United States Patent

[11] **3,607,520**

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Pasadena, Calif.
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[45] Patented **Sept. 21, 1971**
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Neenah, Wis.

[54] **TAMPON MANUFACTURE**
6 Claims, 12 Drawing Figs.

[52] **U.S. Cl.** **156/198,** 156/221, 156/250, 156/273, 156/293, 156/303.1
[51] **Int. Cl.** **B29c 17/00**
[50] **Field of Search** 156/273, 293, 306, 250, 242, 245, 198, 221, 303.1, 244; 128/270, 285

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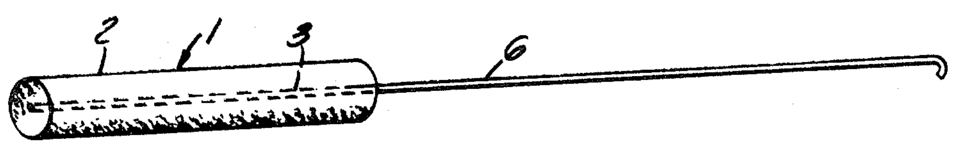
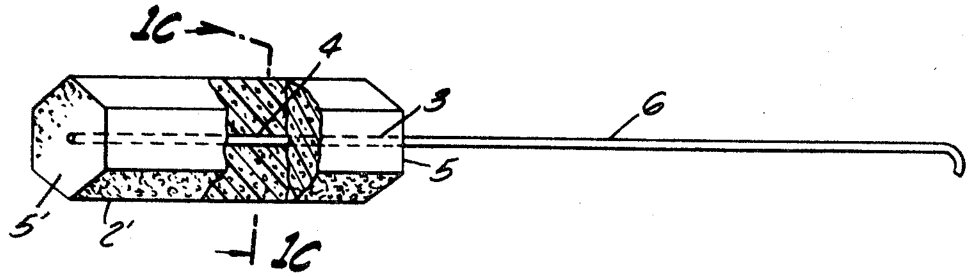
Attorneys—Daniel J. Hanlon, Jr. and Raymond J. Miller

ABSTRACT: A process and apparatus for simultaneously manufacturing a multiplicity of one-piece, regenerated cellulose sponge tampons, for permanently bonding a coaxially disposed withdrawal string within the interior of each of the tampon bodies, and for compressing the tampons into their final form.





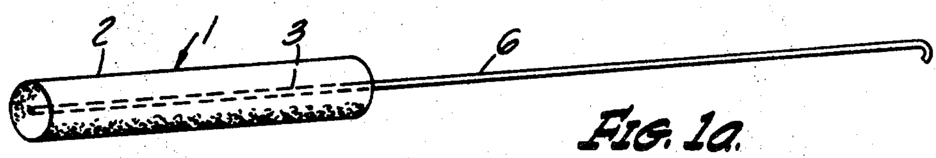


FIG. 1a.

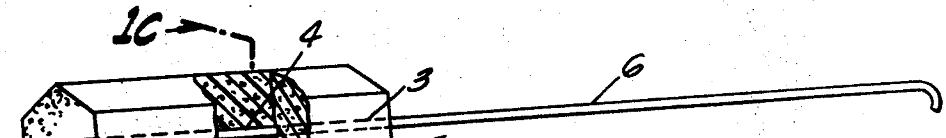


FIG. 1b.

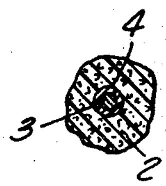


FIG. 1c.

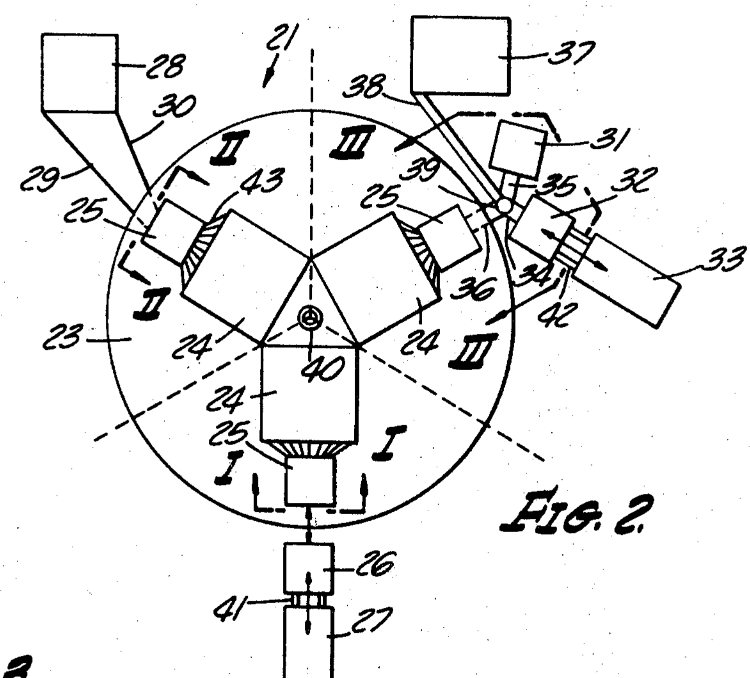
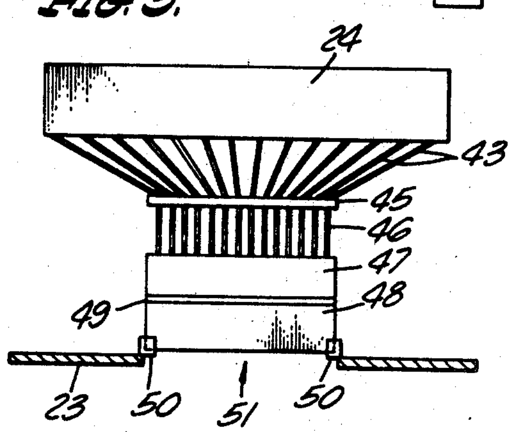


FIG. 2.

FIG. 3.



