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(54) **ROLLS OF TISSUE SHEETS HAVING IMPROVED PROPERTIES**

TISSUEPAPIERROLLEN MIT VERBESSERTEN EIGENSCHAFTEN

ROULEAUX DE FEUILLES DE PAPIER A PROPRIETES AMELIOREES

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(56) References cited:

EP-A- 0 566 775 **GB-A- 2 288 594**
US-A- 4 671 983 **US-A- 5 628 876**
US-A- 5 746 887

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Description

[0001] Through dried tissues have recently been developed which improve a unique combination of bulk and softness. In part, a method for making such tissues includes the use of a throughdrying fabric having high and long machine direction knuckles which impart a high degree of texture to the resulting tissue sheet. When such sheets are used for making bath tissue or paper toweling, they are wound into a roll for sale to the consumer. However, in spite of the high bulk and texture of the resulting tissue sheet, when wound into a roll the sheet has a tendency to "nest" as the protrusions of the sheet mate with corresponding depressions of the adjacent sheet in the wound roll. As a result, the wound roll has good firmness, but does not exhibit exceptional roll bulk befitting of the high texture exhibited by the sheet itself.

[0002] Therefore there is a need for a method of imparting good firmness and high bulk to rolls of tissue sheets having high bulk and texture.

[0003] US 4671983, discloses a repeating arrangement for embossment of roll material attempting to reduce nesting of the material on a roll.

[0004] US 5628876 discloses a secondary belt for papermaking comprising a semi-continuous pattern of protuberances.

[0005] US-A- 574 68 87 discloses a method of making a throughdried tissue sheet upon which the preamble of method claim 26 of the present invention is based.

[0006] It has now been discovered that the bulk/firmness properties of rolls of tissue sheets, including throughdried tissue sheets, can be improved by modifying the fabrics used in the process of manufacturing the tissue sheet. The resulting rolls have both a high degree of bulk and firmness, particularly for rolls made from relatively soft sheets.

[0007] According to the present invention there is provided a throughdried tissue sheet as claimed in claim 1.

[0008] According to another aspect of the present invention there is provided a method of making a throughdried tissue sheet in accordance with claim 26.

[0009] As used herein, the "dryer side" of the tissue sheet is the side of the sheet facing the throughdrying fabric during throughdrying and the "air side" of the sheet is the side of the sheet facing away from the throughdrying fabric during throughdrying. When the sheet is wound into a roll of product, it is often preferred that the air side of the sheet be the side of the sheet facing the core of the roll and the dryer side of the sheet be the outwardly facing side of the sheet.

[0010] Also as used herein, the term "cross-machine direction dominant" means that the bar-like protrusions or troughs run at an angle of about 44° or less, more specifically about 20° or less, and still more specifically about 10° or less, relative to the cross-machine direction of the sheet or fabric. The bar-like protrusions can be parallel with the cross-machine direction of the sheet. Similarly, the term "machine direction dominant" means

that the feature in question runs at an angle of about 44° or less, more specifically about 20° or less, and still more specifically about 10° or less, relative to the machine direction of the sheet or fabric. The machine direction dominant feature in question can also be parallel or substantially parallel to the machine direction of the sheet or fabric.

[0011] The bar-like protrusions can extend continuously across the width of the sheet but, due to some slippage of the woven fabric filaments, in practice the bar-like protrusions within a given sheet randomly vary in length. Accordingly, the length of the bar-like protrusions can be about 3 millimeters or greater, more specifically from about 3 millimeters to about 300 millimeters, more specifically from about 5 millimeters to about 50 millimeters, and still more specifically from about 5 millimeters to about 25 millimeters, including combinations of the foregoing ranges. The width of the bar-like protrusions corresponds to the spacing between the CD dominant filaments of the transfer fabric and can be about 0.3 millimeter or greater, more specifically from about 0.3 to about 3 millimeters, still more specifically from about 0.5 to about 1.5 millimeters. In addition, single CD dominant filaments within the transfer fabric can be replaced with multiple CD dominant filaments piled atop each other to form deeper CD dominant troughs within the fabric and therefore form higher bar-like protrusions in the air side of the sheet.

[0012] The roll of tissue is preferably formed from a tissue sheet having an air side and a dryer side, the dryer side of the sheet having parallel discontinuous rows of machine direction dominant pillow-like elevated regions, which can be imparted to the sheet by the spaces between high and long machine direction dominant knuckles in the throughdryer fabric, wherein the discontinuities in the rows of pillow-like elevated regions are cross-machine direction dominant troughs that appear as cross-machine direction dominant bar-like protrusions on the air side of the sheet. The discontinuities in the rows of pillow-like elevated regions substantially suppress the tendency of the rows of pillow-like elevated regions in the sheet from nesting when the sheet is wound into a roll.

[0013] A method of making a throughdried tissue sheet not within the scope of the present invention is further disclosed, comprising (a) depositing an aqueous suspension of papermaking fibers having a consistency of about 1 percent or less onto a forming fabric to form a wet web; (b) dewatering the wet web to a consistency from about 20 to about 30 percent; (c) transferring the dewatered web from the forming fabric to a transfer fabric travelling at a speed from about 10 to about 80 percent slower than the forming fabric; (d) transferring the web to a throughdrying fabric having from about 5 to about 300 impression knuckles per square inch (78 to 4650 impression knuckles per dm²) which are raised at least about 0.005 inch (0.13 mm) above the plane of the fabric, wherein the web is macroscopically rearranged to conform to the surface of the throughdrying fabric; and (e) throughdrying the

web, wherein the throughdrying fabric has an offset seam which results in the machine direction yarns of the throughdrying fabric being disposed at an angle of about 2° or less, more specifically about 1° or less, still more specifically from about 0.05° to about 1°, and still more specifically from about 0.1° to about 0.6° relative to the machine direction of the fabric. As used herein, the term "offset" means that the seam is formed after the edges of the fabric have been displaced in the cross-machine direction beyond that which may occur inadvertently during normal seaming operations. The concept of an offset seam will be more fully described in the description of Figure 11.

[0014] A roll of tissue made according to the method not within the scope of the present invention may comprise a tissue sheet comprising generally parallel rows of elevated pillow-like regions running at an acute angle relative to the machine direction of the sheet. The angle can be from about 0.05° to about 2°, more specifically from about 0.05° to about 1°, and still more specifically from about 0.1° to about 0.6°. The angle results from an offset seam in the throughdrying fabric and substantially suppresses the tendency of the sheet to nest when wound into rolls. A similar result can be achieved with a conventionally seamed fabric, but by oscillating the roll upon which the web is being wound at an amplitude and frequency which suppresses the tendency of the features of the web to line up and nest and increases the roll bulk/roll firmness ratio relative to a roll of the same sheet material wound without oscillating the roll.

[0015] The roll of tissue preferably has a roll bulk of 16 cubic centimeters or greater per gram and a roll firmness of 8 millimeters or less.

[0016] In another preferred embodiment the roll of tissue has a roll bulk/roll firmness ratio of 20 or more square centimeters per gram and a sheet caliper from about 0.02 to about 0.05 inch (0.51 mm to 1.27 mm).

[0017] In another preferred embodiment the roll of tissue has a roll bulk/roll firmness ratio of 20 or more square centimeters per gram and a geometric mean stiffness of about 8 or less.

[0018] In another preferred embodiment roll of tissue has a roll bulk/roll firmness/single sheet caliper ratio of about 350 or more centimeters per gram and a geometric mean stiffness of about 8 or less.

[0019] The roll bulk for rolls of tissue made in accordance with this invention can be 16 cubic centimeters or greater per gram of fiber, more specifically about 17 cubic centimeters or greater per gram of fiber, and still more specifically from about 17 to about 20 cubic centimeters per gram.

[0020] The roll firmness of rolls of tissue made in accordance with this invention can be about 11 millimeters or less, more specifically about 8 millimeters or less, more specifically about 7 millimeters or less, more specifically about 6 millimeters or less, and still more specifically from about 4 to about 7 millimeters.

[0021] The roll bulk/roll firmness ratio of rolls of tissue

made in accordance with this invention can be 20 or more square centimeters per gram, more specifically about 25 or more square centimeters per gram, and still more specifically from about 25 to about 55 square centimeters per gram.

[0022] The single sheet caliper of the tissue sheets of this invention is preferably from about 0.02 to about 0.05 inch (0.51 to about 1.27 millimeters), and more preferably from about 0.025 to about 0.045 inch (0.64 to about 1.14 millimeters).

[0023] The geometric mean stiffness of the tissue sheets useful for purposes of this invention can be about 8 or less, more specifically about 5 or less, and still more specifically from about 2 to about 5.

[0024] The roll bulk/roll firmness/single sheet caliper ratio of rolls of tissue in accordance with this invention can be about 350 or more centimeters per gram, more specifically about 390 or more centimeters per gram, more specifically about 430 or more centimeters per gram, and still more specifically from about 350 to about 550 centimeters per gram.

[0025] In addition to the above-mentioned properties which directly relate to or impact the properties of a wound roll of product, the absorbent capacity of the sheets useful for purposes of this invention can be about 5 or more grams of water per gram of fiber, more specifically from about 5 to about 8 grams of water per gram of fiber, and still more specifically from about 5.5 to about 7 grams of water per gram of fiber.

[0026] Also, the absorbent rate of sheets useful for purposes of this invention can be about 4 seconds or less, more specifically from about 1 to about 4 seconds, and still more specifically from about 2 to about 3 seconds.

[0027] As used herein, "roll bulk" is the bulk of the wound product, excluding the core volume, and is most easily understood with reference to Figure 2. Figure 2 illustrates a typical roll product having a core, around which the paper product is wound. The radius of the roll product is designated as "R", whereas the radius of the core is designated as "r". The width or length of the roll is designated as "L". All measurements are expressed as "centimeters". The product roll volume "RV", expressed in cubic centimeters (cc), is the volume of the product minus the volume of the core, namely $RV = (\pi R^2 L) - (\pi r^2 L)$. The product roll weight "W" is the weight of the roll minus the weight of the core, measured in grams (g). Alternatively, the roll weight "W" can be calculated by multiplying the basis weight of the sheet, expressed in grams per square meter, by the area of the sheet (length times width), expressed in square meters. Either way, the "roll bulk", expressed in cubic centimeters per gram (cc/g), is "RV" divided by "W".

[0028] As used herein, "roll firmness" is a measure of the extent a probe can penetrate the roll under controlled conditions and is readily understood with reference to Figure 3, which illustrates the apparatus used for determining roll firmness. The apparatus is available from Kershaw Instrumentation, Inc., Swedesboro, NJ and is

known as a Model RDT-101 Roll Density Tester. Shown in Figure 3 is a towel roll 80 being measured, which is supported on a spindle 81. When the test begins a traverse table 82 begins to move toward the roll. Mounted to the traverse table is a sensing probe 83. The motion of the traverse table causes the sensing probe to make contact with the towel roll. When the sensing probe contacts the roll, the force exerted on the load cell exceeds the low set point of 6 grams and the displacement display is zeroed and begins indicating the penetration of the probe. When the force exerted on the sensing probe exceeds the high set point of 687 grams, the traverse table stops and the displacement display indicates the penetration in millimeters. The tester records this reading. Next the tester rotates the towel roll 90° on the spindle and repeats the test. The roll firmness value is the average of the two readings, expressed in millimeters. The test is performed in a controlled environment of $73.4 \pm 1.8^\circ\text{F}$ ($23 \pm 1^\circ\text{C}$) and $50 \pm 2\%$ relative humidity. The rolls are conditioned in this environment at least 4 hours before testing.

[0029] As used herein, "geometric mean stiffness" is the geometric mean slope divided by the geometric mean tensile strength; where the geometric mean tensile strength is the square root of the product of the machine direction tensile strength and the cross-machine direction tensile strength, expressed in grams per 3 inches (7.62 cm); and where the geometric mean slope is the square root of the product of the machine direction slope and the cross machine direction slope, expressed in grams per 3 inches (7.62 cm); and where machine direction slope and cross machine direction slope are as described in U.S. 5,746,887 issued May 5, 1998 to Wendt et al. entitled Method of Making Soft Tissue Products.

[0030] As used herein, the "single sheet caliper" is measured in accordance with TAPPI test method T402 "Standard Conditioning and Testing Atmosphere For Paper, Board, Pulp Handsheets and Related Products" and is measured as one sheet using an EMVECO 200-A Microgauge automated micrometer (EMVECO, Inc., Oregon). The micrometer has an anvil diameter of 2.22 inches (56.4 millimeters) and an anvil pressure of 132 grams per square inch (per 6.45 square centimeters) (2.0 kPa).

