Aug. 23, 1960 J. C. BLETZINGER ET AL 2,950,223

CELLULOSIC PRODUCT

Filed Aug. 6, 1956 3 Sheets-Sheet 1

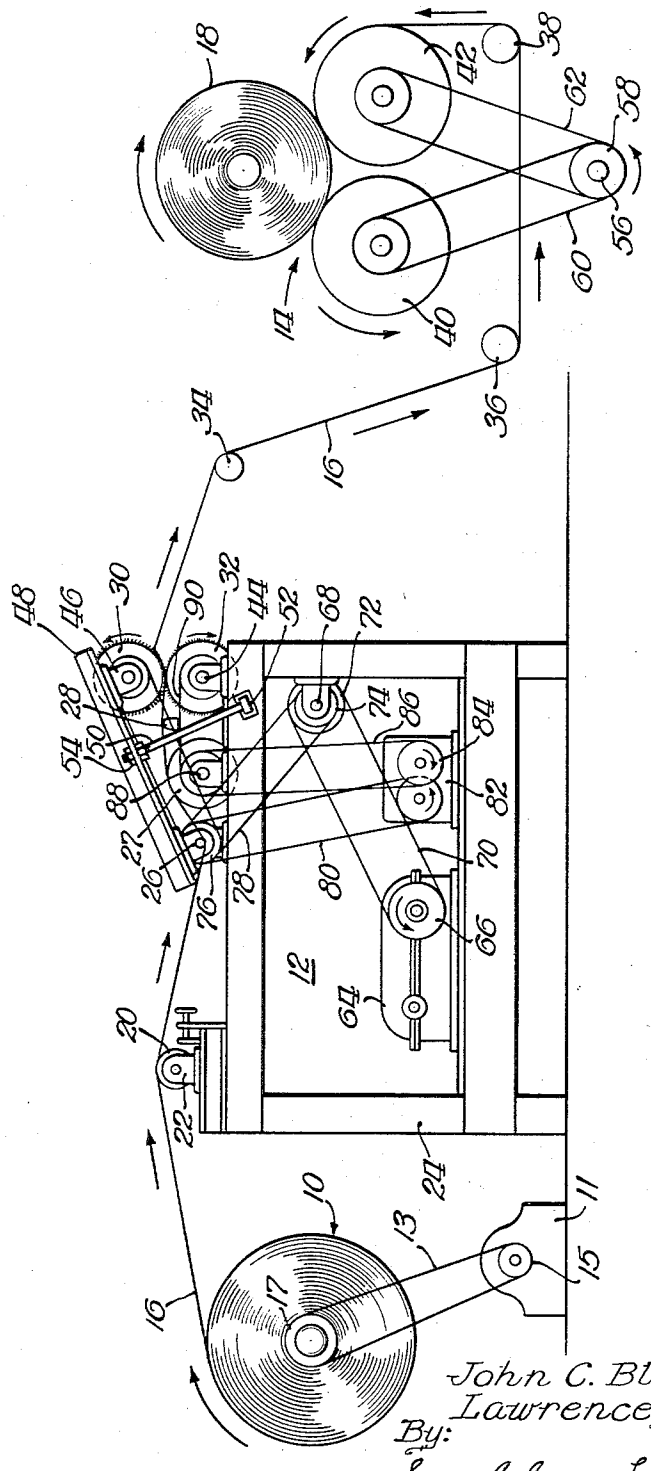


Fig. 1.

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CELLULOSIC PRODUCT

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Fig. 2.

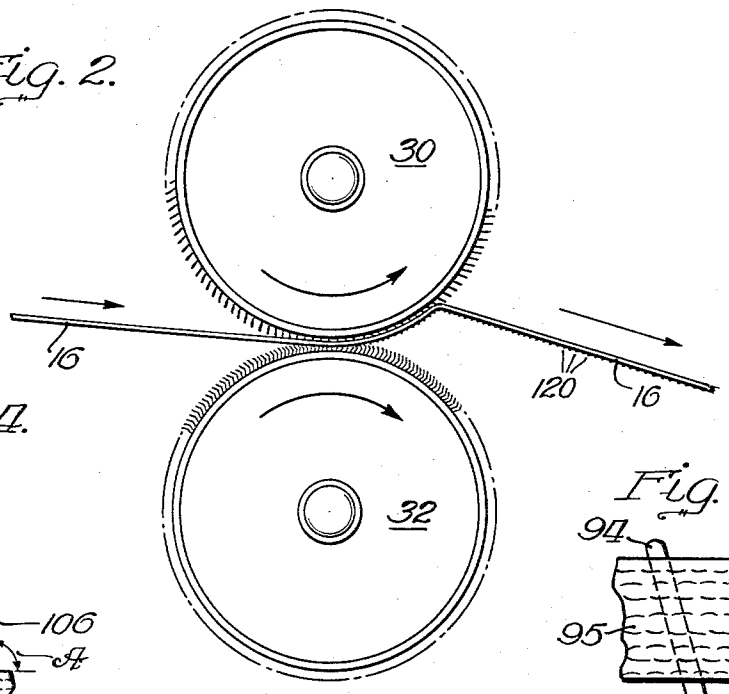


Fig. 4.

