Aug. 28, 1962 G. J. LILOIA ETAL 3,051,171

SURGICAL DRESSING

Filed Feb. 4, 1959 2 Sheets-Sheet 1

Fig. 1.

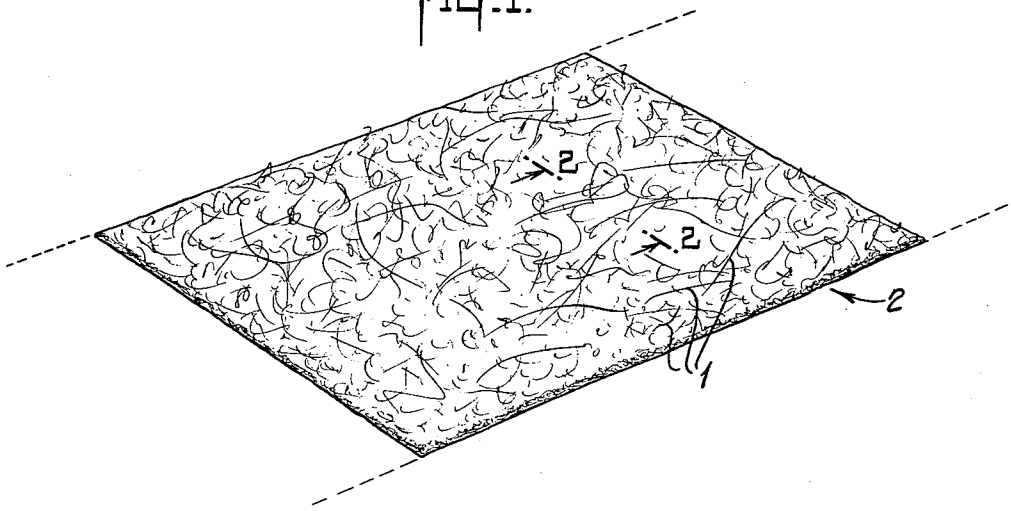


Fig. 2.

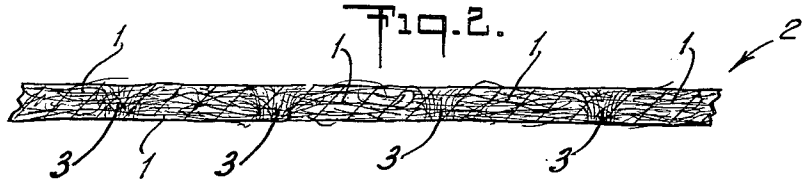
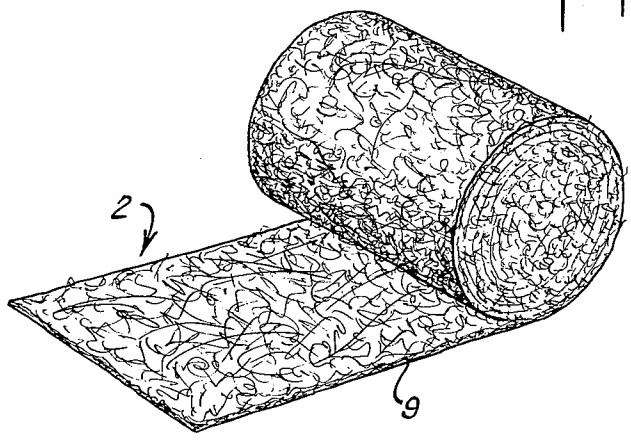


Fig. 3.



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Fig. 4.

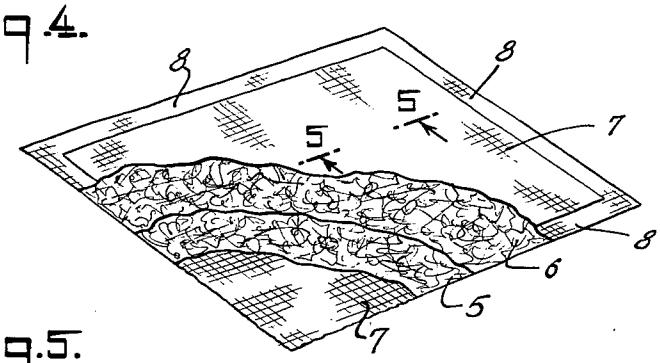


Fig. 5.

