

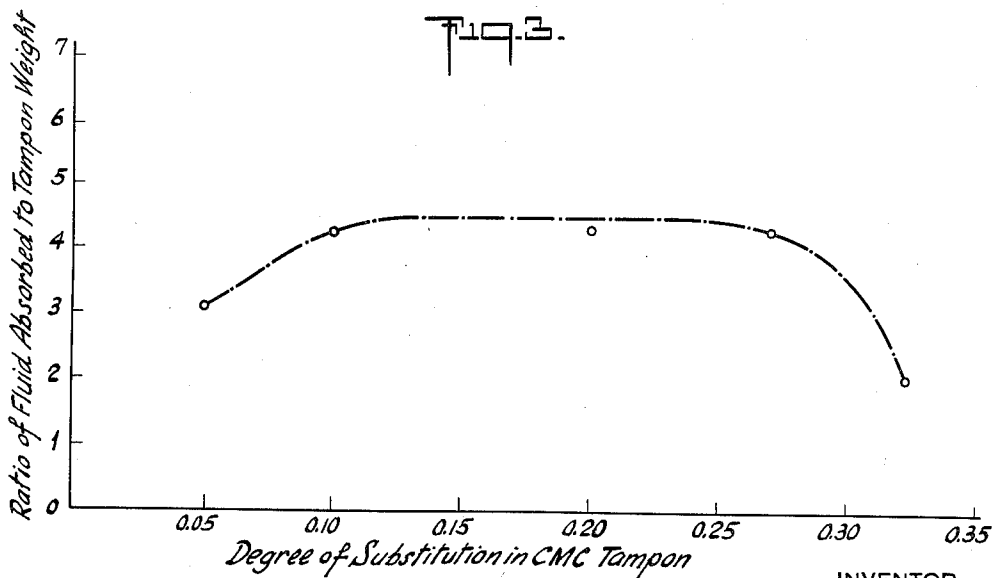
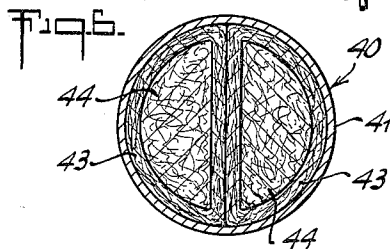
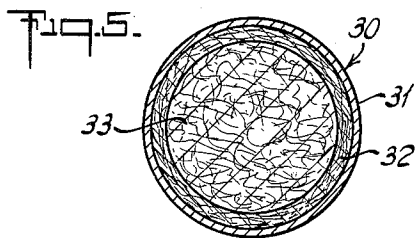
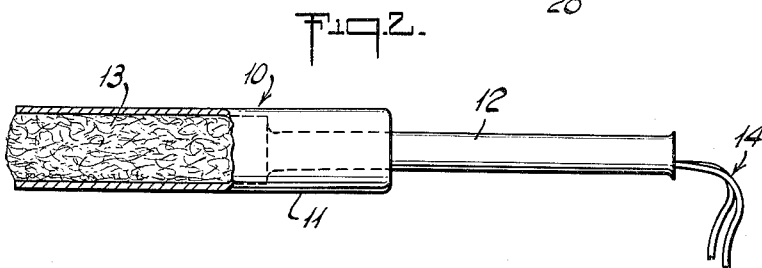
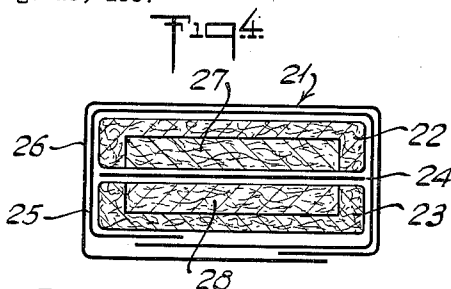
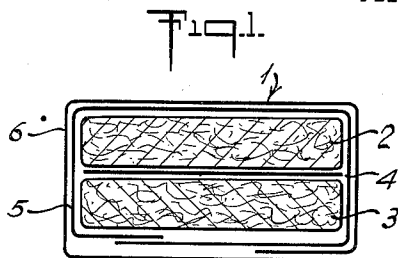
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G. C. GRAHAM, JR

3,055,369

ABSORBENT PRODUCT

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INVENTOR
GEORGE C. GRAHAM JR.
BY
Alexander T. Kardos.
ATTORNEY

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3,055,369

ABSORBENT PRODUCT

George C. Graham, Jr., Colonia, N.J., assignor to Personal Products Corporation, a corporation of New Jersey

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The present invention relates to catamenial devices of improved absorbency and to methods of making the same. More specifically, the present invention is concerned with catamenial napkins and tampons having greater fluid absorptive capacities than are possessed by presently-used cellulosic catamenial devices.

