April 13, 1965 J. R. G. PEARMAN 3,177,872

VAGINAL TAMPON AND APPLICATOR

Filed Nov. 23, 1962

Fig. 1

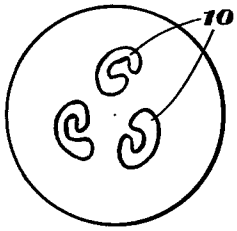



Fig. 2

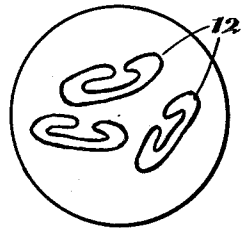



Fig. 3

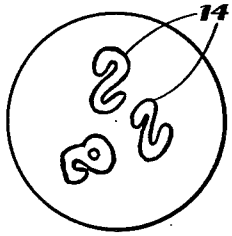
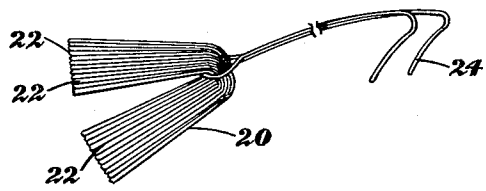



Fig. 4



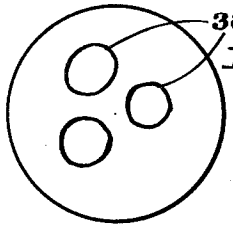




Fig. 8

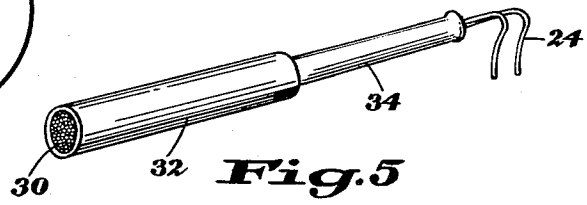



Fig. 5

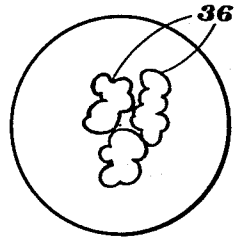



Fig. 7

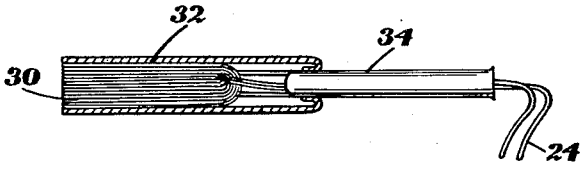



Fig. 6

James R G. Pearman
INVENTOR

BY R. Frank Smith
Charles T. Board
ATTORNEYS

United States Patent Office 3,177,872 Patented Apr. 13, 1965



3,177,872

# VAGINAL TAMPON AND APPLICATOR

James R. G. Pearman, Kingsport, Tenn., assignor to Eastman Kodak Company, Rochester, N.Y., a corporation of New Jersey

Filed Nov. 23, 1962, Ser. No. 239,682
4 Claims. (Cl. 128—263)

This invention relates to articles of manufacture adapted particularly to absorb and retain body fluids. More particularly, this invention relates to tampons for use in body cavities to absorb and retain body fluids.

Tampons and like members have been prepared from synthetic resin filaments. Heretofore, the use of synthetic resin filaments has not proved entirely satisfactory owing to the relatively poor fluid absorption and fluid retention properties of the filaments employed.

This invention is directed to the manufacture of tampons and like absorbent articles from synthetic resin filaments having a specific and critical cross-section whereby the resulting articles have substantially improved fluid absorption and fluid retention properties.

For a complete understanding of this invention reference is made to the following detailed description and drawing, in which:

FIG. 1 is a view in cross-section of a synthetic fiber employed in this invention,

FIG. 2 is a view in cross-section of a fiber to be employed in this invention,

FIG. 3 is a view in cross-section of another type of fiber that can be employed in this invention,

FIG. 4 is a view of a plurality of continuous filaments tied together at their mid-point by a cord or string,

FIG. 5 is a view in perspective of a device embodying the improved tampon of this invention,

FIG. 6 is a view in cross-section of the device shown in FIG. 5,

FIG. 7 is a view in cross-section of a standard fiber derived by solution spinning a synthetic resin through circular orifices, and

FIG. 8 is a view in cross-section of a standard fiber derived by melt spinning a synthetic resin through circular orifices.

