United States Patent [19]

Mesek et al.

[11] **3,903,890**

[45] **Sept. 9, 1975**

[54] **DISPOSABLE DIAPER OF SIMPLE CONSTRUCTION**

[75] Inventors: **Frederick K. Mesek**, Downers Grove; **Virginia L. Repke**, Oak Forest, both of Ill.

[73] Assignee: **Johnson & Johnson**, New Brunswick, N.J.

[22] Filed: **Aug. 20, 1974**

[21] Appl. No.: **498,892**

[52] **U.S. Cl.** ..... **128/287**; 128/290 R; 128/296

[51] **Int. Cl.**[2] **A61F 13/16**

[58] **Field of Search** ..... 128/287, 290 R, 290 P, 128/296; 161/128, 116

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Primary Examiner—Aldrich F. Medbery

[57] **ABSTRACT**

A disposable diaper of economical and simple construction is provided comprising a highly porous batt of short cellulosic fibers and a water-impervious backing sheet adjacent one surface of the batt. Structural integrity is provided to the batt by a binder material applied to the surface opposite the backing sheet and extending through the batt thickness in spaced linear areas.

14 Claims, 3 Drawing Figures

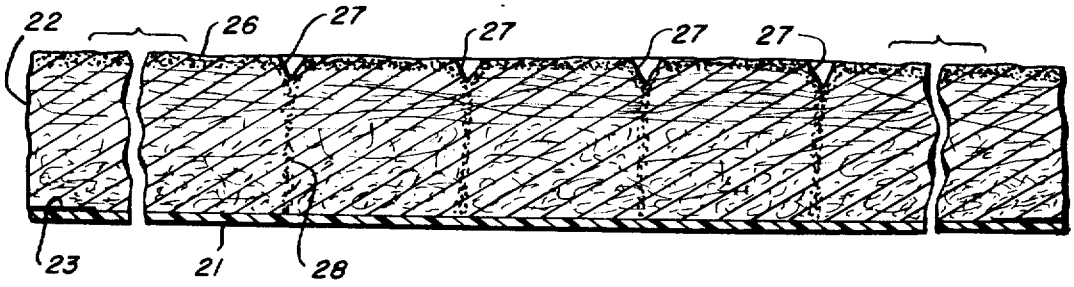


FIG. 2

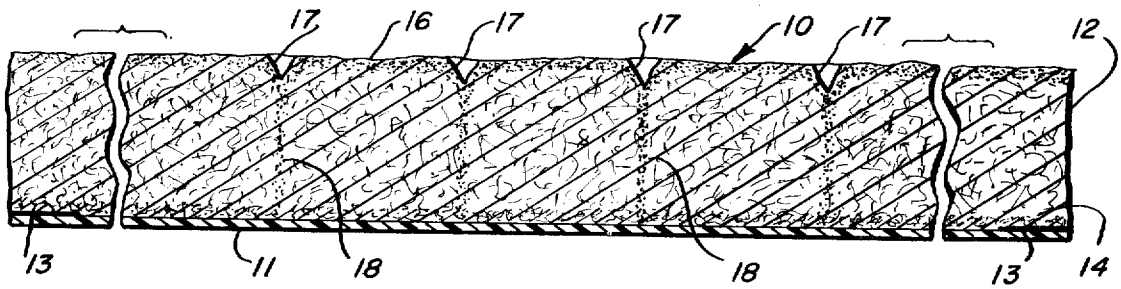


FIG. 3

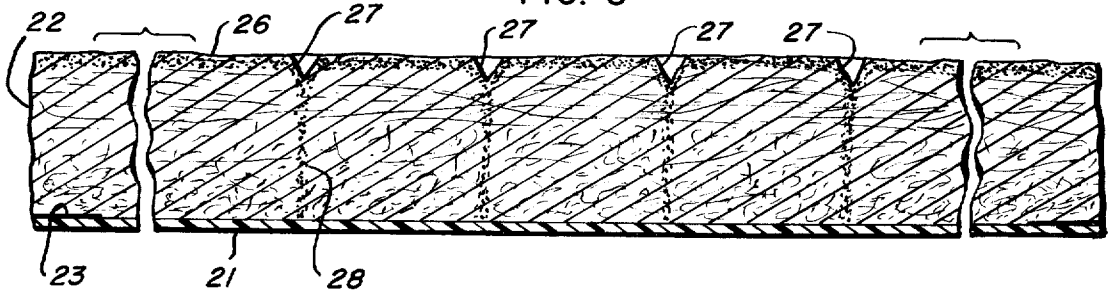
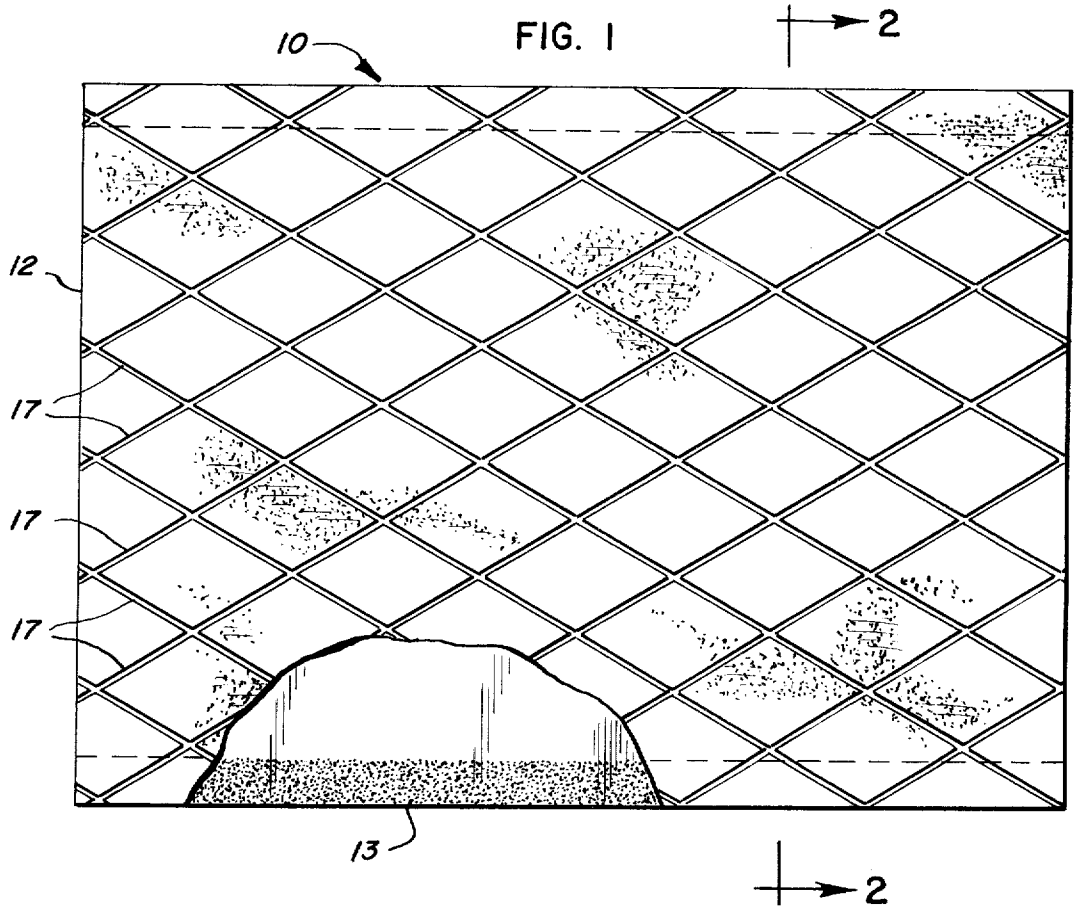


FIG. 1



DISPOSABLE DIAPER OF SIMPLE CONSTRUCTION

BACKGROUND OF THE INVENTION

Disposable diapers provide substantial advantages in convenience over diapers intended to be laundered and reused, particularly when they are used away from home. In recent years, many different disposable diapers have been proposed and some have been successful in the marketplace.

In the usual disposable diaper there are at least two fibrous layers and at least one impervious plastic sheet as the outermost layer to prevent the passage of urine into the bed clothes or outer garments when the diaper is in use. The reason for the use of at least two fibrous layers is that the properties desired for the layer in contact with the infant's skin are at variance, to a large extent, with the properties desired for the portion of the diaper which is not in direct contact with the infant's skin. In the layer intended to be in contact with the infant's skin, generally called th "facing" layer, the properties desired are strength, smoothness, and freedom from shedding or dusting. In the layer of the diaper spaced from the infant's skin the properties desired are high absorbency and low cost. The latter properties are conveniently found in the fibrous batts made of loosely compacted short cellulosic fibers and such batts have very little integral strength and have a substantial tendency to lose fibers by dusting.

