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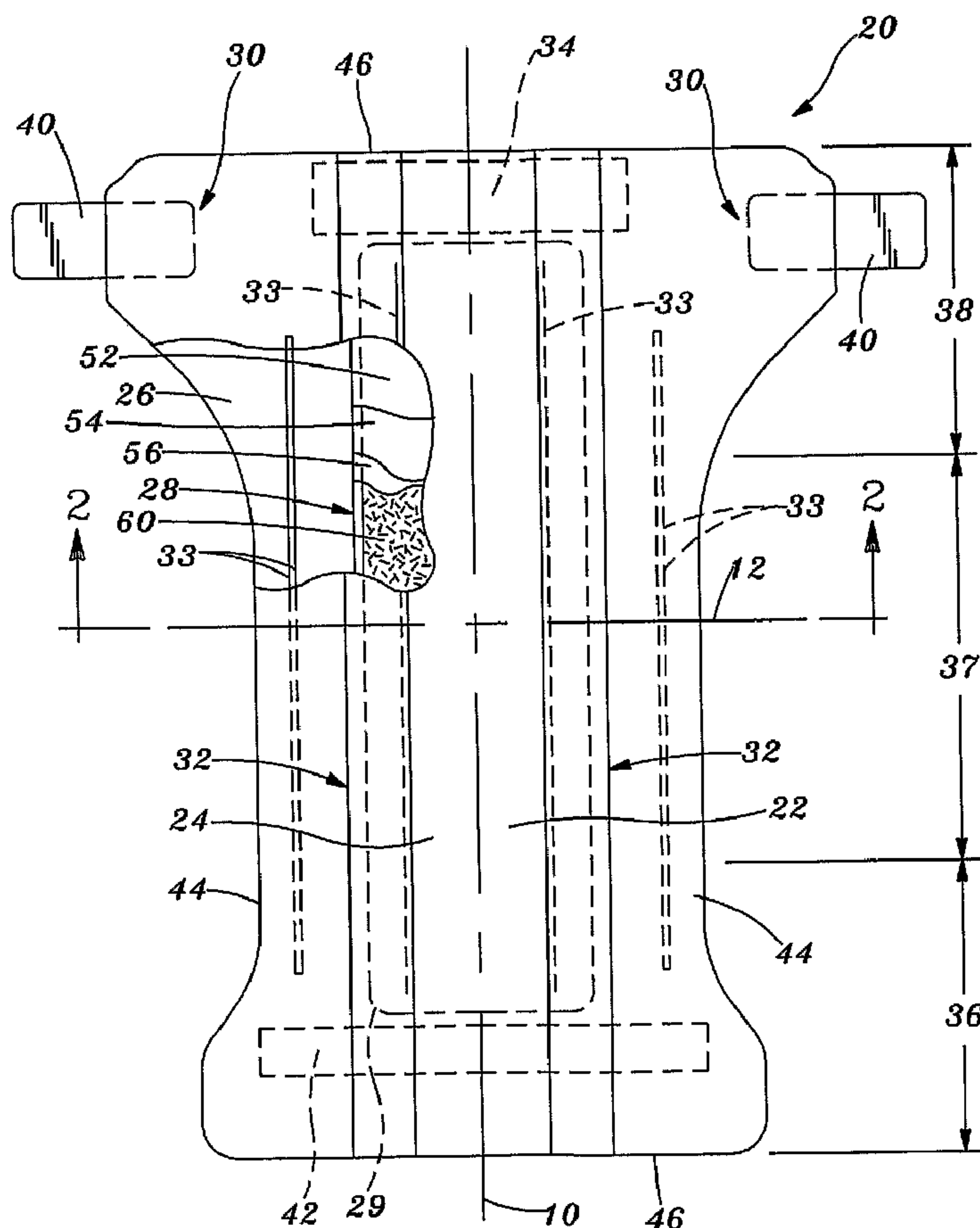
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(54) Title: FLEXIBLE ABSORBENT ARTICLE WITH IMPROVED BODY FIT



(57) Abrégé/Abstract:

An absorbent article that has a thin, conformable absorbent core where the core has at least two layers, both of which are substantially free of cellulosic fibers is described. The absorbent article has a Circular Bend Flexibility of less than about 15 N and an acquisition rate on the third gush of less than about 170 seconds and/or on the fourth gush of less than about 190 seconds.

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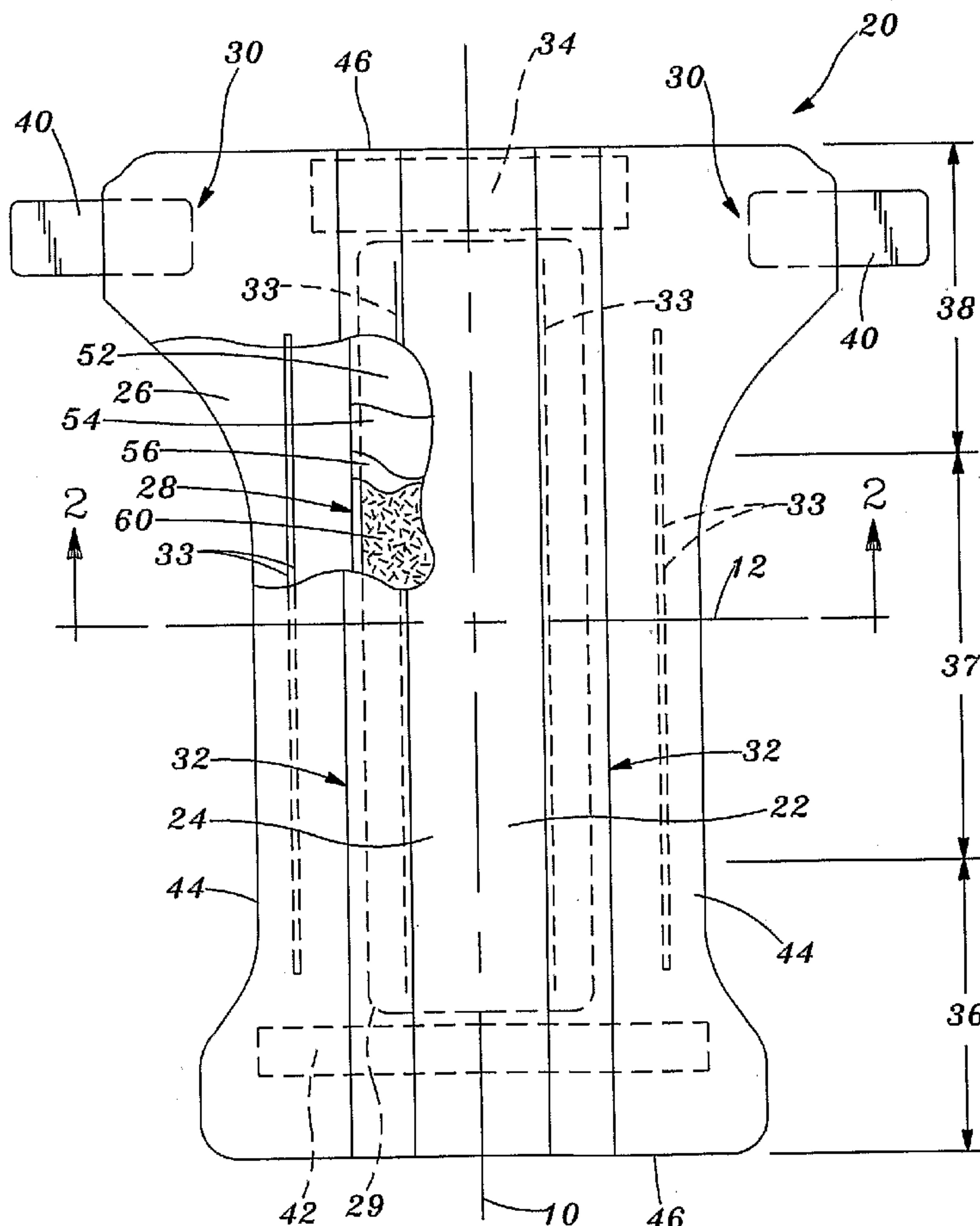
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(54) Title: FLEXIBLE ABSORBENT ARTICLE WITH IMPROVED BODY FIT



(57) Abstract: An absorbent article that has a thin, conformable absorbent core where the core has at least two layers, both of which are substantially free of cellulosic fibers is described. The absorbent article has a Circular Bend Flexibility of less than about 15 N and an acquisition rate on the third gush of less than about 170 seconds and/or on the fourth gush of less than about 190 seconds.

