SELF-ADJUSTING BRA STRAP

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ABSTRACT
A bra strap has stretch properties such that the strap exerts a force that is sufficient to provide adequate support but does not exceed that which is comfortable to the wearer over a wide range of elongation. Thus, the bra strap may be worn by women of varying heights without the need to change the length of the strap prior to use.
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Fig. 23
SELF-ADJUSTING BRA STRAP

[0001] This application claims the benefit of U.S. Provisional Application No. 61/369,539 filed Jul. 30, 2010, which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to straps, and more particularly, to straps for use in brassieres, sports bras, swimwear, and the like.

[0004] 2. Discussion of the Related Art

[0005] It is not practical for bras, and bra straps, to be specially designed for each wearer. Instead, a given bra style may be intended to be worn by women of varying heights. For example, the distance from the top of a bra cup to the top of the shoulder of a wearer may vary substantially requiring bra straps to be shorter or longer for different wearers. Because straps cannot be made shorter, certain wearers obtain no or little support. In other cases, the straps must be stretched to fit a wearer; however, conventional bra straps are made of an elastic having a high modulus. Thus, as the elastic is stretched, the force applied by the strap rapidly increases and the bra becomes uncomfortable to the wearer. Accordingly, it is frequently necessary for a woman to vary the length of the bra strap so that the bra will provide support and properly fit her and additionally the strap will impart a force that is comfortable to her. Specifically, a relatively short woman may need to decrease the length of the bra straps so that the bra provides adequate support. On the other hand, a relatively tall woman may need to increase the length of the bra straps so that the bra does not impart an excessive, uncomfortable force.

[0006] Conventional bra straps incorporate a ring and slide system so that the length of a bra strap may be changed by the wearer prior to or during use to account for the physical dimensions of the wearer. However, the ring and slide system suffers from the following disadvantages. First, the ring and slide system creates a thick bulky area near the slider which is uncomfortable to the wearer and visible through outer garments. Second, the slider may move during use so as to loosen the strap, causing discomfort, a lack of support, and a loose fit. Third, the ring and slide system adds to the cost of the bra.

[0007] As an alternative to the conventional bra, a bra may be provided that has straps comprising a very weak elastic. For example, such a bra has been manufactured by Warnaco. The straps on this bra provide very little support. Instead, the support is provided by the underband and wing construction. In this way, the bra functions similarly to a strapless bra even though straps are provided. However, such a bra fails to provide adequate support during normal use. Additionally, the straps of this bra are prone to slide off the shoulder of the wearer.

[0008] Accordingly, there is a need for a strap to be incorporated into a bra so that the bra may be used by women of different physical dimensions, including heights, without the need to adjust the length of the strap and that provides comfort and support to the wearer.

SUMMARY OF THE INVENTION

[0009] Accordingly, the present invention is directed to a strap that substantially obviates one or more of the problems due to limitations and disadvantages of the related art for use in women’s clothing including brassieres, sports bras, swimwear and the like.

[0010] In one aspect of the invention, a strap is made of a material having stretch properties such that the strap applies a load sufficient to provide support but not in excess to that which is comfortable to a wearer over a wide range of elongation of the strap, which is sometimes referred to as having a flat power curve. In certain embodiments, such a strap may include an elastomeric yarn. In other embodiments, the elastomeric yarn may be covered. In some embodiments, the draft under which the elastomeric yarn is stretched while being covered and the frequency with which the core yarn is covered, measured in turns of covering yarn per unit length of the core yarn, are controlled so as to yield a strap with desirable stretch properties. The invention provides straps of varying widths and styles and is useful for articles of clothing beyond bra straps including leg, head, wrist and waist bands and belts.

[0011] In one embodiment a strap having a flat power curve for use as clothing such as brassieres, sports bras, and swimwear is provided whereby the strap stretches no more than 25% when subjected to a minimal load of 0.6 lbf and stretches at least 60% when subjected to a higher load of 2.2 lbf. The loads and elongation values are determined by employing the Power Curve test method, which is described below.

[0012] In another embodiment, a bra strap is described having various amounts of stretch calculated on the basis of inches, instead of percentages, between high and low forces such that the strap of a bra is stretched distances that range from about 5 to 12 inches in length. Likewise, in other aspects the strap of the invention is defined in terms of percentages such that the differences between high and low stretching are on the order of 50%, 70%, 90% and the like.

[0013] In other aspects, a strap prepared according to the invention is utilized in clothing and is illustrated using various mathematical expressions where the elongation $E$ is shown based on its relationship with force $F$ using data provided by the Power Curve test method. In another aspect, a bra is provided where its design properties are depicted according to a relationship between the length of its strap and the amount of its stretching at top and minimal loads.

[0014] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0015] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention. In the drawings:

[0017] FIG. 1 shows a relationship between elongation and force for conventional straps and straps according to a first exemplary embodiment of the present invention;
FIG. 2 shows a relationship between elongation and force for conventional straps and straps according to a second exemplary embodiment of the present invention;

FIG. 3 shows a drawing-in and reed plan according to a first exemplary embodiment of the present invention, wherein B indicates Back Yarn, F indicates Face Yarn, R indicates Covered Elastomeric Yarn, and O indicates Binding Yarn;

FIG. 4 shows a heald frame lifting plan according to a first exemplary embodiment of the present invention, wherein X indicates Up on chain, C indicates Center on chain, and a blank indicates Down on chain;

FIG. 5 shows a drawing-in and reed plan according to a second exemplary embodiment of the present invention, wherein O indicates Binding Yarn, I indicates Face Yarn, B indicates Back Yarn, R indicates Covered Elastomeric Yarn, and M indicates Static Polyester Monofilament Yarn;

