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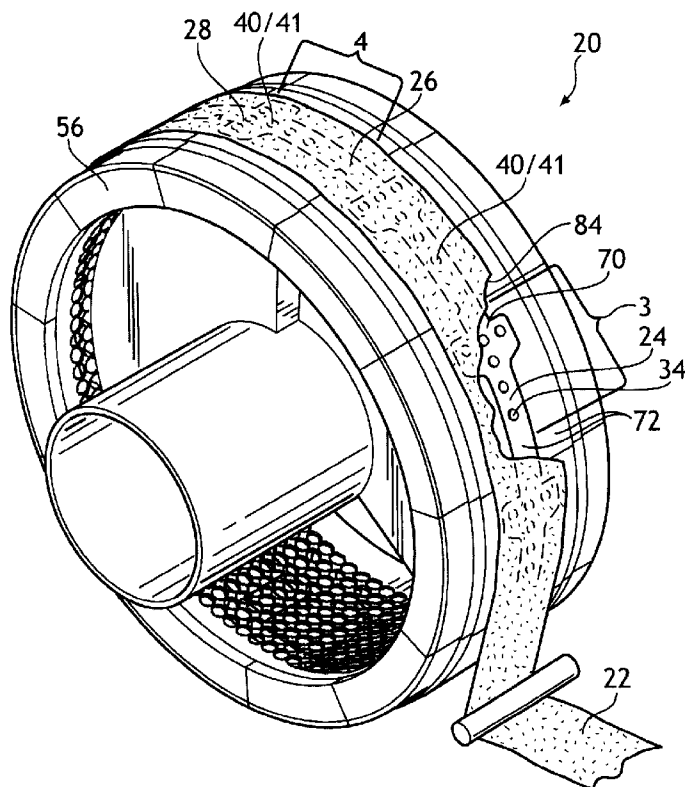
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[Continued on next page]

(54) Title: METHOD FOR MAKING A STABILIZED ABSORBENT COMPOSITE



(57) Abstract: A method for forming and stabilizing an absorbent composite web includes conforming a first web onto a forming surface having a plurality of raised nubs having upper surfaces. The first web defines a plurality of bond areas corresponding to those portions of the first web overlying the upper surfaces of the nubs. The method further includes depositing absorbent material onto the first web to form a unitary absorbent core having a plurality of holes therein. The method further includes joining a second web to the first web at the bond areas to form an absorbent composite web. The unitary absorbent core is positioned between the first web and the second web. The first web and the second web are bonded together through the holes in the absorbent core. The method further includes removing the absorbent composite web from the forming surface.

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METHOD FOR MAKING A STABILIZED ABSORBENT COMPOSITE

BACKGROUND OF THE INVENTION

[001] The present invention relates to stabilized absorbent composites and methods for making stabilized absorbent composites. The absorbent composites of the present invention are suitable for incorporation into a variety of disposable absorbent articles such as, for example, diapers, children's training pants, adult incontinence pads and garments, menstrual pads, bed pads, surgical drapes, and the like.

[002] Conventional absorbent composites have traditionally been made of cellulosic fluff or other fibrous materials. Many have also included superabsorbent particles dispersed within the fibrous materials. However, many of these traditional absorbent composites have suffered from structural breakdowns during use, including, for example, cracking, separating, wadding, and/or "roping." These problems are generally undesirable and may cause discomfort for the wearer and/or may limit the performance of the absorbent composite.

[003] Additionally, some conventional absorbent composites have exhibited undesirable "gel-on-skin" wherein some of the superabsorbent particles escape the absorbent composite and stick to the wearer during use. This problem may be worse with absorbent articles having a higher amount of superabsorbent material as a percentage of the total absorbent material weight.

[004] Various attempts to prevent or minimize structural breakdowns and superabsorbent losses have included, for example, densifying the cellulosic fluff, adding adhesives or other binding agents to the absorbent material, wrapping the absorbent material in nonwovens or tissues, point bonding the absorbent core, aperturing the absorbent core, needling the absorbent core, placing the superabsorbent material in pockets or discrete layers, among others. However, there still exists a need for a simple and efficient way to stabilize absorbent composites to minimize or eliminate structural breakdowns and superabsorbent losses.

SUMMARY OF THE INVENTION

[005] In response to the discussed need, the present invention provides a method for forming and stabilizing an absorbent composite web. The method includes conforming a first web onto a forming surface. The first forming surface has a plurality of raised nubs having upper surfaces. The first web defines a plurality of bond areas corresponding to those portions of the first web overlying the upper surfaces of the nubs. The method further includes depositing absorbent material onto the first web to form a unitary absorbent core having a plurality of holes therein. The method further includes joining a second web to the first web at the bond areas to form an absorbent composite web, wherein the unitary absorbent core is positioned between the first web and the second web. The first web and the second web are bonded together through the holes in the absorbent core. Finally, the method includes removing the absorbent composite web from the forming surface.

[006] In various embodiments, the method may further include applying adhesive to the second web before joining the second web to the first web and/or may include pressing the second web against the first web while the first web is conformed to the forming surface to effectuate the joining of the second web to the first web.

[007] In various embodiments, the method may further include joining the first web and the second web using ultrasonic bonding, thermal bonding, or pressure bonding.

[008] In various embodiments, the first web may be drawn to the forming surface via vacuum forces and the forming surface may be a drum former.

[009] In various embodiments, the nubs may have a height of 1.5 to 6 mm and a surface area of 1 to 25 mm².

[010] In various embodiments, the absorbent material may include superabsorbent particles and cellulose fluff fibers. For example, the unitary absorbent core may include 30 to 90 percent superabsorbent particles and 70 to 10 percent cellulose fluff fibers by weight.

[011] In various embodiments, portions of the absorbent composite web that include the unitary absorbent core may have a thickness of less than 6 mm.

[012] In various embodiments, the method may further include scarfing the absorbent core to expose the bond areas before joining the second web to the first web.

5 [013] In various embodiments, the first web and the second web may be tissue webs and may be joined with adhesive. In various embodiments, the first web and the second web may be nonwoven webs and may be joined by adhesive bonding, ultrasonic bonding, thermal bonding, or pressure bonding.

10 [014] In another embodiment, the present invention provides a method for forming an absorbent composite web that includes conforming a first tissue web onto a forming surface via vacuum forces. The forming surface has a plurality of raised nubs having upper surfaces and wherein the first tissue web defines a plurality of bonding areas corresponding to those portions of the first tissue web overlying the upper surfaces of the nubs. The method further includes depositing superabsorbent and cellulose fluff onto the first tissue web to form a unitary
15 absorbent core having a plurality of holes therein. The method further includes applying adhesive to a second tissue web, pressing the second tissue web against the first tissue web to join the first and second tissue webs at the bonding areas to form an absorbent composite web. The unitary absorbent core is positioned between the first tissue web and the second tissue web. The first
20 tissue web and the second tissue web are bonded together through the holes in the unitary absorbent core. The method further includes removing the absorbent composite web from the forming surface.

25 [015] In various embodiments, the method further includes scarfing the unitary absorbent core to remove substantially all absorbent material from the bond areas.

[016] In various embodiments, the absorbent material may include superabsorbent particles and cellulose fluff fibers. For example, the unitary absorbent core may include 30 to 90 percent superabsorbent particles and 70 to 10 percent cellulose fluff fibers by weight.

30 [017] In various embodiments, portions of the absorbent composite web that include the unitary absorbent core may have a thickness of less than 6 mm.

[018] In another embodiment, the present invention provides a method for forming an absorbent composite web that includes conforming a first nonwoven

web onto a forming surface via vacuum forces. The forming surface has a plurality of raised nubs having upper surfaces and the first nonwoven web defines a plurality of bond areas corresponding to those areas of the first nonwoven web overlying the upper surfaces of the nubs. The method further includes depositing
5 superabsorbent and cellulose fluff onto the first nonwoven web to form a unitary absorbent core, scarfing the absorbent core to remove substantially all absorbent material from the bond areas thereby further defining a plurality of holes in the unitary absorbent core, joining the second nonwoven web to the first nonwoven web at the bond areas using adhesive bonding, ultrasonic bonding, thermal
10 bonding, or pressure bonding to form an absorbent composite web. The unitary absorbent core is positioned between the first nonwoven web and the second nonwoven web. The first nonwoven web and the second nonwoven web are bonded together through the holes in the unitary absorbent core. The method further includes removing the absorbent composite web from the forming surface.

15 [019] In various embodiments, the absorbent material may include superabsorbent particles and cellulose fluff fibers. For example, the unitary absorbent core may include 30 to 90 percent superabsorbent particles and 70 to 10 percent cellulose fluff fibers by weight.

[020] In various embodiments, portions of the absorbent composite web
20 that include the unitary absorbent core may have a thickness of less than 6 mm.

[021] In various embodiments, the method further includes separating the absorbent composite web into discrete absorbent composites and placing the discrete absorbent composites between a bodyside liner and an outercover to form an absorbent article.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 representatively illustrates an exemplary method and apparatus of the present invention.

Fig. 2 representatively illustrates a perspective view of a portion of an exemplary
30 method and apparatus of the present invention.

Fig. 3 representatively illustrates a portion of **Fig. 2** designated by bracket 3.

Fig. 4 representatively illustrates a portion of **Fig. 2** designated by bracket 4.

Fig. 5 representatively illustrates a portion of the method and apparatus of the present invention.

Fig. 6 representatively illustrates a cross-sectional view of the method and apparatus of **Fig. 5** taken along the line 6-6.

5 **Fig. 7** representatively illustrates an exemplary absorbent article of the present invention.

Fig. 8 representatively illustrates the absorbent article of **Fig. 7** in the laid flat condition with the side contacting the wearer facing the viewer.

10 **Fig. 9** representatively illustrates an exemplary absorbent composite of the present invention.

Fig. 10 representatively illustrates the portion of the absorbent composite of **Fig. 9** delineated by box 10.

Fig. 11 representatively illustrates a cross sectional view of **Fig. 10** taken along the line 11-11.

15

DETAILED DESCRIPTION OF THE DRAWINGS

[022] **Fig. 1** representatively illustrates an exemplary method and apparatus of the present invention useful for forming absorbent composite webs.

20 The absorbent composite webs of the present invention may be utilized in various absorbent articles, such as, for example, disposable diapers, adult incontinence articles, children's training pants, feminine hygiene articles, bandages, and the like.

[023] One embodiment of the method of the present invention is illustrated generally at **20** and includes conforming a first web **22** onto a forming surface **24** having a plurality of nubs **34** (**Fig. 2**) protruding therefrom, depositing absorbent material **26** onto the first web **22** to form a unitary absorbent core web **28**, and joining a second web **30** in facing relation with the first web **22** to form an absorbent composite web **32** wherein the absorbent core web **28** is located between the first web **22** and the second web **30**.

30 [024] The method **20** and apparatus of the invention can include a forming chamber **44** through which the forming surface **24** is movable. The forming chamber **44** has an appointed entrance portion **46**, and an appointed exit

portion **48**. A fiber source, such as provided by a fiberizer **50**, can be configured to provide fibrous material into the forming chamber **44**, and a vacuum generator or other vacuum source can be configured to provide an operative, relatively lower pressure, vacuum condition in a vacuum-commutator duct system **52**. In the illustrated configuration, the fiberizer **50** can be provided by a rotary hammer mill or a rotatable picker roll. Other fiberizers may also be employed, as desired.

[025] As the forming surface **24** enters and then traverses through the forming chamber **44**, the component materials of the absorbent core web **28**, such as, the fibrous material, are operatively carried or transported by an entraining air stream that is drawn through the first web **22** and the forming surface **24**. Typically, the low pressure, vacuum generating system is constructed and arranged to produce the desired airflow through the first web **22** and the forming surface **24**. Such vacuum forming systems are well known in the art.

[026] Other component materials for producing the absorbent core web **28** may also be delivered into the forming chamber **44**. For example, particles or fibers of superabsorbent material may be introduced into the forming chamber **44** by employing conventional mechanisms, such as pipes, channels, spreaders, nozzles, and the like, as well as combinations thereof. In the representatively shown configuration, the superabsorbent material can be delivered into the forming chamber **44** by employing an operative conduit and nozzle system **54**. The illustrated orientation of the delivery conduit **54** is exemplary, and it should be readily appreciated that any operative orientation of the delivery conduit and nozzle system **54** may be employed. The fibers, particles and other desired absorbent core materials may be entrained in any suitable gaseous medium.