WO 2007/014235 A1

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FLEXIBLE ABSORBENT ARTICLE WITH IMPROVED BODY FIT

FIELD OF THE INVENTION

The present invention concerns an absorbent article, preferably a disposable absorbent article, such as a diaper. The present invention specifically relates to an absorbent core for such an absorbent article that provides the article with improved softness and conformity to a wearer's body. This absorbent core is also useful for providing an absorbent article having increased wearing comfort.

BACKGROUND OF THE INVENTION

Absorbent articles, such as diapers and adult incontinence products, are well known articles of commerce. Multiple attempts have been made to provide them with an overall good fit and with a high absorbent capacity. Modern diapers make use of superabsorbent materials which allow for storage of significant amounts of aqueous liquids such as urine (e.g., on the order 300 ml for a typical baby diaper).

While such an absorbent article is generally a disposable product, it is frequently worn over many hours and worn in a dry state as well as in a urine loaded state. As a result, providing good wearing comfort is very important both when the article is dry and when the article is fully or partially loaded with urine (or other bodily liquids).

One way the art has approached wearing comfort is to provide thinner absorbent articles. For example, US Pat. 4,673,402 describes an absorbent article with a dual layer core where the lower core component has a relatively high concentration of superabsorbent material and a relatively high density. US Pat. 4,950,264 describes sanitary napkins with fiber/superabsorbent material blends where the superabsorbent is at a relatively high concentration. US Pat. 5,102,597 describes absorbent polymeric macrostructures that comprise an interparticle crosslinked aggregate where individual superabsorbent particles are reacted with an interparticle crosslinking agent to form an aggregate which may take a sheet form. US Pat. 5,411,497 discloses an absorbent article which includes superabsorbent material located in discrete pockets formed between a first and a second carrier layer and water-sensitive attaching means for securing the carrier layers together to form the pockets. US Pat. Publication No. 2004/0167486 discusses

absorbent articles with a discontinuous layer of superabsorbent material. The layer may contain up to 20% of an absorbent fibrous material.

The art has also considered increasing density as a means to achieve thinness. For example, published US Pat. Application 2005/0119632 discloses absorbent structures said to feature a relatively high concentration of superabsorbent material, a relatively high density and a relatively high level of flexibility.

However, there is a continuing need for absorbent articles having improved thinness and flexibility that maintain the capability to acquire and store enough of the fluid deposited thereon so as to continue to provide desirable wearer skin dryness and satisfactory leakage performance. Caregivers and adult wearers of such absorbent articles desire improved discretion in order that a diaper is less visible under clothes or, in the case of an infant diaper, looks more like underwear. More conformable cores are also desired in order to reduce the amount of material placed between a wearer's legs.

SUMMARY OF THE INVENTION

The present invention is directed to an absorbent article, preferably a disposable absorbent article, such as a diaper. The diaper has a thin, conformable absorbent core where the core structure provides the diaper with improved flexibility as measured using a circular bend test. Suitably, the diaper has a core region with a circular bend flexibility of less than about 15 N and an acquisition rate on the third gush of less than about 170 seconds and/or less than about 190 seconds.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a diaper as a preferred embodiment of an absorbent article according to the present invention.

FIG. 2 is a cross-sectional view of the diaper shown in FIG. 1 taken along the sectional line 2-2 of FIG. 1.

FIG. 3 is a schematic view of an apparatus for production of one preferred embodiment of the cores of the present invention.

DETAILED DESCRIPTION

The present invention is directed to an absorbent article, preferably a disposable absorbent article, such as an infant diaper or adult incontinence product.

As used herein, the following terms have the following meanings:

The terms "superabsorbent material"; "superabsorbent polymer"; "SAP"; "absorbent gelling material" and "AGM" all refer to a polymeric material that is capable of absorbing at least about 5 times its weight of an aqueous fluid such as 0.9% saline as measured using the Centrifuge Retention Capacity test as is known to those of skill in the art.

"Absorbent article" refers to devices that absorb and contain liquid, and more specifically, refers to devices that are placed against or in proximity to the body of the wearer to absorb and contain the various exudates discharged from the body. Absorbent articles include but are not limited to diapers, adult incontinence briefs, training pants, diaper holders and liners, sanitary napkins and the like.

"Diaper" refers to an absorbent article generally worn by infants and incontinent persons about the lower torso.

"Disposable" is used herein to describe articles that are generally not intended to be laundered or otherwise restored or reused (i.e., they are intended to be discarded after a single use and, preferably, to be recycled, composted or otherwise disposed of in an environmentally compatible manner).

The terms "comprise," "comprising," and "comprises" specify the presence of what follows (e.g., a component) but do not preclude the presence of other features, elements, steps or components known to the art or disclosed herein.

A structure (e.g. layer) that is "substantially cellulose free" means that the structure comprises at least 90% by weight of superabsorbent material and less than 10% (by weight of the structure) cellulose fibres, typically less than 5% cellulose fibres or less than 1% cellulose fibres, or optionally no cellulose fibres, and typically it means that the structure comprises at least about 90% superabsorbent material. Preferably, such substantially cellulose free structures comprise at least about 95% superabsorbent material, or in certain embodiments at least about 99% superabsorbent material.

FIG. 1 is a plan view of a preferred embodiment of an absorbent article according to the present invention diaper 20. The diaper is shown in its flat out, uncontracted state (i.e.,

without elastic induced contraction). Portions of the structure are cut away to more clearly show the underlying structure of the diaper 20. The portion of the diaper 20 that contacts a wearer is facing the viewer. The chassis 22 of the diaper 20 in FIG. 1 comprises the main body of the diaper 20 and does not include core 28 thereof. The chassis 22 comprises an outer covering including a liquid pervious topsheet 24 and backsheet 26. The chassis preferably further includes side panels 30, elasticized leg cuffs 32, and elastic waist feature 34, the leg cuffs 32 and the elastic waist feature each typically comprise elastic members 33. One end portion of the diaper 20 is configured as a first waist region 36 of the diaper 20. The opposite end portion is configured as a second waist region 38 of the diaper 20. An intermediate portion of the diaper 20 is configured as a crotch region 37, which extends longitudinally between the first and second waist regions 36 and 38. The waist regions 36 and 38 may include elastic elements such that they gather about the waist of the wearer to provide improved fit and containment (e.g., elastic waist feature 34). The crotch region 37 is that portion of the diaper 20 which, when the diaper 20 is worn, is generally positioned between the wearer's legs. The diaper 20 is depicted with its longitudinal axis 10 and its transverse axis 12. The periphery of the diaper 20 is defined by the outer edges of the diaper 20 in which the longitudinal edges 44 run generally parallel to the longitudinal axis 10 of the diaper 20 and the end edges 46 run between the longitudinal edges 44 generally parallel to the transverse axis 12 of the diaper 20.

For unitary absorbent articles, the chassis 22 comprises the main structure of the diaper with other features added to form the composite diaper structure. While diaper 20 may be assembled in a variety of well-known configurations, preferred diaper configurations are described generally in US Pats. 4,940,464, 5,554,145; 5,569,234; 6,004,306, U.S. Pat. Application Publication No. 2003/0233082 and in U.S. Pat. Application Publication No. 2005/0234410.

The absorbent core 28 in FIG. 1 generally is disposed between the topsheet 24 and the backsheet 26. The absorbent core 28 may comprise any absorbent material that is generally compressible, conformable, non-irritating to the wearer's skin, and capable of absorbing and retaining liquids such as urine and other certain body exudates. Exemplary absorbent structures for use as the absorbent assemblies are described in US Pats.

4,610,678; 4,834,735; 5,260,345; 5,387,207; 5,397,316; and 5,625,222.