In accordance with this invention it has been determined that tampons prepared from synthetic resin fibers having a specific and critical cross-sectional shape have substantially improved absorbent and fluid retaining properties. The synthetic resin filaments employed in this invention are of a cross-section such that the fiber has substantially more surface area than the fibers used heretofore in preparing tampons. Furthermore, the fibers of this invention have at least one relatively small cavity running generally lengthwise of the fiber which retain body fluid entrapped therein during use of the tampon.

Fibers or filaments that can be used in carrying out this invention are shown in FIG. 1, FIG. 2, and FIG. 3 of the drawing. Referring to FIG. 1 of the drawing there are shown filaments **10** which have what is referred to in the art as a C-shape cross-section. In FIG. 2 of the drawing there is shown a modified form of C-shaped cross-section fibers **12**; and in FIG. 3 of the drawing there are shown fibers **14** having what is referred to in the art as an S-shape cross-section. Synthetic resin fibers of the type shown in FIG. 1, FIG. 2, and FIG. 3 of the drawing are well known in the art and are available commercially.

In preparing the tampon of this invention it is preferred to employ synthetic resin filaments of continuous length; however, staple length fibers can be employed if desired. The synthetic resin filaments can be prepared by well known solution spinning methods or by well known melt spinning processes. The method employed will depend primarily on the type of resin employed in manufacturing the fibers. Thus, for example, cellulose acetate filaments can be prepared easily by solution spinning methods while polyamide and polyester resins are more easily formed into fibers by melt spinning methods.



This invention is not limited to the specific C-shape cross-section filaments shown in FIG. 1 and FIG. 2 of the drawing, these showings being illustrative only. Thus, the cross-section of FIG. 1 can be more open and approach the cross-section of a U while the cross-section of FIG. 2 can be a flatter cross-section, that is, the fiber will resemble a ribbon with a cavity running generally lengthwise thereof.

Fibers having C-shape cross-sections and S-shaped cross-sections can be prepared from the various synthetic resins commonly employed in the manufacture of synthetic resin filaments of standard cross-section. Examples of such resins include the polyesters such as polyethylene terephthalate and the polyester derived by the condensation of terephthalic acid and 1,4-cyclohexanedimethanol; the polyamides such as hexamethylene adipamide (nylon 66), hexamethylene sebacamide (nylon 68), and polycaprolactam (nylon 6); viscose; the organic acid esters of cellulose such as cellulose acetate, cellulose propionate, cellulose butyrate, cellulose triacetate, cellulose acetate butyrate, and cellulose acetate propionate; the vinyl-type resins such, for example, as the polymer derived from vinyl chloride and vinyl acetate; acrylic-type resins such, for example, as the copolymer of vinyl chloride and acrylonitrile, and polyacrylonitrile; and the polyolefins such, for example, as polyethylene, polypropylene, and poly-1-butene.

The synthetic resin filaments employed in this invention will preferably be of about two to five denier per filament. However, the denier of the filaments can be from about 0.1 to 10 or higher if desired.

In preparing the tampons of this invention it is preferred to employ a plurality of continuous filaments in the form of a tow. The number of filaments or "ends" in any particular tow used in this invention can be varied over a relatively wide range, and will depend to a large extent upon the denier of the individual filaments of which the tow is comprised, and upon the diameter of the tampon to be prepared therefrom. Thus, for example using a filament having a denier of about 5, a tow comprised of about 20,000 filaments can be employed satisfactorily. Using filaments having a denier of about two, tow comprised of as many as about 500,000 filaments can be employed satisfactorily. It has been determined, however, that when filaments having a denier of from about two to about five are employed in carrying out this invention, that the tow can be comprised of from about 30,000 to about 200,000 filaments with highly satisfactory results.

