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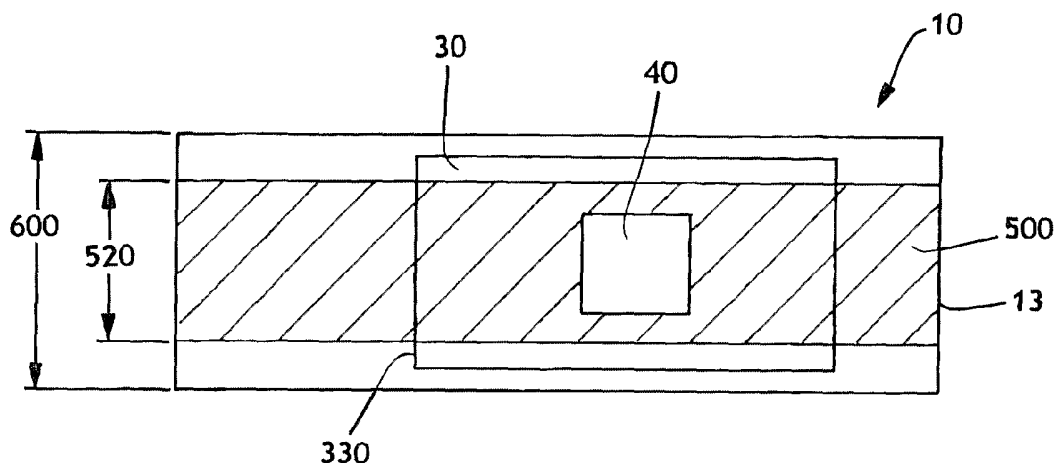
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(54) Title: IMPROVED ABSORBENT SYSTEM DESIGN FOR ABSORBENT ARTICLES



(57) Abstract: The present invention relates to disposable absorbent articles that include absorbent systems. The absorbent system includes an absorbent pad formed of absorbent materials and having a lateral direction and a longitudinal direction. The absorbent pad has a narrow zone area of increased thickness of absorbent materials that has a length greater than or equal to 80% of the length of the absorbent pad. The narrow zone area has a width in the lateral direction of the absorbent pad that is less than or equal to 62% and greater than or equal to 20% of the width of a non-zone area.

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IMPROVED ABSORBENT SYSTEM DESIGN FOR ABSORBENT ARTICLES

5 This application claims priority to provisional application serial number 60/615,161
entitled Improved Absorbent System Design For Absorbent Articles and filed in the U.S.
Patent and Trademark Office on September 30, 2004. The entirety of provisional
application serial number 60/615,161 is hereby incorporated by reference.

Background of the Invention

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Absorbent articles, particularly disposable absorbent articles, have undergone an
evolution since they first became commercially available. Materials, features and designs
made available by new technologies have improved the function and fit of absorbent
articles. An important functional feature of absorbent articles is the ability to intake and
15 contain bodily wastes such as urine and feces. Reliably successful intake and
containment of urine can be challenging when the absorbent article is worn by an
individual that spends significant time in a prone position, such as an infant or an adult
who has lost mobility.

20 Significant research and technology efforts have been dedicated to designing
absorbent systems for absorbent articles that are capable of meeting consumers'
expectations for zero leakage regardless of the age or body shape of the wearer.
Absorbent systems for commercially available absorbent articles typically include multiple
layers. For example, an absorbent system may include a surge layer (to assist with
intake) and an absorbent pad that is a mixture of superabsorbent material and an
25 absorbent filler material, such as cellulose fluff. Improved intake times can be achieved
by increasing the thickness of the absorbent pad in the intake region of an absorbent
article. For a disposable diaper, the intake region may be the crotch region which is the
portion of the diaper that extends between the wearer's legs. A potential downside of
designing the absorbent system to have an absorbent pad that is thicker in the intake
30 region is that fluid does not distribute throughout the entire absorbent pad as well and
consequently, the absorbent pad becomes very bulky, particularly in the crotch region,
when it is wet. In addition to making the absorbent article less comfortable, the increased
bulk may interfere with the article's seals around the leg openings and may result in
increased leakage. Alternatively, the multiple layer absorbent system may be designed to
35 have a very thin and dense absorbent pad. While a very thin, but dense absorbent pad
may provide benefits such as improved fluid distribution, comfort and fit, the intake time is
typically unacceptable. Consequently, there remains a need for an absorbent system that

can be used in a disposable absorbent article that has good fluid distribution after multiple insults, keeps fluid away from the edges of the absorbent to minimize leaks and maintains acceptable intake times.

5 **Summary of the Invention**

The present invention is directed to a disposable absorbent article including an absorbent system. The absorbent system may include an absorbent pad formed of absorbent materials and having a lateral direction and a longitudinal direction. The absorbent pad may have a narrow zone area of increased thickness of absorbent
10 materials. The narrow zone area has a thickness that is greater than the thickness of a non-zone area of the absorbent pad. The narrow zone area may have a width in the lateral direction of the absorbent pad that is less than or equal to 62% and greater than or equal to 20% of the width of the non-zone area of the absorbent pad. The narrow zone area may also have a length in the longitudinal direction of the absorbent pad that is
15 greater than or equal to 80% of the length of the absorbent pad.

The narrow zone area may have a thickness that is 1.2 to 5 times the thickness of the non-zone area. The narrow zone area may have a thickness that is at least 0.1 centimeters greater than the thickness of the non-zone area. Alternatively, the narrow zone area may have a thickness that is at least 0.4 centimeters greater than the thickness
20 of the non-zone area. The absorbent materials in the narrow zone area may have a density that is the same as the density of the absorbent materials in the non-zone area of the absorbent pad. Alternatively, the absorbent materials in the narrow zone area may have a density that is less than the density of the absorbent materials in the non-zone area of the absorbent pad. The absorbent system of the disposable absorbent article may
25 also include a surge layer. Typically, the surge layer is positioned between the liner and the absorbent pad of a disposable absorbent article. The absorbent pad, including both the narrow zone area and the non-zone area, may be a continuous structure or it may be formed of two or more layers. For example, with a two-layer absorbent pad, the narrow zone area may be one layer and the non-zone area may be the other layer. With such a
30 system, the narrow zone area layer and the non-zone area layer would be adjacent to each other or in very close proximity to each other.

Brief Description of the Drawings

The present invention will be more fully understood and further advantages will
35 become apparent when reference is made to the following detailed description of the invention and the accompanying drawings wherein like numerals represent like elements.

The drawings are merely representative and are not intended to limit the scope of the appended claims.

Fig. 1 representatively shows a planar view of an absorbent system having a conventional zoning of absorbent material that extends across the full width of the absorbent pad;

Fig. 2 representatively shows a planar view of an absorbent system of the invention having a narrow zone of an increased thickness of absorbent material that extends the full length of the absorbent pad;

Fig. 3 representatively shows a perspective view of a three-dimensional finite element mesh used to perform computer simulations on various absorbent system designs;

Fig. 4 representatively shows a computer-generated fluid distribution contour map for an absorbent system having a conventional zoning of absorbent material;

Fig. 5 representatively shows a computer-generated fluid distribution contour map for an absorbent system of the present invention having a narrow zone of increased thickness of absorbent material that has a length substantially the same as the length of the absorbent pad;

Fig. 6 representatively shows a computer-generated fluid distribution contour map from a second series of simulations for an absorbent system having a conventional zoning of absorbent materials;

Fig. 7 representatively shows a computer-generated fluid distribution contour map from a second series of simulations for an absorbent system of the present invention;

Fig. 8 representatively shows a computer-generated fluid distribution contour map from a second series of simulations for an absorbent system having a conventional zoning of absorbent materials;

Fig. 9 representatively shows a computer-generated fluid distribution contour map from a second series of simulations for an absorbent system having a conventional zoning of absorbent materials in a shaped absorbent pad;

Fig. 10 representatively shows a computer-generated fluid distribution contour map from a second series of simulations for an absorbent system of the present invention including a shaped absorbent pad;

Fig. 11 representatively shows a graphical depiction of Liquid Distribution (units of grams/square centimeters) versus Distance Along the Longitudinal Center Axis of the Absorbent Pad (units of centimeters) based on the second series of simulations; the

graph depicts the effect of the zoning of absorbent materials on the distribution of liquid within an absorbent pad;

Fig. 12 representatively shows a planar view of a typical disposable absorbent article in which the absorbent systems of the present invention may be incorporated;

5 Fig. 13 representatively shows a cross-section of an absorbent system of the invention including an absorbent pad and showing the difference in the thickness of the narrow zone area and the non-zone area; and

Fig. 14 representatively shows a cross-section of another absorbent system of the invention including an absorbent pad and showing the difference in the thickness of the
10 narrow zone area and the non-zone area.

Detailed Description of the Invention

The present disclosure of the invention will be expressed in terms of its various components, elements, constructions, configurations, arrangements and other features
15 that may also be individually or collectively be referenced by the term, "aspect(s)" of the invention, or other similar terms. It is contemplated that the various forms of the disclosed invention may incorporate one or more of its various features and aspects, and that such features and aspects may be employed in any desired, operative combination thereof.

