

[54] **DISPOSABLE DIAPER WITH IMPROVED LINER MATERIAL**

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[51] Int. Cl.A61f 13/16

[58] Field of Search128/284, 287, 290; 161/148

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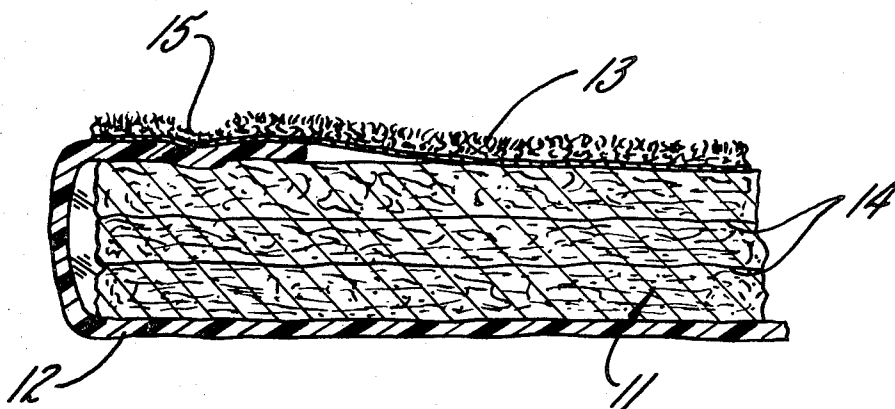
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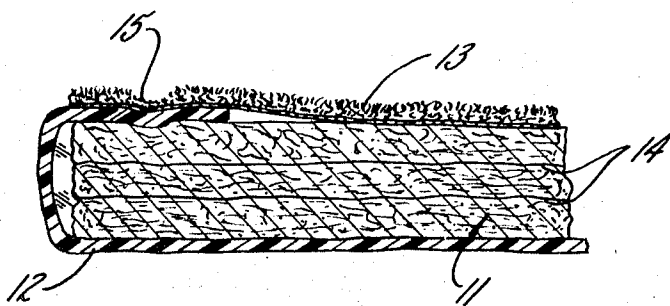
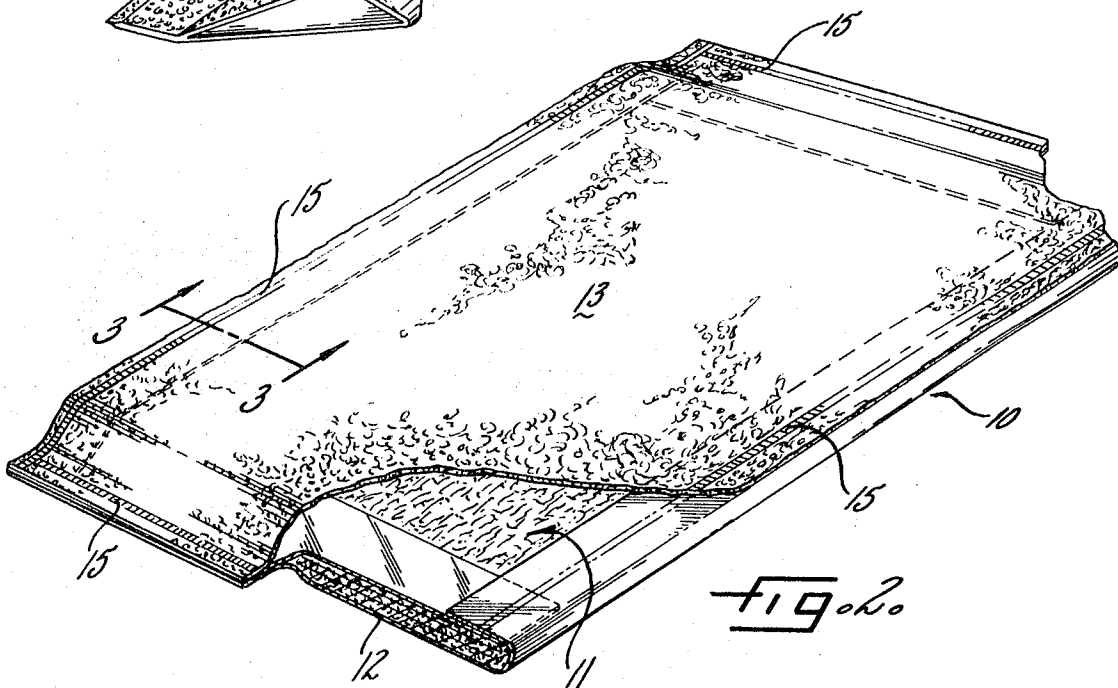
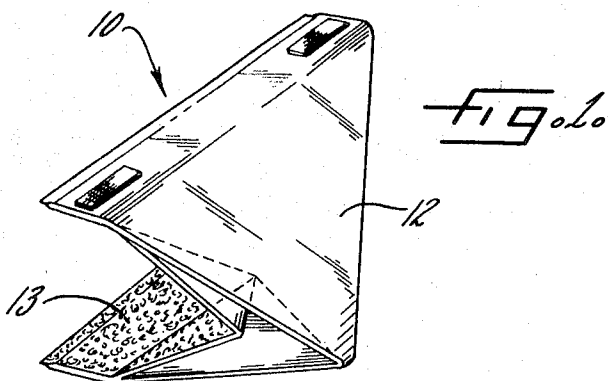
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[57] **ABSTRACT**

