(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 May 2001 (25.05.2001)

PCT

(10) International Publication Number
WO 01/36721 A1

(51) International Patent Classification[7]: D01F 6/70, A61F 13/15

(21) International Application Number: PCT/US00/31671

(22) International Filing Date: 17 November 2000 (17.11.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/166,348 19 November 1999 (19.11.1999) US
09/715,754 16 November 2000 (16.11.2000) US

(71) Applicant: KIMBERLY-CLARK WORLDWIDE, INC. [US/US]; 401 N. Lake Street, Neenah, WI 54956 (US).

(72) Inventors: ZHOU, Peiguang; N362 Tamarack Drive, Appleton, WI 54915 (US). NG, Wing-Chak; 410 Riverwalk Terrace, Suwanee, GA 30024 (US).

(74) Agents: PUGLIESE, Sebastian et al.; Kimberly-Clark Worldwide, Inc., 401 N. Lake Street, Neenah, WI 54956 (US).

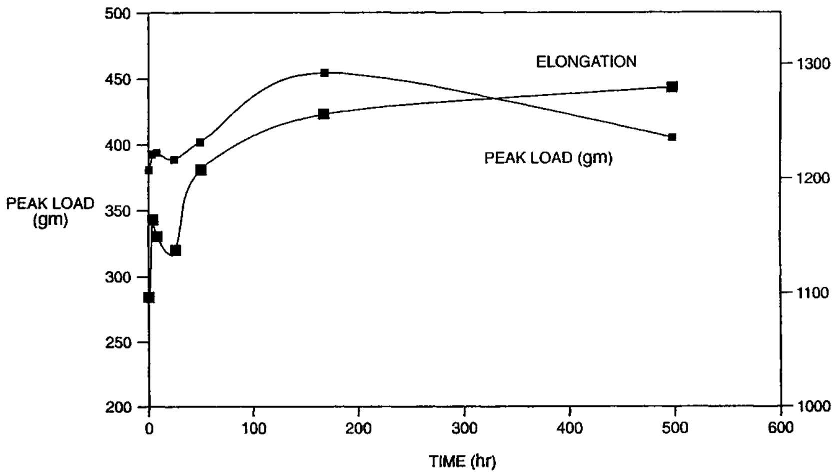
(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*
— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD FOR REGULATING STRENGTH DEGRADATION IN ELASTIC STRAND



(57) Abstract: The present invention is directed to regulating strength degradation in elastic strand by regulating exposure of the strand to water or water vapor. One representative method having features of the present invention includes the steps of: providing elastic strand, the elastic strand having been made by steps comprising extruding, spinning, or otherwise making the strand; and regulating the strand's exposure to water or water vapor so that the strand's strength does not significantly degrade before the strand is used as a raw material on a production machine.

WO 01/36721 A1

METHOD FOR REGULATING STRENGTH DEGRADATION IN ELASTIC STRAND

This application claims priority from U.S. Provisional Application No. 60/166,348 filed on 19 November 1999.

BACKGROUND

People rely on disposable absorbent articles, including diapers and adult incontinence articles, to participate in and enjoy their daily activities.

Disposable absorbent articles are generally manufactured by combining several components. These components typically include a liquid-permeable topsheet; a liquid-impermeable backsheet attached to the topsheet; and an absorbent core located between the topsheet and the backsheet. When the disposable article is worn, the liquid-permeable topsheet is positioned next to the body of the wearer. The topsheet allows passage of bodily fluids into the absorbent core. The liquid-impermeable backsheet helps prevent leakage of fluids held in the absorbent core. The absorbent core is designed to have desirable physical properties, *e.g.* a high absorbent capacity and high absorption rate, so that bodily fluids can be transported from the skin of the wearer into the disposable absorbent article.

Some disposable absorbent articles are constructed with various types of elasticized waistbands and elasticized leg bands or leg cuffs. One method of constructing elasticized regions is to incorporate elastic strands into the disposable absorbent product. For example, elastic strands have been laminated between layers of polymer film and/or layers of woven or nonwoven fabrics to provide such regions. Folded-over layers have also been employed to enclose or envelop selected strands of material. These folded-over layers have been employed to enclose elastomeric strands within the waistband, leg cuff and inner barrier cuff components of disposable diapers and other disposable absorbent articles.

In order to introduce an elastic strand to the product being made, a bobbin or spool of the strand is generally placed on an unwind stand. The strand is then continuously unwound, in the machine direction, with the strand being attached to a substrate, such as a base layer of material, to provide a substrate composite. As stated above, examples of a base material include, but are not limited to, polymeric films and/or woven or nonwoven fabrics. If the elastic strand does not have the integrity to withstand forces placed on it during production of the article being made, then the strand may break. For example, the tension placed on a segment of the elastic strand between an unwind stand and the point of attachment on a base material may exceed the tensile strength of that segment, causing a break. Such breaks lead to costly downtime. Accordingly, producers of disposable absorbent articles, as well as other manufacturers using elastic strands as raw materials in a production process, seek ways of ensuring that the strength characteristics of the elastic strand are sufficient to withstand forces placed on the strand during production, thereby decreasing or minimizing the number of breaks.

What is needed is a method of handling elastic strand so that the strength or integrity of the strand is not significantly degraded before the strand is used as a raw material; and substrate composites and absorbent products made using such elastic strand.

SUMMARY

We have determined that strength characteristics of an elastic strand degrade when the strand is exposed to water or water vapor. If an elastic strand is made at a location different from where the strand is used as a raw material, then the elastic strand must be shipped. During shipping, storage, or other steps the elastic strand may be exposed to amounts of water or water vapor sufficient to degrade the strength characteristics of the strand. If the elastic strand is weakened enough, then it will break more frequently when used as a raw material in a production process (*e.g.*, a conventional, high-speed, disposable-absorbent-article production process running at about 1000 feet per minute or more). Accordingly, the present invention is directed to regulating strength degradation in an elastic strand by regulating the strand's exposure to water or water vapor.

One method having features of the present invention comprises providing elastic strand; and regulating the elastic strand's exposure to water vapor such that the specific humidity around the elastic strand does not exceed about 0.01 pounds-mass of water vapor per pound-mass of dry air, and more specifically about 0.005 pounds-mass of water vapor per pound-mass of dry air during: production of the strand, storage of the strand at the geographic site where the elastic strand is made, shipping of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is to be used as a raw material, storage of the elastic strand at the geographic site where the elastic strand is to be used as a raw material, use of the elastic strand as a raw material, or some combination thereof. In one aspect, the elastic strand is used as a raw material to produce a substrate composite comprising the elastic strand or an absorbent article comprising the elastic strand.

Another method having features of the present invention comprises providing elastic strand; and regulating the elastic strand's exposure to water vapor such that the

specific humidity around the elastic strand does not exceed about 0.017 pounds-mass of water vapor per pound-mass of dry air, specifically about 0.01 pounds-mass of water vapor per pound-mass of dry air, and more specifically about 0.005 pounds-mass of water vapor per pound-mass of dry air during shipment of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is to be used as a raw material. In one aspect, the elastic strand is used as a raw material to produce a substrate composite comprising the elastic strand or an absorbent article comprising the elastic strand.

One representative embodiment of the invention in which elastic strand's exposure to water vapor is regulated comprises controlling the temperature around the strand or around a container that contains the strand. In some versions of the invention, the temperature is controlled to a value not exceeding about 55 degrees Fahrenheit. By regulating temperature, the maximum humidity that may be attained is regulated (*i.e.*, as air temperature decreases, the capacity of the air to hold water vapor decreases).

Another representative embodiment of the invention in which elastic strand's exposure to water vapor is regulated comprises controlling the humidity around the strand or around a container that contains the strand.

In some versions of the invention, the elastic strand comprises polyester, polyurethane, polyether, polyamide, polyacrylate, polyester-b-polyurethane block copolymer, polyether-b-polyurethane block copolymer, or polyether-b-polyamide block copolymer.

In another representative embodiment, the elastic strand's exposure to water vapor is regulated such that the tensile strength of the strand at the time the strand is used as a raw material to produce a substrate composite comprising the elastic strand, or an absorbent article comprising the elastic strand, has not decreased by more than about 20%, particularly about 10%, and specifically about 5% from the tensile strength of the elastic strand when the strand was first produced.

In some embodiments where elastic strand's exposure to water or water vapor is regulated by controlling humidity around the strand, or a container containing the strand, humidity is controlled by steps comprising: sensing a value corresponding to the humidity around the elastic strand; comparing the value to a set point corresponding to a desired humidity; and force adjusting the humidity around the strand to the desired humidity.

In one aspect, the humidity set point is selected by steps comprising:

a. correlating strand breaks per unit time on a production machine using elastic strand as a raw material to the tensile strength of the strand;

b. selecting a minimum tensile strength corresponding to an acceptable number of breaks per unit time;

c. placing samples of the corresponding elastic strand in an environment having a controlled humidity;

d. measuring the tensile strength of the samples after different times of exposure to the humidity to which the environment is controlled to determine a strength-time relationship;

e. optionally repeating steps c and d to determine a plurality of strength-time relationships, each strength-time relationship corresponding to a different humidity; and

f. using the strength-time relationship, or relationships, to select a set point corresponding to a desired humidity for shipping the strand such that the tensile strength of the elastic strand is at or above the minimum tensile strength at the time the elastic strand is used as a raw material on the production machine.