[027] The stream of air-entrained absorbent materials **26** can pass through the forming chamber **44** for deposition onto the first web **22** which overlies the forming surface **24**. The forming chamber **44** can serve to direct and concentrate the air-entrained absorbent materials **26**, and to provide a desired velocity profile in the air-entrained stream of absorbent materials **26**. Typically, the forming chamber **44** is supported by suitable structural members, which together form a support frame for the forming chamber. The frame may be

anchored and/or joined to other suitable structural components, as necessary or desirable.

[028] The forming surface **24** can be provided by any suitable mechanism. In the representatively shown configuration, the forming surface **24** is provided by a forming drum **56**. Other conventional techniques for providing the forming surface **24** may also be employed. For example, the forming surface **24** may be provided by an endless forming belt. Forming belt systems for producing fibrous webs are well known in the art. Examples of such forming belt systems are available from the Paper Converting Machine Company, a business having offices located in Green Bay, Wisconsin, U.S.A.; and from Curt G. Joa Incorporated, a business having offices located in Sheboygan Falls, Wisconsin, U.S.A.

[029] In the representatively shown configuration, a forming drum system operatively provides the moving forming surface **24**. More particularly, the moving foraminous forming surface **24** can be provided by an outer peripheral surface region of a rotatable forming drum **56**. The forming drum **56** is rotatable in a selected direction of rotation, and can be rotated by employing a drum drive shaft that is operatively joined to any suitable drive mechanism (not shown). For example, the drive mechanism can include an electric or other motor which is directly or indirectly coupled to the drive shaft. While the shown arrangement provides a forming drum that is arranged to rotate in a counter-clockwise direction, it should be readily apparent that the forming drum may alternatively be arranged to rotate in a clockwise direction.

[030] A suitable forming drum and forming system are taught in U.S. Patent 6,630,096 to Venturino *et al.* issued October 7, 2003, the entirety of which is incorporated herein by reference to the extent that it is consistent (i.e., not in conflict) herewith.

[031] In the illustrated embodiment, under the influence of the vacuum generating source, a conveying air stream is drawn through the first web **22** and the foraminous forming surface **24** into the interior of the forming drum **56**, and is subsequently passed out of the drum through the vacuum supply conduit **58**. As the air-entrained absorbent materials **26** impinge on the first web **22**, the air component is passed through the first web **22** and the forming surface **24** and the

absorbent materials **26** are retained on the first web **22** to form a nonwoven unitary absorbent core web **28** thereon. The illustrated embodiments show a continuously formed unitary absorbent core web **28** formed on the first web **22**. However, those skilled in the art will readily appreciate that discrete absorbent

5 cores may alternatively be formed on the first web **22** such that a space exists between the absorbent cores. Therefore, where the term “absorbent core web” or “unitary absorbent core web” is used herein, the term “discrete absorbent core” or “discrete unitary absorbent core” is equally applicable in various embodiments.

Suitable methods for forming discrete absorbent cores are disclosed in U.S.

10 Patent Application 11/215876 to Wisneski *et al.* entitled “Method and Apparatus for Making Absorbent Article With Core Wrap” and filed on August 30, 2005, the entirety of which is incorporated herein by reference to the extent that it is consistent (i.e., not in conflict) herewith.

[032] Optionally, a scarfing system may be positioned at the exit region

15 **48** of the forming chamber **44**. The scarfing system can include a scarfing chamber **60** and a scarfing roll **62** which is positioned within the scarfing chamber. The scarfing roll can abrade excess absorbent material **26** from the absorbent core web **28**, and the removed fibers can be transported away from the scarfing chamber **60** with a suitable discharge conduit, as is well known in the

20 art. The removed absorbent material **26** may, for example, be recycled back into the forming chamber **44** or the fiberizer **50**, as desired. Additionally, the scarfing roll can rearrange and redistribute the web material along the longitudinal machine-direction of the web and/or along the lateral cross-direction of the web.

[033] The rotatable scarfing roll may be operatively connected and joined

25 to a suitable shaft member, and may be driven by a suitable drive system (not shown). The scarfing roll system can provide a conventional trimming mechanism for removing or redistributing any excess, z-directional thickness of the absorbent core web **28** that has been deposited on the first web **22**. The surface of the scarfing roll can be adjusted to provide a desired contour along the scarfed surface of the absorbent core web **28**. The scarfing roll can, for example,

30 be configured to provide a substantially flat surface along the scarfed surface of the absorbent core web **28**. The scarfing roll can optionally be configured to provide a non-flat surface. The scarfing roll **62** is disposed in spaced adjacent

relationship to the forming surface **24**, and the forming surface **24** is translated past the scarfing roll. A conventional transporting mechanism, such as a suction fan (not shown) can draw the removed fibrous material away from the formed absorbent core web **28** and out from the scarfing chamber **60**.

5 [034] The scarfing roll **62** may be rotated in a direction which moves a contacting surface of the scarfing roll in a counter-direction that is opposite the movement direction of the absorbent core web **28**. Alternatively, the scarfing roll **62** may be rotated in a co-direction that is the same as the movement direction of absorbent core web **28**. In either situation, the rotational speed of the scarfing
10 roll **62** should be suitably selected to provide an effective scarfing action against the contacted surface of the formed absorbent core web **28**. In like manner, any other suitable trimming mechanism may be employed in place of the scarfing roll assembly to provide a cutting or abrading action to the laid fibrous web by a relative movement between the fibrous web and the selected trimming
15 mechanism. A suitable scarfing system is taught in U.S. Patent 6,627,130 to Kugler *et al.* issued September 30, 2003, the entirety of which is incorporated herein by reference to the extent that it is consistent (i.e., not in conflict) herewith.

[035] After formation of the absorbent core web **28**, the second web **30** is overlaid upon the absorbent core web **28** and the first web **22** while both are
20 conformed to the forming surface **24** and the nubs **34** (**Fig. 2**) protruding therefrom. The second web **30** is then joined to the first web **22** while still conformed to the forming surface **24** and the nubs **34** to form the completed absorbent composite web **32**. Subsequently, with the rotation of the drum, the formed absorbent composite web **32** can be removed from the forming surface
25 **24**. The removal operation may be provided by the weight of the absorbent composite web **32**, by centrifugal force, by a positive air pressure, or by combinations thereof. The positive air pressure can be produced, for example, by a source of compressed air or a fan which generates a pressurized air flow that exerts a force directed outwardly through the forming surface.

30 [036] The portion of the forming surface **24** that is carrying the absorbent composite web **32** can be moved to an optional pressure blow-off zone of the forming drum system. In the blow-off zone, air can be introduced under pressure

and directed radially outwardly against absorbent composite web **32** on the portion of the forming surface that becomes aligned with the blow-off zone. The gas pressure can effect a ready release of the absorbent composite web **32** from the forming surface **24**, and the absorbent composite web **32** can be removed
5 from the forming surface onto a suitable transport mechanism.

[037] A web transporter can receive the absorbent composite web **32** from the forming drum **56**, and convey the absorbent composite web **32** for further processing. In various embodiments, portions the absorbent composite web **32**, such as the first web **22** and/or the second web **30**, may be folded to
10 seal the edges of the absorbent core web **28**.

[038] Suitable web transporters can, for example, include conveyer belts, vacuum drums, transport rollers, electromagnetic suspension conveyors, fluid suspension conveyors, or the like, as well as combinations thereof. As representatively shown, the web transporter can be provided by a system which
15 includes the illustrated endless conveyor belt **64** disposed about rollers **66**. In a particular configuration of the invention, a vacuum suction box **68** can be located below the conveyor belt **64** to help remove the absorbent composite web **32** from the forming surface **24**. The vacuum box **68** opens onto the belt **64**, and a suction of air out of the vacuum box can draw an air flow through perforations in
20 the conveyor belt. This flow of air can, in turn, operate to draw the absorbent composite web **32** away from the forming surface. The vacuum box can be employed with or without the use of a positive pressure in the blow-off zone.

[039] With reference to **Fig. 2**, the forming surface **24** can be provided along the outer, cylindrical surface of the forming drum **56**, and can extend along
25 the axial (cross-directional) and circumferential (machine-directional) dimensions of the forming drum. The structure of the forming surface **24** can be composed of an assembly, and can include a foraminous or otherwise porous member **70** which is operatively connected and joined to the forming drum **56**.

[040] The porous forming member **70** can extend along the outer,
30 circumferential periphery of the forming drum **56**. The forming member **70** can be composed of any suitable porous material. The foraminous member **70** may include a screen, a wire mesh, a hard-wire cloth, a perforated member, or the

like, as well as combinations thereof. In a particular aspect, the foraminous member can include a fluted member having open channels which can extend generally radially and can allow a substantially free flow of air or other selected gas from the outward-side of the drum towards the center of the drum. The flutes
5 or channels can have any desired cross-sectional shape, such as circular, oval, hexagonal, pentagonal, other polygonal shape, or the like, as well as combinations thereof. Such honeycomb structures are well known in the art, and can be composed of various materials, such as plastic, metal, ceramics, and the like, as well as combinations thereof. For example, suitable materials and
10 structures are available from Innovent, a business having offices located in Peabody, Massachusetts, U.S.A.

[041] In various embodiments, the radially outward surface of the fluted member or other foraminous member **70** can be configured with a selected surface contour. The contoured surface regions of the foraminous member **70**
15 can be formed to have any operative shape. In various arrangements, the contour shape can be trapezoidal. Alternatively, the contour shape can be domed or flat.

[042] The forming surface **24**, and particularly the porous member **70**, can include a forming surface contour which is uniform or non-uniform along its depth dimension. For example, the forming surface **24** can provide a relatively
20 low-basis-weight region, and at least one relatively high-basis-weight region, such as provided by pocket regions. In various embodiments, at least one relatively high basis weight region can be positioned along a medial region of the forming surface **24**. Alternatively, at least one relatively high basis weight region can be
25 positioned along one or more other, non-medial regions of the forming surface **24**.

[043] With reference to **Figs. 2, 3, 5 and 6**, at least one side-masking member, such as provided by a side contour ring **72** can be disposed on the foraminous member **70**. In various embodiments, the invention can include a
30 cooperating system of side-masking members. As representatively shown, a pair of laterally opposed, side contour ring members **72** can be configured to extend circumferentially around the forming drum **56**. In a particular aspect, the contour rings **72** can be operatively attached and positioned along laterally opposed,

outboard edge regions of the foraminous member **70**. The contour rings **72** can be joined and assembled to the forming surface **24** by employing conventional attaching or mounting mechanisms.

[044] **Fig. 2** representatively illustrates a perspective view of the first web **22** conforming to a forming surface **24** with portions of the absorbent material **26** and portions of the first web **22** cut away along line **84** to illustrate underlying details. **Fig. 3** representatively illustrates a more detailed view of the portion of **Fig. 2** designated by bracket **3** with the absorbent material **26** removed to illustrate underlying details. **Fig. 4** representatively illustrates a more detailed view of the portion of **Fig. 2** designated by bracket **4**.

[045] Referring now to **Figs. 2** and **3**, the forming surface **24** includes a plurality of raised nubs **34** having upper surfaces **36**. In various embodiments, the raised nubs **34** may also have side surfaces **38**. The first web **22** is conformed about the forming surface **24** and the plurality of nubs **34**. The first web **22** may be drawn down to the forming surface **24** and around the nubs **34** via vacuum forces or the like. The first web **22** overlies the forming surface **24** and the nubs **34** and defines a plurality of bonding areas **40**. The bonding areas **40** correspond to those portions of the first web **22** overlying the upper surfaces **36** of the nubs **34**.

[046] As used herein, the terms “conform,” “conforming,” or derivatives thereof mean to give the same shape, outline, or contour to. For example, when the first web **22** is “conformed” to the forming surface **24**, the first web **22** is generally in contact with most of the forming surface **24** and at least the upper surfaces **36** of the nubs **34**. See **Fig. 6** for an example of the first web **22** conforming to the forming surface **24** and the nubs **34**.

[047] The nubs **34** may be formed out of a wide variety of different materials. For example, the nubs **34** may be formed out of plastic, metal, ceramin, or the like, or combinations thereof. Metallic nubs are advantageous because they are durable and have a relatively low coefficient of friction. An aluminum nub provided with polytetrafluorethylene or other suitable release coating can be used to provide a durable and low friction nub.