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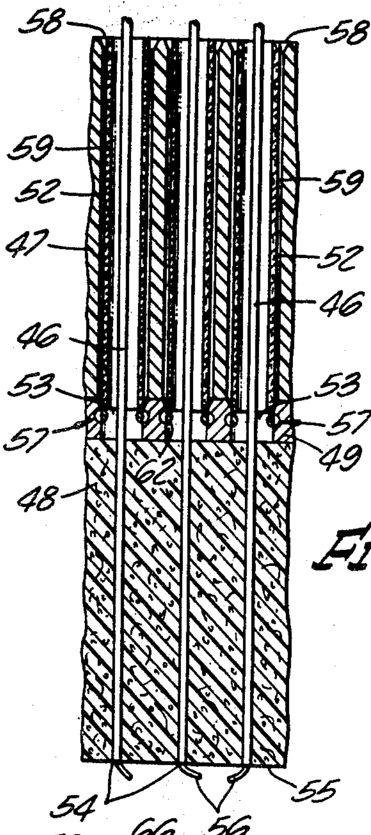
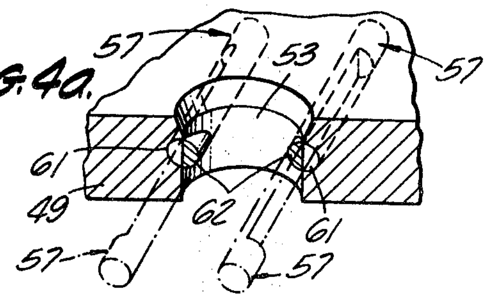


FIG. 4.

FIG. 4a.



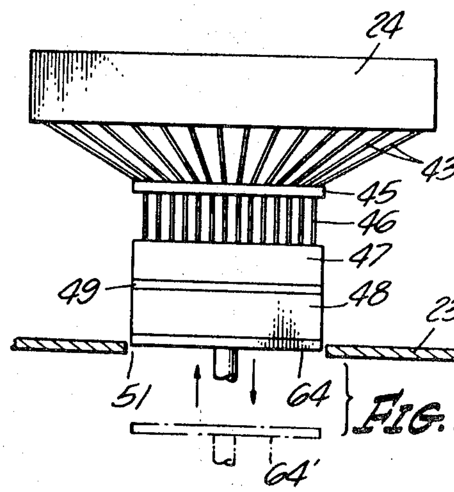


FIG. 5.

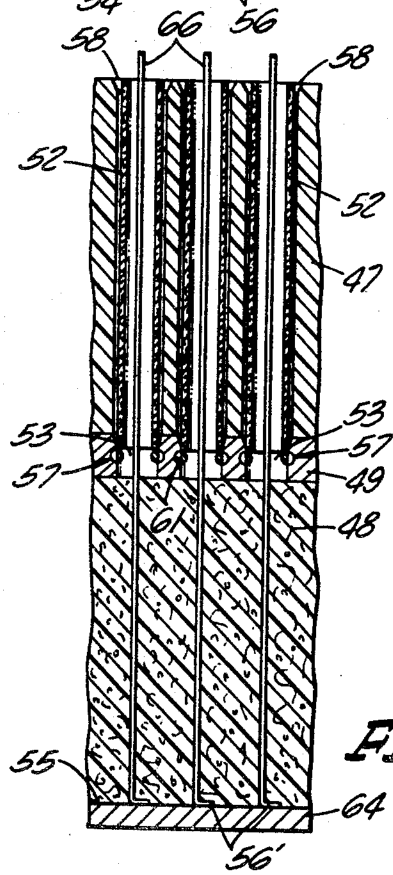


FIG. 6.

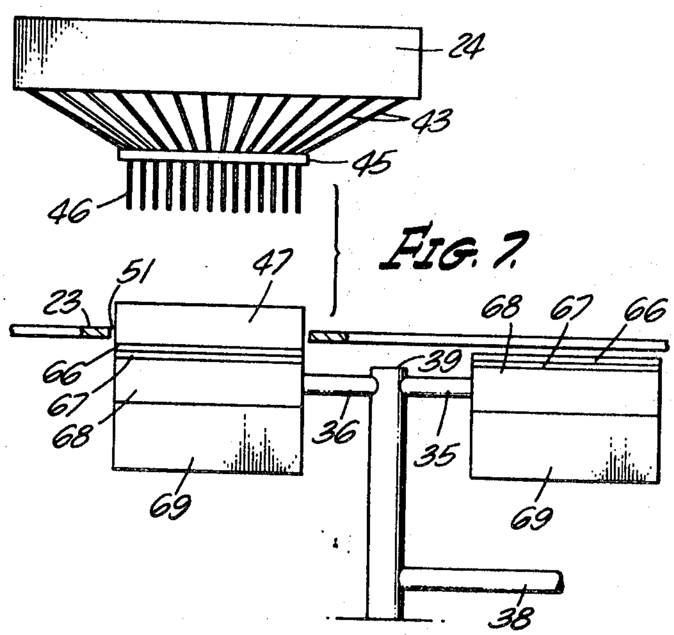


FIG. 7.

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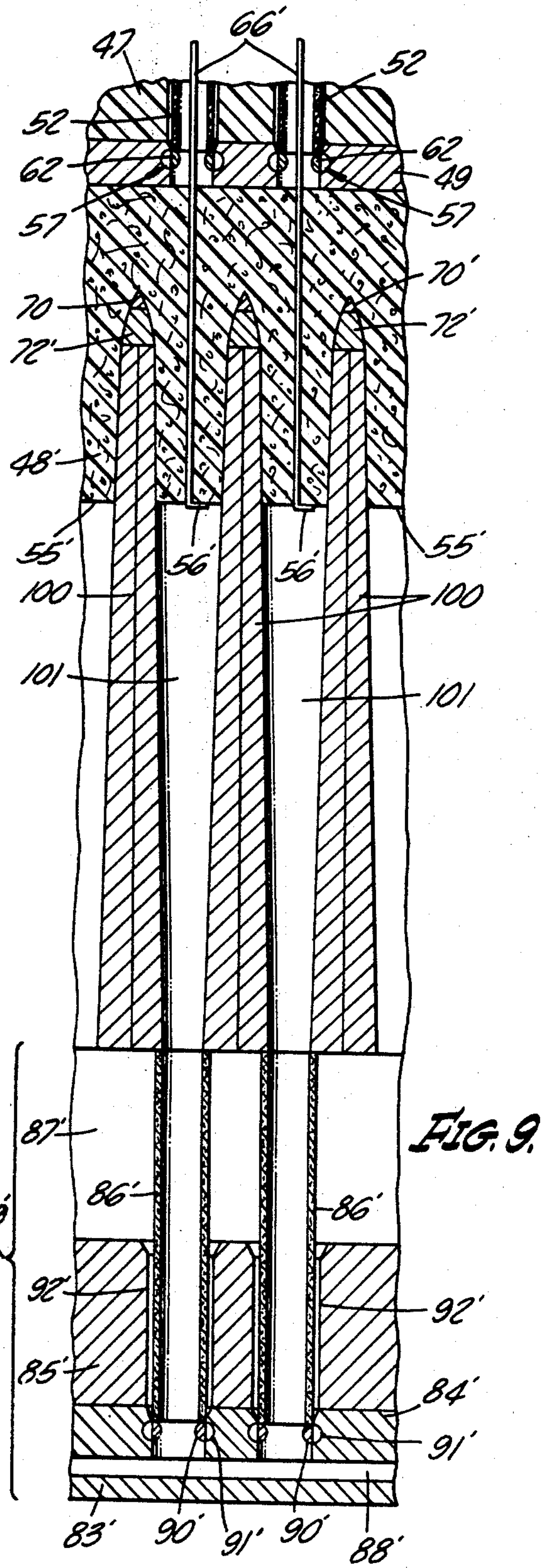