In another aspect, the humidity set point is determined by steps comprising:

a. placing samples of the elastic strand in an environment having a controlled humidity;

b. measuring the tensile strength of the samples after different times of exposure to the humidity to which the environment is controlled to determine a strength-time relationship;

c. optionally repeating steps a and b to determine a plurality of strength-time relationships, each strength-time relationship corresponding to a different humidity; and

d. using the strength-time relationship, or relationships, to select a set point corresponding to a desired humidity for shipping the strand that will reduce the amount of tensile-strength degradation occurring during shipping of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is used compared to the amount of tensile-strength degradation occurring during shipping of elastic strand under similar conditions but with the strand's exposure to water vapor not being regulated.

In some embodiments where elastic strand's exposure to water or water vapor is regulated by controlling temperature around the strand, or a container containing the strand, temperature is controlled by steps comprising: sensing a value corresponding to the temperature around the elastic strand; comparing the value to a set point corresponding to a desired temperature, the desired temperature corresponding to a maximum humidity; and force adjusting the temperature around the strand to the desired temperature.

In one aspect, the temperature set point is selected by steps comprising:

a. correlating strand breaks per unit time on a production machine using elastic strand as a raw material to the tensile strength of the strand;
b. selecting a minimum tensile strength corresponding to an acceptable number of breaks per unit time;
c. placing samples of the corresponding elastic strand in an environment having a controlled humidity, the controlled humidity corresponding to the maximum specific humidity that may be attained at a given temperature;
d. measuring the tensile strength of the samples after different times of exposure to the humidity to which the environment is controlled to determine a strength-time relationship;
e. optionally repeating steps c and d to determine a plurality of strength-time relationships, each strength-time relationship corresponding to a different humidity; and
f. using the strength-time relationship, or relationships, to select a set point corresponding to a desired temperature that corresponds to a maximum specific humidity for shipping the strand such that the tensile strength of the elastic strand is at or above the minimum tensile strength at the time the elastic strand is used as a raw material.

In another aspect, the temperature set point is selected by steps comprising:

a. placing samples of the corresponding elastic strand in an environment having a controlled humidity, the controlled humidity corresponding to the maximum specific humidity that may be attained at a given temperature;
b. measuring the tensile strength of the samples after different times of exposure to the humidity to which the environment is controlled to determine a strength-time relationship;
c. optionally repeating steps a and b to determine a plurality of strength-time relationships, each strength-time relationship corresponding to a different humidity; and
d. using the strength-time relationship, or relationships, to select a set point corresponding to a desired temperature that corresponds to a maximum specific humidity for shipping the strand that will reduce the amount of tensile-strength degradation occurring during shipping of the strand between the

geographic site where the elastic strand is made and the geographic site where the elastic strand is used as a raw material compared to the amount of tensile-strength degradation occurring during shipping of elastic strand under similar conditions but with the strand's exposure to water vapor not being regulated.

Another method having features of the present invention comprises the steps of providing elastic strand; placing the strand in a container comprising a barrier material resistant to penetration by water vapor; and closing the container.

In another representative embodiment in which elastic strand's exposure to water or water vapor is regulated, a container comprising a barrier material is closed at a time t_1, time t_1 being after the time when the strand is first produced and before the time when the strand is shipped from the geographical site where the strand is first produced to the geographical site where the strand is used.

In another aspect, the specific humidity around the strand does not exceed about 0.017 pounds-mass of water vapor per pound-mass of dry air, particularly about 0.01 pounds-mass of water vapor per pound-mass of dry air, and specifically about 0.005 pounds-mass of water vapor per pound-mass of dry air, between time t_1 and time t_2, time t_2 being the time when the closed container comprising a barrier material is first opened.

In some versions of the invention, the barrier material comprises polyethylene, polypropylene, polyvinyl chloride, polyvinylidene chloride, polyester, polycarbonate, nylon, cellulose, or a combination thereof.

In another representative embodiment, closing the container comprising a barrier material comprises heat sealing the container, the barrier material, or both.

In another version of the invention in which elastic strand's exposure to water or water vapor is regulated, desiccant material is placed with the strand before the container is closed (*e.g.*, by heat sealing the container, the barrier material, or both). In another aspect, the desiccant material comprises calcium chloride, calcium sulfate, silica gel, a molecular sieve, Al_2O_3, or some combination of thereof.

In other representative embodiments, methods of the present invention further comprise the steps of displacing any mixture of air and water vapor from the interior of the container comprising a barrier material with an inert dry gas before closing the container (*e.g.*, by heat sealing the container, the barrier material, or both); placing a humidity indicator inside the container comprising a barrier material before closing the container (*e.g.*, by heat sealing the container, the barrier material, or both); or both.

Still other representative embodiments of the invention include elastic strand handled such that the strand's integrity or strength is not significantly degraded before the strand is used as a raw material by regulating exposure of the strand to water or water vapor, and substrate composites and disposable absorbent products made using such elastic strand.

These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings.

DRAWINGS

Figure 1 shows a sectional view of one apparatus for making an elastic strand.

Figure 2 shows a sectional view of one apparatus for making an elastic strand.

Figure 3 shows a plot of peak-load value, in grams, and percent elongation as a function of time of exposure to a specified temperature and relative humidity.

Figure 4 shows a plot of peak-load value, in grams, and percent elongation (right vertical axis) as a function of time of exposure to a specified temperature and relative humidity.

Figure 5 and 5.A. show perspective views of a tensile tester.

DESCRIPTION

The present invention is directed to regulating strength degradation in an elastic strand by regulating exposure of the strand to water or water vapor. A number of representative embodiments are discussed in the paragraphs below.

An elastic strand may be made in various ways, including, but not limited to extrusion and spinning. In an extrusion process, depicted in Figure 1, polymer chips, particulates, pellets, or other solid forms **10** are placed in a hopper **12**. The solid polymer is directed from the hopper to a chamber **14**. The polymer is propelled continuously through the chamber by a rotating screw **16**. As the polymer proceeds through the chamber, the temperature and pressure are such that the solid polymer melts and is compacted. Some of the heat is generated by friction, but typically an external heating source **18** is also used to heat the polymer. The molten polymer is then forced through a die **20** to give a strand, continuous fiber, or filament of a desired structural shape. Possible cross-sectional shapes include, but are not limited to, circular, tri-lobal, polyhedral, rectangular (*e.g.*, a ribbon-like material), or ellipsoidal shapes. The strand cools and solidifies after exiting the extruder.

Rather than use a polymer as a feed material, one or more monomers may be added to the extruder in chip, particulate, pellet or other solid form. The monomers may be added with compounds that promote polymerization. Polymerization occurs within the extruder chamber, but may or may not be complete before the material exits through the die. If polymerization is not complete, then some polymerization could occur after the material is extruded. Also, some of the monomer may not ultimately react to become a part of a polymeric chain in the strand.

A number of materials may be extruded to give an elastic strand. The present invention is directed to a strand that is elastic, but is susceptible to attack by water or water vapor (*e.g.*, by a hydrolysis reaction). Examples of materials that can give such an elastic strand include, but are not limited to: polyester, polyurethane; polyether; polyamide; polyacrylate; or combinations thereof, including random, block, or graft copolymers such as polyester-b-polyurethane block copolymers, polyether-b-polyurethane block copolymers, and/or polyether-b-polyamide block copolymers. As stated above, monomeric or other prepolymeric precursors may be added to the extruder to give the polymeric materials of the type just recited.

Crosslinking agents may also be used when making an elastic strand. To the extent that polymeric chains are crosslinked, it is more likely that crosslinking reactions are initiated after the material is extruded. This may be accomplished, for example, in a separate processing step after the strand is extruded.

After the strand exits the extruder, it may be subjected to additional processing steps. These processing steps may take place at some location between extrusion of the strand and the strand being wound up at a bobbin, spindle, or spool for the first time. Alternatively, one or more of these processing steps may take place after the strand has been wound up for the first time. After a bobbin of elastic strand is made, it may later be unwound and treated in some fashion prior to its being wound up again.

Additional processing steps include, but are not limited to, the following. Air might be directed at the strand exiting the die to increase the cooling rate. A scouring step might be included to remove impurities from the strand by exposing the strand to soaps or detergents. A lubricant may be applied to the strand to reduce friction between strands or between the strand and pieces of equipment. Possible lubricants include, but are not limited to, a vegetable or mineral oil, a suitably refined petroleum product, a silicone-based material, or a surfactant. And a drawing step may be included to help orient the polymers to produce desirable physical properties. In one example of a separate drawing step, the strand is directed over two sets of rolls. The strand passes over a first set of rolls moving at a first velocity, then passes over a second set of rolls moving at a second velocity, the second velocity being greater than the first velocity. The difference in velocity between the first and second sets of rolls increases tension on the strand, thereby helping to orient the constituent polymers of the strand, change physical dimensions of the strand, or effect other changes.

After these or other additional processing steps, the strand is wound up for storage or shipment to another geographic location. During this or other steps in which a spool, reel, or bobbin of an elastic strand is unwound and then wound, the strand may be treated with various additives such as cleaning agents, lubricants, or dyes.

In addition to the example of an extrusion process discussed above, various spinning processes may be used to produce an elastic strand or fiber. In general, these processes require dissolving the polymer in solution or melting the polymer.

In a melt spinning process, as depicted in Figure 2, polymer chips, particulates, pellets, or other solid forms **30** are heated by a heated-metal grid **32** or other heating device. The resulting molten polymer **34** is pumped under high pressure through a plate called a spinneret **38**. The plate generally defines a plurality of small holes. The molten polymer emerges from the face of the spinneret, usually into air, and solidifies. A number of these strands **40** may be brought together to form a cable- or rope-like structure comprising a plurality of strands.