[048] The nubs **34** may be attached to the forming surface **24** by using any suitable means such as, for example, fasteners, welding, adhesives, and the like, and combinations thereof. Alternatively, the nubs **34** may be formed integrally with the forming surface **24**. In various embodiments, the nubs **34** may be the heads of various fasteners, such as, for example, bolts or screws, or the like, having any suitable head, such as, hex heads, button heads, socket heads, cap heads, or the like, or combinations thereof. For example, in some embodiments, the nubs **34** may be bolts secured to the forming surface **24**. The nubs **34** are illustrated as lying within the interior region of the forming surface whereby the nubs **34** will be completely circumscribed by the absorbent material **26** deposited on the first web **22** overlying the forming surface **24**. However, in various embodiments, the nubs **34** may be located at the edges of the forming surface whereby only a portion of one or more nubs **34** may be circumscribed by the absorbent material **26**.

[049] The illustrated nubs **34** do not include perforations or apertures on either the side surfaces **38** or upper surfaces **36** of the nub **34** and, thus, process air is not pulled directly through the illustrated nubs **34**. It would be possible, however, for the nubs to include such openings on the side surface **38** to allow the process air to be removed there though in addition to the remainder of the forming surface **24**.

[050] In various embodiments, the surface area of any individual nub **34** may be 1 mm² (0.0015 in²) to 200 mm² (0.3 in²), 1 mm² (0.0015 in²) to 100 mm² (0.155 in²), or 1 mm² (0.0015 in²) to 25 mm² (0.03875 in²). In some embodiments, the surface area of any individual nub **34** may be less than 200 mm², less than 100 mm², less than 90 mm², less than 80 mm², less than 70 mm², less than 60 mm², less than 50 mm², less than 40 mm², less than 30 mm², less than 20 mm², or less than 10 mm². In various embodiments, the total nub surface area may be between about 1 to about 33 percent, about 1 to about 25 percent, or less than about 10 percent of the total forming surface area. As used herein, the total nub surface area is the combined cross sectional area of the nubs at the base of the nubs where the nubs are attached to the forming surface.

The total forming surface area includes the area of the forming surface on which the absorbent material is deposited plus the total nub surface area.

[051] In various embodiments, the nubs **34** may have any suitable height.

5 The nub height represents the perpendicular distance that the upper surface **36** of the nubs **34** extends from the forming surface **24**. In various embodiments, the nubs **34** may have a height less than 10, less than 9, less than 8, less than 7, less than 6, less than 5, less than 4, less than 3, or less than 2 mm. In some embodiments, the nubs **34** may have a height of 1 mm to 10 mm, 1 mm to 7 mm, or 1.5 mm to 6 mm.

10 [052] The nubs **34** may have a variety of different shapes and/or configurations. For example, the cross section of the nubs **34** may define a circle, oval, star, diamond, rectangle, or any other geometric figure. In some embodiments, the nubs **34** may have an irregular cross sectional shape or may be generally linear or arcuate. Furthermore, the cross sectional shape of the
15 nubs **34** may vary over the height of the nubs **34**. For example, the nubs **34** may be provided with a slight taper whereby the upper surface **36** of the nub **34** has an area which is less than the cross sectional area of the base of the nub at the point where the nub is attached to the forming surface **24**. The inward taper of the side surfaces **38** may be in the range of between 0° to about 15°. For
20 example, side surfaces may have an inward taper of approximately 5° or 7°.

[053] Alternatively, the side surfaces **38** of the nubs **34** may be perpendicular to the forming surface **24**, pitched slightly outward, or vary over the perimeter or height of the nub **34**. For example, a nub **34** could have a leading edge **74** which is perpendicular to the forming surface and a trailing edge **76**
25 which is pitched slightly inward and thus have a pitch which varies over the perimeter of the nub **34**. A nub **34** which is perpendicular near its base (i.e., has a 0° taper) but tapers inwardly near its distal end would have a pitch which varies over the height of the nub **34**. Thus, the nubs **34** may take a variety of different shapes. The configuration of the nubs **34**, however, must account for the
30 interaction of the nub **34** and the first web **22** and the absorbent core web **28**.

[054] In some embodiments, the nubs **34** may have a circular shape.

The nubs **34** may have a diameter of 1 mm to 16 mm, 1 mm to 10 mm, or 1 mm

to 5 mm. In some embodiments the nubs **34** may have a diameter of less than 16 mm, less than 10 mm, or less than 5 mm. The pattern formed by the nubs **34** on the forming surface **24** may be varied significantly.

[055] Referring now to **Figs. 2** and **4**, the method **20** further includes
5 depositing absorbent material **26** onto the first web **22** to form a unitary absorbent core web **28** having a plurality of holes **41** formed therein. The absorbent material **26** surrounds the bonding areas **40** which overlie the nubs **36** thereby defining the holes **41**. The unitary absorbent core web **28** defines lateral side edges **31**. In embodiments with discrete absorbent cores, the discrete absorbent
10 cores further define longitudinal end edges **80** (see **Fig. 9**). In various embodiments, the bonding areas **40** of the first web **22** are free of absorbent material **26** or substantially free of absorbent material **26**. In various embodiments, the bonding areas **40** may include some absorbent material **26** that is removed prior to subsequent processing. In some embodiments, the
15 scarfing roll **62** can optionally be configured to remove most or all deposited absorbent material **26** from the bonding areas **40** of the first web **22**.

[056] As used herein, the term “unitary” means “undivided” and describes an absorbent core wherein no portion of the absorbent core is completely disconnected from any other portion. The unitary absorbent core includes a
20 plurality of holes wherein a first sheet and a second sheet are bonded together through the plurality of holes to form an absorbent composite. In other words, a unitary absorbent core is a “sea” of absorbent material with “islands” of bond points. In contrast, some prior art absorbent cores formed discrete pockets of absorbent material encapsulated between sheets that were connected together
25 between the pockets to create a “sea” of bond areas with “islands” of absorbent material.

[057] Unitary absorbent cores can be formed discretely or can be formed as webs. As used herein, the term “unitary absorbent core web” describes a series of unitary absorbent cores directly connected together to form a web. As
30 used herein, the term “discrete unitary absorbent core” describes a unitary absorbent core that is formed such that it is not directly connected to another unitary absorbent core.

[058] The method **20** further includes joining a second web **30** to the first web **22** on upper surfaces **36** of the nubs **34** to form an absorbent composite web **32** upon the forming surface **24**. **Fig. 5** representatively illustrates a portion of the method **20** not seen in **Fig. 2** wherein the second web **30** is joined in facing
5 relation to the first web **22** at bond points **45** to form the absorbent composite web **32**. The bond points **45** correspond to the bonding areas **40** of the first web **22**. In various embodiments, the second web **30** may additionally be joined to the first web **22** at marginal areas **42**. The marginal areas **42** are defined as the areas outboard of the absorbent core lateral side edges **78** and the longitudinal
10 end edges **80**.

[059] As used herein, the use of the term "join," "joined," "joining," or variations thereof in describing the relationship between two elements means that the two elements can be connected together by heat sealing, ultrasonic bonding, adhesive bonding, thermal bonding, pressure bonding, stitching, or the like, or
15 combinations thereof. Further, the two elements can be joined directly together (i.e., touching), or may have one or more elements interposed between them, all of which are suitably connected together.

[060] In the illustrated embodiments, the absorbent core web **28** is formed as a continuous web and therefore the marginal areas **42** extend beyond
20 the lateral side edges **78** of the absorbent core web **28**. However, those skilled in the art will readily appreciate that discrete absorbent cores may be formed such that a space exists between subsequent absorbent cores. As such, the marginal areas **42** may therefore extend around the entire perimeter **29** of the absorbent core (**Fig. 9**). Suitable methods for forming discrete absorbent cores is disclosed
25 in U.S. Patent Application 11/215876 to Wisneski *et al.* entitled "Method and Apparatus for Making Absorbent Article With Core Wrap" and filed on August 30, 2005, the entirety of which is incorporated herein by reference to the extent that it is consistent (i.e., not in conflict) herewith.

[061] **Fig. 6** representatively illustrates a cross sectional view of the
30 absorbent composite web **32** on the forming surface **24** taken along the line 6-6 of **Fig. 5**. The first web **22** is conformed to the forming surface **24** and overlays the nubs **34** and the side contour rings **72** at the marginal area **42**. The portions

of the first web **22** overlying the upper surfaces **36** of the nubs **34** define the bonding areas **40**. The absorbent material **26** is formed upon the first web **22** and surrounds the nubs **34** to form the unitary absorbent core web **28** having holes **41** therein. The holes **41** are defined by the nubs **34**. The bonding areas **40** of the first web **22** are exposed within the holes **41**. The absorbent core web **28** also includes a perimeter **29** defined in part by the side contour rings **72**. The second web **30** is overlaid on the first web **22** and the unitary absorbent core web **28**. The second web **30** is joined to the first web **22** at the bonding areas **40** to form bond points **45**. The second web **30** may also be joined to the first web **22** at the marginal areas **42**. Therefore, the absorbent composite web **32** is stabilized because the first web **22** and the second web **30** are joined together at bond points **45** which extend through holes **41** in the absorbent core web **28** located between the first web **22** and the second web **30**.

[062] The second web **30** may be joined to the first web **22** by any suitable means to form the absorbent composite web **32**. In various embodiments, the second web **30** may be joined to the first web **22** at the bonding areas **40** and/or the marginal areas **42** by adhesive bonding, ultrasonic bonding, thermal bonding, pressure bonding, and the like, and combinations thereof to form the absorbent composite web **32**. The joining at the bonding areas **40** results in bond points **45**.

[063] In some embodiments, the second web **30** may be joined to the first web **22** by applying adhesive to the second web **30** before overlying the second web **30** in facing relation with the first web **22** and the unitary absorbent core web **28**. The second web **30** may then be directly joined to the bonding areas **40** of the first web **22** via the adhesive to form the absorbent composite web **32** having bond points **45**. In various embodiments, the adhesive may be applied to the first web **22** and/or the second web **30** in any suitable pattern or covering any suitable surface area. For example, the adhesive pattern may include meltblown, swirl, slot coat, beads, or the like, or combinations thereof. The adhesive may be applied across at least 50 percent, at least 60 percent, at least 70 percent, at least 80 percent, or at least 90 percent of the surface area of the first web **22** and/or the second web **30**. The adhesive is preferably applied to at least those

portions of the second web **30** that align with the bonding areas **40** of the first web **22** to effectuate the joining of the webs **22** and **30** at the bonding areas **40** to form the bond points **45**.

[064] In various embodiments, adhesive may be applied to the first web **22**, the second web **30**, or both the first web **22** and the second web **30** before the second web **30** is overlaid upon the absorbent core web **28** and the first web **22**. In various embodiments, the second web **30** may be pressed against the bonding areas **40** to effectuate a stronger joining at the bond points **45** between the first web **22** and the second web **30** while on the forming surface **24**.

[065] In various embodiments, the second web **30** may be joined to the first web **22** at the marginal areas **42** to define a flange **43**. The flange **43** may extend beyond the perimeter **29** of the unitary absorbent core web **28** by any suitable distance. The flange **43** may be subsequently cut by any suitable means into any suitable shape and suitable contour. For example, in some embodiments, the flange **43** may be cut using a die cutter, high pressure water cutter, or the like, and may be shaped to follow the lateral side edges **78** of the unitary absorbent core web **28**. In some embodiments, including the forming of discrete absorbent cores, the flange **43** may be generally shaped to follow the entire perimeter **29** of the discrete absorbent core (**Fig. 9**).

[066] In some embodiments, the marginal areas **42** of the first web **22** may be folded around the absorbent core web **28** and joined to the second web **30** to seal the lateral edges **78** of the absorbent core web **28**. In some embodiments, the marginal areas **42** of the second web **30** may be folded around the absorbent core web **28** and joined to the first web **22** to seal the lateral edges **78** of the absorbent core web **28**. In some embodiments, the flange **43** formed by the first web **22** and the second web **30** may be folded around the absorbent core web **28** and joined to first web **22** and/or the second web **30**. Any suitable means may be used to fold the first web **22**, the second web **30**, and/or the flange **43**. For example, conventional folding boards, and the like, may be used. Suitable folding methods and apparatus are disclosed in U.S. Patent Application 10/955,820 to Mischler *et al.*, filed on September 30, 2004, the entirety of which

is incorporated herein by reference to the extent that it is consistent (i.e., not in conflict) herewith

[067] The present invention advantageously forms holes **41** in the absorbent core web **28** around the bonding areas **40**. The first web **22** and the second web **30** are joined together through the holes **41** at the bonding areas **40** to form bond points **45** while the first web **22** is conformed about the nubs **34** and the absorbent core web **28** is formed about the nubs **34** thereby ensuring registration between the bonding areas **40** and the holes **41**. Furthermore, having both the hole formation step and the bonding step occur on the same forming surface **24** allows the size of the hole **41** to be very similar to the size of the bond point **45** in the bonding area **40** because both are created by the same nub **34** while still engaged with the nub **34**. In other words, the bond points **45** cannot get out of registration with the holes **41**.