Catamenial devices presently in use depend primarily for their efficiency upon the capacity of their fibrous absorptive pad portions to receive, absorb and retain menstrual fluids. These fibrous pad portions are normally made of cellulosic materials, notably wood pulp, paper, cotton, rayon, or blends and mixtures thereof, which possess relatively excellent absorptive characteristics and properties. Notwithstanding such characteristics and properties, however, the efforts to increase the absorptive capacities of such materials are many and varied.

For example, larger and bulkier tampons and napkins have been manufactured and possess greater absorptive capacities but are not fully acceptable inasmuch as the increased size and volume have caused irritation and discomfort, particularly in the case of catamenial tampons. Other efforts have been directed to the use of more highly compressed catamenial devices by using greater pressures on the fibrous materials during the processing and manufacturing of these sanitary devices whereby greater masses of fibers can be contained within normal or regular sizes and theoretically absorb and hold more fluid. Such efforts, however, have similarly not met with complete success. All in all, a great deal of effort has been expended toward the development of improved absorbent bodies but there still remains considerable room for improvement.

It is therefore a principal object of the present invention to provide a catamenial device of improved absorbency without necessarily requiring greater amounts of absorbent fibrous materials or the use of greater pressures during the manufacturing of such devices.

It has been found that the use of a modified cellulosic product, namely a salt of a carboxyalkyl cellulose, such as carboxymethyl cellulose or carboxyethyl cellulose, in such catamenial devices creates enhanced fluid absorptive capacities therein, provided the average degree of substitution of the carboxyalkyl radical in the cellulose molecule is maintained within controlled limits and is not permitted to exceed specified values to be described more fully hereinafter.

Catamenial devices containing such modified cellulosic materials are disclosed and claimed in my copending patent application Serial No. 595,716, filed July 3, 1956, now Patent No. 3,005,456, of which this application is a continuation-in-part.

It has been observed, however, that such catamenial devices occasionally show a tendency to shed or slough fibers during use whereby the possibility of such loose

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fibers remaining in the body cavity after removal is thus created. This, of course, is wholly undesirable and unsanitary, inasmuch as it provides a source for the development of odors and leads to body irritation and personal embarrassment.

It has now been found that such objectionable characteristics may be avoided by positioning the modified cellulosic materials primarily or completely in the center or core of such catamenial absorbent devices and providing thereabout an outer wrapping or sheath of unmodified cellulosic or other fibers, such as nylon, "Orlon," saran, "Dacron," etc.

Such positioning leads to an advantageous feature of the present invention in that the centrally located modified cellulosic materials, due to their greater absorptive capacity, form an internal reservoir for fluids deposited on the catamenial device and permit the outer wrapping or sheath to remain relatively dry. This, of course, is due to the excellent transmissibility of fluid through the fibrous sheath to the modified cellulosic core and its absorption and retention threat.

In the accompanying drawings and following specification, there are illustrated and described preferred designs of articles of manufacture embodying the present invention, but it is to be understood that the inventive concept is not to be considered limited to the constructions disclosed except as determined by the scope of the appended claims.

Referring to the accompanying drawing:

FIGURE 1 is a cross-sectional view of a sanitary napkin, containing the improved absorbent pad of the present invention;

FIGURE 2 is a cut-away view in elevation of a catamenial tampon containing an improved absorbent pad of the present invention;

FIGURE 3 is a graph showing the fluid absorptive capacities of a carboxymethyl cellulose tampon of the present invention;

FIGURE 4 is a cross-sectional view of a sanitary napkin, similar to that disclosed in FIGURE 1 but showing a modified cellulosic core and a fibrous sheath;

FIGURE 5 is a cross-sectional view of a catamenial tampon similar to that disclosed in FIGURE 2 but showing a modified cellulosic core and a fibrous sheath; and

FIGURE 6 is a cross-sectional view of a modification of the catamenial tampon shown in FIGURE 5.