[0031] As used herein, the "absorbent capacity" of tissue sheets is determined by cutting the tissue sheets into 4 inches (10.3 cm) by 4 inches (10.3cm) squares, placing twenty squares into a stack such that all squares are oriented the same relative to the machine direction of the tissue, and stapling the corners of the stack together to form a 20 sheet pad. The pad is placed into a wire mesh basket with the staple points down and lowered into a water bath held at a temperature of $23^\circ\text{C} \pm 2^\circ\text{C}$. When the pad is completely wetted, it is removed and allowed to drain for 30 seconds while in the wire basket. The weight of the water remaining in the pad after 30 seconds is the amount absorbed. This value is divided by the weight of the pad to determine the absorbent capacity, which for purposes herein is expressed as grams of water

absorbed per gram of fiber.

[0032] As used herein, the "absorbent rate" of tissue sheets is determined by same procedure as for the absorbent capacity, except the size of the pad is 2.5 inches by 2.5 inches (6.35 cm x 6.35 cm). The time taken for the pad to completely wet out after being lowered into the water bath is the absorbent rate, expressed in seconds. Higher numbers mean that the rate at which water is absorbed is slower.

[0033] Methods for making throughdried tissues are described in U.S. 5,656,132 entitled "Soft Tissue" issued August 12, 1997 to Farrington et al. and U.S. 5,672,248 entitled "Method of Making Soft Tissue Products" issued September 30, 1997 to Wendt et al.

[0034] The tissue sheets useful for purposes of this invention can have one, two, three or more plies and can be wet-pressed, throughdried, or uncreped throughdried. They can be used for facial tissues, bath tissues, paper towels, dinner napkins and the like, although the greatest utility can be found in roll product forms such as bath tissue and paper towels.

Figure 1 illustrates a schematic view of the method for making uncreped throughdried tissues in accordance with a preferred embodiment of this invention. Figure 2 is a schematic figure of a typical roll product, illustrating the calculation of "roll bulk".

Figure 3 is a schematic representation of the apparatus used for measuring "roll firmness".

Figure 4 is a plot of roll bulk versus roll firmness for products of preferred embodiments of this invention (labeled "I1" - "I13" corresponding to Examples 1 - 13 below), a control point (labeled "Control") made without the methods of this invention as described in Example 14, and a variety of commercially available paper towels (collectively labeled "C1" or "C2" depending upon whether or not they are 1- or 2-ply products, respectively), illustrating the combination of high roll bulk and high roll firmness attained by the products of preferred embodiments.

Figure 5 is a plot of the roll bulk/roll firmness ratio versus single sheet caliper for products of preferred embodiments of this invention and a variety of commercially available paper towels with data points labeled as in Figure 4, illustrating the efficiency of the methods of this invention for attaining firm, bulky rolls with tissue sheets of a given caliper.

Figure 6 is a plot of the roll bulk/roll firmness ratio versus the geometric mean stiffness, similar to Figures 4 and 5 above, illustrating the ability of the methods of this invention to provide a high degree of bulk and firmness with soft (less stiff) sheets.

Figure 7 is a plot of the roll bulk/roll firmness/single sheet caliper ratio versus the geometric mean stiffness, similar to Figures 4, 5 and 6 above, further illustrating the efficiency of the methods of the preferred embodiments of this invention in providing quality bulk and firmness for soft tissue sheets of a

given caliper.

Figures 8A and 8B are photographs of the dryer side (top side) of an uncreped throughdried tissue sheet made in accordance with a preferred embodiment of this invention and a similar sheet made without using the methods of this invention, respectively, illustrating the parallel rows of elevated pillow-like regions in the machine direction which are interrupted by the cross-machine direction dominant troughs imparted to the sheet by the transfer fabric.

Figures 9A and 9B are photographs of the air side (bottom side) of the sheets of Figures 8A and 8B, respectively, further illustrating the bar-like impressions imparted to the tissue sheet by the transfer fabric, which on this side of the sheet are bar-like protrusions.

Figure 10 is a photograph of the sheet side of a transfer fabric used to impart the bar-like protrusions in the air side of the sheet.

Figures 11A, 11B and 11C are schematic illustrations of the steps involved in a method of making an offset seam in a fabric not in accordance with the present invention.

[0035] Referring now to the drawings, preferred embodiments of the invention will be described in greater detail.

[0036] Figure 1 illustrates a method of making an uncreped throughdried tissue sheet in accordance with a preferred embodiment of this invention. Shown is a twin wire former having a layered papermaking headbox 10 which injects or deposits a stream 11 of an aqueous suspension of papermaking fibers between forming fabrics 12 and 13. The web is adhered to forming fabric 13, which serves to support and carry the newly-formed wet web downstream in the process as the web is partially dewatered to a consistency of about 10 dry weight percent. Additional dewatering of the wet web can be carried out, such as by vacuum suction, while the wet web is supported by the forming fabric.

[0037] The wet web is then transferred from the forming fabric to a transfer fabric 17 travelling at a slower speed than the forming fabric in order to impart increased MD stretch into the web. A kiss transfer is carried out to avoid compression of the wet web, preferably with the assistance of a vacuum shoe 18. In accordance with the method of the present invention as claimed in claim 26, the transfer fabric is used to provide cross-machine direction dominant bars to the sheet, and can be as described in Figures 5, 6 and 7 of US Patent No. 5,219,004 entitled "Multi-ply Papermaking Fabric With Binder Warps" issued June 15, 1993 to Chiu. More particularly, referring to a transfer fabric as illustrated in Figure 6 of Chiu, the sheet side of the transfer fabric is the side of the fabric having the long cross-machine direction dominant floats created by filaments 144, and the cross-machine dominant bars in the sheet imparted by the transfer fabric correspond to the troughs formed between cross-

machine direction dominant filaments 144.

[0038] The web is then transferred from the transfer fabric to the throughdrying fabric 19 with the aid of a vacuum transfer roll 20 or a vacuum transfer shoe. The throughdrying fabric can be traveling at about the same speed or a different speed relative to the transfer fabric. If desired, the throughdrying fabric can be run at a slower speed to further enhance MD stretch. Transfer is preferably carried out with vacuum assistance to ensure deformation of the sheet to conform to the throughdrying fabric, thus yielding desired bulk, flexibility; CD stretch and appearance. The throughdrying fabric is preferably of the high and long impression knuckle type generally described in Wendt et al.

[0039] The level of vacuum used for the web transfers can be from about 3 to about 15 inches of mercury (75 to about 380 millimeters of mercury), preferably about 10 inches (254 millimeters) of mercury. The vacuum shoe (negative pressure) can be supplemented or replaced by the use of positive pressure from the opposite side of the web to blow the web onto the next fabric in addition to or as a replacement for sucking it onto the next fabric with vacuum. Also, a vacuum roll or rolls can be used to replace the vacuum shoe(s).

[0040] While supported by the throughdrying fabric, the web is final dried to a consistency of about 94 percent or greater by the throughdryer 21 and thereafter transferred to a carrier fabric 22. The dried basesheet 23 is transported to the reel 24 using carrier fabric 22 and an optional carrier fabric 25. An optional pressurized turning roll 26 can be used to facilitate transfer of the web from carrier fabric 22 to fabric 25. Suitable carrier fabrics for this purpose are Albany International 84M or 94M and Asten 959 or 937, all of which are relatively smooth fabrics having a fine pattern. Although not shown, reel calendering or subsequent off-line calendering can be used to improve the smoothness and softness of the basesheet.

[0041] Figures 2 and 3 have been previously described in connection with the roll bulk and roll firmness measurements.

[0042] Figures 4, 5, 6 and 7 are plots comparing certain properties of commercially available products with the products of this invention made in accordance with the Examples described below.

[0043] Figures 8A and 8B are photographs of the dryer side of an uncreped throughdried tissue sheet made in accordance with a preferred embodiment of this invention (8A) and a similar sheet made without using the methods of this invention (8B). Referring to Figure 8A, shown are the parallel rows of elevated pillow-like regions 85 running in the machine direction which are interrupted by the cross-machine direction dominant troughs 86 in the tissue sheet of the preferred embodiment. In Figure 8B, structure corresponding to the cross-machine dominant troughs is absent.

[0044] Figures 9A and 9B are photographs of the air side of the sheets of Figures 8A and 8B, respectively.

Shown are the CD dominant bar-like protrusions 91 imparted to the air side of the tissue sheet by the transfer fabric.

[0045] Figure 10 is a photograph of the sheet side of an Appleton Mills 2054-A33 transfer fabric used to impart the cross-machine direction dominant bar-like protrusions to the air side of the sheet illustrated in Figures 8A and 9A in accordance with a preferred embodiment of this invention.

[0046] Figures 11A, 11B and 11C are schematic diagrams illustrating the steps used to make a fabric with an offset seam according to a method not within the scope of the present invention. Initially, as shown in Figure 11A, the fabric 100 is laid flat and the degree of offset is determined. Parallel offset lines 102 and 103 are drawn near the edges of the fabric as shown. The angle of these lines relative to the edge of the fabric represents the degree of offset relative to the machine direction of the fabric. The fabric is then formed into a continuous loop with the offset lines aligned as shown in Figure 11B. The two adjacent edges of the fabric are then seamed together. The excess fabric material is then trimmed away using a hot knife or other suitable means, leaving an offset fabric as illustrated in Figure 11C. As a result of this method, the seam 104 of the resulting fabric is not perpendicular to the machine direction of the fabric.

Examples

Example 1.

[0047] An uncreped throughdried tissue sheet was made in accordance with a preferred embodiment of this invention as described above in connection with Figure 1. More specifically, a non-layered single ply towel tissue was made using a furnish comprising 50 dry weight percent northern softwood kraft fiber (NSWK), 25 % northern softwood bleached chemi-thermomechanical fiber (BCTMP), and 25 % southern hardwood kraft fiber (SHWK).

[0048] The NSWK fiber was pulped for 30 minutes at approximately 4 percent consistency and diluted to approximately 3.2 percent after pulping. The BCTMP and SHWK fibers were combined together in a 50:50 ratio and pulped for 30 minutes at approximately 4 percent consistency and diluted to approximately 3.2 percent after pulping. Kymene 557LX was added to both pulp streams at 10 kilograms per metric ton of pulp based on total flow. The NSWK fibers were refined at 1.0 horsepower-day (0.75 kW days) per metric ton. The pulp streams were then blended and diluted to approximately 0.18 % consistency. The diluted suspension was fed to a C-wrap, twin wire, suction form roll, former with forming fabrics (12 and 13) being an Asten 867A and an Appleton Mills (AM) 2164-B33 fabric respectively. The speed of both of the forming fabrics was 1562 feet per minute (7.93 meters/second). The newly formed web was then de-watered to a consistency of about 24 percent using vacuum

suction from below the forming fabric before being transferred to the transfer fabric (17) travelling at 1250 fpm (25 % rush transfer.) The transfer fabric was an Appleton Mills 2054-A33 run with the coarse CD dominant filaments to the sheet side. (See Figure 10). A vacuum shoe pulling 6 inches (152 millimeters) of mercury vacuum was used to transfer the web to the transfer fabric.

[0049] The web was then transferred to a throughdrying fabric (19), which was an Appleton Mills t1205-1. The through drying fabric was travelling at a speed of about 1250 feet per minute (6.35 meters/second). The web was carried over a Honeycomb through-dryer operating at a temperature of about 350°F (177°C) and dried to final dryness of about 97 percent consistency. The resulting uncreped tissue sheet was then calendered at a fixed gap of 0.011 inch (0.028 millimeter) between two 20 inches (508 millimeters) diameter steel rolls and wound into finished product rolls on 1.6 inches (40.6 millimeters) diameter cores.

[0050] The resulting finished product had the following properties: basis weight, 22.8 pounds per 2880 square feet (38.6 grams per square meter); MD tensile, 2480 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2370 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 20.1 percent; CD stretch 9.0 percent; MD slope, 6.05 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 9.29 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 3.10; single sheet caliper, 0.033 inch (0.84 millimeter); roll bulk, 16.7 cubic centimeters per gram; roll firmness, 4.16 millimeters; roll bulk divided by roll firmness, 40.1 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 480 centimeters per gram; absorbent capacity, 6.1 grams water per gram fiber; absorbent rate, 1.9 seconds; roll diameter, 5.19 inch (132 millimeters); roll length, 60.0 feet (18.3 meters).

Example 2.

[0051] A single ply towel was made as described in Example 1 except the furnish consisted of 50 percent NSWK, 25 % BCTMP, and 25 % northern hardwood kraft fiber (NHWK), the NSWK was refined at 1.5 horsepower-days (1.1 kW) per metric ton, the throughdrying fabric was an Appleton Mills t1205-2 fabric, and the resulting basesheet was calendered at a fixed gap of 0.007 inch (0.178 millimeter).

[0052] The resulting finished product had the following properties: basis weight, 22.4 pounds per 2880 square feet (38.1 grams per square meter); MD tensile, 2540 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 1680 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 18.7 percent; CD stretch 10.3 percent; MD slope, 5.43 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 6.36 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 2.84; single sheet caliper, 0.034 inch (0.86

mm); roll bulk, 17.1 cubic centimeters per gram; roll firmness, 7.1 millimeters; roll bulk divided by roll firmness, 24.1 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 280 centimeters per gram; absorbent capacity, 6.56 grams water per gram fiber; absorbent rate, 3.3 seconds; roll diameter, 5.20 inch (132 millimeters); roll length, 62.5 feet (19.1 meters).