From the standpoint of cost and simplicity of fabrication it would be advantageous to have a single fibrous layer which could serve the functions of both the facing layer and the absorbent layer. However, prior to this invention, the satisfactory performance of both the facing function and the absorbent function could not be achieved in a single fibrous layer.

SUMMARY OF THE INVENTION

In accordance with the present invention, a highly porous loosely compacted batt comprised at least primarily of short cellulosic fibers is treated with a liquid resinous binder in certain localized portions to provide a facing surface having the desired strength and the smoothness, and to provide spaced reinforcement to the loosely compacted batt. Specifically, this invention provides a multi-layered disposable diaper having only one fibrous layer and comprising (1) a highly porous batt comprised at least primarily of short cellulosic fibers, and (2) a water-impervious backing sheet adjacent one surface of said batt and bonded thereto in spaced areas of adhesion, the fibers of said batt being bonded together by a resinous binder covering the surface opposite said backing sheet and extending throughout the thickness of said batt in spaced linear areas.

It has been found that upon solidification of the liquid resinous binder on the surface opposite the water-impervious backing sheet, the strength and smoothness of the batt surface is enhanced. It has also been found that upon the solidification of the liquid resinous binder which has been forced or otherwise moved through the thickness of the batt in the spaced linear areas the overall strength of the batt is enhanced without materially detracting from its absorbent capacity.

In a preferred embodiment of this invention, a paper-like, densified, highly compacted layer, or skin, may be formed on the loosely compacted batt on the surface

adjacent the water-impervious backing sheet and opposite the surface to which the resinous binder is applied. The paper-like, densified, highly-compacted cellulosic fibrous layer, or skin, is integral with the loosely compacted batt and is made by lightly moistening the surface of the batt on which the skin is to be formed and thereafter compressing the batt between compression rolls. The paper-like, densified skin is of substantially higher density than the remainder of the loosely compacted batt and therefore tends to draw urine discharge from the remainder of the loosely compacted batt and to spread it laterally within the skin layer away from the point of discharge and toward the edges of the batt. In this manner, a limited discharge of urine is kept as far away as possible from the infants's skin. The purpose of the paper-like densified skin and the manner of its formation is described in more detail in our U.S. Pat. No. 3,612,055, issued Oct. 12, 1971 on application Ser. No. 6,864, filed Jan. 29, 1970.

The fibers of the loosely compacted batt may be composed entirely of short cellulosic fibers, or may combine short cellulosic fibers with textile length fibers, either uniformly throughout the thickness of the batt, or nonuniformly with different relative proportions of short fibers and textile length fibers in different thickness portions of the batt, as described in more detail below.

DESCRIPTION OF THE DRAWINGS

This invention is more readily understood by reference to the drawings, in which:

FIG. 1 is a plan view of the diaper of this invention;

FIG 2 is an enlarged fragmentary cross-sectional view of the preferred embodiment of the diaper of this invention, taken along plane 2—2 of FIG. 1; and

FIG. 3 is an enlarged fragmentary cross-sectional view of another embodiment of the diaper of this invention in which a mixture of fibers is used, the mixture varying in proportions in different thickness portions of the fibrous batt.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings, the diaper assembly **10**, comprises a lowermost water-impervious sheet **11** which is rectangular in shape and a highly water absorbent fibrous pad, or batt **12** which is also rectangular in shape and coextensive with the impervious sheet. The batt and the impervious sheet are adhered to each other at adhesive areas **13** (shown as shaded areas in FIG. 1) along the side margins of the impervious sheet and the batt.

At the surface of the batt adjacent the impervious sheet there is a paper-like densified layer **14** which is an integral portion of the batt and which serves to enhance its strength. In addition, the paper-like densified skin has a greater attraction for urine discharge than the loosely compacted remainder of the batt and tends to draw within itself and to spread rapidly any urine discharged into the loosely compacted portion of the batt.