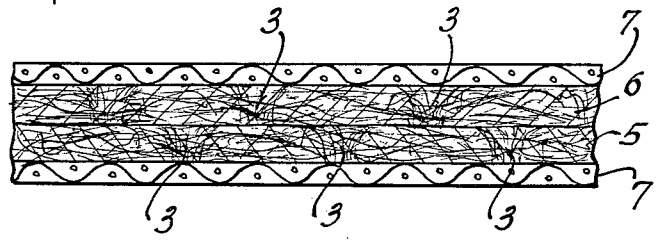




Fig. 6.

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SURGICAL DRESSING

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11 Claims. (Cl. 128—156)

The present invention is drawn to materials suitable for the treatment and protection of wounds and to dressings and bandages made therefrom.

It is standard practice in the treatment of wounds to place over the wound a protective covering or wrapping generally referred to as a dressing or bandage. These dressings or bandages, hereinafter referred to as surgical dressings, serve to protect the wound from outside contact and to absorb wound exudate which, with many types of wounds, may be copious. The surgical dressing not only serves to protect the wound from any outside physical contact which would be painful to the patient but also serves to protect the wound from outside contamination. Although it is recognized that bacteria can be carried by the air and that the wound can be contaminated by air-borne bacteria, it is frequently desirable to permit access of air to the wound to prevent maceration of the skin area adjoining the wound surface. Also, exclusion of all air from the wound tends, in some instances, to interfere with the healing process. Any dressing material which would be readily permeable to air but which would act to filter out most air-borne contamination would therefore be highly desirable for dressing and treating wounds. Particularly, a material of this type which also had a high fluid capacity would be an excellent dressing material.

It has now been discovered that materials of this type can be produced by needling a web of cellulosic fibers. The term "cellulosic fibers," as used herein, includes both fibers formed entirely from cellulose, such as cotton and regenerated cellulose, as well as hydrophilic fibers formed from cellulose derivatives, such as cellulose acetate, cellulose propionate, cellulose butyrate and other cellulose esters and ethers. This needling is carried out by passing barbed needles down through the web to force a portion of the fibers through the main fiber body and mechanically interlock the fibers together. Materials formed in this manner are hereinafter referred to as "needle loomed" fabrics. By starting with a web formed of fibers having a fiber length of 1" to 3" and a denier of about 1 to 5.5 and passing the needles though the web to give needle penetration of at least 50 penetrations per square inch, fabrics having excellent filter characteristics are obtained, particularly where used in several plies so that the areas of needle penetration are covered. These fabrics also show very little resistance to air flow and have high fluid capacities. However, these fabrics are found to have a very low tensile strength and cannot be used except as an absorbent filler or in some other capacity where tensile strength is immaterial. The fabrics, however, are unsuitable for use as dressings in the form of wraps or bandage strips or where the fabric is apt to contact the wound because of the danger of fibers coming loose and becoming embedded in the wound.

It is the conventional practice to treat fibers with a lubricant prior to the carding operation. The lubricant is generally present on the fibers in amounts of 0.2 to 0.3% by weight of the fiber, the lubricant in conventional practice being applied to the fibers in the form of a water emulsion. The lubricant is generally applied by the manufacturer or, where the fiber is a natural fiber such as cotton, by the fiber processor and supplied to the weaver or fabric processor with the lubricant already on the fiber.

We have now descovered that the tensile strength of the needle loomed fabric formed of cellulosic fibers can be substatially increased by maintaining the lubricant content of the fiber within a range of about 0.02 to 0.1% by weight lubricant based on the weight of the lubricated fiber and preferably below 0.06%.