[068] In some embodiments, the first web **22** may provide the functions of both the first web **22** and the second web **30**. For example, the first web **22** may define a forming section and a wrap section. The first web **22** may be provided at a width substantially wider than the width of the absorbent core web **28**. The absorbent core web **28** may be formed on the forming section of the first web **22** as described herein and the wrap section of the first web **22** may be folded and overlaid upon the absorbent core web **28** and joined to the forming section as described herein to create the absorbent composite web **32**.

[069] In various embodiments, the absorbent composite web **32** may be compressed or densified by any suitable means, such as, for example, passing the absorbent composite web **32** through a fixed gap nip commonly referred to as debulking. Debulking the absorbent composite web **32** compresses and expands the unitary absorbent core web **28** and reduces the size of the holes **41**. Therefore, the size of the holes **41** approaches the size of the bond points **45** and results in minimally oversized holes **41** as compared to the bond points **45**.

[070] In various embodiments, the first web **22** may be a tissue web, the second web **30** may be a tissue web, and the second web **30** may be joined to the first web **22** at the bonding areas **40** to form bond points **45** with adhesive or any other suitable means.

[071] In various embodiments, the first web **22** may be a nonwoven web, the second web **30** may be a nonwoven web, and the second web **30** may be joined to the first web **22** at the bonding areas **40** to form bond points **45** by adhesive bonding, ultrasonic bonding, pressure bonding, thermal bonding, or the like, or combinations thereof.

[072] In various embodiments, the first web **22** and the second web **30** may be provided by a similar material. Alternatively the first web **22** and the second web **30** may be provided by dissimilar materials. The first web **22** may be adapted to face a user's body during use, and the second web **30** may be adapted to face away from the user's body during use or the first web **22** may be adapted to face away from a user's body during use, and the second web **30** may be adapted to face the user's body during use.

[073] Various woven and nonwoven fabrics may comprise the first web **22** and/or the second web **30**. For example, the first web **22** and/or the second web **30** may be composed of a meltblown or spunbonded web of polyolefin fibers. The first web **22** and/or the second web **30** may also be a bonded-carded web composed of natural and/or synthetic fibers. The first web **22** and/or the second web **30** may be composed of a substantially hydrophobic material, and the hydrophobic material may, optionally, be treated with a surfactant, or otherwise processed, to impart a desired level of wettability and hydrophilicity. Specifically, the first web **22** and/or the second web **30** may be a nonwoven, spunbond-meltblown-spunbond, polypropylene fabric having a basis weight of about 5 to 30 gsm.

[074] The first web **22** and/or the second web **30** may be stretchable, either elastically or extensibly, thereby allowing the absorbent core web **28** to swell. The first web **22** and the second web **30** may suitably be composed of a material which is either liquid permeable or liquid impermeable. It is generally desirable that at least one of the first web **22** and the second web **30** be formed from a material which is substantially liquid permeable. The liquid permeability may be inherent in the first web **22** and/or the second web **30**, such as in the example of a low basis weight spunbond. Alternatively, the permeability may result from the first web **22** and/or the second web **30** that is inherently liquid

impermeable, such as in the example of a film, which has been modified to provide the permeability, for example by aperturing.

[075] Other suitable materials for the first web **22** and/or the second web **30** are described in commonly assigned U.S. patent application 11/020842 to Abuto *et al.*, entitled, "Stretchable Absorbent Core and Wrap," filed December 21, 2004, the entirety of which is incorporated herein by reference to the extent that it is consistent (i.e., not in conflict) herewith. The first web **22** and/or the second web **30** may be manufactured by any suitable means, such as, for example the processes described in U.S. patent 5,458,592 to Abuto *et al.* and issued October 17, 1995, the entirety of which is incorporated herein by reference to the extent that it is consistent (i.e., not in conflict) herewith.

[076] In some embodiments, the absorbent composite web **32** may be separated into discrete absorbent composites **90** by any suitable means, such as, for example, rotary cutters, high pressure water cutters, die cutters, saw cutters, and the like. The separation of the absorbent composite web **32** into discrete absorbent composites **90** includes the separation of the first web **22** into discrete first sheets **92** and the second web **30** into discrete second sheets **93**. As discussed herein, the absorbent core may be formed as a continuous absorbent core web **28** and cut into discrete absorbent cores **91** or may be formed as discrete absorbent cores **91**. Therefore, the separation of the absorbent composite web **32** into discrete absorbent composites **90** may or may not require the separation of the absorbent core web **28** into discrete absorbent cores **91**.

[077] Referring now to **Figs. 7 and 8**, the discrete absorbent composite **90** of the present invention is representatively illustrated as part of a baby diaper.

The baby diaper is indicated in its entirety by the reference numeral **120**. The diaper **120** can suitably be disposable, which refers to articles that are intended to be discarded after a limited period of use instead of being laundered or otherwise conditioned for reuse. It should also be understood that the absorbent composite **90** of the present invention is suitable for use with various other absorbent articles intended for personal wear, including, but not limited to, children's training pants, feminine hygiene products, incontinence products, medical garments, surgical pads and bandages, other personal care or health

care garments, and the like, without departing from the scope of the present invention.

[078] By way of illustration only, various materials and methods for constructing diapers such as the diapers **120** of the various aspects of the present invention are disclosed in U.S. Patent Application Serial No. 10/836490, filed April 29, 2004, in the name of Schlinz et al.; U.S. Patent 5,496,298 issued March 5, 1996, to Kuepper et al.; U.S. Patent 4,798,603 issued January 17, 1989, to Meyer et al.; U.S. Patent 5,176,668 issued January 5, 1993, to Bernardin; U.S. Patent 5,192,606 issued March 9, 1993, to Proxmire et al., and U.S. Patent 5,509,915 issued April 23, 1996, to Hanson et al., each of which are incorporated herein by reference to the extent that they are consistent (i.e., not in conflict) herewith.

[079] The diaper **120** is illustrated in **Fig. 7** in a fastened condition. The diaper **120** is illustrated in **Fig. 8** in a laid flat and unfastened condition with portions cut away to illustrate underlying detail. The diaper **120** defines a longitudinal direction **146** and a lateral direction **148** perpendicular to the longitudinal direction as shown in **Fig. 8**. The diaper **120** further defines a pair of longitudinal end regions, otherwise referred to herein as a front waist region **122** and a back waist region **124**, and a center region, otherwise referred to herein as a crotch region **126**, extending longitudinally between and interconnecting the front and back waist regions **122**, **124**. The front and back waist regions **122**, **124** include those portions of the diaper **120**, which, when worn, wholly or partially cover or encircle the waist or mid-lower torso of the wearer. The crotch region **126** generally is that portion of the diaper **120** which, when worn, is positioned between the legs of the wearer and covers the lower torso and crotch of the wearer. The diaper **120** also defines an inner surface **128** adapted to be positioned toward the wearer, and an outer surface **130** opposite the inner surface. With additional reference to **Fig. 8**, the diaper **120** has a pair of opposed article side edges **136** extending in the longitudinal direction **146** and a pair of opposed article waist edges **138** extending in the lateral direction **148**, referred to herein as the article back waist edge and the article front waist edge.

[080] The illustrated diaper **120** can include an absorbent chassis, generally indicated at **132**. The absorbent chassis **132** can define a first chassis side edge **190** extending in the longitudinal direction **146** and a second chassis side edge **191** extending in the longitudinal direction **146**, opposite the first chassis side edge **190**. The absorbent chassis **132** can also define a pair of longitudinally opposite chassis waist edges referred to herein as the chassis back waist edge **192** and the chassis front waist edge **194**.

[081] For example, in the aspect of **Figs. 7** and **8**, the diaper **120** includes an absorbent chassis **132** and a pair of ears **134** formed separately from and attached to the absorbent chassis **132** proximate the first chassis side edge **190** and the second chassis side edge **191**. The ears **134** can be attached along seams **156** proximate the chassis side edges **190**, **191** in either the front waist region **122** or in the back waist region **124** of the diaper **120**. In the illustrated aspects, the ears **134** are attached in the back waist region **124**. The ears **134** may be attached to the absorbent chassis **132** using means known to those skilled in the art such as adhesive, thermal bonding, pressure bonding, ultrasonic bonding, and the like, or combinations thereof. In alternative embodiments, the ears **134** may be formed as an integral part of the absorbent chassis **132**. The ears **134** may also include fasteners **160**, as are known in the art, adapted to releasably secure the diaper **120** about the waist of the wearer.

[082] The absorbent chassis **132** is illustrated in **Fig. 8** as being substantially I-shaped. However, it is contemplated that the absorbent chassis **132** may have other shapes (e.g., hourglass, T-shaped, rectangular, and the like) without departing from the scope of this invention.

[083] The absorbent chassis **132** can include an outercover **140** and a bodyside liner **142** in a superposed relation therewith. The liner **142** can be suitably joined to the outercover **140** along at least a portion of the absorbent chassis **132**. The liner **142** can be suitably adapted, i.e., positioned relative to the other components of the diaper **120**, to contact the wearer's skin during wear of the diaper. The absorbent chassis **132** may also include the absorbent composite **90** disposed on the inner surface of the article relative to the outercover **140** for absorbing liquid body exudates. For example, the absorbent

composite **90** can be located between the outercover **140** and the bodyside liner **142**. The bodyside liner **142** and the outercover **140** can be attached to each other by adhesive, ultrasonic bonding, thermal bonding or by other suitable attachment techniques known in the art. Moreover, at least a portion of the
5 absorbent composite **90** can optionally be attached to the bodyside liner **142** and/or the outercover **140** utilizing the methods described above. The liner **142** can be coextensive with the outercover **140** or can be larger or smaller than the outercover **140**.

[084] As discussed herein, the discrete absorbent composite **90** includes
10 a first sheet **92** and a second sheet **93** joined together at a plurality of bond points **45**. The absorbent core **91** is located between the first and second sheets **92** and **93** and the bond points **45** extend through the holes **41** within the absorbent core **91**.

[085] The diaper **120** can optionally include a pair of containment flaps
15 **155** for inhibiting the lateral flow of body exudates. The containment flaps **155** can be operatively attached to the diaper **120** in any suitable manner as is well known in the art. In particular, suitable constructions and arrangements for the containment flaps are generally well known to those skilled in the art and are described in U.S. Patent 4,704,116 issued November 3, 1987, to Enloe, which is
20 incorporated herein by reference to the extent that it is consistent (i.e., not in conflict) herewith.

[086] To further enhance containment and/or absorption of body exudates, the diaper **120** may optionally include waist elastic members **154** in the front and/or back waist regions **122** and **124** of the diaper **120**. Likewise, the
25 diaper **120** may optionally include leg elastic members **158**, as are known to those skilled in the art. The waist elastic members **154** and the leg elastic members **158** can be formed of any suitable elastic material that is well known to those skilled in the art. For example, suitable elastic materials include sheets, strands or ribbons of natural rubber, synthetic rubber, or thermoplastic
30 elastomeric polymers. In one aspect of the invention, the waist elastics and/or the leg elastics may include a plurality of dry-spun coalesced multi-filament

spandex elastomeric threads sold under the trade name LYCRA and available from Invista of Wilmington, Delaware, U.S.A.

[087] The outercover **140** may suitably include a material that is substantially liquid impermeable. The outercover **140** may be provided by a single layer of liquid impermeable material, or more suitably include a multi-layered laminate structure in which at least one of the layers is liquid impermeable. In particular aspects, the outer layer may suitably provide a relatively cloth-like texture to the wearer. A suitable liquid impermeable film for use as a liquid impermeable inner layer, or a single layer liquid impermeable outercover **140** is a 0.025 millimeter (1.0 mil) polyethylene film commercially available from Edison Plastics Company of South Plainfield, New Jersey, U.S.A. Alternatively, the outercover **140** may include a woven or nonwoven fibrous web layer that has been totally or partially constructed or treated to impart the desired levels of liquid impermeability to selected regions that are adjacent or proximate the absorbent body.

