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[72] Inventors **Ingemar Croon**
Alfredshem, Sweden;
Nils Blomqvist, Ornskoldsvik, Sweden

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[73] Assignee **Mo och Domsjo Aktiebolag**
Ornskoldsvik, Sweden
a corporation of Sweden

[54] **DISPOSABLE DIAPER AND PROCESS AND APPARATUS FOR MAKING THE SAME**
10 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **128/287**
[51] **Int. Cl.** **A61f 13/16**
[50] **Field of Search** 128/284, 286, 287, 290, 296

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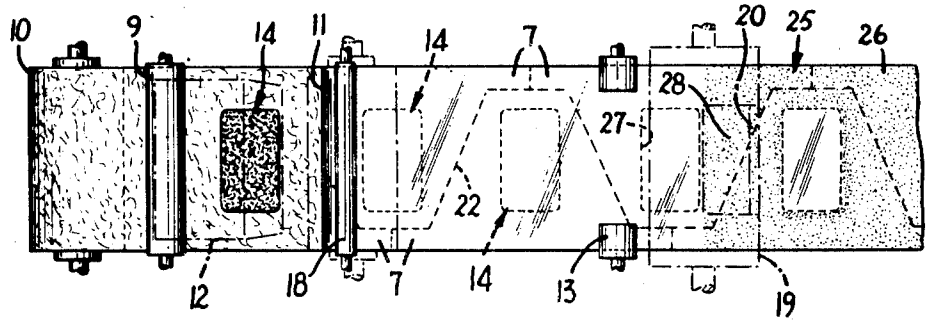
Primary Examiner—Charles F. Rosenbaum
Attorney—Janes and Chapman

ABSTRACT: Disposable diapers are provided comprising an absorbent layer of cellulose fluff fibers enclosed between a water-impervious plastic sheet and a water-pervious sheet material, such as a non-woven fabric.

A process and apparatus are provided for manufacturing disposable diapers having an absorbent layer interposed between a water-impervious sheet and a water-pervious sheet in which the absorbent material is laid down on the water-pervious sheet material, the water-impervious sheet material then placed on top, and the composite bonded together by use of an adhesive binder or heat and pressure. In this way, a long endless strip of disposable diapers placed end-to-end is formed, from which the diapers can be cut off as required. Apparatus for continuously forming diapers of this type also is described.