In the embodiments of the invention shown in the drawing and with particular reference to FIGURE 1, a sanitary napkin 1 comprises an upper fibrous absorptive pad 2 and a lower fibrous absorptive pad 3 which are separated by a water repellent tissue layer 4. Both pads 2, 3 and the layer 4 are folded within an envelope 5 made of paper, non-woven material, or similar material, which, in turn, is wrapped within an external textile cover 6 of a non-woven material or of a woven material such as gauze. The textile cover 6 has a length greater than the other elements above-recited and extends beyond the ends thereof to form fastening or pinning tabs (not shown) to position the napkin in place to conform to the body contours of the user and to receive, absorb and retain catamenial fluids. This structure is exemplary of a form of sanitary napkin in commercial use and is employed to illustrate the invention. It should be realized, however, that such

is not to be construed as limitative of the broader aspects of the present invention.

In FIGURE 2, there is illustrated a catamenial device or tampon **10** comprising a hollow cylindrically-shaped container or applicator **11** and a smaller plunger or ejector **12**, slidably positioned within the applicator **11**. A fibrous absorbent pad **13** is positioned within the applicator **11** and is adapted to be slidably ejectible therefrom by movement of the plunger **12** into the applicator **11** so as to be positioned in a body cavity to conform to the body contours of the user and to receive, absorb and retain catamenial fluids. A withdrawal string or cord **14** is secured preferably to the base of the tampon and is of sufficient length that the free end thereof extends outwardly of the body cavity for withdrawal of the tampon after use. This structure, similarly, is exemplary of a form of catamenial tampon in commercial use and is employed primarily to illustrate the invention. It should be realized, however, that such is not limitative but merely illustrative of the invention.

The fibrous absorptive pad portions **2** and **3** of the sanitary napkin **1** are normally manufactured from a fluffed modified cellulosic wood pulp product wherein the average lengths of the cellulosic fibers are relatively short, usually less than $\frac{1}{2}$ inch, and are not capable of being processed by standard textile equipment, such as a card. On the other hand, the fibrous absorptive pad portion **13** of the tampon **10** comprises absorbent modified cellulosic fibers having an average fiber length of at least about $\frac{1}{2}$ inch and up to about $2\frac{1}{2}$ inches or longer and are capable of being processed by standard textile equipment (such as a card) into the desired forms and shapes.

In FIGURE 4, a sanitary napkin 21 is shown comprising an upper fibrous sheath 22 and a lower fibrous sheath 23 which are preferably cellulosic in nature but which may comprise other fibrous materials. These sheaths are separated by a water repellent tissue layer 24. Both sheaths 22 and 23 are folded within an envelope 25 made of paper, non-woven material, or similar materials which, in turn, is wrapped within an external textile cover 26 of non-woven material, or of a woven material such as gauze.

A centrally located fibrous absorptive pad or core 27 is located within the upper sheath 22 and a centrally located fibrous absorptive pad or core 28 is located within the lower sheath 23. It will be apparent from a consideration of such construction that fluids deposited on the outer surfaces of the sanitary napkin will be transmitted through the sheaths 22, 23 into the cores 27, 28, thus forming a reservoir thereat while leaving the outer surfaces of the sanitary napkin comparatively dry.

In FIGURE 5, a cross section of a catamenial tampon 30 is shown comprising a hollow cylindrically-shaped container or applicator 31, an outer annular cellulosic sheath 32 and a centrally located fibrous absorptive pad 55 or core 33. Such a construction is capable of being manufactured in many ways. A flat strip of the absorptive pad portion may be placed upon a slightly wider flat strip of the sheath portion and rolled into the circular shape shown. Another way is to prepare the cylindrical core 60 first and then helically wrap or wind the strip sheath thereabout in a subsequent operation.

