

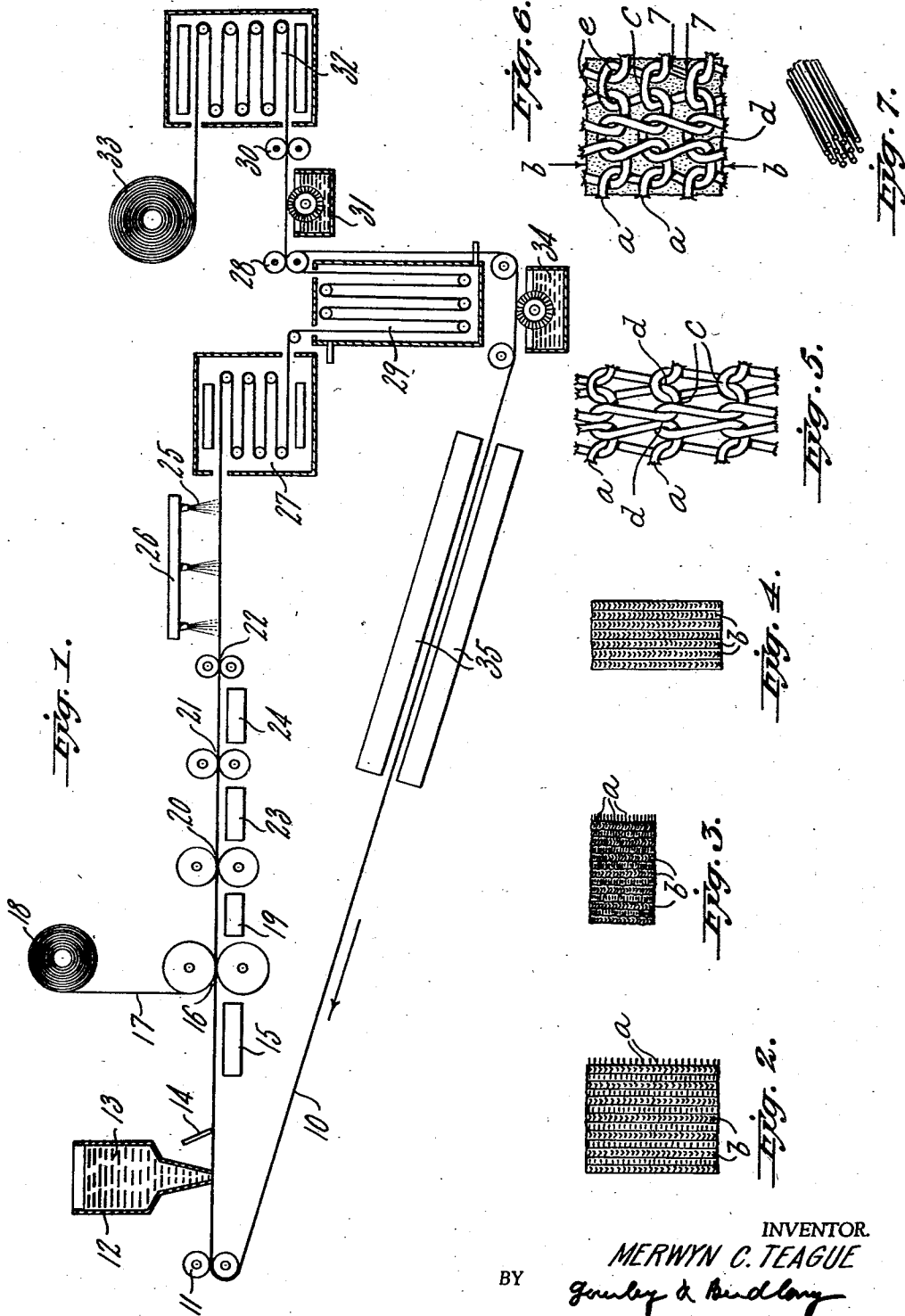
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METHOD OF MAKING ELASTIC FABRIC