FIG. 6 shows a heald frame lifting plan according to a second exemplary embodiment of the present invention, wherein X indicates Up on chain, C indicates Center on chain, and a blank indicates Down on chain;

FIG. 7 shows an exemplary needle edge construction according to the first, second, third, fifth, and sixth exemplary embodiments of the present invention;

FIG. 8 shows a relationship between elongation and force for conventional straps, a strap according to a first exemplary embodiment of the present invention, and a strap according to a second exemplary embodiment of the present invention;

FIG. 9 shows a brassiere comprising a strap according to a third exemplary embodiment of the present invention having a binding area and a split area;

FIG. 10 shows a strap according to a third exemplary embodiment of the present invention having a binding area and a split area;

FIG. 11 shows a drawing-in and reed plan according to a third exemplary embodiment of the present invention;

FIG. 12 shows a heald frame lifting plan of a strap body according to a third exemplary embodiment of the present invention, wherein X indicates Up on chain, C indicates Center on chain, and a blank indicates Down on chain;

FIG. 13 shows a heald frame lifting plan of a Jaquard area according to a third exemplary embodiment of the present invention, wherein X indicates Up on chain, C indicates Center on chain, and a blank indicates Down on chain;

FIG. 14 shows a relationship between elongation and force for conventional straps, a strap according to a first exemplary embodiment of the present invention, and the predicted relationship between elongation and force for a strap according to a fourth exemplary embodiment of the present invention;

FIG. 15 shows a movement number chart according to a fourth exemplary embodiment of the present invention;

FIG. 16 shows a pattern chain according to a fourth exemplary embodiment of the present invention;

FIG. 17 shows a relationship between elongation and force for conventional straps, a strap according to a first exemplary embodiment of the present invention, and a strap according to a fifth exemplary embodiment of the present invention;

FIG. 18 shows a drawing-in and reed plan according to a fifth exemplary embodiment of the present invention, wherein B indicates Back Yarn, F indicates Face Yarn, R indicates Covered Elastomeric Yarn, and O indicates Binding Yarn;

FIG. 19 shows a heald frame lifting plan according to a fifth exemplary embodiment of the present invention, wherein X indicates Up on chain, C indicates Center on chain, and a blank indicates Down on chain;

FIG. 20 shows a relationship between elongation and force for a conventional strap, a strap according to a first exemplary embodiment of the present invention, and a strap according to a sixth exemplary embodiment of the present invention;

FIG. 21 shows a strap according to a sixth exemplary embodiment having been manufactured by weaving a fabric and folding the fabric over onto itself in a lengthwise direction.

FIG. 22 shows a drawing-in and reed plan according to a sixth exemplary embodiment of the present invention;

FIG. 23 shows a heald frame lifting plan according to a sixth exemplary embodiment of the present invention, wherein X indicates Up on chain and a blank indicates Down on chain.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

FIGS. 1-2 show the relationship between elongation and load (also herein referred to as "force") for conventional straps and straps according to the first and second exemplary embodiments of the present invention. The lower of the two horizontal lines in FIGS. 1-2 represents the approximate minimum force (0.6 lb) that most women deem as adequate support. The upper of the two horizontal lines in FIGS. 1-2 represents the approximate maximum force (2.2 lb) that most women find comfortable. Accordingly, it is desirable for a bra strap to exert a force between these two lines, between about 0.6 to about 2.2 lb, over a range of extensions of the strap. Of course, other beneficial ranges of force are provided according to the principles of the invention such as between about 0.3 to about 3.0 lb, between about 0.4 to about 2.8 lb, between about 0.5 to about 2.6 lb, between about 0.5 to about 2.4 lb, between about 0.6 to about 2.4 lb, between about 0.8 to about 2.0 lb, and between about 1.0 to about 2.0 lb.

Further, in order to remove the need to adjust the length of the bra strap prior to use, it is desirable for a bra strap to exert a force within the desired force range over a wide range of elongation. As shown in FIGS. 1-2, the conventional straps exert a force within the desired force range only over a very small range of elongation. By contrast, as shown in FIGS. 1-2, the straps according to the present invention exert a force within the desired force range over a wide range of elongation. Therefore, women of varying heights (e.g., varying distances from top of bra cup to top of shoulder) may wear a bra incorporating the straps of the present invention comfortably without the need to adjust the length of the straps. Typically for a bra to fit on women of all heights, the bra straps need to have the ability to stretch approximately 6½ inches in length, or between 6 and 7 inches in length, or between 5½ and 8 inches in length while remaining within a defined force range. In other aspects of the invention, straps are provided that stretch about 5 inches, about 6 inches, about 7 inches, about 8 inches, about 9 inches, about 10 inches, about 11
In certain embodiments, the elongation of the strap is low at the lower end of the desired force range. Thus, the strap may impart a force that is comfortable and sufficient to provide support without requiring the strap to stretch to a large degree. Accordingly, a bra incorporating such a strap may be comfortable to a relatively short woman without a need to decrease the length of the strap. For example, in one arrangement the strap may be stretched no more than 25% when subjected to a load of 0.6 lb. As used herein, the amount of stretch given as a percentage means the length of the strap in an unstretched state subtracted from the length of the stretched strap divided by the length of the strap in an unstretched state. Thus, for example, a strap that is 8 inches long in an unstretched state is stretched 25% when it is stretched to a length of 10 inches ((10 in−8 in)/(8 in)=25%). In other aspects, the strap is stretched no more than 20%, or no more than 15% when subjected to a load of 0.6 lb.