The thickness of the sheath 32 or the other sheaths disclosed herein may be varied within relatively wide limits but should be sufficiently thick so that it adequately covers the core and effectively prevents slough-off of loose fibers of the core during use. The sheath, however, should not be that thick that it reduces the absorbent capacity of the core. Under normal circumstances, it has been found that the sheath comprises from about 10% up to about 85% of the total weight of the catamenial device and preferably from about 20% to about 75%.

The fibers used in the preparation of the sheath are preferably cellulosic, such as cotton, rayon, etc., but may 75

include other natural and synthetic fibers, notably nylon. Synthetic fibers are preferred in the preparation of the sheath inasmuch as longer lengths thereof up to 4 or 5 inches or even longer may be used whereby the possibility of fibrous slough-off of the sheath is prevented.

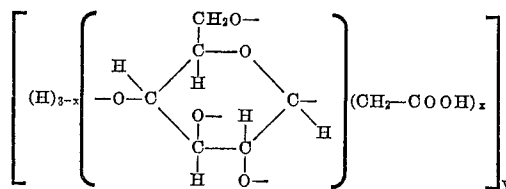
FIGURE 6, a cross section of a catamenial tampon 40 is shown comprising a hollow cylindrically-shaped container or applicator 41. This form of catamenial tampon is initially made similarly to that of FIGURE 5 but is tied in its center with a removal cord, folded in half and then inserted in a container 41. As a result, the sheath is seen in cross-section as two separate contacting semi-annular portions 43, 43 and the core is seen as two separate non-contacting semi-circular portions 44, 44. Consideration of FIGURES 5 and 6 will reveal that the tampons 30, 40, when removed from their containers 31, 41, respectively, and in actual use are capable of receiving fluids deposited on their outer surfaces and transmitting such fluids rapidly through the sheaths 32, 43 into the cores 33, 44, 44 forming reservoirs thereat while leaving the surfaces of the tampon relatively dry.

With particular reference to FIGURE 6 wherein two separate cores 44, 44 are noted, better transfer of fluids is possible from the sheath portion due to the presence of the central cross-portion of the sheath which separates the two cores. This is due most likely to the wicking action exerted by such cross members. Comparison to the form shown in FIGURE 5 indicates the more ready accessibility of all parts of the core to the sheath as shown in FIGURE 6.

The cellulosic fibers of these fibrous absorptive pad portions 2, 3, 13, 27, 28, 33 and 44 are modified according to the present inventive concept within pre-determined limits whereby their fluid absorptive capacities are considerably enhanced. More explicitly, a specified percentage or proportion of the hydroxyl radicals of the cellulose molecule are modified by etherification or carboxyalkylation processes whereby there is obtained a carboxyalkyl cellulosic product having a calculated degree of carboxyalkyl substitution. These products are exemplified by carboxymethyl cellulose and carboxyethyl cellulose.

In the specification terminology, the term carboxymethyl cellulose means carboxymethyl cellulose salts, particularly the sodium salt. Similarly, carboxyethyl cellulose means carboxymethyl cellulose salts, particularly the sodium salt.

The carboxymethyl cellulose which is used to prepare the catamenial devices of the invention may be described structurally as:



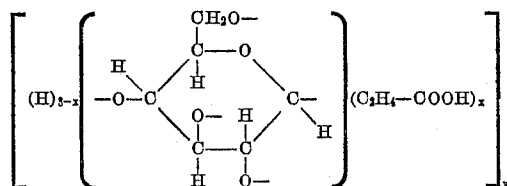
where x is at least equal to 0.03 but not greater than 0.35 and y is a large whole number.

The ring structure represents the anhydroglucose residue which is linked in known manner to similar residues on either side to form a long chain cellulose structure. The bracketed H atoms are attached to side-chain oxygen atoms in the anhydroglucose residue in known fashion. Similarly, the bracketed $-(CH_2-COOH)$ groups are attached to the residue through side-chain oxygen linkages by substituting for the aforementioned H atoms.

The carboxyethyl cellulose which is an alternate to

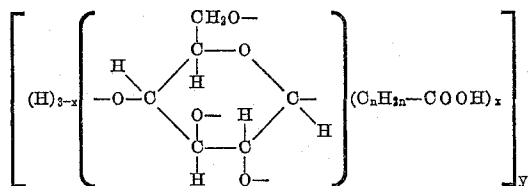
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the carboxymethyl cellulose, may be described structurally as:



x , again, being at least equal to 0.03 but not greater than 0.35 and y a large whole number. The C_2H_4 group is preferably $-\text{CH}_2-\text{CH}_2-$.