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METHOD OF MAKING ELASTIC FABRIC

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9 Claims. (Cl. 154—2)

Elastic fabrics have previously been made by incorporating in the fabric during the weaving or knitting or other manufacturing operation rubber threads which may be bare or covered with textile yarns. Other types of elastic fabrics have been produced from stretchable textile fabrics by calendering sheet rubber onto a surface of the fabric, or by sandwiching sheet rubber between plies of the fabric, or by treating the fabric surface with a rubber-containing fluid, such as solvent rubber cement or an aqueous rubber dispersion, such as latex, as by a spreading or spraying operation, drying the rubber-containing fluid, and plying the coated fabric surfaces together, if desired. Where the textile fabric is capable of stretching, as is generally the case with knitted fabrics, the rubber imparts to the fabric the desired quick recovery from the stretched condition and a capacity to retract to its original condition after stretching, making the fabric an elastic fabric, but with no greater and generally not as great, ultimate elongation in any direction than was originally present in the textile fabric before treatment.

By the present invention, an elastic fabric may be produced having increased capacity to stretch in one or more directions without diminishing the capacity of the fabric to stretch in any other direction. Textile fabrics may be made elastic and have imparted thereto a capacity or an increased capacity to stretch crosswise or lengthwise or in both directions without lessening the capacity to stretch in any other direction. Knitted fabrics having a crosswise or widthwise stretch may be made into elastic fabrics having an increased crosswise stretch without diminishing the amount of stretch, if any, in a lengthwise direction, or may be made into elastic fabrics having a lengthwise stretch or an increased lengthwise stretch without diminishing the amount of stretch or ultimate elongation crosswise of the fabric. Knitted and loosely woven fabrics and net materials composed entirely of textile threads or yarns and which may contain bare or covered rubber threads, may be treated according to the present invention. Such fabrics are hereinafter referred to as textile fabrics.

In the drawing:

Fig. 1 illustrates more or less diagrammatically one embodiment of the process of the present invention;

Fig. 2 illustrates a knitted textile fabric to be treated according to the present invention;

Figs. 3 and 4 illustrate the same fabric after different treatments;

Fig. 5 is an enlarged plan view of a portion of the uncondensed fabric shown in Fig. 2;

Fig. 6 is an enlarged plan view of a portion of the condensed fabric shown in Fig. 3; and

Fig. 7 is a still further enlarged view of one of the yarns taken on the line 7—7 of Fig. 6 and showing the fibers in a separated condition.

According to the present invention, rubber is deposited from a rubber-containing fluid such as a solvent rubber cement or an aqueous dispersion of rubber, such as latex, on to a fabric which is condensed in at least one direction. The rubber thus deposited sets the fabric and maintains it normally in the condensed condition. The textile fabric when condensed has had imparted to it a capacity to stretch in the direction of the condensation of the fabric and to an amount substantially equal to the condensation, and in addition retains all the capacity for stretching it had before the treatment. The rubber imparts to the fabric as a whole the capacity of speedy retraction from stretched condition, thereby making it what is commonly termed an elastic fabric. If the material is a woven fabric substantially without a capacity to stretch either in the direction of its width or length, and the fabric is condensed widthwise, or lengthwise, or both, and then treated with a rubber-containing fluid so as to deposit the rubber on to the fabric and set the same in the condensed condition, the woven fabric will have imparted to it a capacity to stretch and to speedily retract from the stretched condition in the direction or directions and to the extent of the condensation of the fabric. In fabrics having a capacity to stretch before treatment, as is generally the case with knitted fabrics, whatever capacity to stretch in one or more directions that is imparted to the fabric by the condensation process of the present invention is in addition to whatever capacity to stretch the fabric might already have. The rubber deposit may be very light, as produced with a spray, and in such case the porosity of the fabric need be scarcely diminished by virtue of the rubber deposit. If desired, however, heavier films of rubber may be deposited on the fabric, to produce a continuous deposit and which may in addition to making the fabric elastic and imparting a capacity to stretch in one or more directions produce desired water-proofing qualities. The rubber may be used with the deposit on one surface as in the manufacture of rubberized fabrics for shoe manufacture or for the manufacture of rubber lined clothing and the like, or the fabrics may be plied up with the surfaces on

which the rubber has been deposited in contact with each other in order to produce laminated fabrics both the surfaces of which are of textile material and which may simulate an inelastic material, and yet be an elastic fabric with the desired capacity to stretch in one or more directions.