As can be seen more clearly in FIG. 2, absorbent core 28 comprises at least two layers: acquisition system 50 which comprises at least acquisition/storage layer 54 that provides acquisition along with temporary distribution and storage of acquired fluids and permanent storage of a portion thereof and storage system 60 which provides the majority of the storage capacity of diaper 20.

The topsheet 24 is compliant, soft feeling, and non-irritating to the wearer's skin. Further, the topsheet 24 is liquid pervious permitting liquids to readily penetrate through its thickness. A suitable topsheet 24 can be manufactured from a wide range of materials such as porous foams, reticulated foams, apertured plastic films, natural fibers (e.g., wood or cotton fibers), synthetic fibers (e.g., polyester or polypropylene fibers) or from a combination of natural and synthetic fibers. In one embodiment, the topsheet 24 is made of a hydrophobic material to isolate the wearer's skin from liquids in the absorbent core 10. Preferably the topsheet comprises a means to adjust hydrophilicity of the material.

A preferred topsheet 24 comprises a nonwoven material made using means well known to those skilled in the fabrics art. Preferably, the topsheet 24 has a basis weight from about 10 to about 25 g/m², a minimum dry tensile strength of at least about 150 g/cm in the machine direction and a strikethrough of less than about 3 seconds according to European Disposables and Nonwovens Association standard method 150.4-99. One suitable topsheet 24 comprises a polypropylene spunbonded nonwoven comprises fibers of less than 3 denier having a basis weight of about 18 g/m² as is available from BBA Fiberweb of Simpsonville, SC.

The backsheet 26 is preferably joined to the topsheet 24 at least about a portion of the periphery thereof. The backsheet 26 prevents exudates absorbed by the absorbent core 28 and contained within diaper 20 from soiling other external articles that may contact the diaper 20, such as bed sheets and clothing. The backsheet 26 is preferably manufactured from a thin polymer film. In one preferred embodiment the film comprising backsheet 26 is impervious to liquids. Typically, the backsheet 26 comprises a layer of polyethylene film having a basis weight between about 10 g/m² and about 30 g/m², although other flexible, liquid impervious materials can be used. Preferably, the film is breathable (e.g., via micropores) so as to permit vapors to escape from the diaper 20 while still preventing

exudates from passing through the backsheet 26. Particularly preferred backsheet materials have a nonwoven laminated to the film layer so as to make backsheet 26 more "cloth-like". Such a nonwoven layer may comprise a nonwoven material (e.g., one having a spunbonded or other suitable structure) with a basis weight between about 15 g/m² and about 25 g/m². Suitable materials for use as backsheet 26 are available from Clopay Plastic Products Company of Mason, OH.

The diaper 20 may also include such other features (not shown) as are known in the art including front and rear ear panels, waist cap features, elastics and the like to provide better fit, containment and aesthetic characteristics. Such additional features are well known in the art and are e.g., described in US Pat. 3,860,003 and US Pat. 5,151,092.

In order to keep the diaper 20 in place about the wearer, at least a portion of the first waist region 36 is attached by the fastening member 42 to at least a portion of the second waist region 38, so as to form leg opening(s) and a waist opening. The fastening system is designed to allow an article user to hold one element of the fastening system such as the fastening member 42, and connect the first waist region 36 to the second waist region 38 in at least two places. This is achieved through manipulation of bond strengths between the fastening device elements.

FIG. 2 shows a cross section of FIG. 1 taken along section line 2-2 of FIG. 1. Starting from the body facing side, the diaper comprises the topsheet 24, the components of the absorbent core 28, and the backsheet 26. Absorbent core 28 preferably comprises an acquisition system 50, which preferably comprises an acquisition layer 52 underlying topsheet 24 and acquisition/storage layer 54 disposed between acquisition layer 52 and the remaining component of core 28, storage system 60.

In particularly preferred embodiments, core 28 is narrower in crotch region 37 than it is in either of waist regions 36, 38. Preferably, the ratio of the width of core 28 at transverse axis 12 to the widest lateral width thereof in either of first waist region 36 or second waist region 38 is less than 1.0. More preferably the ratio is less than about 0.8, most preferably less than about 0.7.

In one preferred embodiment acquisition layer 52 comprises a non-woven. Alternatively acquisition layer 52 may comprise a chemically stiffened, twisted and curled fibers, foams or other materials suitable for acquiring aqueous fluids as are known to the art. As will be discussed in below, acquisition/storage layer 54 is substantially free of cellulosic fibers and comprises a highly permeable superabsorbent material.

Preferably, acquisition/storage layer 54 is in direct contact with storage system 60. Alternatively, storage system 60 may be wrapped by a core wrap material so as to dispose a layer between storage system 60 and acquisition/storage layer 54. In one preferred embodiment the core wrap material comprises an upper wrap layer 56 and a lower wrap layer 58. No matter what the relationship between acquisition/storage layer 54, storage system 60 and various arrangements of wrap materials, acquisition/storage layer 54 and storage system 60 must be in fluid communication. The material comprising wrap layers 56, 58 preferably is a nonwoven material. One preferred material comprises a spunbonded, a melt-blown and a further spunbonded layer (i.e., a SMS material). The non-woven materials are suitably made using synthetic fibers, such as polyethylene, polyester and, most preferably, polypropylene. Highly preferred are permanently hydrophilic non-wovens, and in particular nonwovens with durably hydrophilic coatings. Such hydrophilicity may be provided by surfactant treatment of the nonwoven. An alternative material comprises an SMMS-structure or a cellulosic tissue structure.

Similarly, but not shown, acquisition/storage layer 54 may be provided with a wrap material so as to enclose the layer. Materials suitable for upper and lower wrap layers 56, 58 are also suitable for use as a wrap material in designs for core 28 where it is desired to wrap acquisition/storage layer 54.

In a third alternative, wrap materials 56, 58 enclose both acquisition/storage layer 54 and storage system 60. In this embodiment acquisition/storage layer 54 and storage system 60 are in direct facing contact.

Suitably, acquisition/storage layer 54 has the same area as storage system 60 or smaller. Preferably, acquisition/storage layer 54 is laterally centered on storage system 60 with the same lateral width but a shorter longitudinal length than storage system 60. Acquisition/storage layer 54 may also be narrower than storage system 60 while remaining centered thereon. Said another way, acquisition/storage layer 54 suitably has

an area ratio with respect to storage system 60 of 1.0. Preferably, the area ratio is less than 1.0 (e.g., less than about 0.75), more preferably less than about 0.50.

When the acquisition/storage layer 54 is longitudinally shorter than the storage system 60, it is positioned such that more than 50% of its longitudinal length is forward of transverse axis 12. This positioning is desirable so as to place acquisition/storage layer under the point where urine is most likely to first contact diaper 20 (Sometimes called the “pee point”). Such positioning will facilitate acquisition of liquids absorbed by acquisition/storage layer 54.

Also, both acquisition/storage layer 54 and storage system 60 may comprise an uneven distribution of superabsorbent material basis weight in one or both of the machine and cross directions. Such uneven basis weight distribution may be advantageously applied in order to provide extra, predetermined, localized absorbent capacity to diaper 20. For example, the basis weight of superabsorbent material in one or both of acquisition/storage layer 54 and storage system 60 could be increased in the region of core 28 adjacent the “pee point”. This “profiled” distribution can also be used to provide diaper 20 with a desirable configuration to core 28 for improved body fit. For example, predetermined regions of low superabsorbent basis weight could be provided to create preferential fold zones in the core to help insure that core 28 flexes in a predetermined manner.

In alternative embodiments (not shown), the article may be preformed by the manufacturer by joining opposing portions of the longitudinal edges 44 that lie adjacent to the end edges 46 to create a pant. The term “pant”, as used herein, refers to disposable garments having a waist opening and leg openings designed for infant or adult wearers. A pant may be placed in position on the wearer by inserting the wearer's legs into the leg openings and sliding the pant into position about the wearer's lower torso. A pant may be preformed by any suitable technique including, but not limited to, joining together portions of the article using refastenable and/or non-refastenable bonds (e.g., seam, weld, adhesive, cohesive bond, fastener, etc.). A pant may be preformed anywhere along the circumference of the article (e.g., side fastened, front waist fastened). While the term “pant” is used herein, pants are also commonly referred to as “closed diapers”, “prefastened diapers”, “pull-on diapers”, “training pants” and “diaper-pants”. Suitable

pants are disclosed in US Pats. 5,246,433; 5,569,234; 6,120,487; 6,120,489; 4,940,464; 5,092,861; 5,897,545; 5,957,908 and in Published US Pat. Application 2003/0233082A1.

