METHOD FOR MAKING A CELLULOSIC PRODUCT

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By:...
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This invention relates to a cellulose product, and more specifically to a tampon or other tampon which comprises an absorbent, compressed body of cellulose or other fibrous material or blends of two or more kinds of fibrous material.

The main objects of the invention are to provide a tampon of predetermined size which, when made for catamenial and other fluid absorbing purposes, will be comfortable and efficient in use; to provide a tampon which can easily be inserted into the vaginal canal and which, upon being wetted in the canal, will rapidly expand both crosswise and lengthwise so as to cause the outside surface of the tampon to quickly come into intimate engagement with the walls of the canal to prevent menstrual fluid from flowing along the walls and leaking past the tampon without being absorbed thereby; and to provide a tampon of the character indicated in which the components are securely bound together so as to prevent their separation incident to forces encountered when the tampon has served its purpose and in wet condition is withdrawn from the vaginal canal.

Other objects of the invention are to provide a tampon of the character indicated which is adapted to be made of a substantial proportion of low cost, relatively short fibers and in which tampon such short fibers will be effectively retained; to provide a tampon of the character indicated which may be made at a high rate of production by automatic machinery; and to provide an improved method of making the tampon whereby expansion of the compressed article when wetted will occur substantially according to a predetermined pattern.

Other objects and advantages of the invention will be understood by reference to the following specification and accompanying drawings (3 sheets) in which there is described and illustrated a tampon embodying a selected form of the invention and a method of making the same.

In the drawings:

Figures 1 to 4 inclusive are perspective illustrations of successive steps in the production of an uncompressed body which is subsequently compressed to produce a tampon according to the present invention;

Figure 5 is a perspective illustration of a modification which may be substituted for the structure shown in Figure 4;

Figures 6 to 12 inclusive are more or less schematic representations of successive steps by which tampon bodies such as shown in Figures 4 and 5 are converted into the desired compressed tampons such as shown in Fig. 12. Figures 11 and 12 each include end and side elevations and Fig. 12 is on an enlarged scale;

Figures 13 and 14 are schematic perspective representations of apparatus for carrying out the steps represented in Figures 6 to 12 inclusive; and

Figure 15 is a schematic representation of another means for making a tampon according to the invention.

According to one example of the invention, an absorbent, compressible tampon body is constructed mainly of two elongated absorbent batts 1a and 1b of selected fibrous material, and a wrapper 2. The said batts 1a and 1b are here shown as of rectangular form in both longitudinal and transverse cross section as represented in Figure 1. The batts may be of other forms, especially in transverse cross section, for example circular, semi-circular, wedge or other regular or irregular shape. These batts or pads of fiber may be made of any suitable fibrous material or mixtures of different kinds of fibrous material. For one example, they are desirably made of a mixture of cotton linters and crimped viscose rayon staple fibers in the proportions of about 60% cotton linters and 40% viscose rayon staple fibers (by weight), the rayon fibers having a denier within the range of about 3 to 15. A more detailed disclosure of the uncompressed tampon body shown in Figures 1-4 may be found in the copending application of William H. Burger, Jr., et al., Serial No. 377,198, filed April 9, 1956, which is also assigned to the assignee of the present invention.

Cotton designated by the term “cotton linters,” comprises cotton fibers of short length, usually within the range of 1/4 to about 1/2 of an inch or even less up to about 3/16 of an inch. The viscose rayon fibers are preferably crimped or crinkled and generally of longer lengths, for example from about ¼ of an inch to about ¾ of an inch or more and they are more resilient than the cotton fiber component referred to. The resiliency of the rayon fiber component provides a desirable force which causes re-expansion of the body from compressed condition to which the body will be converted as hereinafter explained. However, other compressed fiber bodies may also exhibit suitable expansive properties for the purpose of the present invention.

Another suitable fiber blend comprises about 50% of chemical wood pulp fibers (often known as “fluff”), 10% of nylon fibers, and 40% of “B-comber” cotton fibers. Other fibers which will form an absorbent body may be used, and natural and synthetic fibers may be used either alone or in blends of two or more kinds. The fibers may be selected according to their lengths or weights, and various lengths of fiber, weights or both, and various kinds or types and grades of cotton and other fibers may be used. Wood pulp fiber is preferably used in the cotton-fiber-like form known as “fluff,” but it may be used in the form of crepe wadding if desired.

The said blend of cotton linters and viscose rayon is a very satisfactory one in that the rayon fibers are resilient and serve to impart to the pads a resiliency which is highly desirable in the finished tampon represented in Figure 12. The cotton linters in batt form provide excellent absorbing capacity.

In one example the pads 1a and 1b made of said blend of 60% cotton linters and 40% crimped rayon fibers, are 4 inches long, 3/4 of an inch thick and 1/4 inches wide. These proportions are not essential and they are stated merely by way of an example of a size from which a very acceptable tampon may be made.