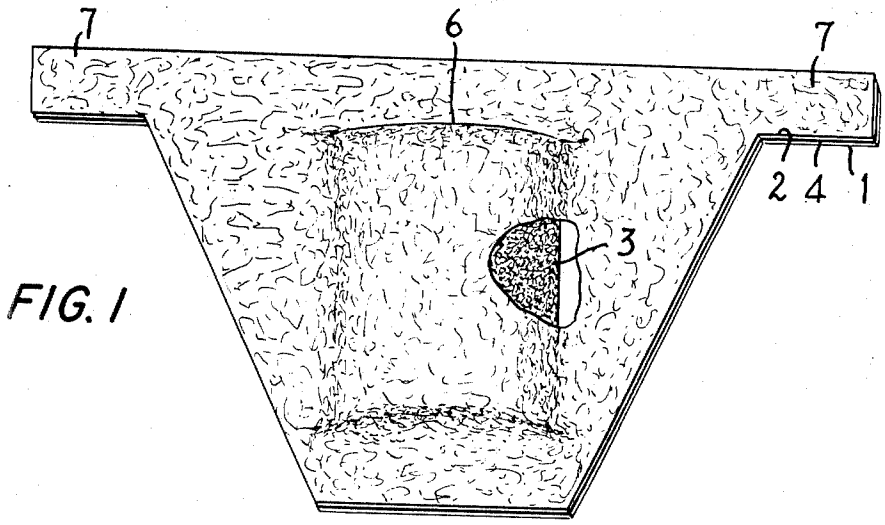


FIG. 1

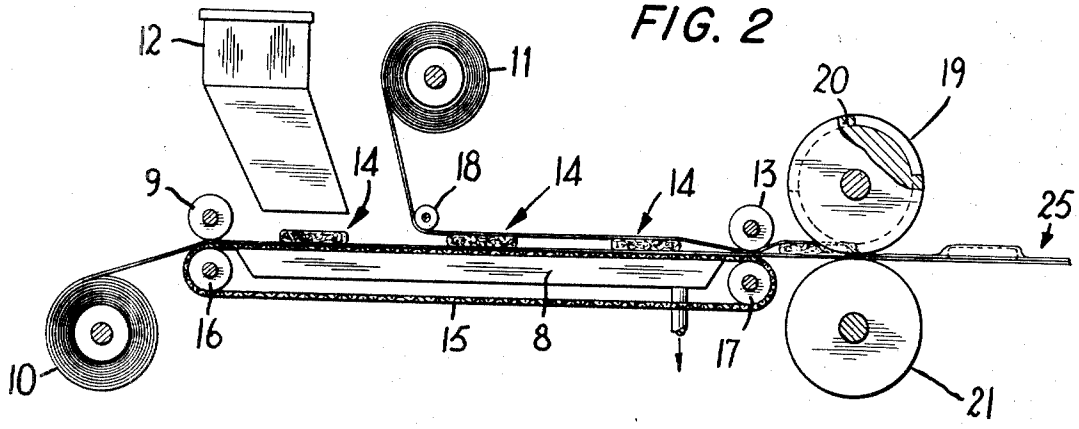


FIG. 2

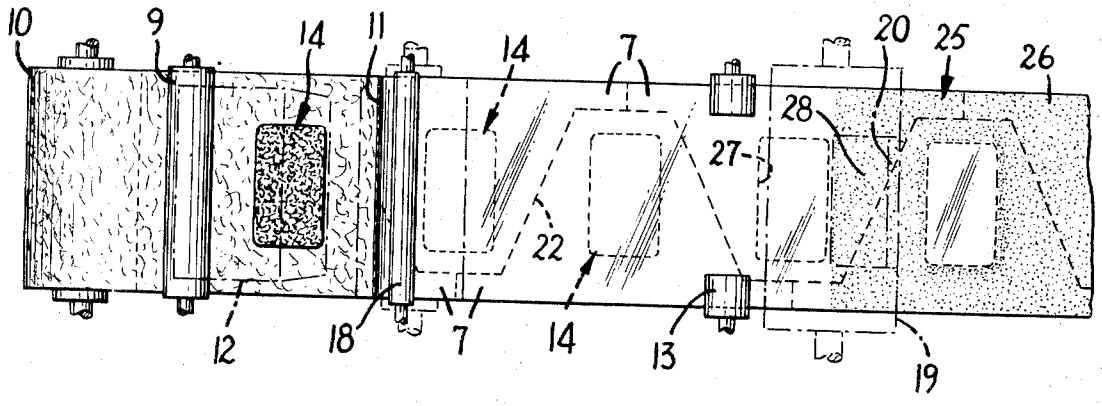


FIG. 3

DISPOSABLE DIAPER AND PROCESS AND APPARATUS FOR MAKING THE SAME

This invention relates to disposable diapers, and to apparatus and a process for making the same, and more particularly, to disposable diapers comprising an absorbent layer of cellulose fluff fibers enclosed between a water-impervious sheet material, and a water-pervious sheet material, such as a non-woven fabric.

Many efforts have been made to develop practicable disposable diapers, but the diapers that have been made available have not received wide consumer acceptance. Despite the burdensome nuisance of collecting and washing cloth diapers for reuse, these are still preferred by most mothers, partly because of the relatively high cost of the available disposable diapers, and partly because these disposable diapers have not been able to match the absorbency of cloth diapers.