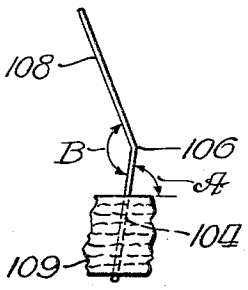


Fig. 5.

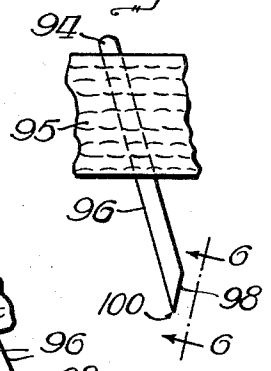


Fig. 3.

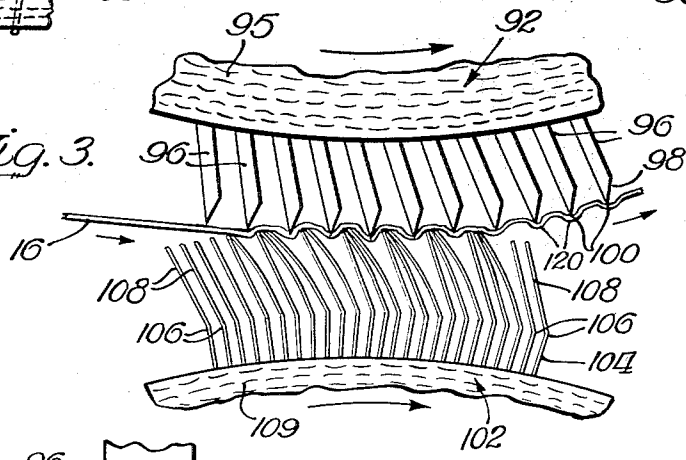
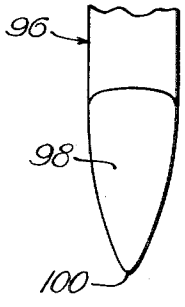


Fig. 6.



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CELLULOSIC PRODUCT

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Fig. 7.

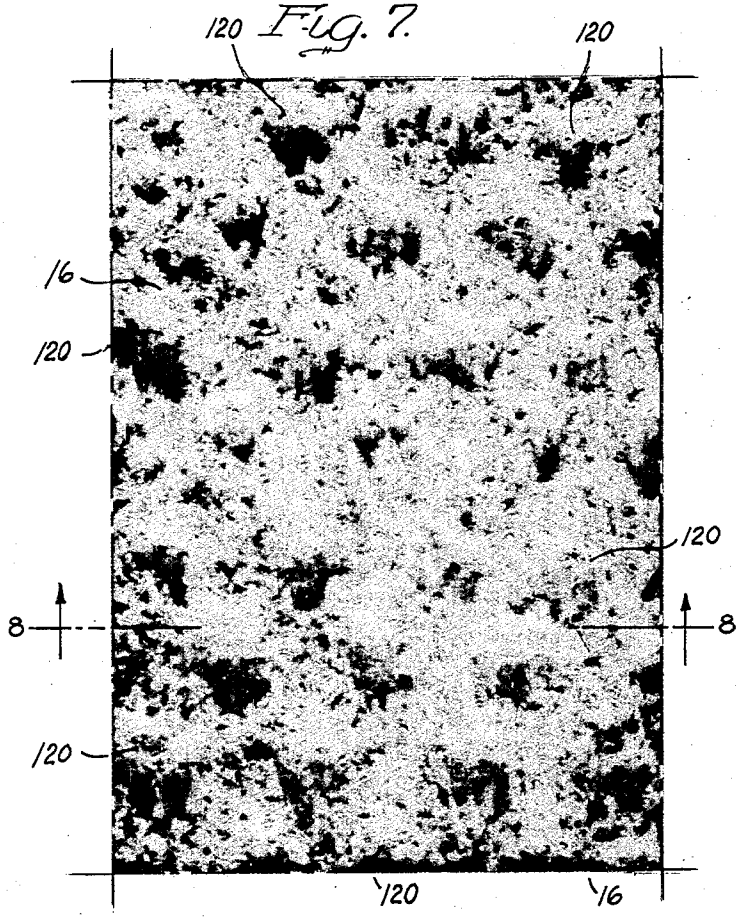
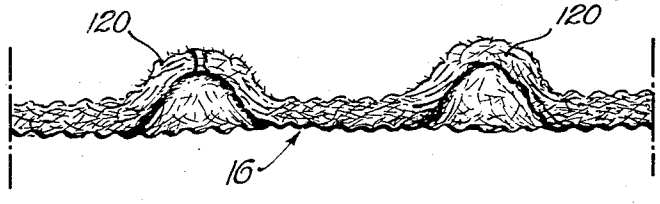


Fig. 8.