At the free surface of the batt, the surface opposite the paper-like densified skin **14**, there is a smooth skin **16** formed by the surface fibers of the batt bonded to each other by a resinous binder. There is a series of grooves **17** in skin **16** which, in the particular embodiment shown in the drawings, produces a diamond shaped pattern, as shown in FIG. 1. Immediately below each groove **17** there is a wall of binder **18** extending

throughout the thickness of the batt. The binder walls are in spaced linear areas, sufficiently close to each other to provide strength reinforcement to the batt. Binder walls **18** are generally from about ½ to about 1½ inches apart.

Batt **13** is formed of loosely compacted short cellulosic fibers, such as wood pulp fibers, or cotton linters, or mixtures thereof. In the major portion of the volume of the batt (the portion outside of the densified skin **14**, the binder-impregnated pattern **16** and the binder walls **18**) the cellulose fibers are primarily held together by interfiber bonds, as is known in the art. Briefly, this batt, outside of the paper-like skin **14** and the resin bonded portions **16** and **18** is a low bulk density coherent web of loosely compacted cellulose fibers preferably comminuted wood pulp fibers in the form of so-called "fluff."

The term "short fibers," as used herein, refers to fibers less than about ¼ inch in length, in contrast to "long fibers", or "Textile length fibers" which are longer than about ¼ inch in length, and generally are between about ½ and 2½ inches in length. The former are substantially less costly than the latter. The classification of fibers by length may be carried out by the Clark Classification procedure described in the test manual of The Technical Association of Pulp and Paper Industry (TAPPI-T233 SU64).

The composite density of batt **12**, including its densified layer **14** and including its resin-impregnated portions **16** and **18** should be above about 0.07 gm./cc., and preferably between about 0.10 and 0.15 gm./cc. The foregoing density values are applicable to the diaper as produced. In storage and handling, the loft or thickness of the batt is increased to some extent, resulting in lowered densities.

An important aspect of this invention is the provision for selective wettability between different portions of the fibrous batt, such that the liquid discharge is selectively drawn from the resin-impregnated surface **16** into the unimpregnated portions of the batt and then from the unimpregnated, loosely compacted portions in the body of the batt into the densified layer thereof.

The least wettable portion of the batt is the resin-impregnated surface **16** since the resinous binder tends to be hydrophobic. However, even in the resin-impregnated surface, the ability to be wetted by water is desired. Water repellency in surface **16** is not desired since it can prevent the liquid from penetrating into the loosely compacted absorbent portion of the batt behind the surface, just as a tent fabric can hold back the penetration of rain water. For this reason, a wetting agent, such as an anionic surfactent, is included in the resinous binder to moderate and reduce its water repellency. Surface **16**, after treatment with a resinous binder containing a wetting agent, is receptive to penetration by urine but remains less wettable than unimpregnated portions of the batt.

When the diaper is in use and urine is passed by the infant wearing it, the urine passes through the relatively unwettable binder-impregnated fibers at surface **16** and into the highly wettable fibers in the body of batt **12**. The urine then passes into the densified layer which is made of the same highly wettable fibers as the body of batt **12**, but which has enhanced wicking power for the urine because of its higher density. The urine in the densified layer spreads through a substantial area in the densified layer before any substantial amount flows back into the body of the batt and thereafter spreads through a substantial area in the body of the batt before any substantial amount flows back through surface **16**. Thus, the diaper of this invention acts to keep urine away from the infant's skin as long as possible in the same manner as the more complex and more expensive diapers made from a plurality of fibrous components.

The diaper is also strong and resistant to dusting because of the binder at its outer surface and in the spaced linear areas.

The nature of the binder material used in accordance with this invention is not critical. Binder materials may be either thermoplastic or thermosetting, the latter being preferred for diapers intended to be heat-sterilized. Preferably, the binder material is in the form of an aqueous emulsion or latex.

One binder that has been employed successfully is a self-cross-linking latex of a polyethylacrylate containing small amounts of acrylonitrile and a cross-linking monomer sold under the trademark 2600X120. The binder latex is preferably of a low viscosity type with a viscosity less than 5 centipoises.

Application of the binder composition to the surface of the batt to the batt interior without penetration of the binder may be in the form of a fine spray. Preferably, the binder application is applied in the form of a froth or foam. By its nature, the foam wets the entire surface of the batt without spreading to the batt interior. The foam cells break on the fibrous surface to form, after curing, a network of bonded fibers over the entire surface of the batt.