Example 3.

[0053] A single ply towel was made as described in Example 2 except the transfer fabric was an Appleton Mills t1605-2 fabric and the throughdrying fabric was an Appleton Mills t1205-2 off-seamed fabric at a finished offset angle of 0.273 degrees.

[0054] The resulting finished product had the following properties: basis weight, 21.8 pounds per 2880 square feet (37.1 grams per square meter); MD tensile, 2130 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 1970 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 17.5 percent; CD stretch 13.0 percent; MD slope, 9.13 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 5.06 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 3.31; single sheet caliper, 0.034 (0.86 mm); roll bulk, 19.4 cubic centimeters per gram; roll firmness, 5.85 millimeters; roll bulk divided by roll firmness, 33.2 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 390 centimeters per gram; absorbent capacity, 6.78 grams water per gram fiber; absorbent rate, 2.2 seconds; roll diameter, 5.43 inch (138 millimeters); roll length, 62.5 feet (19.1 meters).

Example 4.

[0055] A single ply towel was made as described in Example 3 except the resulting basesheet was calendered at a fixed gap of 0.005 inch (0.127 millimeter).

[0056] The resulting finished product had the following properties: basis weight, 21.6 pounds per 2880 square feet (36.7 grams per square meter); MD tensile, 2250 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 1660 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 18.5 percent; CD stretch 11.8 percent; MD slope, 8.98 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 4.47 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 3.28; single sheet caliper, 0.032 inch (0.81 mm); roll bulk, 19.1 cubic centimeters per gram; roll firmness, 6.20 millimeters; roll bulk divided by roll firmness, 30.8 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 380 centimeters per gram; absorbent capacity, 6.83 grams water per gram fiber; absorbent rate, 2.1 seconds; roll diameter, 5.35 inch (136 millimeters); roll length, 62.5 feet (19.1 meters).

Example 5.

[0057] A single ply towel was made as described in Example 3 except the NSWK was refined at 3.0 horsepower-days (2.2 kW days) per metric ton, Kymene 557LX was added at a rate of 12 kilograms per metric ton of fiber, the transfer fabric was an Appleton Mills t216-3 fabric, and the resulting basesheet was calendered at a fixed gap of 0.005 inch (0.127 millimeters).

[0058] The resulting finished product had the following properties: basis weight, 22.2 pounds per 2880 square feet (37.8 grams per square meter); MD tensile, 2870 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2460 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 18.3 percent; CD stretch 11.3 percent; MD slope, 11.1 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 6.20 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 3.12; single sheet caliper, 0.029 inch (0.74 mm); roll bulk, 18.1 cubic centimeters per gram; roll firmness, 4.85 millimeters; roll bulk divided by roll firmness, 37.3 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 500 centimeters per gram; absorbent capacity, 6.0 grams water per gram fiber; absorbent rate, 2.5 seconds; roll diameter, 5.32 inch (135 millimeters); roll length, 62.5 feet (19.1 meters).

Example 6.

[0059] A single ply towel was made as described in Example 5 except the resulting basesheet was calendered at a fixed gap of 0.007 inch (0.178 millimeter).

[0060] The resulting finished product had the following properties: basis weight, 22.3 pounds per 2880 square feet (37.9 grams per square meter); MD tensile, 3330 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2610 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 20.3 percent; CD stretch 11.7 percent; MD slope, 10.9 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 6.85 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 2.92; single sheet caliper, 0.032 inch (0.81 mm); roll bulk, 19.3 cubic centimeters per gram; roll firmness, 5.0 millimeters; roll bulk divided by roll firmness, 38.6 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 480 centimeters per gram; absorbent capacity, 6.14 grams water per gram fiber; absorbent rate, 2.5 seconds; roll diameter, 5.47 inch (139 millimeters); roll length, 62.5 feet (19.1 meters).

Example 7.

[0061] A single ply towel was made as described in Example 5 except the transfer fabric was an Appleton Mills 2054-A33.

[0062] The resulting finished product had the following

properties: basis weight, 22.1 pounds per 2880 square feet (37.6 grams per square meter); MD tensile, 3260 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2120 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 19.1 percent; CD stretch 9.4 percent; MD slope, 5.98 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 9.4 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 2.85; single sheet caliper, 0.031 inch (0.79 mm); roll bulk, 17.6 cubic centimeters per gram; roll firmness, 4.90 millimeters; roll bulk divided by roll firmness, 35.9 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 460 centimeters per gram; absorbent capacity, 5.86 grams water per gram fiber; absorbent rate, 2.74 seconds; roll diameter, 5.24 inch (133 millimeters); roll length, 62.5 feet (19.1 meters).

Example 8.

[0063] A single ply towel was made as described in Example 7 except the resulting basesheet was calendered at a fixed gap of 0.007 inch (0.178 millimeter).

[0064] The resulting finished product had the following properties: basis weight, 22.3 pounds per 2880 square feet (37.9 grams per square meter); MD tensile, 3330 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2270 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 17.4 percent; CD stretch 10.5 percent; MD slope, 6.6 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 8.8 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 2.8; single sheet caliper, 0.032 inch (0.81 mm); roll bulk, 18.4 cubic centimeters per gram; roll firmness, 4.45 millimeters; roll bulk divided by roll firmness, 41.3 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 510 centimeters per gram; absorbent capacity, 5.98 grams water per gram fiber; absorbent rate, 3.0 seconds; roll diameter, 5.35 inch (136 millimeters); roll length, 62.5 feet (19.1 meters).

Example 9.

[0065] A single ply towel was made as described in Example 7 except the former consistency was approximately 0.25 percent.

[0066] The resulting finished product had the following properties: basis weight, 22.2 pounds per 2880 square feet (37.8 grams per square meter); MD tensile, 2940 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2210 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 16.5 percent; CD stretch 10.0 percent; MD slope, 6.65 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 8.50 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 3.00; single sheet caliper, 0.030 inch (0.76 mm); roll bulk, 17.8 cubic centimeters per gram; roll firmness, - 4.55 millimeters; roll bulk divided by roll firmness,

39.1 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 520 centimeters per gram; absorbent capacity, 6.0 grams water per gram fiber; absorbent rate, 2.8 seconds; roll diameter, 5.28 inch (134 millimeters); roll length, 62.5 feet (19.1 meters).

Example 10.

[0067] A single ply towel as described in Example 9 except the resulting basesheet was calendered at a fixed gap of 0.007 inch (0.178 millimeter).

[0068] The resulting finished product had the following properties: basis weight, 22.3 pounds per 2880 square feet (37.8 grams per square meter); MD tensile, 3220 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2370 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 18.5 percent; CD stretch 10.5 percent; MD slope, 6.06 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 8.67 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 2.63; single sheet caliper, 0.033 inch (0.84 mm); roll bulk, 18.4 cubic centimeters per gram; roll firmness, 4.9 millimeters; roll bulk divided by roll firmness, 37.6 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 450 centimeters per gram; absorbent capacity, 5.89 grams water per gram fiber; absorbent rate, 2.8 seconds; roll diameter, 5.35 inch (136 millimeters); roll length, 62.5 feet (19.1 meters).

Example 11.

[0069] A single ply towel was made as described in Example 2 except the resulting basesheet was not calendered.

[0070] The resulting finished product had the following properties: basis weight, 23.6 pounds per 2880 square feet (40.1 grams per square meter); MD tensile, 2570 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2290 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 19.9 percent; CD stretch 12.6 percent; MD slope, 8.98 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 10.2 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 3.93; single sheet caliper, 0.045 inch (1.14 mm); roll bulk, 20.9 cubic centimeters per gram; roll firmness, 4.35 millimeters; roll bulk divided by roll firmness, 48.1 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 420 centimeters per gram; absorbent capacity, 6.56 grams water per gram fiber; absorbent rate, 3.2 seconds; roll diameter, 5.95 inch (151 millimeters); roll length, 65.0 feet (19.7 meters).

Example 12.

[0071] A single ply towel as described in Example 3

except the resulting basesheet was not calendered.

[0072] The resulting finished product had the following properties: basis weight, 22.5 pounds per 2880 square feet (38.3 grams per square meter); MD tensile, 2600 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2410 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 19.6 percent; CD stretch 13.2 percent; MD slope, 12.3 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 8.74 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 4.13; single sheet caliper, 0.043 inch (1.09 mm); roll bulk, 23.2 cubic centimeters per gram; roll firmness, 4.9 millimeters; roll bulk divided by roll firmness, 47.3 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 430 centimeters per gram; absorbent capacity, 6.41 grams water per gram fiber; absorbent rate, 2.2 seconds; roll diameter, 6.1 inch (155 millimeters); roll length, 65.1 feet (19.7 meters).

Example 13.

[0073] A single ply towel as described in Example 7 except the resulting basesheet was not calendered.

[0074] The resulting finished product had the following properties: basis weight, 22.7 pounds per 2880 square feet (38.6 grams per square meter); MD tensile, 3430 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2620 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 21.6 percent; CD stretch 10.7 percent; MD slope, 7.67 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 14.2 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean stiffness, 3.46; single sheet caliper, 0.042 inch (1.07 mm); roll bulk, 21.7 cubic centimeters per gram; roll firmness, 4.40 millimeters; roll bulk divided by roll firmness, 49.2 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 460 centimeters per gram; absorbent capacity, 5.98 grams water per gram fiber; absorbent rate, 2.8 seconds; roll diameter, 5.90 inch (150 millimeters); roll length, 63.5 feet (19.2 meters).

Example 14 (Control).

[0075] A single ply towel as described in Example 1 except the transfer fabric was an AM 2164-B33 and the resulting basesheet was calendered at a fixed gap of 0.011 inch (27.9 mm).

[0076] The resulting finished product had the following properties: basis weight, 22.4 pounds per 2880 square feet (38.1 grams per square meter); MD tensile, 2670 grams per 3 inches (76.2 millimeters) sample width; CD tensile, 2170 grams per 3 inches (76.2 millimeters) sample width; MD stretch, 19.1 percent; CD stretch 9.0 percent; MD slope, 19.6 kilograms per 3 inches (76.2 millimeters) sample width; CD slope, 10.6 kilograms per 3 inches (76.2 millimeters) sample width; geometric mean

stiffness, 5.98; single sheet caliper, 0.033 inch (0.84 mm); roll bulk, 17.0 cubic centimeters per gram; roll firmness, 10.4 millimeters; roll bulk divided by roll firmness, 16.3 square centimeters per gram; roll bulk divided by roll firmness divided by single sheet caliper, 200 centimeters per gram; absorbent capacity, 6.0 grams water per gram fiber; absorbent rate, 2.0 seconds; roll diameter, 5.19 inch (1325 millimeters); roll length, 60.0 feet (18.2 meters).

[0077] It will be appreciated that the foregoing examples, given for purposes of illustration, are not to be construed as limiting the scope of this invention, which is defined by the following claims and all equivalents thereto.

Claims

1. A throughdried tissue sheet having an air side and a dryer side,
characterised by:

the dryer side of the sheet having parallel discontinuous rows of machine direction dominant elevated pillow-like regions (85), wherein the discontinuities in the rows of elevated pillow-like regions are cross-machine direction dominant troughs (86) that appear as cross-machine dominant bar-like protrusions (91) on the air side of the sheet.

2. A roll of tissue (80) comprising throughdried tissue sheet as claimed in claim 1, having a roll bulk of 16 cubic centimeters or greater per gram and a roll firmness of 8 millimeters or less.
3. The roll of tissue (80) of claim 2, wherein the roll firmness is 7 millimeters or less.
4. The roll of tissue (80) of claim 2, wherein the roll firmness is 6 millimeters or less.
5. The roll of tissue (80) of claim 2, wherein the roll firmness is from 4 to 7 millimeters.
6. The roll of tissue (80) of claim 2, wherein the roll bulk is 17 cubic centimeters or greater per gram and the roll firmness is 6 millimeters or less.
7. The roll of tissue (80) of claim 2, wherein the roll bulk is from 17 cubic centimetres per gram to 20 cubic centimeters per gram and the roll firmness is from 4 millimeters to 7 millimeters.
8. The roll of tissue (80) of claim 2, further having a roll bulk/roll firmness ratio of 20 or more square centimeters per gram, and a single sheet caliper from 0.02 inch (0.51 mm) to 0.05 inch (1.27 mm).

