dextrose, sucrose, urea, or glycerol. Thus lithium chloride alone at a percent pickup of, for example, 28 to 34% greatly softens the leached, unsoftened wet-strength paper used in Example 1, and the softness is retained to a large extent at low humidities. When the lithium chloride is used alone, or with another plasticizer of the migrating type, the resulting paper loses appreciable amounts of the softening material on storage in contact with absorbent cellulose; it is, however, suitable for other uses where a soft paper is desired.

Th following examples are given to illustrate this invention further.

Example 1

A paper produced in accordance with U.S. Patent No. 2,046,763 was leached thoroughly with water to remove all water-soluble materials and then dried. The resulting smooth paper which had a basis weight of about 13–15 pounds/3000 sq. ft., was similar in feel to the usual onion skin paper; on crumpling it was rattly and noisy. Its wet tensile strength, after soaking one hour in water at room temperature, was 2 lbs./in. in the machine direction and 1½ lbs./in. in the cross direction, while its wet Mullen burst strength was about 6 lbs.

The paper was then conditioned (to constant weight) at 65% R.H. and 70° F., then weighed and then padded with an aqueous solution containing 33% sorbitol together with varying amounts of lithium chloride. The treated paper was dried, conditioned (to constant weight) at 65% R.H. and 70° F. and then weighed, to determine the "percent pickup" due to treatment with the softener. ("Percent pickup" is

$$\frac{W_2 - W_1}{W_2}$$

where W_1 is the conditioned weight before the softener solution is applied and W_2 is the conditioned weight after the treatment with softener.)

Three different ratios of lithium chloride to sorbitol were employed in separate tests:

(a) The ratio was 1 part of lithium chloride to 20 parts of sorbitol, and the percent pickup was about 30%.

(b) The ratio was 1:10 instead of 1:20 and the percent pickup was about 31%.

(c) The ratio was 1:5 instead of 1:20 and the percent pickup was about 38%. In each case, the softeners appeared to be homogeneously absorbed in the paper and the softened paper was opaque, had a soft pleasant hand and could be crumpled in the hand easily without crackling or rattling. In this series, as the relative ratio of lithium chloride to sorbitol increased, the softness of the paper increased.

The papers were given accelerated tests for loss of plasticizer in contact with a much thicker mass of absorbent cellulose material in the following manner. A 4-inch by 8-inch sheet of the paper (previously conditioned to constant weight at 65% R.H. and 70° F.) was placed on a 4" x 8¼" sheet, weighing 4 grams, of blotter stock (sulfate pulp 6913 Saturating Paper, of Crocker-Hamilton Papers, Inc. having a caliper of 32–34 mils) which had previously been separately conditioned to constant weight at 65% R.H. and 70° F. The assembly was folded widthwise centrally to 4" x 4" to produce a sandwich of two layers of the wet-strength paper within upper and lower layers of blotter stock. The sandwich was placed in a polyethylene bag and then pressed with five similar bags of samples, one on top of another, between two 4" x 4" pieces of Masonite hardboard (with the smooth sides of the hardboard toward the samples), a ½ lb. weight was placed on the upper Masonite board and the whole assembly was placed in an oven at 120 ° F. At the end of three days, the samples were removed from the oven, reconditioned at 65% R.H. and 70° F. and the paper and blotter were separately weighed and examined, after which each blotter sample was reassembled with its corresponding paper sample and the test repeated for additional 3-day intervals.

After 9 days of test the softened paper samples had lost none of their weight (within the experimental accuracy; i.e. the weight change was not over 4 mg.) and they retained substantially their original softness. In all cases the total hand was well below 20.

On conditioning at low humidities, e.g. at 35% R.H. and 79° F., the papers softened with the mixtures retaining their softness to a large degree and to a considerably greater extent than was the case with papers softened only with sorbitol.

Example 2

Example 1 is repeated twice, except that in place of the sorbitol there is used:

(a) Atlas "Arlex," an 83% aqueous solution of sorbitol mixed with sorbitol anhydrides and other polyhydric derivatives of sorbitol. The "Arlex" is a liquid having an average molecular weight (on a dry solids basis) of 196, a viscosity at 25° C. of about 1700 cps., a specific gravity at 25° C. of about 1.32, and a refractive index of about 1.48, it is soluble in water and methanol and insoluble in mineral spirits at 25° C.

(b) Atlas "G–2401," which is an 85% aqueous solution of hydroxypropylsorbitol. It is a liquid having a hydroxyl number of 1350–1500, a specific gravity at 25° C. of about 1.27, a viscosity at 25° C. of about 2500 cps. and a refractive index of about 1.475. It is soluble in water and 5% aqueous solutions of sulfuric acid, sodium hydroxide, aluminum chloride or sodium sulfate; also soluble in ethanol, methanol, propylene glycol, ethylene glycol

and β-ethoxyethanol, but insoluble in acetone, mineral oil and mineral spirits.

Highly stable soft papers are obtained in each case.

Example 3

In place of the leached wet-strength paper of Example 1 there is used a 100% cellulose wet-strength tea-bag type paper whose fibers are hemp having an average fiber length of about ¼–½", and whose bonding agent is regenerated cellulose. The paper has a basis weight of 8.06 lbs./3000 sq. ft.; a caliper of 1.2 mils; a tensile strength of 5.8 lbs./in. (dry) and 1.6 lbs./in. (wet) in the cross direction; a Mullen burst strength of 6.0 lbs. (dry) and 4.5 lbs. (wet).