The tow can be, and preferably, is employed in the crimped condition. Crimping of the tow by well known processes is accomplished preferably prior to its use in the manufacture of tampons of this invention. The number of crimps per inch of tow can vary from about 1 to 2 per inch and up to about 20 to 30 per inch. Various types of well known crimping devices can be employed for crimping the tow. Examples of satisfactory crimping devices are described in Patents 2,090,669; 2,311,174; 2,505,618; 2,698,970; 2,734,228; 2,734,229; 2,734,251; 2,740,992; and 2,749,233. Most of the commercial crimping devices for textile tows are of the "stuffing box" type, although in some instances the "gear" type is used. Both of these types are discussed in the patents listed above.

The tampons of the present invention can be manufactured by providing a tow of continuous substantially parallel filaments as above described. The tow is subsequently bloomed or opened by methods well known

in the art such for example as by the method and apparatus disclosed and described in Caines et al., application Serial No. 27,091, filed May 5, 1960 and now Patent No. 3,099,594. Other suitable methods and apparatus for opening tow are disclosed and described in Patents 3,017,309; 3,016,581; 2,926,392; and 2,794,239.

After the tow has been opened, it is cut into predetermined lengths which will usually be equal to about twice the length of the tampon to be prepared therefrom and subsequently tying or otherwise securing a removal cord or string to the approximate center of the cut tow whereby all of the filaments are bound together substantially at their mid-point. The thus tied tow is folded approximately in half and subsequently compressed into a generally cylindrical shaped member or tampon by suitable means such for example as in a compression type mold of desired size and shape. The thus-compressed member or tampon is inserted into a hollow cylindrical container or tube with the removal cord or string extending outwardly therefrom whereby the individual tampon can be ejected from the container by a suitable positioned plunger and hence positioned in a body cavity for use.

Further, and in accordance with this invention, it has been determined that, if the individual fibers of which the tampon of this invention is comprised carries thereon a relatively thin coating of a specific lubricant, the absorption properties of the individual filaments are improved. Furthermore, the force required to expel the tampon from its hollow cylindrical container is reduced substantially. A particularly suitable lubricant for this purpose is a poly(oxyethylene glycol) having an average molecular weight of from about 1000 to 2000. A poly(oxyethylene glycol) has the structural formula

$$HO(CH_2—CH_2—O)_nH$$

wherein $n$ is an integer of a value to provide a polymeric material having a desired molecular weight. The lubricant employed can be a poly(oxyethylene glycol) having a molecular weight of from about 1000 to 2000 or it can be a mixture of poly(oxyethylene glycols) of varying molecular weights wherein the average of the molecular weights is from about 1000 to 2000. A particularly suitable compound of this type is that available commercially as Carbowax 1540 which has an average molecular weight of from about 1300 to 1600 as disclosed at page 213 of the Seventh Edition of the Merck Index. The lubricant is applied during the forming of the individual fibers of which the tow is comprised and is applied by well known fiber lubricating procedures. Thus, the lubricant can be applied to the fibers by spraying, by roller application, by brush application, and the like.

The following examples are illustrative of this invention.

## EXAMPLE I

Tow comprised of about 30,000 continuous cellulose acetate filaments of about 5 denier per filament and having a C-shape cross-section similar to that shown in FIG. 1 of the drawing are opened up by means of an air jet to provide a band of the filaments of about 6 inches in width. The opened tow is cut at regular intervals into 10 sections, each having a length of about 6 inches. Each section of filaments weighs about 2.5 grams, and the tow used in this example has about 12 crimps per inch.

## EXAMPLE II

Tow comprised of about 30,000 continuous cellulose acetate filaments of about 5 denier per filament and having a standard cross-section (similar to that shown in FIG. 7 of the drawing) are opened to provide a band of filaments about 6 inches in width. The opened tow is cut at regular intervals into ten sections each having a length of about 6 inches and each section weighing about 2.5 grams. The tow used in this example also has about 12 crimps per inch.