[088] The outercover **140** may also be stretchable, and in some aspects it may be elastomeric. For example, such an outercover material can include a 0.3 osy polypropylene spunbond that is necked 60 percent in the lateral direction, creped 60 percent in the longitudinal direction, and laminated with 3 grams per square meter (gsm) Bostik-Findley H2525A styrene-isoprene-styrene based adhesive to 8 gsm PEBAX 2533 film with 20 percent TiO₂ concentrate. Reference is made to U.S. Patent No. 5,883,028, issued to Morman et al., U.S. Patent No. 5,116,662 issued to Morman and U.S. Patent No. 5,114,781 issued to Morman, all of which are hereby incorporated herein by reference, for additional information regarding suitable outercover materials.

[089] The bodyside liner **142** is suitably compliant, soft-feeling, and non-irritating to the wearer's skin. The bodyside liner **142** is also sufficiently liquid permeable to permit liquid body exudates to readily penetrate through its thickness to the absorbent composite **90** and the absorbent core **91** located therein. A suitable liquid permeable bodyside liner **142** is a nonwoven polyethylene/polypropylene bi-component web having a basis weight of about 27 gsm; the web may be spunbonded or a bonded carded web. Optionally, the

bodyside liner **142** may be treated with a surfactant to increase the wettability of the liner material.

[090] Alternatively, the bodyside liner **142** may also be stretchable, and in some aspects it may be elastomeric. For instance, the liner **142** can be a
5 nonwoven, spunbond polypropylene fabric composed of about 2 to 3 denier fibers formed into a web having a basis weight of about 12 gsm which is necked approximately 60 percent. Strands of about 9 gsm KRATON G2760 elastomer material placed eight strands per inch (2.54 cm) can be adhered to the necked
10 spunbond material to impart elasticity to the spunbond fabric. The fabric can be surface treated with an operative amount of surfactant, such as about 0.6 percent AHCOVEL Base N62 surfactant, available from ICI Americas, a business having offices in Wilmington, Delaware, U.S.A. Other suitable materials may be extensible biaxially stretchable materials, such as a neck stretched/creped spunbond. Reference is made to U.S. Patent No. 6,552,245, issued April 22,
15 2003, to Roessler et al., which is incorporated by reference herein to the extent that it is consistent (i.e., not in conflict) herewith.

[091] The absorbent core **91** includes absorbent material **26** and is suitably compressible, conformable, and capable of absorbing and retaining liquid body exudates released by the wearer. For example, the absorbent core **91** can
20 include a matrix of absorbent fibers, and more suitably cellulosic fluff, such as wood pulp fluff, and superabsorbent particles. One suitable pulp fluff is identified with the trade designation CR1654, commercially available from U.S. Alliance, Childersburg, Alabama, U.S.A. As an alternative to wood pulp fluff, synthetic fibers, polymeric fibers, meltblown fibers, short cut homofil bicomponent synthetic
25 fibers, or other natural fibers may be used. Suitable superabsorbent materials can be selected from natural, synthetic, and modified natural polymers and materials. The superabsorbent materials can be inorganic materials, such as silica gels, or organic compounds, such as cross linked polymers, for example, sodium neutralized polyacrylic acid. Suitable superabsorbent materials are
30 available from various commercial vendors, such as Dow Chemical Company of Midland, Michigan, U.S.A., and Stockhausen Inc., Greensboro, North Carolina, U.S.A.

[092] In various embodiments, the absorbent core **91** may include 30 to 90 percent superabsorbent by weight. In some embodiments, the absorbent core **91** may include at least 50, at least 60, at least 70, or at least 80 percent superabsorbent by weight. In various embodiments, the absorbent core **91** may include 70 to 10 percent cellulose fluff by weight. In some embodiments, the absorbent core **91** may include less than 70, less than 60, less than 50, less than 40, less than 30, or less than 20 percent cellulose fluff by weight. In some embodiments, the absorbent core **91** may include 50 to 90 percent superabsorbent material by weight and 50 to 10 percent cellulose fluff by weight.

In some embodiments, the absorbent core **91** may include 60 to 90 percent superabsorbent material by weight and 40 to 10 percent cellulose fluff by weight. In some embodiments, the absorbent core **91** may include 70 to 90 percent superabsorbent material by weight and 30 to 10 percent cellulose fluff by weight.

[093] The absorbent core **91** and/or the absorbent composite **90** may have a variety of shapes and configurations as are known in the art, such as rectangular, hourglass shaped, I-shaped, and the like. The absorbent core **91** may have the same shape or a different shape than the absorbent composite **90**. For example, the absorbent core **91** may have a rectangular shape and the absorbent composite **90** may have a rectangular shape. In another example, the absorbent core **91** may have an hourglass shape and the absorbent composite **90** may have a rectangular shape.

[094] In some embodiments, the portions of the absorbent composite **90** including the absorbent core **91** may have a density within the range of about 0.10 to about 0.5 grams per cubic centimeter. The absorbent core **91** of the present invention may have a uniform density. In other words, the portions of the absorbent core **91** proximate the holes **41** may have essentially the same density as the portions of the absorbent core **91** more distant from the holes **41**. This uniform density is believed to provide for a soft and conforming absorbent composite **90** without hard spots or hard lines in the product.

[095] Traditional cellulose fluff based absorbent products have been made thinner by greater compression resulting in higher densities and less flexibility. Alternatively, thinner absorbent products have been made with less

absorbent material but may not have the absorbent capacity necessary to meet the needs of the wearer. However, as higher concentrations of superabsorbent materials have become more prevalent, thinner absorbent articles with adequate absorbent capacity have been manufactured. Unfortunately, absorbent articles with high concentrations of superabsorbent material have also traditionally suffered from structural breakdowns, superabsorbent shifting, and superabsorbent migration because the relative percentage of cellulose fluff “holding” the superabsorbent in place has decreased relative to the superabsorbent material contained therein.

[096] In general, the method and apparatus of the present invention is compatible with relatively thin absorbent cores **91**. For example, in various embodiments, the absorbent core **91** and/or absorbent composite **90** can have a thickness of about 1 mm to about 10 mm. In some embodiments, the absorbent core **91** and/or the absorbent composite **90** may have a thickness of less than about 9 mm, less than about 8 mm, less than about 7 mm, less than about 6 mm, less than about 5 mm, less than about 4 mm, less than about 3 mm, or less than about 2 mm. The thin absorbent core **91** of the present invention allows for a thinner absorbent article. Thin absorbent articles are generally believed to be well suited for comfort and discretion. As used herein, the thickness of the absorbent composite **90** describes the thickness as measured in those portions including the absorbent core **91**. One skilled in the art will appreciate that portions of the absorbent composite **90** may not include the absorbent core **91** (for example, the marginal areas **42**) and would obviously be thinner at these locations.

[097] The present invention includes a thin absorbent composite having a stabilized absorbent core wherein structural breakdowns, superabsorbent shifting, and superabsorbent migration are believed to be limited. The stabilized absorbent composites include a first sheet joined to a second sheet at a plurality of bond points corresponding with a plurality of holes located within an absorbent core. **Fig. 9** representatively illustrates an exemplary absorbent composite **90**. Portions of the absorbent composite **90** are cut away in **Fig. 9** to illustrate underlying features. **Fig. 10** representatively illustrates the portion of **Fig. 9** delineated by box **10** and magnified for clarity and with portions cut away to

illustrate underlying details. **Fig. 11** is a cross sectional view of the portion of the absorbent composite **90** illustrated in **Fig. 10**.

[098] Referring now to **Figs. 9, 10 and 11**, the absorbent composite **90** includes a first sheet **92**, a second sheet **93**, and a discrete unitary absorbent core **91** located therebetween. The absorbent core **91** has a plurality of holes **41** extending there through and is positioned between the first sheet **92** and the second sheet **93**. The first sheet **92** extends through the holes **41** in the absorbent core **91** and is joined with the second sheet **93** at a plurality of bond points **45**. The plurality of bond points **45** stabilize the absorbent core **91** and the absorbent composite **90**. Therefore, the resulting absorbent composite **90** includes a stabilized discrete unitary absorbent core **91** that is believed to be thin, soft, and compliant having no ridges, hard lines, or hard spots.

[099] The unitary absorbent cores of the present invention have overall “continuity” (i.e., no segmenting) and are believed to promote free fluid movement throughout the entire core. The bond points are believed to improve the integrity of the absorbent composite, but the relatively small holes maintain a large absorbent area available to receive insults. Additionally, it is believed that the unitary absorbent cores with uniform densities will bend continuously and evenly about the wearer. Finally, it is believed that unitary absorbent cores will distribute the weight of the wearer more evenly and won’t result in pressure points possible with discontinuous absorbent cores.

[0100] The holes **41** in the absorbent core **91** may have any suitable shape and any suitable size. For example, the holes **41** may have a circular shape, as illustrated in **Fig. 9**, but may alternatively be in the shape of an oval, square, triangle, or any other suitable geometric shape, irregular, or the like, or combinations thereof. In some embodiments, the absorbent cores **91** may have at least one first hole having a first shape and at least one second hole having a second shape wherein the first shape and the second shape are different. In some embodiments, the absorbent cores **91** may have at least one first hole having a first size and at least one second hole having a second size wherein the first size and the second size are different.

[0101] In various embodiments, the holes **41** may have a hole area **171** of 1 mm² (0.0015 in²) to 200 mm² (0.3 in²), 1 mm² (0.0015 in²) to 100 mm² (0.155 in²), or 1 mm² (0.0015 in²) to 25 mm² (0.03875 in²). In some embodiments, the hole area **171** may be less than 200 mm², less than 100 mm², less than 90 mm², less than 80 mm², less than 70 mm², less than 60 mm², less than 50 mm², less than 40 mm², less than 30 mm², less than 20 mm², or less than 10 mm². In embodiments wherein the holes **41** have a generally circular shape, the holes **41** may have a diameter of 1 mm to 16 mm, 1 mm to 10 mm, or 1 mm to 5 mm. In some embodiments the holes **41** may have a diameter of less than 16 mm, less than 10 mm, or less than 5 mm. In various embodiments, the total area of the holes **41** may be between about 1 to about 33 percent, about 1 to about 25 percent, or less than about 10 percent of the total area of the absorbent core **91**.

[0102] In various embodiments, the absorbent cores may have at least one first hole having a first hole area and at least one second hole having a second hole area wherein the first and second hole areas are different. For example, in some embodiments, the absorbent cores may define a front portion generally oriented towards the front waist region of the absorbent article and a back portion generally oriented towards the back waist region of the absorbent article wherein the back portion includes holes having a larger hole area and wherein the front portion includes holes having a smaller hole area.

[0103] The absorbent material surrounding the holes **41** defines a hole wall **175**. The hole wall **175** is preferably no more or less dense than any other portion of the absorbent core **91** which is believed to be more comfortable to the wearer. In contrast, some traditional methods of stabilizing absorbent cores, such as pin aperturing, embossing, needling, and the like, have resulted in densified regions surrounding indentations. Such densifications may impact fluid movement within the absorbent core, may be noticeable to a wearer and/or caregiver, and may reduce the flexibility of the absorbent core **91**.

[0104] The bonds **45** may be any suitable shape and any suitable size. For example, the bonds **45** may be circular, as illustrated in **Fig. 10**, but may also be oval, square, triangular, or any other suitable geometric shape, irregular, or the like, or combinations thereof. In some embodiments, the absorbent cores **91**

may have at least one first bond having a first shape and at least one second bond having a second shape wherein the first shape and the second shape are different. In some embodiments, the absorbent cores **91** may have at least one first bond having a first size and at least one second bond having a second size wherein the first size and the second size are different.

[0105] In some embodiments, the bonds **45** may have a bond area **173** of 1 mm^2 (0.0015 in^2) to 200 mm^2 (0.3 in^2), 1 mm^2 (0.0015 in^2) to 100 mm^2 (0.155 in^2), or 1 mm^2 (0.0015 in^2) to 25 mm^2 (0.03875 in^2). In some embodiments, the bond area **173** may be less than 200 mm^2 , less than 100 mm^2 , less than 90 mm^2 , less than 80 mm^2 , less than 70 mm^2 , less than 60 mm^2 , less than 50 mm^2 , less than 40 mm^2 , less than 30 mm^2 , less than 20 mm^2 , or less than 10 mm^2 . In embodiments wherein the bonds **45** generally have a circular shape, the bonds **45** may have a diameter of 1 mm to 16 mm, 1 mm to 10 mm, or 1 mm to 5 mm. In some embodiments the bonds **45** may have a diameter of less than 16 mm, less than 10 mm, or less than 5 mm.