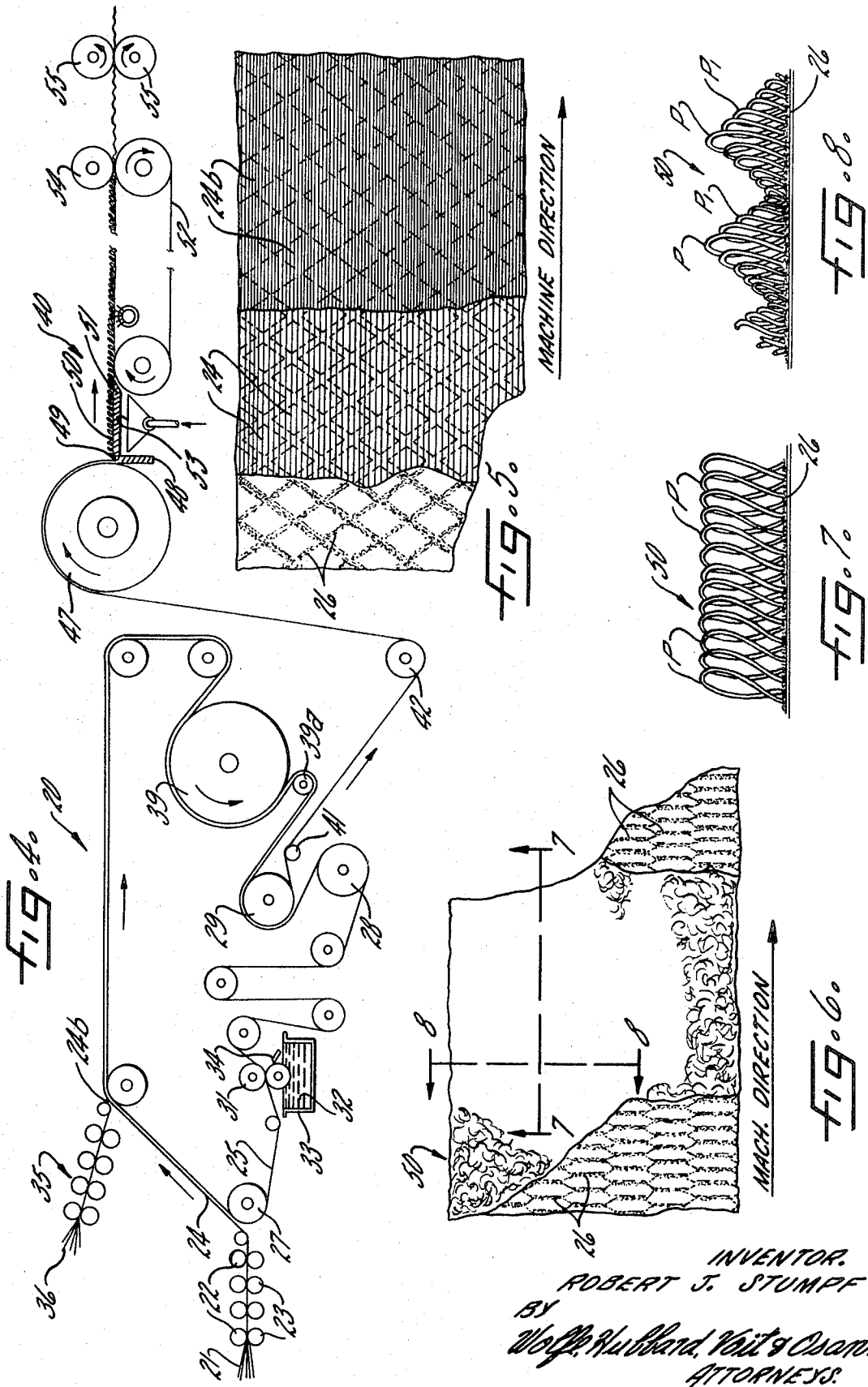
A disposable diaper having a conventional central pad of absorbent material, a conventional layer of fluid impervious material disposed on one side of the central pad and extending around the edges thereof, and an improved liner material disposed on the other side of the central pad and joined to the fluid impervious material around the periphery of the pad. The improved liner material comprises a high-loft, nonwoven fabric having a discontinuous backing layer of flexible adhesive, and including a multiplicity of hydrophobic fibers individually looped outwardly away from the backing layer with the ends of each loop embedded in the backing layer.

10 Claims, 13 Drawing Figures





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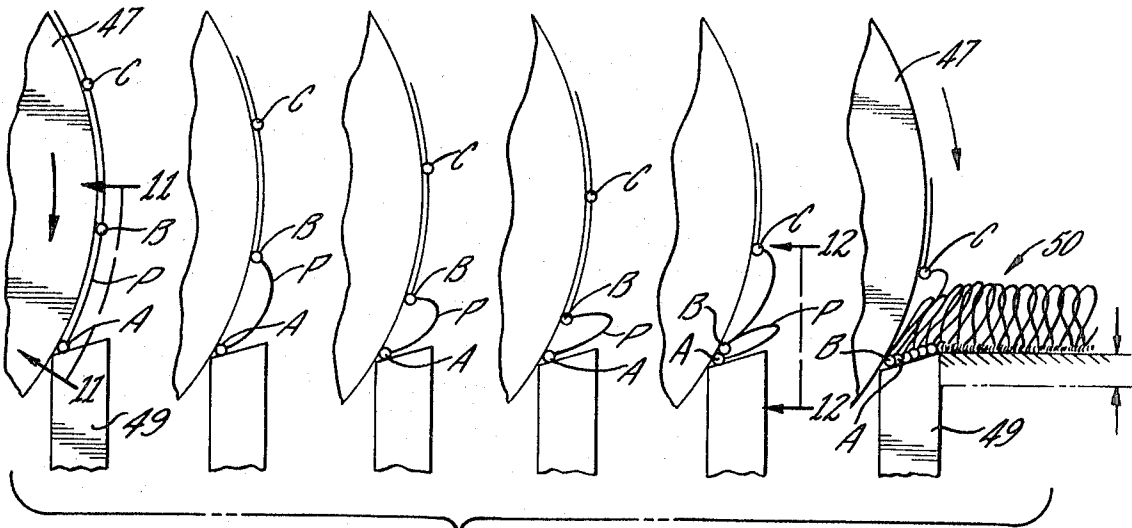