In additional alternative embodiments (also not shown) acquisition/storage layer 54 and storage system 60 can comprise a removable/replaceable component of an absorbent article. Such removable/replaceable components allow the absorbent article to be "refreshed" without the necessity of changing the entire article. The acquisition/storage layer 54 and storage system 60 are disposed beneath at least one fluid permeable layer similar to topsheet 24. Such embodiments having removable/replaceable components are described more fully in one or more of the following: US Patent No. 6,989,005, filed in the name of Lavon, et al. on March 27, 1997 and US Pat. Publication No. 2006/0229582 filed in the name of Lavon, et al. on April 4, 2005 and in published US Pat. Applications 2004/0039361, 2002/0091368, 2003/0199844, 2004/0024379, 2004/0030314.

A particularly preferred storage system 60 is described in aforementioned US Pat. Publication No. 2004/0167486. In summary, the layer comprises a superabsorbent material that is stabilized by a fibrous layer of thermoplastic material, preferably a thermoplastic adhesive to provide dry and wet immobilization of the superabsorbent material. As can be seen, such a structure is substantially free of cellulosic fibers. A particularly preferred superabsorbent material has an Absorption Against Pressure (AAP) of at least about 20 g/g and a Saline Flow Conductivity (SFC) that is greater than about 30×10^{-7} (cm³ seconds)/g. Preferably, AAP is greater than about 23 g/g, more preferably greater than about 25 g/g. AAP is measured according to the method described in the TEST METHODS section below and SFC is measured according to the method described in US Pat. 5,599,335. These superabsorbent materials are used at a basis weight of at least about 200 g/m², preferably at least about 400 g/m², more preferably at least about 600 g/m², to produce storage system 60. In order to maintain satisfactory flexibility, the basis weight is also less than about 2000 g/m².

Because storage system 60 is substantially free of cellulosic fibers, it has a higher density than components of an absorbent core used by the prior art for similar purposes. Suitably, a storage system 60 according to the present invention has a density greater than about 0.4 g/cm³. Preferably, the density is greater than about 0.5 g/cm³, more preferably greater than about 0.6 g/cm³.

Acquisition/storage layer 54 cooperates with storage system 60 to make more efficient use of the capacity thereof by providing temporary capillary storage of acquired fluids to allow time for fluid distribution into storage system 60. In addition, because acquisition/storage layer 54 comprises a superabsorbent material, it provides at least a portion of the ultimate storage capacity of absorbent core 28.

Importantly, because acquisition/storage layer 54 is intended to provide at least some temporary capillary storage and distribution of acquired fluid, it has a more open structure when wet than storage system 60 (i.e., the wet porosity is greater). The art has typically used fibrous structures (e.g., blends of cellulose fluff and superabsorbent material or crosslinked cellulose fibers for this purpose). However, such fibrous structures have considerable dry bulk compared to the substantially cellulosic fiber free acquisition/storage layers 54 of the present invention. Suitable superabsorbent materials for use in acquisition/storage layer 54 are described in US Pat. Publication No. No. 2005/0101928, in US Pat. Application Publication No. 2005/0070867, US Pat. Application Publication No. 2005/0222547 and in JP 2004-105118, entitled "An Aqueous-Liquid-Absorbing Agent and Its Production Process", filed in the name of Nippon Shokubai Co. Ltd. On March 31, 2004. The superabsorbent material is used at a basis weight of at least about 100 g/m², preferably at least about 150 g/m², more preferably at least about 200 g/m², to produce acquisition/storage layer 54.

Because an acquisition/storage layer 54 according to the present invention is substantially free of cellulosic fibers, it has a higher density than components of an absorbent core used by the prior art for similar purposes. Suitably, an acquisition/storage layer 54 according to the present invention has a density greater than about 0.4 g/cm³. Preferably, the density is greater than about 0.5 g/cm³, more preferably greater than about 0.6 g/cm³.

Acquisition/storage layer 54 and storage system 60 also cooperate to provide diaper 20 with improved wearer fit and comfort. Specifically a diaper 20 that comprises a core 28 where the acquisition system 50 includes at least an acquisition/storage layer 54 according to the present invention has desirable low caliper and crotch flexibility. As will be recognized, a low caliper and a flexible material result in a flexible core that can more closely conform to a wearer's body throughout the full range of wearer motion. Such

thin/flexible diapers are also less visible under a wearer's clothing and can have a very underwear-like appearance.

As noted above, cores 28 according to the present invention have a desirable low caliper. Desirably, the acquisition system 50 of the present invention comprises both an acquisition layer 52 and an acquisition/storage layer 54. For a core 28 of this construction dry core caliper is less than about 5 mm when measured at the center of acquisition layer 52. Preferably, the caliper of core 28 is less than about 4.5 mm, more preferably less than about 4 mm when measured at the center of acquisition layer 52. Structures that do not incorporate the acquisition layer 52 are even thinner.

It should be noted that, when many of the absorbent structures of the art discuss caliper, the caliper of the absorbent structure is discussed in terms of only a single layer, rather than the assembled layers necessary to form a complete core 28 for a diaper 20. Thus it is believed the low caliper of a core 28 of the present invention is particularly advantageous. Said another way, the low caliper of core 28 provides diaper 20 with a desirable low caliper. That is, the thickness of all diaper components between the body surface of the topsheet and the garment surface of the backsheet is meaningfully less than the thickness of prior art diapers. For example, in one embodiment, a diaper 20 that comprises a core 28 according to the present invention has a dry caliper (measured 10 cm from the front edge 29 of core 28) that is less than about 5 mm. Preferably, the dry caliper of diaper 20 is less than about 4.5 mm, more preferably less than about 4 mm.

Core 28 according to the present invention is also desirably flexible so as to facilitate reduced bulk and improved conformity of diaper 20. Without being bound by theory, it is believed that the combination of a thin construction as discussed above (as is known, stiffness increases with thickness) and flexible joinder of the absorbent polymer particles by the thermoplastic material (see, for example, published US Pat Application 2004/0162536) cooperate to provide the desirable flexibility. As a result, core 28 can more readily conform to varying wearer body shapes and respond to wearer motion. As can be seen in Example 1, diaper products of the prior art vary widely in flexibility (from 4.0 N to 70.5 N when evaluated according to the Circular Bend Flexibility test). It will be recognized that such flexibility is a result of many factors coming together in a finished diaper product. For example the Circular Bend Flexibility of Comparative Diapers A and

B is markedly different although the diapers have very similar storage systems. Without being bound by theory, it is believed that the difference in Circular Bend Flexibility can be attributed to the difference in the acquisition systems. Specifically, the dual layer acquisition system used in Comparative Diaper A has desirable fluid handling properties (e.g., the dual layer acquisition system provides substantial temporary storage for urine “gushes” with resulting rapid acquisition). These benefits come at the price of substantially less flexibility than Comparative Diaper B. Reference to Example 2 shows that the core designs of the present invention maintain much of the improved flexibility of Comparative Core B (~12N for a core according to the present invention vs. ~44N for Comparative Core A) while also providing the desirable fluid handling properties of Comparative Core A (third gush acquisition rate of ~100 seconds for a core according to the present invention vs. ~200 seconds for Comparative Core B). Specifically, replacing the dual layer acquisition system of Comparative Diaper A with a storage/distribution system according to the present invention provides much of the rapid acquisition of the dual layer system while remaining thin and flexible when dry so as to provide much of the dry flexibility of Comparative Diaper B.

Suitably an absorbent core 28 according to the present invention has a Circular Bend flexibility of less than about 13 N, preferably less than about 12 N, and more preferably less than about 10 N. Similarly, an absorbent article according to the present invention has a Circular Bend Flexibility substantially lower than that of commercially available and prior art diapers. Suitably, an absorbent article according to the present invention has a Circular Bend Flexibility less than about 15 N in a specimen taken from crotch region 37, forward of the lateral centerline of absorbent core 28 thereof. Preferably, the Circular Bend Flexibility in crotch region 37 is less than about 13.5 N, more preferably less than about 11 N. A method for measuring Circular Bend Flexibility is given in the Test Methods section below.