[0106] In various embodiments, the absorbent cores **91** may have at least one first bond having a first bond area and at least one second bond having a second bond area wherein the first and second bond areas are different. For example, in some embodiments, the absorbent cores may define a front portion generally oriented towards the front waist region of the absorbent article and a back portion generally oriented towards the back waist region of the absorbent article wherein the back portion includes bonds having a larger bond area and wherein the front portion includes bonds having a smaller bond area.

[0107] In some embodiments, larger bonds and smaller bonds may be intermixed throughout the absorbent core in any suitable arrangement. In some embodiments, smaller bonds may be adapted to release when the absorbent material is wetted. In some embodiments, larger bonds may be adapted to remain joined when the absorbent material is wetted.

[0108] In some embodiments, the bond area **173** is at least 60, 70, 80, 90, or 95 percent that of the hole area **171**, resulting in an unbonded area **177** that is less than 40, 30, 20, 10, or 5 percent of the hole area **171**. It is believed that having the bond area **173** close to the same size as the hole area **171** results in greater stabilization of the absorbent core **91** because less of the absorbent

material **26** is unsupported, i.e., there is less unbonded area **177**. For example, as illustrated in **Fig. 10**, the bond area **173** is approximately 60 percent of the hole area **171**, whereas the unbonded area **177** is about 40 percent of the hole area **171**.

5 [0109] In some embodiments, the bond area **173** may be substantially devoid of absorbent material **26**. In other words, the first sheet **92** may be joined directly to the second sheet **93** at the bond points **45** with substantially no absorbent material **26** therebetween. In some embodiments, the bond area **173** may be free of absorbent material **26**. In other words, the first sheet **92** may be
10 joined directly to the second sheet **93** at the bond points **45** with no absorbent material **26** therebetween as illustrated in **Fig. 11**.

[0110] As illustrated in **Fig. 11**, the bonds **45** are skewed towards the second sheet **93**. As such, the first sheet **92** extends at least partially through the holes **41** of the absorbent core **91**. In some embodiments, the first sheet **92**
15 extends entirely through the holes **41** of the absorbent core **91**. In one embodiment, the first sheet **92** may be positioned towards the liner **142** and the second sheet **93** may be oriented towards the outercover **140**. In another embodiment, the second sheet **93** may be positioned towards the liner **142** and the first sheet **92** may be oriented towards the outercover **140**.

20 [0111] In various embodiments, the bonds **45** may be generally located within the holes **41**. In some embodiments, the bonds **45** may be registered within the holes **41**. In other words, the bonds **45** may be generally centered within the holes **41**. For a bond **45** to be generally centered within the hole **41** means that the bonds **45** have a center point and the holes **41** have a center
25 point and both center points coincide at common center point **179** as illustrated in **Fig. 10**. In some embodiments, at least 60, at least 70, at least 80, at least 90, and at least 99 percent of the bonds **45** are located with the holes **41**. In some embodiments, 100 percent of the bonds **45** are located within the holes **41**. In some embodiments, at least 60, at least 70, at least 80, at least 90, and at least
30 99 percent of the bonds **45** are registered within the holes **41**. In some embodiments, 100 percent of the bonds **45** are registered within the holes **41**.

[0112] In various embodiments, the absorbent composite may have a “bond point density” of 0.05 to 1.0 bond points **45** per square centimeter of absorbent core **91**. In some embodiments, the absorbent composite may have 0.1 to 0.5 bond points **45** per square centimeter of absorbent core **91**. In some
5 embodiments, the absorbent composite may have 0.2 to 0.4 bond points **45** per square centimeter of absorbent core **91**. In some embodiments, the absorbent core **91** may have a first bond point density in a first region and a second bond point density in a second region. For example, the absorbent core **91** may have a front portion located generally towards the front waist region of the absorbent
10 article and a back portion located generally towards the back waist region of the absorbent article wherein the front portion has a higher density of bond points and the back portion has a lower density of bond points. In some embodiments, the bond points **45** may have a diameter, D, and may be spaced apart by at least one times, two times, three times, or more than four times the diameter, D.

[0113] In various embodiments, the absorbent composite **90** may include an absorbent core **91** located between a liquid pervious first sheet **92** and a liquid pervious second sheet **93**. The liquid pervious first sheet **92** extends through holes **41** in the absorbent core **91** to join with the liquid pervious second sheet **93** at a plurality of bond points **45**. In various embodiments, the absorbent
15 composite **90** may include an absorbent core **91** located between a liquid impervious first sheet **92** and a liquid pervious second sheet **93**. The liquid impervious first sheet **92** extends through holes **41** in the absorbent core **91** to join with the liquid pervious second sheet **93** at a plurality of bond points **45**. In various embodiments, the absorbent composite **90** may include an absorbent
20 core **91** located between a liquid pervious first sheet **92** and a liquid impervious second sheet **93**. The liquid pervious first sheet **92** extends through holes **41** in the absorbent core **91** to join with the liquid impervious second sheet **93** at a plurality of bond points **45**. In various embodiments, the first sheet **92** or the second sheet **93** may face towards the liner **142**.

[0114] In one aspect, the absorbent composite **90** may be stretchable so as not to inhibit the stretchability of other components to which the absorbent composite **90** may be adhered, such as the outercover **140** and/or the bodyside
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liner **142**. For example, the absorbent composite **90** may include materials disclosed in U.S. Patent Nos. 5,964,743, 5,645,542, 6,231,557, 6,362,389, and international patent application WO 03/051254, the disclosure of each of which is incorporated by reference herein to the extent that they are consistent (i.e., not in conflict) herewith.

[0115] In some aspects, a surge management layer (not shown) may be included in the diaper **120**. The surge management layer may be positioned in the diaper **120** in a variety of locations as is known in the art. For example, the surge management layer can be proximate the absorbent composite **90**, for example between the absorbent composite **90** and the bodyside liner **142**, and attached to one or more components of the diaper **120** by methods known in the art, such as by adhesive, ultrasonic bonding, pressure bonding, thermal bonding, and the like, or combinations thereof.

[0116] A surge management layer helps to decelerate and diffuse surges or gushes of liquid that may be rapidly introduced into the absorbent composite **90**. Desirably, the surge management layer can rapidly accept and temporarily hold the liquid prior to releasing the liquid into the storage or retention portions of the absorbent composite **90**. Examples of suitable surge management layers are described in U.S. Patent 5,486,166 and U.S. Patent 5,490,846, the contents of which are incorporated herein by reference to the extent that they are consistent (i.e., not in conflict) herewith.

[0117] While the invention has been described in detail with respect to specific embodiments thereof, it will be appreciated that those skilled in the art, upon attaining understanding of the foregoing will readily appreciate alterations to, variations of, and equivalents to these embodiments. Accordingly, the scope of the present invention should be assessed as that of the appended claims and any equivalents thereto.

CLAIMS:

1. A method for forming and stabilizing an absorbent composite web,
comprising,

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conforming a first web onto a forming surface having a plurality of raised
nubs having upper surfaces, the first web defining a plurality of bond areas
corresponding to those portions of the first web overlying the upper surfaces
of the nubs,

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depositing absorbent material onto the first web to form a unitary absorbent
core having a plurality of holes therein,

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joining a second web to the first web at the bond areas to form an absorbent
composite web, wherein the unitary absorbent core is positioned between
the first web and the second web, and the first web and the second web are
bonded together through the holes in the absorbent core, and

removing the absorbent composite web from the forming surface.

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2. The method of **claim 1** further comprising applying adhesive to the second
web before joining the second web to the first web.

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3. The method of **claim 2** further comprising pressing the second web against
the first web while the first web is conformed to the forming surface to effectuate
the joining of the second web to the first web.

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4. The method of **claim 1** wherein the joining step includes ultrasonic bonding,
thermal bonding, or pressure bonding.

5. The method of **claim 1** wherein the first web is drawn to the forming surface
via vacuum forces and the forming surface is a drum former.

6. The method of **claim 1** wherein the nubs have a height of 1.5 to 6 mm and a surface area of 1 to 25 mm².

5 7. The method of **claim 1** wherein the absorbent material includes superabsorbent particles and cellulose fluff fibers.

8. The method of **claim 7** wherein the unitary absorbent core comprises 30 to 90 percent superabsorbent particles and 70 to 10 percent cellulose fluff fibers by weight.

10

9. The method of **claim 7** wherein portions of the absorbent composite web comprising the unitary absorbent core have a thickness of less than 6 mm.

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10. The method of **claim 1** further comprising scarfing the absorbent core to expose the bond areas before joining the second web to the first web.

11. The method of **claim 1** wherein the first web and the second web are tissue webs and the joining includes adhesive.

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12. The method of **claim 1** wherein the first web and the second web are nonwoven webs and the joining includes adhesive bonding, ultrasonic bonding, thermal bonding, or pressure bonding.

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13. A method for forming an absorbent composite web, comprising,

conforming a first tissue web onto a forming surface via vacuum forces, the forming surface having a plurality of raised nubs having upper surfaces, the first tissue web defining a plurality of bonding areas corresponding to those portions of the first tissue web overlying the upper surfaces of the nubs,

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depositing superabsorbent and cellulose fluff onto the first tissue web to form a unitary absorbent core having a plurality of holes therein,

applying adhesive to a second tissue web,

pressing the second tissue web against the first tissue web to join the first
and second tissue webs at the bonding areas to form an absorbent
5 composite web, wherein the unitary absorbent core is positioned between
the first tissue web and the second tissue web and the first tissue web and
the second tissue web are bonded together through the holes in the unitary
absorbent core, and

10 removing the absorbent composite web from the forming surface.

14. The method of **claim 13** further comprising scarfing the unitary absorbent
core to remove substantially all absorbent material from the bond areas.

15 **15.** The method of **claim 13** wherein the unitary absorbent core comprises 30 to
90 percent superabsorbent and 70 to 10 percent cellulose fluff by weight.

16. The method of **claim 13** wherein portions of the absorbent composite web
comprising the unitary absorbent core have a thickness of less than 6 mm.

20 **17.** A method for forming an absorbent composite web, comprising,

conforming a first nonwoven web onto a forming surface via vacuum forces,
the forming surface having a plurality of raised nubs having upper surfaces,
25 the first nonwoven web defining a plurality of bond areas corresponding to
those area of the first nonwoven web overlying the upper surfaces of the
nubs,

depositing superabsorbent and cellulose fluff onto the first nonwoven web to
30 form a unitary absorbent core,

scarfing the absorbent core to remove substantially all absorbent material from the bond areas and to define a plurality of holes in the unitary absorbent core,

5 joining the second nonwoven web to the first nonwoven web at the bond areas using adhesive bonding, ultrasonic bonding, thermal bonding, or pressure bonding to form an absorbent composite web, wherein the unitary absorbent core is positioned between the first nonwoven web and the second nonwoven web and the first nonwoven web and the second
10 nonwoven web are bonded together through the holes in the unitary absorbent core, and

removing the absorbent composite web from the forming surface.

15 **18.** The method of **claim 17** wherein the unitary absorbent core comprises 30 to 90 percent superabsorbent and 70 to 10 percent cellulose fluff by weight.

19. The method of **claim 17** wherein the absorbent composite web has a thickness of less than 6 mm.

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20. The method of **claim 17** further comprising separating the absorbent composite web into discrete absorbent composites and placing the discrete absorbent composites between a bodyside liner and an outercover to form an absorbent article.