The problem is nicely summarized in U.S. Pat. No. 2,788,786, patented April 16, 1957, to Dexter. Dexter points out that the available disposable diapers have not provided sufficient absorbency without sacrificing characteristics considered necessary to facilitate their disposability. Because of the limited capacity of ordinary waste disposal channels, Dexter accordingly designed his diaper so that it could be easily disposed of by dumping the absorbent material through household plumbing channels.

Various types of disposable diaper constructions have been suggested. Le Bolt, U.S. Pat. No. 2,649,858, patented August 25, 1953, describes a two-ply diaper composed of an inner ply of soft, non-irritating material, such as paper, and an outer ply composed of absorbent material, such as cellulose wadding, preferably in several layers secured together. The entire diaper is formed of this material. A three-ply structure is also described, in which the outer sheet is composed of a waterproof or water-resistant material.

McGraw, U.S. Pat. No. 2,290,110, patented July 14, 1942, describes a disposable diaper made of soft paper, with a seat and crotch of absorbent material such as cotton.

U.S. Pat. No. 2,627,858 to Miller, patented February 10, 1953, provides a diaper composed of an inner sheet of thin sheet material, such as tissue paper or rayon pulp cloth, an outer sheet made of a material such as a wet-proof paper that prevents moisture from escaping from the inside of the diaper, and a filler made of cellulose or similar pulp material interposed between the inner and outer sheets. The filler layer extends throughout the diaper, but a supplemental filler layer of cellulose material similar to the main layer is interposed at the crotch portion of the diaper to provide extra padding and absorbent filler material where it is most needed.

These various types of diapers are bulky, as pointed out by Dexter, because of the relatively low absorbency of the absorbent material employed. Dexter provides a diaper having an outer layer of water-repellent material, an inner layer of water-absorbent material, and an open pocket in the central portion of the diaper for a removable multi-layered pad of highly absorbent material, which can be dumped from the pocket in disposing of the diaper, and thus greatly reduce the bulk of the material being disposed of.

In accordance with the invention, a disposable diaper is provided having a relatively high absorbency compared to previously available disposable diapers. This high absorbency is obtained by employing as the absorbent material cellulose fluff fibers. The layer of absorbent material is interposed between an inner layer of water-pervious sheet material, and an outer layer of water-impervious sheet material. Because of the high absorbency of the absorbent layer, the bulk of the diaper can be greatly reduced, if desired, or, alternatively, a very much higher absorbent capacity obtained for a thickness comparable to that of previously available diapers.

The invention also provides an improved process and apparatus for manufacturing disposable diapers having inner and outer facing layers enclosing an absorbent layer therebetween. This process and apparatus are capable of producing a long or endless strip of disposable diapers arranged side-by-side or end-to-end. The disposable diapers can be cut off this strip or length whenever required. In one preferred embodiment, the boundaries between abutting disposable diapers on the strip are perforated or otherwise weakened to facilitate tearing, and the disposable diapers can then be separated from the strip, one at a time, much as in the manner of paper toweling.

In the process of the invention, water-pervious sheet material is employed as a base material, on which is laid down, either at spaced portions, or continuously, the absorbent layer of the disposable diaper. There is then superimposed thereover the water-impervious sheet material, and this is bonded to the water-pervious sheet material at spaced portions, thus forming the disposable diaper.

The apparatus in accordance with the invention comprises, in combination, means for feeding water-pervious sheet material from a supply source, means for feeding water-impervious sheet material from a supply source, means for laying down on the water-pervious sheet material, absorbent particulate material to form an absorbent layer thereon, means for covering the absorbent layer with water-impervious sheet material, and means for bonding the water-impervious and water-pervious sheet materials together, thereby enclosing the absorbent layer therebetween. Such apparatus optionally includes means for weakening the sheet material between abutting disposable diaper portions of the composite, so as to readily separate such disposable diaper portions from each other.

The drawings illustrate preferred embodiments of the invention.