Further, in some embodiments, the elongation of the strap is high at the upper end of the desired force range. Thus, the strap will provide support and may be stretched a large amount before it will impart a force that exceeds that which is comfortable to the wearer. Accordingly, a bra incorporating such a strap may be comfortable to a relatively tall woman without a need to increase the length of the strap. In one aspect, the strap may be stretched at least approximately 70% when subjected to a load of 2.2 lb. For example, if such a strap (for example SW48303-14) is to be used on a garment, in order to have the ability to comfortably stretch approximately 6½ inches in length at 70% stretch, a strap with a relaxed length of approximately 9/4 inches (6½ inches/0.70) may be used. In other aspects, the strap may be stretched at least about 87% when subjected to a load of 2.2 lb. In such a case, if such a strap (for example SW48303-12) is to be used on a garment, in order to have the ability to comfortably stretch approximately 6½ inches in length, a strap with a relaxed length of 7½ inches may be used. In another embodiment, the strap may be stretched at least around 114% when subjected to a load of 2.2 lb. In this situation, if such a strap is to be used on a garment, in order to have the ability to comfortably adjust approximately 6½ inches in length, a strap with a relaxed length of approximately 5½ inches may be used. Of course, these dimensions are illustrative as a wide range of finished straps may be employed depending on aesthetics and design factors such as back strap size and location, cup size and dimensions, locations of intersections of straps with back strap and cup, and the like. When subjected to a load at the top of the force range a strap may be designed to provide and may attain various stretched lengths while supporting appropriate loads without discomfort. For example, a strap may stretch at least about 5 inches, about 6 inches, about 7 inches, about 8 inches, about 9 inches, about 10 inches, about 11 inches, or about 12 inches when a load at the top of the range is applied.

In certain embodiments, the unstretched length of the strap may be between 14 and 18 inches, between 12 and 14 inches, between 10 and 12 inches, between 8 and 10 inches, between 6 and 8 inches, or less than 6 inches.

In other embodiments, the difference between the length of the strap when subjected to a load of 2.2 lb and when subjected to a load of 0.6 lb may be at least 4 inches, at least 5 inches, at least 6 inches, at least 7 inches, at least 8 inches, or approximately 6½ inches.

In other arrangements, the difference between the elongation of the strap when subjected to a load of 2.2 lb and when subjected to a load of 0.6 lb may be at least 40%, at least 50%, at least 60%, at least 70%, at least 80%, at least 90%, or at least 100%. For example, the difference in stretch between the top and bottom loads of the force range is 50%, when the stretch at the top load is 75% and the stretch at the bottom load is 25%.

In various embodiments, the elongation of the strap, E, measured as a percentage, satisfies the following inequality:

\[ E \leq \frac{F - 0.6 \text{ lb}}{0.2 \text{ lb}} \]

where F is the load applied to the strap for all loads between 0.6 lb and 2.2 lb.

In some arrangements, the elongation of the strap, E, measured as a percentage, satisfies the following inequality:

\[ E \leq \frac{F - 0.6 \text{ lb}}{1.8 \text{ lb}} \]

where F is the load applied to the strap for all loads between 0.6 lb and 2.2 lb.

In certain embodiments, the elongation of the strap, E, measured as a percentage, satisfies the following inequality:

\[ E \geq \frac{F - 0.6 \text{ lb}}{1.5 \text{ lb}} \]

where F is the load applied to the strap for all loads between 0.6 lb and 2.2 lb.

In some arrangements, the elongation of the strap, E, measured as a percentage, satisfies the following inequality:

\[ E \geq \frac{F - 0.6 \text{ lb}}{2.4 \text{ lb}} \]

where F is the load applied to the strap for all loads between 0.6 lb and 2.2 lb.
where $F$ is the load applied to the strap for all loads between 0.6 lbf and 2.2 lbf.

[0054] In other arrangements, the elongation of the strap, $E$, measured as a percentage, satisfies the following inequality:

$$E \leq \frac{F}{2.4 \text{ lbf}}$$

where $F$ is the load applied to the strap for all loads between 0.6 lbf and 2.2 lbf.

[0055] In other embodiments, the elongation of the strap, $E$, measured as a percentage, satisfies the following inequality:

$$E \leq \frac{F + 2.4 \text{ lbf}}{2.4 \text{ lbf}}$$

where $F$ is the load applied to the strap for all loads between 0.6 lbf and 2.2 lbf.

[0056] In other arrangements, the elongation of the strap, $E$, measured as a percentage, satisfies the following inequality:

$$E \leq \frac{F}{0.8 \text{ lbf}}$$

where $F$ is the load applied to the strap for all loads between 0.6 lbf and 2.2 lbf.

[0057] It is understood that loads and elongation values meeting one or more of the inequalities above are contemplated by the invention and are readily appreciated by one of ordinary skill in the art. In order for a strap to meet a limitation of one of the above inequalities, it is contemplated that the term “all loads” means the elongation of the strap satisfies the inequality for every load within the 0.6 lbf and 2.2 lbf range.

[0058] In certain embodiments, a bra comprises a strap with a length chosen based on the stretch properties of the strap. For example, the length of the strap may be chosen so that the following inequality is satisfied:

$$\frac{4 \text{ inches}}{\Delta} \leq L \leq \frac{4 \text{ inches}}{\Delta}$$

where $L$ is the length of the strap, measured in inches, in an unstretched state, $\Delta$ is the difference between the amount of stretch, measured in inches, of a four inch section of the strap when subjected to a load of 0.6 lbf and the amount of stretch, measured in inches, of a four inch section of the strap when subjected to a load of 2.2 lbf. Constant “a” may be 3 inches, 4 inches, 5 inches, or 6 inches. Constant “b” may be 7 inches, 8 inches, 9 inches, 10 inches, 11 inches, or 12 inches.

[0059] The width of the strap may be between approximately 4 mm and 20 mm or between approximately 9 mm and 15 mm. In more specific aspects, the width of the strap may be between approximately 4 mm and 6 mm, between approximately 9 mm and approximately 11 mm, between approximately 11 mm and approximately 13 mm, or between approximately 13 mm and approximately 15 mm. Further, the width of the strap may be approximately 5 mm, 10 mm, 12 mm, or 14 mm.