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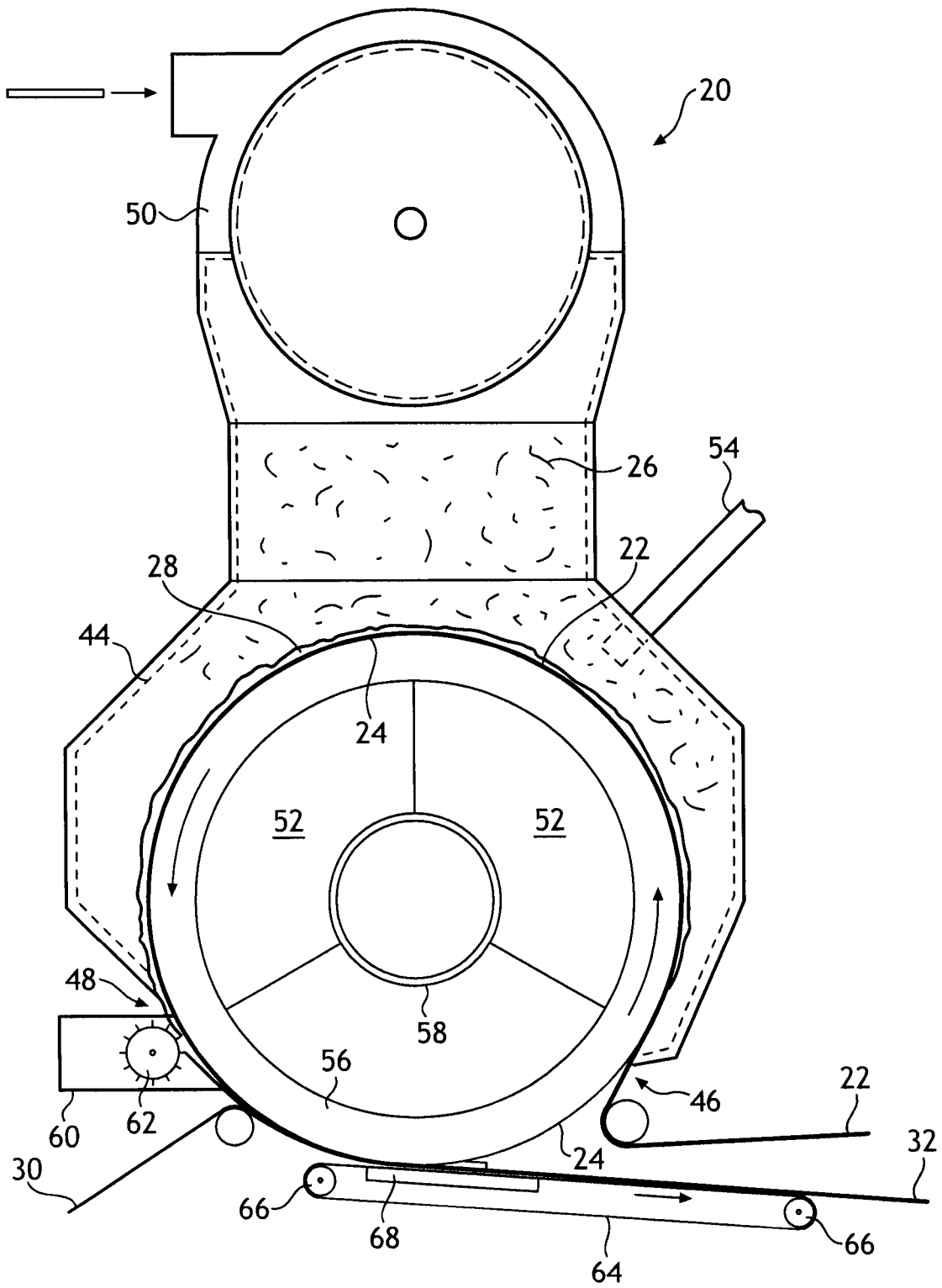


FIG. 1

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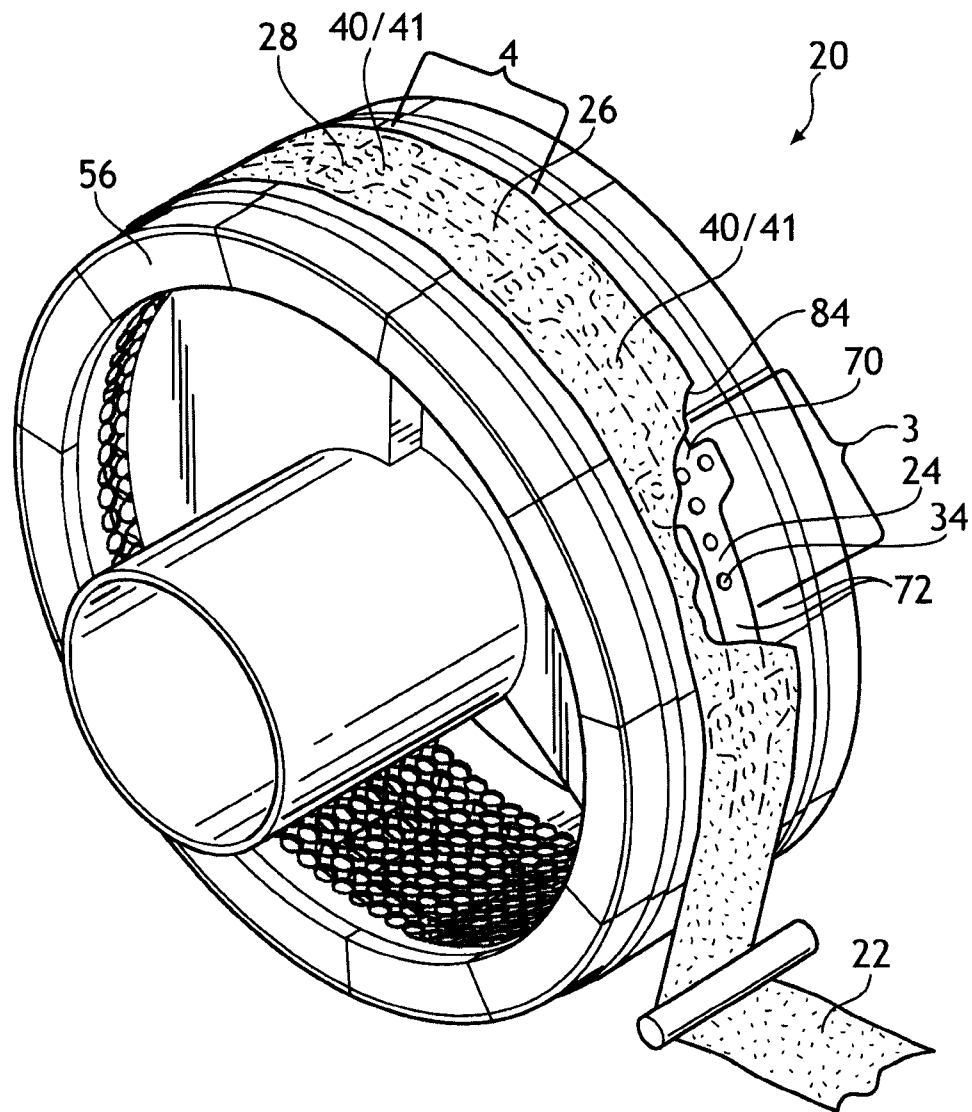


FIG. 2

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FIG. 3

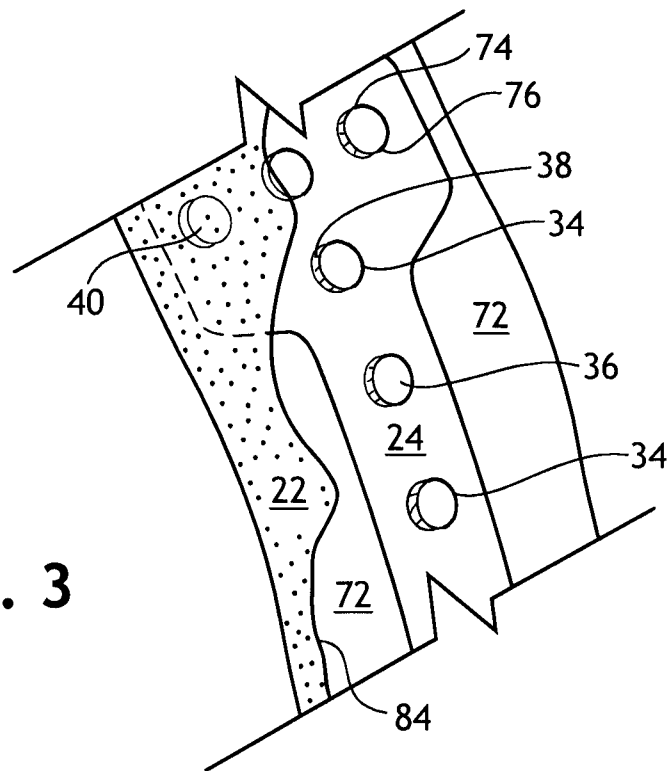
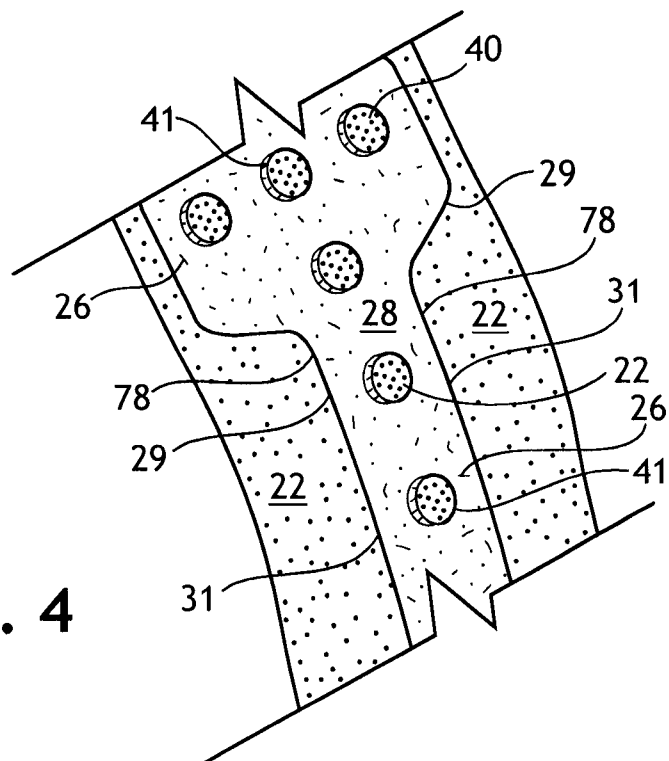