The polymer typically is melted by contacting a hot grid in the form of steel tubing, which is heated electrically, or by some other means. A metering pump **36**, or a combination of a metering pump and a booster pump, may be used to conduct the molten polymer to, and through, the spinneret. Alternatively, an extrusion-type screw may be used to help melt the polymer, and meter the resulting molten polymer, to and through the spinneret.

Generally strands or filaments emerge from the spinneret face into air and begin to cool. Air jets or blasts directed at the emerging strands may be used to speed up the cooling process. After the strands or filaments have traveled far enough to solidify they are processed further. As stated above, additional process steps include, but are not limited to, scouring, lubricating, or drawing the strand or strands. Figure 2, for example, depicts a lubricating disk and trough **42** for applying a lubricant to one or more strands. After processing is complete the strand—in this case a cable- or rope-like structure—is wound up on a reel, spindle, spool, or bobbin **44** at a winding station. Before being wound up, the strand may pass over one or more rolls **46**.

Other spinning processes include wet spinning, in which a solution of a polymer or polymer derivative emerges from a spinneret into a liquid that coagulates the polymer or polymer derivative to form a strand; and dry spinning in which a solution of polymer emerges from the spinneret into air or an inert gas atmosphere into which solvent evaporates, thereby forming a filament or strand.

Generally, the same polymeric, prepolymeric, or monomeric materials useful for extruding an elastic strand are also useful for spinning an elastic strand. As discussed above, the present invention is directed to a strand that is elastic but is susceptible to attack by water or water vapor. Examples of monomeric or polymeric materials that give such a strand are discussed above. Also, crosslinking agents may be used. Again crosslinking will likely be effected after the strand or filament emerges from the spinneret.

Other descriptions of processes for making strand are given in various publications, *e.g.* U.S. Patent Nos. 4,340,563 and 3,692,618 which disclose methods for making strand for purposes of making nonwoven webs and are hereby incorporated by reference in a manner consistent herewith. It should be understood that the above discussion and referenced publications recite exemplars of ways in which strand is made. The present invention is not limited to these exemplars, but may be used in conjunction with other processes that make an elastic material susceptible to attack by water or water vapor such that the strand's strength characteristics are degraded.

If an elastic strand is made at a geographic location different from the location where the strand is used as a raw material, then the elastic strand must be shipped. Prior to shipment the strand may be stored for some period of time. And the strand may be stored for some period of time after delivery but prior to use as a raw material. Even if the elastic strand is made at the same place where the strand is used as a raw material, the strand may be stored for some time. Depending on the time of year; the location of the site where the strand is made; the location of the site where the strand is used as a raw material; the method of shipment; the time that elapses between spinning, extruding, or otherwise making the strand and utilization of the strand as a raw material, as well as other factors, the elastic strand may be exposed to water or water vapor sufficient to degrade strength characteristics of the strand.

Before referring to data demonstrating that water vapor degrades strength in an elastic strand, it is advantageous to discuss certain terms. As discussed herein, "peak load" or "peak-load value" refers to the tensile load placed on a strand, measured in grams, when the strand breaks or fails. Furthermore, "tensile strength," peak load, and peak-load value are used synonymously in this specification. But it should be understood that other measures may be used to characterize the effect of water or water vapor on an elastic strand's strength or integrity. As discussed herein, "elongation" refers to the change in length per unit length at peak load. Typically, elongation is recited as a percentage. The term specific humidity generally refers to the mass of vapor carried by a unit mass of vapor-free gas. As used herein, "specific humidity" refers to the mass of water vapor carried by a unit mass of vapor-free gas, the gas typically being air. The term relative humidity generally refers to the ratio of the partial pressure of the vapor to the vapor pressure of the liquid at the gas temperature. It is usually expressed on a percentage basis, so 100 percent relative humidity means that the gas is saturated with vapor and 0 percent relative humidity means that the gas is vapor free. As used herein, "relative humidity" refers to the ratio of the partial pressure of water vapor to the vapor pressure of water at the gas temperature, the gas typically being air. For purposes of this document, "humidity" refers to a measure of the amount of water vapor in a gas, typically air, and unless stated otherwise, refers to specific humidity and/or relative humidity. The term dew point generally refers to the temperature at which a vapor-gas mixture must be cooled—at constant humidity—to become saturated. As used herein, "dew point" refers to the temperature at which a water vapor-gas mixture must be cooled—at constant humidity—to become saturated, the gas generally being air.

As shown in Figure 3 (discussed below under Examples; the left vertical axis is Peak Load [gram]; the right vertical axis is Elongation [%]; the bottom horizontal axis is Time [day]; the plot of measured elongations contains the point corresponding to an elongation of about 1200% at a time of about 18 days; the plot of measured peak loads contains the point corresponding to a peak load of about 250 grams at a time of about 18 days), continued exposure to a relative humidity of 80% at 100 °F decreases the peak-load value of an elastic strand sold under the trademark GLOSPAN 840, an elastic material made by Globe Manufacturing Company of Fall River, Massachusetts. GLOSPAN 840 comprises a polyester-b-polyurethane block copolymer. A humidity chart for air at atmospheric pressure shows that these conditions correspond to a humidity of about 0.035 pounds-mass ("lb_m") of water vapor per lb_m of dry air. For an example of such a humidity chart, see WARREN L. MCCABE AND JULIAN C. SMITH, UNIT OPERATIONS OF CHEMICAL ENGINEERING, pg. 748 (3d ed. 1976). After 15 days of exposure to these conditions, the peak-load value of GLOSPAN 840 decreased by more than 30% (*i.e.*, from about 375 grams to about 250 grams). After 60 days the peak-load value decreased by about 60% (*i.e.*, from about 375 grams to about 150 grams). The present invention addresses this issue by regulating the amount of water vapor experienced by the strand during one or more processing and handling steps occurring after the strand has been extruded, spun, or otherwise made.

In one version of the present invention, one or more of the processing and/or handling steps following extrusion or spinning are conducted in a controlled-humidity environment. This is generally accomplished by carrying out one or more of said steps in a room, compartment, or other enclosure in which a value corresponding to the humidity in the enclosure is controlled so that it does not exceed a selected set point. The set point corresponds to a desired specific humidity or relative humidity. Control generally comprises first sensing or measuring a value corresponding to the specific humidity or relative humidity in the enclosure. Typically, the device used to sense or measure humidity will be in the vicinity of the elastic strand. The sensed or measured value is transmitted to a controller, computer, or other device that compares the sensed or measured value to a set-point value. If the sensed or measured value is sufficiently different from the set-point value, then a control action is taken such that the specific humidity or relative humidity in the enclosure is force adjusted to be at or below the desired specific humidity or relative humidity.

Typically, the specific humidity or relative humidity is force adjusted by directing the air/water-vapor mixture across cooling coils so that the temperature of the mixture is reduced below the mixture's dew point. As a result of this cooling process, a portion of the water vapor condenses on the coils and is removed as liquid, thereby reducing humidity. By directing a sufficient amount of the air/water-vapor mixture across the cooling coils, and then conducting the dehumidified air into the enclosure, humidity is force adjusted to the desired level. After water vapor has been condensed and removed by this cooling process, the air may be heated to increase the dry-bulb temperature. As used herein, "dry-bulb temperature" refers to the temperature of the air/water-vapor mixture as indicated by a thermometer placed in the mixture. Accordingly, as used herein, "controlled-humidity" refers to environments in which specific humidity and/or relative humidity are controlled, and, if the air is heated to increase the dry-bulb temperature after the air/water vapor mixture is dehumidified, environments in which the dry-bulb temperature is also controlled or regulated.

The air/water vapor mixture may be taken from inside the enclosure, dehumidified, and then recirculated back to the enclosure; or it may be taken from outside the enclosure, dehumidified, and brought into the enclosure; or both. For example, if an enclosure is built around a winding station to which an elastic strand is continuously directed, there will be an opening in the enclosure to allow the strand to enter and be wound up. If the manufacturing environment is hot and humid, then a slight positive pressure will likely be maintained inside the enclosure to reduce the amount of hot, humid air entering the enclosure through the opening. In this case, some quantity of the air/water vapor mixture outside the enclosure will have to be dehumidified and brought into the enclosure to replace the air/water vapor mixture inside the enclosure that is escaping through the opening because of the positive pressure.

Rather than control humidity so that it is at or below a set-point value, the air inside the room or enclosure can be cooled to a temperature set point such that the maximum specific humidity cannot exceed a certain level. Humidity charts for air at atmospheric pressure may be used to select the appropriate temperature set point. For example, at a temperature of 40 °F, even at a relative humidity of 100%, the specific humidity is about 0.006 lb_m of water vapor per lb_m of dry air. This value is less than ¼ of the specific humidity that resulted in a 60% drop in peak-load value over a 60 day period (see Figure 3). Accordingly, as used herein, "controlled-temperature" refers to environments in which temperature is controlled to some value in order to regulate the amount of water vapor experienced by the elastic strand.

