SANITARY NAPKIN

Filed April 27, 1966 Sheet 1 of 2

Fig. 1

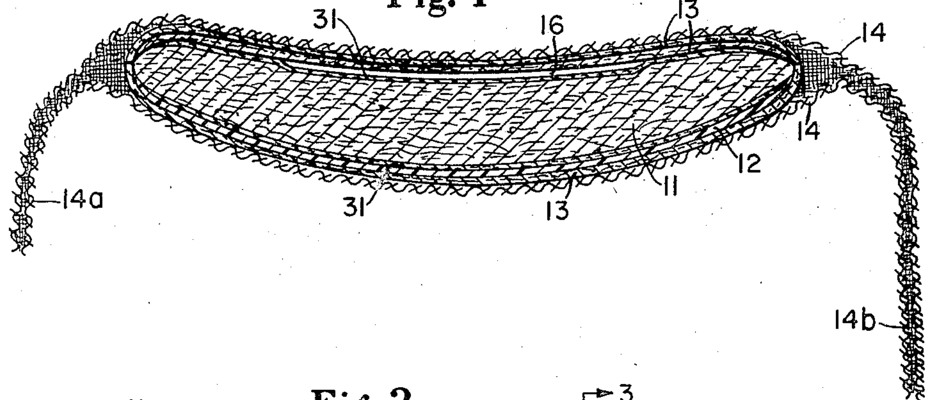


Fig. 2

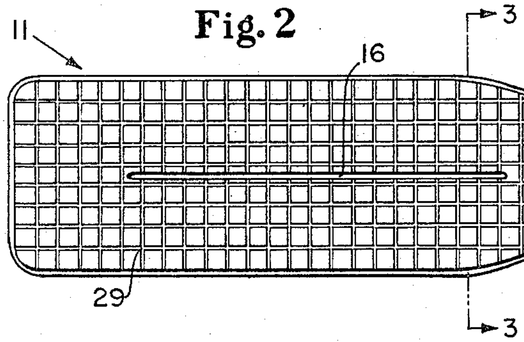
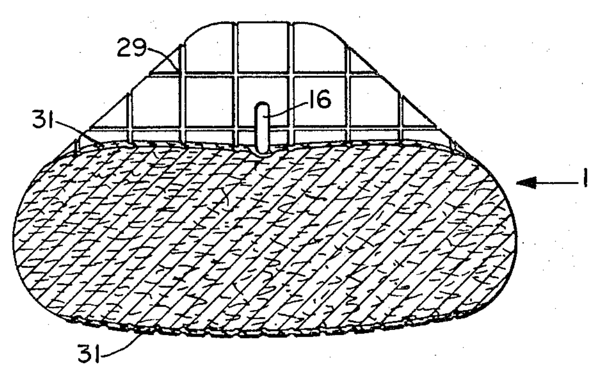


Fig. 3



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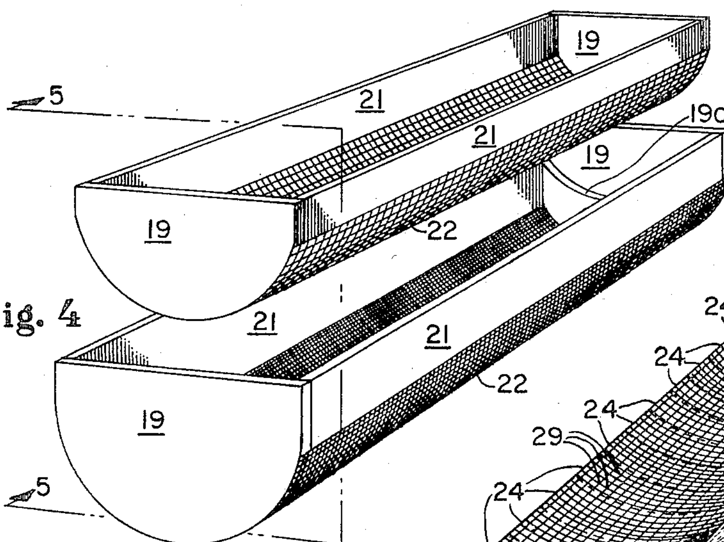