The absorbent cores 28 of the present invention not only have the low caliper and improved flexibility discussed above they also provide a wearer with desirable fluid handling properties. With respect to absorbent articles at least two types of fluid handling properties need to be considered: fluid acquisition and fluid storage capacity.

An absorbent article should have good fluid acquisition properties in order to rapidly transfer aqueous fluids from the body surface of the absorbent article to minimize free fluid that can bypass cuffs and waistbands with a resulting leak. In the case of the present invention, acquisition/storage layer 54 cooperates with acquisition layer 52 (when such an acquisition layer is present) to provide void volume for containing “gushes” of aqueous liquids so as to allow time for storage system 60 to acquire and permanently store such fluids. Because acquisition/storage layer 54 comprises a highly permeable superabsorbent material, such void volume is maintained even after the superabsorbent material comprising acquisition/storage layer 54 begins to swell after exposure to an aqueous fluid. Fluid acquisition properties can be conveniently measured using the Fluid Acquisition test described in the TEST METHODS section below. This test measures the time required for an absorbent article to acquire a predefined volume of fluid that is delivered in a series of “gushes”. The volume and delivery rate are intended to represent typical conditions for a specific size absorbent article. Depending on the size of the article, the time required to acquire the third or fourth gush of fluid can be an important measure of acquisition performance. Suitably, an absorbent article according to the present invention has a third gush acquisition rate of less than about 170 seconds, preferably less than about 150 seconds, more preferably less than about 130 seconds. Particularly preferred embodiments have a third gush acquisition rate of less than about 100 seconds. For larger sizes, acquisition rate for a fourth gush is also important. Suitably, an absorbent article according to the present invention has a fourth gush acquisition rate of less than about 190 seconds, preferably less than about 180 seconds, more preferably less than about 170 seconds.

Specifically, a core 28 of the present invention must provide sufficient storage capacity to function while simultaneously providing substantially reduced dry caliper and improved flexibility. As is also known, the required absorbent capacity for an absorbent article is basically defined by the intended use thereof. That is, an absorbent article intended for adult incontinence uses will have a larger design capacity than an absorbent article intended for an infant. Importantly, an absorbent core 28 according to the present invention does not give up the capacity to store an appropriate quantity of aqueous fluid in order to provide a reduction in core caliper. One way of considering capacity is as normalized capacity, that is capacity per unit area. This approach takes into account that

absorbent articles designed for larger wearers will have both a larger design capacity and a larger core area to absorb fluids deposited thereon. A method for normalized capacity is given in US Pat. Application Publication No. 2005/0222547. Suitably, a core 28 according to the present invention will have a normalized capacity in the portion thereof that comprises acquisition storage layer 54 of greater than about 0.3 g/cm^2 . Preferably, the normalized capacity in the portion thereof that comprises acquisition storage layer 54 is greater than about 1.0 g/cm^2 , more preferably greater than about 2.0 g/cm^2 . In those portions of core 28 that do not comprise acquisition/storage layer 54 the normalized capacity may be lower. For designs where the bulk of the capacity for aqueous liquids is within or adjacent to the crotch region 37, suitably, the normalized capacity in such areas is less than about 0.9 g/cm^2 , preferably less than about 0.5 g/cm^2 , more preferably less than about 0.2 g/cm^2 .

In an alternative embodiment core 28 is designed to provide a substantial portion of the ultimate storage in one or both of waist regions 36, 38. For this embodiment the normalized core capacity in one or both of waist regions 36, 38 may be equal to or higher than the normalized core capacity in crotch region 37. For example such waist region normalized core capacity may be greater than about 1.0 g/cm^2 , even greater than about 2.0 g/cm^2 . For this embodiment, the area of crotch region 37 is less than the area of the embodiment discussed above where the bulk of the capacity for aqueous liquids is within or adjacent to the crotch region 37 and acquisition/storage layer 54 may extend into waist regions 36, 38.

As will be recognized, if it is desired to calculate the total capacity of a core 28, the respective areas of a core 28 with and without acquisition layer 54 can be determined using means known to the art (e.g., image analysis) and those areas multiplied by the normalized capacity for the area to determine the total capacity of a core 28 having a particular size.

Storage system 60 can suitably be produced using the method described in the aforementioned US Pat Application Publication No. 2004/0167486.

Acquisition/storage layer 54 can be produced using a method that is substantially the same as that used to produce storage system 60. The main difference is that, rather than being provided with an uneven surface so as to provide areas of junction where an

adhesive directly contacts a substrate layer as described in US Pat. Application Publication No. 2004/0167486, a laydown drum is provided with a series of "pockets" having a shape and volume substantially defined by the desired shape and volume of acquisition/storage layer 54. As will be recognized, the shape and volume of these pockets may be used to provide a predefined superabsorbent material profile to one or both of acquisition/storage layer 54 and storage system 60. This laydown drum is provided with vacuum means as described in the aforementioned US Pat. Application Publication No. 2004/0167486 that is suitable for drawing a substrate into the pocket. Any nonwoven suitable for use as a substrate for storage system 60 is also suitable for use to produce acquisition/storage layer 54.

In one preferred embodiment, storage system 60 and acquisition/storage layer 54 are produced so as to provide a core 28 with no upper wrap layer 56 therebetween. One suitable process for producing this structure is shown in Fig. 3 and discussed in the following paragraphs.

As can be seen in Fig. 3, a storage layer precursor 160 can be produced by depositing a first superabsorbent material (not shown) that is contained in hopper 105 onto substrate 100. As described in US Pat. Application Publication No. 2004/0167486, first substrate 100 is caused to conform to depressions (not shown) in first laydown drum 110 by a vacuum in first vacuum portion 115 so as to enable filling the depressions with the first superabsorbent material as the depression passes under first hopper 105. After the depression passes under first hopper 105 the first superabsorbent material is stabilized with a thermoplastic polymer applied at first spray station 120 so as to form storage layer precursor 160.

Acquisition/storage layer precursor 154 can be produced in essentially the same manner. Second substrate 130 is caused to conform to a depression in second laydown drum 140 prior to filling with a second absorbent polymer (not shown) delivered from second hopper 135. The second superabsorbent material in the filled depressions is stabilized by thermoplastic polymer delivered from second spray station 150.

To form core precursors 128, the substrate webs carrying storage layer precursor 160 and acquisition/storage layer precursor 154 are phased for proper alignment using methods known to the art and combined at nip 180. As will be recognized, the rolls comprising nip 180 can be provided with pockets to receive precursors 160, 154 to enable

the first and second substrates 100, 130 to be sealed about the periphery of storage layer precursor 160 effectively enclosing core precursor 128 in a wrap material. If necessary, one or both of the rolls comprising nip 180 could be heated to soften the thermoplastic material to facilitate the enclosure step.

As will also be recognized separate nips (not shown) essentially the same as nip 180 and a web of a suitable nonwoven material (not shown) could be provided between the spray stations 120, 150 and nip 180 if it was desired to enclose either or both of precursors 160, 154.

TEST METHODS

Fluid Acquisition

The fluid acquisition test provides a measure of the ability of an absorbent structure to rapidly acquire aqueous fluids under simulated use conditions. The sample is loaded with a gush of 0.9% saline solution at a predetermined volume and rate using a pump (The Model 7520-00 available from Cole Parmer Instruments Co. of Chicago, IL is suitable). The time to absorb saline solution is recorded by a timer. The gush is repeated at 5 minute gush intervals for 4 gushes. The detailed description below is directed to infant diapers, for other types of absorbent articles the gush volume and confining pressure may be adjusted as described herein.

The test sample, which comprises a core and includes a topsheet and a backsheet, is arranged to lie flat on a foam platform within a polymethyl methacrylate (e.g., PERSPEX) box (see the detail assembly of the test apparatus in US Pat. 6,083,210) and a weight representative of a typical confining pressure is placed on a PERSPEX cover as discussed below. The following provides suitable setup parameters for various sizes of infant diapers. If a diaper product to be tested does not list a size, the product size is defined by determining the weight range with the greatest overlap with the weight ranges listed below.