As stated above, one embodiment of the invention is directed to controlling the humidity of one or more of the processing and/or handling steps following extrusion or spinning. Alternatively, the temperature of the processing and/or handling step(s) may be controlled to limit the capacity of the air to hold water vapor. For example, the step in which the elastic strand is first wound up at a winder may be carried out in a controlled-humidity or controlled-temperature environment. Processing steps upstream or downstream of the first winder may also be carried out in a controlled-humidity or controlled-temperature environment. As used herein, "first winder" refers to the winder at which the strand is first wound up after it is extruded or spun; "upstream" refers to those processing steps that occur after the strand is extruded or spun, but before the first winder; and "downstream" refers to those processing steps that occur after the first winder. If one or more additional processing steps occur after the first winding step at a separate unwinding/winding station (*i.e.*, a station where the elastic strand is unwound, processed in some way, and rewound), these one or more additional processing steps may be carried out in a controlled-humidity or controlled-temperature environment. To the extent that bobbins of elastic strand are stored prior to use or shipment, the bobbins may be stored in a controlled-humidity or controlled-temperature environment. If elastic strand is being shipped to another location, the step in which the elastic strand is prepared—perhaps involving another step in which the elastic strand is unwound and then wound back up again—and packaged for shipment may also be carried out in a controlled-humidity or controlled-temperature environment. And the step of shipping or transporting the elastic strand itself may be carried out in a controlled-humidity or controlled-temperature environment.

All of these steps—winding, storing, preparing and packaging for shipment (if shipping is necessary), shipping, and perhaps storing again at the location where the strand will be used as a raw material—can be carried out in a controlled-humidity or controlled-temperature environment such that the tensile strength of the strand at the time it is used as a raw material on a production machine has not decreased by more than about 20%, particularly about 10%, and specifically about 5% from the tensile strength of the strand at the time it was first produced or prepared for shipment.

In some embodiments of the invention, however, some or all of the steps need not be carried out in a controlled-humidity or controlled-temperature environment. For example, the elastic strand can be placed in a container comprising a barrier material. As used herein, "barrier material" refers to a material that is resistant to penetration by water vapor. The step of placing elastic strand in a container comprising a barrier material, *i.e.* packaging the elastic strand for storage or shipment, may be accomplished in a number of ways. Bobbins of elastic strand, or pallets of bobbins of elastic strand, can be wrapped or encased by a barrier material, *e.g.* a suitable shrink-wrap. Alternatively, bobbins of elastic strand, or pallets of bobbins of elastic strand, may be placed in a flexible plastic bag comprising a barrier material. Or the elastic strand may be placed in a box or carton comprising a barrier material, *e.g.* lined with or holding a flexible plastic bag that is resistant to penetration by water vapor. It should be understood that the present invention encompasses other containers comprising a barrier material.

If the elastic strand is placed in a container comprising a barrier material while in a low-humidity environment, then the micro-environment immediately around the elastic strand inside the container will correspond to that low-humidity environment. Subsequent processing steps might be carried out such that the humidity or temperature outside the container is not regulated. The container would likely not be opened until the elastic strand was to be used as a raw material in a production process.

A number of methods may be used to package the elastic strand. The elastic strand may be wound up at a first winder in a controlled-humidity or controlled-temperature environment, and then taken, conducted, or conveyed to a controlled-humidity or controlled-temperature environment for packaging. Alternatively, the elastic strand may be wound up at a first winder and, soon thereafter, taken, conducted, or conveyed to a controlled-humidity or controlled-temperature environment for packaging.

While in a controlled-humidity or controlled-temperature environment, bobbins of elastic strand, or pallets of bobbins of elastic strand are placed in a container comprising a barrier material. Suitable barrier materials that are resistant to penetration by water vapor include, but are not limited to, polyethylene, polypropylene, polyvinyl chloride, polyvinylidene chloride, polyester, polycarbonate, nylon, cellulose, or a combination thereof. The container is then closed in a way that minimizes the amount of water vapor that might reach the packaged strand during subsequent storage and/or shipping steps. For example, if the container comprising a barrier material is a flexible polyethylene bag or other flexible, water-vapor-resistant plastic bag, then the container can be heat sealed after bobbins of elastic strand, or pallets of bobbins of elastic strand, are inserted into the bag. Alternatively, bobbins of elastic strand, or pallets of bobbins of elastic strand, can be placed in a carton or box lined with a barrier material such as a polyethylene bag, the bag being heat sealed after the bobbins of elastic strand are in place.

In another aspect, a method of the present invention further comprises placing a desiccant material near the elastic strand prior to the container comprising a barrier material being closed, *e.g.* heat sealed. To the extent that the container allows water vapor to penetrate into and around the elastic strand, the desiccant acts to preferentially adsorb or absorb the water vapor. Accordingly, the desiccant helps to keep the humidity inside the container at a level that minimizes strength degradation.

Examples of useful desiccants include, but are not limited to, calcium chloride, calcium sulfate, silica gel, a molecular sieve, Al_2O_3, some combination of thereof, or other similar materials. Typically, the desiccant will be put in a receptacle that allows passage of water vapor into the interior of the receptacle and in contact with the desiccant, but keeps the desiccant separate from the elastic strand. An example of a receptacle is a pouch comprising a fibrous web of naturally-occurring fibers—typically having cellulose as a primary constituent—or a nonwoven material such as a polyethylene or polypropylene nonwoven fabric that that is made to allow passage of water vapor.

In another aspect, the present invention further comprises the step of displacing the air/water vapor mixture inside the container comprising a barrier material with a dry, inert gas before closing the container. For example, after pallets of bobbins of elastic strand have been placed inside a container, dry nitrogen gas may be directed to the interior of the container using a flexible conduit. After sufficient time has passed to allow displacement of the air/water-vapor mixture from inside the container, the conduit is removed from the container, and the container is then closed. This displacement step may be used in conjunction with the step of placing a desiccant material with the elastic strand prior to closing the container. In an alternative method, the packaging system may be configured so that any air/water-vapor mixture inside the container comprising a barrier material is evacuated prior to the container being closed.

In another aspect, a humidity detector is placed with the elastic strand before the container comprising a barrier material is closed. When the bag or container is opened, most likely after it has been shipped to a purchaser of the elastic strand, the humidity detector can be examined to determine if the humidity inside the container exceeded a certain value. If the humidity did exceed a certain value, then the bag or container could be rejected and sent back to the supplier. Alternatively, a sample from the shipment could be tested immediately. If the strength characteristics of the strand were deemed acceptable, then the shipment could be accepted for use as a raw material. One example of a suitable humidity detector is the humidity indicator corresponding to catalogue number

HC-10/60-200, available from Omega Engineering Inc., of Stamford, Connecticut. The indicator is capable of detecting relative humidity over the range 10 to 60 percent.

The step of placing a humidity detector with the elastic strand may be used in conjunction with: placing a desiccant with the strand before a container comprising a barrier material is closed; displacing the air/water-vapor mixture inside the container comprising a barrier material with a dry, inert gas before closing the container; or both.

In some embodiments of the present invention, bobbins of elastic strand are stored either at the site where the strand is made, at the site where the strand is used as a raw material, or both. If the strand is not packaged during these storage steps, and the strand is to be stored for more than 10, specifically more than 20, and particularly more than 30 days, then the room, facility, or area in which the strand is stored should be a controlled-humidity or controlled-temperature environment if the ambient humidity is such that the strand's strength might be significantly degraded. But, as discussed above, all of the process and handling steps subsequent to the strand being extruded or spun may be carried out in controlled-humidity or controlled-temperature environment—regardless of the total time between extrusion or spinning of the strand and use of the strand as a raw material—to minimize or eliminate strength degradation. Or the elastic strand can be packaged so that the "micro-environment" inside the container comprising a barrier material has a low water-vapor content (*i.e.*, a low humidity), thereby allowing subsequent processing steps to be carried out such that the environment outside the package need not be controlled.

Another embodiment of the present invention is directed to a series of steps to help select the humidity or temperature set point(s) of any controlled environment used to regulate exposure of the strand to water vapor. Alternatively this method may be used to assess whether elastic strand should be packaged in a container comprising a barrier material before the strand is stored or shipped—with the container being closed before any such storage or shipment (*e.g.*, by heat sealing the container, barrier material, or both). The method comprises the following steps, or some subset thereof.

First, experiments may be conducted to correlate a strength characteristic of an elastic strand, *e.g.* tensile strength, with the number of strand breaks per unit time on a production machine using the strand as a raw material. From this data a specification corresponding to an acceptable number of breaks, such as a minimum tensile-strength specification, is selected. Alternatively a specification thought to lower the current number of strand breaks per unit time is selected based on operating experience, a cost/benefit analysis, or both. For a production machine used to incorporate elastic strand into a substrate composite and/or a disposable absorbent article, the minimum tensile-strength specification will generally correspond to a value not exceeding about 25 strand breaks per day, specifically about 15 strand breaks per day, and more specifically about 5 strand breaks per day. The strand's exposure to water vapor will generally be regulated so that the tensile strength of the strand at the time it is used as a raw material on the production machine will not have decreased by more than about 20%, particularly about 10%, and specifically about 5% from the tensile strength of the strand at the time it was produced or packaged.

Second the average and/or maximum humidity and temperature likely to be experienced by the elastic strand from the time the strand is spun, extruded, or otherwise made and the time the strand is used as a raw material is determined. Such a determination will likely take into account factors that include the anticipated average and/or maximum temperature and humidity at the site where the strand is made at that time of year; the length of time that the strand is stored before the strand is prepared and packaged for shipment; shipping duration, and the temperature and humidity conditions likely to be experienced by the strand during shipping; the anticipated average and/or maximum temperature and humidity at the site where the strand will be used as a raw material at that time of year; and the length of time that the strand might be stored at that site before it is used as a raw material.

Third, samples of the elastic strand are placed in an environment having a controlled temperature and humidity. The tensile strengths of samples are determined after different times of exposure. A number of these strength-time relationships, like the one depicted in Figure 3, are determined at different humidities and temperatures. Ideally, a strength-time relationship is obtained for the average temperature and humidity likely to be experienced by the strand during the time from extruding or spinning of the strand to use of the strand as a raw material. Another useful strength-time relationship corresponds to the maximum humidity and temperature likely to be experienced by the strand during the time from extruding or spinning of the strand to use of the strand as a raw material.