Fig. 4

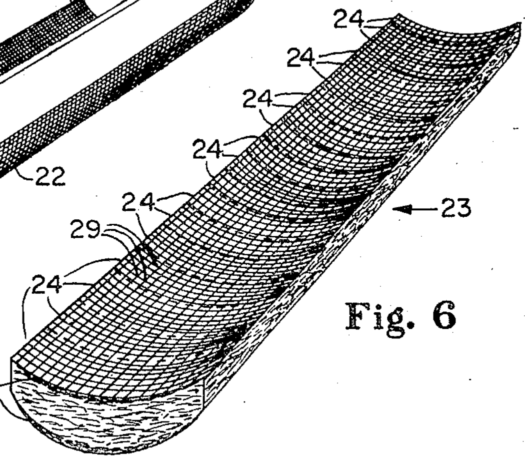

Fig. 6

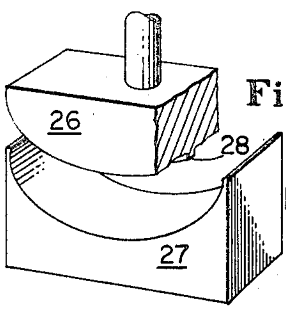

Fig. 7

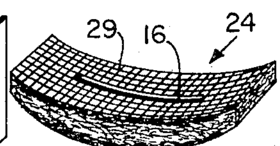

Fig. 8

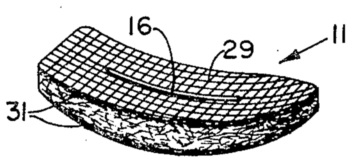

Fig. 9

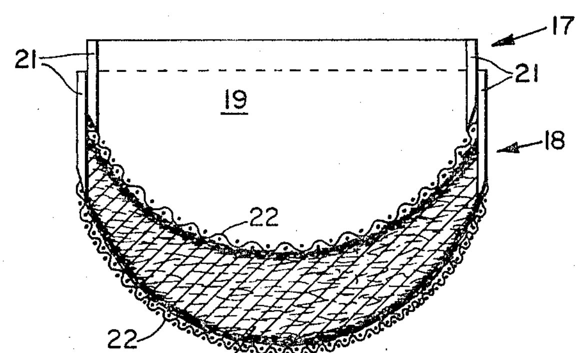

Fig. 5

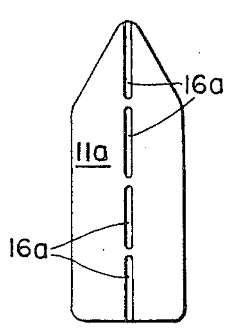

Fig. 2a

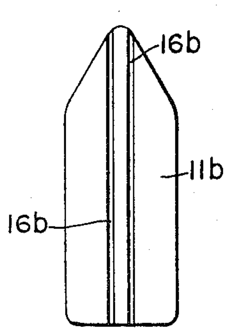

Fig. 2b

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United States Patent Office

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3,430,630
SANITARY NAPKIN

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Filed Apr. 27, 1966, Ser. No. 545,689
U.S. Cl. 128—290 11 Claims
Int. Cl. A61f *13/20;* A61l *15/00*

ABSTRACT OF THE DISCLOSURE

A sanitary napkin adapted to assume a lateral upwardly concave conformation when worn. The napkin comprises a preformed core of longitudinal and lateral arcuate shape which is constructed of fibers of absorbent material held in an integrated or unified condition. A longitudinally extending depression of narrow width and a depth of at least about 1/32 inch is located centrally of the upper surface of the core. The depression in association with the balance of the structure imparts a directed flexure property to the napkin to assure that lateral compression in use will cause the aforesaid lateral upwardly concave conformation to occur.

This invention relates to sanitary napkins and more particularly to sanitary napkins which include, as an element thereof, a preformed arcuately-shaped absorbent core.

Commercially available sanitary napkins are flat and have, when viewed in plan, a configuration which may be substantially rectangular or, alternatively, conformed to fit the user more comfortably, i.e., of trapezoidal or other configuration in which the portion of the napkin to be received between the legs of the user is of reduced width. However, in order to be applied, the napkins have to be bent into a curved shape, when viewed in elevation, which follows the anatomical curves of the user from the perianal area to the area forward and above the vulva. As a result of this bending, transverse ridges and troughs are formed in the top surface of such napkins. These ridges and troughs, because they extend in a transverse direction, encourage the flow of menses to the sides of the napkin, resulting in the soiling of undergarments and the in-use failure of the device substantially before the full utilization of its absorptive capacity. In addition, the thighs of the user press inwardly, forcing such napkins to be folded longitudinally to assume, in use, a transverse upwardly convex curvature. In this condition the downwardly turned sides of the napkins rub against portions of the thigh which move relative to the napkin when the user walks, etc., causing discomfort and chafing of such portions. Such curvature also promotes run-off of menses, slippage of the napkin and smearing. Run-off is leakage of menses over the edge of a napkin; slippage is relative movement between the napkin and the trunk of the user; smearing is the soiling of parts of the body of the user adjacent the labia majora, usually as a result of slippage.

In an effort to eliminate such problems, it has been proposed to impart an arcuate shape to the napkin prior to use whereby to eliminate the ridges and troughs and thus prevent side flow. The object of the arcuate shape is to allow the user to wear a sanitary napkin more comfortably and for a longer period of time before changing becomes necessary. Although the result should be an improved napkin, the change in shape will not by itself significantly reduce the discomfort problems nor will it significantly increase the in-use capacity of such devices since side flow of menses on the napkin and soiling of the undergarments of the user will still occur, as will chafing,

due to the transverse upwardly convex curvature discussed above.

It is an object of the present invention to eliminate the above problems.

It is another object of the present invention to provide a sanitary napkin of arcuate shape which has an effective in-use absorptive capacity substantially higher than that of prior art napkins and which is substantially more comfortable in use.

It is a further object of the present invention to provide an arcuately shaped sanitary napkin which is designed to become folded longitudinally to assume an in-use configuration in transverse cross-section which is substantially different than that assumed by prior art devices whereby to reduce chafing discomfort and improve the effectiveness of the device.