Fig. 1 of the drawing illustrates diagrammatically, one method of carrying out the inventions by condensing the fabric in a lengthwise direction but as will be described later, other methods of condensing fabric in a lengthwise direction, or methods of condensing the fabric in a widthwise direction, or in both directions, are readily accomplished. Referring more particularly to Fig. 1 of the drawing, an elastic belt 10, preferably made of rubber, is passed through a pair of pinch rolls 11, under a container 12 from which a supply of an adhesive material 13, such as glue, is applied to the belt and evenly spread thereon by a spreading knife 14. The adhesive may be sprayed on the belt, if desired. The belt passes over a heater or cooler plate 15 to increase the viscosity or tackiness of the adhesive on the surface of the belt and make it sufficiently tacky to adhere a fabric material thereto. The belt travels through a pair of pinch rolls 16 operating at greater surface speed than the pinch rolls 11 and the rubber belt is thus stretched between the pinch rolls 11 and 16. As the belt in its stretched condition goes between the pinch rolls 16, or slightly in advance of the pinch rolls 16 if desired, the textile fabric 17 which is to be treated according to the present invention is unrolled from supply roll 18 and is made to adhere to the glue or other adhesive 13 on the surface of the belt, as by the pressure of the pinch rolls 16. Further increasing of the viscosity of the adhesive 13 may take place after passage through the pinch rolls 16 by means of the heater or cooler 19 situated on the egress side of the pinch rolls. The belt 10 after passage through the pinch rolls 16 is allowed to relax, preferably in stages as by travel through pinch rolls 20, 21 and 22 rotating at diminishing surface speeds from that of the rolls 16, the surface speed of the last pair of rolls 22 being preferably approximately equal to the surface speed of the rolls 11. Between the pinch rolls 20, 21 and 22 may be positioned additional heaters or coolers 23 and 24 to further dry or increase the viscosity of the adhesive 13 on the belt as the belt relaxes to insure adhesion of the fabric 17 to the belt during the contraction of the belt between the rolls 16 and 22. When the belt leaves the pinch rolls 22, the fabric 17 which is adhered to the belt while the belt was in a stretched condition will have been condensed in a lengthwise direction and in an amount approximately equal to the amount of contraction of the belt between the pinch rolls 16 and 22. To the condensed fabric secured by the adhesive 13 to the belt surface is applied a rubber-containing fluid, for example latex 25, as from a spray device 26 or if desired from a conventional spreading or other device. The rubber is deposited from the fluid on to the fabric by a chemical coagulating and/or by a drying step as in passage through the drier 27. The rubber thus deposited on the fabric sets the fabric and is capable of maintaining the fabric normally in the condensed condition. In ordinary practice where a vulcanizable latex composition is used, this drying may partially or completely cure the rubber deposit. In order to remove the thus treated fabric from the belt to

which it is secured by the adhesive 13, the belt and adhered fabric is passed by means of pinch rolls 28 through a steam chest 29 which softens the adhesive and permits the fabric and belt to be easily separated by means of pull rolls 30. In some cases the heat of the drier 27 sufficiently softens the adhesive while drying the rubber deposit to eliminate the necessity for further softening of the adhesive as by the steam chest 29. The fabric as it is separated from the belt 10 is drawn by the pull-rolls 30 through a washer 31 to wash off the adhesive remaining on the fabric surface and is then passed through a drier 32 which if desired may vulcanize to any degree or complete the vulcanization of the rubber deposit. The rubber coated fabric may be doubled or plied before or after rolling up as at 33. The belt after separation of the fabric from the surface of the same passes through a washer 34 to remove excess adhesive from the surface and then passes between drying plates 35 and back to the pinch rolls 11.