Fourth, one or more of these strength-time relationships may be used to predict whether the strength characteristics of the strand are likely to decrease below the minimum tensile-strength specification, or other strength specification, between the time the strand is produced or packaged and the time the strand is used as a raw material. For example, Figure 3 gives a strength-time relationship showing that GLOSPAN 840 decreased from a peak-load value of about 375 grams to a peak-load value of about 250 grams after 30 days of exposure to a relative humidity of 80% at a temperature of 100 °F. Assume that a peak-load value of a bobbin of GLOSPAN 840 when first produced is about 375 grams. Assume also that the site where the elastic strand is made is in the southeastern United States during summer. If the elastic strand is stored in an unpackaged form in an uncontrolled environment for at least 30 days before shipment, then action is likely required if, for example, the minimum peak-load specification is 350 ± 50 grams. Possible actions include storing the elastic strand in an environment in which humidity and/or temperature are controlled to avoid significant strength degradation; placement of the elastic strand in a container comprising a barrier material and closing the container (*e.g.*, placing the elastic strand in a polyethylene bag and heat sealing the bag) in a way that effects a low-humidity microenvironment in the container (*e.g.*, by displacing any air/water-vapor mixture inside the container before closure with an inert dry gas; by adding a sufficient amount of desiccant to adsorb/absorb any water vapor remaining in the container after the container is closed; and/or controlling the humidity or temperature around the strand when the strand is placed in the container); or both. This analysis assumes that testing conditions (*e.g.*, crosshead speed and gauge length—see Example 1 below) are the same for determining strength-time relationships, the tensile strength of the elastic strand when produced or packaged, and the tensile strength of the elastic strand when used as a raw material.

If, on the other hand, the sites where the elastic strand is made and used as a raw material are in the northeastern United States in January, then action is likely not required if the strand will be used as a raw material within 30 days of its being extruded or spun (again assuming that the peak-load value of the elastic strand when first produced is about 375 grams, and that tensile-testing conditions are the same for the various tensile strength determinations). Even so, some steps may be carried out year round to ensure that strength does not degrade, *e.g.* storing the strand in a controlled-humidity or controlled-temperature environment, placing the strand in a container comprising a barrier material so that the micro-environment inside the package and around the packaged strand has little or no water-vapor, or both.

It should be understood that the tensile strength, or other strength characteristic, of the elastic strand when first produced typically refers to a measurement completed within about 5 days, and particularly within about 2 days of the elastic strand being extruded, spun, or otherwise made. Similarly, the tensile strength, or other strength characteristic, of the elastic strand when packaged refers to a measurement completed within about 5 days, and particularly within about 2 days of the elastic strand being packaged. Furthermore, the tensile strength, or other strength characteristic, of the elastic strand when the container is first opened refers to a measurement completed within about 5 days, and particularly within about 2 days of the container being opened. The tensile strength, or other strength characteristic, of the elastic strand when used as a raw material refers to a measurement completed within about 5 days, particularly within about 2 days of the elastic strand being used as a raw material, *e.g.* incorporated into a substrate composite or disposable absorbent article. Generally the measurement will be made as close in time as is practical to the time of production, packaging, opening of the container, or use of the strand as a raw material. In this way the measurement more accurately reflects the physical characteristics of the strand when it is produced, packaged, first removed from a container, or used.

Fifth, should action be necessary or desirable to ensure that a minimum tensile-strength specification is met, strength-time relationships may be used to select a humidity set-point, or a temperature setpoint corresponding to a maximum humidity, that should keep the strength characteristics of the elastic strand from decreasing below the minimum acceptable strength specification. For example, Figure 4 (discussed below under Examples; the left vertical axis is Peak Load [g]; the right vertical axis is Elongation [%]; the bottom horizontal axis is Time [hour]; the plot of measured elongations contains the point corresponding to an elongation of about 1280% at a time of about 500 hours; the plot of measured peak loads contains the point corresponding to a peak load of about 410 grams at a time of about 500 hours) depicts the peak-load values of GLOSPAN 840 when exposed to a relative humidity of 20% at 120 °F over a 500 hour period (*i.e.*, about a 20 day period). A humidity chart for air at atmospheric pressure shows that these conditions correspond to a humidity of about 0.017 pounds-mass ("lb_m") of water vapor per lb_m of dry air. After 20 days of exposure to these conditions, the peak-load value of GLOSPAN 840 had not decreased. Accordingly, if the elastic strand was packaged in a container comprising a barrier material, and the packaging step was carried out in an environment in which the specific humidity was controlled so that it was at or below about 0.017 pounds-mass ("lb_m") of water vapor per lb_m of dry air, then the peak-load value should be at or above the hypothetical minimum tensile-strength specification of 350 ± 50 grams if the strand is used as a raw material within 20 days or so of the strand's being spun or extruded.

As an example of how the elastic strand could be handled so that this minimum tensile-strength specification was met, assume that GLOSPAN 840 is made at a time of year when, during some arbitrary 30-day period, the relative humidity can exceed 80% with temperatures reaching 80 to 90°F. As shown in Figure 3, the peak-load value of GLOSPAN 840 can decrease by 30 to 60% under comparable humidity and temperature conditions. Assume also that a peak-load value of a bobbin of GLOSPAN 840 when first produced is about 375 grams. To avoid significant strength degradation, and to ensure that the hypothetical minimum tensile-strength specification of 350 ± 50 grams is met when the strand is used as a raw material, the bobbin of GLOSPAN 840, after being wound up, could be directed to a room or enclosure in which specific humidity was controlled so that it did not exceed about 0.017 pounds-mass ("lb_m") of water vapor per lb_m of dry air. Or the temperature in the room or enclosure could be controlled so that the specific humidity at saturation (*i.e.*, 100% relative humidity) did not exceed about 0.017 pounds-mass ("lb_m") of water vapor per lb_m of dry air. In this controlled-temperature or controlled-humidity environment, the bobbin of GLOSPAN 840 could be placed in a carton or box lined with a flexible plastic bag that is resistant to penetration by water vapor. After a pouch of desiccant material was placed inside the bag with the elastic material, the plastic bag could be heat sealed. The packaged strand could then be shipped to the site where the strand was to be used as a raw material. This same sequence of steps could be used for pallets of bobbins of GLOSPAN 840.

Alternatively, the bobbin of GLOSPAN 840, after being wound up, could be directed to a storage room or enclosure in which specific humidity was controlled so that it did not exceed about 0.017 pounds-mass ("lb_m") of water vapor per lb_m of dry air. Or the temperature in the room or enclosure could be controlled so that the specific humidity at saturation (*i.e.*, 100% relative humidity) did not exceed about 0.017 pounds-mass ("lb_m") of water vapor per lb_m of dry air. After being stored for some period of time, the bobbin of GLOSPAN 840 could then be packaged in the same environment. The bobbin would be placed in a carton or box lined with a flexible plastic bag that is resistant to penetration by water vapor. After a pouch of desiccant material was placed inside the bag with the elastic material, the plastic bag could be heat-sealed. The packaged strand could then be shipped to the site where the strand was to be used as a raw material. This same sequence of steps could be used for pallets of bobbins of GLOSPAN 840. As long as the time of storage and shipment was not much more than 20 days, then the elastic strand should meet the hypothetical minimum peak-load specification of 350 $\pm$ 50 grams.

Not all of previous steps one through five need be carried out to determine a humidity set point, a temperature set point, or the need for one or more other means for regulating a strand's exposure to water vapor. For example, steps four and five might be carried out to select a humidity set point such that any tensile-strength degradation occurring during shipment of elastic strand in an environment controlled to that humidity set point is less than the tensile-strength degradation occurring during shipment of elastic strand in which the strand's exposure to water vapor is not regulated. Alternatively, steps four and five might be carried out to ascertain whether elastic strand should be placed in a container comprising a barrier material, such as a polyethylene bag, that is then closed (*e.g.*, by heat sealing) to avoid a significant reduction in strength due to exposure to water vapor during shipment of the strand.

Elastic strand processed or handled in accordance with the present invention may be incorporated into a number of substrate composites and disposable absorbent articles. Examples of such substrate composites and/or disposable absorbent articles are described in U.S. Patent Number 4,940,464, entitled "Disposable Incontinence Garment or Training Pant," which is hereby incorporated by reference in its entirety; U.S. Patent Number 5,904,675, entitled "Absorbent Article with Improved Elastic Margins and Containment System," which is hereby incorporated by reference in its entirety, with column 7, lines 7 through 34 discussing use of elastic strands with a containment flap, and column 9, line 29 through column 10, line 36 discussing elastic members; U.S. Patent Number 5,904,672, entitled "Absorbent Article having Improved Waist Region Dryness and Method of Manufacture," which is hereby incorporated by reference in its entirety, with column 11, line 39 through column 12, line 2 discussing elastic leg members; and U.S. Patent Number 5,902,297, entitled "Absorbent Article Having a Collection Conduit," which is hereby incorporated by reference in its entirety. It should be understood that the present invention is applicable to other structures, composites, or products incorporating one or more elastic strands or elastic material.

An example of a method and apparatus for making an elastomeric laminate web (*i.e.*, for purposes of the present application, a substrate composite incorporating elastic strand) which may be used with the present invention is found in U.S. Patent Number 5,964,973, entitled "Method and Apparatus for Making an Elastomeric Laminate Web," which is hereby incorporated by reference in a manner consistent with the present specification. Again it should be understood that this patent gives exemplars of methods and apparatuses for incorporating elastic strand and/or elastic material into substrate composites, and the present invention may be used with other methods and apparatuses used to make substrate composites and/or absorbent articles.