FIG. 1 represents one form of disposable diaper in accordance with the invention.

FIG. 2 represents a side view of apparatus for forming a disposable diaper of the type shown in FIG. 1.

FIG. 3 represents a top plan view of the apparatus of FIG. 2.

The disposable diaper in accordance with the invention features as the absorbent material cellulose fluff fibers of high absorbency.

Cellulose fluff fibers are cellulose pulp fibers less than 5 mm. in length, and preferably less than about 3 mm. in length. The shorter the fibers, the denser and more relatively non-compressible the absorbent layer is. Also, the fibers are then less subject to breaking under wet conditions, and therefore give a stronger structure. For maximum density and non-swellability at least 20 percent by weight of the fibers should be less than about 0.8 mm. in length.

Cellulose fluff fibers are obtained by the disintegration of wood pulp in sheet or flash-dried form, using mechanical disintegrating apparatus. Such processes are well-known and form no part of the instant invention. The process and apparatus must be of the type that separates the fibers in an efficient way, without cutting the fiber too much. Overcutting the pulp fibers results in cellulose flour, which is unsuitable for the absorbent layer of the invention, and the proportion of cellulose fibers accordingly held to a minimum.

As the source of cellulose fluff fibers there can be used any pulping wood, such as spruce wood, pine wood, hemlock wood, fir wood, birch wood, and other types of coniferous and hard woods.

The cellulose fluff fibers that are preferred for use in the invention are obtained by disintegrating chemical cellulose pulp prepared by the sulfate or sulfite method in such a way that the fibers are set free from the pulp while at the same time avoiding the formation of fiber bundles or knots and cutting of the fibers. This disintegration can be carried out in an apparatus such as a shredder or hammer mill or a disk refiner or a set of circular sawblades mounted on a rotating axis, or a combination of these. For instance, the chemical pulp in the form of sheets can be first roughly dry-disintegrated in a shredder or hammer mill and then further disintegrated in a disk refiner. If the pulp is in the form of rolls, it is possible to

disintegrate it directly in one step in a hammer mill. It is not necessary, and in fact it is undesirable, to materially shorten the fibers of the cellulose pulp after such disintegration, and therefore the disintegration technique and apparatus used should be specially adapted to avoid this, using the known techniques.

It is preferred that the cellulose fibers fall within the following ranges of fiber length distribution:

TABLE I

Fiber Length Range	Percent Distribution
Less than 5 mm. but more than 0.833 mm.	30 to 60.
Less than 0.833 mm. but more than 0.417 mm.	10 to 40.
Less than 0.417 mm. but more than 0.208 mm.	10 to 40.
Less than 0.208 mm. but more than 0.104 mm.	10 to 40.
Less than 0.104 mm.	0 to 20.

In fluff, the proportion of the median fraction of the fibers is somewhat greater than in ordinary chemical pulp. As a result of this difference, small as it is, in the distribution of fibers, fluff fibers have a higher bulk and a greater absorption than ordinary chemical pulp fibers.

Fluff fibers are rather different in physical nature from tissue fibers, which are also obtained from cellulose pulp, but are prepared by a different process. Tissue fibers are obtained by placing sheets or bales of chemical or mechanical cellulose pulp in hollanders, where the pulp is beaten with water. The suspension obtained can then be stored and is next transported to beaters, after dilution to a pulp concentration of 0.5 to 1.5 percent. The beater can be a disk refiner, or a Jordan mill employing a rotating cone, and the beating is mild. After the beating, water is removed from the suspension in an uptaking machine. The fiber length distribution of the resulting tissue fibers is similar to that of fluff fibers, but the product is paper-like, and not bulky. The absorption capacity of tissue fibers is from one-third to one-fourth that of fluff fibers.

Consequently, tissue fibers are not desirable in the manufacturing of diapers in accordance with the invention, because of their low absorption capacity.