As shown in Figure 1, the fiber pads 1a and 1b are disposed in spaced side by side coplanar relation on the wrapper 2 which is of highly pervious material such as open mesh gauze or other suitable pervious material. The space between the pads is not critical, but is preferably within the range of about 3/4 to 1/2 of an inch when the pads are about 3/4 inches thick. This spacing may be eliminated, especially with very thin or resilient pads, or made greater when thicker pads are used.

The wrapper sheet 2 is longer than the length of fiber pads as illustrated, and also wider than the combined widths of said pads so that the pads may be placed on the wrapper to provide marginal portions of
the wrapper which project beyond the opposite ends of the pads and beyond the longitudinal side of one of said pads as shown in Fig. 1. End portions 3 and 4 of the wrapper are folded upwardly over the ends of the pads and inwardly over the respectively adjacent marginal end portions of the pads as shown in Figure 2. The folded marginal end portions 3 and 4 of the wrapper should be adjusted as indicated at 5 to cause the length of the wrapper between its folded ends to be substantially uniform from side to side for purposes which will presently appear. If desired, adhesive may be employed as indicated at 7 to maintain said end margins folded, but this is usually not necessary. When the pads 1a and 1b are of the dimensions above mentioned, the wrapper sheet 2 may be about 6 inches long and about 4½ inches wide, these dimensions being only exemplary and not critical.

After the components have been brought to the condition represented in Figure 2, the pad body 1b together with the wrapper portions which embrace said body, are folded upwardly and inwardly over the pad body 1a so as to place the fiber bodies 1a and 1b in face-to-face relation with marginal end portions of the wrapper disposed between the end portions of said fiber bodies as will be understood by reference to Figures 2 and 3. The next step is to fold the projecting wrapper side portion 5 of the wrapper with its folded ends, upwardly over the adjacent sides of the assembly and over the top thereof into the condition represented in Fig. 4. If desired, adhesive may be employed as indicated at 7 to secure the marginal side portions of the wrapper or jacket in position on the pad structure. When the above is used, it is preferable that it be rather sparingly used and it should be chosen to avoid the production of any hard or stiff areas or spots, and it should be non-toxic and otherwise free from objectionable effects on the sensitive walls of the vaginal cavity.

It is preferred that the width of the wrapper 2 be so selected, and that the fiber pads 1a and 1b be so placed on the wrapper that the free edge of the final fold 6 will terminate within the width of the underlying face of the pad body 1b in at least slightly spaced relation to the nearest side or corner of the tampon body. This will usually prevent said free edge of the wrapper portion 6 from possibly forming a harsh edge on the surface of the compressed tampon which will ultimately be made from the uncompressed body described.

After the components are in the condition represented in Figures 2, 3 and 4, the tampon is assembled. The draw string 8 may be a moisture resistant mercerized, soft cotton or other suitable thread which is folded upon itself and knotted together at its free ends as indicated at 9. The folded end 10 of the draw string is passed through the tampon body so as to pass through the two pad elements 1a and 1b, and through the wrapper margin 3 between the end portions of said pads as well as through the exterior wrapper material. The knotted end of the draw string is passed through the folded or looped end 10 as shown in Fig. 4, so as to form a noose around an end portion of the tampon body. The noose may be drawn as taut as desired so as to hold the folded body structure together. Because of this noose, the employment of adhesive as above mentioned may be omitted or such adhesive may be employed in an area or areas near only the opposite end of the tampon body. The draw string or withdrawal cord is preferably located in offset relation to the longitudinal center of the body as shown in Fig. 4 for a purpose which will presently appear when the body is employed.

It will be seen that the wrapper 2 completely encloses the fiber material absorbent bodies and that the only exposed edge of the wrapper material is the edge 11 of the last folded side margin 6. Also, the folded end portions 3 and 4 of the wrapper are effectively retained in folded condition by being gripped between the fiber bodies 1a and 1b.

In some instances, the pads 1a and 1b may be placed on the wrapper sheet so that marginal portions of the wrapper sheet project beyond all sides of the pad pair. This will permit all of said wrapper margins to be folded over adjacent portions of the pad pair in the manner above described in reference to the wrapper margins 3 and 4. Then, when the pad 1b is folded with the contiguous wrapper portions over the other pad, the resulting structure will have all of the wrapper sheet edges embraced between the pads 1a and 1b.

As above stated, the wrapper 2 may consist of woven gauze, other cotton mesh thread fabric, or other suitable pervious fabric. Non-woven thread wrapper material may be used, for example, in open mesh fabrics of the character indicated by adhesively bonding crossing threads to each other at their intersections.

Non-woven fiber sheets in which the fibers are adhesively bonded together or which sheets are otherwise reinforced to provide the desired strength in the sheet while not being so rigid, and which are provided with one or more withdrawal cords that may be employed for wrapper purposes. Knitted or braided mesh material and any other sufficiently strong and pervious material may also be employed.