The absorbent core which constitutes the major part of the weight of the diaper preferably has no wet strength, so that when placed in a volume of water it will, with slight agitation (as occurs in the flushing of a conventional toilet bowl), disintegrate into a slurry of fibers or small segments. Examples of absorbent materials are water leaf multi-ply crepe wadding or sulfite cellulose fluff, or a defibered flock of bleached softwood kraft fibers, or degreased cotton linters, or combinations thereof. The core will generally have a weight in the range of about 40 to 100 grams of cellulose per square foot of core.

A typical disposable diaper of this invention is shown in the drawing in which FIG. 1 is a perspective view of the diaper and FIG. 2 is a cross-sectional view along the line **2**—**2** of FIG. 1. In the drawing:

The absorbent material is a mass of wood fluff **2** which is the preponderant material by weight in the diaper (e.g. it may be about 6" x 12", about ½" thick and may weight about 15 to 50 g.). To form the absorbent core the wood fluff is enclosed in a thin wrapping of one layer of no-wet-strength tissue paper **4** which keeps the wood fluff particles together. The absorbent core is disposed between two cover layers **5** and **6** of the wet-strength paper. The layers **5** and **6** extend beyond the ends of the core (giving the diaper an area of, for example, 6" x 24"), providing tabs which may be tucked over the child's plastic pants and thereby act to retain the diaper in position on the child. Both edges of one layer **5** are lapped around the absorbent core and under the corresponding edges of the other layer **6** and are spot-bonded, as at **7**, to the tissue paper **4**, as by any suitable adhesive. The layer **6** which is intended for use next to the child's body, is similarly bonded, as at **8**, to the tissue paper at points spaced from the overlapping edges. When the diaper is wet the overlapped edges are held together by the surface tension of the liquid therebetween. This force of the surface tension acts to preclude sliding or other relative movement between the overlapping edges. When it is desired to dispose of the used diaper, it is only necessary to grasp one extended end thereof and place the diaper within the confines of a toilet bowl. Before flushing, the diaper is dipped in the water in the customary manner, commonly used by mothers to remove the bulk soil from cloth diapers. As the cover layers **5**, **6** are respectively secured to the absorbent core only, and not to each other, the action of the water, and the weight of the wet core, causes cover layer **6** to separate from the cover layer **5**. As a result, the soil will be washed into the bowl and the absorbent core will fall into the toilet and disintegrate into a slurry of fibers or small segments. Thereupon, the cover layers may be allowed to drop into the bowl and the entire diaper may be flushed therethrough. Thus, the diaper and its contents is completely disposed of without soiling the hands of the person handling the same.

The cover layers **5**, **6** may contain other additives, such as perfumes and bacteriostatic agents, which are conveniently incorporated with the plasticizer, being added to the aqueous plasticizer solution. For example, a bacteriostatic quaternary ammonium compound may be used, such as para-di-isobutyl-phenoxyethoxyethyl dimethyl benzyl ammonium chloride in amount of 0.016 lb. per 3000 square feet of paper. The perfume may, for instance, be of the coconut extract-synthetic vanillin type used in the amount of 0.01 lb. per 3000 square feet of paper.

Sanitary napkins may be prepared in the conventional manner using the plasticized webs of this invention in place of the non-woven fabrics generally employed as outer wrappers for the sanitary napkins. For example an absorbent cellulose pad, such as is conventionally employed in such napkins (e.g. 7 x 2¼ x ⅝") may be wrapped with a 7" x 19" sheet of the plasticized paper, previously described, in such a manner that the two long edges of the sheet overlap and are bonded together, or to the pad, on the outer surface of the napkin, that is on that side of the napkin which is to be worn away from the body. At the inner surface of the napkin, which is to be in contact with the body, the paper wrapper forms a smooth unbroken layer. The ends of the wrapping sheet extend longitudinally from both ends of the pad to form attaching tabs, for attachment in the usual manner to the sanitary napkin gadget commonly worn by the user.

The plasticizers used in this invention are of course preferably non-toxic and non-irritating to the skin.

It is within the broader scope of this invention to use the plasticizers described here with other wet-strength cellulose webs, such as the known wet-strength substantially structureless non-woven webs, in place of wet-strength paper.

Although the present invention has been described with reference to particular embodiments and examples, it will be apparent to those skilled in the art that variations and modifications of this invention can be made and that equivalents can be substituted therefor without departing from the principles and spirit of the invention.

What is claimed is:

1. A cellulose paper carrying as a softener therefor a mixture of an organic plasticizer and at least 1% lithium chloride based on the amount of said organic plasticizer present.

2. A softened paper as defined in claim **1** which has been treated to impart wet-strength thereto.

3. A paper as defined in claim **2** wherein the organic plasticizer is selected from the class consisting of sorbitol, and hydroxyalkyl ethers of sorbitol, polyethylene glycols, urea and glycerol.

4. A paper as defined in claim **2** wherein the organic plasticizer is sorbitol.

5. A paper as defined in claim **2** wherein the organic plasticizer is hydroxypropyl sorbitol.

6. A softened paper as defined in claim **2** wherein the softener content is from about 5 to 50% by weight.

7. An absorbent article comprising a pad of highly absorbent material covered with a surface layer of a paper as defined in claim **2**.

8. An absorbent diaper article as defined in claim **7**.

9. An absorbent diaper as defined in claim **8** wherein said softened paper is characterized by being resistant to loss of softener on being pressed in contact with said absorbent material for at least 3 days at 120° F. having a wet strength of a least one-half pound per inch in its weaker direction, Gurley porosity such that it passes 100 cc. of air in less than 2 seconds, and a total hand of less than 30.

10. An absorbent diaper as defined in claim **9** wherein the softener content is from about 5 to 50% by weight.

11. A sanitary napkin article as defined in claim **7**.

12. An absorbent diaper article as defined in claim **10** in which the paper contains hemp fibers and a regenerated cellulose bonding agent.

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CHARLES F. ROSENBAUM, *Primary Examiner.*