<u>Size</u>	<u>Approx.</u> <u>Infant Wt</u> (kg)	<u>Loading Vol.</u> (ml)	<u>Loading Rate</u> (ml/sec)	<u>Confining Pressure Weight</u> (kg)
Newborn	<4	16	5.33	0.9 at each end of plate= 1.8 total
1	4-6	24	8	2.3 at each end of plate= 4.6 total
2	5-8	40	8	2.9 at each end of plate= 5.8 total
3	7-13	50	10	4.5 at each end of plate= 9.0 total
4	10-17	75	15	9.1 at each end of plate= 18.2 total
5 and larger	>12	75	15	9.1 at each end of plate= 18.2 total

If products with significantly different capacities from those listed in the table above are evaluated (such as can be envisaged for adult incontinence products or diapers for premature infants), the fluid volume per gush should be adjusted to 20% of the total article design capacity and the weight for the confining pressure should be adjusted to be representative of the pressure exerted a wearer on the product when the wearer is sitting. Design capacity can be determined by summing the capacity of superabsorbent material (defined as the Centrifuge Retention Capacity) and any contribution from fibrous material in the core (e.g., 4 g/g for cellulosic fibers). Any deviation from the standard test protocol should be recorded.

The outer surface of the backsheet faces the foam platform. A PERSPEX plate with a 5 cm diameter opening substantially in its middle is placed on top of the sample. The sample is oriented such that the topsheet is directly below the opening of the PERSPEX plate. The opening in the plate (i.e., the loading point for the saline solution) is placed about 10 cm from the front edge of the complete core and about in the halfway between the lateral sides of the core. Saline solution is introduced to the sample through the cylinder fitted and glued into the opening. Electrodes are about 1 mm to 2 mm above the surface of the absorbent structure and also connected to the timer. Loads are placed on top of the plate to simulate, for example a baby's weight. Two weights with an area of 744.6 cm² (51 cm x 14.6 cm) appropriate for the particular size (see table above) are placed on top of the plate.

As saline solution is introduced into the cylinder, it builds up on top of the absorbent structure thereby completing an electrical circuit between the electrodes. This starts the timer. The timer is stopped and recorded when the absorbent structure has absorbed the gush, and the electrical contact between the electrodes is broken.

Acquisition rate is defined as the time in seconds required to absorb the gush volume that is delivered. The acquisition rate is calculated for each gush introduced into the sample.

Basis Weight

European Disposables and Nonwovens Association (EDANA) standard method for Mass per Unit Area (40.3-90) is suitable

Caliper

European Disposables and Nonwovens Association (EDANA) standard method for Thickness (No 30.5-99) is suitable. A suitable apparatus is described in paragraph 4.1. The specified pressure is 2.1 kPa.

Density

Divide the basis weight determined using the Basis Weight method by the caliper determined by the Caliper method.

Circular Bend Flexibility

Sample Preparation

This method is suitable for measuring the flexibility of absorbent articles or absorbent article components having a core with sufficient area to cut a 2.5 inch X 6.5 inch (6.4 cm X 6.4 cm) sample therefrom. Samples should equilibrate at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and $50\% \pm 2\%$ relative humidity for at least 2 hours before testing. Open the side seals if the absorbent article is a pants type diaper. Remove all elastics (leg cuffs, waist bands, etc.) from the absorbent article. Gently stretch the absorbent article on a flat surface, with the backsheet toward that surface, to eliminate any folds therein. Mark the intersection of the longitudinal and transverse axes of the absorbent core. Measure 62 mm along the longitudinal axis toward the front waist edge of the absorbent article, and make a second mark. Using a hydraulic press (suitable presses are available from Carver, Inc. of

Wabash, IN) with a 2.5 inch square die (6.4 cm), cut a sample centered at the second mark.

Apparatus and Method

The circular bend method is performed on a constant rate of extension tensile tester with computer interface (a suitable instrument is the MTS Q-tester using Testworks 4 Software; as is available from MTS Systems Corp, Eden Prairie, MN) and a 100 N load cell. The instrument is set up for a standard compression test using the platform and plunger fixtures described in ASTM D4032-94 (Standard Test Method for Stiffness of Fabric by the Circular Bend Procedure). The sample is centered on the platform over the aperture. The piston is rigidly connected to the crosshead of the tensile tester, centered on the aperture and positioned 20 mm above the top plane of the platform at the start of the test. Upon test initiation, crosshead motion causes the plunger to descend at a rate of 100 mm/min to a depth of 15 mm below the top plane of the platform.

Replicates and Calculations

At least 5 replicates for each sample are evaluated.

The circular bend flexibility is reported as the maximum peak force in Newtons (N). Each set of five identical replicates (or n replicates if n is greater than 5) is tested and the five values measured for that set are averaged as the value for the sample.

EXAMPLES

Example 1

This example is intended to show the flexibility of the core region of machine made diaper products of the prior art. In this example, commercially available diapers, and other diapers according to the prior art were evaluated for Circular Bend Flexibility in two sections of the crotch region (before and after the lateral centerline of the core) using the method described herein. The results of this evaluation can be found in Table 1.

Table 1

<u>Diaper Type</u>	Circular Bend Flexibility
	<u>Crotch Front</u> (N)
Pampers Easy Ups ^{®1} 3T/4T	51.3
Pampers Feel n Learn ^{®1}	24.4
Huggies Pull Ups ^{®2} Girl	
Size 2T/3T	18.4
Size 3T/4T	24.7
Size 4T/5T	15.6
Huggies Pull Ups ^{®2} Boy Size 4	49.3
Pampers Cruisers ^{®1} Size 4	43.9
Huggies Supreme ^{®2} Size 4	70.5
Huggies Baby Shape ^{®2} Size 4	38.2
Comparative Diaper A ³	50.1
Comparative Diaper B ⁴	4.0
Cloth Underwear ⁵	0.2

1. Available from Procter & Gamble of Cincinnati, OH
2. Available from Kimberly Clark of Neenah, WI
3. Storage system according to published US Pat Application 2004/0162536 with dual layer acquisition system comprising crosslinked cellulose fibers (250g/m²) and carded/resin bonded polyester nonwoven (60 g/m²)
4. Storage system according to published US Pat Application 2004/0162536 with nonwoven acquisition layer comprising carded/resin bonded polyester nonwoven (43 g/m²)

5. Hanes Her Way[®] cotton briefs Size 4 available from Hanes Company, Inc. of Winston-Salem, NC, two plies of fabric in crotch area. A 10 N load cell was used in the force measurement instead of a 100 N load cell due to the high flexibility.

As can be seen, there is a wide variation in flexibility among the diapers tested and underwear is the most flexible of all products tested.

Example 2

This example is intended to compare the flexibility and acquisition rate of absorbent cores according to the present invention with two cores from the prior art. In this example the core samples are disposed on a backsheet comprising a laminate of a 18 g/m² spunbonded polypropylene from BBA Fiberweb of Simpsonville, SC and a 28 g/m² polyethylene film from Clopay Plastic Products Company of Mason, OH. with a topsheet (18 g/m² spunbonded polypropylene from BBA Fiberweb of Simpsonville, SC) disposed thereon and are evaluated for Circular Bend Flexibility in the front portion of the crotch region (before the lateral centerline of the core) and Third Gush Acquisition Rate.

Table 2

<u>Diaper Type</u>	<u>Average Circular Bend</u>	
	<u>Flexibility Crotch Front</u>	<u>Acquisition Rate 3rd Gush</u>
	(N)	(seconds)
Comparative Core A ¹	44	90
Comparative Core B ²	2	198
Core According to Present Invention ³	12	97

1. Storage system according to published US Pat Application 2004/0162536 (800 g/m²) with dual layer acquisition system comprising crosslinked cellulose fibers (250 g/m²) and carded/resin bonded polyester nonwoven (60 g/m²)
2. Storage system according to published US Pat Application 2004/0162536 (400 g/m²) nonwoven acquisition layer comprising carded/resin bonded polyester nonwoven (43 g/m²)
3. Storage system according to published US Pat Application 2004/0162536 (680 g/m²), acquisition/storage layer according to the present invention (superabsorbent material according to US Pat. Application Publication

No. 2005/0222547 with a basis weight of 200 g/m²) and carded/resin bonded polyester nonwoven (60 g/m²)

Example 3

This example is intended to compare the dry caliper of diapers according to the present invention with commercially available diapers and a diaper made according to published US Pat Application 2004/0162536. This comparison is shown in Table 3.