It should also be noted that, when employed in the present disclosure, the terms
20 "comprises", "comprising" and other derivatives from the root term "comprise" are intended to be open-ended terms that specify the presence of any stated features, elements, integers, steps, or components, and are not intended to preclude the presence or addition of one or more other features, elements, integers, steps, components, or groups thereof.

25 The present invention is directed to solving problems related to providing absorbent systems for disposable absorbent articles that have improved fluid distribution, reduced leakage and maintain good intake times. Desirably, absorbent systems function to receive multiple fluid insults in such a way that the fluid is distributed uniformly along the length of an absorbent pad and the fluid is not concentrated along the longitudinal edges
30 of the absorbent pad (in order to reduce leakage).

The present invention relates to an improved absorbent system design. The improved design includes several aspects. For example, absorbent systems of the present invention include an absorbent pad that has increased thickness of absorbent materials (both superabsorbent material and absorbent filler) within a narrow zone area
35 that extends along the majority of the length of the absorbent pad. The increased

thickness may be achieved with higher basis weight, lower density or other configurations of absorbent materials. Absorbent articles typically have a longitudinal direction that coincides with the length of the article and a lateral direction that coincides with the width of the article. The different regions of a disposable diaper are typically a front waist
5 region, a crotch region and a back waist region where the length of the article is measured from the lateral edge of the front waist region to the lateral edge of the back waist region. The width of the article is measured from one longitudinal edge to the other longitudinal edge and typically varies for the different regions of the article. For example, typically the width in the crotch region is the narrowest. The absorbent pad portion of the
10 absorbent system may extend the full length of the absorbent article or it may extend over a portion of the length. With the absorbent systems of the invention, the narrow zone area of increased thickness has a width that is significantly less than the width of the non-zone area in the crotch region. The absorbent systems of the invention have improved fluid distribution along the length of the absorbent pad without compromised intake times
15 and result in improved comfort and fit of the article. The improvements are believed to result because the absorbent pad remains relatively thin, even when wet, along the lateral edges of the article.

Typically, thicker absorbent pads have better intake rates than thin absorbent pads. An explanation for this result is that liquid transport becomes boundary-limited in the Z-direction (thickness) before it becomes limited in the Y-direction (length) or X-direction
20 (width). However, there seems to be a "critical thickness" that is the maximum thickness for which an intake benefit can be achieved. Thicknesses greater than the "critical thickness" do not result in additional intake improvement. The "critical thickness" can be calculated, using the following equation, if the moisture diffusivity, D, is known:

25

$$Z_{crit} = \sqrt{\frac{Dt}{n}}$$

In this equation, "n" represents porosity of the absorbent pad and "t" represents time. For an airlaid absorbent pad, a conservative estimate of moisture diffusivity is 0.2 cm²/sec for
30 an absorbent pad having a porosity, n, of 0.8 and a typical insult time of 5 seconds. Applying these values to the equation above, a thickness of about 1.0 cm could be effectively wetted (interstitial saturation >= 0.5) in the time frame of an insult. A thickness of about 0.5 cm would wet out in a time frame of 1.2 seconds. These thicknesses are greater than what is typically used in absorbent articles, therefore intake performance is

not maximized. Increased absorbent pad thickness also aids in-plane liquid transport because there is greater cross-sectional area available for flow in the longitudinal and lateral directions.

The absorbent systems of the present invention include an absorbent pad that has a narrow zone area of increased thickness of absorbent materials positioned along, and extending laterally outward, from the lateral centerline (which can also be referred to as the centerline running in the longitudinal direction) of the article. The narrow zone area of increased thickness may be located above or beneath a relatively thin main absorbent layer of the absorbent pad (See Figs. 13 and 14). The narrow zone area may have a length in the longitudinal direction of the article that is substantially the same as the length of the absorbent pad. The narrow zone area may also have a length in the longitudinal direction of the article that is greater than or equal to ninety-five percent of the length of the absorbent pad. Alternatively, the narrow zone area may have a length in the longitudinal direction of the article that is greater than or equal to ninety percent of the length of the absorbent pad. The narrow zone area may also have a length in the longitudinal direction of the article that is greater than or equal to eighty percent of the length of the absorbent pad. The narrow zone area may have a width in the lateral direction of the article that is less than or equal to sixty-two percent of the width of the non-zone area of the absorbent pad. Alternatively, the narrow zone area may have a width in the lateral direction of the article that is less than or equal to sixty percent of the width of the non-zone area of the absorbent pad. The narrow zone area may also have a width in the lateral direction of the article that is less than or equal to fifty-five percent of the width of the non-zone area of the absorbent pad. Additionally, the narrow zone area may have a width in the lateral direction of the article that is less than or equal to fifty percent of the width of the non-zone area of the absorbent pad. The narrow zone area may have a width in the lateral direction of the article that is less than or equal to forty-five percent of the width of the non-zone area of the absorbent pad. The narrow zone area may also have a width in the lateral direction of the article that is less than or equal to forty percent of the width of the non-zone area of the absorbent pad. Further, the narrow zone area may have a width in the lateral direction of the article that is less than or equal to thirty percent of the width of the non-zone area of the absorbent pad. The narrow zone area may also have a width in the lateral direction of the article that is greater than or equal to twenty percent of the width of the non-zone area of the absorbent pad. The design of the absorbent systems of the invention improves the flow of fluid along the longitudinal direction of the absorbent pad and therefore, fluid is more likely to be kept away from the longitudinal edges of the article and as a result, have less contact with the

wearer's skin. Therefore, the absorbent systems of the invention are believed to provide skin health benefits in addition to improved fit, comfort and leakage control.

The absorbent pad may be formed of a continuous structure of absorbent materials or it may be formed of two or more layers of absorbent materials that are adjacent to each other. With absorbent pads having a continuous structure of absorbent materials, the narrow zone area and the non-zone area are continuous with each other and the narrow zone area has a thickness that is in addition to the thickness of the non-zone area. Therefore, the narrow zone area has an increased thickness of absorbent materials compared to the non-zone area. With absorbent pads having two or more adjacent layers of absorbent materials, the narrow zone area may be a layer of absorbent materials and non-zone area may be a separate layer of absorbent layers. The thickness of the narrow zone area is the sum of the thicknesses of both layers and therefore, the narrow zone area has an increased thickness of absorbent materials compared to the non-zone area.

Description of a Typical Disposable Absorbent Article in which the Absorbent Systems of the Invention May Be Used

Fig. 12 representatively illustrates an embodiment of a disposable absorbent article **200** in which the absorbent systems of the present invention may be used. The surface of the article which contacts the wearer is facing the viewer. The absorbent article **200** defines a front portion **22**, a rear portion **24** and a crotch portion **26** connecting the front portion **22** and the rear portion **24**. The front portion **22** defines a front waist region **23** and includes a front waist edge **41**. The rear portion **24** defines a rear waist region **25** and includes a rear waist edge **43**. The absorbent article **200** also defines a longitudinal direction **48** and a lateral direction **50**. The absorbent article **200** includes a bodyside liner **300**, an outer cover **32** and an absorbent pad **10** located between the bodyside liner **300** and the outer cover **32**. The absorbent article **200** includes an inner surface **31** generally oriented towards the skin of the wearer and an outer surface **33** generally oriented towards the clothing of the wearer.

As used herein, reference to a front portion refers to that part of the absorbent article which is generally located on the front of a wearer when in use. Reference to a front waist region refers to that part of the front portion which is located generally near the waist opening. Reference to the rear portion refers to the portion of the article generally located at the rear of the wearer when in use. Reference to a rear waist region refers to that part of the rear portion which is located generally near the waist opening. Reference to the crotch portion refers to that portion which is generally located between the legs of

the wearer when in use. In some embodiments, the liner forms the inner surface. In some embodiments, the outer cover forms the outer surface.

5 The crotch portion **26** has opposite longitudinal side portions **28** which may include a pair of elasticized, longitudinally-extending leg cuffs **36**. The leg cuffs **36** are generally adapted to fit about the legs of a wearer in use and serve as a mechanical barrier to the lateral flow of body exudates. The leg cuffs **36** may be elasticized by a pair of leg elastics **38**. The absorbent article **200** may further include a front waist elastic **400** and/or a rear waist elastic **42**. The rear portion **24** of the absorbent article **200** may further include a fastening means **44** which is intended to hold the absorbent article **200** about the waist of
10 the wearer when in use. The absorbent article **200** may also include a pair of containment flaps **46** which extend longitudinally along the absorbent article **200** and are also adapted to provide a barrier to the flow of body exudates. It should be recognized that individual components of the absorbent article **200**, such as the elastic members, may be optional depending upon the intended use of the absorbent article **200**.