## EXAMPLE III

The ten sections of tow of Example I and the ten sections of tow of Example II are evaluated for fluid retention properties by the Basket Test. Test results show that the average amount of water retained by the Example I sections is about 31.0 grams for each gram of section and the average amount of water retained by the Example II sections is about 27.3 grams for each gram of section.

The Basket Test consists essentially of placing a section to be tested in a small cylindrical wire basket and placing the basket beneath the surface of distilled water. After being immersed for a specified period of time, the basket containing the sample is removed from the water, drained and then weighed. The weight of the wet section less its dry weight gives the amount of water retained. By dividing the amount of water retained by the dry weight of the section there is obtained the amount of water retained for each unit weight of section.

## EXAMPLE IV

Several tampons are made from various types of cellulose acetate continuous filament tow and tested for fluid retention properties. The tow has about 12 crimps per inch. The results of these tests are set forth in Table 1 below. The tampons tested are formed by opening the tow and cutting it into 6-inch lengths. A cotton string is tied at the mid-point or center of the cut length and the tied member is folded at the center to provide a member about 3 inches long. The folded member is compressed in a mold into a substantially cylindrically shaped member having a cross-sectional diameter of about 0.52 inch and a length of about 2½ inches.

*Table 1*

| Tampon | Shape of Cross Section of Filament | Denier per Filament | Weight of Tampon in Grams | Tampon Density, Grams/cc. | Fluid Retention, Grams of Fluid Retained For Each Gram of Tampon, Average of 10 Samples Tested |
|---|---|---|---|---|---|
| 1 | "C" | 1.3 | 1.50 | 0.14 | 6.9 |
| 2 | "C" | 1.3 | 1.75 | 0.16 | 7.1 |
| 3 | "C" | 1.3 | 2.00 | 0.18 | 6.1 |
| 4 | "C" | 1.3 | 2.25 | 0.20 | 6.0 |
| 5 | "C" | 1.3 | 2.50 | 0.22 | 6.9 |
| 6 | Standard | 1.3 | 1.50 | 0.14 | 5.51 |
| 7 | do | 1.3 | 1.75 | 0.16 | 5.23 |
| 8 | do | 1.3 | 2.00 | 0.18 | 4.02 |
| 9 | do | 1.3 | 2.25 | 0.20 | 3.41 |
| 10 | do | 1.3 | 2.50 | 0.22 | 3.59 |

It can be readily seen, from the above test results, that the fluid retention is substantially higher for the tampon prepared from the C-shaped cross-section fibers than for the tampon prepared from filaments of standard cross-section. It is also apparent from the above test data that the fluid retention of the tampons prepared from filaments of C-shaped cross-section is affected much less by changes in tampon density than by the tampons derived from fibers of substantially standard cross-section. Fluid retention properties are determined by the Syngyna test developed by G. W. Rapp, Ph. D., Professor of Biochemistry and Physiology, of the Department of Research, Loyola University, Chicago, Illinois.

## EXAMPLE V

Additional tampons are prepared from various weights of cellulose acetate continuous filament tow and tested for fluid retention in the manner employed in Example IV. These tampons are prepared in substantially the same manner as those employed in Example IV. That is, the tow is opened and cut into lengths of about 6 inches and a cotton cord or string is tied about the mid-point of each 6-inch length. The tied lengths are folded about the center and placed in a compression mold where they are molded into cylindrical members. The expulsion force or the force required to expel the tampons of this

example is measured by forcing the tampon from an applicator tube with a hydraulic cylinder and measuring the pressure required to eject it from the cylinder. This pressure is then converted into pounds of force. The results are set forth in Table 2 below.