9. The roll of tissue (80) of claim 8, wherein the roll bulk/roll firmness ratio is 25 or more square centimeters per gram.
10. The roll of tissue (80) of claim 8 or 9, wherein the roll bulk/roll firmness ratio is from 25 to 55 square centimeters per gram. 5
11. The roll of tissue (80) of claim 8, 9 or 10, wherein the single sheet caliper is from 0.025 to 0.040 inch (0.64 mm to 1.02 mm). 10
12. The roll of tissue (80) of claim 2, further having a roll bulk/roll firmness ratio of 20 or more square centimeters per gram and a geometric mean stiffness of 8 or less. 15
13. The roll of tissue (80) of claim 12, wherein the roll bulk/roll firmness ratio is 25 or more square centimeters per gram. 20
14. The roll of tissue (80) of claim 12, wherein the roll bulk/roll firmness ratio is from 25 to 55 square centimeters per gram. 25
15. The roll of tissue (80) of claim 12, 13 or 14, wherein the geometric mean stiffness is 5 or less.
16. The roll of tissue (80) of claim 12, 13 or 14, wherein the geometric mean stiffness is from 2 to 5. 30
17. The roll of tissue (80) of claim 2, further having a roll bulk/roll firmness/single sheet caliper ratio of 350 or more centimeters per gram and a geometric mean stiffness of 8 or less. 35
18. The roll of tissue (80) of claim 17, wherein the roll bulk/roll firmness/single sheet caliper ratio is 390 or more centimeters per gram. 40
19. The roll of tissue (80) of claim 17, wherein the roll bulk/roll firmness/single sheet caliper ratio is 430 or more centimeters per gram.
20. The roll of tissue (80) of claim 17, wherein the roll bulk/roll firmness/single sheet caliper ratio is from 350 to 550 centimeters per gram. 45
21. The roll of tissue (80) of any of claims 17 to 20, wherein the geometric mean stiffness is from 2 to 5. 50
22. The roll of tissue (80) of any of claims 2 to 21, wherein the tissue has an absorbent capacity of 5 or more grams of water per gram of fiber. 55
23. The roll of tissue (80) of any of claims 2 to 22, wherein the tissue has an absorbent rate of 4 seconds or less.
24. The roll of tissue (80) of any of claims 2 to 23, wherein said throughdried tissue sheet is an uncreped throughdried tissue sheet.
25. The roll of tissue (80) of claim 2, further having a single sheet caliper from 0.02 inch (0.51 mm) to 0.05 inch (1.27 mm).
26. A method of making a throughdried tissue sheet comprising:
- (a) depositing an aqueous suspension of paper-making fibers onto a forming fabric (13) to form a wet web;
 - (b) dewatering the wet web to a consistency from 20 to 30 percent;
 - (c) transferring the dewatered web from the forming fabric (13) to a transfer fabric (17) traveling at a speed from 10 to 80 percent slower than the forming fabric (13);
 - (d) transferring the web to a throughdrying fabric (19) having from 50 to 300 machine direction impression knuckles per square inch (78 to 4650 impression knuckles per cm²) which are raised at least 0.005 inch (0.13 mm) above the plane of the fabric (19) and
 - (e) throughdrying the web;
- characterised by:**
- the sheet side of the transfer fabric containing cross-machine direction dominant troughs (86) which impart cross-machine direction bar-like protrusions (91) to the air side of the tissue sheet; and
- wherein the web is macroscopically rearranged to conform to the surface of the throughdrying fabric (19) providing the dryer side of the sheet with parallel discontinuous rows of machine direction dominant elevated pillow-like regions.
27. The method of claim 26, wherein said throughdried tissue sheet is an uncreped throughdried tissue sheet.
28. The method of claim 26 or 27, wherein the cross-machine direction troughs in the transfer fabric (17) have a width corresponding to the spacing between cross-machine direction dominant filaments of the transfer fabric.
29. The method of claim 28, wherein the spacing between cross-machine direction dominant filaments of the transfer fabric (17) is about 0.3 millimeter or greater.
30. The method of claim 28, wherein the spacing between cross-machine direction dominant filaments

of the transfer fabric (17) is from about 0.3 to about 3 millimeters.

31. The method of claim 28, wherein the spacing between cross-machine direction dominant filaments of the transfer fabric (17) is from about 0.5 to about 1.5 millimeters.
32. The method of claim 28, wherein the transfer fabric (17) contains multiple cross-machine direction dominant filaments piled on top of each other to form deeper cross-machine direction troughs.

Patentansprüche

1. Durchluftgetrocknetes Tissue-Blatt mit einer Luftseite und einer Trocknerseite,
dadurch gekennzeichnet, dass:

die Trocknerseite des Blattes parallele, unterbrochene Reihen von maschinenrichtungsdominanten, erhabenen, kissenähnlichen Bereichen (85) aufweist,
wobei die Unterbrechungen in den Reihen der erhabenen, kissenähnlichen Bereiche maschinenquerrichtungsdominante Prägungen (86) sind, die als maschinenquerrichtungsdominante, strangähnliche Vorsprünge (91) auf der Luftseite des Blattes erscheinen.

2. Tissue-Rolle (80), enthaltend ein durchluftgetrocknetes Tissue-Blatt nach Anspruch 1, mit einem Rollen-Bulk von wenigstens 16 cm³/g und einer Rollenfestigkeit von höchstens 8 mm.
3. Tissue-Rolle (80) nach Anspruch 2, bei der die Rollenfestigkeit höchstens 7 mm beträgt.
4. Tissue-Rolle (80) nach Anspruch 2, bei der die Rollenfestigkeit höchstens 6 mm beträgt.
5. Tissue-Rolle (80) nach Anspruch 2, bei der die Rollenfestigkeit im Bereich von 4 bis 7 mm liegt.
6. Tissue-Rolle (80) nach Anspruch 2, bei der der Rollen-Bulk wenigstens 17 cm³/g und die Rollenfestigkeit höchstens 6 mm beträgt.
7. Tissue-Rolle (80) nach Anspruch 2, bei der der Rollen-Bulk im Bereich von 17 cm³/g und 20 cm³/g und die Rollenfestigkeit im Bereich von 4 mm bis 7 mm liegt.
8. Tissue-Rolle (80) nach Anspruch 2, die weiterhin ein Verhältnis zwischen Rollen-Bulk und Rollenfestigkeit von wenigstens 20 cm²/g und ein Einzelblattickenmaß im Bereich von 0,02 Zoll (0,51 mm) und 0,05

Zoll (1,27 mm) hat.

9. Tissue-Rolle (80) nach Anspruch 8, bei der das Verhältnis zwischen Rollen-Bulk und Rollenfestigkeit wenigstens 25 cm²/g beträgt.
10. Tissue-Rolle (80) nach Anspruch 8 oder 9, bei der das Verhältnis zwischen Rollen-Bulk und Rollenfestigkeit zwischen 25 und 55 cm²/g liegt.
11. Tissue-Rolle (80) nach Anspruch 8, 9 oder 10, bei der das Einzelblattickenmaß im Bereich von 0,025 bis 0,040 Zoll (0,64 mm bis 1,02 mm) liegt.
12. Tissue-Rolle (80) nach Anspruch 2, die weiterhin Verhältnis zwischen Rollen-Bulk und Rollenfestigkeit von wenigstens 20 cm²/g und eine mittlere geometrische Steifigkeit von höchstens 8 hat.
13. Tissue-Rolle (80) nach Anspruch 12, bei der das Verhältnis zwischen Rollen-Bulk und Rollenfestigkeit wenigstens 25 cm²/g beträgt.
14. Tissue-Rolle (80) nach Anspruch 12, bei der das Verhältnis zwischen Rollen-Bulk und Rollenfestigkeit im Bereich von 25 bis 55 cm²/g liegt.
15. Tissue-Rolle (80) nach Anspruch 12, 13 oder 14, bei der die mittlere geometrische Steifigkeit höchstens 5 beträgt.
16. Tissue-Rolle (80) nach Anspruch 12, 13 oder 14, bei der die mittlere geometrische Steifigkeit im Bereich von 2 bis 5 liegt.
17. Tissue-Rolle (80) nach Anspruch 2, die weiterhin ein Verhältnis zwischen Rollen-Bulk, Rollenfestigkeit und Einzelblattickenmaß von wenigstens 350 cm/g und eine mittlere geometrische Steifigkeit von höchstens 8 hat.
18. Tissue-Rolle (80) nach Anspruch 17, bei der das Verhältnis zwischen Rollen-Bulk, Rollenfestigkeit und Einzelblattickenmaß wenigstens 390 cm/g beträgt.
19. Tissue-Rolle (80) nach Anspruch 17, bei der das Verhältnis zwischen Rollen-Bulk, Rollenfestigkeit und Einzelblattickenmaß wenigstens 430 cm/g beträgt.
20. Tissue-Rolle (80) nach Anspruch 17, bei der das Verhältnis zwischen Rollen-Bulk, Rollenfestigkeit und Einzelblattickenmaß im Bereich von 350 bis 550 cm/g liegt.
21. Tissue-Rolle (80) nach einem der Ansprüche 17 bis 20, bei der die mittlere geometrische Steifigkeit im Bereich von 2 bis 5 liegt.

22. Tissue-Rolle (80) nach einem der Ansprüche 2 bis 21, bei der das Tissue eine Absorptionskapazität von wenigstens 5 Gramm Wasser je Gramm Faser hat.

23. Tissue-Rolle (80) nach einem der Ansprüche 2 bis 22, bei der das Tissue eine Absorptionsrate von höchstens 4 Sekunden hat.

24. Tissue-Rolle (80) nach einem der Ansprüche 2 bis 23, bei der das durchluftgetrocknete Tissue-Blatt ein ungekrepptes, durchluftgetrocknetes Tissue-Blatt ist.

25. Tissue-Rolle (80) nach Anspruch 2, die weiterhin ein Einzelblattickenmaß im Bereich von 0,02 Zoll (0,51 mm) bis 0,05 Zoll (1,27 mm) hat.

26. Verfahren zur Herstellung eines durchluftgetrockneten Tissue-Blattes, enthaltend:

(a) Abscheiden einer wässrigen Suspension von Papierherstellungsfasern auf einem Formstoff (13), um eine nasse Bahn zu formen;

(b) Entwässern der nassen Bahn auf einen Gehalt von 20 bis 30%;

(c) Übertragen der entwässerten Bahn vom Formstoff (13) auf einen Transferstoff (17), der sich mit einer Geschwindigkeit bewegt, die 10 bis 80% geringer ist als die des Formstoffes (13);

(d) Übertragen der Bahn auf einen Durchlufttrocknungsstoff (19), der 50 bis 300 Eindrückausbuchtungen pro Quadratzoll (78 bis 4.650 Eindrückausbuchtungen pro cm²) in Maschinenrichtung aufweist, die um wenigstens 0,005 Zoll (0,13 mm) über die Ebene des Stoffes (19) erhaben sind, und

(e) Durchlufttrocknen der Bahn;

dadurch gekennzeichnet, dass

die Blattseite des Transferstoffes maschinenquerrichtungs-dominante Prägungen (86) enthält, die maschinenquerrichtungs-dominante strangähnliche Vorsprünge (91) auf der Luftseite des Tissue-Blattes hervorrufen; und

die Bahn makroskopisch neugeordnet wird, um sich der Oberfläche des Durchlufttrocknungsstoffes (19) anzupassen, der auf der Trocknerseite des Blattes parallele, unterbrochene Reihen von maschinenrichtungs-dominanten, erhabenen, kissenähnlichen Bereichen erzeugt.

27. Verfahren nach Anspruch 26, bei dem das durchluftgetrocknete Tissue-Blatt ein ungekrepptes, durchluftgetrocknetes Tissue-Blatt ist.

28. Verfahren nach Anspruch 26 oder 27, bei dem die maschinenquerrichtungs-dominanten Prägungen im Transferstoff (17) eine Breite haben, die dem Ab-

stand zwischen den maschinenquerrichtungs-dominanten Fäden des Transferstoffes entsprechen.

29. Verfahren nach Anspruch 28, bei dem der Abstand zwischen den maschinenquerrichtungs-dominanten Fäden des Transferstoffes (17) wenigstens etwa 0,3 mm beträgt.

30. Verfahren nach Anspruch 28, bei dem der Abstand zwischen den maschinenquerrichtungs-dominanten Fäden des Transferstoffes (17) im Bereich von 0,3 bis 3 mm liegt.

31. Verfahren nach Anspruch 28, bei dem der Abstand zwischen den maschinenquerrichtungs-dominanten Fäden des Transferstoffes (17) im Bereich von 0,5 bis 1,5 mm liegt.

32. Verfahren nach Anspruch 28, bei dem der Transferstoff (17) mehrere maschinenquerrichtungs-dominante Fäden enthält, die aufeinander geschichtet sind, um tiefere maschinenquerrichtungs-dominante Prägungen zu erzeugen.

Revendications

1. Feuille de papier mousseline séchée par air traversant ayant un côté air et un côté sécheur, **caractérisée en ce que :**

le côté sécheur de la feuille ayant des rangées parallèles discontinues de régions surélevées en forme de coussin (85) dominantes dans le sens machine, dans laquelle les discontinuités des rangées de régions surélevées en forme de coussin sont des auges (86) dominantes dans le sens travers de la machine qui apparaissent comme des saillies (91) en forme de barre dominantes dans le sens travers de la machine sur le côté air de la feuille.