15 The bodyside liner **300** of the absorbent article **200** suitably presents a bodyfacing surface which is intended to be worn adjacent the body of the wearer and is compliant, soft feeling and nonirritating to the wearer's skin. A suitable bodyside liner **300** may be manufactured from a wide selection of web materials, such as porous foams, reticulated foams, apertured plastic films, natural fibers (for example, wood or cotton fibers),
20 synthetic fibers (for example, polyester or polypropylene fibers), or a combination of natural and synthetic fibers.

The outer cover **32** of the absorbent article **200** may suitably be composed of a material which is either liquid permeable or liquid impermeable. It is generally preferred that the outer cover **32** be formed from a material which is substantially impermeable to
25 fluids. For example, a typical outer cover can be manufactured from a thin plastic film or other flexible liquid-impermeable material. For example, the outer cover **32** may be formed from a polyethylene film. If it is desired to present the outer cover **32** with a more clothlike feeling, the outer cover **32** may comprise a polyethylene film having a nonwoven web laminated to the outer surface thereof, such as a spunbond web of polyolefin fibers.
30 Methods of forming such clothlike outer covers are known to those skilled in the art.

The bodyside liner **300** and outer cover **32** are generally joined together so as to form a pocket in which the composite absorbent pad **10** is located. The bodyside liner **300** and outer cover **32** may be joined directly to each other around the outer periphery of the absorbent article **200** by any means known to those skilled in the art such as, for
35 example, adhesive bonds, sonic bonds or thermal bonds. Such bonding means may also

be suitable for attaching other components of the composite absorbent pad and absorbent article of the present invention together. The leg cuffs **36** are suitably formed by portions of the outer cover **32**, and/or bodyside liner **300**, which extend beyond the longitudinal sides of the composite absorbent pad **10**. Naturally, the leg cuffs **36** may also
5 be formed from separate materials which are attached to the outer cover **32** and/or bodyside liner **300**.

The leg cuffs **36** may include leg elastics **38**. Waist elastics **400** and **42** may also be provided. The leg elastics **38** are arranged to draw and hold the absorbent article **200** against the legs of the wearer. The waist elastics **400** and **42** are also arranged to draw
10 and hold the absorbent article **200** against the wearer. Materials suitable for use in forming leg elastics **38** and waist elastics **400** and **42** are known to those skilled in the art. Exemplary of such materials are strands or ribbons of a polymeric, elastomeric material which are adhered to the absorbent article **200** in a stretched position, or which are attached to the absorbent article while the article is pleated, such that elastic constrictive
15 forces are imparted to the absorbent article **200**. In a particular aspect of the invention, the elastics may be composed of individual strands of LYCRA which are available from INVISTA Co., a business having offices in Wichita, Kansas, USA.

The leg elastics **38** and waist elastics **400** and **42** may have any configuration which provides the desired performance. For example, the leg elastics **38** and waist elastics **400**
20 and **42** may comprise a single strand of elastic material, or may comprise several parallel or non-parallel strands of elastic material. The leg elastics **38** may be generally straight or optionally curved to more closely fit the contours of the legs and buttocks of the wearer and better contain bodily exudates. The leg elastics **38** and waist elastics **400** and **42** may be attached to the absorbent article **200** in any of several ways which are well known
25 to those skilled in the art. For example, the elastics may be ultrasonically bonded, thermally bonded or adhesively bonded to the absorbent article **200**.

The fastening means **44** are typically applied to the corners of the rear portion **24** of the absorbent article **200** to provide a means for holding the article **200** on the wearer. Suitable fastening means **44** are well known to those skilled in the art and can include
30 tape tab fasteners, hook and loop fasteners, mushroom and loop fasteners, snaps, pins, belts, and the like, and combinations thereof. Typically, the fastening means **44** are configured to be refastenable. It should also be understood that it may be possible to dispense with the fastening means **44** in an absorbent article having a given design configuration.

In some embodiments, the fastening means **44** may be adapted to engage or otherwise join with a fastener landing material **45**. Typically, the fastener landing material **45** is a loop material joined to the outercover **32** in the front waist region **23** and is adapted to engage hook-type fastening means **44**. In alternative embodiments, the fastener landing material **45** may be a film adapted to engage with tape tab fastening means **44**.

The absorbent pad **10** is positioned between the bodyside liner **300** and the outer cover **32** to form the absorbent article **200**. The absorbent pad **10** is generally conformable and capable of absorbing and retaining body exudates. It should be understood that, for the purpose of the present invention, the absorbent pad **10** may comprise a single, integral piece of material or, alternatively, may comprise a plurality of individual separate pieces of material which are operably assembled together.

The absorbent pad **10** may have any of a number of shapes and sizes. The absorbent pad **10** may suitably comprise various types of wettable, hydrophilic fibrous materials. Examples of suitable materials include naturally occurring organic fibers composed of intrinsically wettable material, such as cellulosic fibers; synthetic fibers composed of cellulose or cellulose derivatives, such as rayon fibers; inorganic fibers composed of an inherently wettable material, such as glass fibers; synthetic fibers made from inherently wettable thermoplastic polymers, such as particular polyester and polyamide fibers; and synthetic fibers composed of a nonwetable thermoplastic polymer, such as polypropylene fibers, which have been hydrophilized by appropriate means known to those skilled in the art. The absorbent pad **10** may also comprise selected blends of the various types of fibers mentioned above. The absorbent pad **10** may include a matrix of hydrophilic fibers, such as a web of cellulosic fibers, mixed with particles of a high-absorbency material such as that commonly known as superabsorbent material.

The absorbent article **200** of the present invention may also contain a surge layer **30** to advantageously improve the overall fluid intake rate of the absorbent pad **10**. The surge layer **30** is typically less hydrophilic than the absorbent pad **10** and is configured to collect and temporarily hold fluid surges. This configuration can also help prevent fluid exudates from pooling and collecting on portions of the absorbent pad **10**.

Performance of Absorbent Systems of the Invention

A series of computer simulations using finite element analysis was run to compare the fluid intake and fluid distribution of absorbent systems having a design of the present

invention with designs of known absorbent systems. The "known" absorbent system design included a "standard" zoned absorbent. The general configuration of the standard zoned absorbent representing a known absorbent system is representatively illustrated in Fig. 1. The absorbent pad 10 includes a region of zoned absorbent material 20 (the region 20 is represented in Fig. 1 by cross-hatching) that extends from just ahead of the back edge 330 of a surge layer 30 to almost the front edge 13 of the absorbent pad 10. The length of the region of zoned absorbent material is indicated by reference numeral 230. The predicted insult zone 40 for the absorbent pad 10 is representatively shown in Fig. 1. The length of the region of zoned absorbent material 230 is approximately 64% of the total length of the absorbent pad 10 and the width is the entire width of the absorbent pad 10. The region of zoned absorbent material 20 may have a thickness that is greater than the thickness of the remainder of the absorbent pad 10. In the simulation, the region of zoned absorbent material 20 had a thickness of 0.46 cm and the remainder of the absorbent pad 10 had a thickness of 0.30 cm. Thus, the region of zoned absorbent material 20 was 0.16 cm thicker than the rest of the absorbent pad 10.

The design of the absorbent system of the invention used for the simulation included a narrow zone area of increased thickness of absorbent materials having a length extending the full length of the absorbent pad in the longitudinal direction and having a width representing 62% of the width of the non-zone area of the absorbent pad in the lateral direction of the article. In the simulation, the narrow zone area of increased thickness had a thickness of 0.46 cm and the non-zone area of the absorbent pad had a thickness of 0.30 cm. Therefore, the narrow zone area was 0.16 cm thicker than the non-zone area of the absorbent pad. A general configuration of an absorbent pad including a narrow zone area representing an absorbent system of the invention is representatively illustrated in Fig. 2. The design of the absorbent pad 10 of the invention includes a narrow zone area of absorbent material 500 that extends the full length of the absorbent pad 10 in the longitudinal direction of an article. The narrow zone area of absorbent material 500 has a width 520 that is representatively illustrated in Fig. 2 as 62% of the width 600 of the non-zone area of the absorbent pad 10. The absorbent system representatively illustrated in Fig. 2 also includes a surge layer 30 and a representation of the insult zone 40. For both absorbent system designs tested through the simulation, the capacity of the absorbent pads was the same, about 550 grams of saline. Figs. 13 and 14 also representatively illustrate absorbent pads 10 that may be incorporated into absorbent systems of the invention. Fig. 13 representatively shows a cross-section of an absorbent pad 10 having a narrow zone area 500 that may be oriented toward the inner surface 31 of a disposable absorbent article 200. The narrow zone area 500 has a

thickness 510 that is greater than the thickness 110 of the non-zone area of the absorbent pad 10. The narrow zone area 500 also has a width 520 that is representatively shown in Fig. 13 to be 62% of the width 600 of the non-zone area of the absorbent pad 10. Fig. 14 representatively shows a cross-section of an absorbent pad 10 having a narrow zone area 500 that may be oriented toward the outer surface 33 of a disposable absorbent article 200. The narrow zone area 500 has a thickness 510 that is greater than the thickness 110 of the non-zone area of the absorbent pad 10. The narrow zone area 500 also has a width 520 that is representatively shown in Fig. 14 to be 62% of the width 600 of the non-zone area of the absorbent pad 10.