Briefly stated, in accordance with one aspect of this invention there is provided a sanitary napkin comprising an absorptive, preformed, arcuately-shaped core. The core has an upper and a lower surface, each of which is upwardly concave along longitudinal and lateral (transverse) lines, i.e., lines which extend lengthwise of and across the width of the core. The core has a centrally located, longitudinally-extending depression formed in its upper surface. The depression has a depth of at least about 1/32″ whereby to provide a pivot line which causes the napkin to assume a lateral upwardly concave conformation when worn.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the present invention it is believed that the invention will be better understood from the following description taken in connection with the accompanying drawing, in which:

FIGURE 1 is a vertical longitudinal sectional view of a sanitary napkin including one embodiment of an absorbent core of the present invention;

FIGURE 2 is a plan view of the preformed, arcuately-shaped absorbent core of FIGURE 1;

FIGURE 2*a* is a plan view of another embodiment of an absorbent core of the present invention employing a plurality of aligned depressions;

FIGURE 2*b* is a plan view of a further embodiment of an absorbent core of the present invention employing a plurality of parallel depressions;

FIGURE 3 is an enlarged vertical transverse sectional view of the preformed core taken along line **3—3** of FIGURE 2;

FIGURE 4 is a perspective view of a mold for forming an elongated arcuately-shaped log from which the blanks for individual cores may be separated by cutting on transverse planes;

FIGURE 5 is a vertical transverse cross-section taken along line **5—5** of FIGURE 4 and illustrating the mold in the process of forming an arcuately shaped log;

FIGURE 6 is a perspective view of a log produced by the mold of FIGURE 4;

FIGURE 7 is a perspective view illustrating die apparatus suitable for impressing the central depression in a blank for a core of the present invention;

FIGURE 8 is a perspective view of an individual core blank cut from the log of FIGURE 6 and having the central depression impressed therein; and

FIGURE 9 is a perspective view of the blank of FIGURE 8 following the conversion thereof into a core in condition to be incorporated in the napkin of FIGURE 1.

Referring to FIGURE 1, there is shown a sanitary napkin having a preformed, arcuately-shaped core **11**, herinafter described in greater detail, which has a moisture impermeable film **12** extending continuously across the lower surface of the core and upwardly along both longitudinal edges thereof. A fleece wrapping **13** (i.e., a thin, soft, compliant, absorbent, fibrous batt) is applied to the core **11** and film **12**, and, as shown, can be a single thickness around the lower portion of the napkin while overlapped along the top surface therof. A fabric **14** surrounds the wrapped, film-covered core, maintaining the elements properly in the assembly and having end extensions **14*a*** and **14*b*** by means of which the napkin is affixed to a sanitary belt. While the described combination of elements is a preferred construction of a napkin employing the embodiment of core **11** shown, it will be understood that the film **12**, wrapping **13**, or fabric **14** can be omitted or arranged in various other ways whereby the napkin will derive the benefits of a core of the present invention. In this connection, it is feasible to use the core alone as the sanitary napkin, securing the same in position in use by pinning it to an undergarment, for example.

The film **12**, if used, can comprise any suitable and compliant moisture impermeable membrane. It has been found that one-half mil polyethylene film having a length approximating or somewhat less than that of the core **11** and a width which equals the total of the width of the core **11** plus twice its center thickness (in the embodiment described, about 8" x 4") performs satisfactorily in use. When used with a core having reduced width and/or thicknesses in certain portions, the film **12** can be tapered or configured as necessary to compensate for such variations so as to make the side edges thereof align generally with the side edges of the upper surface of core **11**.

The fleece **13** as a wrapping which can be applied in order to impart softness to the napkin. The fleece has the ability to stretch in all directions and gives the napkin a smooth yet fluffy surface, thus also imparting a better appearance to the product. The fleece can comprise rayon, cotton, or other natural or man-made absorptive fiber which is formed into a batting of about ⅛" thickness by being, for example, carded or garnetted. The batting may be randomly laid, straight lapped, cross-lapped and needle punched, if desired. It has been found that fleece having dimensions sufficient to surround the core **11** with a full overlap on the top surface and weighing approximately two grams perform satisfactorily. Alternatively, the fleece can be applied only to the bottom and sides of the core **11** or omitted entirely, if desired.

The fabric **14** is an overwrap which can be about 19" long and has a width sufficient to encircle the transverse section of the napkin with slight overlap permitting the longitudinal edges of the fabric (which extend lengthwise of the napkin) to be united by means of adhesives or by mechanical means. The fabric can be gauze, a knitted scrim or, preferably, a bonded non-woven material which is smooth, soft, porous, liquid permeable, non-pilling and adapted to cover a curved object.

The core **11**, as shown in FIGURES 1, 2 and 3, is somewhat boat-like in configuration and is a fibrous, unified structure which contains a network of void spaces or openings to provide high absorbency. Interconnections among the openings exist such that fluid is conveyed by capillary action through the network. These interconnections or "capillaries" control the rate of fluid transmission (wicking) from one area of the core to another. The upper and lower surfaces of the core **11** are upwardly concave in the longitudinal and lateral directions. The upward lateral concavity does not have to be pronounced and can be virtually imperceptible. In addition, the lateral concavity does not have to be formed by any particular configuration of surface or portion thereof so long as the effect is to make the surface generally upwardly concave, i.e., with the central portion thereof below the level of the portions to either side of it. Preferably, the radius of curvature in the longitudinal dimension of the upper and lower surfaces should be in the range of from about 3½" to about 6", desirably about 4¼". These radii may be adjusted to yield a maximum thickness of the core **11** along the longitudinal central area thereof so that the thickness decreases, tapers, towards the end. The tapered thickness insures greater comfort and is desirable for cosmetic reasons (less showing of the outline of the napkin during use). Although not essential, the rear end of the core **11** can be tapered inwardly so as to present a width which is more comfortable to the user when applied.