The lubricant may be any of the conventional fiber lubricants, some examples of which are the polyoxyethylene monolaurates, oleic acid, sodium oleate, sodium stearate and other metal soaps or fatty acids. Where the amount of lubricant is much in excess of 0.10, the resulting fabric, even when needled to as high a degree as 200 needle penetrations per square inch, is found to be quite weak, having tensile strength in the strongest direction of less than 90 grams per inch of width. Tensile strengths throughout the present specification are on the basis of a pull rate movement of 1.5 inches per minute. The tensile strength indicates the force required for complete separation of fabric.

The preferred cellulosic fibers are those formed from regenerated cellulose such as viscose rayon, the crimped fibers generally being preferred over those possessing no initial crimp.

In preparing the needle loomed fabrics of the present invention, a web of fibers is first prepared generally having a weight of about 1 to 5 ounces per square yard. This web is fed into a conventional needle loom having a vertically reciprocating plate carrying a plurality of barbed needles. The barbs are generally formed to catch fibers on the downward travel of the needle, forcing these fibers through the carded web. A stripper plate is provided above the web, the needles passing through the stripper plate. On the upward movement of the needle carrying plate, the stripper plate prevents the fiber web from following the needles and permits withdrawal of the needles prior to the next penetration. On withdrawal of the needles, the web is moved forward a predetermined distance. The forward movement of the web is then stopped and the needle plate, with its needles, again lowered. This operation is repeated again and again, each needle penetration being in a different area due to the intermittent forward web movement.

It has been found that not only does the degree of needling affect the tensile strength of the finished fabric but spacing of the stripper plate above the carded web also has some effect. In order to obtain needle loomed fabrics of cellulosic fibers in which the fabric tensile strength is in excess of 100 grams per inch of width, generally at least 100 needle penetrations per inch are required. It is also desirable to have the stripper plate close to the face of the web being needled. However, it should not be so close as to place a drag on the movement of the web.

The effect of degree of needling and height of stripper plate are well illustrated by the following table. The

needle plate used contains 4.4 needles per square inch. The needles have an equilateral triangular cross section, the base of the triangle being 0.026 inch, and containing 3 spaced barbs on each edge, giving a total of 9 barbs per needle. The web is formed of crimped rayon fibers having a denier of 3.0 and a staple length of 1.125 inches. The fiber contains about 0.035% by weight polyoxyethylene sorbitan monolaurate as lubricant. The web has a thickness of about 0.030 inch and a weight of about 2 ounces per square yard.

Tensile Strength In Grams Per Inch of Width	Stripper Plate Height Inches Above Bed Plate	Needle Penetrations Per Square Inch
146	0.38	243
110	0.63	243
102	0.38	120

In the preferred fabrics 125 to 400 needle penetrations per square inch are used.

An examination under a microscope of a cross section of needle loomed fabric shows the fabric to be formed of longitudinally extending fibers bound together by fibers extending down through the fabric, the whole body of fibers being mechanically interlocked and bound together with numerous openings or cells between. It is apparently this structure together with the hydrophilic nature of the fibers which gives the fabric its high fluid capacity, ready permeability to air, good filtering ability, and other characteristics which make it such an excellent dressing material.

Not only do these materials have a high fluid capacity, but the materials also act to rapidly absorb and spread fluids. This is probably due in large part to the fiber arrangement whereby the fibers extending down through the fabric act to wick fluids up into the main fiber body. These downwardly extending fibers also resist flattening or pressing together of the fibers of the fabric, giving the fabric its soft and resilient characteristics which make it so suitable for wound protection.

This high capacity for fluids is particularly useful in the treatment of heavy drainage wounds. It not only enables the use of lighter dressings, but it also decreases the amount of dressing material needed and thus materially reduces the cost of wound treatment. It further acts to reduce the number of changes of dressings that might otherwise be required. The high fluid capacity is also helpful where wet dressings are employed, the dressing being wet with a medication either before or after application to the wound.

