

June 11, 1968

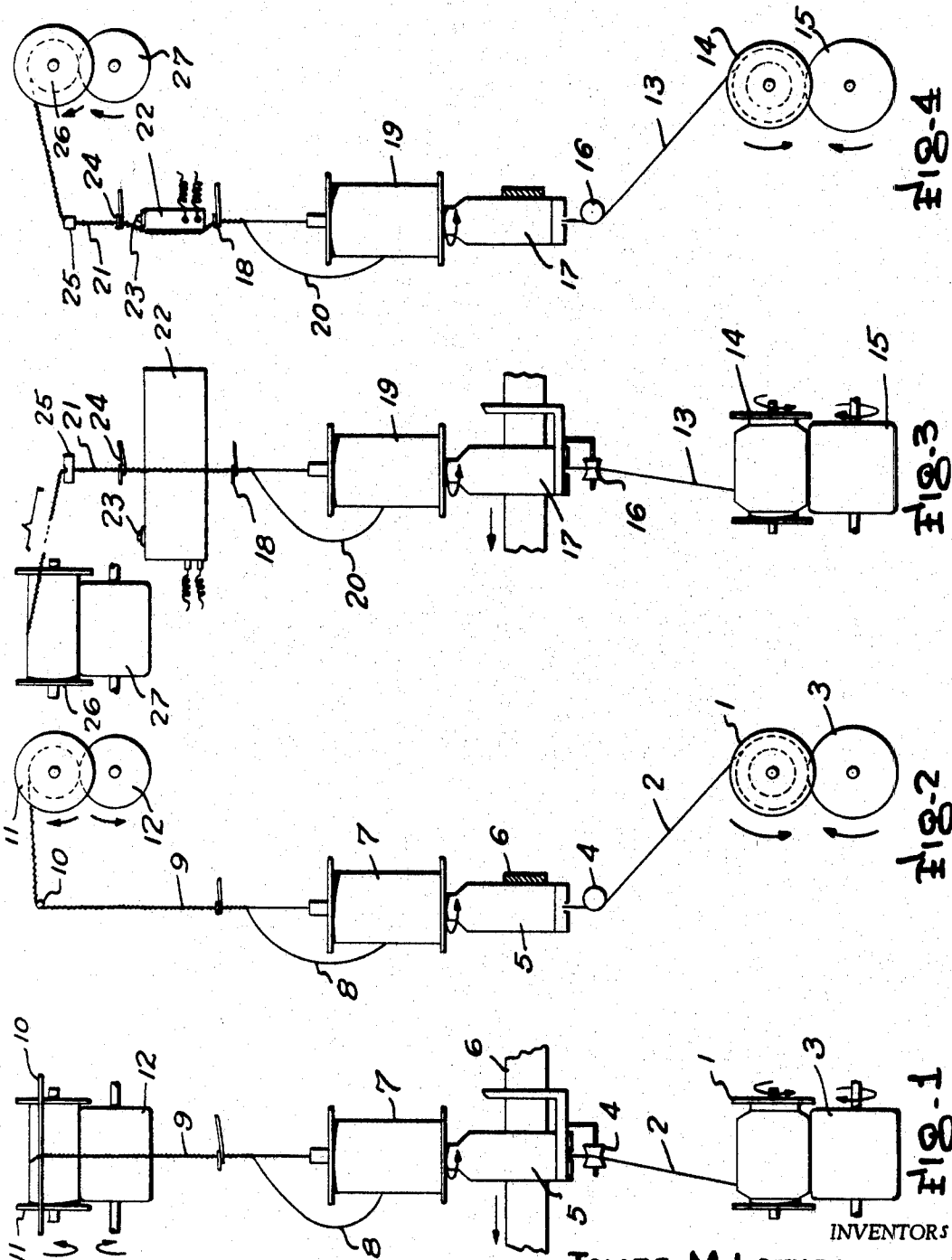
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3,387,448

STRETCHED AND STABILIZED YARNS AND FABRICS

Filed Dec. 30, 1963

4 Sheets-Sheet 1



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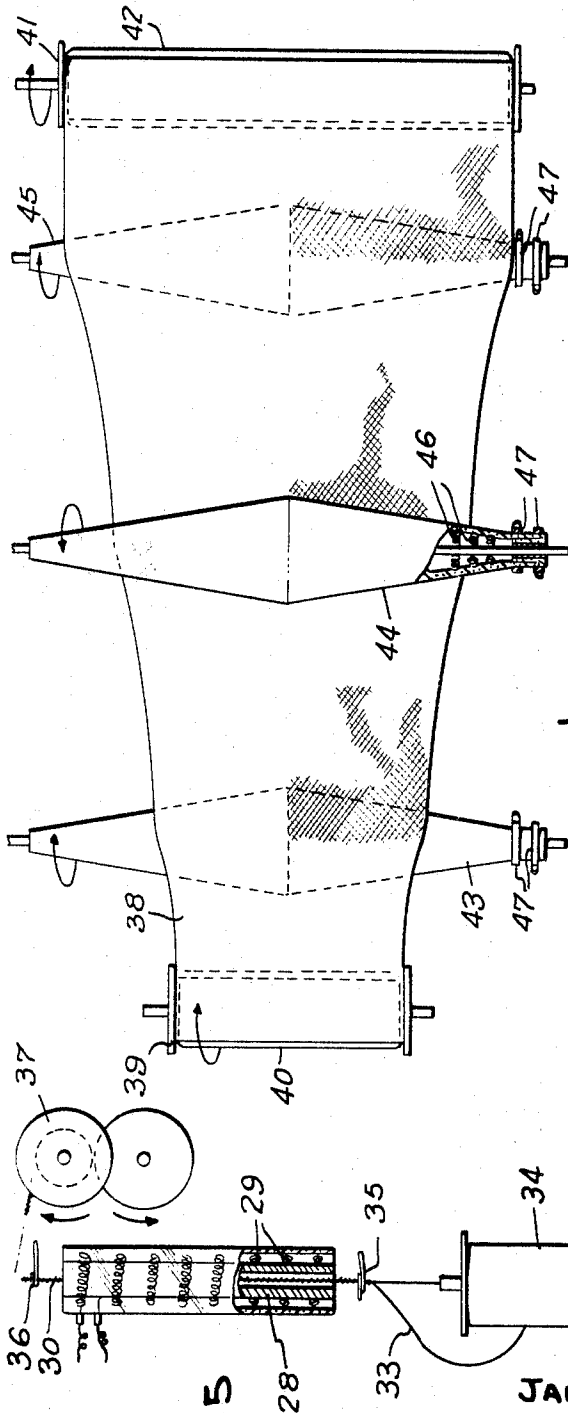
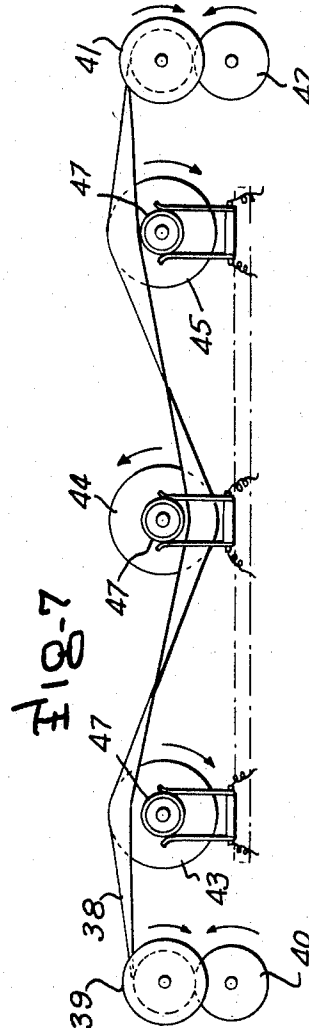


Fig. 6



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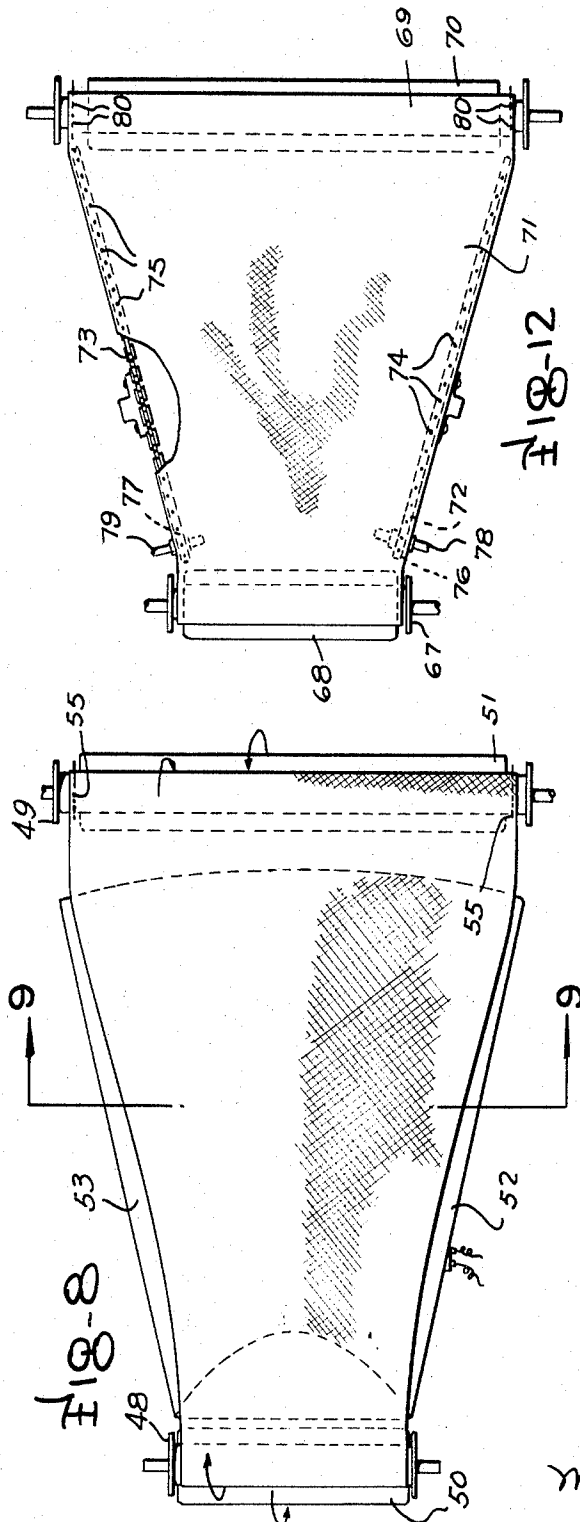
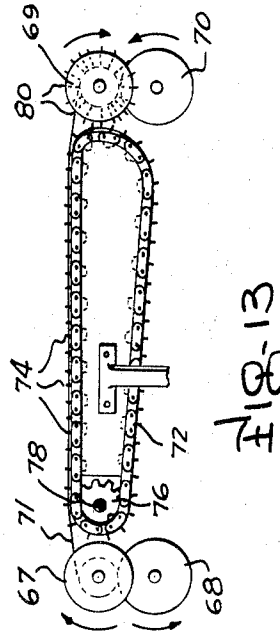
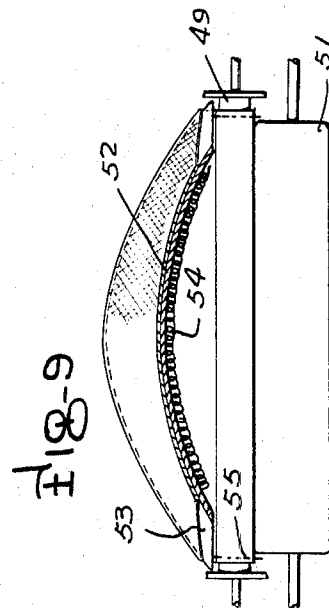
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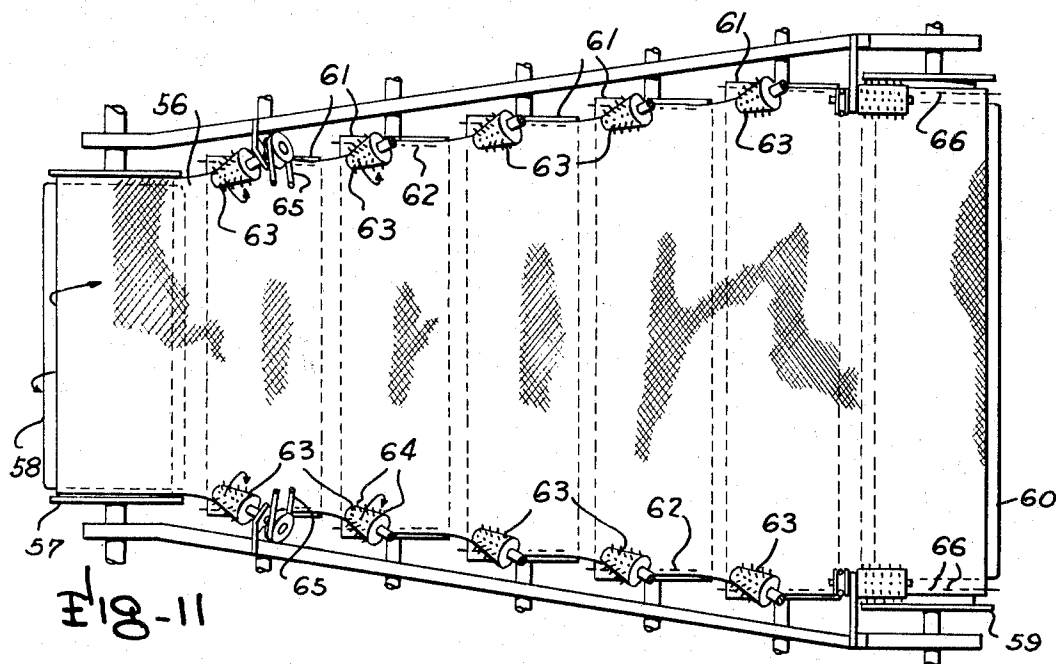
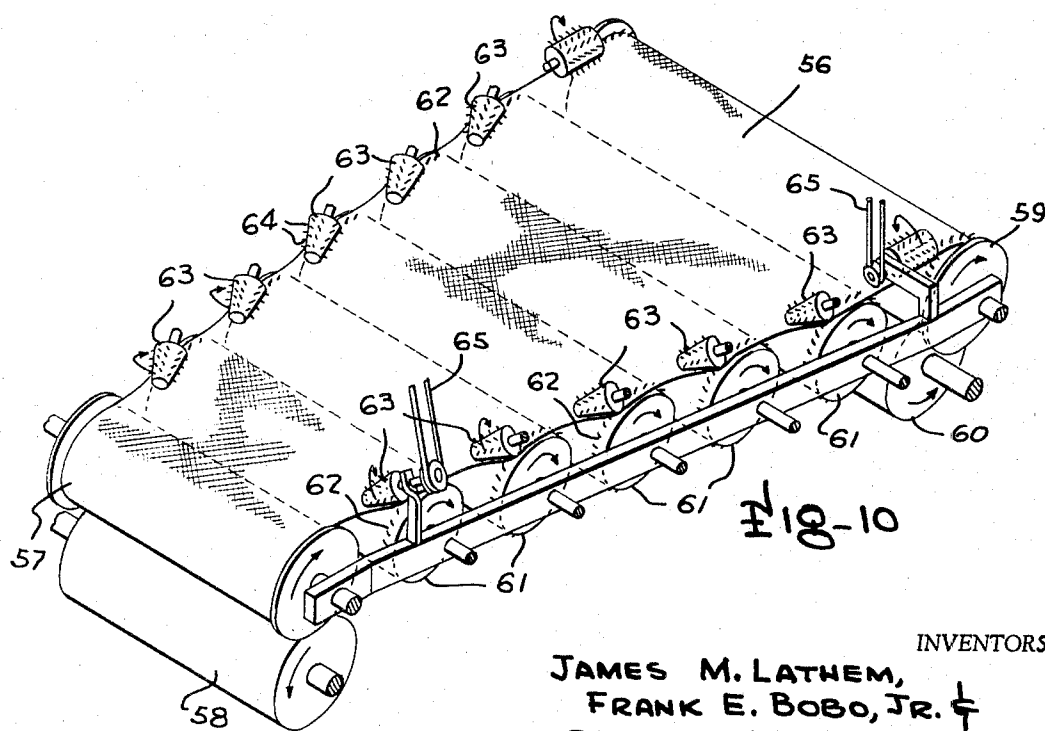
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STRETCHED AND STABILIZED YARNS AND FABRICS

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ABSTRACT OF THE DISCLOSURE

A stabilized spandex yarn made by stretching the yarn and heat setting in the stretched condition to provide reduced denier, increased yardage and reduced stretch over that which was originally present in the yarn.

This invention relates to improved synthetic elastomeric yarns and fabrics which have been drawn and stabilized, and to apparatus by which these improved yarns and fabrics may be produced.

In our prior, copending application, Ser. No. 202,192, filed June 13, 1962, entitled Method of Drawing, Covering, and Stabilizing Synthetic Elastomer Yarn, now Patent No. 3,115,745, dated Dec. 31, 1963, there is disclosed a method of treating synthetic, elastomeric yarn, such as spandex to make it more suitable for knitting, to stabilize it with respect to its stretch and retractibility properties and to produce lower denier yarn with greater yardage. The method disclosed includes the steps of elongating a spandex yarn, thereby reducing its diameter, or denier, wrapping the drawn elastomeric yarn with a suitable covering yarn, such as, for example, multifilament nylon yarn, winding the drawn and wrapped yarn under tension, and heating the drawn and wrapped yarn sufficiently to stabilize the elastomeric core yarn. The prior application also states that the stabilizing heat may be applied to an elongated, bare spandex yarn, or to the tensioned composite yarn, prior to winding on the take-up bobbin. The said application provides a complete disclosure of the method of treating the yarn, and reference may be had to that disclosure for the details.

One of the objects of this invention is to provide yarn of certain characteristics made in accordance with the method of the prior application.

Another object is to provide an improved fabric produced from the treated yarns mentioned above, or from untreated, wrapped or unwrapped synthetic, elastomeric yarn, and further treated to enhance its sheerness, hand, and elastic properties, and increase the yardage.

It is also an object of the invention to provide apparatus for producing the improved yarn and fabric through both batch and continuous processes.

Other objects of the invention will become apparent from the following description of practical embodiments thereof, when taken in conjunction with the drawings which accompany, and form part of, this specification.

In the drawings:

FIGURE 1 is a somewhat diagrammatic front view of apparatus suitable for elongating and covering synthetic elastomeric yarn and winding the covered yarn under tension on a bobbin;

FIGURE 2 is a side view of the apparatus shown in FIGURE 1;

FIGURE 3 is a front view of apparatus similar to that of FIGURES 1 and 2 but suitable for continuous heat stabilization of the yarn;

FIGURE 4 is a side view of the apparatus of FIGURE 3;

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FIGURE 5 shows another apparatus for continuous processing of the yarn;

FIGURE 6 is a top plan view of apparatus for simultaneously extending fabric both longitudinally and transversely;

FIGURE 7 is a side view of the apparatus shown in FIGURE 6;

FIGURE 8 is a plan view of a modified form of fabric stretching and stabilizing apparatus;

FIGURE 9 is a vertical, transverse section through the apparatus of FIGURE 8, taken on the line 9—9 of FIGURE 8;

FIGURE 10 is a perspective view of another form of fabric stretching apparatus;

FIGURE 11 is a top plan view of the structure shown in FIGURE 10;

FIGURE 12 is a top plan view of still another form of fabric stretching mechanism; and

FIGURE 13 is a side view of the apparatus shown in FIGURE 12.

Following the method set out in the above referred to copending application, a synthetic elastomeric yarn, such as that known as spandex, which is understood to be a polyurethane yarn, is elongated, wrapped with a multifilament nylon yarn, and heat set. The elastomeric yarn which forms the core of the composite yarn is preferably in an untwisted condition, and is maintained in this condition throughout the drawing and setting operations. The raw, untreated elastomeric yarn with which this application is concerned will be capable of stretching in the range of approximately 500% to approximately 700%. It has been found that best results are obtained when the core yarn is elongated prior to heat stabilizing within the ratio of 2.5 to 1 and 5 to 1.

The cover yarn preferably is a low denier textured thermoplastic yarn. These yarns impart a soft hand and high coverability at a relatively low number of wraps per inch. It is desirable that the number of wraps per unit length of core yarn be sufficient to cause the strands of wrapping yarn to lay close to the core yarn when the composite yarn is relaxed. It has been found that in most instances, from 10 to 50 turns per inch will be sufficient. If too many wraps per inch are made the composite yarn takes on a certain amount of twist liveliness which is not completely overcome in the stabilizing operation.

The heat stabilization may take place after the tensioned composite yarn is wound on a package, or in a continuous manner prior to winding. In view of the fact that shorter time periods are involved in continuous heat setting processes, higher temperatures will be required. Whereas 180° F. to 220° F. for periods of from one-half to two hours are suitable for batch operations, temperatures of from 200° F. to 700° F. are required for continuous processing.

The following examples are illustrative of yarns produced by the above described process:

Example 1

140 denier Lycra yarn was processed in a manner heretofore described by a drawing ratio of 4 to 1 and a covering of 24 wraps per inch in left hand direction with 20 denier 7 filaments "S" twist torque textured nylon. After processing, the take-up bobbin was steamed at 220° F. for a period of one hour. The resultant yarn performed satisfactorily on a circular knitting machine of the type used in the manufacture of ladies seamless hosiery. A soft pleasing hand was noted in the fabric. The composite yarn was found to have a relaxed denier of approximately 110. The Lycra core yarn, which was

originally 140 denier, was found to be approximately 80 denier. The composite yarn has a stretch of 170%.

Example II

70 denier Lycra yarn was drawn at a ratio of 3.9 to 1 while being covered with 40 wraps per inch in a left hand direction. The wrap yarn was 15 denier, 3 filaments "S" twist torque textured nylon. After processing, the take-up bobbin was steamed at 220° F. for one hour. The resultant composite yarn had a denier of approximately 65. The Lycra core yarn had a denier of approximately 40. The composite yarn had a stretch of approximately 175%.

The resultant composite yarn may be used for knitting various articles, such as girdles, underwear, hose, etc., or knitted or woven into tubular form, flat goods, etc. and it has been found that the resulting garments, or piece goods, may be further enhanced and the yardage greatly increased by a subsequent treatment of stretching and heat stabilizing.

With a fabric, whether piece goods, tubular or formed into a shaped garment, such as hose, there is generally both longitudinal and transverse extension and stabilization while the fabric is extended. If the fabric is stretched equally in both directions, the basic structural pattern will be unchanged, except that it will be more open, but the fabric will be more sheer and have a much softer hand.

The amount of stretch which can be given a fabric, within practical limits, is from 30% to 250%. The degree to which the fabric can be stretched and the amount of stretch which will be retained after heat setting, will depend to some extent on how the fabric is made. The type of yarn, stitch size of knit goods, amount of tension on the yarn, and possibly other factors will have a bearing on the amount of stretch to be given a particular fabric.

An illustrative but non-limiting example of fabric and its treatment concerns a tricot fabric made from yarn processed as above described. The yarn was made from a 70 denier spandex core drawn with a 4 to 1 ratio, and wrapped in a "Z" direction, forty turns per inch with 15 denier, 3 filament, "S" torque textured nylon yarn and stabilized with steam for two hours at 210° F. The wrapped and stabilized yarn had a stretch of 175%. This yarn was knit on a tricot machine, and the fabric was stretched and stabilized with steam at 270° F. for 30 minutes. The following results were noted:

	Length, inches	Width, inches	Stretch Length- wise, percent	Stretch Width- wise, percent
Original dimensions.....	18	4	133	125
Stretched dimensions (on cylinder).....	27	7	-----	-----
Dimensions after stabilizing....	24¼	6	42	50

The resulting fabric was of much finer quality than before treatment, it was sheerer, softer, and, although freely stretchable, had less retractive pull. The fabric had increased in size and quality.

Other types of fabric similarly treated showed equally good results.

Several types of apparatus for treating the yarn and the fabric as described have been designed and these are shown on the accompanying drawings.

Referring first to FIGURES 1 and 2, there is shown a supply bobbin 1, for spandex yarn 2, which is drawn by face contact at a constant rate of speed by drive roller 3. The yarn is fed from bobbin 2 over a guide roll 4 and through a hollow spindle 5, driven by a belt 6.

Spindle 5 carries a supply bobbin 7 for wrapping yarn 8. Bobbin 7 is rotated in such manner than it will cause the yarn 8 to wrap on and around the spandex yarn as it travels upward from the spindle 5. The spandex yarn wrapped with the yarn 8 produces a composite yarn 9

which passes through a traverse guide 10 and onto a take-up bobbin 11. The take-up bobbin is driven at a constant rate of speed by a take-up drive roll 12.

The speed of the drive roll 3 is lower than that of take-up drive roll 12 so as to draw out the spandex yarn to increase its yardage and reduce its diameter. The relative speeds of the two drive rolls are determined by the percentage of elongation desired in the spandex yarn. As indicated above, an elongation ratio of 4 to 1 has been found practical and desirable, but other ratios can be used and the relative drive roller speeds will be set accordingly.

When using apparatus as shown in FIGURES 1 and 2, the composite yarn 9 will be wound on bobbin 11 under tension, and the wound package still held under tension will be placed in a suitable steam cabinet and heat stabilized.

In FIGURES 3 and 4, a modified apparatus is shown for continuously drawing, wrapping and stabilizing the yarn. In this case, spandex yarn 13 is fed from bobbin 14 at a constant rate by drive roll 15. The yarn passes over guide roll 16, through hollow spindle 17 and toward a lower, fixed, pigtail guide 18. Spindle 17 carries wrap yarn bobbin 19 and wrap yarn 20 is caused to wrap about yarn 13 between the end of spindle 17 and pigtail guide 18. Thus, the pigtail serves to ensure completion of the wrapping operation beneath the pigtail and as an aligning guide to hold the spandex yarn centered within the spindle. From pigtail 18, composite yarn 21 is drawn over the face of a heater block 22. The block may be any means for transferring a controlled and adequate amount of the heat to the yarn to stabilize it. The drawing shows a diagrammatic representation of a thermostatically controlled electric resistance heater, with the temperature being regulated by a thermostat 23. The yarn then goes through an upper pigtail guide 24 in vertical alignment with lower pigtail guide 18, through traverse guide 25 and onto a take-up bobbin 26 driven by drive roll 27. It will be noted that the heater block is positioned so that its operative face is offset from the vertical center line of the guides 18 and 24 so that the composite yarn is held in intimate contact with the face of the block. In this structure, as in that previously described, the relative speeds of the supply bobbin 14 and take-up bobbin 26 determine the percentage of elongation of the spandex yarn.

FIGURE 5 shows a modification of the structure shown in FIGURES 3 and 4, wherein a heater tube 28 is substituted for the heating block. The tube is hollow, and may be wrapped with a resistance wire 29 which may be encased in glass. The composite yarn 30, formed of spandex yarn 31 from supply bobbin 32 and wrap yarn 33 from bobbin 34 passes through guide 35, tube 28, and guide 36, and is wound on bobbin 37. Here, again, the differential in speed between the spandex supply bobbin and the take-up bobbin is used to produce elongation in the elastomeric yarn. The composite yarn is stabilized as it passes through the heater tube.

Good results have been obtained with this apparatus with yarn of light or heavy denier. The tube may be stainless steel, of considerable length, say 24 inches, and of small inside diameter of the order of ¼ of an inch. Temperatures of from 200° F. to 700° F. are suitable, but some difficulty may be encountered at the higher temperatures during thread-up due to the tendency of the yarn to melt.

It will be obvious that in either that form of the invention shown in FIGURES 3 and 4, or other form shown in FIGURE 5, the heater may be positioned below the wrapping point so that the elastomeric yarn will be stabilized prior to wrapping. With both types of apparatus bare spandex yarns may be processed by eliminating the wrap yarn supply.

When it is desired to increase the size of a fabric in accordance with the method previously described, longitudinal stretch can be obtained in the same manner as is

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used for elongating yarn filaments, that is, by different speeds of supply and wind-up. A different problem arises, however, when it becomes necessary to provide widthwise stretch simultaneously with longitudinal stretch. Several mechanisms have been devised for accomplishing this.

In FIGURES 6 and 7 one form of apparatus for providing both longitudinal and widthwise stretch is shown. The fabric 38 to be processed is delivered from a supply beam 39 which is rotated by means of contact drive roller 40. The fabric is taken up on a take-up beam 41 driven by drive roller 42. The speed differential between drive roller 40 and drive roller 42 is set to give the desired longitudinal stretch.

Intermediate the supply and take-up beams there is a plurality of rollers 43, 44 and 45, extending transversely to the direction of fabric travel. The rollers are located substantially in the horizontal plane of the supply and take-up beams, and the fabric follows an undulating path travelling over the roller 43, under the roller 44 and over roller 45. This ensures ample surface contact between the rollers and fabric to permit the rollers to exert a positive force on the fabric. The rollers are tapered from their centers to their ends so that the fabric will be forced to spread widthwise. By rotating the rollers 43, 44 and 45 at surface speeds faster than the linear speed of the fabric, the spreading action will be increased.

Each tapered roller is hollow and has a resistance wire 46 wound inside to heat the roller, so that the roller surface can transfer heat to the fabric and set it in its stretched condition. The rollers may have collection rings 47 at one end to which the wires are connected.

With the above-described arrangement, the fabric will be stretched longitudinally due to beam speed differential, and transversely in steps by the tapered rollers. The fabric is set by each roller, and this will cause the fabric to spread to a greater extent at each roller as the heat setting at the previous roller has reduced the tendency of the fabric to contract. The fact that the rotational speed of the tapered rollers exceeds the forward travel of the fabric assures maximum heat transference to the fabric.

A modification of the continuous fabric stretching apparatus just described is shown in FIGURES 8 and 9. In this form of the apparatus, the supply and take-up beams 48 and 49 are driven by contact drive roller 50 and 51, respectively. The take-up is faster than the supply feed to provide desired longitudinal elongation. Between the two beams there is a plate 52 which has a transversely convex upper surface 53. The surface area increases progressively with the distance from the supply beam. In other words, the plate edges diverge from the end adjacent the supply beam. Resistance wire 54 is arranged beneath the plate to heat it.

When the fabric is drawn from the supply beam across the plate, the longitudinal pull on the fabric by the take-up roll will pull the fabric tight over the convex plate surface causing it to spread. The heated surface will set the fabric in the stretched condition.

If desired, the take-up beam may be equipped with rows of pins 55 adjacent its ends to engage and hold the fabric side edges. If this is done, the same equipment may be used for continuous or batch setting. If continuous setting is desired, the heating system for the plate is operated. If a batch system is to be used, the plate will be left cold, but the fabric will be held transversely extended by the pins 55 until the beam is filled and the fabric is set.

A different stretching apparatus has been shown in FIGURES 10 and 11. Here, the fabric 56 is delivered from a supply beam 57 driven by roller 58 and wound upon a take-up beam 59 driven by roller 60. The take-up drive roller, of course, will rotate at a faster rate than drive roller 58 so as to elongate the fabric. Intermediate the supply and take-up beams there is a plurality of rollers 61. Each roller 61 is of different length, the

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rollers being arranged in a progressively lengthening sequence, with the shortest roller adjacent the supply beam and the longest adjacent the take-up beam. Each roller has a peripheral row of pins 62 at each end.

The fabric is stretched transversely intermediate the supply beam and the adjacent roller 61, and between each two adjacent rollers 61 to provide a plurality of stages of transverse stretch. The transverse stretch is accomplished by means of spiked conical rollers 63 which are located above the fabric path so that their spikes 64 engage the selvages of the fabric at the width it leaves the supply beam, or preceding roller 61, as the case may be. The conical rollers 63 are arranged so they rotate generally at right angles to the path of travel of the fabric with cones at opposite selvages of the fabric rotating in opposite directions. The cones may be driven by belts 65 from a convenient drive shaft (not shown).

With the apparatus shown in FIGURES 10 and 11 the fabric leaving the supply beam 57 is caught by the first set of cone rollers, and, as the lower surfaces of the cones are moving outwardly relative to the fabric, the fabric will be stretched widthwise. The speed of the cones will be set to stretch the fabric sufficiently to bring the selvages out to the vertical plane of the rows of pins on the next adjacent roller 61. This same operation will take place at each cone and roller combination to extend the fabric widthwise in a series of successive steps. When the fabric is extended to its full width at the last roller 61, it passes onto the take-up beam 59 where the edges are caught on pins 66 carried at the ends of the beam. Thus, the fabric will be held extended on the beam and the filled beam can be subjected to heat to stabilize the fabric.

A still further type of apparatus suitable for extending fabric both longitudinally and transversely is illustrated in FIGURES 12 and 13. In this form, the apparatus includes a supply beam 67 driven by drive roller 68 and a take-up beam 69 driven by drive roller 70. Fabric 71 is elongated in passing from the supply beam to the take-up beam by the speed differential between the two beams. The transverse stretch is accomplished by means of chains 72 and 73 which follow diverging paths from the outer edges of the supply beam to the outer edges of the longer take-up beam. The chains carry pins 74 and 75 to engage the fabric selvages and progressively extend the fabric as the fabric moves from the supply beam to the take-up beam. The chains are trained over sprockets 76 and 77 on shafts 78 and 79 and move in vertical orbits. With this form of apparatus also, the take-up beam has rows of pins 80 on its ends to hold the fabric under tension until it can be heat set.

While in the above several embodiments of the invention have been disclosed, it will be understood that the details of construction shown and described are merely by way of example and the invention may take other forms within the scope of the appended claims.

What is claimed is:

1. A stabilized spandex yarn with properties of reduced denier, increased yardage and reduced stretch over the spandex yarn from which it was formed, said properties having been obtained by stretching the yarn in the range of 250% to 500% and stabilizing in stretched condition by heat in the range of 180° F. to 700° F.

2. A spandex yarn as claimed in claim 1, wherein the spandex yarn is a core yarn and is wrapped with a multifilament nylon cover yarn with 10 to 50 turns of cover yarn per inch of core yarn.

3. A stabilized fabric composed at least in part of spandex yarns, the fabric having properties of reduced yarn denier, increased yardage and reduced stretch over the fabric from which it was formed, said properties having been obtained by stretching a fabric longitudinally and transversely in the range of 30% to 250% and stabilizing the fabric in stretched condition by heat from 180° F. to 700° F.

4. A fabric as claimed in claim 3, wherein the spandex yarns are core yarns and are wrapped with multifilament nylon cover yarns with 10 to 50 turns of cover yarn per inch of core yarn.

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