The rubber belt may be contracted from stretched condition at the pinch rolls 16 in one step rather than in a series of steps as by the series of pinch rolls of gradually diminished surface speeds, if desired. The adhesive may be a water soluble material such as the glue described above or in case it is desirable to eliminate all water-soluble substances from the elastic fabric, shellac or copal or cellulose compounds or other gums or resins which are soluble in rubber non-solvents instead of a water-soluble adhesive may be used, whereupon the belt, after deposition of the rubber on the fabric, may be passed through such a rubber non-solvent to remove the adhesive. The rubber may be deposited from the rubber-containing fluid, if a latex composition, by a chemical coagulation of the rubber particles as by treatment with a latex coagulant, which may be admixed with the adhesive, to at least aid in setting the fabric in the condensed condition. The rubber-containing fluid may contain the rubber in vulcanized condition in which case no further vulcanization is necessary. Preferably, the rubber-containing fluid takes the form of a vulcanizable latex composition, and where the fabric is to be utilized without doubling or plying, substantially complete vulcanization is made to take place by the time the elastic fabric leaves the drier 32. Where two fabrics treated according to the invention are doubled or plied with their rubber sides in contact or an untreated fabric is so doubled or plied to the rubber side of a treated fabric to form a laminated fabric, at least complete vulcanization of the deposit is preferably prevented until after the plying operation. The rubber-containing fluid may be so modified as to adjust the feel, modulus of stretch and other properties of the finished condensed fabric as described. Instead of single or plied fabrics, as above described, the rubber side of a single texture fabric, or of a plied fabric having a rubber exposed surface may be flocked.

The apparatus in Fig. 1 condenses continuous lengths of a textile fabric in only a lengthwise direction and hence imparts a capacity to stretch or gives the fabric an increased ultimate elongation only in a lengthwise direction. In order to produce a contraction in the width of the fabric to be treated, pieces of the fabric may be cut in lengths equal to the width of the belt 10 and the cut lengths placed crosswise on the belt before the pinch rolls 16.

If it is desired to impart a stretch or to add

additional stretch to continuous lengths of a fabric in a crosswise direction, then a rubber belt similar to the rubber belt 10 may be used as in the apparatus of Figure 1 but the stretch of the belt should be crosswise instead of lengthwise. This is readily accomplished by means of a conventional tentering device in which the opposite rows of pins or clamps holding the edges of the elastic belt are caused to diverge during the forward movement of affixed belt and thereby stretch the belt in a crosswise direction and maintain this relation until the fabric has been adhered to the belt, following which the opposite rows of pins or clamps are then caused to gradually converge to a parallel relation during the continuous forward motion of affixed belt to release the crosswise tension on belt and thereby condense the fabric in the crosswise direction. It is to be understood that the adhesive may be applied to the belt either before or after stretching crosswise by means of tentering device and that the subsequent steps of treating condensed fabric would then follow in the manner previously outlined after crosswise tension has been released as described in reference to Fig. 1.

If desired, belt 10 of Fig. 1 may be stretched by a tenter frame in a crosswise direction after it has been stretched in a lengthwise direction as by the pull rolls 11 and 16, and in such a case on retraction of the belt in both crosswise and lengthwise directions after the fabric has been sufficiently adhered to the stretched belt, a condensation of the fabric will occur both crosswise and lengthwise.

The removable adhesive may be applied to the belt in any desired pattern as by means of spaced or engraved rollers or a grooved or notched bar or knife instead of by a spreading or spraying operation and the fabric made to adhere to the belt only at those parts where the adhesive has been applied in the desired design. In this way the fabric will be condensed only in those areas which were adhered to the belt and the finished elastic fabric will have a design by virtue of those portions of the fabric which were not adhered to the belt presenting a more or less crinkled or puckered appearance.