The first set of computer simulations were run in a way to simulate the geometry that the absorbent systems would have if they were part of an absorbent article being worn by a person in the prone position. The simulated geometry (three-dimensional finite element mesh) is representatively illustrated in Fig. 3. The sequence of the simulation included the following events: (1) a 70 gram liquid insult; (2) a 60 second hold time (in which no liquid is allowed to enter the absorbent system, however liquid may re-distribute itself within the absorbent system); (3) a second, 70 gram liquid insult; and (4) a second, 60 second hold time. The simulation included predictions of intake time and liquid distribution after completion of all of the simulation events. In addition to the absorbent pad 10 configurations shown in Fig. 1 ("known" absorbent system) and Fig. 2 (absorbent system of the invention), the simulations also included the additional components of a spunbond liner and a spunbond-meltblown-spunbond barrier wrap material. The simulated spunbond liner was located on top of the surge layer 30 and the simulated barrier wrap material was located between the surge layer 30 and the absorbent pad 10.

Fig. 4 representatively shows the total liquid mass distribution (g/cm^2) for the absorbent pad 10 having a "known" design (e.g. the design shown in Fig. 1) after completion of the simulation events. Fig. 5 representatively shows the total liquid mass distribution (g/cm^2) for the absorbent pad 10 having a design of the present invention (e.g. the design shown in Fig. 2) after completion of the same sequence of simulation events. Despite being loaded with the same mass of fluid (140g), the distribution of liquid in the two absorbent pad designs is very different. As shown in Fig. 4, the "known" absorbent pad design loaded in such a way that more of the fluid remained in the region of the absorbent pad closest to the insult zone and the fluid spread over a greater portion of the width in the lateral direction of the absorbent pad. As shown in Fig. 5, the absorbent pad design of the invention loaded in such a way that the fluid distributed over a greater portion of the length of the absorbent pad and over less of the width. The difference in the longitudinal distribution of fluid is representatively illustrated by comparing the location

of the 0.18 g/cm^2 contour in Fig. 4 versus Fig. 5. The 0.18 g/cm^2 contour in Fig. 5 is further away from the center of the absorbent pad than in Fig. 4. Additionally, due to the geometry of the absorbent pads in the simulations, the distribution of fluid in Fig. 5 represents fluid transport in an upward direction relative to the location of the insult zone.

- 5 The distribution distances and intake times for the absorbent pad designs represented in Fig. 4 and Fig. 5 are quantitatively compared in Table 1. below.

Table 1.

	"Known" Absorbent Pad Design	Absorbent Pad Design of the Invention
Distance Traveled by Fluid Toward Front Edge of Absorbent Pad	9.71 cm	12.64 cm
Distance Traveled by Fluid Toward Back Edge of Absorbent Pad	13.69 cm	20.24 cm
Intake Time for First Insult	12.1 sec	14.8 sec
Intake Time for Second Insult	25.9 sec	32.7 sec

- The values in Table 1. compare the front and back liquid distributions for the absorbent pad designs shown in Fig. 4 and Fig. 5 by comparing the locations of the 0.53 g/cm^2 (contour line toward the front edge of the simulated absorbent pad; that is, toward the right edge of the simulated absorbent pad shown in Fig.4 and Fig. 5) and 0.16 g/cm^2 (contour line toward the back edge of the simulated absorbent pad; that is toward the left edge of the simulated absorbent pad shown in Fig. 4 and Fig. 5) contours. While the 0.53 g/cm^2 and 0.16 g/cm^2 contour lines are not specifically labeled in Fig. 4 and Fig. 5, they may be located between the contour lines that are labeled. As described above, the liquid distribution in the longitudinal direction is more extensive and the liquid spreads less toward the longitudinal edges of the absorbent pad for the absorbent pad design of the invention. It is expected that the liquid distribution achieved by the absorbent pad design of the invention would result in less leakage because gasket function around the leg openings would be better maintained as a result of reduced thickness across the width of the absorbent pad. While the absorbent pad design of the invention has slightly longer intake times after both the first and second insults, the slightly increased times would not be expected to detrimentally affect performance of the absorbent pad. Based on the results of the simulations, it would be expected that an absorbent pad having a reduced width of the narrow zone area of absorbent material along with an increased thickness of the absorbent material (in order to maintain capacity) would further improve the final liquid distribution without significant impact on the intake time.

The narrow zone area of increased thickness of absorbent material may have a thickness that is up to about 1 cm greater than the thickness of absorbent material in the non-zone area of the absorbent pad. The density of absorbent material in the narrow zone area may be the same as the density of absorbent material in the non-zone area of the absorbent pad or it may have a different density. For example, it may be desirable to construct the narrow zone area to have a lower density than the non-zone area of the absorbent pad, but to form it from smaller diameter, high wetting fibers in order to maximize diffusivity. The properties of the narrow zone area may vary along the length and the width of the absorbent pad. For example, the density could gradually increase along the length of the narrow zone area between the insult zone and the lateral edges of the absorbent pad. The narrow zone area for absorbent systems of the invention may be formed by using zoning screens. Zoning screens may be used to form absorbent pads 10 in which the narrow zone area 500 is located both toward the inner surface 31 and the outer surface 33 of the disposable absorbent article 200 in which the absorbent pad 10 is used (see Figs. 13 and 14). Alternatively, the narrow zone area 500 may be formed by densifying an initially uniform thickness absorbent pad 10 along the longitudinal sides resulting in a central zone of lower density and higher thickness of absorbent material. Additionally, the absorbent pad 10 may be constructed of two or more layers that are adjacent to each other. In such a configuration, the narrow zone area 500 may be formed of one layer of absorbent material and the non-zone area may be formed of a second layer of absorbent material. The two layers may be attached to each other by adhesive, ultrasonic, thermal or other bonding techniques. The thickness of the narrow zone area 500 is the sum of the thicknesses of the individual layers and therefore, is greater than the thickness of the non-zone area layer alone.

A second series of computer simulations using finite element analysis was run to further illustrate the performance benefits of absorbent system designs of the present invention. Each of the absorbent system designs in the second series had several features in common: (1) the shape of the absorbent pads 10 was rectangular (except for the shaped absorbent examples) and the dimensions of the absorbent pads 10 were 36 centimeters by 8 centimeters; (2) the absorbent materials used to form the absorbent pads had a density of 0.24 grams/cubic centimeters, included 60% pulp fiber and 40% superabsorbent and had a contact angle of 35 degrees; (3) each absorbent system included a 0.04 centimeter barrier layer around the absorbent pad 10; (4) each absorbent system included a surge layer 30 having a density of 0.028 grams/cubic centimeters, except as will be noted; and (5) the absorbent systems did not include a liner. In the second series of simulations, the insult area was the same for each absorbent system and

the simulations were run as if the user of the absorbent systems was in a standing position. For the examples having a narrow zone area of increased thickness of absorbent materials, the narrow zone area had a length in the longitudinal direction of the absorbent system equal to the length of the absorbent pad 10. The sequence of insult events for the second series of simulations included the following: (1) a 70 gram liquid insult; (2) a 120 second hold time (in which no liquid is allowed to enter the absorbent system, however liquid may re-distribute itself within the absorbent system); (3) a second, 70 gram liquid insult; (4) a second, 120 second hold time; and (5) a third, 70 gram liquid insult. The simulations included predictions of intake time and liquid distribution after completion of all of the simulation events. The results of the simulations are provided in Table 2. below.

Table 2.

Code Name:	Code ID	Absorbent Zone Ratio	Surge Density (g/cm ³)	Surge Thickness (cm)	First Intake Time (sec)	Second Intake Time (sec)	Third Intake Time (sec)
Conv. Zone StdS	1	2.06	0.028	0.3	3.4	5.38	7.85
NZA-50-StdSX	2	3	0.028	0.4	3.61	5.38	7.46
NZA-50-StdSX	3	2	0.028	0.4	3.7	5.51	7.71
Conv. Zone DStdS	4	2.06	0.037	0.3	3.71	5.9	8.52
NZA-50-StdS	5	2	0.028	0.3	4.73	7.36	10.3
NZA-75-StdS	6	1.33	0.028	0.3	4.94	7.71	10.88
FLAT-StdS	7	1	0.028	0.3	5	7.76	10.97
Shaped Absorbent StdSX	8	2	0.028	0.4	5.32	6.62	9.42
Shaped Absorbent StdS	9	2	0.028	0.3	6.48	8.61	12.23
Shaped NZA StdSX	10	2	0.028	0.4	6.98	8.79	12.49

The Code Names in Table 2. represent the following absorbent systems:

"Conv. Zone StdS" = Conventional zoning of absorbent materials as shown in Fig. 1 with standard surge layer 30.