Cotton cellulose fibers differ materially from cellulose pulp fibers. They are materially longer, greatly exceeding 5 mm. in length. Because of their length, they are subject to breakage and rupture, and give diapers which are not as strong as those obtained using cellulose pulp fibers. Moreover, they are more expensive. Consequently, they are not employed in the diapers of the invention.

The water-pervious layer can be any porous flexible sheet material that has a high wet strength. By high wet strength according to the present invention is meant from three to six kilograms per 50 millimeters strip in the length direction and from 0.3 to 1 kilograms per 50 millimeter strip in the transverse direction as measured according to TAPPI 456 m—49. Textile fabrics of material and synthetic fibrous material can be used. Non-woven mats, sheets and fabrics of nonabsorbent synthetic fibers or impregnated or coated natural fibers are preferred sheet materials. The non-woven materials are cheap, and would normally be employed. These materials can be made of any type of synthetic fiber, such as acetate rayon, nylon, polyacrylamides, polyvinyl chloride, polyvinylidene chloride, terephthalic acid-ethylene glycol polymers (Dacron), polyacrylonitrile (Orlon and Vinyon N), polyethylene, and polypropylene, or of natural fibers impregnated or coated with a sufficient amount of such materials to render them nonabsorbent, or of high wet modulus viscose rayon fibers.

For greatest strength and resistance to disintegration in use, the fibers of the water-pervious non-woven sheet material are preferably bonded at their points of crossing by a synthetic resin binder material, such as a thermoplastic or thermosetting resin. The amount of binder that is employed should not materially reduce the porosity of the sheet, nor should the resiliency thereof be greatly affected, since an unduly rigid sheet material is hard to fold and wrap around the baby. Flexibility of the sheet material is very desirable and has very little effect on the strength of the final product. Relative non-compressibility can be obtained because of the nature of the cellulose fluff fiber layer. This layer can be laid down and compacted very tightly, and consequently makes possible a relatively low bulk for its absorbency of the diapers of the invention, as compared to the known products.

Among the binder materials that can be used are polyvinyl chloride, polyethylene, polypropylene, nylon, polyacrylonitrile, ethylene glycol-terephthalic acid copolymers, polyvinyl acetate, copolymers of vinyl acetate and vinyl chloride, polyvinyl butyral, polytrifluorochloroethylene, urea-formaldehyde, melamine-formaldehyde, phenol-formaldehyde, and alkyd resins. It is very suitable to use a binder comprising the same material as the fibers. These can be formulated into binder compositions of conventional type, including plasticizers, pigments, and fillers. Such compositions are well known, and form no part of the instant invention. In all cases, however, the binder composition should be resistant to and insoluble in body fluids.

The water-impervious layer can be any plastic sheet material. Synthetic resin films are easily available and inexpensive, and consequently are preferred. Among the plastic sheet materials that can be employed are polyethylene, polypropylene, polyvinyl chloride, copolymers of vinyl chloride and vinyl acetate, polyvinylidene chloride, chlorinated rubber, polyvinyl butyral, and chlorinated polyethylene. Cellulose derivative films also can be employed, such as cellulose acetate, and cellulose acetate propionate. Some forms of cellophane are water-impervious, and this also can be used. This sheet should also be flexible.

Because of the high absorbency of the cellulose fluff fiber absorbent layer, it is really unnecessary that the absorbent layer be present in any portions of the disposable diaper other than those in the area of the crotch and directly above and below the crotch. In the remaining portions of the diaper, the inner and outer facing layers can be securely bonded together, thus reducing the thickness and increasing the strength of the diaper, and preventing the absorbent layer from shifting about in the space between these layers, in effect confining it to a pocket at the crotch area.

The inner and outer facing layers can be bonded together by use of an adhesive or binder. Any of those referred to above as binders for the water-pervious layer can be employed. It is preferred, however, that the inner and outer sheets be at least in part of thermoplastic material, so that they can be bonded together by application of heat and pressure sufficient to soften and fuse the sheets together. This greatly facilitates manufacture of the diaper, using, for example, the process and apparatus of the invention. If the materials of which the inner and outer facing layers are made is solvent-softenable in whole or in part, a solvent can also be employed to effect bonding therebetween.