Other methods of condensing the fabric may be utilized, as for example, using a non-elastic belt of rubber, fabric or metal or the like, and applying the removable adhesive to the belt, and then passing the fabric and belt between a pair of squeeze rolls or under a single roll located between two adjacent rolls in which the roll next to the fabric to be condensed runs at a faster or friction speed as compared to the speed of the belt or rolls whereby if the adhesive is still somewhat plastic yet very sticky, and if the friction of the greater speed roll has a gripping surface, the fabric will be condensed and adhered to the belt as a result of the friction speed. The fabric will be held in the condensed condition as illustrated in Fig. 1 until the rubber has been deposited from the rubber-containing fluid onto the fabric. The fabric is then set by the rubber deposit and the treated fabric removed from the belt.

Other methods than by the utilization of glue or other temporary adhesive may be utilized to maintain the fabric in a condensed condition until after deposition of the rubber from the rubber-containing fluid to set the fabric in the condensed condition. For example, the fabric may be treated with the rubber-containing fluid and before depositing the rubber from the same

to set the fabric, the thus treated fabric may be sandwiched tightly between two stretched belts, the tensions on which belts are released before or while setting or depositing the rubber, as by a drying operation or by coagulation. In this case, the friction between the rubber belts and the fabric causes the fabric to condense.

It is desired to point out that while the apparatus illustrated in Fig. 1 of the drawing is constructed to apply the rubber-containing fluid to the fabric after the fabric has been condensed, it is also contemplated that the rubber-containing fluid may be applied to the fabric before the latter is condensed and then coagulated or vulcanized after the fabric is condensed to yieldingly hold the fabric in the condensed or contracted condition. The use of rubber-containing fluid, first as an adhesive to secure the fabric to the stretched portions of the belts and later as a permanent elastic binder is the subject matter of an application Serial No. 69,302, filed March 17, 1936, by Merwyn C. Teague and Thomas G. Hawley, Jr.

Figs. 3 and 4 illustrate the condensation of the textile fabric of Fig. 2 in a lengthwise direction, and in a widthwise direction, respectively. In Fig. 2 is shown a ribbed-knit textile fabric, the horizontal lines *a* of which representing the knitted courses of yarn in the under surface of the fabric widthwise of the material, and the vertical columns *b* representing the wales on an outer surface of the fabric, lengthwise of the material. Such a knitted textile fabric as shown in Fig. 2 has a considerable capacity to stretch crosswise, that is in the direction of the courses but very little capacity to stretch lengthwise in the direction of the wales.

When the fabric of Fig. 2 has been treated by the apparatus of Fig. 1, that is condensed in a lengthwise direction and the fabric set in the condensed condition and made elastic by means of the rubber deposit, it will have the appearance of the fabric of Fig. 3. The capacity of the fabric to stretch in a widthwise direction, that is in the direction of greater stretch in the direction of the courses, is substantially unchanged, but the fabric has had imparted to it a considerable capacity to stretch in a lengthwise direction, that is in the direction of the wales where previously it had a small or no capacity for a stretching. The condensing of the fabric lengthwise has produced from a textile fabric having a capacity to stretch substantially only in a widthwise direction, an elastic fabric with a capacity to stretch in a lengthwise direction as well as a widthwise direction, and substantially without diminishing the amount of stretch widthwise of the fabric.

When the fabric of Fig. 2 has been treated according to the present invention and condensed in a widthwise direction as described above, it will have the appearance of the fabric of Fig. 4. The fabric remains substantially incapable of stretching lengthwise in the direction of the wales but the condensation of the fabric widthwise has substantially increased the amount of stretch possible in the direction of the courses by the amount of condensation of the fabric. Thus from a textile fabric having a capacity to stretch in substantially only one direction has been produced an elastic fabric capable of stretching in the same direction but to an appreciably greater amount than before treatment.