FIG. 4



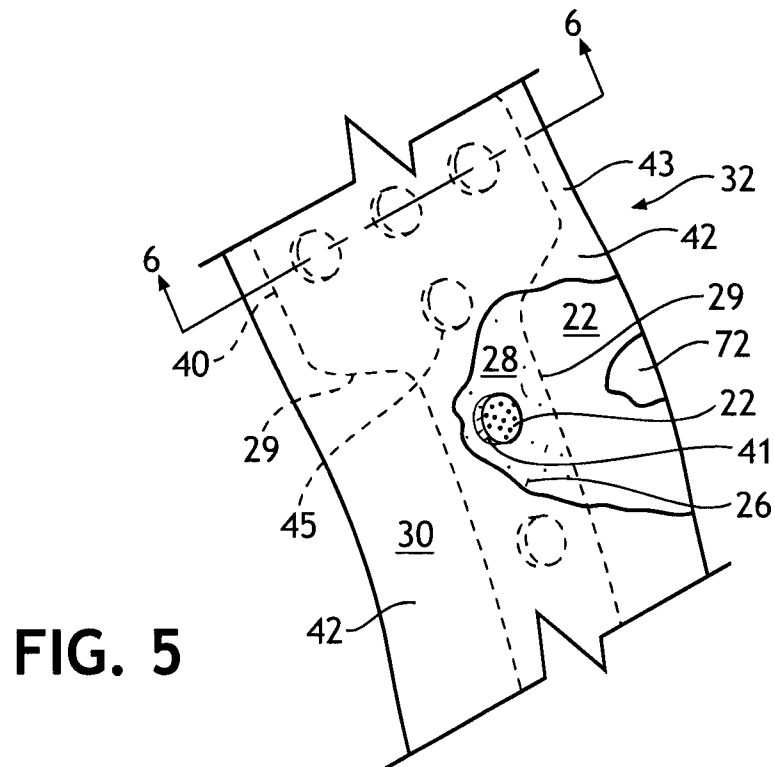


FIG. 5

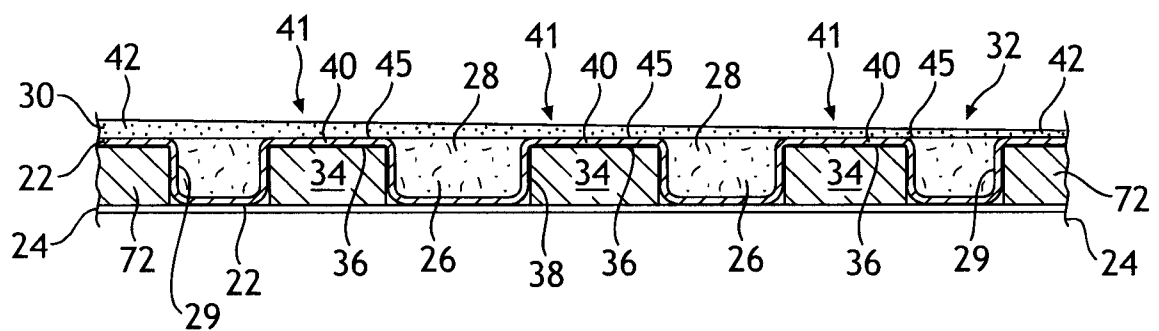


FIG. 6

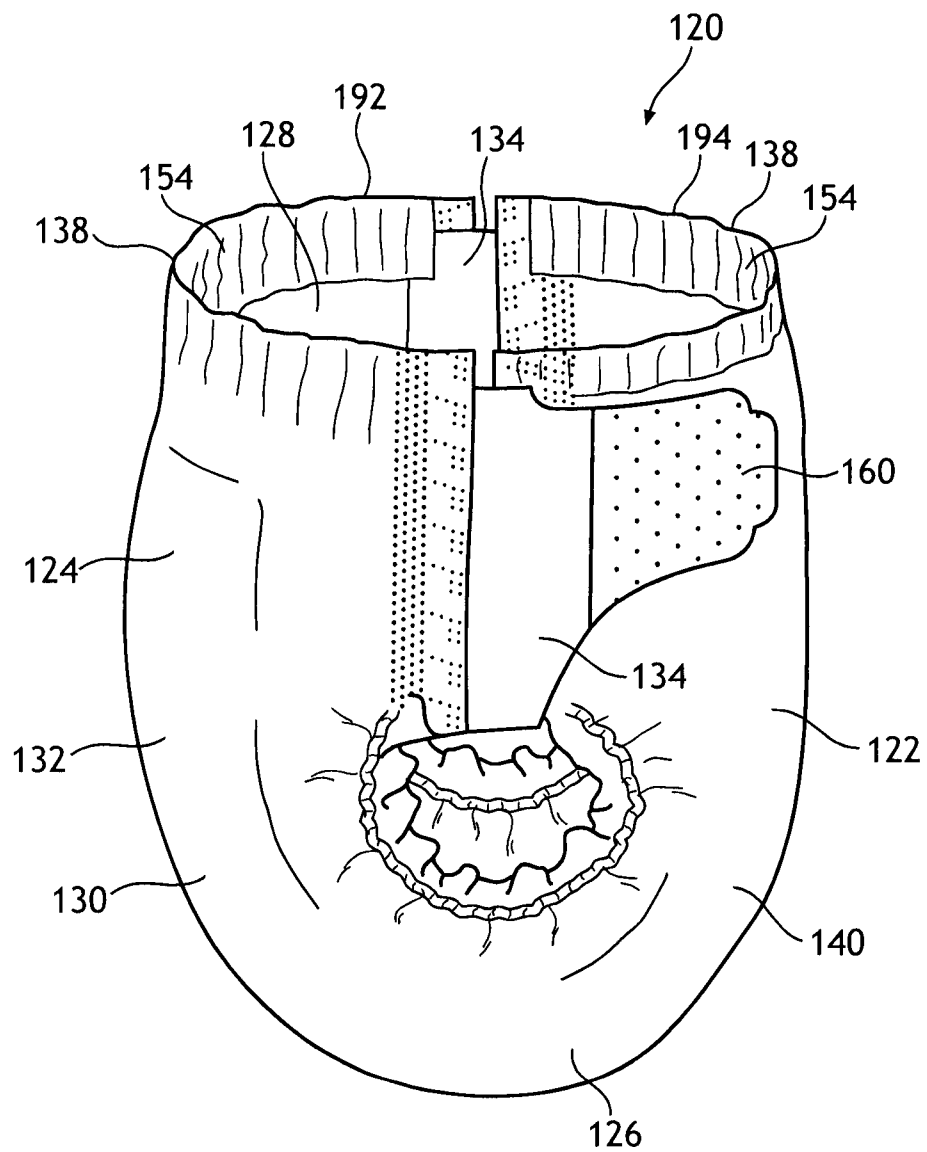


FIG. 7

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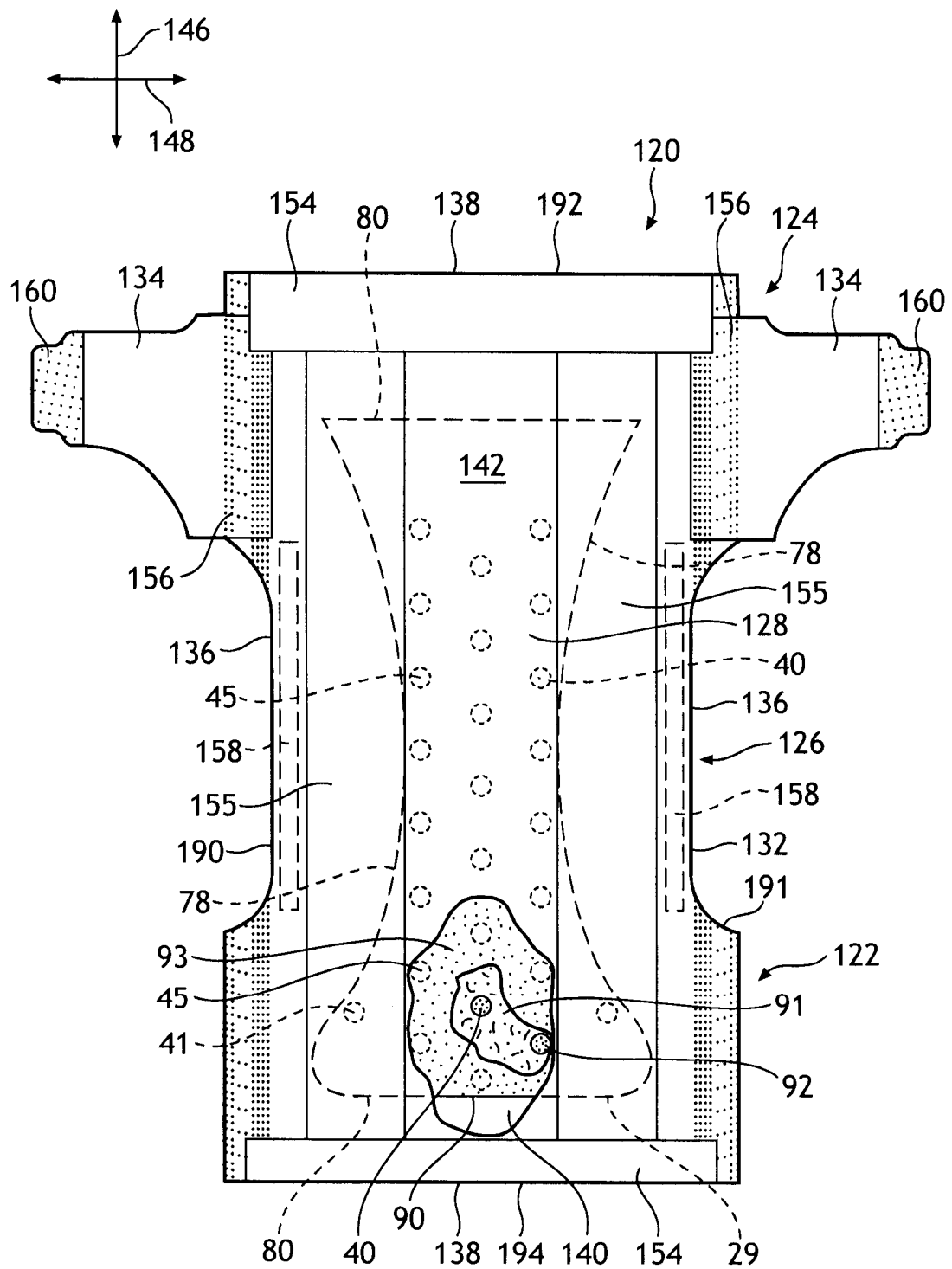


FIG. 8

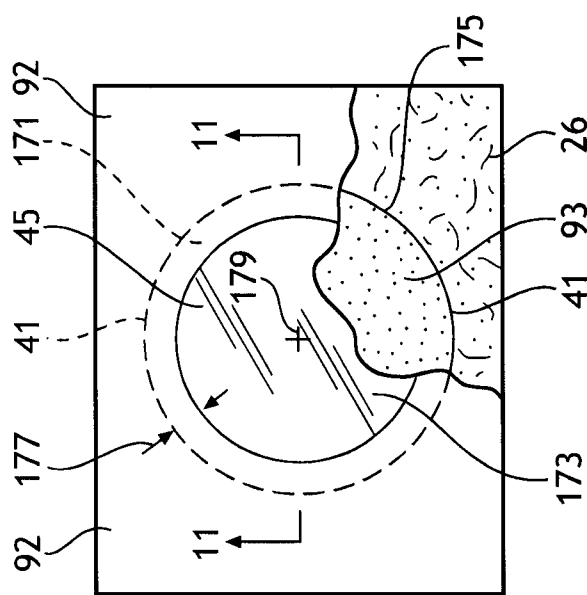


FIG. 10

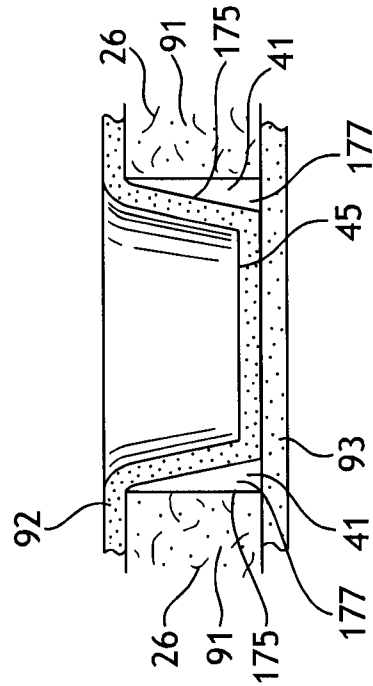


FIG. 11

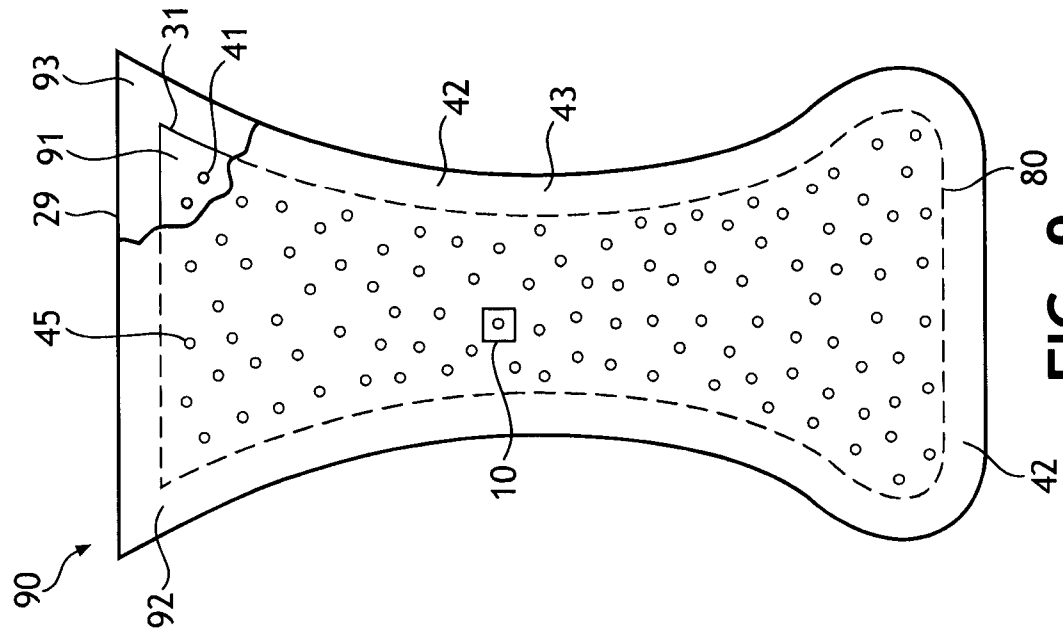


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2007/051172

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61F13/15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/102392 A1 (FISH JEFFREY E [US] ET AL) 1 August 2002 (2002-08-01) paragraphs [0002], [0027], [0065], [0068], [0069]	1-20
A	US 2003/139721 A1 (MELIUS SHANNON K [US] ET AL) 24 July 2003 (2003-07-24) paragraphs [0005], [0006], [0009], [0010]	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

27 August 2007

Date of mailing of the international search report

12/09/2007

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2007/051172

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