*Table 2*

| Tampon | Cross Section of Fiber | Denier per Filament | Weight of Tampon in Grams | Tampon Density, Grams/cc. | Expulsion Force in Lbs. |
|---|---|---|---|---|---|
| 1 | "C" | 5 | 1.50 | 0.14 | 1.37 |
| 1 | "C" | 5 | 1.75 | 0.16 | 1.40 |
| 3 | "C" | 5 | 2.00 | 0.18 | 1.89 |
| 4 | "C" | 5 | 2.25 | 0.20 | 2.10 |
| 5 | "C" | 5 | 2.50 | 0.22 | 2.41 |
| 6 | Standard | 5 | 1.50 | 0.14 | 2.06 |
| 7 | do | 5 | 1.75 | 0.16 | 2.77 |
| 8 | do | 5 | 2.00 | 0.18 | 3.30 |
| 9 | do | 5 | 2.25 | 0.20 | 3.98 |
| 10 | do | 5 | 2.50 | 0.22 | 3.20 |

From the test results set forth in Table 2 above it can be readily seen that the tampons prepared from fibers having a C-shaped cross-section have the lowest expulsion force for a specified weight of tampon and that the change in expulsion force for a given change in weight is smaller for the tampons prepared from the C-shaped cross-section fibers than for the tampons prepared from fibers of standard cross-section.

## EXAMPLE VI

A substantially cylindrical dental plug about 1½ inches in length and having a cross-sectional diameter of about ⅜ inch is prepared from cellulose acetate tow comprised of filaments having a substantially C-shape cross-section and having a denier of about 5, the total denier of the two being about 80,000. These dental plugs are prepared by wrapping these filaments in paper prepared from synthetic acrylic fibers (Orlon) and weighing about 7.8 lbs. for a ream of 500 sheets, a sheet being 26½-inches by 26½-inches. Ten of these plugs are prepared. Ten other dental plugs are prepared in a similar manner with the exception that the tow employed consists of filaments of standard cross-section instead of filaments of C-shape cross-section. All 20 dental plugs are evaluated for fluid retention by allowing water to enter the plugs from one side while the plug is maintained under pressure. The pressure employed on all plugs is the same. The plugs made from the tow consisting of C-shape cross-section fibers have about 9% higher fluid retention than the samples prepared from tow consisting of filaments of standard cross-section.

## EXAMPLE VII

Tampons weighing about 2.0 grams are prepared from cellulose acetate tow containing about 20,000 filaments, each filament having a denier of about 5. The tampons are compressed in a compression chamber under a pressure of about 2500 pounds per square inch to provide tampons having a cross-sectional diameter of about 0.5312 inch and a length of about 2.5 inches. The samples are prepared from tow comprised of standard cross-section filaments carrying thereon a lubricant coating of a poly(oxyethylene glycol) having an average molecular weight of between about 1300 and 1600, and other samples are prepared from cellulose acetate tow the filaments of which have had applied thereto a mineral oil based lubricant of the type commonly applied to cellulose acetate tow. The tampons are placed in applicator tubes and allowed to remain in the applicator tubes for about 30 days. After this time 10 tampons are tested to determine the expulsion force required to expel them from the tubes and also for their fluid retention properties. The force required to expel the tampons prepared from acetate tow carrying thereon the conventional lubricant is about 1.29 pounds and the fluid retention is 6.21 grams of fluid for each gram of tampon. The tampons prepared from the acetate tow carrying thereon the poly(oxyethylene glycol) lubricant require an average of about one pound of force for expulsion from the applicator tube and the fluid retention is about 6.46 grams per gram of tampon.

Similar results are obtained by employing C-shape cross-section cellulose acetate filaments in place of the standard cross-section cellulose acetate filaments of Example VII.

Commercially available tampons prepared from cotton fibers and weighing about 2.40 grams are tested in a manner similar to that of Example VII and the expulsion force required to expel the cotton tampon from its applicator tube was about 0.80 and the fluid retention is about 6.30 grams of fluid for each gram of tampon. The fluid retention is measured in accordance with the test employed in Example IV.

Referring to FIG. 4 of the drawing there is shown a length of tow **20** comprised of continuous synthetic resin filaments **22** of C-shape cross-section secured together substantially at its mid-point or center by a removal cord or string **24**. This member is placed in a suitable compression mold as hereinbefore described and pressure is applied thereto to provide a tampon of desired size, shape and density. Usually, the shape will be substantially cylindrical.