FIG. 9.

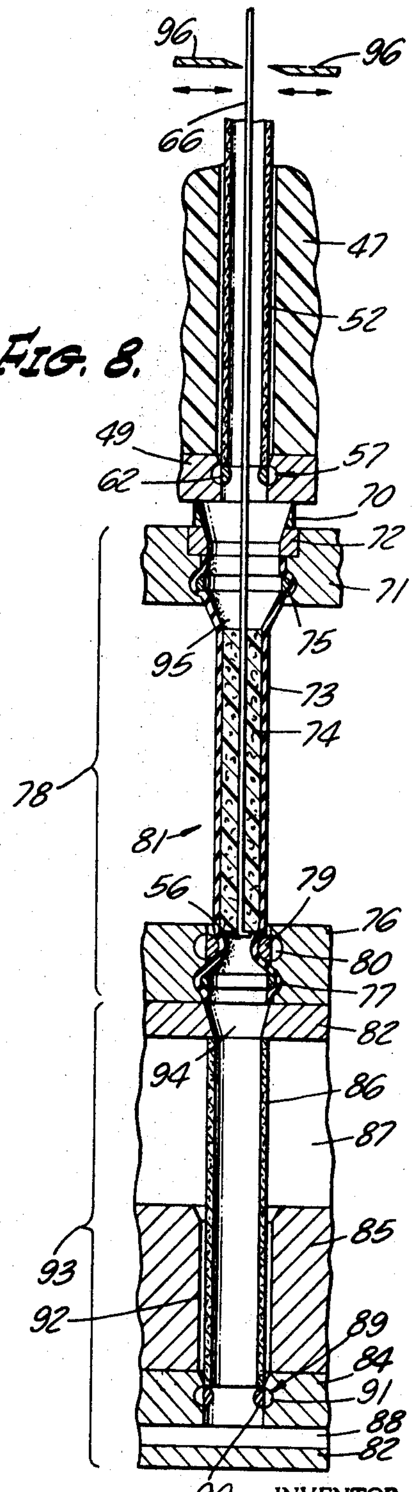

FIG. 8.

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TAMPON MANUFACTURE

This application is a division of copending application Ser. No. 619,509 filed Feb. 13, 1967. This application is also a continuation-in-part of my copending application, Ser. No. 350,193, filed Mar. 9, 1964, now U.S. Pat. No. 3,342,237. My present invention relates to new and useful improvements in a method and machine for manufacture of menstrual tampons.

Included in the objects of my invention are:

First, to provide a simple, relatively inexpensive and rapid method of simultaneously manufacturing multiple quantities of individual, dry, radially compressed, cylindrical, regenerated cellulose sponge tampons.

Second, to provide an inexpensive and simple machine for rapidly fabricating simultaneously a plurality of individual menstrual tampons, each tampon having a coaxially centered withdrawal string centered in and bonded in the tampon.

Third, to provide a method of simultaneously making a large number of catamenial devices or menstrual tampons from a single billet or block of a dry, fine-pore regenerated cellulose sponge.

Fourth, to provide a method of permanently bonding a coaxial withdrawal string in a polygonal cross section cylinder of dry, one piece, fine-pore regenerated cellulose sponge.

Fifth, to provide compressing means for rapidly forming and individually radially compressing one piece, fine-pore regenerated cellulose menstrual tampons in a multiple-forming operation.

Sixth, to provide a machine for simultaneously manufacturing a multiple number of menstrual tampons from a regenerated cellulose sponge billet.

Further objects and advantages of my invention will become apparent in the following description, to be read in connection with the accompanying drawings.

My earlier copending application, Ser. No. 350,193 teaches a dry, radially compressed, regenerated fine-pore cellulose sponge, having a coaxial withdrawal string disposed in the length of the cylinder, and forming a menstrual tampon.

FIG. 1*a* is a perspective view of a radially compressed menstrual tampon of my invention.

FIG. 1*b* is a perspective and partial sectional view of an uncompressed, or fully expanded, menstrual tampon of my invention, showing details of my withdrawal string structure. The relative diameters of the tampons of FIG. 1*b* and FIG. 1*a* show the relative diameter of my tampons before and after radial compression of the one piece, regenerated cellulose sponge.

FIG. 1*c* shows enlarged details of my withdrawal string structure, in use in my tampon.

FIG. 2 is a plan view of a modification of my machine invention capable of simultaneously manufacturing multiple lots of menstrual tampons of my invention.

FIG. 3 is an elevation view of my machine of FIG. 2 at its station I.

FIG. 4 is a detailed elevation sectional view of components illustrating the performance at station I of my machine on a billet of expanded, fine-pore regenerated cellulose.

FIG. 4*a* illustrates details of my invention relating to the retainer rod structure.

FIG. 5 is a partial elevation view of components of my machine invention operating at station II of my machine, as illustrated in FIG. 2.

FIG. 6 is a more detailed elevational sectional view of the machine of my invention performing at station II of my machine of FIG. 2.

FIG. 7 is a perspective elevation view of my machine operating at station III, as previously illustrated in FIG. 2.

FIG. 8 is a detailed elevation sectional view of one modification of the machine components of my invention operating at station III of my machine as illustrated in FIG. 2.

FIG. 9 is another modification representing a detailed elevation sectional view of the machine components of my invention operating at station III of my machine shown in FIG. 2.