Open mesh wrapper material should be of such mesh that it will effectively retain in the absorbent body, any short fiber component thereof, for example, the shorter fibers of a cotton linter component or of a "fluff" component such as above mentioned. For a body which contains such short fibers, a suitable wrapper is provided by woven gauze having a thread construction of about 24 x 24 or by other fabric having comparable openness. In some instances, the wrapper material may be a more open thread-formed web having a lower thread construction count—say about 16 x 8—and a facing F (Fig. 1) of cotton or other fibers fractionally or adhesively attached to the thread web, preferably on its inside face. Such a fiber facing serves in cooperation with the more open mesh fabric to effectively contain short fibers in the absorbent body, and it imparts a desirable smooth feel to the outside of the wrapper, probably because of the projection of some of the facing fibers through the meshes of the wrapper to the outside thereof. Such a fiber facing serves in cooperation with the meshes if desired but it is, in general, less important on smaller mesh fabrics. Said fiber facing may be very light; for example, it may have a basis weight within the range of 1½ to 6 grams per square yard.

The uncompressed body shown in Fig. 4 is preferred for conversion into a compressed tampon according to the present invention, but the converting steps which are about to be described may be applied to or practiced with uncompressed absorbent bodies of other kinds. For example, the body may consist of a simple elongated rectangular fiber pad 12 shown in Fig. 5 which is preferably formed from a cotton bat in such a manner that the predetermined direction of fiber lay in the pad 12 is transverse to its length as indicated by the arrow 13 in Fig. 5. The bat 12 is reinforced by a line of thread stitching 14 through the thickness of the bat and extending lengthwise thereof along or adjacent the longitudinal center of the width of the bat, the line of stitching being extended beyond one end of the bat to form a withdrawing cord 14a. As illustrated in Fig. 5 and for a purpose to be presently explained, the stitching which forms the withdrawal cord, may be offset to one side of the longitudinal center of the pad width—especially adjacent the end of the pad from which said cord 14a extends. The withdrawal cord 14a may be provided by attaching a separate string to the fiber body in any suitable manner.
According to one embodiment of the invention, if a compressed tampon is to be made having a length of about 134 inches and a diameter of about ½ inch, the starting body may be of the construction shown in Fig. 4 having length (L), width (W), and thickness (T) dimensions about as follows:

L = 4”
W = 1 ¼”
T = ¾”

When such starting body comprises the aforesaid blend of 60% cotton linters and 40% crimped rayon fibers, it weighs about 3 grams (including the wrapper) and compression and re-expansion steps to which the body is subjected will result in temporary or intermediate and final dimensions approximately as hereinafter specified. However, it should be understood that the specific dimensions may vary somewhat and that when other kinds of starting bodies are employed, the dimensions thereof may be different both at the start and in the intermediate stages even though the finished products are intended to be of the same size and shape.

One step in making a compressed tampon from an uncompressed body such as specified in the preceding paragraph, is to compress the thickness T of the body to a predetermined thickness which is preferably somewhat less than the corresponding dimension of the compressed tampon which is to be made. For example, if the compressed tampon is to be of cylindrical form about ½ inch in diameter, the thickness T of the uncompressed body may be compressed from its initial starting thickness of about ¾ of an inch to about ¾ of an inch. This step is represented in Fig. 6 where the reduced thickness is represented by T1.

Another step is to compress the wide face width W of the body to a reduced width W1 as represented in Fig. 7. The reduced width W1 is somewhat greater than the corresponding transverse thickness of the compressed tampon which is to be made. For example, if the tampon is to be made approximately cylindrical in its finished form with a diameter of about ¼ inch, the face width W of the uncompressed body may first be reduced to about ¾ to ¼ of an inch which is represented at W1 in Fig. 7.

A further step consists in reducing the longitudinal dimension L of the body to somewhat less than ½ of its initial length or, with reference to the compressed tampon being made, to about the desired length of the compressed tampon or slightly less, for example, to about 1½ inches, this reduced length being indicated at L1 in Fig. 8.

The foregoing thickness, width and length compression steps constitute a series of compression steps which may be designated, for convenience, pre-compression steps since they are preliminary to additional compression steps which result in the production of the compressed tampon of the required size.

After the body is pre-compressed to the condition represented in Fig. 8, the body is permitted to expand due to its inherent resiliency, this expansion serving to enlarge the pre-compressed body to a condition in which the length and width are somewhat greater than corresponding dimensions of the compressed body which is to be made, as represented by the dimensions L2 and W2 respectively, while the thickness is also caused to expand to a dimension T2 which, like the dimension T1, is somewhat less than ½ of the diameter of the cylindrical body which is to be formed. The expanded length, width and thickness dimensions are respectively designated L2, W2 and T2 in Fig. 9. For the example being described these expanded dimensions are approximately as follows:

L2 = 2 inches
W2 = ¾ inch
T2 = ½ inch

If the tampon is to be produced with an applicator stick receiving socket in one end (see Milcent Patent 2,607,346, August 19, 1952) as represented in Figs. 11 and 12, such a socket is initially formed in the pre-compressed tampon body when the length of the starting body is reduced from the length L1 to the length L4 as shown in Fig. 8. This socket may be produced by providing one of a pair of mutually opposed longitudinal compressing members with a projecting pin which will enter the string end of the tampon body as an incident to the longitudinal compressing operation, thereby to form a preliminary socket 15a in said string end of the body as represented in Fig. 8. This preliminary socket 15a may be formed to a depth which is somewhat more than the desired full depth of the socket in the final compressed tampon; for example, the socket 15a may be made to a depth of about ¾ inch when the depth of the socket 15 in the finished product is to be about ¼ of an inch. The diameter of the preliminary socket formation 15a may be slightly greater or approximately the same as the diameter of the socket 15 in the finished product. In some instances, the socket 15 will be made cylindrical without coming to a point or it may be made only slightly tapered for a portion of its length or from end to end whatever the desired shape of the socket, the forming pin will be appropriately shaped.

After the pre-compressed tampon has expanded to a limited extent as represented in Fig. 9, it is subjected to a second longitudinal compressing step which is represented in Fig. 10 where the length of the body is represented as having been compressed to the desired final compressed length L3 which, in the example referred to is intermediate the pre-compressed length L1 and the expanded length L2. For example, the compressed length L3 may be about 1¾ inches when the pre-compressed length L1 is 1¾ inches and the expanded length L2 is 2 inches.

During the second longitudinal re-compression step, the thickness T2 of the body may be maintained by providing the compression chamber with a corresponding dimension. It is preferred that the dimension T2 of the re-expanded body be slightly less than the corresponding dimension of the compression chamber so as to facilitate introduction of the expanded, pre-compressed body into such chamber. For example, said compressing chamber dimension may be about ½ inch and the second step of longitudinal compression will cause the thickness of the body to expand to that dimension which is represented at T3 in Fig. 10. This slightly expanded thickness is approximately the same as the corresponding dimension of the completed compressed tampon.

The longitudinally re-compressed body is then subjected to another step of side compression whereby its width W2 is reduced to a width W3 (Fig. 11) which will be somewhat less than the desired corresponding dimension of the completed compressed tampon. For example, if the diameter of the compressed cylindrical tampon is to be ½ inch, the compressed width W3 may be about ¾ inch or less than ¼ of an inch. The compressed body will now be removed from the compressing mechanism and it will expand to a limited extent. Such re-expansion will occur mainly in the direction of the width in which the body was last compressed and re-expansion in the direction of length and thickness will usually be very slight. The re-expanded product will be of approximately cylindrical shape but with slightly flattened top and bottom surfaces illustrated in Fig. 7.

The W3 dimension of the compressed tampon will expand to substantially ½ inch as indicated at W4 in Fig. 12, the dimensions L3 and T3 usually changing so little that for practical purposes they may be regarded as unchanged.

During the second longitudinal compression step represented in Fig. 10, the socket 15a may be reduced sub-
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 substantially to the desired final size of the socket 15 by providing the appropriate longitudinal compression plus a socket forming pin of the required size. The subsequent width compression step (Fig. 11) is effected with the socket forming pin in place and will not materially affect the size of the socket 15. The side compression devices employed in the second side compression step (Fig. 11) are provided with suitable con- cavities so impart to the compressed body the more or less cylindrical form represented in Fig. 11.

In order to obtain a compressed tampon which is substantially stable in the condition represented in Fig. 12, the compression steps represented in Figs. 6 to 11 inclusive are effected while the tampon body contains a moisture content which will facilitate locking of the fibers in their compressed or compacted condition subject only to the limited expansion already indicated. This moisture content depends somewhat upon the particular character and kind of fibers employed in the fiber body. For the said blend of cotton liners and viscose rayon, a moisture content within the range of 8% to 14% of the weight of the body and uniformly distributed there- in, appears satisfactory, a moisture content in the vicinity of 10.5% or 11% being preferred. To provide a moisture content such as indicated, the uncompressed tampon body may be subjected to steaming, spraying or any other suitable treatment which will result in the said moisture content condition.

When the fiber body containing a moisture content as set forth is compressed, the compression by which the finished length and diameter is produced becomes substantially stable and the compressed body expands only to the indicated limited extent. Nevertheless, the locking effect by which such stabilization is obtained is readily released when the tampon is wetted in normal use, and the tampon then expands toward restoration of the dimensions of the uncompressed body but not fully to that extent. Initial expansion of the body upon wet- ting will tend to cause its cross sectional shape and diameter to revert to the larger cross sectional dimensions W1 or W2 of Figs. 8 and 9 respectively, and it tends to restore the thickness T3 to a thickness intermediate said initial thickness T and the preliminary compression thickness T1. Longitudinal expansion will also expand in connection with such transverse expansion. Expans- tion tends to occur in substantially the reverse order of compression although it is not meant to say that expa- ntion occurs in separate and distinct steps transversely and longitudinally.

By causing substantial expansion to occur both trans- versey and longitudinally more or less simultaneously, improved effects are obtained in respect of the establish- ing of adequate contact between the surfaces of the tampon and the walls of the vaginal cavity to prevent the flow of fluid along the walls of the cavity past the tampon.