2. Rouleau de papier mousseline (80) comprenant la feuille de papier séchée par air traversant selon la revendication 1, ayant un bouffant de rouleau de 16 cm³/g ou plus et une résistance mécanique de rouleau de 8 mm ou moins.

3. Rouleau de papier mousseline (80) selon la revendication 2, dans lequel la résistance mécanique du rouleau est de 7 mm ou moins.

4. Rouleau de papier mousseline (80) selon la revendication 2, dans lequel la résistance mécanique du rouleau est de 6 mm ou moins.

5. Rouleau de papier mousseline (80) selon la revendication 2, dans lequel la résistance mécanique du

rouleau est de 4 à 7 mm.

6. Rouleau de papier mousseline (80) selon la revendication 2, dans lequel le bouffant du rouleau est de 17 cm³/g ou plus et la résistance mécanique du rouleau est de 6 mm ou moins. 5
7. Rouleau de papier mousseline (80) selon la revendication 2, dans lequel le bouffant du rouleau varie de 17 cm³/g à 20 cm³/g et la résistance mécanique du rouleau varie de 4 mm à 7 mm. 10
8. Rouleau de papier mousseline (80) selon la revendication 2, comprenant en outre un rapport bouffant de rouleau/résistance mécanique de rouleau de 20 cm²/g ou plus et une épaisseur de feuille unique de 0,02 po (0,51 mm) à 0,05 po (1,27 mm). 15
9. Rouleau de papier mousseline (80) selon la revendication 8, dans lequel le rapport bouffant de rouleau/résistance mécanique de rouleau est de 25 cm²/g ou plus. 20
10. Rouleau de papier mousseline (80) selon l'une des revendications 8 et 9, dans lequel le rapport bouffant de rouleau/résistance mécanique de rouleau varie de 25 à 55 cm²/g. 25
11. Rouleau de papier mousseline (80) selon l'une des revendications 8, 9 ou 10, dans lequel l'épaisseur d'une feuille unique varie de 0,025 à 0,040 po (0,64 mm à 1,02 mm). 30
12. Rouleau de papier mousseline (80) selon la revendication 2, comprenant en outre un rapport bouffant de rouleau/résistance mécanique de rouleau de 20 cm²/g ou plus et une rigidité géométrique moyenne de 8 ou moins. 35
13. Rouleau de papier mousseline (80) selon la revendication 12, dans lequel le rapport bouffant de rouleau/résistance mécanique de rouleau est de 25 cm²/g ou plus. 40
14. Rouleau de papier mousseline (80) selon la revendication 12, dans lequel le rapport bouffant de rouleau/résistance mécanique de rouleau varie de 25 à 55 cm²/g. 45
15. Rouleau de papier mousseline (80) selon l'une des revendications 12, 13 ou 14, dans lequel la rigidité géométrique moyenne est de 5 ou moins. 50
16. Rouleau de papier mousseline (80) selon l'une des revendications 12, 13 ou 14, dans lequel la rigidité géométrique moyenne varie de 2 à 5. 55
17. Rouleau de papier mousseline (80) selon la reven-

dication 2, comprenant en outre un rapport bouffant de rouleau/résistance mécanique de rouleau/épaisseur de feuille unique de 350 cm/g ou plus et une rigidité géométrique moyenne de 8 ou moins.

18. Rouleau de papier mousseline (80) selon la revendication 17, dans lequel le rapport bouffant de rouleau/résistance mécanique de rouleau/épaisseur de feuille unique est de 390 cm/g ou plus.
19. Rouleau de papier mousseline (80) selon la revendication 17, dans lequel le rapport bouffant de rouleau/résistance mécanique de rouleau/épaisseur de feuille unique est de 430 cm/g ou plus.
20. Rouleau de papier mousseline (80) selon la revendication 17, dans lequel le rapport bouffant de rouleau/résistance mécanique de rouleau/épaisseur de feuille unique varie de 350 à 550 cm/g ou plus.
21. Rouleau de papier mousseline (80) selon les revendications 17 à 20, dans lequel la rigidité géométrique moyenne varie de 2 à 5.
22. Rouleau de papier mousseline (80) selon l'une quelconque des revendications 2 à 21, dans lequel le papier mousseline possède une capacité d'absorption de 5 g d'eau ou plus par gramme de fibres.
23. Rouleau de papier mousseline (80) selon l'une quelconque des revendications 2 à 22, dans lequel le papier mousseline possède une vitesse d'absorption de quatre secondes ou moins.
24. Rouleau de papier mousseline (80) selon l'une quelconque des revendications 2 à 23, dans lequel la feuille de papier mousseline séchée par air traversant est une feuille de papier mousseline séchée par air traversant non crêpée.
25. Rouleau de papier mousseline (80) selon la revendication 2, dans lequel l'épaisseur d'une feuille unique varie de 0,02 po (0,51 mm) à 0,05 po (1,27 mm).
26. Procédé de fabrication d'une feuille de papier mousseline séchée par air traversant comprenant :
 - (a) le dépôt d'une suspension aqueuse de fibres pour la fabrication de papier sur une toile de formation (13) pour former une feuille continue humide ;
 - (b) l'épaississement de la feuille continue humide à une consistance de 20 à 30 % ;
 - (c) le transfert de la feuille continue épaissie de la toile de formation (13) à une toile de transfert (17) se déplaçant à une vitesse de 10 à 80 % inférieure à celle de la toile de formation (13) ;
 - (d) le transfert de la feuille continue à une toile

de séchage par air traversant (19), ayant de 50 à 300 coudes d'impression dans le sens machine par pouce carré (78 à 4650 coudes d'impression par cm²) qui sont soulevés d'au moins 0,005 po (0,13 mm) au-dessus du plan de la toile (19), et 5

(e) le séchage par air traversant de la feuille continue ;

caractérisé par : 10

le côté feuille de la toile de transfert comprenant des auges (86) dominantes dans le sens travers de la machine qui transmettent des saillies en forme de barre (91) dominantes dans le sens travers de la machine sur le côté air de la feuille de papier mousseline ; et 15

dans lequel la feuille continue est réarrangée au niveau macroscopique pour être conforme à la surface de la toile de séchage par air traversant, 20

procurant au côté sécheur de la feuille des rangées discontinues de régions en forme de coussin dominantes dans le sens machine.

27. Procédé selon la revendication 26, dans lequel la feuille de papier mousseline séchée par air traversant est une feuille de papier mousseline séchée par air traversant non crêpée. 25
28. Procédé selon l'une des revendications 26 ou 27, dans lequel les auges dans le sens travers de la machine dans la toile de transfert (17) ont une largeur qui correspond à l'espace entre les filaments dominants dans le sens travers de la machine de la toile de transfert. 30 35
29. Procédé selon la revendication 28, dans lequel l'espace entre les filaments dominants dans le sens travers de la machine de la toile de transfert (17) est d'environ 0,3 mm ou plus. 40
30. Procédé selon la revendication 28, dans lequel l'espace entre les filaments dominants dans le sens travers de la machine de la toile de transfert (17) varie d'environ 0,3 mm à environ 3 mm. 45
31. Procédé selon la revendication 28, dans lequel l'espace entre les filaments dominants dans le sens travers de la machine de la toile de transfert (17) varie d'environ 0,5 mm à environ 1,5 mm. 50
32. Procédé selon la revendication 28, dans lequel la toile de transfert (17) comprend de multiples filaments dominants dans le sens travers de la machine empilés les uns sur les autres pour former des auges plus profondes dans le sens travers de la machine. 55