Referring to FIG. 1*a* in detail, the menstrual tampon 1 comprises a dry, radially compressed, minimum pore volume, regenerated cellulose cylinder 2, and a withdrawal string 3 coaxially located in and along the cylinder axis length and extending beyond the cylinder, forming a sting handle 6. FIG. 1*b* shows more detail of my tampon invention, being a perspective and partial cross section view of the dry, fine-pore, expanded, regenerated cellulose, polygonal cross section cylinder 2′, prior to radial compression to form the cylinder 2. The coaxially located withdrawal string 3, shown in the cylinder 2′, is also coaxially surrounded by a permanent bond means 4 extending the length of the cylinder 2′. The cylinder 2′ has area ends 5 and 5′. The permanent bond means 4 is an annular cylindrical-shaped zone which is shown in enlarged cross-sectional detail in FIG. 1*c*, taken through 1*c*—1*c* of FIG. 1*b*.

I have found that the permanent bond means 4 can comprise a thermally fused bond formed between a fused yarn structure of the withdrawal string and the regenerated cellulose sponge structure. The fused yarn is cooled to room temperature to form a permanent bond means 4. I have also found that the permanent bond means 4 can be formed by a hot melt adhesive, cooled to room temperature to form a bond between the withdrawal string and the regenerated cellulose sponge structure. My permanent bond means 4 provides a bond between the withdrawal string and the regenerated cellulose sponge which will withstand the stresses of commercial storage conditions, immersion in menstrual fluid and the force required to remove a wet used tampon from a vagina.

I have found that a bifilament withdrawal string made of 50 wt. percent regenerated cellulose rayon yarn—50 wt. percent cellulose acetate yarn, made in a conventional two-ply with a wet strength of 6.5 pounds, is a representative bifilament yarn or string useful in my invention.

By using such an above described bifilament yarn as the withdrawal string 3 in the cylinder 2, I may then thermally fuse or melt the cellulose acetate yarn in the string 3. On cooling the fused yarn, the solidifying cellulose acetate yarn melt will bond to both the rayon yarn and the regenerated cellulose sponge, particularly if the sponge is rapidly radially compressed, before the fused yarn begins to solidify. I use a second nonmelting or nonthermally decomposing yarn as a second filament in the bifilament yarn structure, to provide a second strength member of the bifilament yarn which will not fuse. A fusible yarn used alone may stress crack on cooling, possibly breaking off the withdrawal string on application of the force required to withdraw a used tampon from a vagina, the nonfusing yarn will not break off.

Cotton yarn plied with cellulose acetate yarn is also a suitable bifilament yarn construction for my withdrawal string 3. Cotton yarn plied with polyvinyl chloride yarn; also regenerated rayon plied with nylon yarn, or like combinations of fusible yarns plied with nonfusible yarns can be used to make my withdrawal string 3. The bifilament yarns form a permanent bond means 4 on application of the required heat of fusion for the fusible yarn, followed by rapid radially compressing the cylindrical tampon, allowing the fused yarn to cool and solidify.

I have likewise found that a hot melt adhesive can coat, or impregnate and coat, a nonfusible string, forming a string composition which is not melted or sticky at body temperature, or soluble in menstrual fluid. A typical mercerized cotton string impregnated and coated with a plasticized cellulose diacetate composition can be used to form a suitable string 3. The above cotton string, with the plasticized cellulose acetate coating thereon, is preheated prior to location in the sponge billet, but not to the coating fusion temperature. After locating the preheated, coated cotton string in the sponge cylinder, both the sponge cylinder 2 and the coated string are further heated above the fusion temperature of the cellulose acetate coating and then rapidly compressed. The compressive force aids the formation of a strong permanent bond means 4 between the withdrawal string 3 and the sponge cylinder 2, when the string **3** and sponge cylinder **2** are cooled to room temperature.

Other nonfusible yarns or strings, selected from cotton, linen, hemp, regenerated cellulose rayon or the like, can be combined with hot melt adhesive coatings. Suitable hot melt coatings are plasticized vinyl chloride resin, plasticized vinyl acetate vinyl chloride copolymer, plasticized cellulose acetate butyrate, polyethylene or the like fusible coatings. My hot melt coatings should not fuse or lose bonding strength at human body or commercial storage temperatures, yet should be readily fusible at the higher temperatures to which the regenerated cellulose sponge can be heated without decomposing the sponge. Controlled heating of all bond components can effect a good bond between the sponge, the cooled and solidified hot melt coating, and the nonfusible, yarn or string.

I have invented a method of rapidly manufacturing a multiplicity of menstrual tampons in a combination of simple steps, also enabling the manufacture in seconds of multiple lots of several hundred tampons on one machine of my invention, as described herein.

In my method, a billet of dry, expanded, fine-pore, regenerated cellulose sponge is shaped to provide a thickness equal to a typical tampon length, as for the tampon device of FIG. **1***a* or **1***b*, and also to provide a pair of parallel plane billet faces. One separate billet face area is at least equal to the combined areas of the ends **5** and the other billet face is equal to the combined areas of the separate ends **5'** for the multiple number of tampons to be made in one lot. An additional small rim area of the sponge billet provides a mounting means during the manufacturing procedure.

My method is summarized as follows:

1. Place a dry, expanded, fine-pore, regenerated cellulose-shaped sponge, sufficing in face area for multiple tampons, in position under a multiple strings insertion means. See FIG. **3**, for example.

2. Optionally, preheat the multiple-bondable withdrawal strings and the sponge billet to a temperature slightly less than the respective fusion temperatures of the fusible yarn structure or the hot melt adhesive coating of FIG. **1***c* of my above described withdrawal string structures. See FIG. **1***c* and FIG. **3**, for example.

3. Insert the multiple-bondable withdrawal strings simultaneously into a multiplicity of parallel, regularly spaced positions, perpendicular through both parallel plane faces of the sponge billet, each string located in a position adapted to later form a coaxial string length in a single tampon. See FIG. **4**, for example.

4. Heat the cellulose sponge billet and the multiple-bondable withdrawal strings to the required fusion temperature for the respective fusible yarn structures or the hot melt coatings. See FIGS. **5** and **6**, for example.