"NZA-50-StdSX" = Narrow zone area of absorbent materials wherein the narrow zone area has a width in the lateral direction of the absorbent system that is 50% of the width of the non-zone area of the absorbent pad 10 with standard surge layer 30, but the surge layer 30 having a greater thickness.

"Conv. Zone DStdS" = Conventional zoning of absorbent materials as shown in Fig. 1 with standard surge layer 30, but the surge layer 30 being of higher density.

"NZA-50-StdS" = Narrow zone area of absorbent materials wherein the narrow zone area has a width in the lateral direction of the absorbent system that is 50% of the width of the non-zone area of the absorbent pad 10 with standard surge layer 30.

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"NZA-75-StdS" = Narrowed zone of absorbent materials wherein the narrowed zone has a width in the lateral direction of the absorbent system that is 75% of the width of the absorbent pad 10 with standard surge layer 30.

10 "FLAT-StdS" = Absorbent pad 10 that does not have any zoning of absorbent materials with standard surge layer 30.

"Shaped Absorbent StdSX" = Shaped absorbent pad 10 having a curved perimeter that would be located in the front waist region 23 of an absorbent article (as shown in Fig. 12) with standard surge layer 30, but the surge layer 30 having a greater thickness.

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"Shaped Absorbent StdS" = Shaped absorbent pad 10 having a curved perimeter that would be located in the front waist region 23 of an absorbent article (as shown in Fig. 12) with standard surge layer 30.

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"Shaped NZA StdSX" = Shaped absorbent pad 10 having a curved perimeter that would be located in the front waist region 23 of an absorbent article (as shown in Fig. 12) with a narrow zone area having a width in the lateral direction of the absorbent pad 10 that is 50% of the width of the non-zone area of the absorbent pad 10, also with standard surge layer 30, but the surge layer 30 having a greater thickness.

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For the second series of computer simulations, the surge contact angle was 65 degrees for the rectangular absorbent pads 10 on all events in the simulations, including insults and holds. The surge contact angle was 65 degrees for the shaped absorbent pads 10 on the first insult and 50 degrees for the other events. Except for Code ID numbers 2, 6 and 7, each of the codes had a zoning ratio of approximately 2. Since density is uniform, the zoning ratio is the ratio of the thickness of the absorbent materials in a defined zone (e.g. narrow zone area) to the thickness of the absorbent materials in the remainder of the absorbent pad 10 (e.g. non-zone area).

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The results of the simulations provide a comparison between the performance of the "conventional" zone of absorbent material and the narrow zone area of absorbent

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material. One performance aspect of absorbent systems is their ability to intake fluids at a rapid rate. Comparing the First, Second and Third Intake Times for Code ID 1 to those for Code ID 5 and comparing the Intake Times for Code ID 8 to those for Code ID 10, the simulation results show that the "conventional" zones of absorbent material tend to intake multiple fluid insults in shorter amounts of time than the absorbent systems having narrow zone areas of absorbent material. However, comparing the Intake Times for Code ID 1 to those for Code IDs 2 and 3, the simulation results show that narrow zone areas of absorbent material combined with increased thickness surge layers 30 have comparable intake performance to absorbent systems having "conventional" zones of absorbent material. That being said, the intake performance of Code ID 5 (50% width narrow zone area of absorbent material) compared to Code ID 7 (a flat or uniform distribution of absorbent material) is better. Another performance aspect of absorbent systems is their ability to distribute fluid throughout the absorbent system and keep fluid away from the edges of the absorbent system to prevent or reduce leakage of fluid out of the absorbent system. The simulations also provide predicted fluid distributions for the different Code IDs; representations of fluid distribution, including contour lines representing different magnitudes of liquid mass per area, are provided for Code ID 4 (Fig. 6); Code ID 3 (Fig. 7); Code ID 6 (Fig. 8); Code ID 9 (Fig. 9); and Code ID 10 (Fig. 10). Fig. 11 is a plot of Liquid Distribution (grams/square centimeters) along the longitudinal centerline of the absorbent pads 10 of Code ID numbers 3, 4, 5, 6 and 7 at the end of the second "hold" periods in the simulations. Looking at Fig. 11, the Code IDs having a narrow zone area of absorbent material that has a width in the lateral direction that is less than or equal to 62% of the width of the non-zone area of the absorbent pad and having a length substantially the same as the length of the absorbent pad perform better at distributing liquid to the far ends of the absorbent pads and at confining liquid along the longitudinal centerline.

Looking at the fluid distribution contour maps of Figs. 6-10, Code ID 4 is represented in Fig. 6. With this "conventional" zone of absorbent material, there is very little distribution of fluid to the ends of the simulated absorbent pad and there is a heavy concentration of fluid near the longitudinal edges of the simulated absorbent pad, suggesting that leakage could occur. Code ID 6 is represented in Fig. 8 and simulates the performance of a zone of absorbent material that is approximately 75% of the width of the simulated absorbent pad. The fluid distribution for Code ID 6 is more spread out toward the ends of the simulated absorbent pad than it was for Code ID 4, but there is still a heavy concentration of fluid near the longitudinal edges. Code ID 3 is shown in Fig. 7 and represents an absorbent system of the invention. With this example, the fluid distribution extends to both ends of the simulated absorbent pad and there is a lighter

concentration of fluid near the longitudinal edges. Fig. 9 shows the fluid distribution contour map for Code ID 9, "conventional" zoning of absorbent material within a shaped (rather than rectangular) absorbent pad. As with Code ID 4 and Code ID 6, the fluid is concentrated in the center of the pad and there is minimal distribution to the ends of the simulated absorbent pad. Additionally, there is a heavy concentration of fluid near the longitudinal edges. Fig. 10 shows the fluid distribution contour map for Code ID 10, an absorbent system of the invention. Code ID 10 includes a narrow zone area of absorbent material having a width that is approximately 50% of the width of the non-zone area of the simulated, shaped absorbent pad in a crotch region. As with Code ID 3, the fluid distribution extends to both ends of the absorbent pad and there is a lighter concentration of fluid near the longitudinal edges.

In conclusion, computer simulations of absorbent systems that are exposed to multiple insults show that absorbent pads that include a narrow zone area of additional thickness of absorbent material that extends approximately the full length of the absorbent pad have better fluid distribution than absorbent pads with "conventional" zoning. While absorbent pads having "conventional" zoning of absorbent material may have better intake times, the absorbent systems of the invention can achieve comparable intake performance through simple modifications such as changing the thickness of the surge material that is used.

While the absorbent systems of the invention have been described in detail with respect to specific aspects thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing, may readily conceive of alterations to, variations of and equivalents to these systems. Accordingly, the scope of the present invention should be assessed as that of the appended claims and any equivalents thereto.

We claim:

1. A disposable absorbent article comprising:
5 an absorbent system, wherein the absorbent system includes an absorbent pad formed of absorbent materials and having a lateral direction and a longitudinal direction, wherein the absorbent pad has a narrow zone area of increased thickness of absorbent materials, wherein the narrow zone area has a width in the lateral direction of
10 the absorbent pad that is less than or equal to 62% and greater than or equal to 20% of the width of a non-zone area of the absorbent pad and the narrow zone area has a length in the longitudinal direction of the absorbent pad that is greater than or equal to 80% of the length of the absorbent pad.
- 15 2. The disposable absorbent article of claim 1, wherein the width of the narrow zone area is less than or equal to 55% of the width of the non-zone area.
3. The disposable absorbent article of claim 1, wherein the width of the narrow zone area is less than or equal to 50% of the width of the non-zone area.
- 20 4. The disposable absorbent article of claim 1 wherein the width of the narrow zone area is less than or equal to 45% of the width of the non-zone area.
5. The disposable absorbent article of claim 1 wherein the length of the narrow zone
25 area is greater than or equal to 90% of the length of the absorbent pad.
6. The disposable absorbent article of claim 1 wherein the length of the narrow zone area is greater than or equal to 95% of the length of the absorbent pad.
- 30 7. The disposable absorbent article of claim 1, wherein the thickness of the narrow zone area is 1.2 to 5 times a thickness of the non-zone area.
8. The disposable absorbent article of claim 1, wherein the thickness of the narrow zone area is at least 0.1 centimeters greater than a thickness of the non-zone area.
- 35 9. The disposable absorbent article of claim 1, wherein the thickness of the narrow zone area is at least 0.4 centimeters greater than a thickness of the non-zone area.

10. The disposable absorbent article of claim 1, wherein a density of absorbent materials in the narrow zone area is the same as a density of absorbent materials in the non-zone area.
- 5
11. The disposable absorbent article of claim 1, wherein a density of absorbent materials in the narrow zone area is less than a density of absorbent materials in the non-zone area.
- 10
12. The disposable absorbent article of claim 1, further comprising a surge layer.
13. The disposable absorbent article of claim 1, wherein the narrow zone area and the non-zone area of the absorbent pad are a continuous structure.
- 15
14. The disposable absorbent article of claim 1, wherein the narrow zone area and the non-zone area of the absorbent pad are separate, but adjacent structures.