Although overall lengths and widths may be varied in accordance with the size of the napkin desired, it has been found that for the "regular" size, a core having a length of approximately 8" along the top surface and a width of about 2¼" to 2½" which tapers at the rear end to a width in the range of from about ¾" to 1" is satisfactory as far as comfort is concerned. This size core advantageously weighs from about 7½ to about 10 grams. It will be understood that for the so-called "junior" size of napkin the weight of the core **11** can be less than about 7.5 grams and that a heavier core, say 10–14 grams, would be preferred for a "super" size or for hospital uses in which absorbent capacity is the dominant consideration. The taper described may commence at a distance of approximately 3" from the rear end and desirably is uniform on each side of the napkin.

The core **11** has a longitudinally extending depression **16** which is impressed in the central portion of the upper surface and preferably spaced from each end of the napkin. For reasons which will become apparent from subsequent description a single elongated depression **16** is preferred; however, a plurality of parallel or aligned depressions can be used to derive substantially the same advantages as the single lines so long as the combined effect of the parallel or aligned depressions is equivalent to the single line. FIGURE 2*a* illustrates a multiplicity of aligned depressions **16*a*** in the top surface of arcuate core **11*a***; FIGURE 2*b* shows a multiplicity of parallel depressions **16*b*** in the top surface of core **11*b***.

When using a single elongated depression **16**, the depression should be long enough to assure that the napkin will flex therealong in use, i.e., either side will pivot as a unit about the depression. The length of the depression **16** is preferably greater than about 3" and is desirably, though not necessarily, shorter than the length of the core **11** to decrease the likelihood of fluid wicking over the napkin ends with resultant end soiling. Its width must exceed about 1/64" and preferably be less than about 30% of the width of the napkin and its depth must be at least about 1/32" but not sufficiently deep to cause the material of the core **11** underlying the depression **16** to be compressed to the extent that it cannot at least partially recover following the formation of the depression **16** in the core **11** in accordance with a process such as the die pressing processes to be hereinafter described. If such material does not partially recover, i.e., re-expand to regain some but not all the bulk it possessed prior to pressing, it will be floppy (i.e., have little or no resistance to lateral flexure) and the fluid holding properties in the depressed area are destroyed. Preferably, the depth of the depression should not exceed about 75% of the core **11** thickness, as measured at an undepressed portion thereof adjacent the depression. If it is desired to use a plurality of depressions such as those shown in FIGURES 2*a* or 2*b*, the comments regarding depth stated above are still applicable. With the aligned depressions of FIGURE 2*a*, the width and length limitations remain as above, only in this case the length referred to is the cumulative or effective length, which preferably should exceed about 3". The interruption in the depressed line (i.e., the distance between adjacent depressions **16*a***) should be small enough, however, preferably less than about 25% of the length of the depression **16*a*** of least length on either side thereof, to prevent interference with the cooperative functioning of the depressions **16*a***. With the parallel depressions **16*b*** of FIGURE 2*b*, the length of each depression should preferably exceed about 3" and the overall (outside) width of the area in which the depressions are made should preferably be less than about 30% of the width of the napkin.

The major benefit derived from the use of the depression **16** in the arcuately shaped core **11** is directed flexure, i.e., conditioning the structure to assure that, when it is laterally compressed in use, the core **11** will assume an upward concave configuration in transverse section. If the core **11** did not incorporate the depression **16** the lateral in-use compression exerted by the user's thighs would eventually deform the core **11** whereby it will assume an upwardly convex transverse cross-section, presenting the same problems of discomfort, run-off, slippage, and smearing previously described. In contrast, due to the described directed flexure, the side edges of a napkin incorporating a core of the present invention, i.e., a unitized arcuately shaped absorptive body which has a depression **16** therein, extend upwardly adjacent the center of movement of the legs of the user, substantially eliminating chafing of the user's thighs and presenting a device highly resistant to run-off, slippage and smearing. The directed flexure also maintains the in-use absorbent capacity of the device at a high level since it is free to yield without subjection to undue overall lateral compression which would result in the reduced in-use capacity generally suffered by napkins which do not possess the directed flexure property. In addition when the depression is impressed as described in the die pressing processes to be hereinafter described, the material comprising the core is more densely compacted below the line of the depression **16** and therefore causes menses being absorbed by the napkin to wick more rapidly longitudinally along the smaller "capillaries" of the compressed area rather than laterally into the "capillaries" of the relatively uncompressed areas.

The dimensions of the depression **16** set forth above are critical in achieving the desired results. If the depression has an effective length which is substantially less than about 3″, then it would not function properly as a line of pivotal movement for the sides of the napkin, and hence, it will considerably reduce the propensity of the napkin to assume the desired transverse upwardly concave configuration. A width of depression produced by an instrument narrower than 1/64″, which is tantamount to the use of a knife edge, would possess none of the advantageous results of the depression **16.** On the other hand, if the depression **16** is wider than about 30% of the total napkin width, this will excessively shorten the moment arm for the pivoting action of the sides of the napkin, since the pivotal action takes place largely at the edges of the depression. Such shortening of the moment arm makes the napkin feel stiff in the lateral direction. Similarly where multiple depressions are used (as in FIGURE 2*b*) if the outside width of the area in which the depressions are made is more than 30% of napkin width, the shorter moment arm is effected. It will be realized that the use of a single depression can give a longer moment arm than that in connection with a plurality of depressions and this is the reason for the preference for the single depression. If the depression **16** is less than about 1/32″ deep it will have no beneficial effect on the performance of the napkin; if too deep, i.e., more than 75% of the thickness of pad **11**, excessive weakening of the core **11** will result and the absorbent capacity of the material of the core **11** below the depression will be reduced.