In one embodiment, the inner and outer facing layers are bonded together throughout the area of the diaper, except in the portions in which these layers are separated by the absorbent layer. In another embodiment, the inner and outer facing layers are bonded together only at bands or lines, by heat and pressure or by an adhesive, along the boundary of the pocket area, and also along the external periphery of the diaper, with additional bands or lines, if desired in intermediate portions, for greater strength. In still another embodiment, the diaper can have the inner and outer facing layers bonded together at spaced portions in a haphazard or regular pattern, so as to permit flow of fluid between the facing layers, but with a continuous bond along the external periphery of the diaper, so as to prevent escape of fluid from the interior of the diaper at the outer seam.

The disposable diaper illustrated in FIG. 1 is composed of an outer water-impervious layer of polyethylene film 1 and an

inner water-pervious layer of non-woven acetate rayon material **2**, in which the fibers are bonded together by a cellulose acetate binder. Held therebetween, and slightly compressed, is a layer **3** of cellulose fluff fibers obtained from bleached sulfite pine pulp. The inner and outer facing layers are bonded together at their interface **4** in band areas **26,28** outside the pocket portion **6** by application of heat and pressure, so as to fuse the inner and outer layers together at these points, and completely seal the pocket portion on all sides. The absorbent layer **3** is confined to the pocket portion **6** in this way, and cannot be removed without tearing the diaper apart.

The diaper is formed in a generally trapezoidal shape, with two end flaps **7** so as to facilitate application to the baby. It can, however, be formed in any desired shape, such as square, rectangular, elliptical, circular, triangular, or in any polygonal shape. For instance, any of the shapes of U.S. Pat. Nos. 2,788,786, 2,627,858, 2,290,110, and 2,649,858 can be employed, if desired. Other shapes and configurations will be apparent to those skilled in this art.

Such a diaper is readily obtained as a continuous strip of disposable diapers arranged side-by-side (or end-to-end) employing the apparatus shown in FIGS. **2** and **3**. This apparatus includes a storage supply roll of water-pervious sheet material **10** such as a non-woven acetate rayon material, a storage roll of plastic film **11**, such as polyethylene film, and a hopper **12** for supplying at spaced portions of the sheet material **10** pads or layers **14** of absorbent fibers, in this case, cellulose fluff fibers.

For support of the sheet material during laydown of the pads **14**, an endless band of stainless steel wire mesh **15** is provided. This is rotated clockwise about guide roll **16** and driven roll **17**. Guide rolls **9** and **13** direct the sheet **10** upon the belt, and suction box **8** draws a flow of air through the material **10** to hold it and the pads **14** on the belt **15**. Guide roll **18** directs the sheet **11** into place on top of the composite of **10** and **14**. Heated pressure rolls **19** and **21** are provided, for bonding the inner and outer facing layers **10,11** together, to form the diaper.

In operation, the water-pervious sheet material **10** is fed from the supply roll to the upper surface of the endless belt **15**. The flow of air drawn down through the sheet by suction box **8** holds the material firmly on the belt.

Pads **14** of cellulose fluff fibers are deposited in spaced portions on the sheet material **10**. These portions constitute the absorbent layer of the final diaper.

The plastic film **11** is fed from the supply roll beneath the guide roll **18** into close contact with the upper face of the absorbent layer portions **14**, and the composite is then fed beneath the guide roller **13**, which compacts the absorbent layer slightly, and brings the plastic film closer to the water-pervious layer on the mesh belt. The composite then passes between the heated pressure rolls **19** and **21**, where the plastic film is brought smartly against the base layer of water-pervious film, and bonded thereto by heat and pressure throughout the portions in which they are thus brought in contact. The two sheets **10,11** are thus united everywhere except where they are kept apart by the pads **14**.