The described two stage method of effecting prelimi- nary and final compression of the absorbing body with an intermediate re-expansion step is representative of one practical way in which the desired compression may be effected with relatively simple compressing equipment comprising separate preliminary and final compressing mechanisms, the tampon material being transferred from the preliminary compressing mechanism to the final com- pressing mechanism. However, it is not essential that the compressing operations be effected in such separated steps with an intervening period during which re-expan- sion is permitted to occur. The described compressing steps may be substantially continuously performed in a single compressing mechanism and without permitting said intermediate re-expansion. Such a continuous com- pressing method utilizes the above described preliminary thickness, width, and length compression steps to arrive at a pre-compressed body as represented in Figure 10,

which, when of the aforesaid blend of 60% cotton and 40% rayon fibers, has dimensions about as follows:

<table>
<thead>
<tr>
<th>L3</th>
<th>W2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>15&quot;</td>
<td>34&quot;</td>
<td>½&quot;</td>
</tr>
</tbody>
</table>

The re-expansion step represented in Fig. 9 is omitted and the final width compression step represented in Fig. 11 is then effected to complete the process.

Apparatus for effecting the described two stage compression of the fiber body is schematically represented in Figs. 13 and 14, and for effecting said compression in a continuous, single operation, in Fig. 15. The appa- ratus may embody many different forms and those shown should be understood as being merely exemplary.

The two stage mechanism comprises two units of mechanism respectively in Figs. 13 and 14, the mechanism shown in Fig. 13 being employed for effecting the pre-compression or preliminary compression steps represented in Figs. 6 to 8 inclusive, and the me- chanism represented in Fig. 14 is employed to effect the final compression steps represented in Figs. 10 and 11.

As represented in Fig. 11, an uncompressed body B is delivered into a chamber formed between a pair of reciprocably movable side compression plunger 16 and 17, the bottom of the chamber being formed by the bottom of a recess in a base plate 19 in which said side compression plunger 16 and 17 are movable. The top of the chamber is formed by a plate 20 which is hinged as indicated at 21 to the base plate 19. The cover 20 is adapted to be swung to an open position to permit placement of the tampon body B as illustrated in Fig. 13 and then closed into face-to-face relationship to the top face 22 of the base plate 19 and the corresponding top faces of said side compression plunger 16 and 17.

When the cover 20 is thus closed, the tampon body will have its thickness compressed to correspond with the depth of the chamber formed between said plunger 16 and 17, this depth being, in this instance, 9/5% of an inch. By closing the cover 20, the tampon body B will be reduced in thickness as represented in Fig. 6.

The side compression devices 16 and 17 will next be advanced toward each other to reduce the width W to the pre-compressed reduced width W1 as represented in Fig. 7. While the dies remain in their advanced positions with the cover 20 closed, a plunger 23, which is longitud- inally reciprocable in a guideway 24 provided in the base plate, is actuated to effect endwise compression of the body B against the end wall 25 of the compression chamber, the body B being thereby put in the condition represented in Fig. 8. This longitudinal plunger 23 is slidable between the advanced side compression plunger 16 and 17 and said longitudinal plunger may be provided with a pin 26 which will enter the end of the tampon body B to form the socket 15a. The withdrawal cord 8 during these pre-compressing operations may be per- mitted to remain on the top surface of the body B or it may be compressed against the adjacent end of said body. Another way of handling the withdrawal cord it to provide the plunger 23 with a hole 27 into which the cord may be pneumatically drawn as the plunger advances.

The compressed body is then removed from the compressing mechanism and will expand approximately to the proportions represented to Fig. 9. This expansion occurs as an incident to the resiliency of at least some of the fibers in the tampon body and due to the fact that the extent of compression effected is sufficiently limited to avoid such consolidation or compaction of the fibers that they are permanently locked against expa- ntion. The compressing pressures employed to attain the indicated result are variable in accordance with the size or bulk and density of the starting body B, the kind of fibers in the pad body, its moisture content, and per- haps other factors.
The secondary or final compression of the expanded pad body of Figure 9 is then effected by mechanism such as represented in Fig. 14. As there shown, the pre-compressed but slightly re-expanded pad body B1 is delivered into a guideway or channel 28 provided in a base plate 29. An abutment die block 30 is fixedly secured in said channel adjacent one end thereof, said abutment block being provided with the concave abutment face 31 against which the pad body B1 will be compressed by the action of a suitable reciprocating plunger 32 which is slidable in said guideway or channel 28. A normally fixed top plate 33 extends over the channel portion 28 into which the precompressed pad body is passed. A set of side compression plungers 34 and 35 are slidably mounted in said base plate 29 for reciprocating movement transversely of the length of said guideway 28, and said plungers have inner or adjacent ends 36 of more or less concave form so that when they compress the tampon body B1 between them, the body will be given a more or less cylindrical shape.