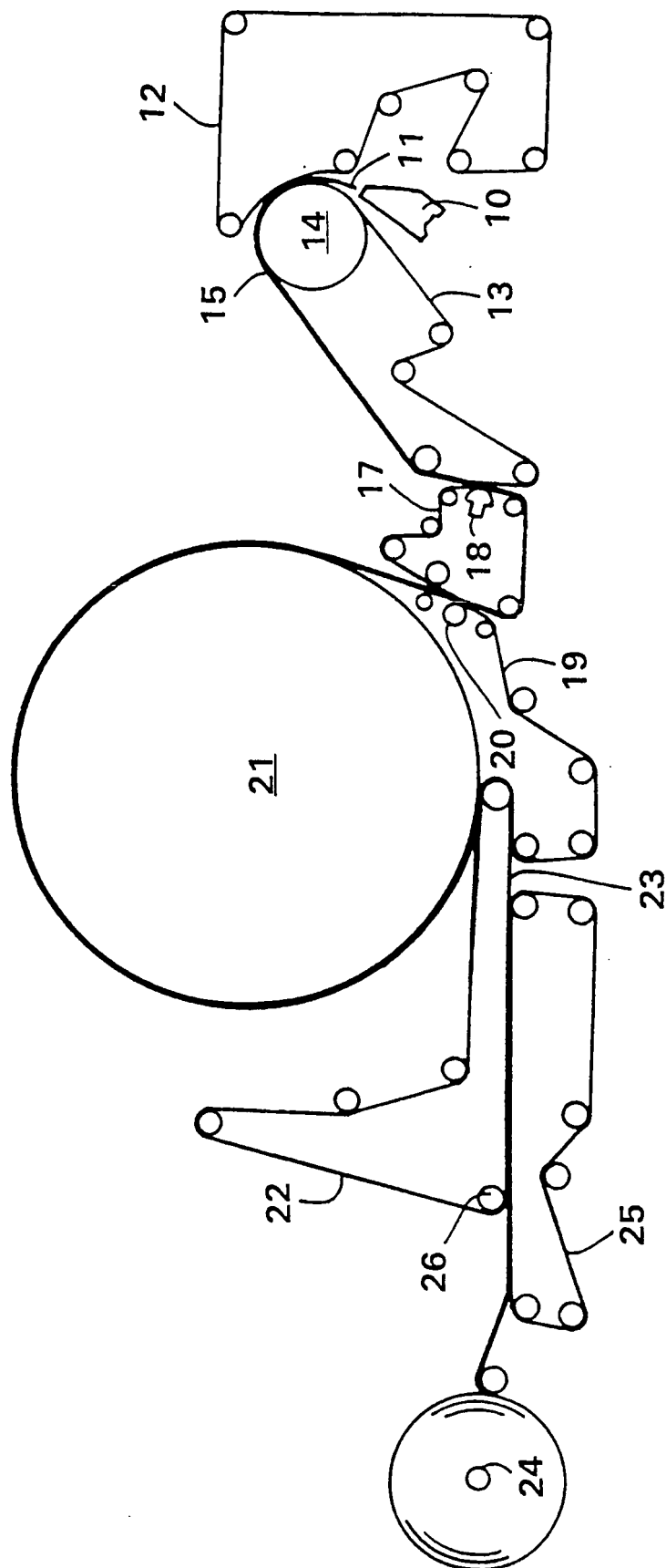


FIG. 1

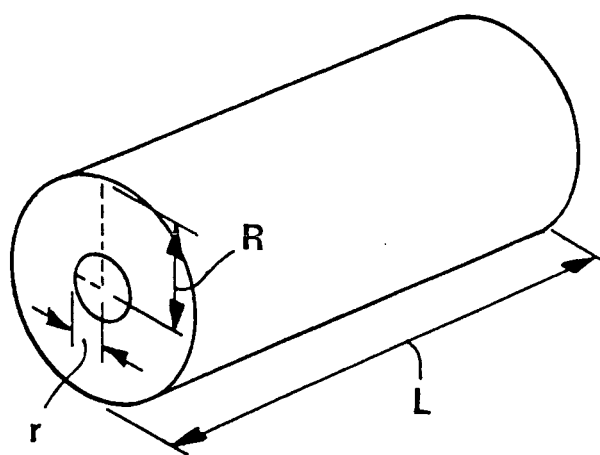


FIG. 2

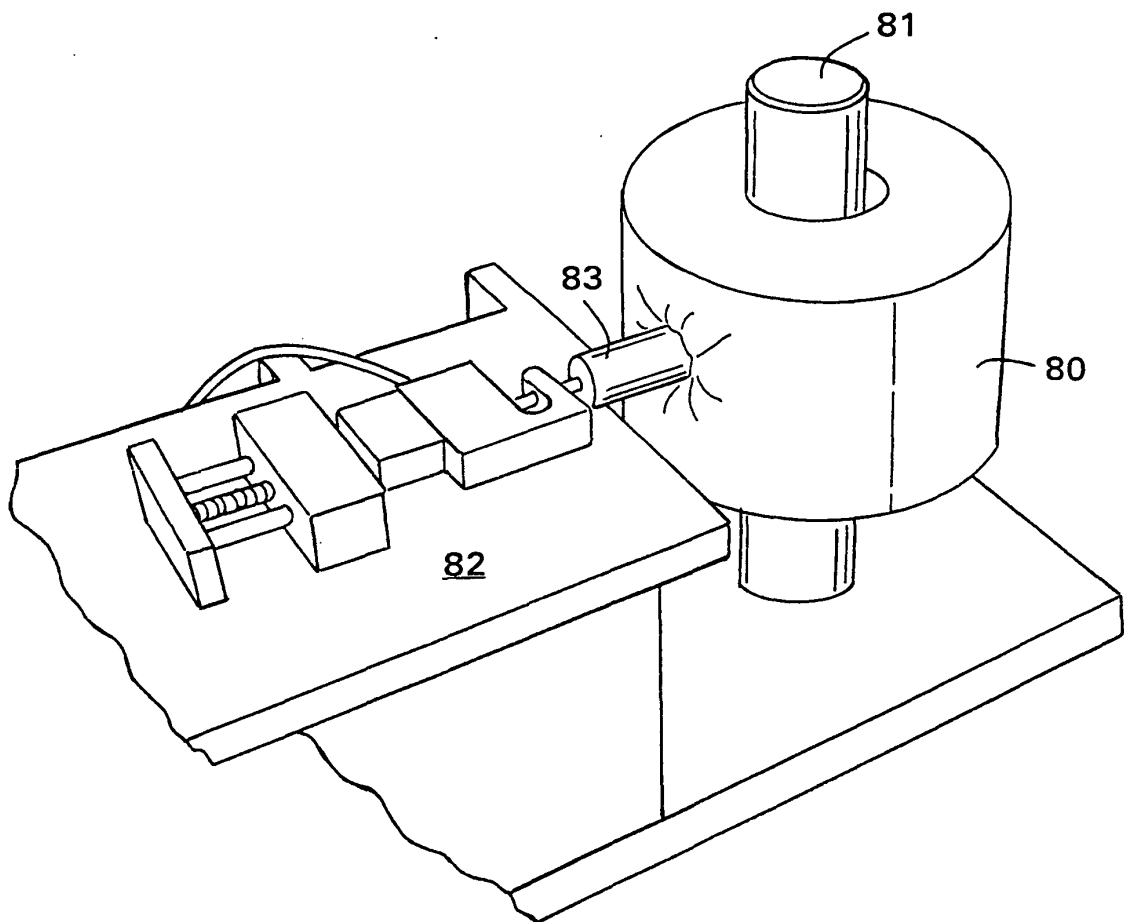
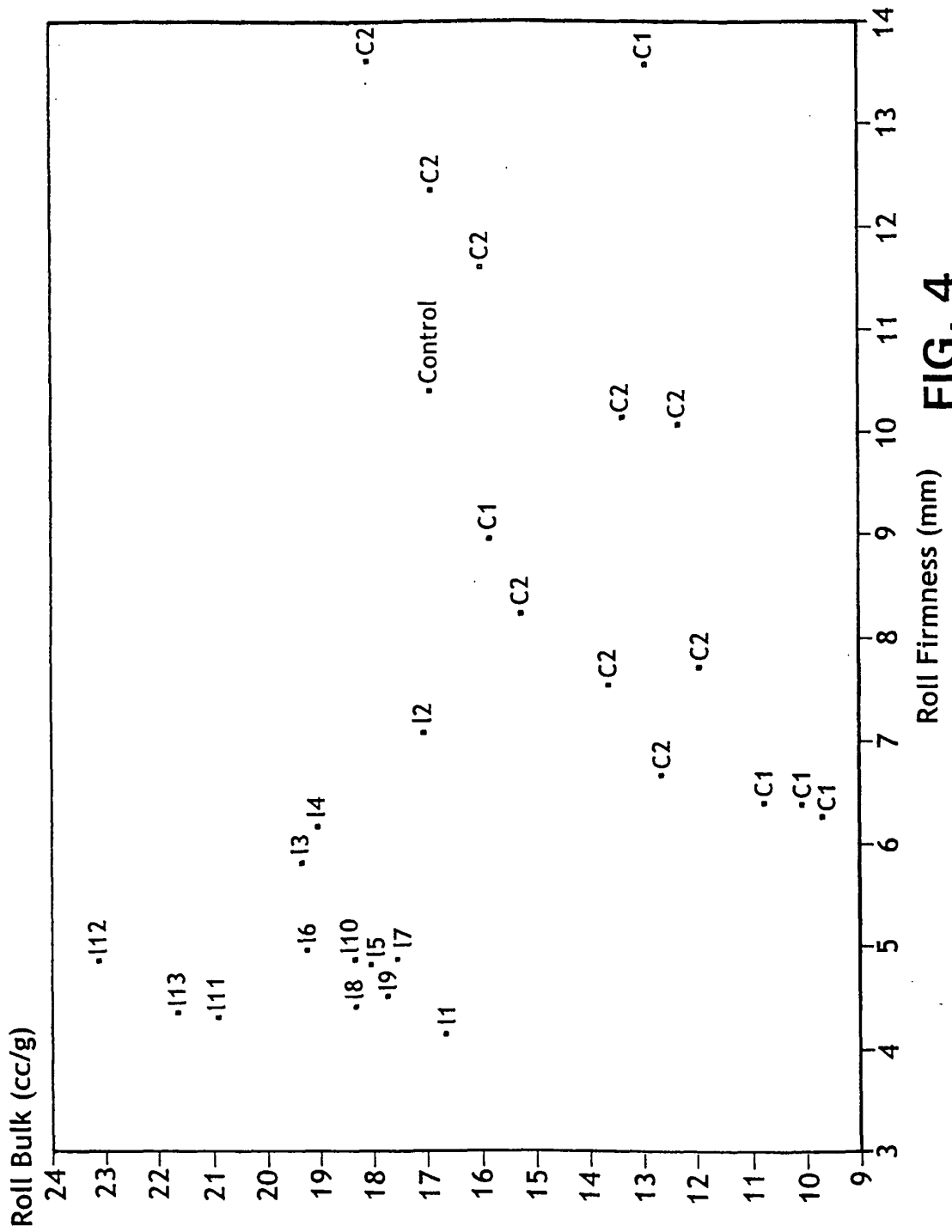
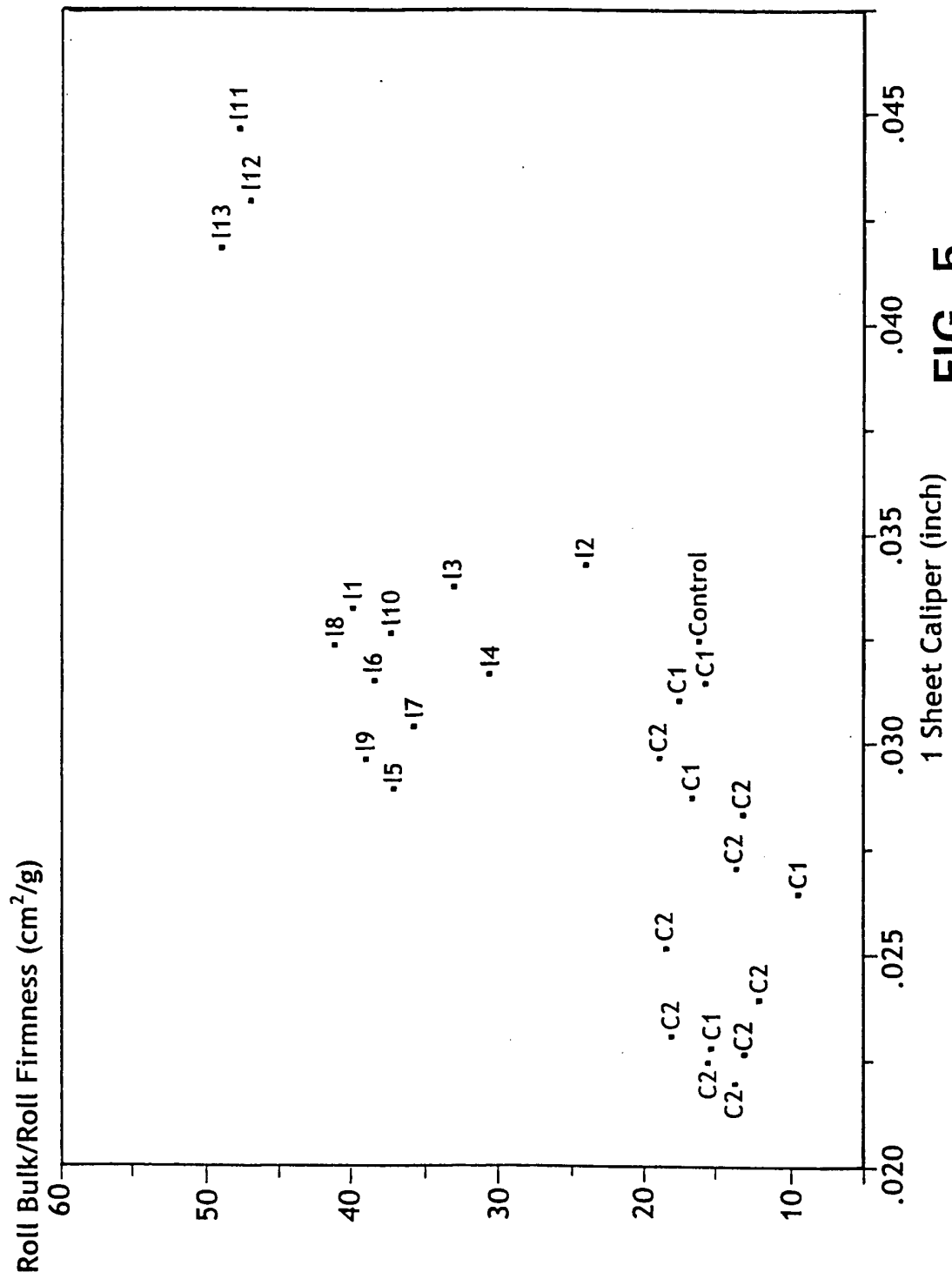