5. Very rapidly after the step **4** above, simultaneously cut the sponge billet into a multiplicity of individual polygonal sponge cylinders, each one of said polygonal cylinders shaped and arranged to contain a single withdrawal string coaxial with the axis of the cylinder length. See FIGS. **7**, **8** and **9**, for example.

6. Very rapidly after step **5** above, simultaneously radially compress each one of the multiplicity of individual polygonal cylinders to a diameter range of 0.40–0.50 of the original polygonal cross section area cylinder diameter. See FIGS. **7**, **8** and **9**, for example.

7. Cut the multiple withdrawal strings to the required lengths.

As further steps in my process I may proceed further with the multiple lot of tampons, as follows:

8. Drop and align the inner plunger tubes of a multiplicity of a pair of telescoping tampon insertion tubes, along the uncut multiplicity of withdrawal strings, prior to insertion of the individual tampons in the outer tampon insertion tubes.

9. Place each one of the multiplicity of individual compressed tampons into the separate individual outer tampon insertion tubes, by the application of a pneumatic or ram force to the tampon end from which the withdrawal string extends.

10. Then, cut the multiple withdrawal strings to the required lengths.

Referring to FIG. **2** through FIG. **9**, I illustrate embodiments of my machine invention which can rapidly, simultaneously manufacture my menstrual tampons of FIGS. **1***a* and **1***b* in large lots. My machine invention embodies the steps of my process invention; however, my process invention can be practiced by other means than shown in my machine invention. I do not wish to be limited in my process invention to the machine invention herein disclosed and claimed.

Referring to FIG. **2** in detail, my tampon-manufacturing machine **21** has a rotary index table **23** adapted to rotate on the pivot means **40**, with the three index stations I, II and III, as shown. Each station I, II and III of the index table **23** has a withdrawal string yarn hopper **24** disposed thereon, adapted to provide a multiple cone storage source of yarn for withdrawal string for each of three multiple yarn insertion means **25**. The multiplicity of parallel, regularly spaced bondable withdrawal string yarn are arranged to simultaneously feed from the yarn cones located in the yarn hopper **24**, individually through multiple yarn insertion means **25**. The multiple-yarn insertion means **25** are shown located directly above and cover an inner plunger tube tray at each station I, II, III. A fourth inner plunger tube tray **26** is shown in an inner plunger tube-loading position in the station I area, adjacent to an automatic inner plunger tube loader and photoelectric eye tube position scanner **27** which counts the number of tubes in the tray **26**.

In the station II area of FIG. **2** the high frequency dielectric power heater **28** is shown, connected by wires **29** and **30** to the electrodes (not shown) located below the multiple-yarn insertion means **25**. At station III of FIG. **2**, the multiple-yarn insertion means **25** shown is located directly above a multiple-die-cutting, sponge-compressing and tube-loading means, not shown. At tray **31** the multiplicity of tampons are being unloaded, each tampon enclosed in a pair of standard telescoping insertion tubes and the withdrawal string **3** projecting from one end of the inner plunger tube. At tray **32** the multiplicity of outer tampon insertion tubes are loaded from an outer insertion tube loader **33**, which is provided with a photoelectric eye scanner to count the number of tubes loaded in tray **32**.

The three hollow arms **34**, **35**, **36** are adapted to support the trays **32**, **31** and the tray located underneath the insertion means **25** at station III, and also adapted to rotate on the pivot means **39**. The compressed air vacuum source means **37** is connected through the hollow tube means **38** to the three rotary hollow arms **34**, **35**, **36**, to provide air pressure or vacuum to the trays, as required on signal. The rotary index table **23** rotates on the pivot means **40** on signal, to transfer a partially fabricated product output from station I to station II, then to station III and final unloading of the multiplicity of individual tampons.

The inner plunger tube loader **27** operates on signal in a reciprocal motion along guide means **41**, to index above the inner plunger tube tray **26** for loading purpose. The outer tampon insertion tube loader **33** also operates on signal in a reciprocal motion along guide means **42**, to index above the tray **32** for loading purposes. Personnel are stationed at stations I and II for manual tending and control operations.

At station I, referring to FIG. **3** in detail, the withdrawal string yarn hopper **24** is shown elevated above the rotary index table **23**. A multiplicity of heat conductive heater tubes **43** contain the bondable yarns, electrically preheated to just below the fusion temperature of the permanent bond means **4**. The multiplicity of tubes **43** are flexible and attach to the yarn insertion needle force plate **45**. The plate **45** has a multiplicity of hollow needles **46** secured to it, the needles **46** spaced and adapted to insert the multiplicity of withdrawal string yarns, one yarn extending through each single needle **46**, and through the inner plunger tube tray **47**. Each individual hollow needle **46** has a yarn terminus protruding slightly from the open needle terminus. The multiplicity of needles **46** can be inserted in the sponge billet **48** by a force applied to the force plate **45**. The length of the needles **46** and the guided downward motion of the force plate **45** are both adapted to control the penetration of the needles completely through the sponge billet **48**. The bottom plate of the inner plunger tube tray **47** forms a combination electrically insulated electrode and force plate **49**, which can secure the sponge billet **48** in position on the rotatable corner billet supports **50**, above the opening **51** of the index table **23**. There is a separate similar opening **51** at each corresponding position of stations II and III of the table **23**. FIG. 3 illustrates my index table **23** station I prior to insertion of the hollow insertion needles **46** in the sponge billet **48**.

At station I, referring to FIG. 4 in detail, multiple hollow insertion needles **46** coaxially extend through the inner plunger tubes **52**, and also pass through the openings **53** in the bottom combination electrically insulated electrode and force plate **49** of the electrically nonconducting, inner plunger tube tray **47**. The hollow needles **46** are shown positioned with their open terminii **54** flush with the bottom face **55** of the sponge billet **48**. The withdrawal string yarn tips **56** are shown projecting a small distance (one-eighth–one-fourth inch) below the sponge billet face **55**.

The rotary tube retainer rods **57** are shown in cross section view located in the combination electrically insulated electrode and force plate **49**. The conical plunger tube tray entrances **58**, and the conical plunger tube tray exits **53**, facilitate the movement of the plunger tubes through the close fitting tube openings **59**.