The general formula of the materials used to prepare catamenial devices according to the invention is therefore:



where x is at least equal to 0.03 but not greater than 0.35, n is 1 or 2, and y is a large whole number.

The degree of substitution (D.S.), a term commonly employed in connection with cellulose derivatives of the nature used in the invention catamenial devices, is an important property and indicates the average number of substituent groups per glucose unit in the cellulose molecular chain (i.e., the value of x in the above formulae). Since there are originally three hydroxyl groups and hence three possible points of substitution per glucose unit, the maximum degree of substitution is 3. It has been found according to the present invention that the degree of substitution is an important factor in determining the water solubility or insolubility and the absorptive activity of the particular cellulose ether. More specifically, it has been found that, as the degree of substitution increases, the water solubility and the catamenial absorptive capacity increase up to a maximum but then rapidly fall thereafter off to very low values.

Without being bound to the following theory, it is believed that the water insolubility and the increased absorbency is due to the reception and retention of fluids within the individual modified cellulosic fibers in addition to the usual reception and retention of fluids in the capillary spaces between the individual fibers. This phenomenon apparently exists up to a degree of substitution of about 0.35 (approximately one carboxyalkyl radical for every three glucose residues) and surprisingly falls off and disappears when the degree of substitution is increased thereafter.

The graph shown in FIGURE 3 illustrates clearly the striking relationship of the degree of substitution and the fluid absorptive capacity of the resulting tampon. The curve shown in FIGURE 3 is based on the following table.

Table 1

Degree of substitution (CMC):	Fluid absorbed/ tampon weight
0.05 -----	3.12
0.10 -----	4.26
0.20 -----	4.28
0.27 -----	4.33
0.32 -----	2.02

It is quite apparent from the graph that values as low as about 0.03 carboxymethyl substitution show improved results but that values in excess of about 0.35 carboxymethyl substitution markedly decrease the absorptive properties of the materials and consequently render the

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same undesirable for use in catamenial devices. Within the more commercial aspects of the present invention, a range of carboxymethyl substitution of from about 0.05 to about 0.30 has been found preferable. Such figures are based on the values in the table by comparison to equivalent values for cotton absorbency. The tampons used in deriving the values of the above table are the so-called "Super" size, weighing approximately 54 grains (3.5 grams) and having a length of about 1 1/4 inches and a diameter just under 0.6 inch.

The test procedures used in obtaining the values shown in Table 1 are as follows:

The test tampons (dry) comprising carboxymethyl cellulosic fibers having an average fiber length greater than 1/2 inch are measured for length, diameter and weight and are then placed in porous plate Buchner funnels. A resilient rubber surface which snugly fits within the funnel is lowered to contact the tampon and pressure equal to about 24 inches of water is applied to the tampon through the resilient rubber surface. The test fluid (sp. gr. 1.04) is introduced upwardly through the stem of the funnel and just covers the test tampon. Absorption is permitted to take place at the 24 inch water pressure for 5 minutes. The test fluid is then removed and the test tampon is permitted to drain for 1 minute under the 24 inch water pressure. The pressure is then removed and the wet tampon is removed, quickly weighed and the results recorded. Test samples of similar length, diameter and weight tampons of untreated cotton fibers (0% CMC) are tested along with the 5% and 10% carboxymethyl cellulose test tampons and give comparative results of 2.8 and 2.8, as compared to the 3.12 and 4.26 values obtained for the treated test tampons as noted in the table.

The particular process used to introduce the carboxyalkyl radical into the glucose residue in the cellulose may be selected from any of the known processes now used commercially involving the use of cellulose (preferably cotton or fluffed wood pulp in the desired fiber length form), monochloroacetic acid and sodium hydroxide. In the case of the fluffed wood pulp, the only requisite is the introduction of the pre-determined number of carboxymethyl radicals in the glucose residues. In the case of the cotton fibers, however, an additional requirement in the selection of the particular process is the control and ability to introduce up to about 0.35 carboxyalkyl groups per glucose residues in the cellulose without destroying the fibrous structure of the cellulosic materials or reducing the fiber length to less than about 1/2 inch. The products of such processes are available commercially.