FIG. 10

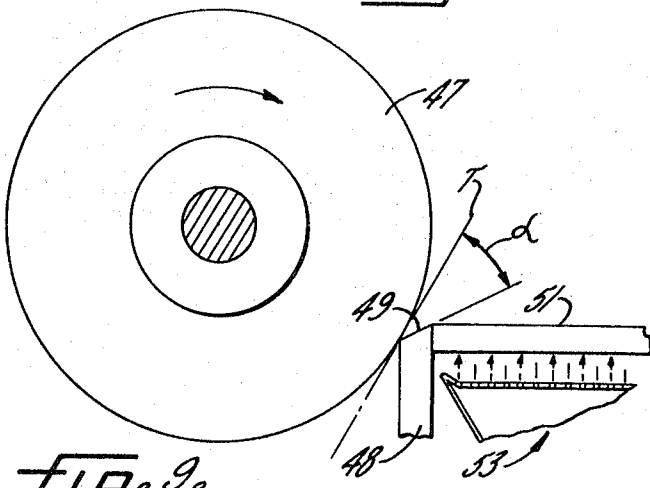


FIG. 9

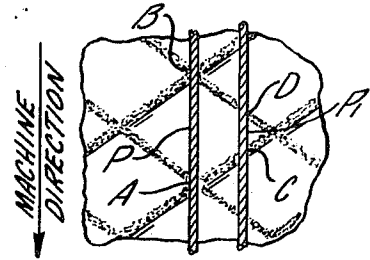


FIG. 11

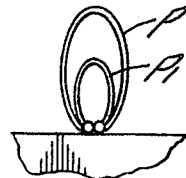


FIG. 12

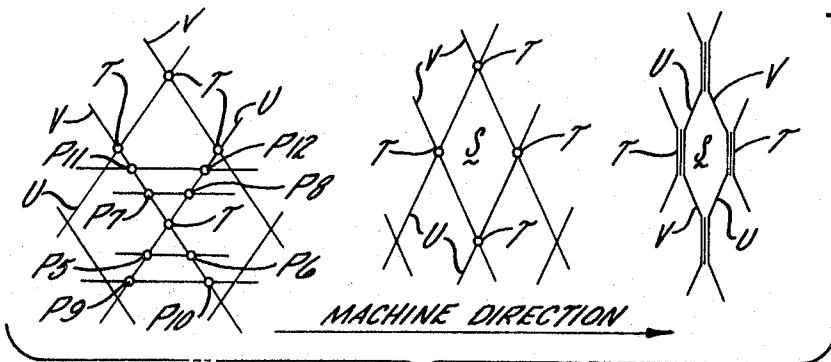


FIG. 13

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DISPOSABLE DIAPER WITH IMPROVED LINER MATERIAL

The present invention relates generally to disposable diapers and, more particularly, to a disposable diaper having an improved liner material.

It is a primary object of the present invention to provide a disposable diaper having an improved liner material which provides good characteristics for absorbing body liquids and transmitting the same to an inner core of absorbent material, and yet spaces the inner core of absorbent material away from the infant's skin so that the liquids retained in the absorbent core do not remain in contact with the skin.

A more specific object of the invention is to provide an improved disposable diaper of the foregoing type which is soft and comfortable to the infant wearing the diaper.

Another specific object of the invention is to provide such an improved disposable diaper which minimizes retention of body liquids in the liner material, thereby minimizing rash and skin irritation problems.

It is another object of the invention to provide an improved disposable diaper of the type described above which provides extremely rapid absorption of body liquids, combined with good liquid retention characteristics.

A still further object of the invention is to provide such an improved disposable diaper having a liner which is abrasion resistant so that it does not break down in use, and which does not lint onto the infant's skin.

Other objects and advantages of the invention will be apparent from the detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a disposable diaper embodying the invention, with the diaper in its folded condition;

FIG. 2 is an enlarged perspective view of the diaper of FIG. 1 in its unfolded condition with fragments broken away to reveal the internal structure;

FIG. 3 is an enlarged section taken along line 3—3 in FIG. 2;

FIG. 4 is a schematic side elevation of one form of apparatus which may be used to produce the improved liner material included in the diaper of FIGS. 1 and 2;

FIG. 5 is a fragmentary plan view somewhat simplified and exaggerated for the sake of clarity of illustration, of an illustrative web of base material prepared by the apparatus of FIG. 4 with portions of the material broken away to expose the various layers;

FIG. 6 is a fragmentary plan view of the liner material employed in the diaper of FIGS. 1 and 2, with portions broken away to expose the various layers;

FIG. 7 is an enlarged, simplified and somewhat exaggerated section taken along section line 7—7 in FIG. 6;

FIG. 8 is an enlarged, simplified and somewhat exaggerated section taken along line 8—8 in FIG. 6;

FIG. 9 is an enlarged schematic detail in side elevation of the forming drum and gathering blade of the apparatus shown in FIG. 4;

FIG. 10 is a further enlarged schematic side elevation illustrating in somewhat idealized fashion the sequence of gathering and looping of individual fibers;

FIG. 11 is an enlarged schematic fragmentary view taken along the line 11—11 of FIG. 10 showing a fragment of the fiber web and adhesive pattern with illustrative fibers attached to the adhesive;

FIG. 12 is a simplified schematic view taken along the line 12—12 of still another sequence as shown in FIG. 10; and

FIG. 13 is an enlarged schematic bottom view showing the sequence of the partial consolidation or closing of the open adhesive pattern to form a discontinuous adhesive backing.

While the invention will be described in connection with certain preferred embodiments, it will be understood that it is not intended to limit the invention to these particular embodiments. On the contrary, it is intended to cover all alternative, modifications, and equivalent arrangements as may be included within the spirit and scope of the invention.

In disposable diaper construction, it is desirable to have an absorbent structure which (1) immediately accepts body liquids, (2) rapidly transports the liquids away from the discharge source, and (3) effectively contains the liquids within the confines of the diaper, all while the inside surface of the diaper is maintained relatively dry. In addition, the absorbed liquids should not be allowed to run over the inside surface of the diaper, or soak through the bottom of the diaper, especially if the absorptive capacity of the diaper has not been reached.