Table 3

<u>Product</u>	<u>Dry Caliper</u> (mm)
Pampers® Active Fit (size 4) ¹	7.1
Huggies® Super-Flex (size 4) ²	7.2
Huggies® Pull-Ups® Girl ³	3.2
Huggies® Pull-Ups® Boy ³	4.0
Diaper According to published US Pat Application 2004/0162536 ⁴	5.9
Present Invention ⁵	3.9

1. Available from Procter & Gamble GMBH of Schwalbach am Tanus, Germany
2. Available from Kimberly Clark of Reigate, United Kingdom
3. Available from Kimberly Clark of Neenah, WI
4. Dual layer acquisition system: consists of curly cellulosic fiber (200g/m²) and carded/resin bonded polyester nonwoven (60 g/m²)
5. Acquisition/storage layer according to the present invention

All documents cited in the Detailed Description of the Invention are,
not to be construed
as an admission that it is prior art with respect to the present invention.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and

modifications can be made without departing from the spirit and scope of the invention. As will be also be apparent to the skilled practitioner, all combinations of the embodiments and features taught in the foregoing disclosure are possible and can result in preferred executions of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

What is claimed is:

1. An absorbent article comprising:
 - a) a fluid permeable topsheet;
 - b) a backsheet, said backsheet being joined to said topsheet about a periphery of said absorbent article; and
 - c) a core disposed between said topsheet and said backsheet, said core comprising:
 - i) a storage system comprising at least one storage layer having a density of at least about 0.4 g/cm^3 ; and
 - ii) an acquisition system comprising at least 90% superabsorbent material, said acquisition system comprising an acquisition/storage layer having a density of at least about 0.4 g/cm^3 which comprises a superabsorbent material; and
 - iii) regions of low superabsorbent basis weight in both the acquisition/storage layer and the storage system to create one or more preferential fold zones;

wherein said absorbent article has a circular bend flexibility of less than about 15 N in a crotch region thereof and an acquisition rate selected from measurements of at least one of the following gushes:

 - a) on a third gush of less than about 170 seconds; or
 - b) on a fourth gush of less than about 190 seconds.
2. An absorbent article according to Claim 1 wherein said absorbent article has a circular bend flexibility of less than about 13.5 N in a crotch region thereof.

3. An absorbent article according to Claim 2 wherein said absorbent article has a circular bend flexibility of less than about 11 N in the crotch region thereof.
4. An absorbent article according to Claim 1 wherein said core has a circular bend flexibility of less than about 13 N.
5. An absorbent article according to Claim 4 wherein said core has a circular bend flexibility of less than about 12 N.
6. An absorbent article according to Claim 5 wherein said core has a circular bend flexibility less than about 10 N.
7. An absorbent article according to Claim 1 wherein said absorbent article has an acquisition rate on the fourth gush of less than about 180 seconds
8. An absorbent article according to Claim 7 wherein said absorbent article has an acquisition rate on the fourth gush of less than about 170 seconds.
9. An absorbent article according to Claim 1 wherein said absorbent article has an acquisition rate on the third gush of less than about 150 seconds.
10. An absorbent article according to Claim 9 wherein said absorbent article has an acquisition rate on the third gush of less than about 130 seconds.
11. An absorbent article according to Claim 1 wherein said absorbent article further has a dry caliper less than about 5 mm.
12. An absorbent article according to Claim 9 wherein said absorbent article has a dry caliper less than about 4 mm.
13. A removable/replaceable absorbent core, whereby an absorbent article can be refreshed without the necessity of changing the entire article, comprising:
 - a) a fluid permeable layer; and

- b) an absorbent core disposed beneath said fluid permeable layer, wherein said absorbent core comprises at least about 90% superabsorbent material, said absorbent core comprising:
 - i) a storage system comprising at least one storage layer having a density of at least about 0.4 g/cm^3 and
 - ii) an acquisition system comprising an acquisition/storage layer having a density of at least about 0.4 g/cm^3 which comprises a superabsorbent material, said acquisition system overlying said storage system; and
 - iii) regions of low super absorbent basis weight in both the acquisition/storage layer and the storage system to create one or more preferential fold zones;

wherein said absorbent article has a circular bend flexibility of less than about 15 N in a crotch region thereof and an acquisition rate selected from measurements of at least one of the following gushes:

- a) on a third gush of less than about 170 seconds; or
- b) on a fourth gush of less than about 190 seconds.

14. An absorbent article according to Claim 13 wherein said absorbent article has a circular bend flexibility of less than about 13.5 N in the crotch region thereof.

15. An absorbent article according to Claim 14 wherein said absorbent article has a circular bend flexibility of less than about 11 N in the crotch region thereof.

16. An absorbent article according to Claim 1 wherein said acquisition system comprises at least about 95% superabsorbent material.

17. An absorbent article according to Claim 16 wherein said acquisition system comprises at least about 99% superabsorbent material.