[0060] A strap exhibiting the stretch properties described above may be manufactured in multiple ways. For example such a strap may be manufactured by weaving, knitting, binding or by making a narrow tape with a flexible material such as polyurethane or latex rubber individually or together with a textile material to look and perform like a strap. Below, two exemplary embodiments of a woven strap are provided.

Example 1

[0061] According to a first exemplary embodiment of the present invention, a strap is formed by weaving a covered elastomeric yarn, a face yarn, a back yarn, a binding yarn, two weft yarns, and a catch thread. The details for these yarns are provided below.

[0062] The details of the covered elastomeric yarn are as follows. A core elastomeric yarn of 400 denier is provided. The core yarn is stretched to a draft of 4.9 and is covered by a bottom cover yarn and a top cover yarn while the core yarn is stretched. Draft is a unitless measure of how much a single unit of elastomeric yarn will be stretched to at the point at which the elastomeric yarn is covered. For example, a draft of 4.9 indicates that 1 unit of an elastomeric yarn will be stretched to 4.9 units. The bottom cover yarn is 1/20/20 Polyn A 6.6 Z textured. The top cover yarn is 1/20/20 Polyn A 6.6 Z textured. The core yarn is covered by the bottom cover yarn at a rate of 800 Tors Per Meter ("TPM"). TPM refers to the number of revolutions the cover yarn makes around the core yarn per meter of length of the core yarn. The core yarn and the bottom cover yarn are covered by the top cover yarn at a rate of 620 TPM. The top cover yarn is wrapped around the core yarn and bottom cover yarn in a direction opposite to that in which the bottom cover yarn is wrapped around the core yarn.

[0063] The details of the remaining yarns are as follows. The face yarn is 2/44/34/100 Polyn A 6.6 SD textured. The back yarn is 2/44/34/100 Polyn A 6.6 SD textured. The binding yarn is 1/44/12/150 Polyn A 6 BT flat. The first weft yarn is 1/44/12 Polyn A 6.6 SD flat. The second weft yarn is 1/44/12 Polyn A 6.6 SD flat. The catch thread is 1/76/24 Polyn A 6.6 SD textured.

[0064] The covered elastomeric yarn, face yarn, back yarn, binding yarn, first and second weft yarns, and catch thread are woven according to the drawing-in and reed plan shown in FIG. 3, the heald frame lifting plan shown in FIG. 4, and the needle edge construction shown in FIG. 7. In FIG. 7, warp yarn 5, top and bottom weft yarns 2, and catch thread 3 are constructed using weft needle 1 and latch needle 4. Top and bottom weft yarns 2 thus become weft yarns on the fabric 6. The two weft yarns are fed according to a twin weft construction. The width of the strap may be controlled by varying the number of ends of the yarns.

[0065] The load-elongation relationship for straps according to the first exemplary embodiment of the present invention is shown in FIG. 1. In FIG. 1, the curve for each strap represents the load applied at a given elongation during the expansion of the strap. The three, nearly vertical curves shown together on the left hand side of FIG. 1 reflect the sharp, high force at low elongation relationship possessed by conventional straps (having widths of 14 mm, 12 mm and 10 mm, respectively from left to right). The three gradually sloping, flat power curves that extend to the right of the vertical curves demonstrate the properties of one example of the invention for straps having widths of 14 mm, 12 mm and 10 mm (from left to right). The flat power curves exhibit a
dramatically greater range of stretching or elongation compared to conventional straps within a similar range of force. [0066] The core yarn used in Example 1 is a 400 denier spandex manufactured by Lrubizol. Other useful yarns include the elastomeric sold under the trademark Lycra 902 manufactured by Invista, the elastomeric sold under the trademark CREORA manufactured by Hyosung, the elastomeric sold under the trademark ROICA HS manufactured by AsahiKASEI, and the like.

[0067] In addition to the materials used above, other materials/yarns may be used. For example, core elastomeric yarns of counts different than that provided above may be used. The bottom cover yarn and top cover yarn may be 1/10/2 polyamide 6 or 66, 1/20/12 or 1/44/12 or 1/78/24 Nylon 6, 66, polyester or any textile yarn. For the face yarn, back yarn, binding yarn, first weft yarn, second weft yarn, and catch thread, any textile yarn may be incorporated as long as it meets the desired load-elongation parameters according to the principles of the invention. Further, other manufacturing variables such as modified values for draft and TPM may be used according to the principles of the invention. It is understood that depending on the selected construction and desired aesthetics, the spandex can be either bare, single covered, double covered, air covered or even knitted around with a chain stitch to use as a covered yarn.

Example 2

[0068] According to a second exemplary embodiment of the present invention, a strap is formed by weaving a covered elastomeric yarn, a face yarn, a back yarn, a binding yarn, two weft yarns, and a catch thread. The details for these yarns are provided below.

[0069] The details of the covered elastomeric yarn as follows. A core spandex yarn of 400 denier, is provided. The core yarn is stretched to a draft of 3.4 and is covered by a cover yarn while it is stretched. The cover yarn is 1/20/20 Polyamide 6.6 Z textured. The core yarn is covered by the cover yarn at a rate of 900 TPM.

[0070] The details of the remaining yarns are as follows. The face yarn is 1/44/12/150 Polyamide 6 BT flat. The back yarn is 2/44/12/100 Polyamide 6 SD textured yarn. The binding yarn is 1/44/12/150 Polyamide 6 BT flat. The first weft yarn is 1/44/12 Polyamide 6 BT flat. The second weft yarn is 1/44/12 Polyamide 6 BT flat. The catch thread is 1/44/12 Polyamide 6 SD textured.

[0071] The covered elastomeric yarn, face yarn, back yarn, binding yarn, first and second weft yarns, and catch thread are woven according to the drawing-in and reed plan shown in FIG. 5, the heald frame lifting plan shown in FIG. 6, and the needle edge construction as shown in FIG. 7. The two weft yarns are fed according to a twin weft construction. Based on the width of the elastic, the number of ends of the tape will vary. For example, for a 10 mm shiny strap, 84 covered spandex ends, 58 face yarn ends, 35 back yarn ends, and 31 binding yarn ends are used. For a 12 mm shiny strap, 92 covered spandex ends, 78 face yarn ends, 43 back yarn ends, and 40 binding yarn ends are used. For a 14 mm shiny strap, 102 covered spandex ends, 91 face yarn ends, 53 back yarn ends, and 47 binding yarn ends are used.

[0072] The load-elongation relationship for straps according to the second exemplary embodiment of the present invention is shown in FIG. 2. In FIG. 2, the curve for each strap represents the load applied at a given elongation during the expansion of the strap. The three, nearly vertical curves shown together on the level hand side of FIG. 2 reflect the sharp, high force at low elongation relationship possessed by conventional straps (having widths of 14 mm, 12 mm and 10 mm, respectively from left to right). The three gradually sloping, flat power curves that extend to the right of the vertical curves demonstrate the properties of one example of the invention for straps having widths of 14 mm, 12 mm and 10 mm (from left to right). The flat power curves exhibit a dramatically greater range of stretching or elongation compared to conventional straps within a similar range of force.

[0073] The core yarn used in Example 2 is a 400 denier spandex manufactured by Lrubizol. Other useful yarns include the elastomeric sold under the trademark Lycra 902 manufactured by Invista, the elastomeric sold under the trademark CREORA manufactured by Hyosung, the elastomeric sold under the trademark ROICA HS manufactured by AsahiKASEI, and the like.

[0074] In addition to the materials used above, other materials/yarns may be used. For example, core elastomeric yarns of counts different than that provided above may be used. The cover yarn may be 1/10/2 polyamide 6 or 66, 1/20/12 or 1/44/12 or 1/78/24 Nylon 6, 66, polyester or any textile yarn. The face yarn, back yarn, binding yarn, top weft yarn, bottom weft yarn, and catch thread may be 1/20/12 bright or semi dull (SD) or Full Dull (FD) N6 or 66, 1/78/24 polyamide 6 or 66 bright or semi dull (SD) or Full Dull (FD), 1/110/34 polyamide 6 or 66 bright or semi dull (SD) or Full Dull (FD) or even polyester of similar counts or any textile yarn provided the described elongation-load relationship is met according to the invention. Further, other values for draft and TPM may be used according to the principles of the invention. It is understood that depending on the selected construction and desired aesthetics, the elastomeric yarn can be either bare, single covered, double covered, air covered or even knitted around with a chain stitch to use as a covered yarn.

[0075] As can be seen from FIGS. 1 and 2, the strap described in Example 1 results in a “flatter” power curve than the power curve of the strap described in Example 2. It is desirable that a strap have a power curve the same as or similar to the power curves for Examples 1 and 2. It is also desirable for a strap to have a power curve that falls between the power curves for Examples 1 and 2.

[0076] One of ordinary skill in the art will appreciate that the composition and construction of the elastomeric yarn in a strap affect the power curve of the strap. One of ordinary skill in the art will also appreciate that the manner in which the strap is constructed affects the power curve of the strap. Accordingly, one of ordinary skill in the art will appreciate that it is possible to manufacture fabrics with a range of elastic properties and that it is possible to manufacture fabrics having the same elastic properties in numerous ways.

[0077] With respect to the composition and construction of the elastomeric yarns, the count of the core yarn and cover yarns, the draft of the core yarn, the arrangement of the covering yarn (e.g., single-covered, double-covered, or air-mingled), and the TPM of the covering yarn when the core yarn is single-covered or double-covered by the covering yarn are factors that influence the elastic properties of the elastomeric yarn. One of ordinary skill in the art will appreciate that changing these parameters in a given manner will tend to either increase or decrease the stretch of the elastomeric yarn.

[0078] For example, by increasing the draft while holding the TPM and count of the yarns constant, a “weaker” elastomeric yarn will result. By a “weaker” elastomeric yarn, it is
meant an elastic with more stretch for a given load, i.e., an elastic with a flatter power curve. Conversely, by decreasing the draft while holding the TPM and count of the yarns constant, a “stronger” elastomeric yarn will result. By a “stronger” elastomeric yarn, it means an elastic with less stretch for a given load; i.e., an elastic with a sharper power curve.

By increasing the TPM while holding the draft and count of the yarns constant, a stronger elastomeric yarn will result. Conversely, by decreasing the TPM while holding the draft and count of the yarns constant, a weaker elastomeric yarn will result.

A low draft and a low TPM will result in a stronger elastomeric yarn. Conversely, a high draft and a high TPM will result in a weaker elastomeric yarn.

By increasing the count while holding the draft an TPM constant, a stronger elastomeric yarn will result. Conversely, by decreasing the count while holding the draft and TPM constant, a weaker elastomeric yarn will result.

Finally, by arranging the covering yarn in a single-covering arrangement, a weaker elastomeric yarn will result. Conversely, by using a double-covering arrangement, a stronger elastomeric yarn will result.

With respect to the manner in which the strap is constructed, the method of construction (e.g., weaving or knitting), the density of the warp and weft yarns in the fabric, the number of picks per cm (i.e., the number of threads in the weft direction), the amount of elastomeric yarn in the fabric, and tensioning in the fabric during the finishing and dyeing steps are factors that influence the elastic properties of the strap. One of ordinary skill in the art will appreciate that changing these parameters in a given manner will tend to either increase or decrease the stretch of the strap.

For example, by increasing weft yarn density while keeping picks/cm and warp yarn density constant, a stronger strap will result. Conversely, by decreasing weft yarn density while keeping picks/cm and warp yarn density constant, a weaker strap will result.

By increasing warp yarn density while keeping picks/cm and weft yarn density constant, a stronger strap will result. Conversely, by decreasing warp yarn density while keeping picks/cm and weft yarn density constant, a weaker strap will result. Varying warp yarn density has less of an effect than varying weft yarn density.

Finally, by increasing picks/cm while keeping weft and warp yarn density constant, a stronger strap will result. Conversely, by decreasing picks/cm while keeping weft and warp yarn density constant, a weaker strap will result.

Examples 3-6, described below, are further exemplary embodiments where desirable power curves are obtained.

Example 3

According to a third exemplary embodiment of the present invention, a strap has two sections: a body part and a Jacquard area. The Jacquard area comprises a split-strap part and a binding area as shown in FIGS. 9 and 10. The details of these yarns are provided below. The strap is formed by weaving a covered elastomeric yarn, two weft yarns and a binder yarn. A gut yarn is provided inside the tubular strap to fill the tubular strap and thereby provide improved comfort for the wearer.

The details of the covered elastomeric yarn are as follows. A 78 decitex spandex yarn is provided as the core elastomeric yarn. The core yarn is stretched to a draft of 2.9 and is covered by a cover yarn while the core yarn is stretched. The cover yarn is 1/78/24 Polyamide 6 SD Textured z twist. The core yarn is covered by the cover yarn at a rate of 804 TPM.

The details of the remaining yarns are as follows. The gut yarn is 2/78/24 Polyamide SD textured N6. The first weft yarn is 1/44/12 Polyamide 6.6 SD Flat. The second weft yarn is 1/44/12 Polyamide 6.6 SD Flat. The binder yarn is composed of two covered yarns that are the same as the covered yarn used for the warp.

The yarns are woven according to the drawing-in and reed plan shown in FIG. 11, the heald frame lifting plans shown in FIGS. 12 and 13, and the needle edge construction shown in FIG. 7. Other needle edge constructions known to those of ordinary skill in the art may be used. The heald frame lifting plan in FIG. 12 is for the strap body and the heald frame lifting plan in FIG. 13 is for the Jacquard area. Based on the width of the strap, the number of ends of the yarn will vary. For a 10 mm strap, 164 covered elastomeric yarns and 72 gut yarns may be used.

The load-elongation relationship for straps according to the third exemplary embodiment of the present invention is shown in FIG. 8. In FIG. 8, each curve represents the load applied at a given elongation during the expansion of the respective strap. The three curves on the left hand side represent the power curves of conventional straps. The curve on the right hand side represents the power curve of a 10 mm strap according to the first exemplary embodiment. The curve in the middle, labeled “SJ49920-10 mm,” represents the power curve of a 10 mm strap made according to the third exemplary embodiment of the present invention.

Example 4

According to a fourth exemplary embodiment of the present invention, a strap is knitted. In the warp direction, a 400 decitex elastomeric yarn is provided. Around this yarn, a covered elastomeric yarn is knitted. The covered elastomeric yarn comprises a core yarn of a 78 decitex elastomeric yarn covered by a 1/44/13 Polyamide 6.6 SD textured parallel yarn. The core yarn of the warp is covered by the cover yarn by air mingling. However, single covered, double covered, or regular yarn may be used as the warp.

The weft yarn is 2/78/24 Polyamide SD textured N6.6.

For a 10 mm strap, 20 ends of the 400 decitex elastomeric yarn (2x10 ends) and 1 end of the weft yarn may be used.

The 400 decitex elastomeric yarn, covered elastomeric yarn, and weft yarn are knitted according to the movement number chart in FIG. 15 and the pattern chain in FIG. 16.

The predicted load-elongation relationship for straps according to the fourth exemplary embodiment of the present invention is shown in FIG. 14. In FIG. 14, each curve represents the load applied at a given elongation during the expansion of the respective strap. The three curves on the left hand side represent the power curves of conventional straps. The curve on the right hand side represents the power curve of a 10 mm strap according to the first exemplary embodiment. The curve in the middle, labeled “SX49919_10 mm,” repre-
sents the predicted power curve of a 10 mm strap according to the fourth exemplary embodiment of the present invention.

Example 5

[0099] According to a fifth exemplary embodiment of the present invention, a strap is formed by weaving a covered elastomeric yarn, a face yarn, a back yarn, a binding yarn, two weft yarns, and a catch thread.

[0099] The details of the covered elastomeric yarn are as follows. A core elastomeric yarn of 400 decitex is provided. The core yarn is stretched to a draft of 4.9 and is covered by a bottom cover yarn and a top cover yarn while the core yarn is stretched. The bottom cover yarn is 1/20/20 Polyamide 6.6 Z SD textured. The top cover yarn is 1/20/20 Polyamide 6.6 Z SD textured. The core yarn is covered by the bottom cover yarn at a rate of 800 Turns Per Meter ("TPM"). The core yarn and bottom cover yarn are covered by the top cover yarn at a rate of 620 TPM. The yarn has a covered rubber stretch (relaxed length) of 305% of the length of the original core yarn.

[0100] The details of the remaining yarns are as follows. The face yarn is 2/44/34/100 Polyamide 6.6 SD textured. The back yarn is 2/44/34/100 Polyamide 6.6 SD textured. The binding yarn is 1/44/12/150 Polyamide 6 BT flat. The first weft yarn is 1/44/12 Polyamide 6.6 SD flat. The second weft yarn is 1/44/12 Polyamide 6.6 SD flat. The catch thread is 1/78/24 Polyamide 6.6 SD textured.

[0101] The covered elastomeric yarn, face yarn, back yarn, binding yarn, first and second weft yarns, and catch thread are woven according to the drawing-in and reed plan shown in FIG. 18, the needle frame lifting plan shown in FIG. 19, and the needle edge construction shown in FIG. 7. Other needle edge constructions may be used. The two weft yarns may be fed according to a twin weft construction.

[0102] The load-elongation relationship for a 10 mm strap according to the fifth exemplary embodiment of the present invention is shown in FIG. 17. In FIG. 17, each curve represents the load applied at a given elongation during the expansion of the respective strap. The three curves on the left hand side represent the power curves of conventional straps. The curve on the right hand side represents the power curve of a 10 mm strap according to the first exemplary embodiment. The curve immediately adjacent to the curve on the right hand side, labeled "SW49852-10 mm," represents the power curve of a 10 mm strap made according to the fifth exemplary embodiment of the present invention.

Example 6

[0103] According to a sixth exemplary embodiment of the present invention, a strap is formed by weaving a covered elastomeric yarn and a weft yarn. The yarn is then folded over onto itself in the lengthwise direction and secured, such that the final width of the strap is half of the width of the original woven fabric as shown in FIG. 21.

[0104] The details of the covered elastomeric yarn are as follows. A core elastomeric yarn of 400 decitex is provided. The core yarn is stretched to a draft of 4.9 and is covered by a bottom cover yarn and a top cover yarn while the core yarn is stretched. The bottom cover yarn is 1/20/20 Polyamide 6.6 Z SD textured. The top cover yarn is 1/20/20 Polyamide 6.6 Z SD textured. The core yarn is covered by the bottom cover yarn at a rate of 800 TPM. The core yarn and bottom cover yarn are covered by the top cover yarn at a rate of 620 TPM. The yarn has a covered rubber stretch (relaxed length) of 305% of the length of the original core yarn.

[0105] The weft yarn is 1/110/34 Polyamide 6.6 SD flat.

[0106] The covered elastomeric yarn and weft yarn are woven according to the drawing-in and reed plan shown in FIG. 22 and the head frame lifting plan shown in FIG. 23.

[0107] The load-elongation relationship for a 16 mm strap according to the sixth exemplary embodiment of the present invention is shown in FIG. 20. In FIG. 20, each curve represents the load applied at a given elongation during the expansion of the respective strap. The curve on the left hand side represents the power curves of a conventional 16 mm strap. The curve labeled "SW48303-16 mm" represents the power curve of a 16 mm strap according to the first exemplary embodiment. The curve labeled "SW49826-32 mm," represents the power curve of a 16 mm strap (after folding) made according to the sixth exemplary embodiment of the present invention.

[0108] The core yarns in examples 3-6 may be a spandex manufactured by Lubrizol. Other useful yarns include the elastomeric sold under the trademark LYCRA 902 manufactured by Invista, the elastomeric sold under the trademark CREORA manufactured by Hystong, the elastomeric sold under the trademark ROICA HS manufactured by AsahiKASEI, and the like.

[0109] The data shown in FIGS. 1, 2, 8, 17, and 20 and utilized in the inequality equations above were obtained using the load-elongation Power Curve test method for elastic trans that is described below. The data shown in FIG. 14 for the curve labeled "SK49919_10 mm" shows the predicted results of a test using the same test method. Some parameters of this method are derived from test method LTD 06 entitled "Elastics: Load, Elongation & Recovery" published by Limited Brands. The details of the load-elongation Power Curve test method are as follows:

[0110] The test is performed on a constant rate elongation tensile tester with a low range load cell (approximately 100 lbs). A Tinius Olsen H5 may be used as the constant rate tensile tester.

[0111] The web is conditioned for four hours prior to testing at 20° C. +/- 2° C. and 65% +/- 2% relative humidity.

[0112] The test specimens are 6 inches in length. A four inch bench mark is centered on the specimen.

[0113] The chart speed is 10 inches/minute.

[0114] The cross head speed is 10 inches/minute.

[0115] The jaw clamps are 3 inches wide.

[0116] The gauge length is 4 inches.

[0117] A specimen is tested according to the following steps:

[0118] 1) The four inch marking is aligned between the jaw clamps.

[0119] 2) The top clamp is tightened and the load is tared to zero.

[0120] 3) The bottom clamp is tightened without applying pressure.

[0121] 4) The specimen is elongated to a specified load and returned to zero extension. The specified loads are as follows:

[0122] a) For a specimen width of 1 to 15 millimeters, the specified load is 3.3 lbs.

[0123] b) For a specimen width of 16 to 50 millimeters, the specified load is 9.35 lbs.
For a specimen width of over 50 millimeters, the specified load is 16.5 lbs.

The specimen is elongated again while the load and elongation are measured and recorded. The load is returned to zero.

The above steps are repeated for two additional specimens and the test results are averaged.

Other measuring methods may be useful to demonstrate the advantages of the invention. For example, British Standard BS EN 4952; testing standard MTLS1031 entitled “Narrow Elastics: Load, Elongation, and Recovery” authorized by Dr. Sandeep Khattus, ASTM standard D4964-96 (2004); and testing procedure P14 entitled “Extension and Modulus of Elastomeric Fabrics and Narrow Elastics” published by Marks & Spencer may be used.

The load-elongation Power Curve test method directly measures how much a four inch long section of a strap stretches under a given load. In order to determine how much a strap of a length other than four inches will stretch, it is necessary to multiply the length the four inch long section stretches by the ratio of the length of the strap to four inches. For example, if it has been measured that a four inch long section stretches 3 inches when a load of 2.0 lbf is applied, it can be determined that a 10 inch long strap will stretch 7.5 inches (3 inches x (10 inches / 4 inches)) when a load of 2.0 lbf is applied. In other words, the elongation of a 10 inch strap (or any other length) may be determined even though only four inch sections are stretched according to the load-elongation Power Curve test method. The calculated length that a strap, having a length other than four inches, stretches under a given load is referred to as the “Calculated Stretched Length.” Thus for this example, the Calculated Stretched Length is 7.5 inches.

Unless otherwise indicated herein, where a load is specified for a given elongation or where an elongation is specified for a given load, it is meant to reflect the load or elongation as measured during the expansion of the strap when subjected to the load-elongation Power Curve test method.

It will be apparent to those skilled in the art that various modifications and variations can be made in the self-adjusting bra strap of the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A strap having a flat power curve for incorporation into women’s clothing including brassieres, sports bras, and swimwear, wherein the strap stretches no more than 25% when subjected to a load of 0.6 lbf and stretches at least 60% when subjected to a load of 2.2 lbf when the strap is subjected to the Power Curve test method.

2. The strap of claim 1, wherein the strap is manufactured by weaving.

3. The strap of claim 1, wherein the strap comprises elastic yarn.

4. The strap of claim 1, wherein the strap comprises covered elastic yarn.

5. The strap of claim 1, wherein the strap has a width of between 10 and 14 millimeters.

6. The strap of claim 1, wherein the strap stretches between 10% and 25% when subjected to a load of 0.6 lbf.

7. The strap of claim 1, wherein the strap stretches between 25% and 50% when subjected to a load of 1.2 lbf.

8. The strap of claim 1, wherein the strap stretches between 35% and 85% when subjected to a load of 1.6 lbf.

9. The strap of claim 1, wherein the strap stretches between 60% and 110% when subjected to a load of 2.0 lbf.

10. The strap of claim 1, wherein the strap stretches between 70% and 125% when subjected to a load of 2.2 lbf.

11. A bra comprising a strap according to claim 1.

12. A bra comprising a strap, wherein the distance between the Calculated Stretched Length of the strap when subjected to a load of 2.2 lbf is at least four inches greater than the Calculated Stretched Length of the strap when subjected to a load of 0.6 lbf, wherein the loads are applied according to the Power Curve test method.

13. The bra according to claim 12, wherein the difference between the Calculated Stretched Length of the strap when subjected to a load of 2.2 lbf is at least five inches greater than the Calculated Stretched Length of the strap when subjected to a load of 0.6 lbf.

14. The bra according to claim 13, wherein the length of the strap in an unstretched state is less than 10 inches.

15. The bra according to claim 12, wherein the difference between the Calculated Stretched Length of the strap when subjected to a load of 2.2 lbf is at least six inches greater than the Calculated Stretched Length of the strap when subjected to a load of 0.6 lbf.

16. The bra according to claim 15, wherein the difference between the Calculated Stretched Length of the strap when subjected to a load of 2.2 lbf is less than eight inches greater than the Calculated Stretched Length of the strap when subjected to a load of 0.6 lbf.

17. The bra according to claim 12, wherein the difference between the Calculated Stretched Length of the strap when subjected to a load of 2.2 lbf is approximately 6½ inches greater than the length of the strap when subjected to a load of 0.6 lbf.

18. The bra according to claim 17, wherein the length of the strap in an unstretched state is less than 10 inches.

19. A strap comprising a flat power curve, wherein the difference between the percent of stretch of the strap when subjected to a load of 2.2 lbf and the percent of stretch of the strap when subjected to a load of 0.6 lbf is at least 50% when the strap is subjected to the Power Curve test method.

20. The strap according to claim 19, wherein the difference is at least 70%.

21. The strap according to claim 20, wherein the difference is at least 90%.

22. A strap for incorporation into women’s clothing including brassieres, sports bras, and swimwear, wherein the strap stretches an elongation E, measured as a percentage, under force F, force F being applied by stretching the strap according to the Power Curve test method, wherein

\[ E = \frac{F - 0.6 \text{ lbf}}{3.0 \text{ lbf}} \]

for all values of F between 0.6 lbf and 2.2 lbf.
23. The strap according to claim 22, wherein

\[ E \geq \frac{F - 0.6 \text{ lbf}}{2.4 \text{ lbf}} \]

for all values of \( F \) between 0.6 lbf and 2.2 lbf.

24. The strap according to claim 22, wherein

\[ E \leq \frac{F + 1.2 \text{ lbf}}{2.4 \text{ lbf}} \]

for all values of \( F \) between 0.6 lbf and 2.2 lbf.

25. The strap according to claim 23, wherein

\[ L \leq \frac{F}{a + b} \]

for all values of \( F \) between 0.6 lbf and 2.2 lbf.

26. The strap according to claim 22, wherein the strap has a width of between 9 and 15 mm.

27. A bra comprising a strap, wherein

\[ \frac{4 \text{ inches}}{a} \leq L \leq \frac{4 \text{ inches}}{b} \]

wherein \( L \) is the length of the strap, measured in inches, in an unstretched state,
wherein \( \Delta \) is the difference between the amount of stretch, measured in inches, of a four inch section of the strap when subjected to a load of 0.6 lbf and the amount of stretch, measured in inches, of a four inch section of the strap when subjected to a load of 2.2 lbf,
wherein \( 3 \leq a \leq 6 \) inches and \( 7 \leq b \leq 12 \) inches, and
wherein the loads are applied according to the Power Curve test method.

28. The bra according to claim 27, wherein \( a = 4 \) inches and \( b = 9 \) inches.

29. The bra according to claim 27, wherein \( a = 6 \) inches and \( b = 7 \) inches.

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