Turning now to the drawings, and referring first to FIGS. 1 and 2, there is shown a disposable diaper 10 having a main absorbent material, a fluid impervious outer sheet 12, and a fluid pervious liner 13 on the inside surface. In FIG. 1, the diaper is illustrated as partially opened and ready for application to an infant, but it will be understood that as packaged the diaper is flat folded with symmetrical half portions contiguously engaged to minimize package volume. The illustrative diaper is formed by suitable infolding of a single blank along fold lines of patterned configuration as described in more detail in U.S. Pat. No. 3,196,874.

The absorbent core 11 may be of varying construction, such as multiple sheets of creped cellulose wadding 14. Alternatively, the core 11 may comprise a layer of cellulosic fluff or any other material offering suitable fluid absorbent characteristics, it being the function of the core 11 to provide substantial softness and bulk in addition to its primary function as the major fluid absorbent element.

Because of the fluid impervious outer sheet 12, the illustrative diaper eliminates the need for a separate protective garment such as rubber pants or the like. The sheet 12 may be polyethylene sheet stock or the like which offers the desirable characteristics of flexibility and softness while serving its primary function as a fluid impervious envelope for the associated diaper elements. The sheet 12 extends coextensively of the core 11 and the margins thereof preferably enclose the marginal areas of the core 11 with the sheet 12 being heat sealed or otherwise bonded along areas shown at 15 to the underside of the overlying liner sheet 13, thereby forming a unitary assembly defining an envelope-like enclosure for the core 11.

In accordance with the present invention, the disposable diaper is provided with an improved liner material comprising a high-loft, nonwoven fabric, having a discontinuous backing layer of flexible adhesive disposed adjacent the central pad, and a multiplicity of fibers individually looped outwardly from said backing layer with the ends of each loop embedded in the backing layer. Thus, in the illustrative embodiment, the liner material 13 is a high-loft, nonwoven material preferably prepared by the method and apparatus illustrated in FIG. 4. This apparatus includes a web forming section 20 and an adhesive compacting and fiber looping section 30. The web forming section 20 is generally similar to the apparatus disclosed in copending applications Ser. No. 498,929 and Ser. No. 553,483.

Multiple slivers 21 of heat-settable textile fibers are drawn from their respective supply cans (not shown) into a draw frame 22 which comprises a series of pairs of grooved rolls 23, the rolls of each pair being driven by appropriate gearing well known in the art, at a peripheral rate of speed slightly faster than the rate of operation of the preceding pair. As the juxtaposed slivers pass through draw frame 22, the individual fibers are drafted and spread out to form a flat striated web of substantially aligned fibers as shown at 24. Web 24 is maintained on a supporting conveyor sheet 25 on the surface of which a patterned adhesive has been previously applied.

In the illustrative arrangement the conveyor sheet 15 comprises an endless conveyor belt treated on at least its upper surface with a release agent, e.g., a woven glass fiber with a surface coating of tetrafluoroethylene resin. Other release coatings are well known, and comprise such materials as silicone, fatty acid metal complexes, certain acrylic polymers, and the like. Heat resistant films or thin metal sheets treated with release agents may also be used as the carrier sheet.

Prior to the time the web 24 is picked up by the belt 25, the latter has imprinted on its release-treated surface a pattern of flexible thermoplastic adhesive such as is shown at 26 in FIG. 5. It is understood that the adhesive is actually on the underside of belt 25 which becomes the upper surface after passing around roll 27 whereby the adhesive pattern 26 directly contacts the fiber web 24. The pattern is shown as being visible in FIG. 5 only for illustrative purposes.

The belt 25 is fed around roll 27 at a speed slightly in excess of the delivery speed of the final pair of rolls 23 in order to maintain web 24 under slight tension whereby the individual highly-drafted fibers are retained in their aligned and tensioned condition. Drive rolls 28, 29 are rotated to drive belt 25 at a speed sufficient to maintain the proper tension on the web 24.

In the method shown for applying adhesive, the belt 25 is fed through a nip formed between the printing roll 30 and a back-up roll 31 maintained in very light pressure engagement therewith. The surface of printing roll 30 is provided with an intaglio pattern which picks up adhesive 32 from dip pan 33. Part of the adhesive thus picked up is removed by a doctor blade 34 leaving only the intaglio patterned surface filled. The printing roll 30 then transfers this metered amount of adhesive in a preselected pattern to the underside of release coated belt 25. The pattern shown in FIG. 5 is in the form of an open diamond pattern of adhesive.

Since the surface of belt 25 is treated with a release coating, the adhesive remains substantially on the surface with no penetration therein and is preferably in a somewhat tacky condition. The printed belt is drawn from the printing nip around roll 27 positioned closely adjacent the output end of draw frame 22, and, as stated above, at a speed slightly in excess of the delivery speed of the last two rolls in the draw frame. The web 24 emerging from the draw frame 22 is deposited on the tacky adhesive on belt 25 and held in tensioned engagement therewith by the adhesive and the above-mentioned speed differential. This continuous tension prevents the fibers in the web from losing their highly-drafted and aligned condition.

If desired, additional aligned and highly drafted fibers may be added to the web 24 on the adhesively printed belt 25. For this purpose, a second draw frame 35 similar to the draw frame 22 is provided to draw additional slivers 36 of fibers from their supply cans (not shown) and, after drafting and aligning them, deposit the fibers on the moving web 24 carried by the belt 25. In such cases, the amount of adhesive printed on the belt 25 is increased so that some penetrations of the adhesive pattern reach the fibers from the second draw frame 35, and together with the speed differential of the belt 25 relative to the last pair of rolls in the draw frame 35, maintains these fibers under slight tension whereby they also maintain their highly-drafted and aligned condition.