The rollers **19,21** shown have a recessed central portion, with raised end portions extending circumferentially and with raised ribs **20** extending lengthwise of the rollers, spaced apart by a distance equal to the width of the pads **14**. Thus, they effect bonding between the layers **10** along the periphery of the strip as a narrow band **26**, and crosswise of the strip as bands **28** on each side of the pads **14**, thus wholly enclosing the pads **14** in a pocket **27**. Any design or pattern of such limited band or line contact bonding between the juxtaposed upper and lower facing layers can be effected by providing these rolls with appropriately placed raised portions, thus effecting heat sealing only at the raised portions of the rolls. The finished diapers **25** are still an integral part of the strip, and can be rolled up and stored or transported, as desired. The rolls can be sold as such, and the diapers cut off by the housewife or mother.

The juxtaposed diapers can be cut off the strip, in the manufacturing plant, if desired, by cutting in the desired shape for the diaper. Since the pads **14** are in fixed relation to each other on the strip, diapers in an eccentric shape, such as a trapezoid, are cut out along line **22**, so as to use the strip material in the most efficient manner. The shape shown is trapezoidal, with end flaps **7**, as is best seen in FIG. **3**. The cutting knife cuts in the diagnonally disposed line **22** across the sheet, and first the line defines the flaps on one side and then on the other side of the strip.

It is also possible to simply apply weakening lines, such as score lines or perforations across the strip at these portions, in the pattern or shape of the diaper, and wind up the finished strip of disposable diapers in a roll, from which the disposable diapers can readily be separated by tearing along these lines by the housewife or mother.

The process and apparatus of the invention are best used in the preparation of the disposable diapers of the invention. However, they can also be used in the preparation of any type of disposable diaper, having an absorbent layer enclosed between bonded-together inner and outer facing layers of water-pervious and water-impervious sheet material. In such layers, the absorbent material need not be cellulose fluff fibers. Other types of absorbent material can be used, such as cotton wadding, cotton fibers, cellulose pulp fibers, cellulose tissue fibers, and other types of absorbent fibers. These can be confined in the crotch area or can be distributed throughout the space between the inner and outer facing layers of the diaper.

I claim:

1. A strip of disposable diapers consisting essentially of an inner water-pervious facing layer of sheet material, an outer water-impervious facing layer of sheet material, and enclosed therebetween an absorbent layer of cellulose fluff fibers, the diapers being arranged in side-by-side relationship, composed of a long strip of the inner and outer facing materials, and spaced portions of the absorbent material disposed therebetween, the strip being weakened along the boundaries of the juxtaposed disposable diapers to facilitate separation of the diapers from the strip.

2. A strip of disposable diapers according to claim **1**, in which the strip is weakened by perforations along such boundaries.

3. A strip of disposable diapers according to claim **1**, in which the inner water-pervious facing layer comprises a non-woven fibrous sheet material.

4. A strip of disposable diapers according to claim **3**, in which the non-woven sheet material comprises acetate rayon fibers.

5. A strip of disposable diapers according to claim **1**, in which the outer water-impervious sheet material is a plastic film.

6. A strip of disposable diapers according to claim **5**, in which the plastic film is a synthetic resinous material.

7. A strip of disposable diapers according to claim **6**, in which the synthetic resinous material is polyethylene.

8. A strip of disposable diapers according to claim **1**, in which the inner and outer facing layers are bonded together by heat and pressure at spaced portions defining a pocket therebetween in which the absorbent layer of cellulose fluff fibers is confined.

9. A strip of disposable diapers according to claim **1**, the individual disposable diaper portion being in a generally trapezoidal shape.

10. A strip of disposable diapers according to claim **9**, the diaper portion having end flaps at opposite sides of the long side of the trapezoid, to facilitate wrapping the diaper about a baby.