In FIG. 4*a* I show details of my rotary tube retainer rods **57** in projected sectional view. The view shows the pair of retainer rods **57** inserted in the pair of close fitting cylindrical openings **61**, with the pair of lands **62** shown projecting as tube stops into the inner plunger tube circular openings **53** in the plate **49**. Each of the rods **57** rotate within the cylindrical opening **61** on signal. When the pair of lands **62** of the pair of rods **57** are rotated 180° in the cylindrical openings **61**, the pair of lands **62** are indexed into the openings **61**, permitting any inner plunger tube **52** to drop down from the tray **47**, as in FIG. 4.

In FIGS. 5 and 6 the elevation view of the machine through II—II of station II shows the yarn cone hopper **24**, the yarn heater tubes **43**, the needle force plate **45**, and the multiplicity of hollow needles **46** which were shown in detail in FIGS. 3 and 4. In this view of station II the needles **46** have been withdrawn from the sponge billet **48**, also through the openings **59** of the tray **47**, to a position coaxially and vertically above the openings **59**. Just prior to withdrawing the needles **46** as described above, the lower electrode clamp plate **64**, which is permanently located at station II is elevated from below the index table **23**, from the position of electrode clamp plate **64'**, compressively securing the yarn projections **56'**. The electrode clamp plate **64** is then located in contact with the face **55** of the billet **48**, compressing the yarn projectors **56** into close physical contact with the billet **48**, as shown in detail in FIG. 6. The surface of the electrode clamp plate **64** adjacent the sponge billet **48** is coated with tetrafluoroethylene resin to prevent the sticking of fused yarn or adhesive and the like to the plate **64**.

Thus, in station II, as illustrated by FIGS. 5 and 6, the sponge billet **48** is clamped between the electrode clamp plate **64** and the force plate **49**, the electrode clamp **64** compressively securing the yarn projections **56'**. The high-frequency dielectric heating power source **28** is turned on or activated on signal, when the components are in the detailed position illustrated in FIG. 6. The high-frequency power is conducted to the electrode clamp **64** and force plate **49**, through the wire conductors **29** and **30**.

In FIGS. 7 and 8 I show further steps in the operation of my machine at station III. In FIG. 7 I show the yarn cone hopper **24**, the heat conductive heater tubes **43**, the force plate **45** and the multiplicity of insertion needles **46**, all together operated as a component subunit, and shown elevated perpendicularly above the other station III operations taking place below. The multiplicity of withdrawal string yarns which connect the sponge billet **48** to the yarn cone hopper **24** at stations I and II are now cut.

Further, in FIG. 7 the tray **47** is now pushed down and rests on the honeycomb die plate **66**, which is permanently indexed below the index table **23** at the opening **51**. A shaping orifice plate **67** lies directly below the die plate **66**. A vacuumtight tampon compressor die **68** lies directly below the orifice plate **67**, and a vacuumtight outer applicator tube tray **69** lies directly below the die **68**. The tubular rotary arms **35** and **36** support the two shown separate sets of cooperative multiple die-cutting means, multiple individual radial compressive means, and multiple tampon insertion means for outer applicator tubes embodied in components **66**, **67**, **68** and **69**. The arms **36** and **35** rotate on the pivot means **39**, and are supplied through line **38** with the air pressure and vacuum means on signal. In FIG. 7, the sponge billet **48**, which was shown earlier at stations I and II in FIGS. 3, 4, 5 and 6, is now die cut into a multiplicity of individual polygonal sponge cylinders which are inside the components **66**, **67**, **68** and **69** located in the opening **51**.

In FIG. 8 I show the details of my multiple die-cutting means **66**, multiple individual radial compressive means **67** and **78**, and multiple tampon insertion means **93** for outer applicator tubes. The view shows an individual regular hexagonal cross section, cylindrical tampon **74** radially compressed in the tampon compressor means **78**. Prior to the compression step, the tray force plate **49** has moved vertically downward, forcing the sponge billet **48** through the sharp edges of the regular hexagonal-shaped honeycomb-cutting die **70**, then through the converging venturi-type-shaped opening of the shaping orifice **72**. The cutting die **70** cuts the sponge billet into a multiplicity of individual hexagonal cross section cylindrical tampons, one tampon in each shaped die opening of die **70**. The shaping orifice **72** lying directly under the thin wall blades of the die **70**, supports the die **70**, on the top plate **71** of the compressor mold means **78**. The orifice **72** slightly reduces the diameter of the tampon when the tampon is pushed through the cutting die **70**, and then through the orifice **72**. The tampon **74**, prior to the radial compression step, drops into the thin wall, rubber tubular membrane hollow cylinder **73**. Prior to dropping tampon **74** into cylinder **73**, the thin wall, rubber cylinder **73** is in the fully stretched or expanded state, as a result of applying a vacuum to the interior of the compressor mold means **78**. The compressor mold means **78** is an airtight mold or box having the top plate **71** and the bottom plate **76**. The individual thin wall, rubber tubular membrane hollow cylinders **73** are secured to the top plate **71** and the bottom plate **76** by the expanding retaining rings **75** and **77** respectively. The retainer rod lands **79** can be rotated on signal in the cylindrical openings **80**, providing a stop for the tampon sponge as it is pushed through the orifice opening **72** and drops into the expanded cylinder **73**. The lands **79** distend the rubber cylinder **73** when rotated into position against the rubber membrane, providing the stop. When high-pressure air is applied on signal to the interior of the compressor mold means **78**, the tampon sponge **74** is radially compressed.

The outer applicator tube tray **69** of FIG. 7 is shown in structural detail in the outer applicator component tray assembly **93**, wherein the removable tray top plate **82** and the removable tray bottom plate **83** enclose the evacuable components. The removable top plate **82** has a multiplicity of shaped openings **94**, one opening **94** coaxially located directly below each rubber tubular membrane cylinder **73**. Between the removable top plate **82** and the support plate **84**, the outer tampon applicator tube **86** is supported perpendicularly in the opening **92** in the tube block **85**. The removable top plate **82**, the tube block **85**, and the support plate **84** have a set of concentric or coaxial openings located therein, providing an aligned passage for the radially compressed tampon on release of the stop provided by the bands **79**, when they are engaged to distend the rubber tubular membrane **73**. By providing for the evacuation of the outer applicator tray assembly **93** on signal, together with the simultaneous evacuation of the vacuumtight compressive mold means **78**, and the simultaneous rotation of the lands **79**, to release the tampon stop, the compressed tampon is pushed by the atmosphere above the tampon into the evacuated outer applicator tube **86**. The tube **86** is held in position by the close fitting opening **92** in the tube block **85** and the rotary lands **90** of the retainer rods **89** in the openings **91**. The openings **87**, **88** provide ample space for evacuation of tray assembly **93**, preventing the collapse of the tube **86** due to a pressure differential across the thin tube wall.