An example of the web 24 formed by the apparatus 20 is shown in FIG. 5. As previously mentioned, a series of parallel and diagonally disposed lines of adhesive are printed in criss-cross fashion on the belt 25 to form pattern 26 of adhesive having substantial open spaces in the configuration of diamonds. It should be appreciated, of course, that FIG. 5 is only intended to be illustrative and, while the lines representing the fibers for both components 24a and 24b are spaced apart for clarity, in practice the highly-drafted fibers of both components are very close to one another. Following deposit of web components 24a and 24b on the adhesive printed belt 25, the belt is drawn around a heated drum 39 where fusing and curing of the adhesive is substantially completed while the web 24 is maintained in firm contact therewith to bond the individual fibers. To insure effective heating and fusing of the adhesive, it is desirable that travel of the combined belt and web be around a substantial portion of the drum 39. In the illustrated embodiment, a fly roll 39a is disposed to provide wrap for the combined belt and web as they travel around the drum 39 to insure complete embedment of the fibers in the adhesive. The fibers of the web 24 are thus bonded together while retaining their highly-drafted and substantially aligned condition in the particular pattern in which they were deposited on the open pattern of adhesive 26 printed on the

belt 25. After leaving the fly roll 39a, the combined web 24 and belt 25 are preferably passed over the drive roll 29 which also serves as a cooling drum, to set the adhesive. The bonded web 24 is stripped from the release coated surface of the belt 25 by the guide roll 41 as the web leaves the cooling roll 29.

In general, any of the various known adhesives may be employed. It should, however, be appreciated that the particular adhesive used is dependent upon the characteristics of the flexible heat-settable fibrous web that is being employed, i.e. —the adhesive should be reactivatable and softened in the heat-setting range of the particular fibrous material being used. In addition, the adhesives should also: be applicable to the base web 24 by procedures which will not disarrange the fibrous structure of the web; be reactivatable in the subsequent adhesive gathering and partial consolidation stage of the process; and form a flexible discontinuous backing layer for the finished fabric and should strongly bond the fiber loops in place.

While various well-known adhesives may be employed in the foregoing process, advantages reside in the use of plastisols, which are colloidal dispersions of synthetic resins in a suitable organic ester plasticizer, and which under the influence of heat provide good binding power while remaining soft and flexible. While many adhesives of this type are known, those found particularly useful for incorporation in the product of this invention include vinyl chloride polymers, and copolymers of vinyl chloride with other vinyl resins, plasticized by organic phthlates, sebacates, or adipates. These provide a fast curing plastisol adhesive characterized by relatively low viscosity, low migration tendencies, and minimum volatility. Such adhesives remain soft and flexible after curing, and can be reactivated by subsequent heating.

It has been found that other adhesive systems may be employed in the process, such as organosols, utilizing resins such as the vinyl chloride polymers, and copolymers. Furthermore, other adhesives may be employed provided that they satisfy specified characteristics in the base web produced in the web forming stage, and in the finished fabric produced in the adhesive compacting and fiber looping stage. For example, emulsions of thermoplastic resins such as acrylics and rubber-like compounds illustratively ABS have the requisite properties to serve as the bonding adhesive for the web 24.

The base material made as heretofore described and comprising a web of highly drafted, heat-settable, fibers embedded in an open adhesive pattern, is then fed into the adhesive consolidating and fiber looping section 40 of the system shown in FIG. 4. The web 24 while still under tension is fed around an idler roll 42 and onto the surface of a heated forming drum 47. The forming drum is maintained at a temperature which will soften the adhesive to a tacky state so that it adheres to the drum surface while also heating the fibers sufficiently to bring them into their heat-setting range. In its preferred embodiment the drum 47 is made of metal with a highly polished chromium plated surface which is internally heated. Also, the web 24 is desirably arranged to travel a substantial distance around the drum 47 (i.e. —have a relatively high degree of wrap) with the open pattern of adhesive 26 in contact with the heated drum surface to provide adequate residence time.

As the web 24 is fed onto the drum 47 the heat from the drum surface heats the fibers to their heat-setting temperature range and reactivates and softens the adhesive printed on the underside of the web, causing it to become tacky and to adhere slightly to the drum surface thereby maintaining the web under constant tension. The drum temperature should be maintained below the melting point of the adhesive to prevent dispersion of the adhesive into the fibers of the web and to minimize bonding of the adhesive lines as will hereinafter be described in greater detail. The web of fibers and softened adhesive is reformed by the cooperative action of the drum 47 and a gathering blade 48 having a flat edge 49. The blade edge 49 operates to consolidate the open adhesive pattern 26 into a backing layer of adhesive while simultaneously looping the fibers of the web outwardly from the open spaces in the

The present invention may be more completely understood from the following examples, which are illustrative of the invention but are not intended as limiting the scope of the invention. The method and apparatus of FIG. 4 was employed for forming the liner material for the products described in the ensuing examples. The adhesive used was a plastisol formulation including, by weight: "Geon 135" polyvinyl chloride resin (manufactured by B. F. Goodrich, Akon, Ohio), about 60 parts per 100 parts resin of "GP-261" diotyl phthalate plasticizer (B. F. Goodrich), about 2.5 parts per 100 parts resin of "CAB-O-SIL" pyrogenic silica (Cabot Corporation, Boston, Mass.) and a sufficient amount of mineral spirits to bring the viscosity into the desired range (generally from about 3 to 5 percent by weight, based on the total weight of the other components for a viscosity range of 3,500 - 4,000 cps). The viscosities were measured with a Brookfield viscometer using a No. 4 spindle and operating at 20 r.p.m. The polyester used in the Examples was "Fortrel" Type 400 staple fibers, commercially available from Celanese Fibers Marketing Company, Charlotte, N.C. The approximate tenacity of these fibers is 4.8 g.p.d. with elongation at break falling in the 45-55 percent range. Other physical properties include: loop tenacity (g.p.d.) - 4.4, initial modulus (g.p.d.) - 40-45, yield stress (g.p.d.) - 1.0, yield strain - 3.7 percent, specific gravity - 1.38 and melting point - 500° F.

EXAMPLE I

The base web was made from polyester fiber having a denier of about 2.25 and an average fiber length of 2½ inches. The polyvinyl chloride plastisol, having a viscosity of from 3,700 to 4,000 centipoises, was applied in diagonal lines one-fourth inch apart in both directions to form a diamond pattern. Rotogravure printing was employed and the intaglio roll had adhesive cells or lines 0.006 inch deep and 0.028 inch wide. The weight of the base web was about 12.8 grams/sq. yd., with equal weights of fiber and adhesive being included.