The binder composition, as stated above, preferably contains a surfactant to avoid water-repellency in the binder-treated fibers. In addition, the surfactant can act as a foaming agent when the binder composition is to be used in the form of a foam.

Suitable surfactants are the alkyl aromatic sulfonates, fatty alkyl sulfates, sulfated oils, sulfated esters, petroleum sulfonates, carboxylic acid soaps, quaternary ammonium compounds, amine salts, and the like. Specific surfactants suitable for producing foam are dodecyl benzene sulfonate, sodium stearyl sulfopropionate, lauryl alcohol sulfonate, monostearylethylenediamine and trimethyl ammonium methyl sulfate. A typical surfactant which has been found to be suitable is the ionic sulfonated alkyl ester sold under the trademark Triton GR-5. The amount of surfactant used may be varied over relatively wide limits of from about 0.18 to about 5 percent based on the weight of the binder, though it is preferred that from about 0.5 percent to 2½ percent of surfactant be used in producing the foamed binder.

The desired binder distribution in the batt used in the diaper of this invention is obtained by compressing the web from which the batt is made between a smooth compression roll (on the dry side of the batt) and a compression roll having ridges corresponding to the spaced linear areas in which the binder is to be distributed (on the side of the batt wet with binder). Compression in the localized linear areas forces liquid binder material from the surface of the web into the body of the web and through its entire thicknesses.

Suitable apparatus for making the batt is similar to that shown in U.S. Pat. No. 3,444,859, issued May 20, **1969** to Frank Kalwaites, except that foam is applied to only one side of the web and the compression rolls are of the type described above, one roll being smooth and the other having ridges.

In the preferred embodiment in which the batt includes a densified, paper-like layer, the layer is preferably formed on the web from which the batt is made prior to the application of binder thereto.

The backing sheet may be placed in juxtaposition to the web from which the batt is made before the application of binder and the application of localized pressure to force the binder into and through the web. In this case, the binder, upon compression, will come into contact with the backing sheet in the areas of compression and will, after curing, serve to adhere the batt to the backing sheet in the localized areas.

In another embodiment, the application of binder, the application of localized pressure to force the binder into and through the web and the curing of the binder takes place before the backing sheet is applied to the web. In this case, the web and backing sheet are adhered to each other independently of the linear areas of the web which contain binder. The adhesion of the web to the backing sheet may be by lines, dots or other discontinuous areas of adhesion distributed throughout the area of contact between the web and the backing sheet, it may be by marginal areas of adhesion either completely around the outer edges of the diaper, or (as shown in FIG. 1) only on the side edges.

In another embodiment of this invention, textile length fibers may be used in combination with the short cellulosic fibers in the loosely compacted batt to provide added strength and better feel. The textile fibers may range in length from about ½ inch to about 2½ inches and may be of either uniform or non-uniform lengths. Suitable textile fibers are those of rayon, polyester, cellulose acetate, nylon, etc.

The textile length fibers may be uniformly blended with the short fibers by air laying techniques in weight proportions up to about 25 percent, as disclosed in Liloia et al, U.S. Pat. No. 3,663,348, issued May 16, 1972, the disclosure of which is hereby incorporated by reference.

Alternatively, and as illustrated in FIG. 3, the textile fibers may be blended in a non-uniform manner so that the proportion of short and long fibers varies at different thicknesses. In such non-uniform blends, it is preferable that an enriched concentration of textile fibers be present at face 26, opposite backing sheet 21, so that strength and smoothness are provided at the outermost face. Face 26 has grooves 27, similar to groves 17 of FIG. 2, and is impregnated into resin to a short depth near face 26.

The remainder of batt 22 has a lower proportion of long fibers and has spaced resin-impregnated areas 28, similar to areas 18 of FIG. 2. The batt is adhered to the backing sheet at areas 23 similar to areas 13 of FIG. 2.

Batts of the nature of batt 22 may be prepared by any of several methods. A preferred method utilizes separate feeds of short and long fibers to each of two counter-rotating lickerins from which the fibers are picked up in separate gas streams and thrown toward each other so that they cross over each other before the fibers are deposited onto a foraminous belt below the lickerins. Such methods are described in the copending, coassigned application of Ruffo et al, Ser. No. 108,546, filed Jan. 21, 1971, the disclosure of which is hereby incorporated by reference. Webs of the nature of those disclosed in said Ruffo et al application have a concentration of long fibers in excess of the overall concentration at face 26, a concentration of short fibers in excess of the overall concentration at the face adjacent the backing sheet and a gradual transition between these faces.