EXAMPLES

Example 1

A bobbin of GLOSPAN 840 (Globe), an elastic strand comprising a polyester-b-polyurethane block copolymer, was obtained from Globe Manufacturing Company. The elastic strand had been coated with a silicone-based lubricant. Samples of the strand were placed in a controlled environment, with the temperature controlled to a value of 100°F and the relative humidity controlled to a value of 80%. At selected times of exposure to these conditions, samples of the strand were withdrawn from the controlled environment and taken to a testing room. Generally about 15 to 30 minutes elapsed between the time the sample was withdrawn from the controlled environment and the time the sample was tested.

Both the tensile strength and the elongation of a strand sample were determined using a Sintech tensile tester, available from MTS System Corporation of Eden Prairie, Minnesota. The opposing holders on the tensile tester consisted of cylindrical rods **60**, as shown in Figures 5 and 5.A. The gauge length was set at 1.5 inches by moving the holders such that the central axes **62** of the rods were 1.5 inches apart. One end of a length of strand was then wrapped twice around one cylinder. The other end was then taken and wrapped twice around the other cylinder. The tester was then activated so that the opposing holders moved in opposite directions at a crosshead speed of 20 ± 0.4 inches min^{-1}. The strand was pulled apart at this speed until the strand broke. The peak-load value, in grams, and percent elongation, which reflects the change in length per unit length, were recorded at the point where the strand broke. Values plotted in Figure 3 reflect the average of 5-10 replicates. This testing process was repeated at selected times of exposure to the specified conditions of relative humidity and temperature to give the plot depicted in Figure 3.

Example 2

Samples from the same bobbin of GLOSPAN 840 discussed in Example 1 were placed in a heated environment, with the temperature at 120°F and the relative humidity at 20%. Using the same procedure described in Example 1, samples of the strand were tested at selected times of exposure to these conditions to give the plot depicted in Figure 4.

Example 3

Samples from a bobbin of LYCRA 940 from Dupont Corporation of Wilmington, Delaware were placed in an environment with relative humidity controlled to a value of 80% and temperature controlled to a value of 100°F. After 2 months' exposure to these conditions, samples of LYCRA 940 exhibited a peak-load value 10% lower than the peak-load value of LYCRA 940 that had not been exposed to these conditions.

Although the present invention has been described in considerable detail with reference to certain versions, other versions are possible. The spirit and scope of the appended claims should not be limited to the description of specific versions contained herein.

What is claimed is:

1. A method of handling elastic strand, the method comprising the steps of:

providing elastic strand; and

regulating the elastic strand's exposure to water vapor such that the specific humidity around the elastic strand does not exceed about 0.01 pounds-mass of water vapor per pound-mass of dry air during production of the strand, storage of the strand at the geographic site where the elastic strand is made, shipping of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is to be used as a raw material, storage of the elastic strand at the geographic site where the elastic strand is to be used as a raw material, use of the elastic strand as a raw material, or some combination thereof.

2. The method of claim 1 wherein the elastic strand is used as a raw material to produce a substrate composite comprising the elastic strand or an absorbent article comprising the elastic strand.

3. The method of claim 2 wherein the specific humidity around the elastic strand does not exceed about 0.005 pounds-mass of water vapor per pound-mass of dry air.

4. The method of claim 2 wherein the elastic strand's exposure to water vapor is regulated during shipping of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is used as a raw material.

5. The method of claim 4 wherein regulating the strand's exposure to water vapor comprises controlling the temperature around the strand or around a container that contains the strand.

6. The method of claim 5 wherein the temperature is controlled to a value not exceeding about 55 degrees Fahrenheit.

7. The method of claim 4 wherein regulating the strand's exposure to water vapor comprises controlling the humidity around the strand or around a container that contains the strand.

8. The method of claims 6 or 7 wherein the elastic strand comprises polyester, polyurethane, polyether, polyamide, polyacrylate, polyester-b-polyurethane block copolymer, polyether-b-polyurethane block copolymer, or polyether-b-polyamide block copolymer.

9. The method of claim 2 wherein the elastic strand's exposure to water vapor is regulated such that the tensile strength of the strand at the time the strand is used as a raw material to produce a substrate composite comprising the elastic strand, or an absorbent article comprising the elastic strand, has not decreased by more than about 20% from the tensile strength of the elastic strand when the strand was first produced.

10. The method of claim 7 wherein humidity is controlled by steps comprising: sensing a value corresponding to the humidity around the elastic strand; comparing the value to a set point corresponding to a desired humidity; and force adjusting the humidity around the strand to the desired humidity.

11. The method of claim 10 wherein the set point is selected by steps comprising:

a. correlating strand breaks per unit time on a production machine using elastic strand as a raw material to the tensile strength of the strand;
b. selecting a minimum tensile strength corresponding to an acceptable number of breaks per unit time;
c. placing samples of the corresponding elastic strand in an environment having a controlled humidity;
d. measuring the tensile strength of the samples after different times of exposure to the humidity to which the environment is controlled to determine a strength-time relationship;
e. optionally repeating steps c and d to determine a plurality of strength-time relationships, each strength-time relationship corresponding to a different humidity; and
f. using the strength-time relationship, or relationships, to select a set point corresponding to a desired humidity for shipping the strand such that the tensile strength of the elastic strand is at or above the minimum tensile strength at the time the elastic strand is used as a raw material on the production machine.

12. The method of claim 10 wherein the set point is selected by steps comprising:

a. placing samples of the elastic strand in an environment having a controlled humidity;

b. measuring the tensile strength of the samples after different times of exposure to the humidity to which the environment is controlled to determine a strength-time relationship;

c. optionally repeating steps a and b to determine a plurality of strength-time relationships, each strength-time relationship corresponding to a different humidity; and

d. using the strength-time relationship, or relationships, to select a set point corresponding to a desired humidity for shipping the strand that will reduce the amount of tensile-strength degradation occurring during shipping of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is used compared to the amount of tensile-strength degradation occurring during shipping of elastic strand under similar conditions but with the strand's exposure to water vapor not being regulated.

13. The method of claim 5 wherein temperature is controlled by steps comprising: sensing a value corresponding to the temperature around the elastic strand; comparing the value to a set point corresponding to a desired temperature; and force adjusting the temperature around the strand to the desired temperature.

14. The method of claim 13 wherein the set point is selected by steps comprising:

a. correlating strand breaks per unit time on a production machine using elastic strand as a raw material to the tensile strength of the strand;

b. selecting a minimum tensile strength corresponding to an acceptable number of breaks per unit time;

c. placing samples of the corresponding elastic strand in an environment having a controlled humidity;

d. measuring the tensile strength of the samples after different times of exposure to the humidity to which the environment is controlled to determine a strength-time relationship;

e. optionally repeating steps c and d to determine a plurality of strength-time relationships, each strength-time relationship corresponding to a different humidity; and

f. using the strength-time relationship, or relationships, to select a set point corresponding to a desired temperature that corresponds to a maximum specific humidity for shipping the strand such that the tensile strength of the elastic strand is at or above the minimum tensile strength at the time the elastic strand is used as a raw material.

15. The method of claim 13 wherein the set point is selected by steps comprising:

a. placing samples of the corresponding elastic strand in an environment having a controlled humidity;
b. measuring the tensile strength of the samples after different times of exposure to the humidity to which the environment is controlled to determine a strength-time relationship;
c. optionally repeating steps a and b to determine a plurality of strength-time relationships, each strength-time relationship corresponding to a different humidity; and
d. using the strength-time relationship, or relationships, to select a set point corresponding to a desired temperature that corresponds to a maximum specific humidity for shipping the strand that will reduce the amount of tensile-strength degradation occurring during shipping of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is used as a raw material compared to the amount of tensile-strength degradation occurring during shipping of elastic strand under similar conditions but with the strand's exposure to water vapor not being regulated.

16. A method of handling elastic strand, the method comprising the steps of:
providing elastic strand;
placing the strand in a container comprising a barrier material resistant to penetration by water vapor; and
closing the container.

17. The method of claim 16 wherein the container comprising a barrier material is closed at a time t_1, time t_1 being after the time when the strand is first produced and before the time when the strand is shipped from the geographical site at which the strand is first produced to the geographical site at which the strand is used.

18. The method of claim 17 wherein the specific humidity around the strand does not exceed 0.017 pounds-mass of water vapor per pound-mass of dry air between time t_1 and time t_2, time t_2 being the time when the closed container comprising a barrier material is first opened.

19. The method of claim 17 wherein the specific humidity around the strand does not exceed 0.01 pounds-mass of water vapor per pound-mass of dry air between time t_1 and time t_2, time t_2 being the time when the closed container comprising a barrier material is first opened.

20. The method of claim 17 wherein the specific humidity around the strand does not exceed 0.005 pounds-mass of water vapor per pound-mass of dry air between time t_1 and time t_2, time t_2 being the time when the closed container comprising a barrier material is first opened.

21. The method of claim 18 wherein the barrier material comprises polyethylene, polypropylene, polyvinyl chloride, polyvinylidene chloride, polyester, polycarbonate, nylon, cellulose, or a combination thereof.

22. The method of claim 21wherein closing the container comprising a barrier material comprises heat sealing the container, the barrier material, or both.

23. The method of claim 22 further comprising the step of placing desiccant material with the strand before heat sealing the container, the barrier material, or both.