FIG. 3





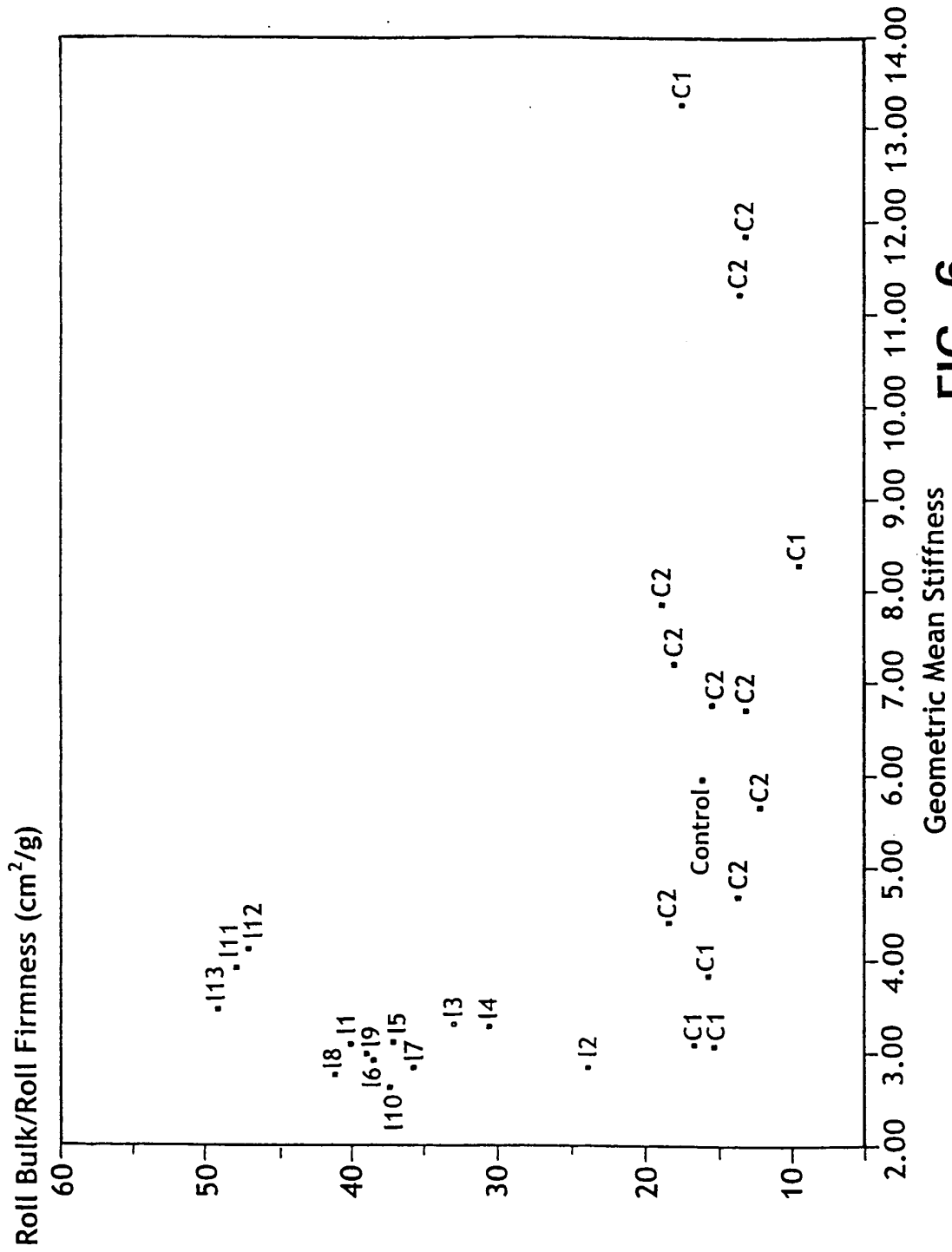
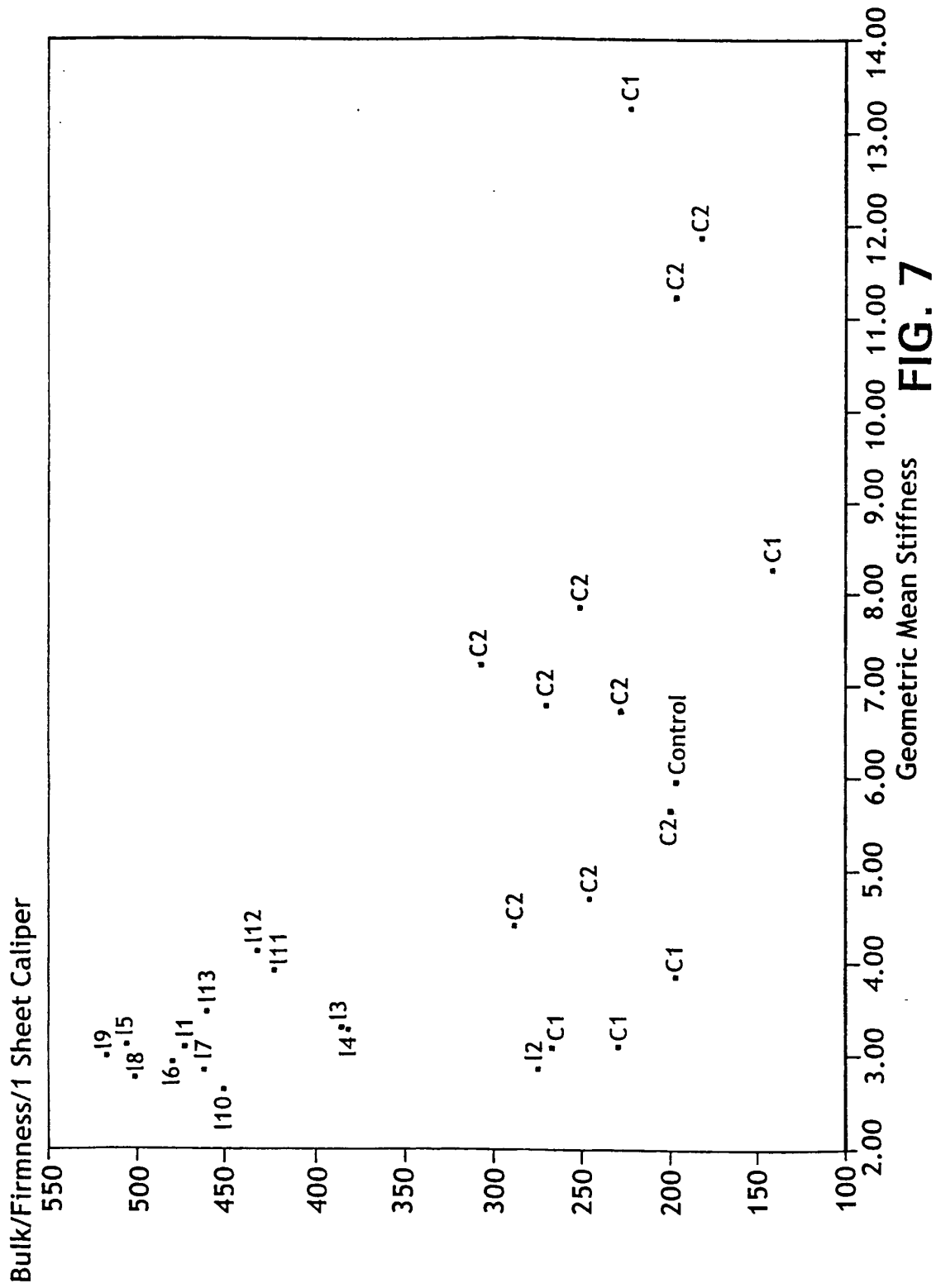