The core **11** can comprise any highly absorbent material capable of being formed into an integral structure. In one preferred embodiment, the core is constructed of a distended fibrous material prepared in a manner similar to that outlined in U.S. Patent 1,740,280 which issued to Frank L. Bryant on Dec. 17, 1929 for "Distended Fibrous Material and Process for Producing the Same," the disclosure of which is incorporated herein by reference. In such a process, wood fibers, cotton linters, rayon floc, mixtures thereof, or, generally speaking, any fibers which have a range of lengths predominantly from about ½ millimeter to about 7 millimeters and are capable of forming hydrogen bonds can be used. It will be understood that when included in minor amounts fibers as long as ½″ and so short as to have almost negligible leingth can also be used. Such fibers are mixed with solutions containing foam-forming substances and the mixture agitated to cause the solution to become a foam comprising relatively stable bubbles about which the fibers are carried. Then the foam is placed in a mold of the desired shape and dried, thereby effectively removing the bubbles but leaving the fibers secured by hydrogen bonds in the distended condition created by the bubbles. Preferably the dried, distended fibrous material prior to the compressing operation to be described has a density in the range of from about 1.2 to about 1.8 pounds per cubic foot and an absorptive capacity (unstressed) of from about 0.9 to about 1.1 grams of citrated whole blood per gram of distended fibrous material. Capacity is determined by noting the amount of fluid held by the material at the instant of bottom strikethrough following introduction of the liquid into the center of the upper surface of the material at the rate of about one cubic centimeter per minute. Strikethrough occurs when it is observed that the fluid reaches the bottom surface.

In a specific application of the Bryant process, wood fibers, e.g., softwood papermaking fibers (which have lengths in the range of from about ½ millimeter to about 7 millimeters), were placed in slurry form in a mixing tank. The slurry had approximately 1½% consistency, i.e., 1½ pounds of fiber per 98½ pounds of water. The slurry was agitated sufficiently to assure proper fiber separation and homogeneity of the slurry. Then a foaming agent was added to the slurry.

The foaming agent to be used can be any surfactant capable of forming a foam throughout the slurry and can, for example, be any synthetic detergent (including anionic, nonionic, cationic, amphoteric, ampholytic and zwitterionic detergents) which possesses good foaming properties. The preferred foaming agents are higher fatty acid soaps, anionic organic synthetic detergents, phosphine and amine oxides and fatty acid amides. Anionic synthetic detergents can be broadly described as the water-soluble salts, particularly the alkali metal salts of organic sulfuric reaction products having in their molecular structure an alkyl radical containing from about 22 carbon atoms and a radical selected from the group consisting of sulfonic acid and sulfuric acid ester radicals. The term alkyl includes the alkyl portion of higher acyl radicals. Examples of such anionic synthetic detergents are: the sodium alkyl sulfates, especially those obtained by sulfating the higher alcohols (C_8–C_{18} carbon atoms) produced by reducing the glycerides of tallow or coconut oil; sodium or potassium alkylbenzenesulfonates, in which the alkyl group contains from about 9 to about 15 carbon atoms; sodium alkyl glyceryl ether sulfonates, especially those ethers of the higher alcohols derived from tallow and coconut oil; sodium coconut oil fatty acid monoglyceride sulfates and sulfonates; sodium or potassium salts of sulfonated alpha olefins; sodium or potassium salts of sulfuric acid esters of the reaction product of one mole of a higher fatty alcohol (e.g., tallow or coconut oil alcohols) and about 1 to 6 moles of ethylene oxide; sodium or potassium salts of alkyl phenol, ethylene oxide ether sulfate with about 1 to about 10 units of ethylene oxide per molecule and in which the alkyl radicals contain about 9 to about 12 carbon atoms; the reaction product of fatty acids esterified with isethionic acid and neutralized with sodium hydroxide, where, for example, the fatty acids are derived from coconut oil; sodium or potassium salts of fatty acid amide of a methyl tauride in which the fatty acids, for example, are derived from coconut oils; and others known in the art, a number being specifically set forth in United States Letters Patent Nos. 2,486,921, 2,486,922 and 2,396,278.

Amine oxides correspond to the following general formula, $R_1R_2R_3N \rightarrow O$ wherein R_1 is an alkyl radical of from about 8 to 18 carbon atoms and R_2 and R_3 are each methyl or ethyl radicals. The arrow in the formula is a conventional representation of a semi-polar bond. Examples of such amine oxides include dimethyldodecylamine oxide, dimethyloctylamine oxide, dimethyldecylamine oxide, dimethyltetradecylamine oxide and dimethylhexadecylamine oxide. Phosphine oxides are described in British Patent 995,260, dated Mar. 19,1962.

Fatty amides have the chemical formula

$$R{-}CO{-}N\begin{matrix} \diagup X \\ \diagdown Y \end{matrix}$$

in which R—CO— is an aliphatic acyl radical, preferably of a higher fatty acid, having from about 10 to 20, and preferably about 12 to 16 carbon atoms, and X and Y may each be selected from the group consisting of hydrogen, and alkyl and alkylol radicals of 1 to about 5 carbon atoms each, and preferably about 2 carbon atoms. Specific examples of such fatty amides are: palmitic monoethanolamide, myristic monoethanolamide, lauric monoethanolamide, oleic monoethanolamide, myristamide, lauramide, stearamide, lauric diethanolamide, and amide-type mixtures prepared from mixtures of higher fatty acids derived from various fats, oils, and waxes of animal, vegetable or marine origin.

Continuing the specific example started above, when linear sodium dodecylbenzene sulfonate was employed as the foaming agent, this was used in an amount of about 700 parts per million parts of slurry. Next, the mixture was vigorously agitated so as to uniformly mix the fibers and develop a foam. Such agitation was continued until the foam ratio (the ratio of the final volume of foam to the initial volume of slurry) was 3 to 1.

The foam produced by the agitation was then placed in a device adapted to form the foam as desired, for example, the foraminous mold illustrated in FIGURE 4. This mold comprises two portions, upper mold section **17** and lower mold section **18**. The sections **17** and **18** are quite similar in construction, the only significant difference being that the upper section **17** is designed to telescope within the lower section **18**. The sections each have a pair of end panels **19**, the lower edge of each of which is formed with a radius of curvature based on the curvature ultimately desired for the core **11** (taking into consideration loss of some curvature during subsequent processing steps to be described) and the other edges of which are rectilinear. The end panels **19** of section **18** can be provided with a stop **19***a* to limit or adjust the extent of telescoping movement of section **17** in section **18**.

Side panels **21** of elongated rectangular configuration lie intermediate the end panels **19**, being affixed to corresponding sides thereof to form a frame-like assembly. The lower edges of the side panels **21** and the curved lower edges of end panels **19** of each mold section define an upwardly concave peripheral support surface along which is attached a screen member **22**. The securement of the side and end panels to one another and of the screen **22** to the frame-like assembly may comprise gluing, welding, nailing, soldering, or any other means well known in the art for fastening the types of materials from which the parts are made (which could, for example, be metal, plastic or wood). Note that by using the same radius of curvature on all the end panels and therefore on both screen members **22**, as shown in FIGURE 5, the distance therebetween at the centers of the screens will be greater than that at the ends. This provides the desired tapered thickness of the cores produced in the mold.

The screen members **22** are preferably in the range of from about U.S. Standard 4 mesh to about U.S. Standard 60 mesh. In this connection, the screen opening should not be too large in order to avoid loss of fibers through the screen, "stapling" of fibers over the wires of the screen and excessively rough surface in finished pads. On the other hand, the mesh should not be so small as to impede drainage of liquid through the screen. In any event, the size of the mesh used controls, to some extent, the surface texture of finished pads. As shown, the screen **22** of lower section **18** is constructed of mesh which is smaller than that of the screen **22** of upper section **17**.

With the upper mold section **17** removed from the lower section **18**, the foam was poured into the lower section **18** to a vertical thickness of approximately 4". At this point water drained through the screen **22** of lower section **18**. When the foam drained sufficiently to raise the consistency thereof to about 8% (8 pounds of fiber per 92 pounds of water), the upper mold section **17** was telescoped within the interior of lower mold section **18** and slowly pressed downwardly on top of the foam until a vertical foam thickness of approximately $1\frac{3}{4}$" was present in the center of the mold. Next, further draining was permitted until the foam reached a consistency of approximately 10%, i.e., 10 pounds of fiber per 90 pounds of water (or alternatively, the drying step described below can be directly performed).

Then the foam in the mold was oven dried to produce the distended fibrous material desired. In this connection, the foam can be exposed to temperatures up to about 300°, with the range of from about 275° F. to about 300° F. and the use of flowing air preferred to accelerate the drying. It should be noted, however, that the foam cannot be left too long at the high end of such a temperature range since cellulose degradation starts at about 284°. In this way the distended fibrous material was brought to approximately bone dry condition as a unified structure. The foam-forming substance, the linear sodium dodecylbenzene sulfonate, which did not drain out with excess liquid prior to drying remains incorporated throughout the mass of distended fibrous material as a residue and amounts to about 0.5% to about 1.0% by weight of fiber. This will vary somewhat if the process example described is changed; for example, if the concentration of foam forming substance and/or the type of fiber are changed. Then the molded product, the log **23** illustrated in FIGURE 6, is removed from the mold.

FIGURE 5 illustrates the general arrangement of the upper and lower sections **17** and **18** of the mold during the final portion of the molding operation and the way in which the arrangement of fibers is affected in the foam when the screens **22** approximate as the upper mold section **17** telescopes within lower mold section **18**. This pressing action causes a skin-like arrangement of the fibers to form along the upper and lower surfaces of the log **23**. In many respects the skin **31** formation is similar to that described in U.S. Patent 1,841,785 which issued to Frank L. Bryant on Jan. 19, 1932 for "Method of Making Layers of Distended Fibrous Materials." While it is preferred to have both an upper and lower skin, one or both of the skins may be eliminated or made so thin as to be negligible.

The skins are densified layers of fibers which can be of sufficient thickness to add significant strength to a log **23** comprised of distended fibrous material and thereby provide increased resistance of cores **11** to crumpling, twisting and loss of shape. Excessively thick skins, however, produce undesirable stiffness or rigidity in the core **11**, making napkins constructed therewith uncomfortable. It has been found that a range of skin thickness of from paper thickness (i.e., about .001") to about $\frac{3}{32}$" is desirable while the preferred thickness within that range is from about $\frac{1}{32}$" to about $\frac{1}{16}$". The thickness of the skin can be controlled by varying the rate and amount of pressure applied during molding and by changing the consistency and/or the foam ratio of the foam. In addition, it has been found that earlier pressing accentuates the skin. Vacuum can be employed to supplement the pressing action applied to the foam between the screens **22** of the mold sections **17** and **18** if a thicker skin is desired.

Referring to FIGURE 6, the log **23** is the source of a multiplicity of blanks **24** cut transversely of the log whereby the length of each blank **24** extends in the direction of the curve imparted to the log **23** by means of the arcuate conformation of screens **22**. The blanks **24** can be separated by any convenient means such as band saw type cutters or the like. It will be noted that the log **23** has a screen-like pattern **29** formed on its upper surface by screen member **22** of mold section **17**. Although it is not shown, a similar pattern is formed on the lower surface by screen member **22** of mold section **18**.

From what was previously said, it will be understood that each blank **24** made in accordance with the processes described in approximately 2¼" to 2½" wide, has an inside (top) length of approximately 8" and a center thickness of about 1¾". These dimensions can be varied as desired, within a range of sizes acceptable for use in sanitary napkins, but do represent the measurements of a core **11** blank of distended fibrous material which has been found to be satisfactory.

Each of the blanks **24** is placed between a pair of dies such as that illustrated in FIGURE 7, wherein reference numeral **26** denotes the male die half and **27** the female die half. The male die half **26** has protruding from the surface thereof, a rib **28** having the approximate dimensions desired for the depression **16**. For example, the rib **28** can be about 4½" long, $\frac{1}{16}$" to ⅛" wide and approximately $\frac{1}{16}$" to ⅛" deep. The die halves **26** and **27** and the rib **28** are each curved, the radius of curvature thereof preferably being somewhat smaller than that desired in the finished core **11**, e.g., if a core having a 4½" radius of curvature is desired, a radius of curvature of approximately 3½" can be used on the dies to allow for subsequent relaxation or loss of curvature of the core **11**.

Following the placement of the blank **24** between the dies, the die halves are moved toward one another and the blank compressed therebetween. The amount of pressure exerted and rate of pressure application on each core will vary depending upon the blank size, the size and shape of the rib **28** and the result desired. Too little pressure results in insufficient lateral flexibility of the core and too much pressure causes loss of body, insufficient resistance to lateral flexure and ultimate fracture below the depression **16**. With a blank **24** made as described above and employing dies having a rib **28** of the dimensions previously described, a total force of approximately 2000 pounds is placed on the intervening blank **24** and the resulting product after release of pressure is as shown in FIGURE 8, wherein the blank **24** has been reduced in thickness to a range of from about ¾" to about ⅞", and the top surface thereof retains the depression **16**, the impression made by the rib **28**. At this point the distended fibrous material made preferably has a density of about 2.0 to about 3.0 pounds per cubic foot and an absorptive capacity of about 1.3 to about 1.5 grams citrated whole blood per gram of core, in accordance with the previously described procedure.

Either before or after the compressing operation the tapered rear end portion of the core **11** can be produced, if desired, by trimming the excess material from the blank **24** by any convenient means, e.g., cutters, saws, or the like. At the same time it is desirable to remove a portion of the upper and lower skins, if present, near the edges, so that the relatively stiff portions of the core become spaced from the edge of the napkin in use. Such removal may be accomplished, for example, by the use of an abrasive wheel having a coarse, outwardly facing, concave annular abrading surface. The abrading surface is passed along the periphery of the blank, producing a rounded edge as illustrated in FIGURE 9, and can, if desired, also be used to form the taper concurrently therewith instead of performing the operations separately. Following trimming, the core **11** can be flexed mechanically or by hand to preliminarily soften the core prior to assembly.

The napkin described is assembled as shown in FIGURE 1 by first placing the film **12** along the sides and bottom of the core **11**, enwrapping the film and core with the fleece **13**, encircling the fleece-covered core with the fabric **14** and adhesively attaching the overlapped longitudinal edges of the fabric. This assembly can be performed by machinery which forms no part of the present invention and therefore is not described or, alternatively, may be performed quite adequately by hand. For greatest softness, the completed napkin is worked, i.e., by flexing either by hand or mechanically.

When employing the type of core described above, the depression **16** is impressed in the longitudinally arcuate upper skin **31**. Because of its attachment at a multiplicity of points to the inside of the core, the upper skin **31** is stressed, pulling the sides of the napkin up and the ends inwardly. This same action will occur, although less pronounced, if the core **11** is made a skinless distended fibrous material since in this case the stresses on the unified structure of the core itself produce the desired lateral concavity. The upward lateral concavity of the core **11** is present before use, although it can be virtually imperceptible, and, in combination with the depression **16** which provides a hinge line, controls the direction in which the sides will move when pressed inwardly in use, viz, the side edges move upwardly instead of downwardly as is the usual case with sanitary napkins. This is the directed flexure property previously described which greatly increases the comfort and comformability of the napkin for the user and provides for a self-adjusting width during use without the otherwise compressive deformation which would reduce absorbent capacity. Also due to the impressed depression of the described core, the central longitudinal portion of the core is densified and provides an incidental benefit, flow direction control, which helps to provide the fuller utilization of the absorptive capacity of the core. Although this latter aspect contributes to the increase in in-use capacity, the bulk of the increase is attributable to directed flexure property which provides a more efficient vehicle for the collection and retention of the menses and resists run-off, slippage and smearing.

Although the dry distended fibrous material described above with reference to the Byrant patent is a preferred material for the absorptive core of this invention, the core can also be formed by other means which provides the desired integrated longitudinally arcuate shape in absorptive fibrous material suitable for use as an absorptive element in sanitary napkins. The core can, for example, be formed from a bonded airfelt material, i.e., and air-laid fluff or felt comprising air-deposited, adhesive-bonded fibers, various apparatus and methods of production of which are well known in the art. One specific example of the various means for forming the material from which the blank can be later cut is disclosed in U.S. Patent 2,940,134, issued to C. C. Heritage on June 14, 1960 for "Dry Felting Apparatus and Process." The bonded airfelt can also be produced by spraying a binding material, e.g., a resin dispersion, on individual fibers during the felting process. In connection with the latter felting technique, there are many ways of producing such material; for example, the methods described in connection with the formation of a sliver or mat in Canadian Patent 642,566 which issued to Robert W. Johnson, Jr., et al. on June 12, 1962 for "Catamenial Napkin" and in Williams, U.S. Patent 1,961,272, issued June 5, 1934 for "Felting Machine." The disclosures of the above-mentioned Heritage, Johnson et al. and Williams patents are incorporated herein by refernce. Both the process used and the adhesive employed are matters which are not critical to this invention so long as the integrated structure produced is suitable for use in a sanitary napkin. For example, the bonding substance can be a thermoplastic or thermosetting resin, and can be solvent (including water) soluble or insoluble. In this respect, the substance can be starch, melamine formaldehyde, sodium carboxymethylcellulose, or other bonding material.

A flat mat of airfelt is formed about 3″ in thickness, molded, dried (if necessary), and cut into blanks having the same curved configuration as blank **24**. During the molding process the flat mat is placed between male and female mold halves which impart the curvature to the mat and reduce its thickness to approximately 1¼″ to about 2½″. Such operations are all well known by those skilled in the art and are therefore not described in detail. The airfelt blank should be approximately the same dimensions and weight as the distended fibrous material blank described above.

The airfelt blank is then cut to shape and a depression corresponding in all respects to depression **16** previously described is impressed in the top surface thereof by a die similar to that illustrated in FIGURE 7. The impressing operation further reduces the thickness of the blank to the desired range; for example, to the thickness of from about ¾″ to about ⅞″. Where the airfelt is made of pulp fibers, e.g., the softwood papermaking fibers previously described, bonded with about 1% by weight of a medium viscosity sodium carboxymethylcellulose (having a degree of substitution of between about 0.65–0.85) such as the material known as CMC 7M (product of Hercules Powder Company), for example, it has been found satisfactory to use a total force of about 1000 pounds applied to the blank by the dies. In this case the density of the core also preferably ranges from about 2.0 to about 3.0 pounds per cubic foot and the absorptive capacity thereof is preferably about 1.3 to about 1.5 grams of citrated whole blood per gram of core, in accordance with the previously described procedure. Following the impressing operation, the assembly of the napkin proceeds exactly as set forth above in connection with the distended fibrous material core.

Due to the specific integrated structure of the bonded airfelt core and the provision of the recess in the top surface thereof, such an airfelt core possesses the same attributes and advantages as the distended fibrous material core **11** described previously, viz directed flexure with its resultant comfort, resistance to run-off, slippage and smearing, and increased in-use absorptive capacity. Although the bonded airfelt type core does not have skins such as those of the other (distended fibrous material) core, it does have the depression in an integrated or unitary arcuately shaped structure and this is the basic requirement necessary to achieve the above advantages in such structures.

Many modifications of the above invention may be used and it is not intended to hereby limit it to the particular embodiments shown or described. The terms used in describing the invention are used in their descriptive sense and not as terms of limitation it being intended that all equivalents thereof be included within the scope of the appended claims.

What is claimed is:

1. A sanitary napkin comprising an absorptive, preformed longitudinally and laterally arcuately-shaped core of unitary structure throughout, said core having an upper surface and a lower surface which are each upwardly concave along longitudinal and lateral lines, said core having in said upper surface a centrally located longitudinally extending depression of narrow width and having a depth which is at least about 1/32″ whereby to cause said napkin to assume a lateral upwardly concave conformation when worn.

2. The sanitary napkin of claim **1** in which the portion of the core below said depression is more densely compacted than other portions of the core.

3. The sanitary napkin of claim **2** in which said depression has an effective length of at least about 3″ and a width of between about 1/64″ to about 30% of the width of said napkin.

4. The sanitary napkin of claim **3** in which said depression is spaced from each end of said core.

5. The sanitary napkin of claim **1** in which said core comprises a dried, molded distended fibrous material.

6. The sanitary napkin of claim **5** in which the upper and lower surfaces of said core are in the form of densified integrally molded skins of said fibrous material.

7. The sanitary napkin of claim **6** in which the portion of the core below said depression is more densely compacted than other portions of the core.

8. The sanitary napkin of claim **6** in which said skin has a thickness in the range of from about 1/1000″ to about 3/32″.

9. The sanitary napkin of claim **1** in which said core comprises a bonded airfelt material which is maintained in unitary condition by means of a bonding substance.

10. The sanitary napkin of claim **9** in which the portion of the core below said depression is more densely compacted than other portions of the core.

11. The sanitary napkin of claim **10** in which said depression has an effective length of at least about 3″ and a width in the range of from about 1/64″ to about 30% of the width of said napkin.

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