The longitudinal compression plunger 32 is at first operated to advance the tampon body B1 into the chamber formed between the side compressing plungers 34 and 35 and between the cover plate 33 and the bottom of the guideway 28. Advancement of the plunger 32 is effected until its leading end 37 becomes aligned with the side edges 38 and 39 of the guideway in which the side compression plungers 34 and 35 operate. This results in the desired limited secondary longitudinal compression of the tampon body B1 which is represented in Fig. 10. While the plunger 32 remains in its advanced position to hold the tampon compressed longitudinally to the extent indicated, the side compression plungers 34 and 35 are actuated to effect side compression so as to reduce the width dimension W2 of the compressed body to the desired final width dimension W3 as represented in Fig. 11. During the longitudinal compression of the tampon by the plunger 32 the withdrawal cord 8 may be received in a bore 40 in the plunger 32, the cord being pneumatically drawn into said bore.

In the apparatus represented in Fig. 15 for effecting the desired compression in a continuous series of operations, a die chamber is formed between opposed pairs of side compressing plungers, one pair comprising plungers 41a and 41b, the opposed pair comprising plungers 42a and 42b. These pairs of plungers are reciprocated toward and from each other intermediate top and bottom plates (not shown) which cooperate with the plungers to form a chamber which is open at said end and closed at the other end by a member 43. A reciprocating longitudinal compressing plunger, comprising a center rod 44 and outside members 45a and 45b, is operative to feed an uncompressed tampon body B into the chamber or to hold it in the chamber if it is pneumatically or otherwise fed thereto. The plunger rod 44 may be equipped with a pin projection 46 which will easily enter the body B to form a socket 15 if such socket is desired.

The pad body B having been first compressed or formed to a thickness T1, is put in the chamber between the opposed pairs of side compression plungers and said top and bottom plates and said pairs of side compressing plungers are advanced toward each other to effect the initial transverse compression step represented in Fig. 7. The plungers of each pair have aligned end faces and they initially move as a unit so that their end faces reach a preliminary position indicated at 47 and 48 respectively. In this preliminary advanced position, the width of the body B is compressed to the width W1 as represented in said Fig. 7.

While the pairs of plungers remain advanced to the positions represented at 47 and 48, the endwise compression plungers 44, 45a and 45b are advanced as a unit between said side compression plungers to effect longitudinal compression of the fiber body B to a length L1 which corresponds to the width of the chamber portion which is traversed by the opposed transverse plunger elements 41b and 42b. The plungers 41b and 42b may now be advanced to effect transverse compression of the longitudinally compressed body to the width W3 as represented in Fig. 11. The body will re-expand slightly as represented in Fig. 12 upon removal from the compressing chamber.

The purpose of providing pairs of dies in the manner indicated is to permit the plunger portions 41b and 42b to effect the final transverse compression while the plunger members 41a and 42a remain in the advanced positions represented at 47 and 48 with the plunger elements 44, 45a and 45b therebetwen to confine the tampon body to the length of the chamber in which said plungers 41b and 42b move transversely.

The finished tampon represented in Fig. 12, when made from a two part body enclosed in a wrapper as shown in Figs. 1 to 4 inclusive will have the wrapper material or jacket pressed into the body so that the jacket material is not clearly identifiable on the surface of the tampon but is more or less hidden by some of the fiber material which is forced outwardly through the interstices of the wrapper material. The surface of the tampon body is accordingly characterized by a surface which is softer and smoother than the wrapping material itself. The jacket is more or less gathered over the surface of the tampon in proportion to the extent to which the tampon body is compressed in the direction of its thickness, width and length (as indicated at 41 and 42 in Fig. 12). When the tampon is wetted to release the locks which hold it compressed, the jacket will also be released and will be capable of being expanded by the force of the expanding fiber body. The turned end margins of the wrapper fabric will remain gripped between the end portions of the fiber body so that the wrapper always completely surrounds and wholly contains the fiber body.

We believe that effectiveness of the described method of tampon making, that is to say, the improved characteristics of the tampon so made, are to a considerable extent, dependent upon the density of the pre-compressed body represented in Fig. 7. This density in turn depends somewhat upon the kind of material of which the body is made. For example, a density of approximately 11 pounds per cubic foot gives satisfactory results for a fiber body which weighs about 3 grams (including the wrapper) and which body consists of the aforesaid mixture of 60% cotton linters and 40% crimped rayon fibers which is pre-compressed to the dimensions above referred to in respect of Fig. 7 (3/4" x 5/6" x 4"). If the density of such a pre-compressed body is much less than about 6.5 pounds per cubic foot, the final results are rather unsatisfactory in that the longitudinal and transverse compression steps produce relatively deep creases, folds or convolutions in the body. Such deep creases or folds tend to result in a rough, uneven surface on the finished tampon and such roughness persists even in the re-expanded tampon under normal use conditions. The deep creases or folds are objectionable in that they tend to resist re-expansion of the body and reduce its absorptive capacity.

If the tampon body is made wholly of cotton fiber, a density of about 12 pounds per cubic foot in a pre-compressed body represented in Fig. 10 and of the size referred to, gives very good results.