It is to be appreciated that, since there is an over-all average of less than one carboxyalkyl group per glucose residue, some individual residues will be unaffected and have no carboxyalkyl groups, whereas others may have one, two or perhaps even three carboxyalkyl groups. Such is undesirable and is of a purely local nature but cannot be avoided due to the nature of the chemical modification.

Additionally, it is not necessary that all of the fibers be exposed to carboxyalkylating treatment inasmuch as it is possible to carboxyalkylate some of the fibers to higher degrees (provided water insolubility is maintained) and then mix, blend, or form layers of the modified fibers with unmodified fibers whereby the necessary over-all average of below about 0.35 substitution is obtained. Blends of 10-90% cotton and 90-10% modified cotton are found particularly advantageous.

Alternatively, it is possible to carboxyalkylate some of the fibers as high as 0.35 and use such fibers in a body as one of the components of an absorptive pad portion, the other components being for example, lesser modified cellulosic fibers, unmodified cellulosic fibers or other cellulosic materials. In such a case, although the degree of carboxyalkyl substitution of the fibers in one component may thus be very high, the over-all average degree of substitution of the complete absorptive pad portion, when you

consider all cellulosic components thereof, may be very low and on the order of 0.02, 0.01 or even lower.

As an example of the blending of unmodified cotton and modified cotton, a 50-50 blend (by weight) of 0.32 D.S. carboxymethyl cellulose and unmodified cotton is employed to make a "Super" tampon having physical dimensions as described previously. Such a tampon, when evaluated by the test procedures disclosed herein, possesses a ratio of fluid absorbed to tampon weight of 4.53.

Additional 50-50 blends (by weight) of 0.30 D.S. carboxymethyl cellulose and unmodified cotton, when manufactured into test tampons and evaluated by the test procedures described herein, yield ratios of fluid absorbed to tampon weights of 4.46, 4.69 and 5.05, for samples having densities of 170, 100 and 85 grains per cubic inch respectively. Similar samples of 100% unmodified cotton manufactured to similar specifications yield ratios of fluid absorbed to tampon weight of 2.6, 3.4 and 3.8 respectively.

Blends are similarly of applicability in the central or core forms of the present invention, although it is to be noted that greater average degrees of substitution are utilizable (provided water-solubility is avoided) where the outermost layer or sheath is unmodified cellulose such as cotton. Such avoids the shedding and sloughing off of the fibers and permits a more rapid transmittal of fluid to the centrally located modified cellulosic core while leaving the outer core relatively dry.

Additional 50-50 blends (by weight) of 0.30 D.S. carboxymethyl cellulose and unmodified cotton, when manufactured into tampon cores and wrapped within long staple cotton sheaths, yield satisfactory ratios of fluid absorbed to total tampon weight (80% core-20% sheath). Substantially no sloughing-off or fiber loss can be detected. Sheaths of rayon staple and nylon staple (average 2½ inch length) are similarly found acceptable. Other tampons having 40% and 60% cotton sheaths with 60% and 40% carboxymethyl cellulose-cotton blends (50-50 0.3 D.S.) by weight are also acceptable, although slight decreases in total absorptive capacity are observed as the proportion of the carboxymethyl cellulose-containing core becomes less.

Although the present invention has been described primarily with carboxymethyl cellulose, it is to be appreciated that carboxyethyl cellulose, such as obtainable from the treatment of the cellulose fibers with sodium hydroxide and monochlorpropionic acid, instead of monochloracetic acid, is also applicable within the more general aspects of the present invention.

If desired, the modified cellulosic fibers, either by themselves or in blends or layers with unmodified cellulosic fibers, may be mixed with other fibers to obtain special characteristics and properties. Such other fibers include rayon (regenerated cellulose), cellulose esters (cellulose acetate), vinyl fibers ("Vinyon"), acrylic fibers ("Orlon," "Acrilan"), vinyl-acrylic fibers ("Dynel"), nylon, saran and "Dacron" polyester fibers. It is to be noted that such fibers, if they are to be used in sanitary napkins in conjunction with fluffed wood pulp, may be very short. On the other hand, if such fibers are to be used in tampons in conjunction with cotton staple of greater length, they should have an average length of at least about ½ inch so that they will be capable of being processed on standard textile apparatus and equipment.