As previously stated, fabrics formed by needle looming cellulosic fibers offer very little resistance to the passage of air. This ready permeability to air is highly advantageous in a wound dressing as long as it does not permit contamination of the wound, since the ready access of air prevents maceration and hastens the healing process. Where the dressing is prepared of several layers of needle loomed cellulosic fibers, so that the areas of needle perforations are covered, dressings having excellent filter characteristics while offering little resistance to air flow are obtained. For example, 2 plies of needle loomed fabric formed of rayon fibers, each having a thickness of 0.068 inch and 184 needle penetrations per square inch completely filters out air-borne dye particles having a size such that at least 30% of the particles are 1 micron or less. Yet, this same 2-ply fabric offers negligible resistance to the flow of air therethrough. The product with an air flow of 85 liters per minute through a surface area of 227 square centimeters gives a pressure drop of only 0.01 inch of water.

It is frequently desirable when a limb is immobilized by placing it in a plaster cast or where a joint, such as a sprained ankle, is immobilized or supported by wrapping with adhesive tape to place next to the skin a cushioning material to protect the enclosed area from undue soreness resulting from the plaster cast or the tightly wrapped adhesive tape pressing on the wrapped member. This protecting underwrap is preferably applied in the form of a bandage which is wrapped around the member prior to application of the cast or adhesive tape wrapping. Since continuing pressure at any one point can become exceedingly painful, it is important that the underwrap conform as nearly as possible to the surface contour of the limb wrapped and be free from any wrinkling or gathering which would result in a pressure point.

Dressing materials formed by needle looming cellulosic fibers having 0.02% to 0.1% fiber lubricant by weight of lubricated fiber are well suited for this purpose since these materials conform readily to uneven surfaces, are quite resilient, have a tensile strength well in excess of 90 grams per inch width, and have the added advantage of being self-adherent. Also, their low resistance to the passage of air permits more ready access of air to the wrapped limb than can be obtained with the conventional underwrappings.

The ability of the material to cling to itself gives a bandage roll in which the bandage material will stay on the roll until actually unwrapped during use. Also, the bandage while wrapping clings to the lower wraps so that slipping and falling off of the bandage is avoided. When used as an underwrap for plaster casts, the excellent absorptive properties of the bandage material together with its low resistance to the movement of air help in the drying and setting of the plaster. Orthopedic bandage rolls of needle loomed bandage material are further described and claimed in our co-pending application "Bandage," application Serial No. 791,021, filed of even date with the present application.

The higher tensile strength needle loomed cellulosic fiber fabrics prepared in accordance with the present invention may also be used for the direct wrapping of wounds or may be used as an overwrap providing an absorbent air permeable covering for primary dressings on burns or other surgical lesions associated with relatively large amounts of wound exudate. Bandages formed of the fabric also offer an advantage where it is desirable to quickly apply a relatively thick bandage for the protection of injuries and are well suited for first-aid type usage for practically all manner of injuries.

The ability of the bandaging material to cling to itself and its high degree of conformability make it easy to apply and result in complete coverage of the wrapped area, the edges of the bandage clinging to lower wraps to form a continuous unbroken covering.

If a "wet dressing" is required, where it is desirable to apply liquid medications continuously to infected wounds or to acute exudative skin diseases, the bandage may be applied in any desired thickness and then kept moistened with whatever medication is most appropriate.

Where the dressing is in the form of a bandage, the bandage fabric preferably has a thickness of about $\frac{1}{30}$ to $\frac{1}{20}$ inch, as measured on a Randall Stickney gauge having a "dead load" dial micrometer. The measurements are made under "no load" conditions; however, the weight of the movement is 56.70 grams on a 1.0 square inch area. This thickness gives adequate tensile strength while at the same time it permits a uniform neat wrap to be obtained. Where the thickness of the bandage material is much in excess of $\frac{1}{8}$ inch, the bandage is appreciably less conforming, more difficult to use and gives a wrapping which is substantially less uniform in appearance. Also, the thicker edge is apt to give pressure spots when the bandage is applied as an underwrap.

The following examples, which are given for the purpose of illustration only, will help to further illustrate the practice of the invention:

Example I

A carded web of rayon fibers having a weight of about

2 ounces per square yard is fed into a needle loom having 4.4 needles on the needling board per square inch. The stripper plate of the loom is 7/16 inch above the bed plate. The carded web is passed through the loom at a linear speed of 150" per minute and the carding board is oscillated so as to press the needles through the fabric 600 times per minute, giving an over-all needling of 184 per square inch. The needles are about .026 inch in diameter, each containing 9 barbs slanted so as to catch the fibers on the downward stroke. The fiber from which the web is formed is a commercial grade rayon fiber containing 0.25% by weight lubricant. The fibers have a length of about 1 9/16 inches and a denier of 3.0.

The resulting fabric has a weight of 1.3 ounces per square yard, a thickness of 0.04 inch as measured under "no load" conditions and a tensile strength in the longitudinal direction of 77 grams per inch of width. The fabric offers little resistance to air flow, has a soft feel and is quite resilient when compressed. When subjected to only a slight pull, however, the fabric is torn apart and is unsuitable for any dressing use that would subject it to any appreciable tension. Using a similar fiber, except for a lubricant content of 0.035% by weight of the lubricated fiber, and needle looming under the same conditions, a fabric is obtained having all of the desirable characteristics of the previous fabric but in addition having a substantially stronger fiber bond, thus avoiding the separation of loose fibers. The fabric also has a substantially improved tensile strength, the tensile strength being in the order of 128 grams per inch width. When a 3-inch width strip of this fabric is wrapped around the ankle of a wearer, each lap overlapping the previous wrap by about ½ the bandage width, the fabric is found to conform readily to the contour of the wrapped member, stretching around the projecting ankle bone without the formation of open areas or wrinkles. The fabric clings readily to itself so that as it is wrapped it remains in position without any sliding or falling off, thus avoiding the necessity of a continuous pull being applied during the whole wrapping procedure. Also, the edges of the bandage cling to the lower laps, giving an even wrap that closely follows the surface contour of the wrapped member.

Example II

A carded web of 3½ ounces per square yard weight is prepared from a 3.0 denier, 1⅛" staple length, crimped viscose rayon fiber. The carded web is fed into a needle loom having 4.4 needles on the needling board per square inch. The web is intermittently passed through the loom at an over-all linear speed of 150 inches per minute and the needle board is oscillated so as to press the needles through the fabric 600 times per minute, giving an over-all needling of 184 punches per square inch. The forward movement of the web is stopped during each penetration of the needles. The needles are about 0.026 inch in diameter, each containing 9 barbs slanted so as to catch the fibers on the downward stroke. The stripper plate of the needle loom is set ½ inch above the bed plate.

The physical characteristics of a resulting fabric after being prepared in the form of an orthopedic felt bandage roll are as follows:

Weight of fabric per sq. yd.	grams	65
Thickness (1)		
No load	inch	.038
Load	do	.030
Softness (2)	percent	26.6
Water retentivity (3)	do	3120
Tensile strength (4)		
Warpwise—grams/inch of width		218
Total elongation (5)	percent	33

The measurements for the values are made in the following way:

(1) *Thickness.*—Thickness is measured with a "dead load" dial micrometer. Under "no load" conditions, the weight of the movement is 56.70 grams on 1.0 sq. inch. Under "load" conditions, the weight of the movement is 454 grams on 1.0 sq. inch.

(2) *Softness.*—The thickness of the sample is measured with the "dead load" dial micrometer under "no load" conditions (56.70 gms./sq. inch) and with a weight of 454 grams. Softness is equal to the difference in thickness expressed as a percentage of the thickness under a 454-gram load. Substantially total recovery to "dead load" thickness is obtained on removal of the 454-gram load.

(3) *Water retentivity.*—Samples having an area of 16.0 sq. in. are immersed in water at 25° C.±1° C. for 10 seconds. The samples are then removed, allowed to drain for 10 seconds and then weighed.

$$\text{Retentivity (in percent)} = \frac{\text{Weight of water in wet sample}}{\text{Weight of dry fiber in sample}} \times 100$$

(4) *Tensile strength.*—Breaking strength is measured on strips cut to 1" x 5". A Thwing-Albert hydraulic tensile tester is used, the jaw setting being 3 inches and the pull speed being 1½ inches per minute.

(5) *Total elongation.*—

$$\text{Elongation (in percent)} = \frac{\text{length at break-original length}}{\text{original length}} \times 100$$

The fabric is highly permeable to air, has a soft feel and is quite resilient when compressed, giving a good cushioning effect. When a strip of the fabric is wrapped around the ankle of a wearer, the fabric is found to conform readily, bending around the projecting ankle bone and giving a smooth, clean fit with no wrinkles. The fabric clings readily to itself so that as it is wrapped it remains in position without any sliding or falling off, thus avoiding the necessity of a continuous pull being applied during the whole wrapping procedure. Also, the edges of the bandage cling to and blend well with the lower laps, giving a relatively smooth, uniform surface.

To further illustrate dressings of the present invention and the needle loomed fabrics used therein, drawings have been included wherein are set forth by way of illustration and example certain embodiments.

Referring to these drawings,

FIG. 1 illustrates a strip of needle loomed fabric material;

FIG. 2 is an enlarged cross-sectional view taken along line 2—2 of FIG. 1 showing generally the fiber arrangement and the areas of needle penetration;

FIG. 3 is a bandage roll of the needle loomed bandage material.

FIG. 4 is a composite dressing having a portion broken away to show the component parts;

FIG. 5 is an enlarged cross-sectional view taken along line 5—5 of FIG. 4; and

FIG. 6 illustrates the application of a dressing of the present invention, when in bandage form, to the limb of a patient.

Referring to the drawings, it will be noted that the needle loomed dressing material, as previously described, is formed of fibers 1 mechanically interlocked to form a porous, resilient, absorbent fiber web 2. The fibers, as previously described, are primarily held together through the process of needling wherein barbed needles are passed through a fiber web to mechanically interlock the fibers. On removal, these needles leave areas 3, best illustrated in FIG. 2, wherein the fibers tend to extend down through the web and wherein in some instances actual needle holes can be seen on close observation. As previously described, in forming dressings of the needle loomed fabric a plurality of plies are preferably used, the plies being placed with respect to each other so that the needle penetrations 3 of one ply are not directly

superimposed over the area of needle penetration of the next ply.

Referring to FIG. 4, a composite dressing is illustrated in which two superimposed plies, 5 and 6, of needle loomed fabric are contained between two outer coverings of gauze 7, the component parts being secured together around the marginal edge 8 by sewing, use of adhesive, or other means not shown. Referring to FIG. 5, it will be noted that the needle loomed fabric plies 5 and 6 are so placed that the areas of needle penetration 3 of one ply are adjacent areas of no needle penetration in the adjacent ply. By this structure, the excellent filter characteristics of the needle loomed fabric are taken advantage of, as heretofore described. Although in the illustration only two plies of the needle loomed fabric have been used, numerous plies may be used depending on the amount of absorption of drainage for which the composite dressing is designed.

In FIG. 6, the application of a bandage wrap 7 composed of needle loomed fibers is illustrated. In the wrap, not only does the self-clinging characteristic of the needle loomed fabric material substantially help in placing the bandage on the leg, but the conforming nature of the material permits close wrapping of protruding portions, such as the angle and the base of the toes, without creasing. The bandage on application lies close to the wrapped member, thus excluding the entrance of contaminating materials. Also, by having each convolution overlap the previous convolution, a bandage is obtained which has excellent filter characteristics with respect to the filtering out of air-borne contamination while at the same time offering very little resistance to the entrance of air, as previously described.

The needle loomed cellulosic fiber fabrics may be applied directly to the wound where the fabric is formed of low lubricant content fibers. They may also be used as part of a composite dressing where the dressing material is used primarily because of its high capacity for fluid absorption or because of its ability to permit ready passage of air while filtering out harmful bacteria. In such use, the higher tensile strength and fiber bond are not as necessary and the needle loomed cellulosic fibers of higher lubricant content can also be used. A use of this type would be a combination dressing in which the needle loomed fabric is sandwiched between other materials, such as gauze or perforated films. The needle loomed cellulosic fiber fabrics may also be employed in such articles as underpads for patients where it acts primarily to absorb fluids and is separated from the patient by an outer permeable surface covering of low fluid capacity. If desired, other fibers may be included together with the cellulosic fibers in small amounts so long as the fibers are not injurious to the skin and do not deleteriously effect the desirable characteristics of the needle loomed dressings. For example, where it may be desirable to give the dressing a cupped or other permanent form a small amount of thermoplastic fibers may be added so that the dressing can be heat molded under limited pressure. However, these fibers should generally not be included in amounts in excess of about 20 percent of the total fiber weight.

The unique characteristics of high liquid capacity, ready permeability to air, good filter characteristics, self-clinging characteristics and high degree of conformability make these dressing materials suitable for many applications which will be readily apparent to one reading the present specification.

Having thus described our invention, we claim:

1. In a surgical dressing, an absorbent, resilient, non-woven web of mechanically interlocked cellulosic fibers wherein the fibers are not twisted together by spinning into the form of threads and wherein said unspun fibers have a fiber length of about 1 to 3 inches and a denier of about 1 to 5.5, unspun fibers of said web while in a dry state having been mechanically interlocked by some of the fibers having been mechanically forced into the web in a direction crosswise thereof with the result that portions of such fibers extend downwardly through said web and interlock the fibers of said web together, said downwardly extending fibers also acting to draw fluid from the surface of said web up into the main body of said web when the surface of said web is wetted.

2. A needle loomed fabric suitable for use in surgical dressings and surgical wraps comprising an absorbent, resilient, non-woven web of mechanically interlocked cellulosic fibers wherein the fibers are not twisted together by spinning into the form of threads and where said unspun fibers have a fiber length of about 1 to 3 inches, a denier of about 1 to 5.5 and a surface lubricant content of 0.02 to 0.1% by weight lubricant based on the weight of the lubricated fiber, unspun fibers of said web while in a dry state having been mechanically interlocked by some of the fibers having been mechanically forced into the web in a direction crosswise thereof with the result that portions of such fibers extend downwardly through said web and interlock the fibers of said web together, said downwardly extending fibers also acting to draw fluid from the surface of said web into the main body of said web when the surface of said web is wetted, said needle loomed fabric having a tensile strength in at least one direction in excess of 100 grams per inch width.

3. A surgical dressing of claim 1 wherein said cellulosic fibers are of the group consisting of natural fibers and regenerated cellulose fibers.

4. A surgical dressing of claim 3 wherein said fibers are viscose rayon fibers.

5. A surgical dressing of claim 4 wherein said viscose rayon fibers possess a permanent crimp.

6. A fabric of claim 2 in which said cellulosic fibers are of the group consisting of natural fibers and regenerated cellulose fibers.

7. A fabric of claim 6 in which said fibers are crimp rayon fibers.

8. In an article adapted to absorb body fluids, a readily air permeable absorbent having good filter characteristics comprising a plurality of plies of needle loomed 1.0 to 5.5 denier cellulose fibers having a fiber length of about 1" to 3", the plies being arranged with respect to each other so that areas of needle penetrations in one ply are covered by areas having no needle penetrations in the adjacent ply.

9. An article of claim 8 adapted to absorb body fluids in which said absorbent is contained in an air permeable outer covering.

10. An article of claim 8 adapted to absorb body fluids in which the cellulosic fibers of said absorbent are of the group consisting of natural fibers and regenerated cellulose fibers.

11. An article of claim 10 adapted to absorb body fluids in which the cellulose fibers are rayon fibers.

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