It is not practicable to set forth specific densities or ranges of density suitable for each of the many kinds of fiber bodies which may be made into tampons according to this invention. For the above described 3 gram body consisting of 60% of cotton linters and 40% crimped rayon fibers, a satisfactory density range is about 6.5 pounds per cubic foot to about 13 pounds per cubic foot in the pre-compressed body of Fig. 7, and this density range may be considered generally applicable to other fiber bodies.
When the density of the pre-compressed body is properly selected, compression thereof results in only relatively small increases in the body and compaction of the body is effected mainly by forcing the fibers into more intimate engagement and interlaced relationship whereby stability of the compressed body in normally dry condition is obtained. Complete elimination of such folds or creases is desirable and the described sequence of compression steps tends to effect such elimination in that the folds are made very small. One objection to large, deep convolutions is that they tend to produce extra hard, high density portions in the bends of the convolutions while permitting the leg portions which extend from said bends to remain softer. The hard density areas that hamper expansion of the tampon when wetted reduce its absorbing capacity.

By contrast, in the specific example described, the depth of the creases is generally not greater than about 1/8 of the average diameter of the compressed tampon and only a small proportion of the creases attain that depth. The depth of such creases in the surface of the tampon is not uniform but varies widely, and a majority of said creases range in depth from about 1/32 inch to about 3/64 inch, when the body is of said 60% cotton linters and 40% crimped rayon fibers composition and the described sequence of compression steps is followed.

The transverse thickness compression represented in Figure 6 does not generally produce creases or folds. Compression of the width of the body to about one-half its original width as represented in Figure 7 may result in the appearance of a few slight longitudinally extending creases. The longitudinal compression step represented in Figure 8 generally causes a number of shallow transverse folds or creases to appear on both the wide and narrow faces of the body. When the pre-compressed body of Figure 8 is permitted to re-expand to slightly more than tampon length as represented in Figure 9, the depth of the transverse creases will be reduced and the slight longitudinal re-compression represented in Figure 10, does not materially change the size of said transverse creases. Direct longitudinal compression of the fiber body from the condition represented in Figure 7 to tampon length as represented in Figure 10, also results in the formation of similar shallow creases. The final transverse compression which reduces the width W3 to tampon width W3 effects some further longitudinal folding but this appears to be minimized by resistance offered by the existing transverse folds and of course the higher density.

The longitudinal and transverse folds or creases each tend to break up the continuity of the other so that not only the shallow depth of the folds but also the discontinuity thereof aid in the attainment of a smooth surfaced product.

The small transverse and longitudinal folds occur in greater numbers and frequency than when fewer but larger folds are formed. The greater frequency of the smaller folds also contributes to the formation of a smooth surface on the compressed tampon. When the tampon is wetted and expanded, a few of the folds, probably the largest of them, may appear as creases in the surface of the expanded body.

Smoothness of the surface of the compressed body is highly desirable not only from an appearance standpoint, but also because it makes insertion of the tampon into the vaginal cavity easier and less discomforting. Surface smoothness in the wetted and expanded tampon is believed to aid in maintaining effective continuous contact, both circumferentially and longitudinally, between the tampon and the walls of the vaginal cavity so as to prevent leakage of menstrual fluid past the tampon. Such smoothness of the wetted and expanded tampon also makes withdrawal of the tampon easy and free from discomforting effects.

The described construction and compressing sequence impacts to the tampon when wetted, a capacity for expanding to a size intermediate its initial uncompressed size and its described compressed size as represented in Figures 8 and 10. This results in very efficient use of the absorbing capacity of the amount of fiber present in the tampon and the described tampon has an absorbing capacity which we believe to be somewhat greater than that of a compressed tampon made of a like amount of fiber by conventional methods.

Another desirable feature of the tampon when produced in the manner described, is its tapered or rounded front or inner end portion as shown in Figs. 11 and 12, which is produced without significantly hardening said end portion, i.e., without significantly increasing the density of said end portion as compared with the density of the body portion of the tampon intermediate its end portions. The formation of the illustrated rounded end shape is initiated by the final longitudinal compression step in which the fiber body is compressed longitudinally against the concave, approximately semi-cylindrical end wall 31 of the die block 30; this imparts to the fiber body, a preliminary, approximately semi-cylindrical end. However, said rounded, approximately hemispherical end results primarily from the final side or transverse compression step. To obtain said rounded end shape by the final transverse compression step, the side compressing dies 41b and 42b in Fig. 15, have their cooperating semi-cylindrical concave faces 36 terminated in mutually opposed hemispherical end portion 36a. The said hemispherical end portions 36a of said cooperating faces apply pressure to the fiber body at angles which appear to cause shifting or flow of the fiber material in the adjacent end portion of the body lengthwise of the body to such an extent that the density of the compressed tapered or rounded end of the tampon is not significantly different than the density of said intermediate portion of the body. High density in the inner or front end portion of the tampon is somewhat objectionable because a tampon with a hardened end is not comfortably inserted and because the hardness tends to retard expansion of the front end of the tampon upon being wetted and this results in discomfort to the user.

There may be some increase in the density of the outer or rear end portion of the tampon body when it is compressed around a socket forming core such as the core or pin carried by the end 37 of the longitudinal compression plunger 32. This strengthens the socketed end portion of the body so that there is less danger of distorting said end portion as an incident to insertion of the tampon by means of an inserter stick seated in such socket.

Various other fiber components may be employed instead of those specifically mentioned and the principle of pre-compression to attain a selected density, followed by additional final compression steps may be applied to other forms of compressible tampon bodies to produce a tampon having the advantages of the constructions described. Also, instead of pre-compressing a starting body to obtain a desired density as a part of an integrated method of procedure, the method may start with absorbent bodies of suitable size separated from a supply of material which is of the desired density. Various other changes may be made while employing the principles of the described invention.

We claim:

1. The method of making a compressed tampon from a substantially uncompressed elongated body of absorbent material of predetermined longitudinal and transverse size, said length and transverse size being greater than the longitudinal and transverse size of the desired compressed tampon, comprising the steps of compressing said body transversely of its length to a predetermined reduced transverse size which remains greater than the transverse size of the desired compressed tampon, substantially maintaining said reduced transverse size and compressing the body
longitudinally to approximately the desired length of the finished tampon and again transversely compressing the body to a further reduced transverse size which is approximately the desired transverse size of the desired compressed tampon.

2. The method of making a compressed tampon from an elongated body of absorbent material having a predetermined density and of predetermined length and transverse size, said length and transverse size being greater than the length and transverse size of the desired compressed tampon, comprising the steps of compressing said body transversely of its length to a predetermined reduced transverse size which remains greater than the transverse size of the desired compressed tampon, substantially maintaining said reduced transverse size and compressing the body longitudinally to approximately the desired length of the finished tampon, and again transversely compressing the body to a further reduced transverse size which is approximately the desired transverse size of the desired compressed tampon, said predetermined density depending upon the kind of material in the body and being within a range which causes the compressibility of the body to develop relatively shallow folds or creases in the surface of the tampon.

3. The method of making a compressed tampon from an elongated body of absorbent material having a predetermined density and of predetermined length and transverse size, said length and transverse size being greater than the length and transverse size of the desired compressed tampon, comprising the steps of compressing said body transversely of its length to a predetermined reduced transverse size which remains greater than the transverse size of the desired compressed tampon, substantially maintaining said reduced transverse size and compressing the body longitudinally to approximately the desired length of the finished tampon, and again transversely compressing the body to a further reduced transverse size which is approximately the desired transverse size of the desired compressed tampon, said predetermined density depending upon the kind of material in the body and being within a range which causes the compression of the body to develop folds or creases in the surface of the tampon which have an average depth which does not exceed about one-eighth of the average diameter of the compressed tampon.

4. The method of making a compressed tampon from a substantially uncompressed elongated body of absorbent material of predetermined length, width and thickness, all of said dimensions being greater than the desired corresponding dimensions of the tampon which is being made, comprising the steps of compressing the thickness of said body to a thickness which is greater than the corresponding dimension of the finished tampon, compressing the width of the body to a width which is substantially greater than the corresponding dimension of the finished tampon, compressing the body longitudinally to a length which is not greater than the desired length of the tampon which is being made while substantially maintaining the body compressed transversely as aforesaid, permitting the body to expand longitudinally and transversely, re-compressing the body longitudinally to approximately the desired length of the finished tampon and incidentally causing the thickness of the body to expand to approximately the desired corresponding dimension of the tampon which is being made, and compressing the width of the body to slightly less than the desired width of the tampon being made, then permitting said width to expand to the desired tampon width.

5. The method of making a compressed tampon from a substantially uncompressed elongated body of absorbent material of predetermined length, width and thickness all of said dimensions being greater than the desired corresponding dimensions of the tampon which is being made, comprising the steps of compressing the thickness of said body to a thickness which is less than the corresponding dimension of the finished tampon, compressing the width of the body to a width which is substantially greater than the corresponding dimension of the finished tampon, compressing the body longitudinally to a length which is less than the desired length of the tampon which is being made while substantially maintaining the body compressed transversely as aforesaid, permitting the body to expand longitudinally and transversely, re-compressing the body longitudinally to approximately the desired length of the finished tampon and incidentally causing the thickness of the body to expand to approximately the desired corresponding dimension of the tampon which is being made, and compressing the width of the body to slightly less than the desired width of the tampon being made, then permitting said width to expand to the desired tampon width.

6. The method of making a compressed tampon from a substantially uncompressed elongated body of absorbent material of predetermined length and transverse size, said length and transverse size being greater than the length and transverse size of the compressed tampon, comprising the steps of compressing said body transversely of its length to a predetermined reduced transverse size which is greater than the transverse size of the compressed tampon, compressing the body longitudinally approximately the length of the compressed tampon, and again transversely compressing the body to a reduced transverse size which is approximately the transverse size of the compressed tampon.

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