The preheat drum 39 in the first stage of forming the web was maintained at about 300° F. and operated at a surface speed of 65 ft./min. The base web 24 was thus carried to the heating drum 37 at a surface speed of 65 ft./min.

The gathering blade 48 was positioned at an angle λ of 54° and maintained against the drum with a pressure of 27 p.s.i. The drum (9 inches in diameter) was internally heated and maintained at a temperature of about 260° F.

The take-away speed was 8 ft./min. to provide a take-away ratio (i.e. - surface speed around drum/take-away speed) of 8.125. The resultant product weighed about 104 grams/yd.² This material was then opened between two nips, the first traveling one-sixth the speed of the second, and then allowed to relax. The final product, which weighed 32 grams/yd.², was used as a diaper liner in disposable diapers made with the same materials used in the present commercial disposable diapers known as "Kimbies" (except for the liner material). Subjective tests conducted with these diapers yielded relatively consistent favorable comments on the softness and strength of the liner material and particularly on the improved dryness of the skin of the infants on whom the diapers were used.

EXAMPLE II

Example I was repeated, except that the blade angle λ was varied between 17° and 74° (17°, 34°, 37°, 45°, 54°, and 74° being specifically used), and the weight of the base web was about 13 grams/sq. yd., with equal weights of fiber and adhesive being included.

Elastic nonwoven material capable of being stretched up to about twice its opened machine direction length with a recoverability of from 80 to 100 percent was obtained when the blade angle λ was between about 20° and 54°, (i.e. - optimum stretch was not obtained with angles of 17° and 74°).

EXAMPLE III

The base web was made from polyester fiber having a denier of 2.25 and an average fiber length of 3 inches. The polyvinyl

chloride plastisol having a viscosity of about 3,800 centipoises was applied in diagonal lines one-fourth inch apart in both directions to form a diamond pattern. The intaglio roll used was the same as in Example I. The base web, which weighed 12.5 grams/yd.², was cured on the preheat drum 39 at 290° F at a surface speed of 58 fpm. It was then carried to the heating drum 37. The gathering blade 48 was positioned at an angle λ of 74° and maintained with a pressure of 27 p.s.i. The drum 37 was heated to a temperature of 270° F. The take away was run at 40 ft./min. (i.e. 1.45 to 1 ratio). The resultant product weighed 18.1 grams/yd.

As has been thus seen from the preceding Examples, elastic, high-loft nonwoven diaper liners can be made in accordance with the present invention by carefully controlling certain process parameters. Initially, the edge angle λ must be kept within certain critical ranges, depending upon the other parameters involved such as, for example, type of adhesive pattern and fiber stiffness. Thus, while angles of from about 20° to about 120° could be employed, the critical range narrows when fiber stiffness, type of adhesive and adhesive pattern are known. For example, with a 2.25 denier polyester, a polyvinyl chloride plastisol and a diamond pattern, a range of from about 20° to 54° should be employed.

The take-away speed of the fabric from the blade edge is also important. With blade 48 having an edge angle λ within the preferred range, and assuming the take-away surface is cooled to substantially an ambient temperature, e.g. - 75° F. to 80° F., the normal ratio of the surface speed of the heating drum 37 to the take-away speed should be maintained in the range of from about 5:1 to about 10:1, with a ratio of 7 to 8:1 being preferred. By increasing the ratio above 10:1, by slowing down the fabric take-away speed, more adhesive consolidation has been obtained and the mass of the fiber loops is made somewhat more dense, so that a fabric with a higher weight has been produced; but the adhesive lines become more strongly bonded together so subsequent drawing cannot open the adhesive. By increasing the fabric take-away speed, such that the fabric is not allowed to gather at the blade edge, the fabric will be drawn or extended while the adhesive layer is still in a plastic condition, thereby opening the adhesive layer, but not allowing sufficient residence time for the fibers to become as well heat set. Such webs while not as elastic still retain the properties of rapid liquid passage and no strikeback.

Further parameters that affect adhesive consolidation, fiber looping at the blade edge and the stretchability and elasticity characteristics of the elastic nonwoven fabric are the adhesive pattern applied to the fibers in the formation of the base web, the adhesive weight as a percentage of the weight of the web, and the area of the web covered by the adhesive pattern. The adhesive was applied in the preparation of Examples I and II in the form of diagonal lines, criss-crossed, to provide an open diamond pattern with the size of the opening in the diamond in the machine direction less than the lengths of the fibers used for the base webs. Thus, where "Fortrel" T-400 polyester was used, with fiber lengths from 2½ inches to 3 inches, a ¼ inch diamond pattern applying adhesive to 20 to 25 percent of the total web surface was found effective. The transverse adhesive lines, when consolidated by the action of the gathering blade, are moved into proximity or abutment with each other but are only minimally bonded together. Thus, when the closed form of the elastic nonwoven is opened, the original pattern will reappear but will be foreshortened (i.e. - the machine direction distance of the pattern will be less).

In the application of the adhesive to the base web, it has been observed that by increasing the adhesive viscosity a sharp, distinct printed pattern will be obtained such that the fibers are securely attached to the adhesive at distinct spaced points and are not embedded in adhesive throughout their length. It is desired to have spaced points of fiber adhesive attachment so that the fiber loops will be distinctly and separately formed at the gathering blade so as to extend outwardly from the bonding adhesive layer. Fiber sizes over the entire prepared range of 1.5 to 3.0 denier have been successfully

original adhesive pattern. The reformed and consolidated material 50 then leaves the blade edge 49 and onto a flat take-off surface 51 and a discharge conveyor 52.

The speed at which the material leaves the gathering blade is closely coordinated with the surface speed of the drum to heat set the fibers in their looped positions while rendering the adhesive non-tacky so the consolidation of the adhesive will only be partial and the bonding of transverse lines of adhesive minimized. To this end and as shown in FIG. 4, this may be accomplished by maintaining the take-off surface 51 at the ambient temperature or slightly higher by directing an air spray 53 at the bottom surface of take-off member 51. While this provides adequate cooling to carry out the objectives of the conditioning step, other means such as a water spray or a refrigerated fluid could be employed to provide a lower temperature if desired. Indeed, as long as the fluid is inert as regards the fibers and adhesives, application may be directly on the partially consolidated and reformed web. The take-away speed should then be set so that, at the temperature of the take-away surface, the fibers will be heat set and yet the bonding of merging lines of adhesive will be minimized. In this connection, it should be noted that the adhesive should be maintained below its melting point to minimize the flowing together of the merging adhesive lines which would provide undesired bonds.