1/3

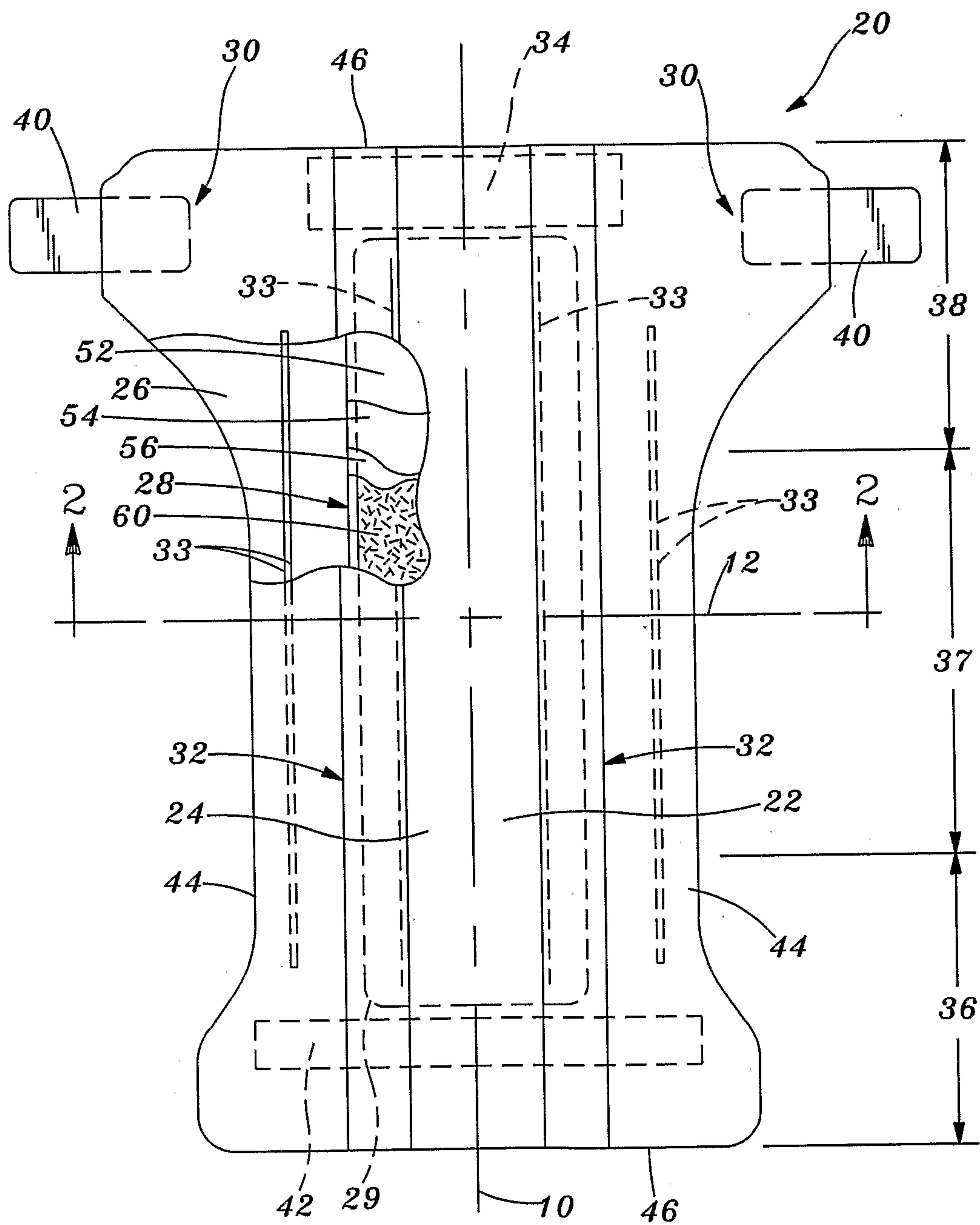


Fig. 1

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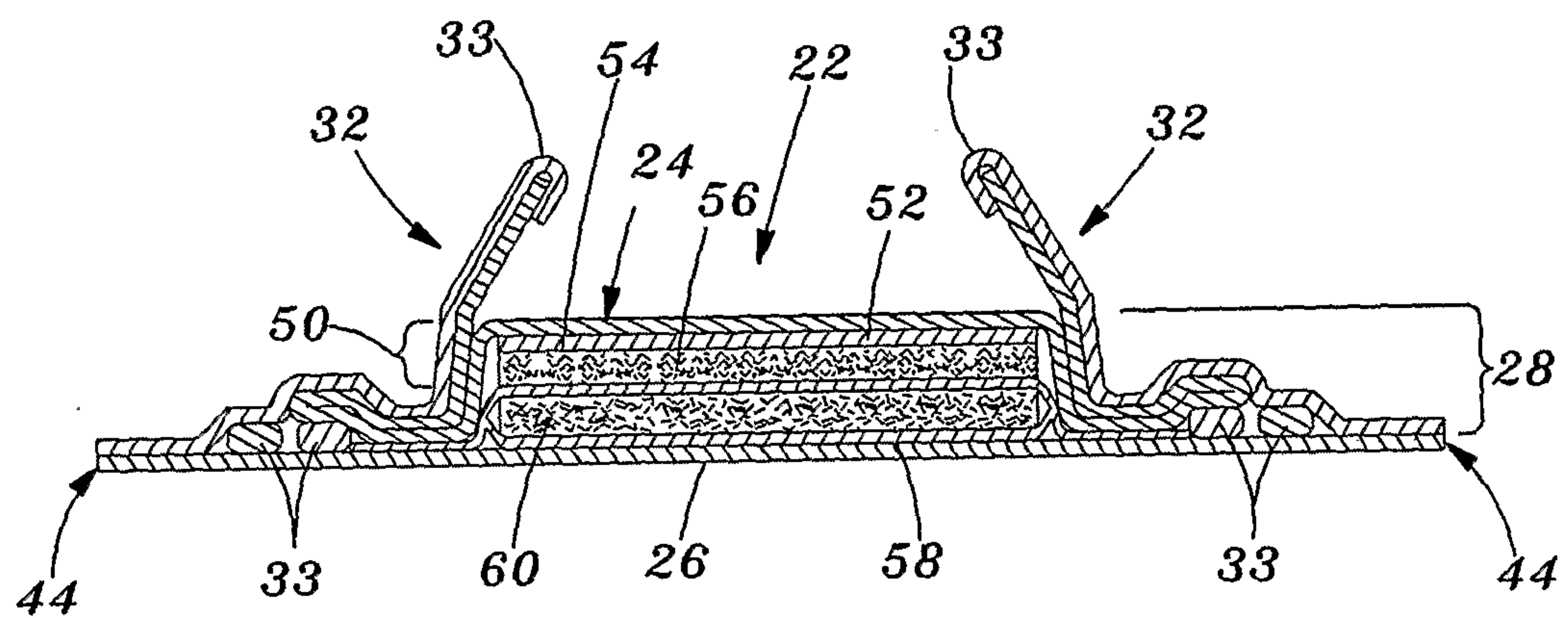


Fig. 2

3/3

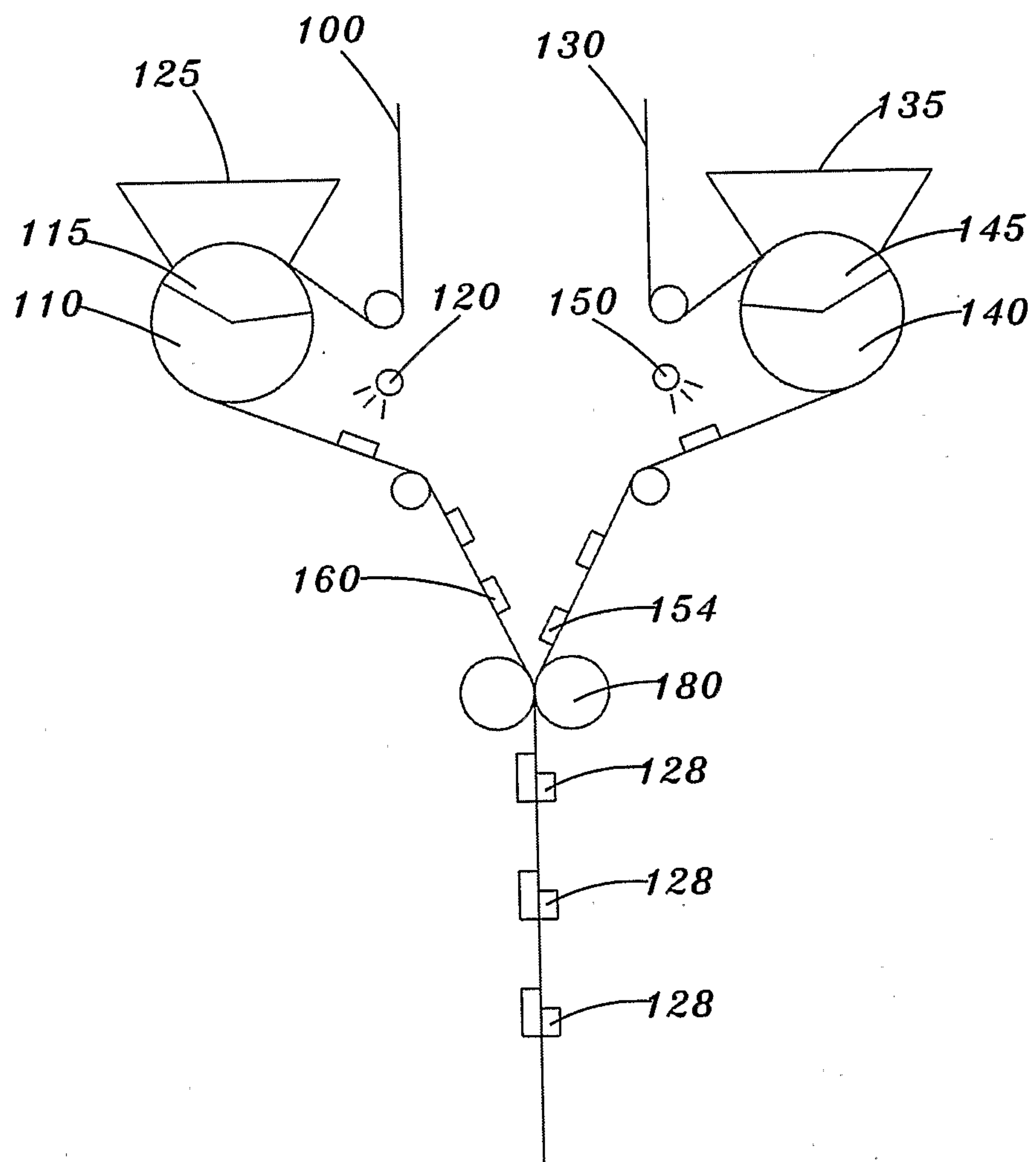


Fig. 3