FIG. 6



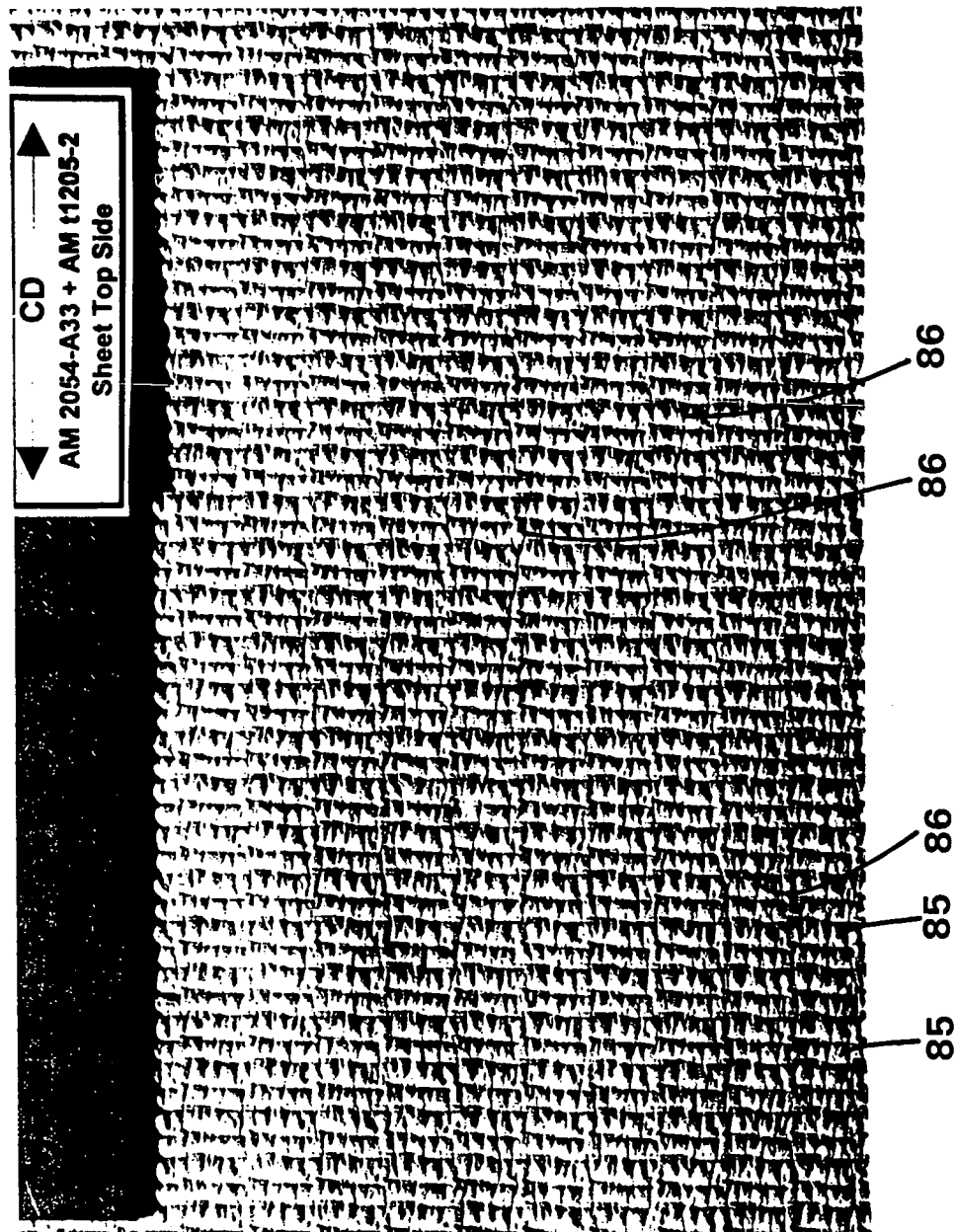


FIG. 8A

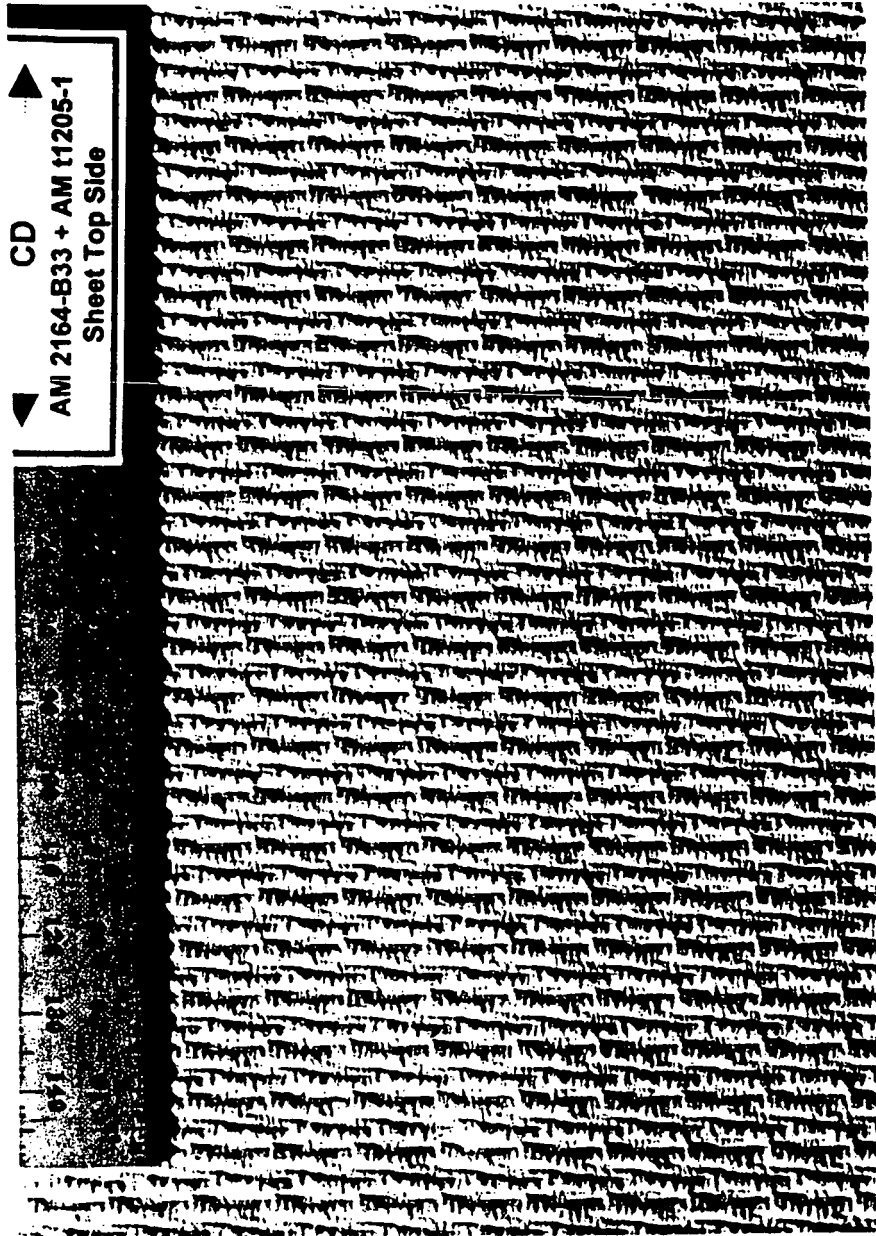


FIG. 8B

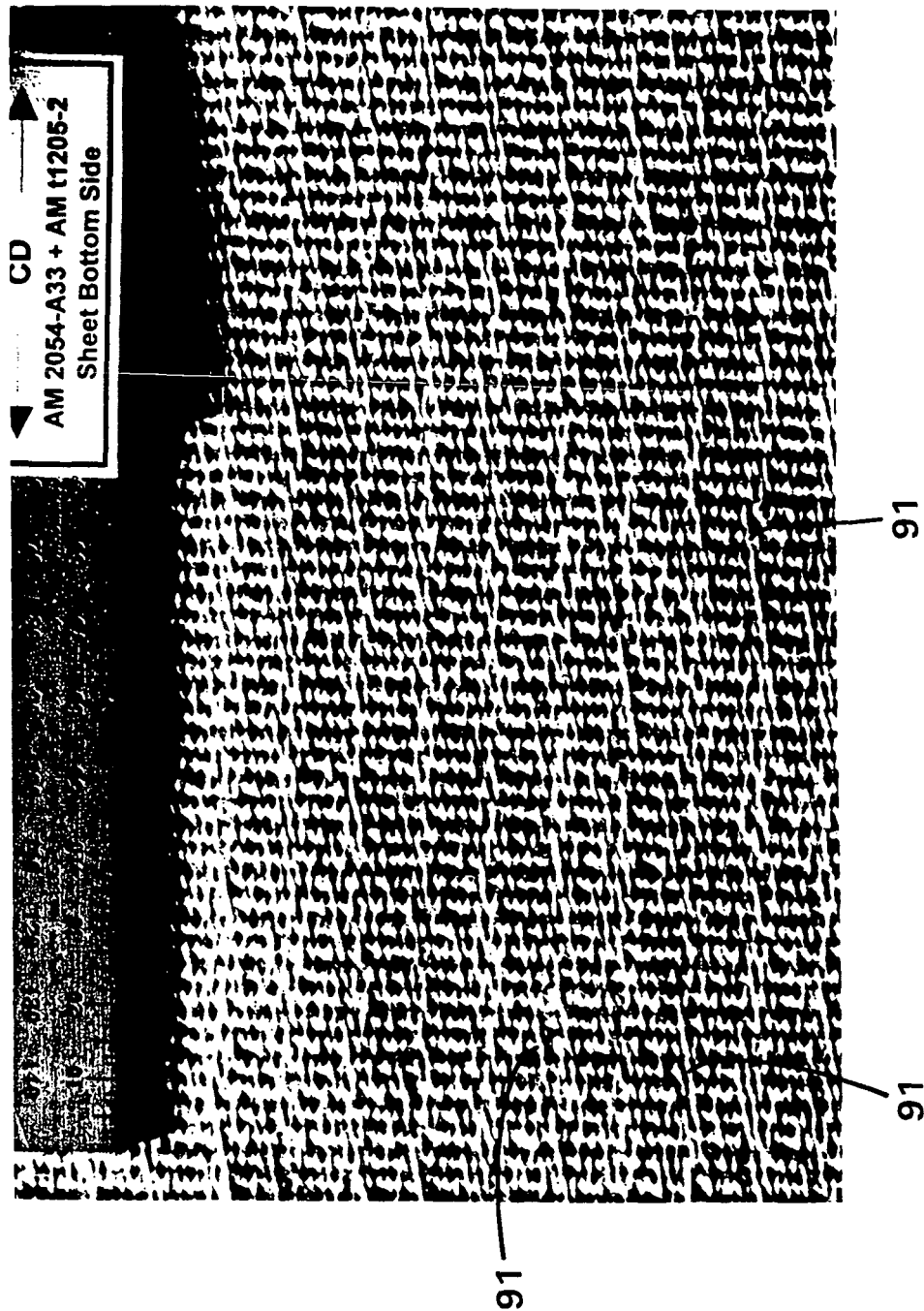


FIG. 9A

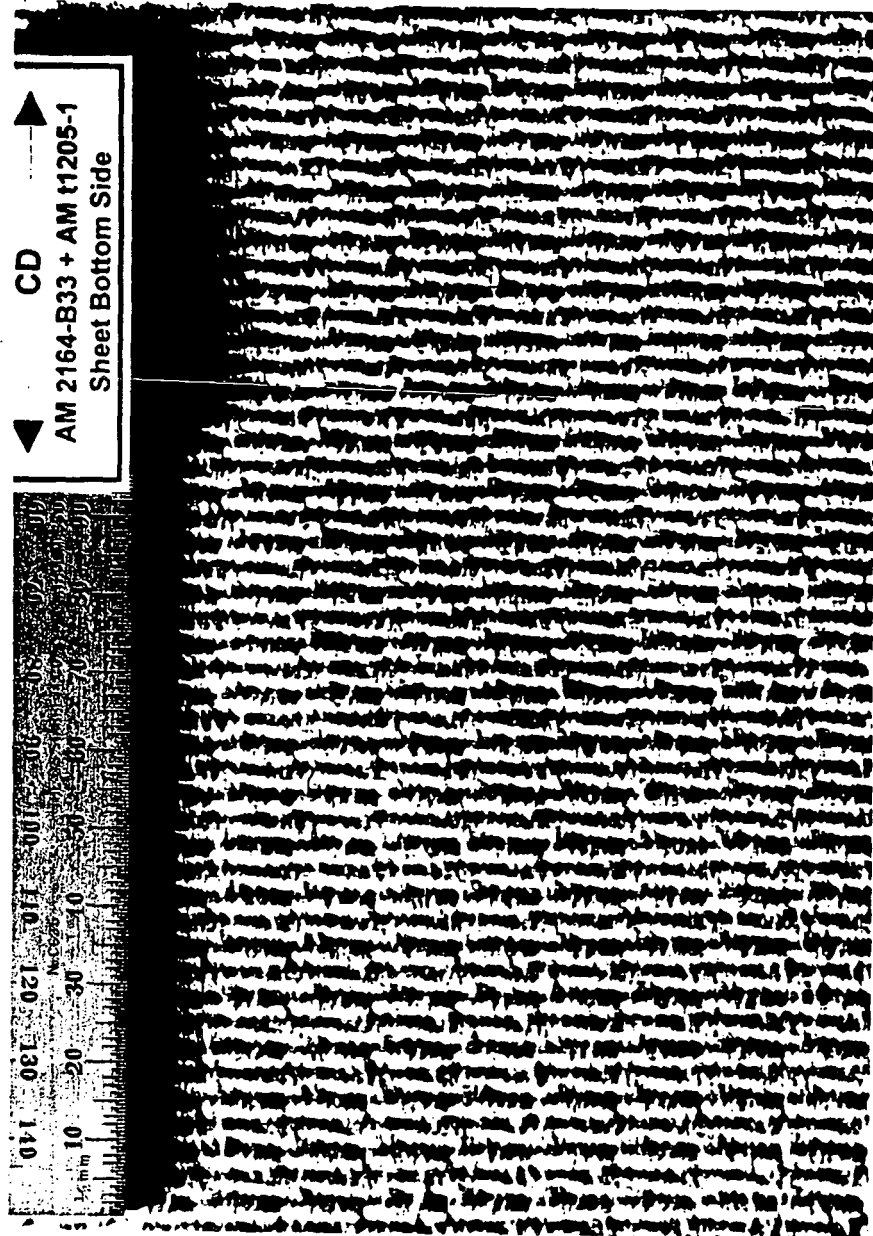


FIG. 9B

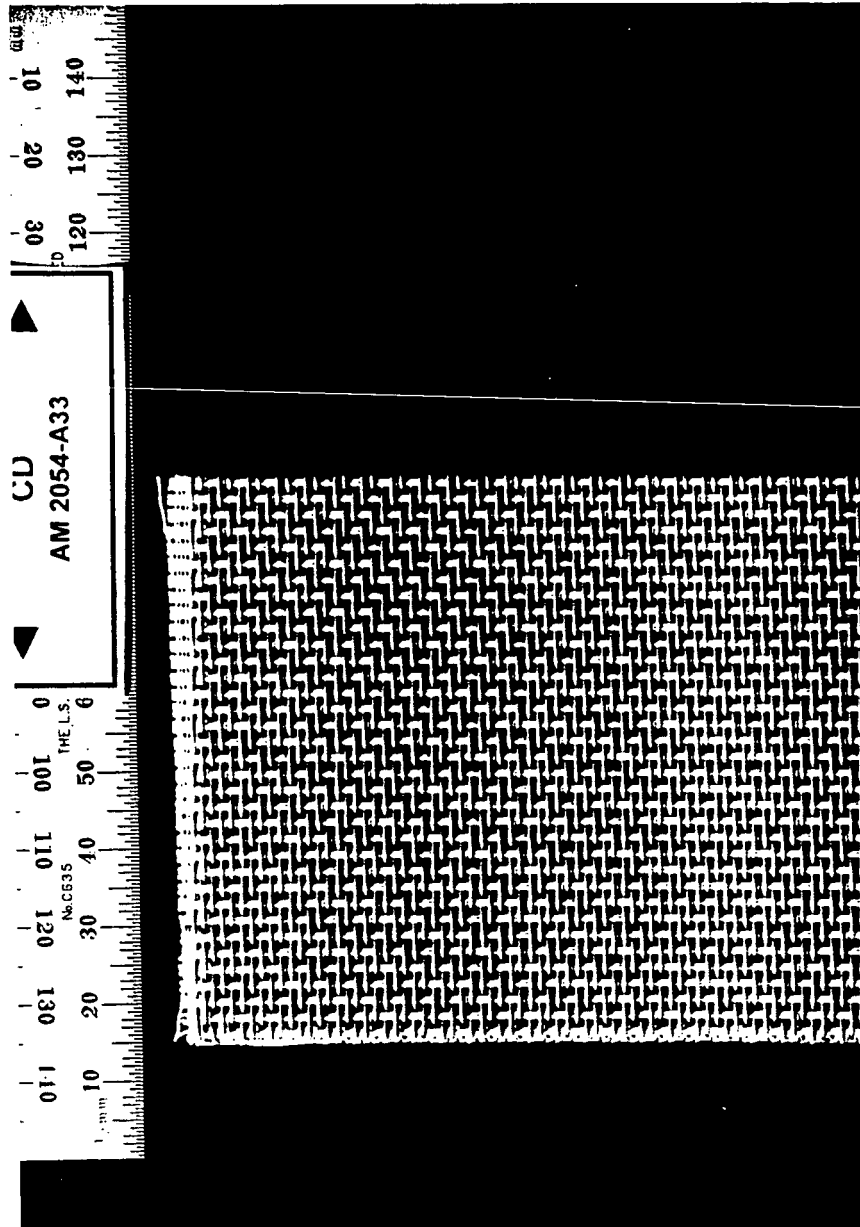


FIG. 10

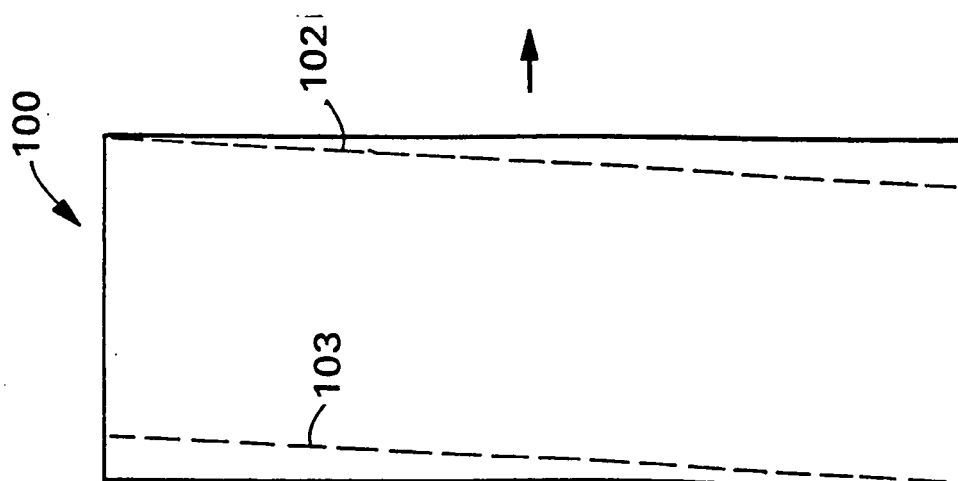


FIG. 11A

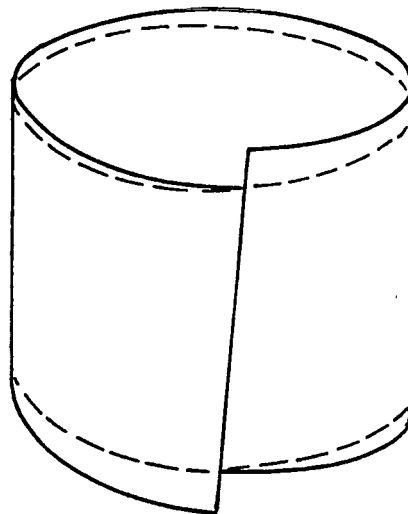


FIG. 11B

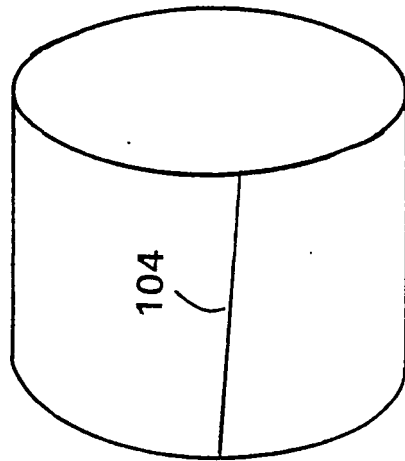


FIG. 11C

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4671983 A [0003]
- US 5628876 A [0004]
- US 5746887 A [0005] [0029]
- US 5656132 A, Farrington [0033]
- US 5672248 A [0033]
- US 5219004 A [0037]