Turning now to FIGS. 10 through 13, the method of making the elastic, high-loft, nonwoven fabric 50 will be explained in greater detail in connection with an illustrative sequence of the gathering and looping of single fibers of the web 24 (FIGS. 10 through 12) and the partial consolidation of the illustrative diamond adhesive pattern 26 (FIG. 13). As seen in FIG. 11, the fiber has a portion which extends across the open space of the diamond pattern of adhesive 26 from point A to B where it is embedded in the adhesive. Referring to FIG. 10, the series of views in this Figure illustrates how the portion P of the fiber is formed into a loop; when point A being carried around the heated drum 47 impinges against the gathering blade edge 49, its forward motion is halted and it is scraped along the surface of the drum. Point B continues to advance with the drum surface since due to its softened and tacky condition it adheres to the smooth drum surface.

As point B advances relative to point A, the portion P of the fiber between points A and B is caused to bow outwardly from the drum surface. Finally, point B overtakes point A and these points of adhesive are brought close together without being consolidated as seen in FIG. 12. In the meantime, fiber portion P has been looped outwardly from the drum surface. While this is occurring, of course, additional adhesive points C-D, etc., travelling around the drum 47 impinge against the gathering blade edge 49 causing a consolidation of these adhesive points and looping of their intermediate fiber portions P₁ as is also indicated in FIG. 12. This occurs simultaneously at all points across the web at the blade edge producing a backing layer of adhesive from which extends the multiplicity of loops formed by the fibers of the base web. The layer of adhesive is carried away from the blade edge along the take-off surface 51 and provides a backing layer for the outwardly looped fibers, thus producing the fabric 50.

Also, not only does each fiber portion P loop outwardly from the drum surface but as the loop is formed it may twist or turn. The degree of loop twisting, and indeed, whether any twisting occurs, is dependent upon such factors as the degree of adhesive consolidation, fiber stiffness, blade angle (as hereinafter defined) and relative uniformity of loop size. In a particular situation, the formed loops may turn through an angle of up to 180°.

FIG. 13 illustrates the partial consolidation that is desired when the open adhesive pattern is the exemplary diamond pattern. Thus, considering a single diamond S, each of the four corners T represents the crossing point of two intersecting lines of adhesive U and V. At every corner T then, as the adhesive is scraped along the surface of the drum, the crossing adhesive lines U and V are brought close and closer together.

The points closest to the corners T merge first because of the shorter distance of separation. Accordingly, point P₅ on line U will merge with point P₆ on line V before point P₃ will meet point P₁₀. Similarly, on the other side of the corner, the closer set of points (e.g. —P₇ and P₈) will merge before points P₁₁ and P₁₂.

To provide the desired liner material for use in the present invention, the take-away speed is maintained at a rate such that the adhesive diamonds are not completely consolidated but are collapsed into flat hexagonal shapes in which the crossing points of adhesive have been transformed by partial consolidation of the adhesive into lines that form the sides of the highly elongated hexagons, as shown in FIG. 13. The closed, compact form of the nonwoven fabric may be stretched apart to break the bonds of minimal strength (i.e. — the bonds that will break before adhesive rupture or other degradation of the product). The fabric is then allowed to relax to come to an equilibrium state in its drawn or open position.

The drawing may be accomplished by hand and can be achieved by pulling the fabric apart (i.e. —along the machine direction). As shown in FIG. 4, the fabric exit end of the conveyor 52 may be provided with a roll 54 to form a nip and a pair of rolls 55, also forming a nip. Drawing is accomplished by driving the rollers 55 at a higher speed.

With respect to the loops, it should be appreciated that the heights of the fiber loops throughout the fabric vary according to the spacing between the points of attachment of each fiber to the open adhesive pattern in the base web. Referring to FIGS. 8, 11 and 12, it will be seen, for example, that the loop formed by the fiber portion P₁ between the points of adhesive attachment C,D will have a lower height than the loop formed by the longer fiber portion P between the points A,B. This results in a dense fabric with the lower loops supporting and filling around the higher loops and the top surface of the fabric being formed by the tops of the higher loops.

In accordance with an important aspect of this invention, the base web used to form the high loft liner material comprises fine denier, heat settable, hydrophobic fibers. The fine denier of the fibers provides desired softness to the fabric, the heat settable characteristic improves the loft or bulk stability of the fabric, and the hydrophobic nature of the fibers provides a liner material which is substantially non-wetting while at the same time readily passing body fluids therethrough. The denier of the fibers is preferably in the range of from about 1.5 to about 3.0 denier. Suitable hydrophobic properties are provided by fibers of polyester, polypropylene, or acrylic. By heat-settable it is meant that the material will maintain the looped configuration into which it has been formed in accordance with the present invention, regardless of whether the stability of the loop may be attributed to what is technically considered heat setting or whether the setting is the result of some other phenomena. Representative examples of suitable materials include any of the commercially available acrylic fibers such as, for example, "Creslon" (American Cyanamid, Stamford, Conn.) and "Orlon" (E.I. duPont de Nemours and Company, Wilmington, Del.) and olefins such as polypropylene. If desired, a blend of fibers may be used in which only a portion of the fibers are heat settable. This will not, of course, provide the optimum elastic properties. Moreover, not only highly drafted webs and carded webs of staple length fibers may be used for the base but also garneted and air laid webs of such fibers as well as directly laid aligned webs of monofilament. It has been noted, however, that when webs such as carded webs are used for the base web in which an important proportion of the fibers are randomly oriented, those fibers not aligned with the machine direction appear to interfere with the loop production by the gathering blade and the ultimate stretch characteristics. The most regular formation of loops and optimum elastic and stretch in the formed fabric has been produced with those base webs having the highest proportion of fibers aligned with the machine direction as, for example, the highly drafted webs made with the apparatus illustrated in FIG. 4.

utilized in the base web with a 1/4 inch diamond pattern of adhesive. With the light weight webs of polyester used in the Examples, the ratio of fiber to adhesive was approximately 1:1. It has been found that the degree of adhesive-fiber attachment in the base web is affected when the fiber to adhesive ratio with such type fibers is increased above about 2.5:1, so that the fiber loops do not form properly at the blade nor do the fibers have sufficient attachment to the adhesive layer in the finished fabric. On the other hand, increasing the relative amount of adhesive in the base web tends to produce a thicker adhesive layer in the finished material and more secure fiber attachment, but the adhesive lines tend to disperse so that the pattern becomes less open affecting the height of the loops, which is undesirable. The fiber-adhesive ratio will be different, however, for base webs of yarns and threads where it appears that less amounts of adhesive, relatively speaking, will provide adequate attachment of the loops to the adhesive backing layer. For the purposes of the present invention, the aforementioned parameters are all preferably selected to provide a final gathered web of about 25 to about 40 grams/yd.

It is also recognized that to produce a material in accordance with the invention, the elements should be sufficiently flexible to allow the loops to form under the action of the adhesive consolidating and gathering blade. Thus, neither stiff strands which do not loop under the action of the gathering blade, nor multiple strand yarns in which the lay of the strands opposes the tendency of the loops being formed to assume their equilibrium position under the action of the blade, will satisfactorily serve as elements of the base web when it is desired to produce a fabric fully in accordance with the invention.

As shown in FIG. 4, the fabric is carried along the take-away surface 51 by the action of the conveyor 62. Since the adhesive backing is hot and tacky as the fabric flows onto the take-away surface 51 which is maintained substantially at ambient temperatures, that surface may be treated with a nonstick or release coating to insure that the fabric may be drawn smoothly along the surface.

To cool the belt of the conveyor 52 and prevent it from becoming overheated from the hot adhesive back of the fabric 50, streams of air may be blown against the underside of the belt from suitably placed air nozzles 60. This will also serve to cool the fabric 50, although it may be necessary or desirable to pass the fabric through a cooling station or zone to cool the adhesive and thermoplastic fibers clearly below their softening temperatures or to eliminate tackiness of the adhesive.

The improved liner material provided by this invention provides rapid passage of urine and other body liquids into the absorbent core material, and yet the absorbed liquid does not strike back through the liner material. In fact, the liner material is essentially non-wettable by the body liquids. It is believed that these results are due to the unique combination of characteristics of the liner material, particularly its bulk or loft and its hydrophobic nature.

I claim as my invention:

1. An improved disposable diaper comprising the combination of a central pad of absorbent material, a layer of fluid impervious material disposed on one side of said central pad and extending around the edges thereof, and an elastic liner disposed on the other side of said central pad and joined to said fluid impervious material around the periphery of said central pad, said liner comprising an elastic high-loft, non-woven fabric having a discontinuous backing layer of flexible adhesive disposed adjacent to said central pad, and a multiplicity of heat settable hydrophobic fibers individually

looped outwardly from said backing layer and heat set in the looped form with the ends of each loop embedded in said backing layer.

2. An improved disposable diaper as set forth in claim 1, wherein said liner fabric has a weight of from about 25 to about 40 grams per square yard.

3. An improved disposable diaper as set forth in claim 1, wherein said fibers in said liner fabric have a denier of from about 1.5 to about 3.0.

4. An improved disposable diaper as set forth in claim 1, wherein said backing layer of said liner fabric comprises a series of interconnected hexagons of adhesive.

5. An improved disposable diaper as set forth in claim 1, wherein said fiber loops in said liner fabric lie in planes extending in the cross direction of the fabric.

6. An improved disposable diaper as defined in claim 1 wherein the length of the fibers forming said loops varies regularly in the cross direction throughout the high-loft, nonwoven fabric liner, the embedded ends of said loops laying essentially in the same plane.

7. An improved disposable diaper as defined in claim 1 wherein the fabric is formed of a blend of fibers in which at least some of said fibers are heat settable and heat-set in the looped configuration to provide a stretchable and elastic liner.

8. An improved disposable diaper as defined in claim 1 wherein substantially all of said fibers loop outwardly and span the open spaces in the discontinuous backing layer to provide a stretchable liner, said open spaces facilitating the passing of fluids through said liner to said central pad of absorbent material.

9. An improved disposable diaper comprising the combination of a central pad of absorbent material, a layer of fluid impervious material disposed on one side of said central pad and extending around the edges thereof, and an elastic liner disposed on the other side of said central pad and joined to said fluid impervious material around the periphery of said central pad, said liner comprising a high-loft, non-woven fabric having a discontinuous backing layer formed by an open pattern of flexible adhesive disposed adjacent to said central pad, and a multiplicity of heat settable hydrophobic fibers which are individually looped outwardly from said backing layer and heat set in the looped form with the ends of each loop embedded in said backing layer, said loops extending over the spaces in said open adhesive pattern forming said discontinuous backing layer, said spaces providing apertures through which fluids may freely pass into said central pad of absorbent material.

10. In a disposable diaper comprising the combination of a central pad of absorbent material, and a layer of fluid impervious material disposed on one side of said central pad and extending around the edges thereof, an improved liner disposed on the other side of said central pad and joined to said fluid impervious material around the periphery of said central pad, said liner comprising an elastic high-loft, non-woven fabric having a discontinuous backing layer of flexible adhesive disposed adjacent to said central pad and a multiplicity of heat settable hydrophobic fibers individually looped outwardly from said backing layer and heat set in the looped form with the ends of each loop embedded in said backing layer, said backing layer having been formed by gathering and thereafter partially reopening an open adhesive pattern upon which a flat web of generally longitudinally oriented heat settable hydrophobic fibers are bonded, said gathering being effective to outwardly loop said fibers from said discontinuous backing layer of flexible adhesive.

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