In FIG. **9** I show a further modification of my individual radial compressive means adapted to receive the individual tampon cylinder and to radially compress the tampon. Inner plunger tubes **52** are shown located in the tube tray **47**, concentric with the yarns **66'**, and adjacent the force plate **49**. The lands **62** of the retainer rods **57** are in the exposed position supporting the tube ends. The force plate **49** is exerting a uniform pressure on the sponge billet **48'**, pushing the billet down on the regular hexagon-shaped honeycomb die **70'**, which cuts the billet into individual tampons. The shaping orifice **72'** has a venturi-type contour entrance, which begins the radial compression step. The force applied by the force plate **49** is assisted by the vacuum applied through the conical openings **101** of the conical-shaping dies **100**. Thus the sponge billet **48'** is shown partially cut into individual tampons having the faces **55'** and the yarn projections **56'**. The vacuum is obtained by evacuating on signal the tray **69'** through the opening **87'**, the opening **88'** and the empty outer applicator tubes **86'**. The tubes **86'** are located in the openings **92'** in the tray **85'**, supported by the retainer rods **91'**. As the force plate **49** pushes down the sponge billet **48** and completes cutting the billet into individual tampons, the vacuum sucks and elongates the individual tampons. The pressure differential between the individual sponge face **55'** and the opposite end of the sponge tampon may be increased by increasing the air pressure through the inner plunger tube **52**. The pressure differential forces the individual sponge tampons down through the conical mold openings **101**, into the individual outer applicator tubes **86'**.

In the compressed tampon-forming means of FIG. **8**, when the tampon **74** drops and is sucked into the outer applicator tube **86** on signal, a similar signal actuates the retainer rods **57**, permitting the inner plunger tube **52** to drop down along the uncut yarn **66** as a guide. The tube **52** passes through the expanded rubber cylinder **73**, locating on top of the tampon end **95**. Similar steps can take place on signal in the compressed tampon-forming means of FIG. **9**, placing the inner plunger tube **52** on the compressed tampon face opposite tampon face **55'**.

As a final step I sever or cut the yarn **66** to form a completed tampon with a withdrawal string. The yarn-cutting step may be completed simultaneously with the arrival in final position of the tampon **74** in the applicator tube 86. In FIG. **8** I show a pair of cutting blades **96**, which can move in a reciprocating horizontal motion, cutting the yarn **66** on signal, to form a tampon withdrawal string.

My invention uses dry, expanded, regenerated cellulose sponge of fine-pore structure as a basic raw material. I define expanded, fine-pore regenerated cellulose sponge as the dry sponge of fully distended pore structure, not yet subjected to a compressive force which collapses the pore dimensions.

Typically, my white sponge has pores in the dry, expanded state ranging from 0.5 to 2.0 mm. diameter and the like, and a 1 mm. pore diameter is common. A typical dry, expanded regenerated cellulose sponge density is 0.0296 g./cc. When fully saturated with water the typical regenerated cellulose sponge density is 1.00 g./cc., so a fully saturated wet sponge may absorb approximately 0.97 g./cc. of water or relatively similar density menstrual fluid.

I may preheat the sponge billet **48**, or the like, in an air heated oven, or the like, prior to placing the sponge billet on the station I four rotatable corner supports **50**. The sponge billet may be preheated in the oven to 250° F. and then transferred to station I, then station II and station III. Thus, time and electric power input required for the yarn fusion step at station II is decreased. I may also conductively preheat the yarns **66** in the heater tubes **43**, or the like, preheating the yarn to slightly less than the fusion temperature of the fusible yarn structure or the hot melt adhesive of the yarn **66** modification. Thus, a shortened heating cycle is possible for the station II. FOr example, I may preheat the sponge billet to 250° F. in an air oven, and preheat a permanent bond means 4 forming modification, such as a hot melt adhesive coated yarn to a temperature just below the fusion temperature of the hot melt adhesive. Then the hot melt adhesive coated yarn **66** is inserted in the hot sponge billet and the fusion of the hot melt adhesive can be completed, as the adhesive melts at a temperature below the sponge billet temperature. Thus, the electrical heater requirement of the dielectric power heater **28** or the like is completely eliminated.

If additional heat energy is required as an input at station II, the high-frequency dielectric power heater is a very suitable heater means for rapidly generating the heat with the sponge billet and the yarn, where it is needed, As an example, an 11×11 inch parallel face area ×2 ¼ inch thick dry, expanded sponge billet can be heated to about 250° F. in less than 2 seconds, but the application of 12 kilowatts of 40.68 mc. at 10,000 volts. Preheated bifilament yarn of cellulose rayon yarn and cellulose acetate yarn plied together may be conductively preheated, then inserted in the sponge billet in station I, and further heated in the station II dielectric power heater to the cellulose acetate yarn ply fusion temperature range, as I have earlier described. I may use other high-frequency power bands allotted to industrial use, ranging typically from 13.56 mc., 27.12 mc., to 40.68 mc., with corresponding changes in required dielectric heating times.

An advantage of my process and of my machine is the conservation of regenerated cellulose sponge raw material and the high rate of simultaneous manufacture of radially compressed tampons. Typically, an 11×11 inch billet face of sponge can be cut into approximately 400—9/16 inch cross section hexagons with a honeycomb opening die. Likewise, a 10×10 inch billet face can be cut into approximately 280 tampons of ⅝-inch hexagon cross section diameter, and approximately 203 tampons of ¾-inch hexagon cross section diameter, all diameters measured normal to two opposite parallel edges of the hexagon. I may likewise simultaneously cut ⅞, ¾ or ⅝ round cross section tampon contiguous cylinders in appropriate numbers from a sponge billet. Each tampon cylinder-cutting die is matched with a corresponding coaxial yarn insertion needle centered on the tampon die center, so as to provide a withdrawal string yarn coaxially located in the polygonal cross section cylinder length of sponge.

I may use also a standard straight-sewing needle having an eyelet on the free needle end, with the yarn inserted through the needle eyelet, as in standard industrial sewing practice.