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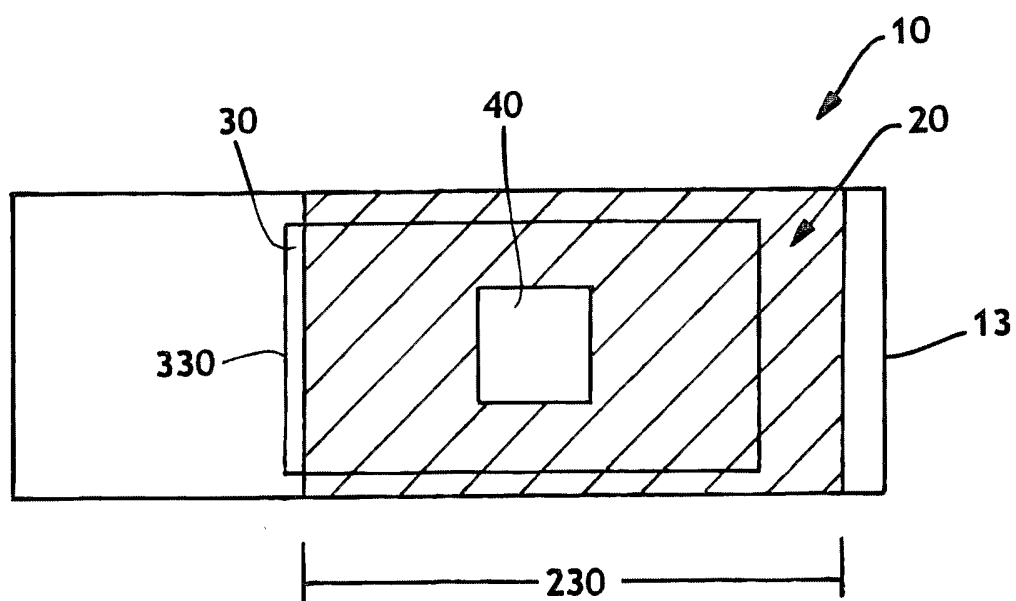


FIG. 1

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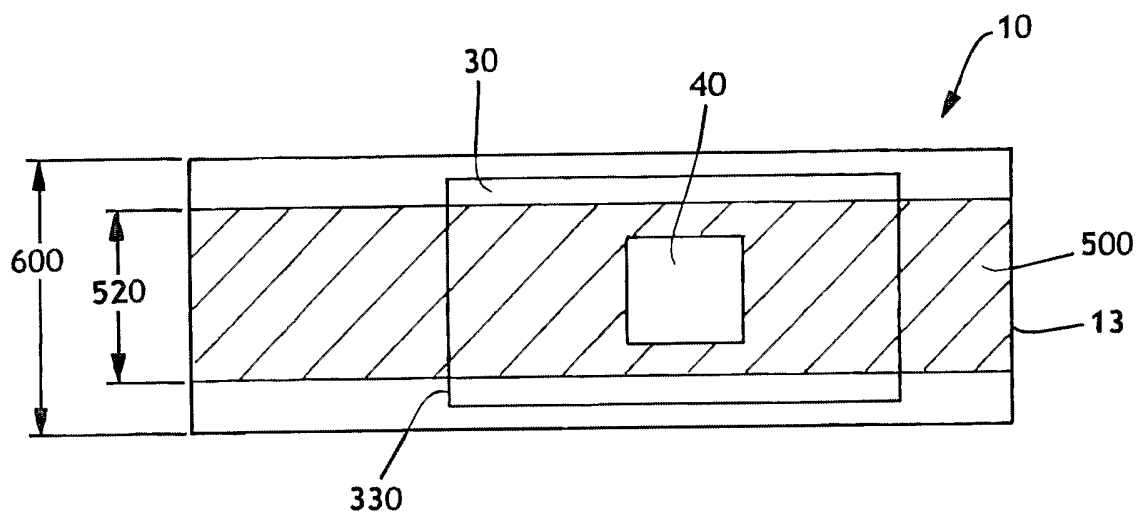
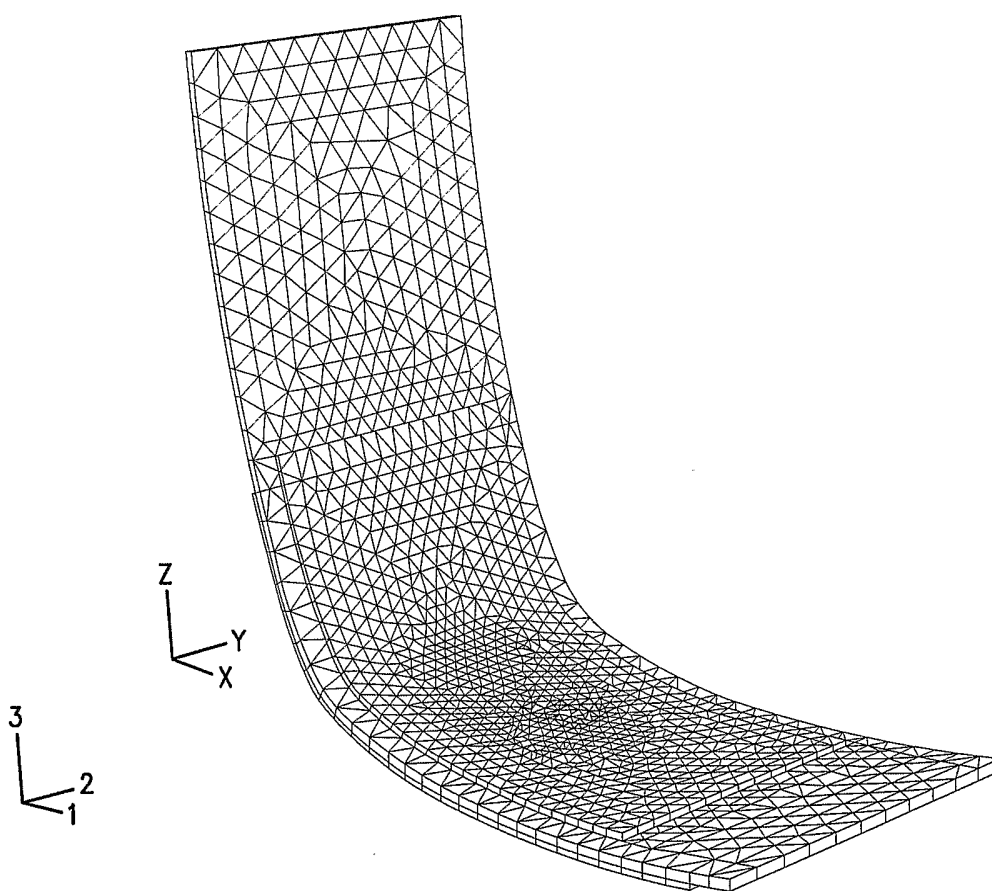


FIG. 2

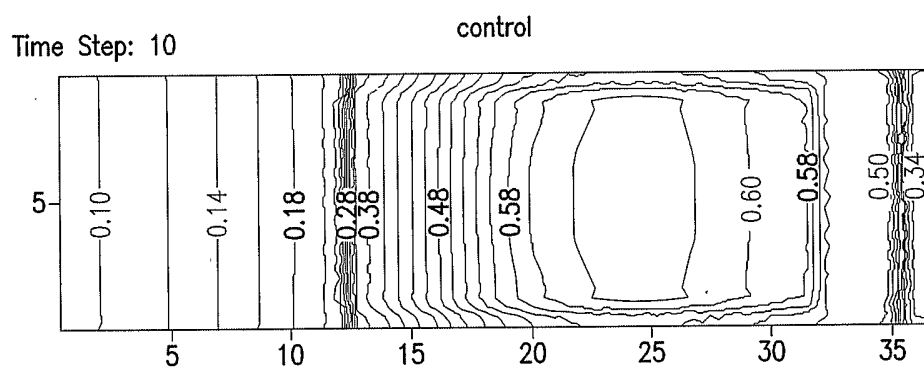
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Total Liquid Mass Distribution (g/sqcm) For Absorbent
Pad Having a Known Design.

**FIG. 3**

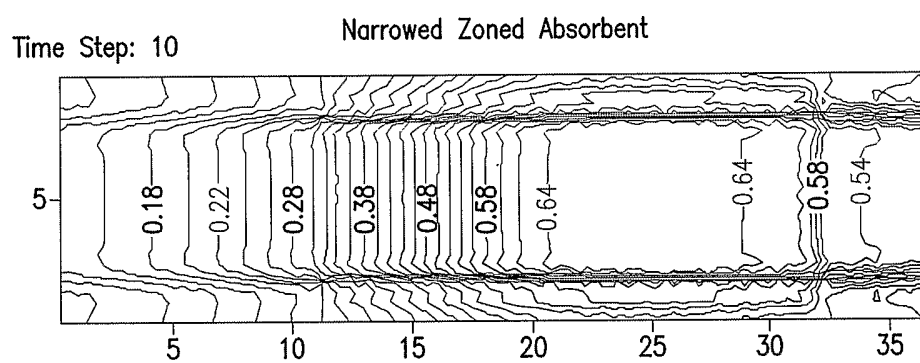
4 / 11

Total Liquid Mass Distribution (g/sqcm) For Absorbent Pad Having a Known Design.

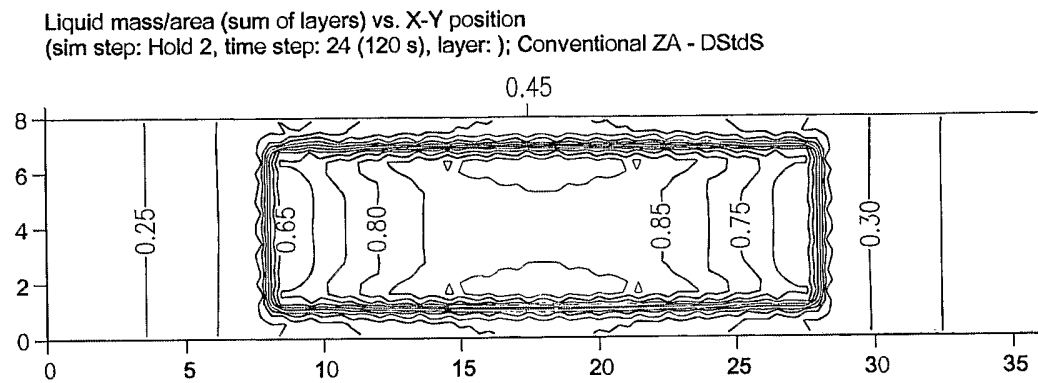
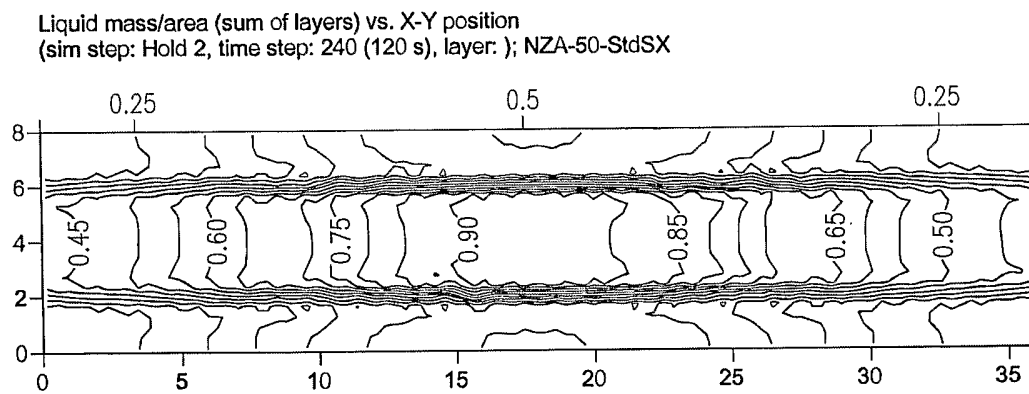
**FIG. 4**

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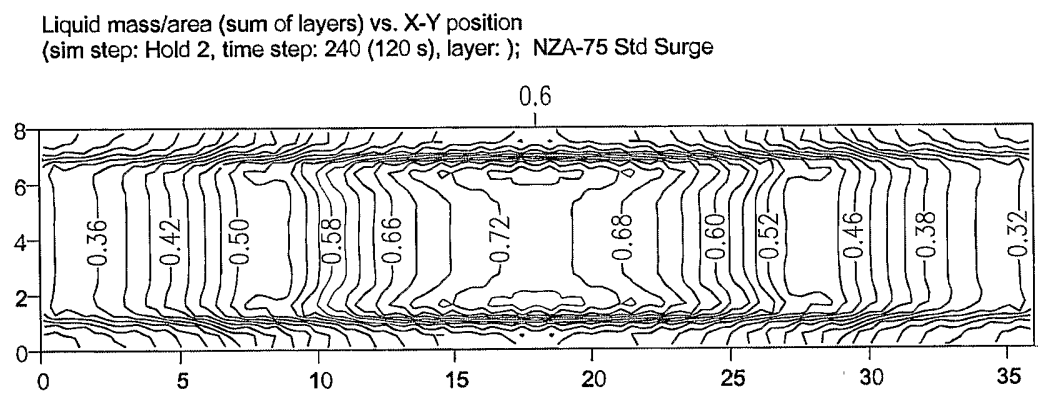
Total Liquid Mass Distribution (g/sqcm) For Absorbent Pad Having
A Design of the Present Invention

**FIG. 5**

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**FIG. 6****FIG. 7**

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**FIG. 8**

Liquid mass/area (sum of layers) vs. X-Y position
(sim step: Hold 2, time step: 24 (120 s), layer:); Conventional Zoning.

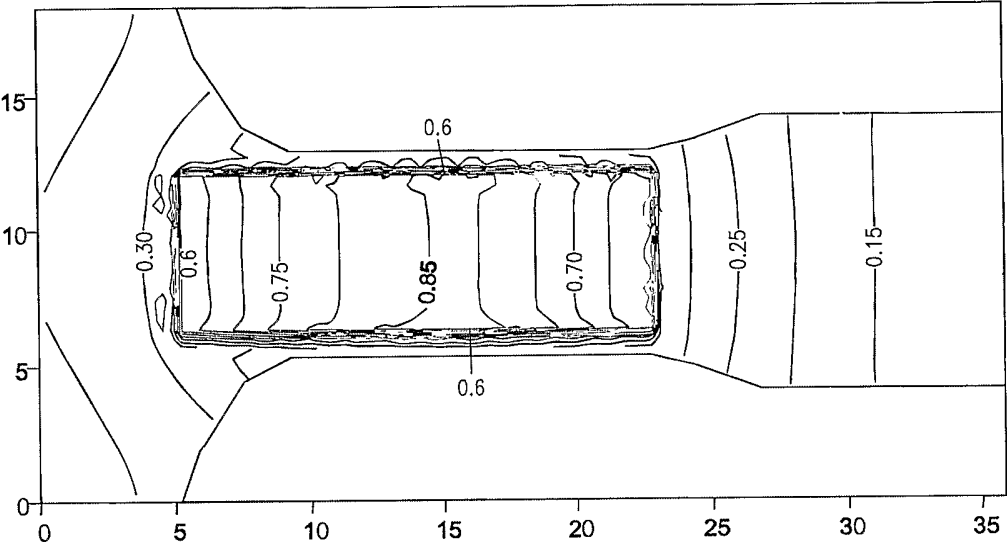


FIG. 9

Liquid mass/area (sum of layers) vs. X-Y position
(sim step: Hold 2, time step: 24 (120 s), layer:); Narrow Zoning.

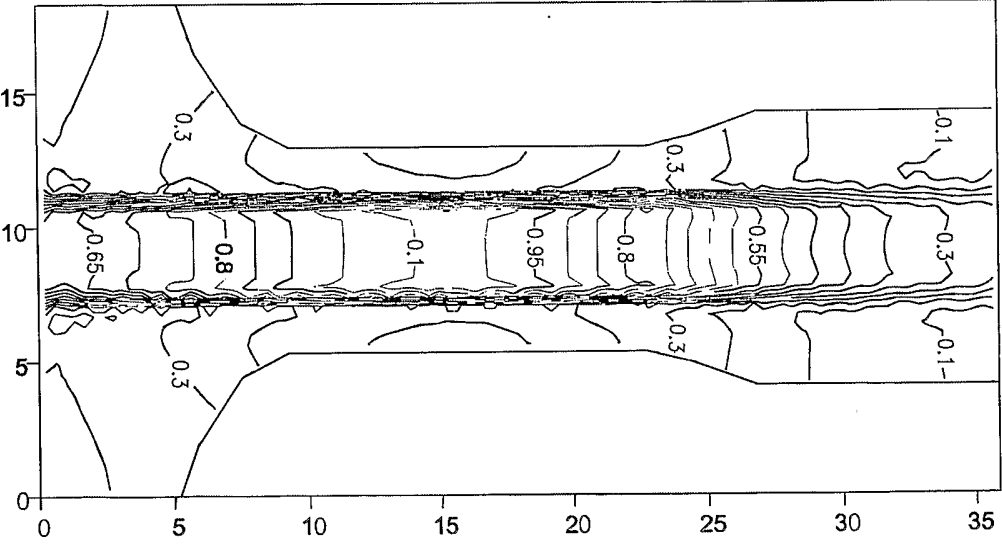
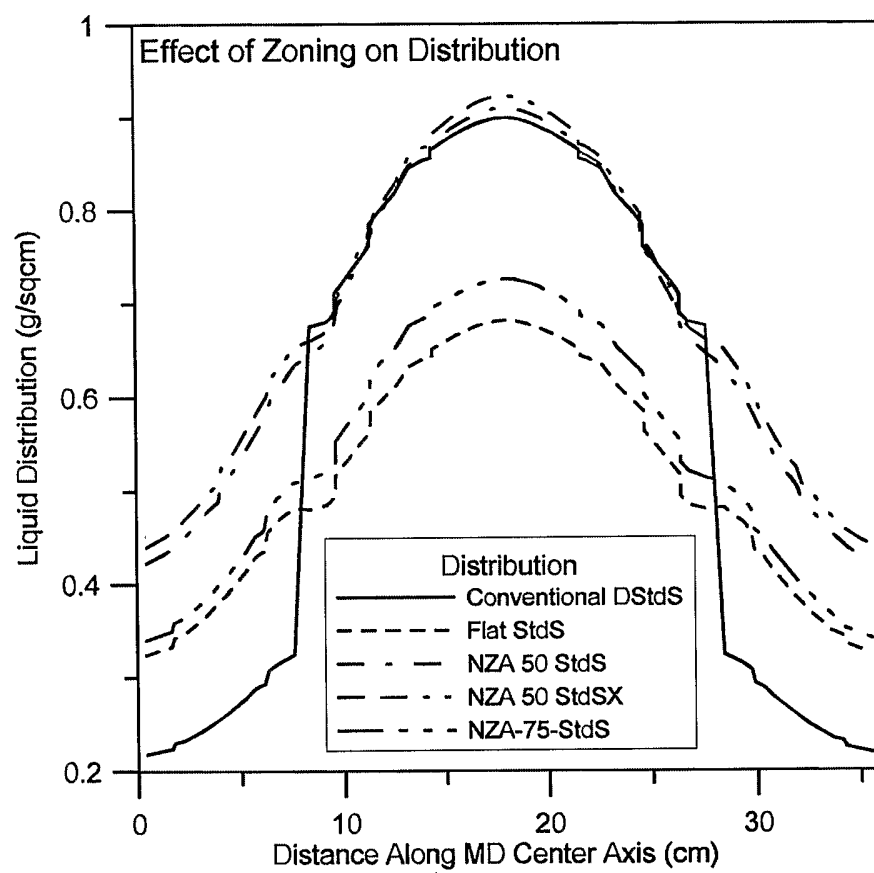


FIG. 10

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**FIG. 11**

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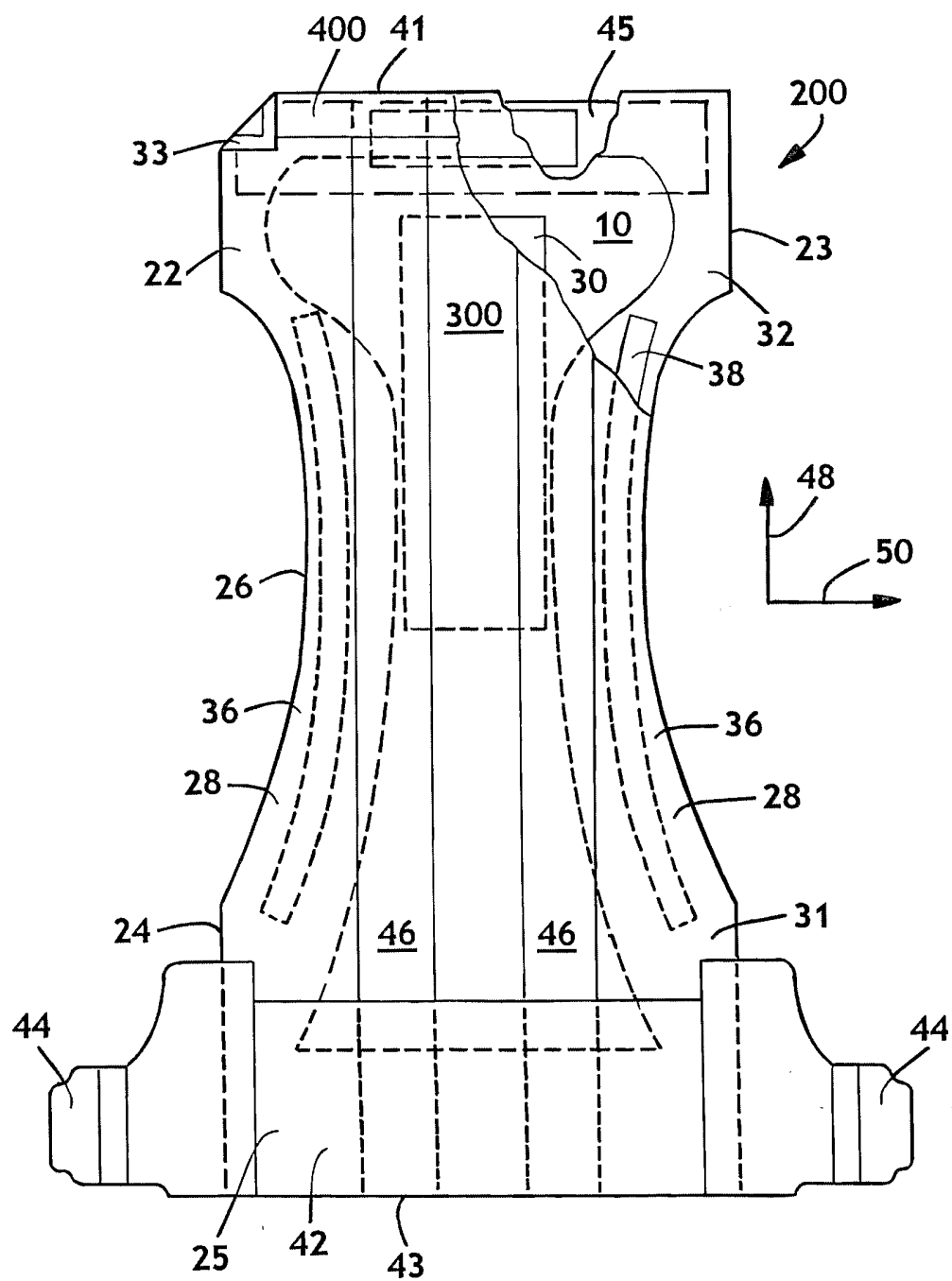


FIG. 12

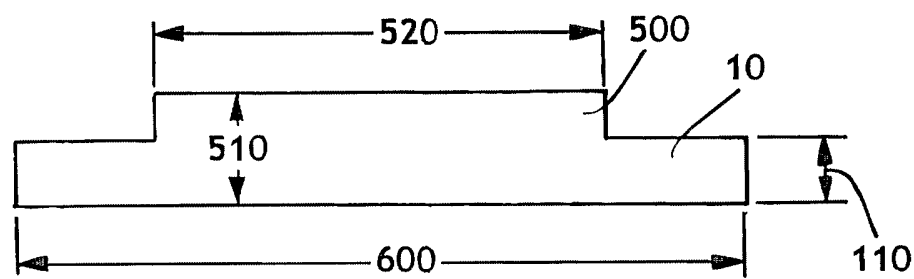


FIG. 13

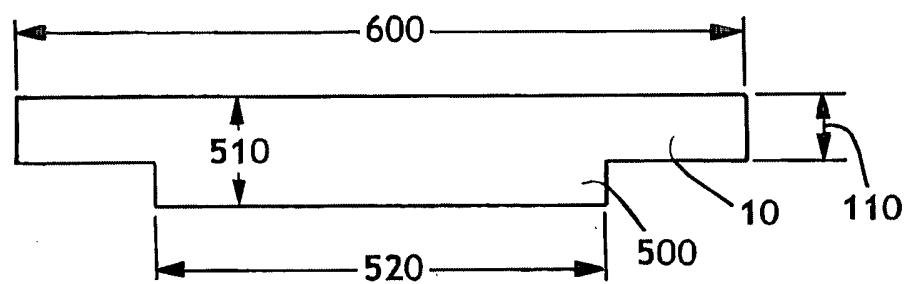


FIG. 14

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US2005/035647

A. CLASSIFICATION OF SUBJECT MATTER

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.
X	US 5 853 402 A (FAULKS ET AL) 29 December 1998 (1998-12-29)	1-6, 10-14
Y	column 6, line 61 - column 12, line 65 column 12, lines 41-52 figures 2-6; examples 1-4	7-9
Y	US 2003/119413 A1 (CHAKRAVARTY JAYANT ET AL) 26 June 2003 (2003-06-26) paragraphs '0102! - '0105!; figures 2-4	7-9
A	US 2003/012928 A1 (MALOWANIEC KRZYSZTOR D ET AL) 16 January 2003 (2003-01-16) paragraphs '0058! - '0062!; figure 7	1-14

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

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

17 January 2006

Date of mailing of the international search report

27/01/2006

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INTERNATIONAL SEARCH REPORT

International Application No
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