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2,950,223

CELLULOSIC PRODUCT

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Filed Aug. 6, 1956, Ser. No. 602,202

10 Claims. (Cl. 162—114)

This invention relates generally to cellulosic products and is more particularly directed to the treatment of cellulosic sheet material, to provide certain desired characteristics in the sheet. The invention has particular advantages in the treatment of creped cellulosic tissue to provide an improved towel.

Within the past relative few years bibulous paper products have attained a position of widespread use in both home and industry. One of the many uses for such bibulous paper has been for toweling, particularly disposable towels in the home, and various paper products have been marketed for this purpose. Generally, however, each of these products lacks one or more characteristics which are believed desirable in a satisfactory absorbent wiping sheet. In order that such a sheet be satisfactory, it is especially desirable that the product be strong but yet be flexible and conformable to irregular surfaces, and that it have a high rate of absorbency in use and be capable of holding a fair amount of liquid. It is also important that the sheet be capable of holding a considerable quantity of dirt, grease and the like which may have accumulated on the surface to be wiped.

In known products and in the methods used for producing paper towels and the like, it would appear practically inescapable that certain of the desired characteristics are achieved or improved only at the expense of one or more of the other desirable features. This is believed to be fairly well evidenced by the character of the known products, which are generally not very conformable to irregular surfaces and which, in many instances, provide a somewhat unsatisfactory wiping effect, particularly with regard to the quantity of liquids and solid particles that can be picked up.

The principal object of this invention is to provide a method for treating a web of stretchable fibrous material in such a way that the conformability and absorbency rate of the web in use will be improved without any appreciable sacrifice of the strength and liquid holding capacity of the web. A further object is to provide apparatus for treating a web of fibrous material so as to improve the conformability, softness and absorbency of the web in use, through a novel manner of texturing the web which does not result in any appreciable densifying or compacting of the web. Still another object is to provide an improved disposable sheet which is particularly adapted for use in wiping liquids, greases and discrete solid particles from a surface.

Generally, the stated objectives have been attained by the use of a process and apparatus which involves the principle of continuously exerting pressure over a large number of spaced, localized areas on one side of a web of stretchable fibrous sheet material, in a manner whereby there is achieved a permanent stretching of the web in the areas of pressure application without any appreciable compacting of the web. It is conceivable that the desired result might be achieved in any of several ways without deviating from the principles of this invention. However, it is important that the stretchable web of

fibrous sheet material be subjected to pressure over many very small, spaced areas, with the pressure being of sufficient magnitude to dislocate or reorient the fibers in each such area and thereby permanently stretch the web in such areas. The particular mechanical means used in achieving this result is not essential in the broader aspects of the invention and may be any suitable means for handling the web, in a manner resulting in the creation of pressures over relatively small areas of the web so as to thereby stretch the web without compacting or densifying it. However, the specific method of practicing the invention herein disclosed has important advantages over any other known method and, especially when used on dry creped tissue, produces a product having certain unique advantages, as will hereinafter appear.

In this preferred method of practicing the invention, the fibrous web is propelled through a pair of movable supports which are synchronized to travel at essentially the same speed and in the same direction as the travelling web. One of the supports is fitted with a set of needle-like elements, and the other support includes a discontinuous, resilient outer surface which is adapted to accommodate the penetration thereof by the needle-like elements.

The supports for the needles and for the discontinuous, web-supporting surface may be in the form of continuous belts, but it is preferred to use opposed rolls. Furthermore, it has been found advantageous to have the needles inclined with respect to the plane of the travelling web, in the direction of travel of the web, and to provide adequate area on the outer tips of the needles to effect primarily a pressure on the web rather than an ordinary puncturing of the web.

The most advantageous utilization of the principle of this invention has been in connection with fibrous sheet material, wherein the fibers are relatively loosely related so that they may be rather easily rearranged as an incident to the localized stretching of the sheet. For this reason, the detailed description of the invention is related to the treatment of a sheet of this type, specifically dry creped cellulosic tissue.

In the drawings:

Figure 1 is a diagrammataic view of the web treating apparatus;

Figure 2 is an enlarged diagrammatic view of the rolls used in the treatment of the web;

Figure 3 is a greatly enlarged, fragmentary view of the rolls in Figure 2;

Figure 4 is an enlarged view of one of the elements mounted on the lower roll in Figure 3;

Figure 5 is an enlarged view of one of the needles mounted on the upper roll in Figure 3;

Figure 6 is an enlarged view taken along the line 6—6 in Figure 5;

Figure 7 is a micro-photographic view of a single-ply creped tissue treated in accordance with invention; and

Figure 8 is a diagrammatic sectional view of a single-ply crepe tissue as it might appear if taken along the line 8—8 in Figure 7,

With reference to Figure 1, it is seen that the apparatus selected to illustrate this invention comprises generally a supply roll 10 of a fibrous material, a web treating device 12, and a rewind structure 14. The roll 10 is driven by a motor 11, through belt 13 and sheaves 15 and 17, and the web 16 is unwound from the roll 10, in the direction of the arrows, through the web-treating apparatus 12 and into the rewind roll 18.

As the web enters the web-treating apparatus 12 it travels over a roller 20 carried by suitable bearings 22 mounted on the frame 24 of the apparatus. From the roller 20 the web 16 then travels around another rod or roller 26 also rotatably mounted on the frame of the

machine. From the roll **26** the web then travels around a driven roller **27** of substantial diameter which is also mounted on a stationary axis carried by the frame **24**. From the roll **27** the web then travels over the smooth upper edge of a spreader bar **28**, which serves to remove any wrinkles which might have developed in the web, and then into the throat or nip of a pair of web-treating or texturing rolls **30** and **32**. After leaving the latter rolls, the web **16** passes around fixed rollers **34**, **36**, and **38** and is then wound up into the roll **18** by conventional rewinding apparatus which comprises supporting rolls **40** and **42**, driven at a peripheral speed preferably at least as high as the speed of travel of the web through the apparatus **12**.

The lower roll **32** of the web-treating rolls is mounted on a fixed axis **44** and in suitable bearings on the fixed frame of the apparatus. The upper roll **30** is mounted to rotate in bearings **46** carried by the upper end of an inclined frame **48** which is pivoted on the frame **24** on an axis coinciding with the axis of the roll **26**. The position of the adjustable roll **30** relative to the fixed position roll **32** is controlled by a pair of adjusting rods **50**, the lower ends of which have heads **52** seated in slots of the frame **24** while the upper ends of the rods **50** are threaded and accommodate nuts **54** by means of which said adjustment can be readily effected.

The motive power for rewinding the web **16** onto roll **18** and propelling the web through the apparatus **12** is provided by a suitable motor or motors not shown. To rewind the web, power is applied to the shafts of rolls **40** and **42** by means of a driven shaft **56**, driven pulleys **58** on shaft **56**, and belts **60** and **62**. Through adjustable speed reducing gears contained in the housing **64** carried by the frame **24**, a power take-off pulley **66** drives a jack shaft **68** through a belt **70** and pulley **72**. Another pulley **74** on jack shaft **68** drives a pulley **76** through belt **78** and in a similar manner the shaft of the pulley **76** drives the upper roll **30**. The last-mentioned shaft also drives a belt **80** which drives suitable gearing within the housing **82** so as to impart to the pulley **84** a rotary movement opposite to that of the preceding train of pulleys. The oppositely rotating pulley **84**, through a belt **86**, drives a pulley on the shaft **88**, and that shaft drives the lower roll **32** through a suitable pulley and belt **90**.

The opposing rolls **30** and **32**, which are best shown in detail in Figures 2 through 6, are somewhat similar in construction to carding rolls and like such rolls are provided with wire clothing. The clothing **92** for the upper roll **30** includes a cotton or other suitable fabric foundation **95** through which is passed a plurality of double-ended wires **94** made in the form of staples and preferably arranged in closely spaced relation in a pattern on the clothing foundation **95**. The clothing **92** is suitably wound around the roll and secured thereto by cement or other appropriate means. The ends of the legs of each staple **94** form a pair of needle-like elements **96**, which are preferably formed by clipping or otherwise trimming such ends to achieve the generally triangular-shaped, pointed tips seen particularly in Figures 5 and 6.

It will be noted, particularly in Figure 3 that all of the elements **96** are disposed in inclined relation to the periphery of the roll **30**, rather than extending radially from the roll **30**, and that the elements **96** are all inclined at approximately the same angle and in the direction of travel of the support **30**. Further, it will be seen in the drawings that all of the elements **96** have their triangular-shaped tip **98** facing in the direction of travel of the web **16**, with their end points **100** disposed on the trailing edge of each needle-like element.

The clothing **102** for lower roll **32** also includes a suitable foundation of cotton fabric or the like through which is passed a plurality of double-ended wires **104** of substantially smaller diameter than the elements **96** on roll **30**, and which are also preferably made in the form of staples arranged in closely spaced relation in a pattern on the clothing. As seen in Figure 3, the wires **104** are

much more closely spaced than are the larger elements **96** on the upper roll. The wires **104** are quite resilient and mounted so as to present a discontinuous freely yieldable surface to the pressure of the larger elements **96** as the latter are brought into contact therewith. This is greatly facilitated by providing each of the wires **104** with a bend **106** at an intermediate point therealong, so that the outer end **108** of the wire is inclined with respect to the path of travel of the larger needle-like elements **96** as the rolls **30** and **32** are rotated together. In the particular embodiment illustrated, this inclination of the wire ends **108** is in the direction opposite to that of the path of travel of the web **16**, as seen in Figure 3. The ends or tips of the wires **104** are preferably cut generally transversely of the wire, so as to provide a small supporting area for the web and the wire ends are not pointed in the manner of the needle-like elements **96**.

As indicated above, the outer ends of the wires **104**, being closely spaced, provide a substantial supporting surface area for the web **16** which, at the same time, is discontinuous in nature. This characteristic, in combination with the flexible nature of the wire ends **108**, provides means for easy entry of the needle-like elements **96** below such discontinuous surface. In this way, the elements **96** can apply local pressure on the web **16**, which pressure is not initially resisted by the web-supporting surface provided by the wires **104** to an extent such that puncturing of the web might result, to thereby stretch the web downwardly into the opening afforded by the flexing of the wires **104** on the web-supporting roll. The extent of the stretching and whether the web is finally punctured or broken depends largely upon the spacing of rolls **30** and **32**, which in turn determines the depth of travel of the elements **96** into the zone of the wires **108**.

It should be understood, that while the described arrangements and shapes of the clothing elements **96** and the wires **104** have particular advantages in the practice of the invention, certain of the advantages of the invention can be accomplished by the use of other web-supporting and web-working arrangements.

With respect to the above-described action of the web-supporting wires **104**, it is believed that there is an additional advantage in the use of a relatively large number of closely spaced, yieldable elements to support the web during the action of the needle-like elements **96**. The wire ends **108** provide some resistance to the web depressing action of the elements **96**. In effect they provide a support for the web which is substantially unresistant to the passing thereinto of the cooperating needle-like elements **96**. The discontinuous freely yieldable surface formed by wires **108** is of such degree of yieldability that needles **96** are capable of weakening and reducing the fiber-to-fiber bonds in the area of the web which are engaged by the needles **96** during the operation on the web. This is accomplished without increasing the density of the web in the area which has been deformed. The wire ends brush lightly against the fibers of the web as the latter is pressed downwardly by each of the elements **96**, and this brushing action of the wire ends **108** on the web softens the fibers and thereby makes the entire web softer and more easily conformable to irregular surfaces. There is a lessening of the number of fibers per unit area in the deformed portions of the web, with corresponding reduction in the unit density in those portions; there is a reduction or weakening of the fiber-to-fiber bonds in those areas and there is an increase in the web bulk.

In operation, the web **16** travels into the throat of the rolls **30** and **32** where the web is supported on the discontinuous, yieldable surface provided by the wire ends **108**. As these rolls rotate, the ends of the elements **96** on the upper roll move downwardly and forwardly into engagement with the web. In so doing, the elements **96** also exert a pressure on certain of the wire ends **108**, as the latter are engaged thereby, and cause the wires **108** to flex or bend rearwardly, as indicated in Figure 3. This

bending of the wire ends **108** increases with the downward movement of the elements **96** to provide an open area wherein the web can be stretched and deformed to provide protuberances which extend outwardly along the lower surface of the web. Preferably, the rolls **30** and **32** are set together close enough to achieve the desired amount of stretch for each area encountered by one of the needle-like elements **96** without effecting any substantial breaking or puncturing of the web.

In using the invention, particularly good results have been obtained with the use of a clothing strip on the upper roll **30** having a fabric foundation about 3/16 of an inch in thickness with the needle-like elements **96** made of wire which is generally triangular in cross-section with such cross-section having a width of about .020 inch at the base and a length or altitude for the triangle of about .030 inch. Each of the elements **96** extends from the clothing foundation **95** a maximum distance of about 3/16 inch at the outer tip, with the surface of the outer end of the needle-like element disposed at about 35 degrees with respect to the longitudinal axis of the element. Each of the elements **96** is disposed at about 75 degrees with respect to the outer circumference of the clothing foundation **95**, inclined in the direction of travel of the supporting roll **30**, with the base of the triangular-shaped tip disposed at the forward end of the needle-like element and the point of the element **96** trailing. The elements **96** are arranged in the clothing in a diamond-shaped pattern with the elements transversely spaced apart about 0.170 inch and spaced about 0.120 inch in the direction of travel of the roll. This provides about 98 needles per square inch of surface area on the roll.

In the specific embodiment illustrated in the drawings, the lower roll **32** includes a cotton composition clothing foundation **109** having about 600 to 700 wires per square inch which are arranged in a diamond-shaped pattern and project from the clothing foundation a distance of about 1/4 of an inch. The wires **104** are No. 34 United States Standard wire gauge and are initially bent at a point **106**, approximately 1/3 of the projecting distance, with the inner 1/3 of each wire disposed at about 82 degrees with respect to the tangent at the point where the wire intersects the roll circumference, the angle A in Figure 4. The wires **104** are inclined in the direction of movement of the roll, and the outer 2/3 of each wire bent in a direction opposite to that of the roll movement to form an interior angle of about 150 degrees with the inner one-third portion of the wire, the angle B in Figure 4. Usage of the rolls will, of course, result in some deformation of the wires **104** but if initially disposed as described such deformation will not seriously impair, and may in fact improve their usefulness. The rolls **30** and **32** are cylinders having a diameter of about 6 inches and a length of about 27 inches.

The above apparatus has been used most successfully in treating creped tissue sheet material in order to improve its usefulness as a towel. In a particular operation a creped tissue sheet of 100 percent chemical wood cellulose fiber, which had been treated with suitable material to give it web strength, was used in the machine. The sheet was single ply with a dryer basis weight (at a moisture content of about 4.5 percent by weight) of 12.25 pounds per standard ream of 2880 square feet before creping, and had a crepe ratio of 1.35. At the time of treatment in the machine the sheet included about 5 to 7 percent by weight of moisture. The sheet, prior to treatment in the apparatus **12**, had an apparent density of 6.0 pounds per cubic foot, which afforded a porosity for the web of about 37 cubic feet of air per minute, per square foot of the sheet area, at a water pressure drop of 1/2 inch, as measured by a Frazier permeometer, or equivalent instrument.

The single ply creped tissue sheet was run through the rolls at a speed of about 500 feet per minute with

the rewind **14** maintaining a positive but minimum draw on the sheet at all times. The rolls **30** and **32** were spaced in this instance to provide an overlap of about 0.060 inch at the throat or nip. This arrangement provided for a permanent stretching of the web in the area of each of the needle-like elements **96**, as the web passed between the rolls and was supported by the wires **108** on the lower roll **32**. This stretching of the web to provide many small protuberances over its surface is particularly illustrated in Figures 7 and 8, wherein the protuberances or projecting portions are indicated by the number **120**. The average overall depth or thickness of the single ply sheet was increased from about .011 inch to about .018 thickness, that is about 60 percent increase in bulk was achieved, and, as indicated in Figures 7 and 8, there was no apparent compressing or compacting of any portions of the web resulting from the action of the rolls **30** and **32**. The described setting of the rolls achieved most of the desired stretching prior to any rupturing or puncturing of the web, and in a substantial portion of the web there were in fact no openings formed in the web by the needle-like elements.

After the web had passed through the apparatus **12**, the web has a porosity of about 105 cubic feet of air per minute, as measured above, and an apparent density of about 3.3 pounds per cubic foot. It is seen, therefore, that the characteristics of the web had been altered substantially and, particularly, that the density of the web had been reduced by about 45 percent. Further, it was also noted that the described treatment of the web does not materially lessen the strength of the web in a cross-machine direction.

The described transformation of the sheet offers very definite advantages in making the product more satisfactory for its intended use as a disposable wiping sheet or towel. It is particularly noteworthy that the treated sheet is more flexible and conformable to irregular surfaces, and it provides a better wiping action in readily absorbing and collecting fluids, greases, dirt particles and the like.

Certain of the advantages of the invention can be obtained with other webs having loosely related fibers, which are adaptable to fiber reorientation in the described manner to provide permanent stretching of the web in many discrete areas. However, a dry creped treated tissue produces a very satisfactory disposable wiping sheet, the most satisfactory results being obtained with material having an uncreped basis weight between from about 3 to 20 pounds per 2880 square feet, at 6% moisture and having a crepe ratio of between about 1.15 and 3.0.

If more web deformation is desired, it can be achieved by increasing the amount of overlap between the needle-like elements **96** and the wires **108**. This increase in overlap may be desired in some instances, particularly when treating a heavier web, either single or multi-ply, but in any event it is believed that the most effective use of the described apparatus is attained when the overlap of the rolls is within the capacity for deformation of the wires **108**, so as not to compact the wires and thereby provide a continuous surface upon which the web can be compressed.

In the above described example, the action of the rolls **30** and **32** on the web was much like that illustrated in Figure 3 of the drawings, with the elements **96** forcing the web between the yieldable wires **108** so as to permanently stretch the web in the area surrounding each of the needle-like elements **96**. Further, there was sufficient displacement of the web by the needles **96** to cause the web to cling to the points of the needle throughout a portion of the upward travel of the needles, as seen also in Figure 2. However, when the inclined needles **96** approached a position of extending generally in the direction of travel of the web, the draw on the web was sufficient to strip the web from the needles

and pass it into the rewind mechanism **14**. The above described angular disposition of the needles on the roll permitted this pick-off of the web from the upper roll to occur earlier than might be possible if the needles are arranged to extend radially from the roll.

The inclined tip surface **98** of the needle-like elements **96** is preferably achieved by clipping the wires, and the resulting roughened condition of the tip may be an aid in attaining a permanent stretching of the web before any puncturing of the web occurs and in keeping the web stretched between adjoining needles as the web passes over the supporting wires **108**.

Tests have also been made of the invention with regard to creped web products formed by the wet-creping method. The results of these tests on wet-creped sheets indicate that such products are also improved by treatment in accordance with the principles of this invention.

The method and apparatus disclosed herein provides a novel treatment for various types stretchable fibrous sheet materials of a bibulous or absorbent nature. The invention accomplishes important improvement in the physical characteristics of such products, especially toweling which is made of creped cellulosic tissue, although important advantages are realized by use of the invention on other types of absorbent sheets.

Included among the attained advantages are increase in the bulk of the product and increased absorbency in use. A high liquid-retaining capacity is preserved in the sheet, and the flexibility and conformability of the sheet, are also improved. All of these features makes the product more easily conformable to irregular surfaces for wiping purposes. Further, the resulting irregular surface of the sheet provides a better wiping action in that a greater percentage of the area of the sheet is disposed at an angle to the surface being wiped. All of these advantages are attained without material impairment of the strength of the sheet.

An important feature of the disclosed method is the application of pressure to the stretchable web over a large number of relatively small, spaced areas, while at the same time providing minimum resistance, externally of the web, to the pressure applied in each such area. By this procedure, the fibers in the web are rearranged or reoriented, primarily by breaking or weakening the bond between the individual fibers so as to stretch the web in each of the small areas of pressure application, as seen in Figures 7 and 8, without, however, any compacting of the fibers. Further, the pressure applied to each of the spaced areas is regulated in its magnitude and duration of application to the web to provide a permanent stretch of the web area without destroying the continuity of the web in each such area. It is particularly important to note that the stretched areas **120** and the areas surrounding each do not include any compacted fibers, and, consequently, the entire web including the protuberances **120** is readily yieldable to conform with irregular surfaces wiped by the sheet. It is believed that it will be apparent to those skilled in the art that the term "pressure" as used herein includes a negative pressure or suction on the web as well as a direct force against the web.

It will also be apparent that both surfaces of a web may be treated in the described manner, preferably in sequence, in order to provide a napped or textured surface on both sides of the web. Also the invention may be used to advantage with certain special types of webs, such as thread-reinforced webs.

We claim:

1. Means for texturing stretchable fibrous sheet material to improve its conformability and absorbency, comprising a pair of continuous endless supports disposed in adjacent relation to each other to provide a throat between which a web of fibrous sheet material may pass, one of said supports including a plurality of spaced needles arranged in a predetermined pattern, said needles when at the throat extending outwardly in the general direction of the other support and inwardly of the outer surface thereof, and the other of said supports including a discontinuous freely yieldable surface which is of such degree of yieldability that said needles are capable of weakening and reducing the fiber-to-fiber bonds in the areas of said web which are engaged by said needles during the operation on said web without compacting the web and thereby increasing the density of said web in said areas, and means for continuously moving said supports past each other in the same direction and at a rate of travel substantially equal to that of the web.

2. Apparatus for texturing a fibrous sheet material so as to improve its conformability and absorbency by reducing the density of the web per unit area in a closely spaced predetermined pattern while increasing its bulk, comprising a pair of continuous endless supports arranged for movement in adjacent relation to each other to thereby provide a throat between which a fibrous sheet material may pass, one of said supports including a plurality of closely spaced needles arranged in a predetermined pattern, said needles, when at the throat, extend outwardly in the general direction of the other support and in penetrating, inclined relation to the plane of travel for the web between said throat, said needles being inclined in the direction of travel of said supports, and the other of said supports including a discontinuous freely yieldable surface comprising a plurality of flexible elements which are of such degree of yieldability that said needles are capable of weakening and reducing the fiber-to-fiber bonds in the areas of said web which are engaged by said needles during the operation on said web without compacting the fibers between said supports and thereby increasing the density of said web in said areas, and means for continuously moving said supports past each other in the same direction and at a rate of travel substantially equal to that of the web.

3. Apparatus for texturing a fibrous sheet material so as to improve its conformability and absorbency by reducing the density of the web per unit area in a closely spaced predetermined pattern while increasing its bulk, comprising a pair of continuous endless supports arranged for movement in adjacent relation to each other to thereby provide a throat between which a fibrous sheet material may pass, one of said supports including a plurality of closely spaced needles arranged in a predetermined pattern, said needles, when at the throat, extend outwardly in the general direction of the other support and in penetrating, inclined relation to the plane of travel for the web between said throat, said needles being inclined in the direction of travel of said supports, and the other of said supports including a discontinuous freely yieldable surface comprising a plurality of flexible elements, said flexible elements having at least their outer end portions inclined opposite to the direction of movement of said support and of such degree of yieldability that said elements yield under pressure transmitted thereto by said web as said needles penetrate the latter to an extent to insure that no compaction of the web results in the web areas between said needles and said flexible elements, whereby said needles are capable of weakening and reducing the fiber-to-fiber bonds in the areas of said web which are engaged by said needles during the operation on said web without increasing the density of said web in said areas, and means for continuously moving said supports past each other in the same direction and at a rate of travel substantially equal to that of the web.

4. A method for the treatment of a stretchable, absorbent fibrous web, which comprises supporting the web for movement into and through a treating zone, yieldingly supporting the web in the treating zone at a multiplicity of spaced-apart positions along the web, applying pressure to a multiplicity of non-contiguous portions of the web intermediate the positions of yielding support, so that the pressure is not applied in the immediate areas of support for the web and so that the pressure receiving

portions are displaced from the plane of the web sufficiently to provide a permanent reorientation of the fibers in the web intermediate the areas of pressure and the areas of support to produce permanent protrusions in the web, the support for the web yielding sufficiently to afford said displacement of web portions without any appreciable compacting of any of the fibers in the web.

5. A method for the treatment of a stretchable, absorbent fibrous web, which comprises supporting the web for movement into and through a treating zone, yieldingly supporting the web in the treating zone at a multiplicity of spaced-apart positions along the web, applying pressure to a multiplicity of non-contiguous portions of the web intermediate the positions of yielding support, thereby avoiding any compacting of the fibers against the web supports, the pressure being sufficient so that such portions are displaced from the plane of the web and there is a permanent reorientation of the fibers in the web intermediate the areas of support to thereby produce permanent protrusions in the web without any appreciable compacting of any of the fibers in the web.

6. A method for the treatment of a stretchable, absorbent fibrous web to increase its bulk and to improve its conformability and absorbency, which comprises moving the web into a treating zone, yieldingly supporting the web in the treating zone at a plurality of spaced-apart positions along the web, applying pressure to a multiplicity of non-contiguous, small areas of the web intermediate the positions of yielding support so that such areas are displaced from the plane of the web with an accompanying decrease in the number of fibers per unit area in the deformed areas of the web through a weakening and reduction in the fiber-to-fiber bond in such areas, to thereby provide a permanent reorientation of the fibers in the web intermediate the positions of support and produce permanent protrusions in the web.

7. A method for the treatment of a stretchable, absorbent fibrous web to increase its bulk and to improve its conformability and absorbency, which comprises moving the web into a treating zone, yieldingly supporting the web in the treating zone at a plurality of spaced-apart positions along the web, applying pressure to a multiplicity of non-contiguous, small areas of the web intermediate the positions of yielding support so that the web is not compacted against the supports and so that such areas are displaced from the plane of the web with an accompanying decrease in the number of fibers per unit area in the deformed areas of the web through a weakening and reduction in the fiber-to-fiber bond in such areas, to thereby provide a permanent reorientation of the fibers in the web intermediate the areas of support and produce permanent protrusions in the web, the supports for the web yielding sufficiently to afford said displacement of web areas without any appreciable compacting of any of the fibers in the web.

8. A method for producing a towel from a stretchable, fibrous web, which comprises causing the web to travel between a plurality of spaced-apart needles arranged in a predetermined pattern and disposed to engage one side of the web, and a supporting member which engages the other side of the web and which comprises a plurality of flexible elements providing a discontinuous yieldable supporting surface, the needles and yieldable surface moving continuously at substantially the same speed and in the same direction as the web, with the yieldable surface being positioned relative to the needles for penetration thereof by the needles, the needles moving through the normal plane of the web while traveling therewith, the extent of movement of the needles relative to the normal plane of the web being coordinated with the disposition and yieldability of the supported surface, so that the movement of the needles into the web is effective to permanently and radially stretch the web in the area surrounding each needle without compressing the web against the yieldable supporting surface to compact the fibers and before causing any substantial penetration of the web by the needles.

9. A sheet material consisting of a web of cellulosic fibers some of which are disposed in a manner to form closely spaced protuberances extending outwardly of the plane of the web, the fibers forming said protuberances being sufficiently dislocated and reoriented in respect to fibers of the web intermediate said protuberances to effect permanent stretch and reduction of fiber density throughout the protuberance forming areas with attendant reduction of inter-fiber bonds in those areas in respect to corresponding inter-fiber bonds in areas intermediate the protuberances, whereby said low fiber density protuberances impart characteristics of high fluid absorbency, softness, flexibility, and stretchability to said web.

10. A highly absorbent stretchable fibrous web having a normally planiform portion and a plurality of closely spaced mound-like portions disposed in patterned configuration and extending outwardly from at least one surface of the planiform portion of the web, said web being of a generally uniform unit density throughout the planiform portion thereof and of lower unit density throughout the mound-like portions thereof with fewer and weaker fiber-to-fiber bonds in the latter portions than in the planiform portion.

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