While I have shown and described what I believe to be a preferred embodiment of the invention in the matter of simplicity of construction, ease of utilization, etc., it will be appreciated that the details of such construction may be more or less modified within the scope of the claims without departure from the principles of the construction or material sacrifice of the advantages of the preferred design.

I claim:

1. A catamenial device of improved absorbency comprising a self-supporting, disposable body containing an

inner core portion of absorbent cellulosic fibers having an average degree of carboxyalkyl substitution of from about 0.03 to about 0.35 carboxyalkyl group per glucose residue in the cellulose, said carboxyalkyl groups being in the form of a salt, and an outer sheath portion of fibers having greater fluid transference ability and lesser absorptive capacity than said core; and means associated therewith to position said body of fibers for the reception, absorption and retention of catamenial fluids.

2. A catamenial device as defined in claim 1 wherein the carboxyalkyl group is carboxymethyl.

3. A catamenial device as defined in claim 1 wherein the carboxyalkyl group is carboxyethyl.

4. A catamenial device as defined in claim 1 wherein the cellulosic fibers are cotton.

5. A catamenial device as defined in claim 1 wherein the cellulosic fibers are fluffed wood pulp.

6. A catamenial device of improved absorbency comprising a self-supporting, disposable body containing an inner core portion of absorbent cellulosic fibers having an average degree of carboxyalkyl substitution of from about 0.03 to about 0.35 carboxyalkyl group per glucose residue in the cellulose, said carboxyalkyl groups being in the form of a salt, and an outer sheath portion of chemically unmodified cellulosic fibers; and means associated therewith to position said body of fibers for the reception, absorption and retention of catamenial fluids.

7. A catamenial device of improved absorbency comprising a self-supporting, disposable body containing an inner core portion of absorbent cellulosic fibers having an average fiber length of from about ½ inch to about 2½ inches, said cellulosic fibers having an average degree of carboxyalkyl substitution of from about 0.03 to about 0.35 carboxyalkyl group per glucose residue in the cellulose, said carboxyalkyl groups being in the form of a salt, and an outer sheath portion of chemically unmodified cellulosic fibers; and means associated therewith to position said body of fibers for said reception, absorption and retention of catamenial fluids.

8. A catamenial device of improved absorbency comprising a self-supporting, disposable, substantially cylindrical body containing an inner core portion of absorbent cellulosic fibers having an average fiber length of at least about ½ inch, said cellulosic fibers having an average degree of carboxyalkyl substitution of from about 0.03 to about 0.35 carboxyalkyl group per glucose residue in the cellulose, said carboxyalkyl groups being in the form of a salt, and an outer sheath portion of chemically unmodified cellulosic fibers, a tubular member containing said cylindrical body of cellulosic fibers, and a plunger telescopically associated with said tubular member to eject said cylindrical body of fibers from said tubular member and position the same in a body cavity for use therein as a tampon.

9. A catamenial device as defined in claim 7 wherein the carboxyalkyl group is carboxymethyl.

10. A catamenial device as defined in claim 7 wherein the carboxyalkyl group is carboxyethyl.

11. A catamenial device as defined in claim 7 wherein the cellulosic fibers are cotton.

12. A catamenial device as defined in claim 7 wherein the cellulosic fibers are fluffed wood pulp.

13. A catamenial device of improved absorbency comprising a self-supporting, disposable, substantially cylindrical body containing an inner core portion of absorbent cellulosic fibers having an average fiber length of from about ½ inch to about 2½ inches, said cellulosic fibers having an average degree of substitution of from about 0.03 to about 0.35 carboxyalkyl group per glucose residue in the cellulose, said carboxyalkyl groups being in the form of a salt, and an outer sheath portion of chemically unmodified cellulosic fibers; an applicator for containing said cylindrical body of cellulosic fibers; and a plunger to eject said cylindrical body of fibers from said appli-

cator and position the same in a body cavity for use therein as a tampon.

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