24. The method of claim 23 wherein the desiccant material comprises calcium chloride, calcium sulfate, silica gel, a molecular sieve, Al_2O_3, or some combination of thereof.

25. The method of claim 22, 23, or 24 further comprising one or both of the steps of: (1) displacing any mixture of air and water vapor from the interior of the container comprising a barrier material with an inert dry gas before heat sealing the container, the barrier material, or both; (2) placing a humidity indicator inside the container comprising a barrier material before heat sealing the container, the barrier material, or both.

26. The method of claims 21 wherein the elastic strand comprises polyester, polyurethane, polyether, polyamide, polyacrylate, polyester-b-polyurethane block copolymer, polyether-b-polyurethane block copolymer, or polyether-b-polyamide block copolymer.

27. The method of claim 26 wherein the elastic strand's exposure to water vapor is regulated such that the tensile strength of the strand at the time the strand is used to produce a substrate composite comprising elastic strand, or an absorbent article comprising elastic strand, has not decreased by more than about 20% from the tensile strength of the strand when the strand was first produced.

28. Elastic strand handled by the method of claims 18, 21, or 26.

29. A substrate composite comprising the elastic strand of claim 28.

30. A disposable absorbent product comprising the substrate composite of claim 29.

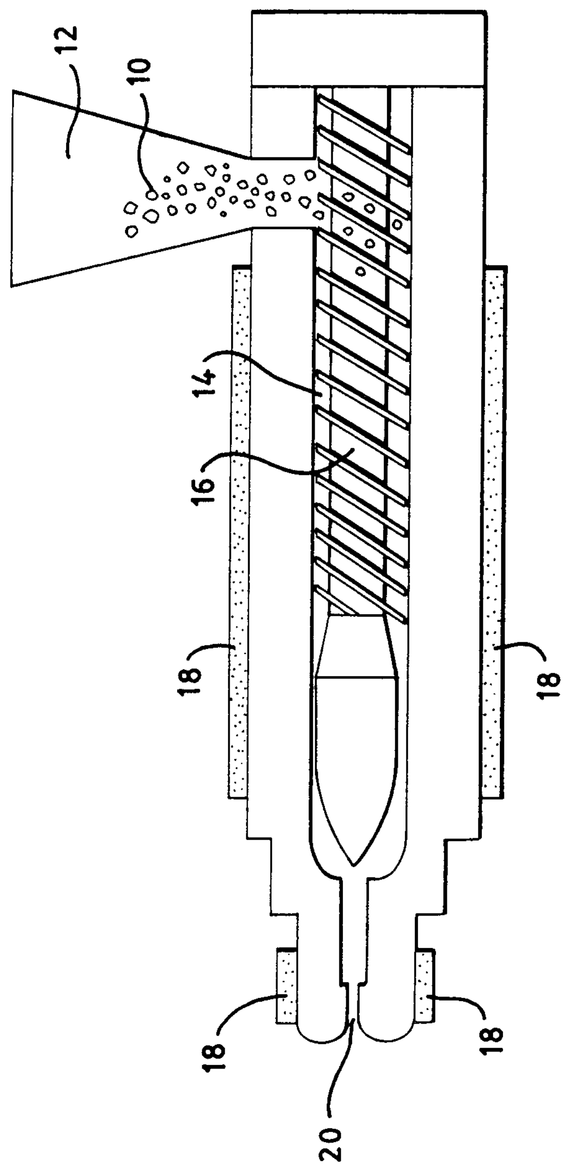


FIG. 1

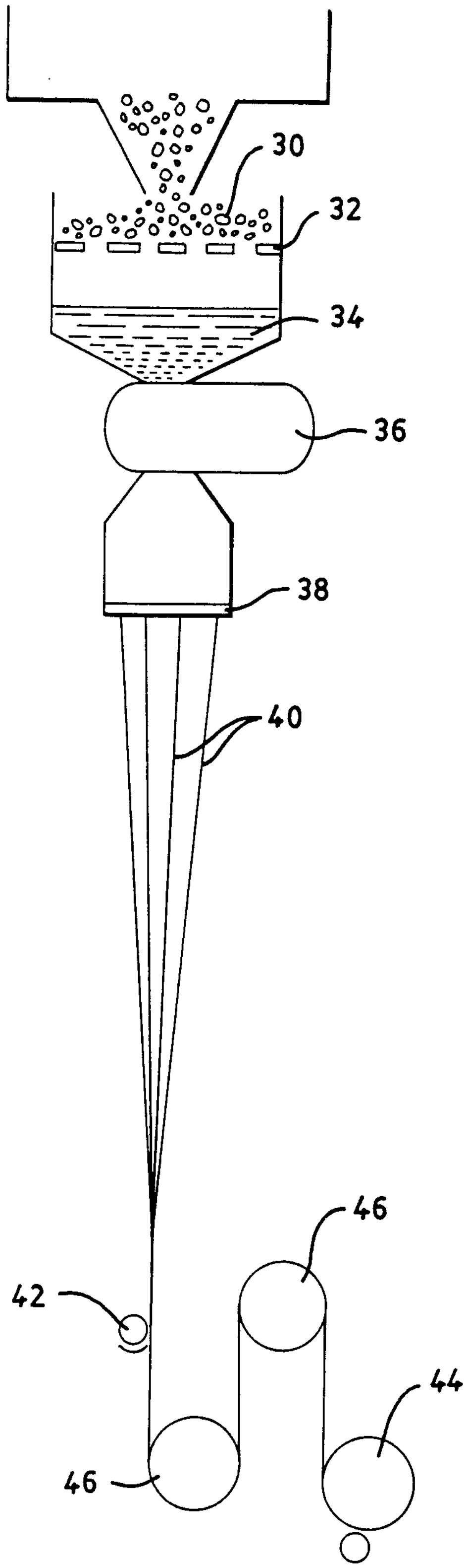


FIG. 2

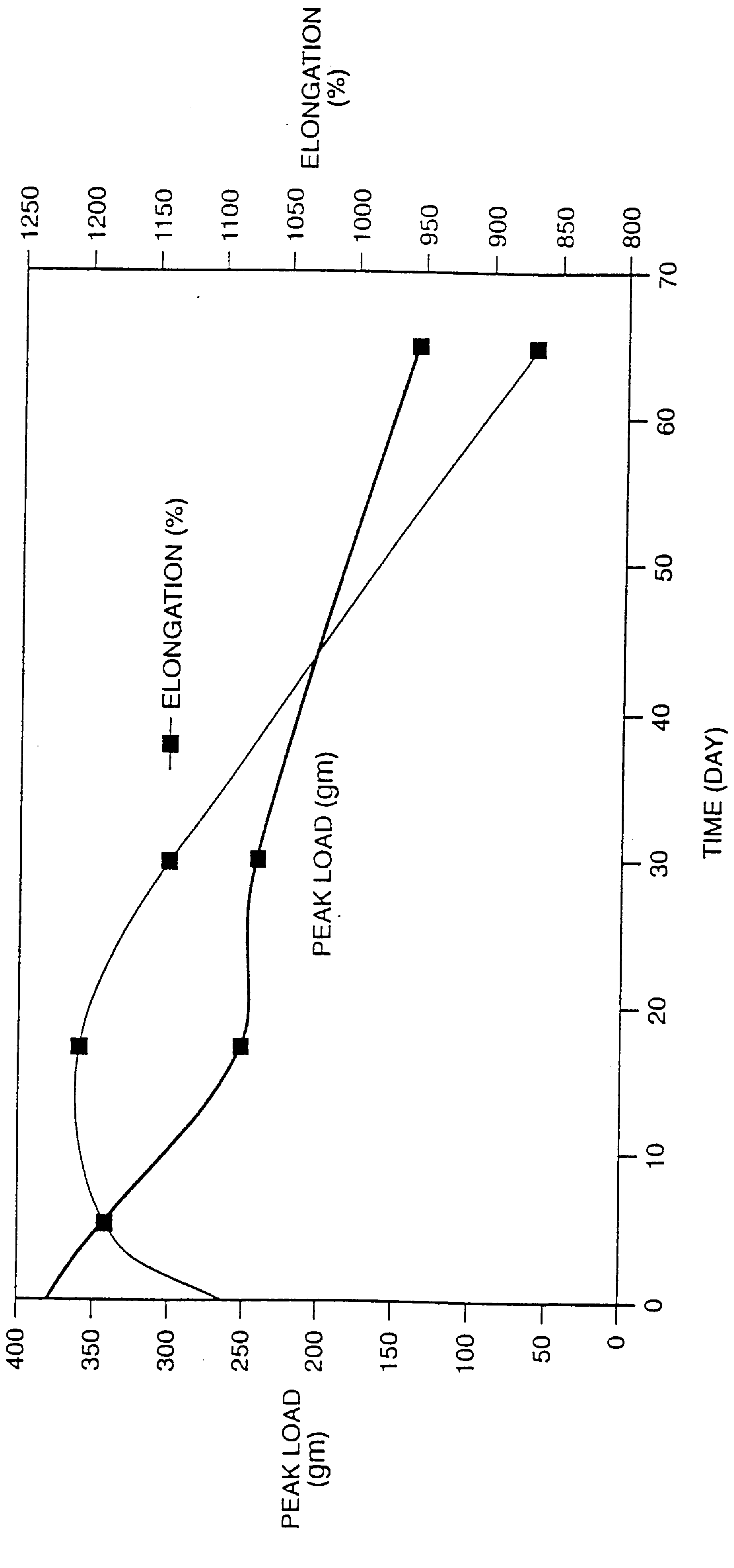

ELONGATION (%)
1250
1200
1150
1100
1050
1000
950
900
850
800
ELONGATION (%)
PEAK LOAD (gm)
PEAK LOAD (gm)
400
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
TIME (DAY)