Shown in FIGS. 5 and 6 of the drawing a compressed member or tampon **30** is inserted into container or outer tube member **32** with the removal string **24** extending outwardly therefrom through an ejector or inner tube member **34**. Movement of the ejector **34** to the left as viewed in FIGS. 5 and 6 will eject the tampon **30** outwardly to be inserted and positioned in a body cavity where it will receive, absorb, and retain body fluids. The tampon will flare open upon ejection from the outer tube. Other means known to the art can be employed to position the tampon in a body cavity, and this invention is not limited to the specific means shown and described.

Reference is made in this specification to filaments of standard cross-section and this is defined, for the purposes of this invention, as being the cross-section derived by spinning a synthetic resin spinning solution or melt through orifices of substantially circular cross-section. Thus, for example, when cellulose acetate is solution spun by the method of Patent 2,000,047 or by the method of Patent 2,000,048 filaments having a cross-section similar to filaments **36** shown in FIG. 7 of the drawing are obtained. Melt spinning produces filaments having a cross-section similar to filaments **38** of FIG. 8 of the drawing.

Tampons prepared from cotton fibers are easily produced by feeding a loosely formed rod of the cotton fibers into a machine in which the material is compressed to a predetermined size. The cotton plug or tampon is then placed into an applicator tube if one is to be used. Generally, as the density of the tampon or plug prepared from cotton or standard cross-section cellulose acetate fibers is increased the amount of fluid retained thereby decreases. It has been determined, in accordance with this invention, that tampons prepared from tow of cellulose acetate filaments having a substantially C-shape cross-section have a considerably less loss of fluid potential as the density is increased than that shown by tampons prepared from cotton fibers or from cellulose acetate fibers of regular cross-section.

While the above invention has been directed primarily to the preparation of tampons, it is to be understood that other members such, for example, as dental plugs, absorbent bandages, and the like can be prepared in accordance with the teachings of this invention. Practically any member required to receive, absorb, and retain body fluids therein can be prepared in accordance with the teachings of this invention.

It is to be understood that the above description,

drawing, and examples are illustrative of this invention and not in limitation thereof.

I claim:

1. A tampon product comprised of an outer tube, an inner tube slideably positioned therein, and a vaginal tampon capable of expulsion under reduced force of about 1 to 3.5 pounds positioned in the outer tube and being ejectable therefrom by moving said inner tube towards said tampon, said vaginal tampon being comprised of a plurality of continuous synthetic filaments folded approximately in half and compressed into generally cylindrical tampon form selected from the group consisting of C-shape cross-section filaments, S-shape cross-section filaments, and mixtures thereof, said filaments being of a denier of 0.1–10 and numbering 15,000 to 50,000, being crimped to from 1–2 up to about 20–30 crimps per inch and having been prepared from tow cut into lengths of about twice the length of said tampon, and said tampon having a removal cord sescured thereto.

2. The article of manufacture of claim 1 wherein the filaments range in denier from 2–5, number 30,000–50,000 and are of a C-shape cross-section cellulose acetate.

3. A tampon product comprised of an outer tube, an inner tube slideably positioned therein, and a vaginal tampon capable of expulsion under reduced force of about 1 to 3.5 pounds positioned in the outer tube and being ejectable therefrom by moving said inner tube towards said tampon, said vaginal tampon being comprised of a plurality of synthetic filaments of C-shaped



cross-section folded approximately in half and compressed into generally cylindrical tampon form selected from the group consisting of cellulose acetate, cellulose propionate, cellulose butyrate, cellulose triacetate, cellulose acetate butyrate and cellulose acetate propionate, said filaments being of a denier of 0.1–10 and numbering 15,000 to 50,000, being crimped to from 1–2 up to about 20–30 crimps per inch and having been prepared from tow cut into lengths of about twice the length of said tampon, and said tampon having a removal cord secured thereto.

4. The article of manufacture of claim 3 wherein the filaments range in denier from 2–5, number 30,000–50,000 and have on the surface thereof a relatively thin coating of a polyethylene glycol of an average molecular weight of from about 1000 to 2000.

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RICHARD A. GAUDET, *Primary Examiner.*

JORDAN FRANKLIN, *Examiner.*