In still another embodiment of this invention, batt 22, instead of being substantially uniform thickness as shown in the drawings, may be shaped to be thicker in its mid-portion in transverse cross section and thinner near its side edges. A batt of this type is advantageous in that it is more conformable when wrapped around an infant and in that it concentrates the maximum weight of absorbent in the portion of the diaper most likely to be the site of wetting.

Batts having a shaped transverse contour with a peak at the mid-portion may be made in several ways. For example, the method of the aforementioned Kalwaites U.S. Pat. No. 3,444,869 may be modified by feeding two pulp boards to hammer mill 12 rather than the single pulp board 11 and centrally disposed therewith. Alternatively, the opening below the hammer mill and above the belt may be diamond-shaped, or octagonal so that the center line of conveyor 13 is under the opening for a longer period than the sides of the conveyor and thus gets more of a deposit of fibers.

In the embodiment of the invention described above the resinous binder has been applied solely to the surface of the batt opposite the surface adjacent the backing sheet. In some cases, however, it may be desirable to apply the resinous binder to both surfaces of the batt before bringing the batt into contact with the backing sheet so that the application of pressure in the localized linear areas forces the liquid binder from both surfaces into the interior of the batt and throughout its thickness in those localized areas. In this embodiment, a smaller amount of binder is required on the surface opposite the backing sheet since the binder is forced inwardly from both surfaces; and this embodiment may be preferred with binders tending to impart a harsh feel to the outer surface when used thereon in greater amounts.

It will be understood by those skilled in the art that other variations and modifications of the specific embodiments described above may be employed without departing from the scope of the invention as defined in the appended claims.

We claim:

1. A multi-layer disposable diaper comprising (1) a highly porous batt comprised at least primarily of short cellulosic fibers and (2) a water-impervious backing sheet adjacent one surface of said batt and bonded thereto in spaced areas of adhesion, the fibers of said batt being bonded together by a resinous binder covering the surface opposite said backing sheet to provide a smooth permable skin as a body contacting surface of said batt, said resinous binder extending throughout the thickness of said batt in spaced linear areas.

2. The diaper of claim 1, wherein said batt includes a densified, paper-like layer adjacent said impervious layer.

3. The diaper of claim 1, wherein said backing sheet is adhered to said batt by said binder in said spaced linear areas.

4. The diaper of claim 1, wherein said backing sheet is adhered to said batt by a separate adhesive in the marginal areas of the region of contact between said backing sheet and said batt.

5. The diaper of claim 1, wherein said binder contains a surfactant.

6. The diaper of claim 1, wherein said binder is a thermoset material.

7. The diaper of claim 1, wherein said highly porous batt is comprised entirely of short fibers.

8. The diaper of claim 1, wherein said highly porous batt is comprised of short fibers and long fibers.

9. The diaper of claim 8 wherein said short and long fibers are uniformly blended.

10. The diaper of claim 8 wherein said batt comprises different proportions of short and long fibers at different thickness portions thereof with a maximum concentration of long fibers at the surface opposite said backing sheet.

11. A method of making a diaper comprising the steps of applying a liquid resinous binder to a surface of a highly porous batt of short cellulosic fibers, compressing said batt in spaced linear areas to cause said liquid resinous binder to move through the thickness of said batt in said area, solidifying said binder to provide a smooth fluid permable skin as a body contacting surface of said bott and to form spaced binder walls extending throughout the thickness of the batt and adhering the surface of said batt opposite said first named surface to a water-impervious backing sheet.

12. The method of claim 11, wherein said liquid resinous binder is applied as a foam.

13. The method of claim 11, wherein said liquid resinous binder is an aqueous latex of a thermosetting material.

14. The method of claim 11, wherein said liquid resinous binder contains a surfactant.

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Notice of Adverse Decision in Interference

In Interference No. 99,302, involving Patent No. 3,903,890, F. K. Mesek and V. L. Repke, DISPOSABLE DIAPER OF SIMPLE CONSTRUCTION, final judgment adverse to the patentees was rendered June 29, 1977, as to claims 1, 4, 5, 6, 7, 8, 9, 11, 13 and 14.

[*Official Gazette September 20, 1977.*]