FIG. 3

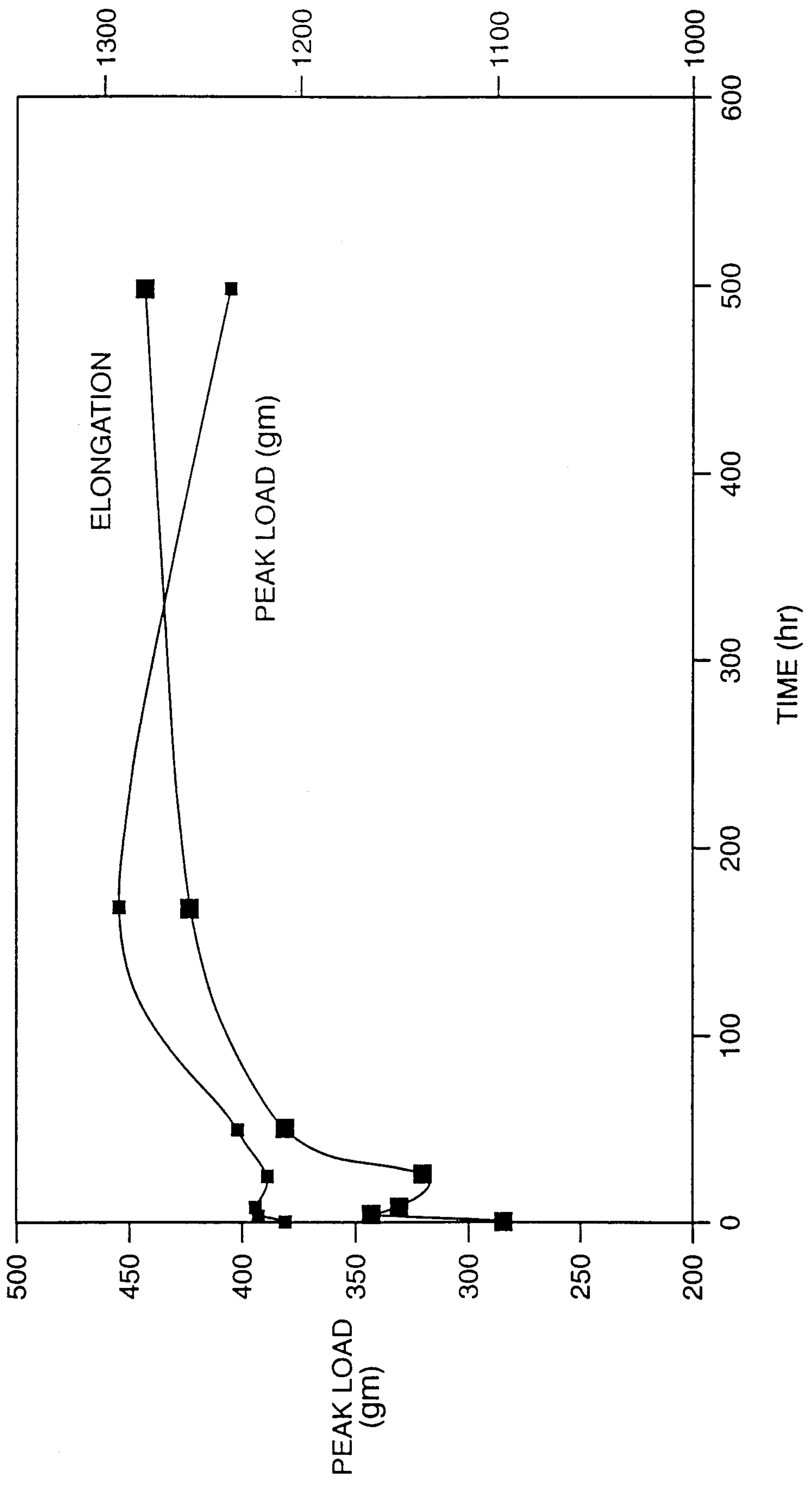

ELONGATION
PEAK LOAD (gm)
PEAK LOAD (gm)
TIME (hr)
0
100
200
300
400
500
600
200
250
300
350
400
450
500
1000
1100
1200
1300

FIG. 4

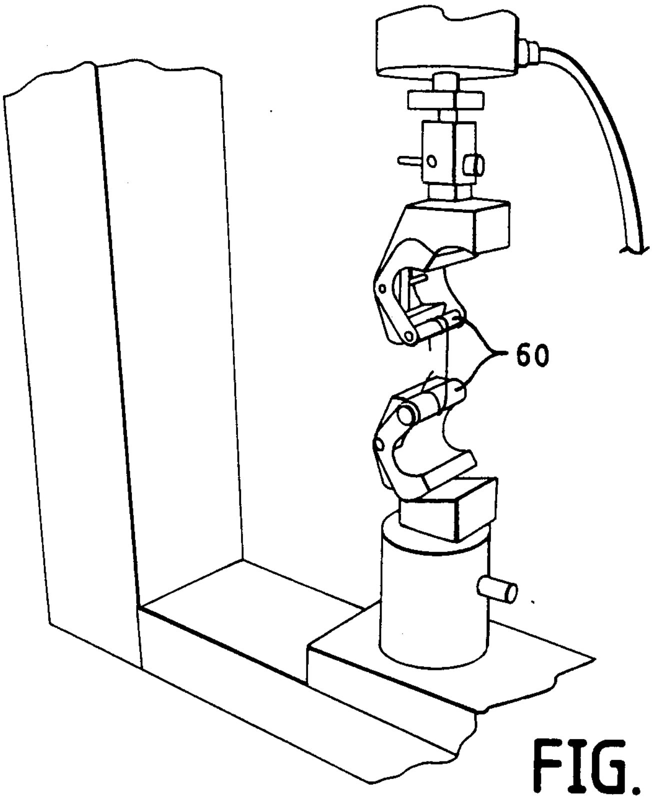


FIG. 5

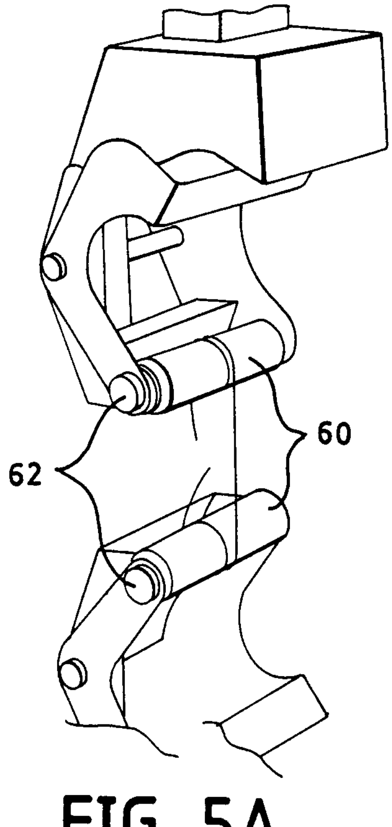


FIG. 5A

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/31671

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D01F6/70 A61F13/15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D01F A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ANONYMOUS: "Dorlastan-Eigenschaften und Einsatzgebiete" XP002163133 "Hinweise für die Lagerung" page 7, paragraph 4 ---	1-30
X	ANONYMOUS: "GLOBE MANUFACTURING COMPANY. TECHNICAL INFORMATION BULLETIN. TYPE S-7. POLYESTER SPANDEX. FIBER TECHNOLOGY" XP002163134 "Storage of Glospan/Cleerspan Fibers" page 18, paragraph 1 ---	1-30
A	WO 97 49847 A (E.I. DU PONT DE NEMOURS AND COMPANY) 31 December 1997 (1997-12-31) page 1, line 10 - line 37 --- -/--	1-30

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 March 2001	02/04/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Tarrida Torrell, J

1

International Application No
PCT/US 00/31671

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 935 019 A (BAYER AG ;BAYER FASER GMBH (DE)) 11 August 1999 (1999-08-11) page 1, line 17 - line 32	1-30
A	US 5 964 973 A (FRENCH TIMOTHY ALAN ET AL) 12 October 1999 (1999-10-12) cited in the application the whole document	29
A	US 5 904 675 A (JOHNSON ERIC DONALD ET AL) 18 May 1999 (1999-05-18) cited in the application the whole document	30

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 00/31671

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9749847 A	31-12-1997	EP 0907771 A	14-04-1999
		JP 2000513414 T	10-10-2000
EP 0935019 A	11-08-1999	DE 19805104 A	12-08-1999
		BR 9901995 A	08-02-2000
		CN 1229154 A	22-09-1999
		JP 11269770 A	05-10-1999
		PL 331275 A	16-08-1999
		TR 9900242 A	21-09-1999
US 5964973 A	12-10-1999	AU 2325399 A	09-08-1999
		WO 9937480 A	29-07-1999
US 5904675 A	18-05-1999	AU 705076 B	13-05-1999
		AU 1057997 A	27-06-1997
		BR 9612575 A	27-07-1999
		CA 2166008 A	19-06-1997
		CN 1203521 A	30-12-1998
		CZ 9801707 A	13-01-1999
		EP 0866682 A	30-09-1998
		HU 9902158 A	28-10-1999
		JP 2000500987 T	02-02-2000
		NZ 323595 A	29-03-1999
		PL 327039 A	09-11-1998
		SK 72798 A	11-01-1999
		TR 9801013 T	21-09-1998
		WO 9720532 A	12-06-1997