My dry, radially compressed minimum pore volume, regenerated cellulose tampons, having coaxially located withdrawal strings permanently bonded the length of the sponge cylinder, have been tested in menstrual absorption application with very favorable results. The small diameter radially compressed sponge cylinder does not cause discomfort in females and is easily inserted by a correspondingly sized conventional pair of telescoping paper tubes. The sponge tampon expands on absorption of menstrual fluid and is removed by pulling on the permanently bonded withdrawal string **3**, or the like. The wet sponge is soft and pliable, and does not damage or tear tissue. If the menstrual fluid is insufficient to fully wet the tampon, the dry portion of the tampon does not expand, and hence is easily removed from the vagina.

Typical absorption test data is listed below in table I. The data clearly establish the use of my tampon to absorb a daily menstrual flow at the range of normal flow rate in a normal use pattern, without discomfort. In addition, the relative small diameter of my radially compressed tampons are supported in table II by the comparison of my sponge tampon diameters, before and after radial compression to a minimum pore volume. I compare both dry, expanded regular hexagon polygons and circular cross section tampons, since for my purpose I classify a circle as an infinite sided polygon. The radial compression ratio is substantially constant, independent of the tampon expanded cross section diameter.

TABLE I.—TAMPON PERFORMANCE

Test No. 1.—Tampon size: 7/8 inch hexagon x 2½ in. long; Dry blank wt.: 0.9 gram

Tampon No.	Day of menstrual period	Time		Tampon weight (grams)
		Insertion	Removal	
1	1st–2nd	10:00 P.M	8:30 A.M	11.0
2	2nd	8:30 A.M	11:00 A.M	9.0
3	2nd	11:00 A.M	1:30 P.M	11.5
4	2nd	1:30 P.M	4:30 P.M	10.1
5	2nd	4:30 P.M	8:30 P.M	9.0

Test No. 2.—Tampon size: ¾ inch round x 2¼ in. long; Dry blank wt.: 0.8 gram

Tampon No.	Day of menstrual period	Insertion	Removal	Tampon weight (grams)
1	1st	8:00 P.M	10:00 P.M	5.0
2	1st–2nd	10:00 P.M	6:45 A.M	7.2
3	2nd	6:50 A.M	11:10 A.M	3.0
4	2nd	11:10 A.M	4:30 P.M	3.2
5	2nd	4:30 P.M	8:15 P.M	3.9
6	2nd–3rd	8:15 P.M	2:30 A.M	1.9
7	3rd	2:30 A.M	8:40 A.M	4.7
8	3rd	8:40 A.M	12:45 P.M	1.2
9	3rd	12:45 P.M	6:00 P.M	3.1

TABLE II.—TAMPON DIAMETER COMPRESSION RATIOS

Tampon No.	Before compression (inch)	After compression (inch)	Ratio (after compression/before compression)
1	0.56 round	0.25	0.45
2	1.00 round	0.44	0.44
3	0.75 round	0.31	0.42
4	0.75 hexagon	0.31	0.42
5	0.88 hexagon	0.39	0.44
6	0.63 hexagon	0.28	0.44

Obviously, many modifications and variations in my menstrual tampon, method and machine for manufacture of menstrual tampons may be made in the light of my teachings. It is therefore understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A process for manufacturing a menstrual tampon comprising: inserting a multiplicity of parallel, regularly spaced, bondable withdrawal strings perpendicularly through a first face of a pair of opposed parallel faces of a billet of dry, expanded, fine-pore regenerated cellulose sponge, to the required depth in said billet; heating said multiplicity of bondable withdrawal strings and said billet to a bonding temperature, then rapidly and simultaneously cutting said billet into a multiplicity of polygonally shaped sponge cylinders, each one of said polygonal sponge cylinders arranged to contain a single coaxial bondable withdrawal string; then rapidly radially compressing to a cylinder of circular cross section and minimum pore volume each of said multiplicity of polygonal sponge cylinders, each single radially compressed cylinder forming a bond with one of said multiplicity of bondable with withdrawal strings; and cutting said multiplicity of withdrawal strings at the required lengths.

2. In the process of claim 1, the step of inserting a multiplicity of parallel, regularly spaced, bondable withdrawal strings perpendicularly through a first face and a parallel, opposed second face of a billet of dry, expanded, fine-pore regenerated cellulose sponge, each one of said multiplicity of withdrawal strings being positioned to form-securing terminus exteriorly adjacent said second face of said billet.

3. In the process of claim 1, the step wherein said multiplicity of parallel, regularly spaced, bondable withdrawal strings inserted into said billet of dry, expanded, fine-pore regenerated cellulose sponge are heated to bonding temperature by high frequency, electrical energy dielectric heat generated in said withdrawal strings and said adjacent billet.

4. In the process of claim 1, the step wherein said multiplicity of parallel, regularly spaced, bondable withdrawal strings, perpendicularly inserted into said billet of dry, expanded, fine-pore, regenerated cellulose sponge are conductively heated to bonding temperature.

5. In the process of claim 1, the step of rapidly radially compressing to a minimum pore volume a multiplicity of polygonal sponge cylinders to a multiplicity of single compressed sponge cylinders of circular cross section by simultaneously enclosing each single polygonal sponge cylinder in an individual, thin wall tubular rubber membrane, and uniformly applying pneumatic pressure to the exterior face of said individual rubber membrane, whereby said membrane radially compresses each single polygonal cylinder to a cylinder of circular cross section and minimum pore volume.

6. In the process of claim 1, the step of rapidly compressing radially said multiplicity of polygonal sponge cylinders to a multiplicity of single compressed sponge cylinders by simultaneously passing each single polygonal cylinder through a single hollow truncated cone means; initially inserting a first end of each polygonal sponge cylinder into the larger opening of said cone means, then applying a forcing means to said first end of each sponge cylinder, while simultaneously applying an evacuating means to the smaller opening of said cone means, thereby radially compressing said sponge cylinder and ejecting the radially compressed sponge cylinder from the smaller opening of said cone means.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,607,520 **Dated** September 21, 1971

Inventor(s) John Leslie Jones

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Column 2, line 5, "sting" should read -- string --.
In Column 3, line 33, "sufficing" should read -- sufficient --.
In Column 8, line 7, "FOr" should read -- For --.
In Column 8, line 21 "needed, As" should read -- needed. As --.
In Column 8, line 23, "but" should read -- by --.
In Claim 1, line 8, delete "with" second occurrence.

Signed and sealed this 28th day of March 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents