July 5, 1955 J. K. PHILLIPS 2,712,170

TREATMENT OF TEXTILE FABRICS

Filed Sept. 6, 1952

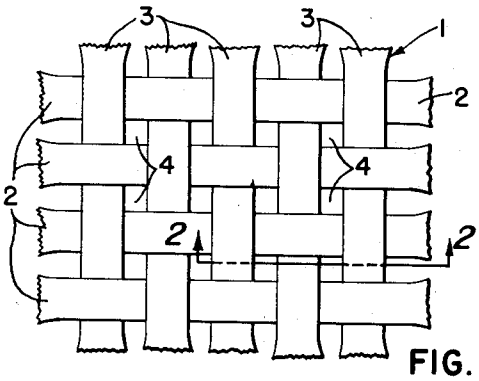

FIG. 1

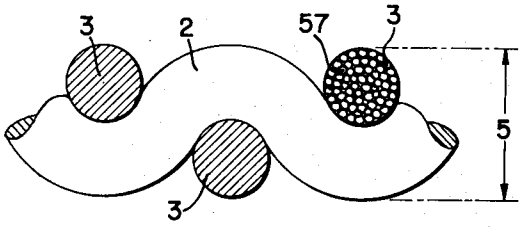

FIG. 2

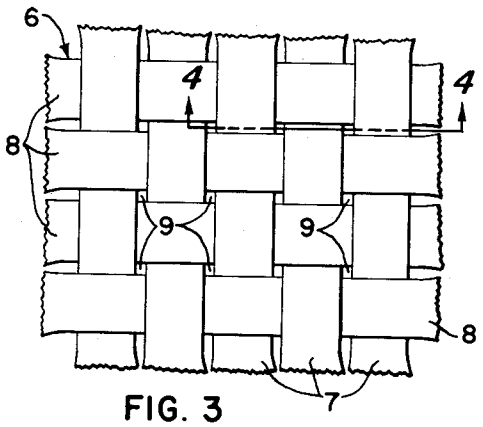

FIG. 3

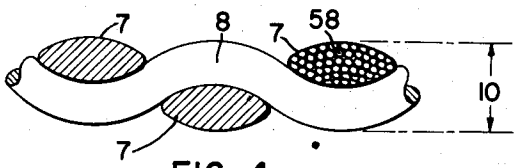

FIG. 4

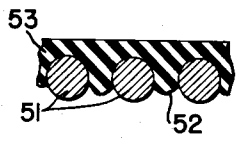

FIG. 6

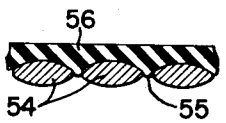

FIG. 7

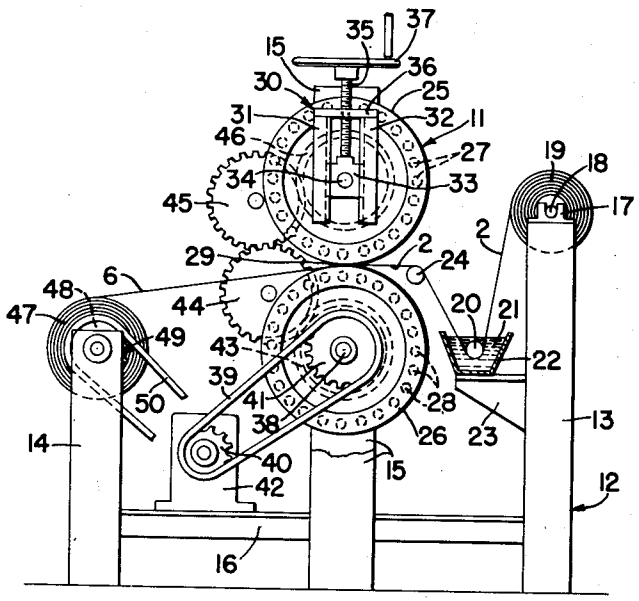

FIG. 5

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TREATMENT OF TEXTILE FABRICS

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10 Claims. (Cl. 26—1)

The present invention relates to a novel method of treatment for textile fabrics. More particularly the invention pertains to a process for treating a textile fabric to reduce the fabric gauge and to lower its porosity by spreading the component yarns forming the fabric to ribbons.

The process of the present invention differs from and is not to be confused with an ironing or pressing operation which has for its primary object the smoothing or flattening of the material to remove wrinkles or other similar forms of surface irregularities. In the conventional ironing or pressing operations the fabric is usually subjected to heat while somewhat damp as a result of the moisture absorbed in the fibers or filaments comprising the yarns of which the fabric is woven and supported in contact with a comparatively flexible or padded surface to prevent crushing of the fabric. Moreover, the fabric is ordinarily subjected to pressure or at least the weight of that element of the apparatus embodying the heating surface during the ironing or pressing operation in order to insure a uniformly smooth surface on the treated fabric.

The process of the present invention unlike the aforementioned ironing or pressing operation actually effects changes internally of the fabric structure, principally in the physical characteristics of the yarns which form the fabric. This process, which is hereinafter generally referred to as "steam blasting" of fabric, contemplates the substantially instantaneous application of heat at relatively high temperatures to a wet fabric while it is being confined or restrained in its cross-sectional dimension.

In the steam blasting of fabric, according to the present invention, the liquid contained in the fabric is instantaneously converted into vapor by the heat applied to the fabric. Since the fabric is restrained on both surfaces thereof, the expansive force of the vapor thus generated internally of the fabric is concentrated in the longitudinal and transverse dimensions of the fabric. This force which is in the nature of an explosion in each of the yarns causes the fibers or filaments thereof to spread and close the weave. This spreading of the fibers or the filaments of the yarn and closing the interstices in the weave reduces the gauge and porosity of the finished fabric.

In the steam blasting of fabric, it is desirable that the opposed confining surfaces applied to both sides of the fabric be heated and rigid so as to insure that the quick volatilization of the liquid in the individual yarns of the fabric will produce internal forces in the yarns such that they will spread and become flattened. The opposed confining surfaces must also be capable of being adjustably positioned to a predetermined spacing.

It will be readily understood that the steam blasting process of the present invention may be applied equally advantageously to a variety of different types of fabric construction or weave such, for example, as twill, sateen, plain, basket or the like as well as to a combination of different constructions. Moreover, the process of the present invention is not to be limited to fabrics made from

any one class of yarns whether they be of natural or synthetic origin. The process is especially well adapted to be employed with fabrics comprising yarns which are readily wetted with liquids, in particular those liquids which volatilize readily upon application of heat.

The steam blasting process is applicable broadly to fabrics formed of multiple filament or fibrous yarns as opposed to the monofils and to the use of any type of liquids which will satisfactorily wet the yarn. Wetting of the yarn contemplates the complete permeation of the yarns by the liquid. Obviously, the selection of the liquid for application to the fabric to be treated should be such that the yarns composing the fabric will not be dissolved or otherwise deleteriously affected thereby. With the exception of these prerequisites any form of fabric and any class of liquid may be used.

It will be understood that the physico-chemical characteristics of the yarns comprising the fabric will necessarily determine not only the selection of the liquid to be used in wetting the yarn but also in the determination of temperatures to be used in the heating operation. Fabrics composed of certain yarns of thermoplastic materials, the acetates, the polyamides (nylons), the polyesters and the like must not be subjected to excessive heat since this would tend to soften or melt the filaments. Thus, a liquid having a relatively low volatility may be required to wet the yarns to guard against defects in the finished fabric.

With fabrics formed of yarns of cellulosic origin, water alone has been found to be a satisfactory liquid since it is generally readily available in quantity, economical to use and creates no particular problem in connection with the venting of the gas or vapor formed as a by-product of the process. In the event that satisfactory penetration of the water into the yarn is not achieved with water alone, water solutions of various types including pretreating materials, wetting and softening agents, emulsions, detergents, and the like can be employed to advantage.

It is one of the principal objects of the present invention to provide a process of treating woven textile fabrics to materially reduce the porosity of the fabric.

Another important object of the invention is to provide a method of treatment of fabric which will modify the internal structure of the individual yarns comprising the fabric so as to result in a reduction in the gauge of the fabric.

It is another object of the present invention to produce a steam blasted woven textile fabric which will require, by reason of its reduced porosity, a much smaller quantity of coating compound to render it impervious to gases, vapors and liquids than would be required by the same fabric which has not been steam blasted.

Other important objects and advantages of the present invention will become apparent as the detailed description of the accompanying sheet of drawings which illustrates certain of the features thereof proceeds.

Fig. 1 of the drawings represents a plan view of a partial segment of fabric of plain weave design before being treated in accordance with the teachings of the present invention. Fig. 2 is an enlarged cross-sectional view taken substantially along the line 2—2 in Fig. 1. Fig. 3 is a plan view corresponding generally to Fig. 1 illustrating the same segment of fabric shown in Fig. 1 after having been subjected to treatment in accordance with the present invention. Fig. 4 is a cross-sectional view taken substantially along the line 4—4 in Fig. 3. Fig. 5 is a diagrammatic representation of one form of apparatus which may be employed to perform the process of the present invention. Figs. 6 and 7 correspond generally to Figs. 2 and 4 and illustrate graphically one of the advantages of the processes of the present invention.

In Fig. 1 of the drawing, a partial segment of untreated plain weave fabric with which the teachings of the present invention are advantageously employed is identified generally by the reference character **1**. The fabric segment **1** is constructed from the yarns **2** and **3** comprising the warp and fill, respectively.

It will be apparent from Fig. 2 that the yarns **2** and **3** are substantially circular in cross section. This cross-sectional configuration of the yarns **2** and **3**, although slightly exaggerated in Fig. 2, clearly demonstrates the limitation which this factor places on the ability to construct a fabric of closed or relatively non-porous character. As a result, the fabric **1** has a large number of large openings or interstices **4** formed between the warp and fill yarns **2** and **3**.

In addition to the open character of the weave in the fabric **1**, the relationship of the yarns **2** and **3** produces a fabric **1** of considerable thickness or gauge as indicated by the dimension **5** in Fig. 2. Among other things, it is an object of the present invention to reduce materially the dimension **5** and the size of the interstices **4** of the fabric **1**.

The fabric segment **6** shown in Fig. 3 illustrates very well the beneficial effects produced by the practice of the present invention on all forms of fabric. In the fabric **6**, the individual warp and fill yarns **7** and **8** have undergone a distinct change in cross-sectional shape from a generally circular to a substantially elliptical cross section. This is accomplished by dispersing the filaments composing the yarns **2** and **3** through use of explosive forces in the yarns into a relationship such that the shape of the yarns **7** and **8** will be more nearly that of a flat ribbon.

The resultant fabric **6** will be much less porous and the interstices, which were previously of the size of the openings **4** in the weave, will thereafter be materially reduced to a size comparable to those identified by the reference character **9** in Fig. 3. At the same time, due to the rearrangement or dispersal of the individual filaments forming the yarns **7** and **8**, the resultant gauge **10** of the treated fabric **6** is reduced to the extent indicated in Fig. 4.

The process of the present invention may be carried out by several different forms of apparatus only one form of which is illustrated in Fig. 5 of the drawing. This machine or steam blasting apparatus which is identified generally by the reference character **11** is in the nature of a conventional calendering apparatus. It differs principally therefrom in that it is designed so that the heating elements thereof will merely constrain the fabric while it is being treated.

The steam blasting apparatus **11** embodies a frame **12** comprising the pairs of vertical members **13**, **14** and **15** and cross members **16**. At the uppermost end of the vertical members **13** are bearings **17** supporting a roll **18** having a supply **19** of untreated fabric **2** thereon. The fabric **2** is directed from the supply **19** under a suitably mounted roller **20** submerged in a body of liquid **21** contained in a tank **22** supported by means of a bracket **23** upon the pair of vertical members **13** of the frame **12**. The liquid **21** may be heated if desired.

The untreated fabric **2**, now thoroughly wet, is passed over a convenient guide roller **24** which may be freely rotatably mounted in any suitable fashion from the frame **12** and thence between the heated cylinders or drums **25** and **26**. The drums **25** and **26** are heated by any suitable medium such, for example, as high pressure steam circulated through the tubes **27** and **28** therein. Any desired form of thermostatic control (not shown) may be employed to maintain the temperature of the drums within certain predetermined limits and to prevent any marked fluctuation in the drum temperatures.

As explained above in some detail, it is essential that one of the drums **25** and **26** be adjustably mounted to insure a predetermined degree of constraint upon the wet fabric **2** as it passes therebetween. Thus, the gap **29** between the drums **25** and **26** must be capable of adjustment within carefully controlled predetermined limits. This is accomplished by providing an adjustable mounting means **30** for the top drum **25** on the pair of vertical members **15** of the frame **12**.

The adjustable mounting means **30** comprises a pair of guides **31** and **32** suitably mounted on each of the vertical members **15** to support the floating bearing block **33** carrying one end of the shaft **34** of the drum **25**. The position of the bearing block **33** in the guides **31**, **32** is determined by the screw **35** threaded through the plate **36**. A hand wheel **37** is provided to adjust the screw **35**. The shaft **38** of the drum **26** is mounted in fixed bearings (not shown) supported by each of the vertical members **15**.

The drums **25** and **26** are arranged to be driven by a chain **39** and sprockets **40**, **41** from a suitable change speed drive unit **42**. The positive drive of the drums **25** and **26** is assured by the provision of the gear-train embodying gears **43**, **44**, **45** and **46**. This drive arrangement insures a predetermined speed of travel of the untreated fabric **2** through the gap **29** between the drums **25** and **26** and the treated fabric **6** into the windup package **47** on the roll **48** supported on the vertical members **14** of the frame **12**.

The roll **48** is adapted to be rotated by the sprocket **49** and chain **50** from the drive unit **42** in properly timed relation to the delivery of the treated fabric **6** from the gap **29**. It will be apparent that, as the package **47** on the roll **48** builds up, it is desirable to have the wind-up speed reduced uniformly to insure that minimum tension is introduced in the fabric. The treated fabric **6** comprising the package **47** is now ready for any desired subsequent treatment or for any other use to which it is to be subjected.

One of the distinct advantages which is readily apparent as a direct result of the steam blasting treatment is illustrated in Figs. 6 and 7. In Fig. 6, the untreated fabric, which is composed of the yarns **51**, has a multiplicity of interstices **52** and, when the fabric is subjected to a coating **53** of rubber or other suitable material to render the fabric gas-impervious, it is apparent that a very appreciable quantity of the compound is required to fill the voids created by the interstices **52**. By comparison, the steam blasted fabric shown in Fig. 7 is characterized by the ribbon-like yarns **54** which are closely spaced and the smaller interstices **55** therebetween are capable of being closed by a smaller quantity of the coating compound **56**.

The direct result of the steam blasting of fabrics is that a much more dense fabric is produced having a lower gauge. This treated fabric, when coated or subsequently processed, exhibits a much more satisfactory finished product in that a smaller quantity of coating compound will be required to produce the desired result.

As previously indicated herein, the steam blasting process effects changes internally of the fabric itself. The liquid with which the fabric is saturated penetrates into the voids between the several fibers or filaments comprising the yarns which are fabricated into the fabric. When the heat is applied instantaneously, the liquid is volatilized and the sudden creation of vapor, when it is prevented from escaping except in the lateral or longitudinal dimension of the fabric itself, exerts a force which tends to rearrange the fibers or filaments of the yarns causing them to spread out in the manner graphically shown in Figs. 2 and 4 of the drawing with the results hereinbefore described.

Thus, the fibers or filaments **57** shown in the yarn **3** in Fig. 2 are spread apart and rearranged to the positions identified by the reference numeral **58** in the yarn **7** as shown in Fig. 4. This redisposition of the fibers or filaments in the yarns comprising the fabric is brought about by what corresponds to an explosive action of the liquid as it is changed into vapor form. Since, due to the re-

strictive action of the rigid surfaces disposed above and below the fabric, the explosive action is confined to the plane of the fabric, the filaments can only move in that direction, hence the flattening effect.

It should be understood that since the procedure can be employed with fabrics embodying natural or synthetic yarns composed of staple fibers such as cotton, cut rayon and the like, it is desirable to employ the term "fibers" when referring to staple fiber yarns and the term "filaments" when referring to the synthetic type materials embodying extremely long or substantially continuous length elements. Thus, it is intended that wherever the terms "filament" or "filaments" are used herein, the process applies with equal advantage to fabrics made up of certain types of staple fiber yarns.

The degree of porosity and gauge reduction is dependent upon the ratio of yarn diameter in the fabric to adjacent void spaces which may be closed by the steam blasting of the yarn. Fabric porosity has been reduced by this process as much as 80%. In some cases, the gauge of steam blasted fabric has been reduced as much as 60%. These results are borne out by the following examples:

Example 1

A sample of 2 x 2, 4.5 ounces per square yard, basket weave Fortisan (a saponified acetate rayon) fabric constructed of cabled yarn, was thoroughly soaked in water. The wet fabric sample was passed through a pair of heated rolls in which the spacing of the rolls was preset to a predetermined gauge and the roll temperature maintained at 350° Fahrenheit. A control sample of the material was run through the same rolls.

When the control and steam blasted samples were compared with a sample of the same fabric in its original state, it was found that where the air porosity of the original untreated fabric was 56.3 cubic feet per minute per square foot, the control sample was 13.6 cubic feet per minute per square foot and the steam blasted sample was 1.3 cubic feet per minute per square foot. This porosity test was carried out in accordance with the procedure outlined in the National Bureau of Standards Research Paper RP 1471 as part of the Journal of Research of the National Bureau of Standards, vol. 28, May 1942. The gauge values, in the same order of reference, were .0090, .0080 and .0050 inch.

Example 2

Samples of 2 x 2, 3.5 ounces per square yard, basket weave Fortisan fabric were tested under the same conditions as those employed in Example 1. Here, however, the effect of steam blasting upon fabrics which had been treated to improve their flex resistance characteristics was investigated. Fabrics specially treated to enhance their flex resistance exhibit a higher porosity and increased gauge than the original untreated fabric of the same construction.

A sample of fabric which had been specially treated to enhance its flex resistance was substituted for the control sample employed in Example 1. The original untreated fabric had an air porosity of 30.2 cubic feet per minute per square foot. The control sample having improved flex resistance had an air porosity of 273.6 cubic feet per minute per square foot while the sample having improved flex resistance when steam blasted exhibited an improved air porosity of 51.8 cubic feet per minute per square foot. The gauge of the samples in the order of reference mentioned above was .0075, .0120 and .0050 inch respectively.

Example 3

Similar steam blasting tests were made on a plain weave fabric of essentially no twist rayon. The air porosity rate for the untreated control sample was 189.0 cubic feet per minute per square foot and the steam blasted sample was 56.7 cubic feet per minute per square foot. The gauge was reduced by the steam blasting treatment from .0120 to .0070. It is interesting to note also that the initial tensile strength of the untreated fabric was 501 pounds in the warp and 450 pounds in the fill. After steam blasting, the tensile strength of the same fabric was 545 pounds in the warp and 479 pounds in the fill.

Example 4

A sample of 5 x 5, 5.5 ounces per square yard, basket weave cotton fabric was found to have an air porosity rate of 116 cubic feet per minute per square foot and a gauge of .0160 inch. A steam blasted sample of the same fabric had an air porosity rate of 35.6 cubic feet per minute per square foot and a gauge of .0110 inch.

A sample of each of the cotton fabrics employed in Example 4 was coated with neoprene in accordance with standard spreading practices for the purpose of determining the amount of coating compound required to produce a fabric having a good hydrogen diffusion rate such, for example, as that required by the type of fabric employed in standard airship designs.

It was found that, in order to produce a fabric having the desired attributes, it was necessary to spread approximately 9.8 ounces per square yard of coating compound on the fabric which had not been subjected to steam blasting. In order to produce the same result with steam blasted fabric of the same construction, approximately 7.6 ounces per square yard of coating compound were required. This represents a reduction of 2.2 ounces per square yard in the amount of coating required or a saving of more than 22% in the amount of coating compound as a direct result of the steam blasting of the fabric.

The time-temperature relationship for the steam blasting process will vary considerably with the type of fabric being steam blasted and the liquid content of the fabric, but the following examples will serve generally to define what is meant by the term "instantaneously" when employed herein to indicate the rate at which the liquid is converted to vapor.

With the cotton fabric such as that used in Example 4, when 8 inch diameter rolls were employed heated to a temperature of 350° Fahrenheit, highly satisfactory steam blasting of the fabric was produced with the fabric traveling at a speed of 1.5 feet per minute through the rolls. With fabrics embodying synthetic cellulosic yarns of the type employed in Examples 1 and 2 under the same conditions, the speed of the fabric through the rolls was increased to 3.5 feet per minute. It is obvious that much higher temperatures may be employed to advantage with a corresponding reduction in time of exposure of the fabric.

It should be explained also that the expression "plane of the fabric" as employed herein is intended to mean that area defined by the lateral and longitudinal dimensions of the fabric.

While certain representative embodiments and details have been shown for the purpose of illustrating the invention, it will be apparent to those skilled in this art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

I claim:

1. In the treatment of fabric having a multiplicity of interstices in the weave, the process of steam blasting the fabric to reduce the gauge and lower the porosity thereof which comprises the steps of saturating the yarns of which the fabric is formed with a liquid which volatilizes at a temperature lower than that at which a deleterious effect is produced upon the yarns themselves, whereby the liquid is dispersed between the component filaments of each of the yarns in the fabric in order to saturate the same; passing the saturated fabric between confining structures which are spaced apart to a predetermined gauge and which are heated to a temperature in excess of the boiling point of the liquid saturant,

whereby the liquid in the individual yarns of the fabric is volatilized substantially instantaneously; and constraining the fabric between said spaced-apart confining structures in a direction normal to the plane of the fabric concomitantly with the heating step, whereby the volatilization of the liquid in the yarns exerts a vapor pressure within the yarns of the fabric which spreads the filaments in the yarns causing them to substantially fill the interstices in the weave of the fabric.

2. The process according to claim 1 in which the liquid employed in saturating the yarns is water.

3. The process according to claim 1 in which the liquid employed in saturating the yarns is a solution in which water is one of the constituents.

4. The process according to claim 1 in which the fabric is subjected to heat at a temperature approximately 138° Fahrenheit in excess of the boiling point of the liquid with which the yarns are saturated.

5. The process according to claim 1 in which the fabric is subjected to heat at a temperature approximately 275° Fahrenheit in excess of the boiling point of the liquid with which the yarns are saturated.

6. The process according to claim 1 in which the fabric is subjected to heat at a temperature within the range of from about 350° to 450° Fahrenheit.

7. The process according to claim 1 in which the fabric to be treated is composed of yarns which are characterized by substantially no twist.

8. In the treatment of fabric having a multiplicity of interstices in the weave, the process of steam blasting the fabric to reduce the gauge and lower the porosity thereof which comprises the steps of applying water to the fabric, whereby the water is dispersed between the several component filaments of each yarn in the fabric in order to saturate the same; passing the saturated fabric at the rate of from about 1.5 to 3.5 feet per minute between rolls which are spaced apart to a predetermined gauge, said rolls being heated to a temperature in the range of about 350°–450° Fahrenheit, whereby the water dispersed in the yarns of the fabric is converted into steam; and preventing the escape from the fabric of the steam so formed in any direction other than that corresponding to the lateral and longitudinal dimensions of the fabric, whereby the vapor pressure exerted by the steam within the yarns rearrange the individual filaments of the yarns thereby causing them to flatten and thereby causing them to substantially fill the interstices in the weave of the fabric.

9. The process of treating fabric having a multiplicity of interstices in the weave comprising the steps of (1) substantially completely saturating the yarns which comprise the fabric with a nonviscous liquid which has a boiling point lower than the softening point of the filaments which comprise the yarns and (2) passing said fabric between heated spaced apart cylindrical rolls, at least one of said heated cylinder rolls being constructed with a conductive metal surface, said rolls being adjusted to a predetermined opening which is substantially less than the original gauge of the fabric to be passed therebetween and adapted to readily heat the saturated fabric to a temperature sufficient to instantaneously volatilize the liquid fabric saturant so that the instantaneous conversion of the liquid to a vapor creates a vapor pressure within the yarns of said fabric which is confined by said rolls to the longitudinal and transverse dimensions of said fabric in order that the yarns which comprise the fabric will be expanded and flattened by said pressure to provide a reduction in the gauge of the fabric equivalent to the predetermined opening between the rolls and a substantial closing of the interstices of the fabric.

10. The process of treating fabric having a multiplicity of interstices in the weave comprising the steps of (1) substantially completely saturating the yarns which comprise the fabric with a nonviscous liquid which has a boiling point lower than the softening point of the filaments which comprise the yarns and (2) passing said fabric between heated spaced apart cylindrical rolls, at least one of said heated cylinder rolls being constructed with a conductive metal surface, said rolls being adjusted to a predetermined opening which is substantially less than the original gauge of the fabric to be passed therebetween and adapted to readily heat the saturated fabric to a temperature sufficient to instantaneously volatilize the liquid fabric saturant so that the instantaneous conversion of the liquid to a vapor creates a vapor pressure within the yarns of said fabric which is confined by said rolls to the longitudinal and transverse dimensions of said fabric in order that the yarns which comprise the fabric will be expanded and flattened by said pressure to provide a reduction in the gauge of the fabric of from 60 to 80% of the original gauge and a substantial closing of the interstices of the fabric.

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