The appearance of the fabrics of Figs. 3 and 4 differ vastly from each other and from the fabric

of Fig. 2 before treatment. In Fig. 3 the knitted courses *a* are still visible below the outer surface of the fabric but the loops are closer together and the wales *b* have become somewhat zig-zag in appearance due to the lengthwise condensation of the fabric. In Fig. 4, the loops of the knitted course below the surface of the fabric have become completely hidden behind the wales *b* while the wales remain substantially straight. Other types of knitted constructions will have other changes in appearance depending on whether the condensation of the fabric is in a crosswise or lengthwise direction or both. The invention is applicable to woven and bias and net fabrics and on the constructions of the fabrics and the direction or directions of condensation will depend the changes in appearance. The constructions of the uncondensed fabric shown in Fig. 2 and of the condensed fabric shown in Fig. 3 are shown in detail respectively in Figs. 5 and 6. It will be noted that when the fabric is condensed in the direction of the wales (as indicated by the arrows *b*) from the uncondensed condition shown in Fig. 5 to the condensed condition shown in Fig. 6, the courses *a* are moved closer together and the heads *c* of the loops in the same course are moved along the necks *d* of the cooperating loops of such course and are spaced therefrom as indicated at *e*. The length of the loops extending between the courses are also shortened to such an extent that the fibers of the yarns are caused to buckle to such an extent that they separate from one another as shown in Fig. 7. A fabric condensed in accordance with the process described herein is further characterized by having all of the tension released from the yarns extending in the direction in which it is condensed. Greater capacity for stretching results from the foregoing characteristics imparted to the fabric.

When the rubber backing or lamina consists of rubber deposited in situ, i. e., directly from a rubber containing fluid, it is grainless and has a uniform modulus of elasticity in all directions, and such rubber being applied in a fluid or pasty condition to the fabric an excellent bond is obtained. It is preferred to obtain the rubber lamina from rubber latex to obtain greater elasticity, better aging properties, and greater strength for a given amount of rubber. An elastic fabric thus constructed is provided with a uniform modulus of elasticity and is advantageous over a fabric having a grained rubber backing, such as is produced by calendering and whose modulus of elasticity is different in the direction of the grain from that in the transverse direction.

As various other modifications will occur to those skilled in the art, it is not intended to limit the invention other than as set forth in the appended claims.

This application is a continuation in part of application Serial No. 758,009, filed December 18, 1934.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. The process of making an elastic fabric comprising the steps of adhering a textile fabric to a supporting surface with a removable adhesive, applying forces to the textile fabric in a direction substantially parallel to the surface of the textile fabric, said forces being resisted by the adherence of the textile fabric to the supporting surface so as to crowd the threads of the textile fabric extending transversely to the forces closer together and to relax the threads extending in the direction of said forces, holding the textile fabric

in the condensed condition on the surface by the adhesive, applying a rubber-containing fluid to the surface of the textile fabric opposite to the side on which is the removable adhesive, treating the rubber-containing fluid to deposit the rubber therefrom and to convert it into an elastic medium which adheres to and is capable of yieldingly retaining the textile fabric in its condensed condition, and removing the textile fabric with the rubber adhered thereto from the supporting surface.

2. The process of making an elastic fabric comprising the steps of adhering a textile fabric to a supporting surface with a removable adhesive, applying forces to the textile fabric in a direction substantially parallel to the surface of the textile fabric, said forces being resisted by the adherence of the textile fabric to the supporting surface so as to crowd the threads of the textile fabric extending transversely to the forces closer together and to relax the threads extending in the direction of said forces, holding the textile fabric in the condensed condition on the surface by the adhesive, spraying rubber latex upon the textile fabric, treating the latex to deposit the rubber therefrom and to convert it into an elastic medium which adheres to and is capable of yieldingly retaining the textile fabric in its condensed condition, and removing the textile fabric with the rubber adhered thereto from the supporting surface.

3. The process of making an elastic woven fabric comprising the steps of adhering with a removable adhesive a woven textile fabric to an elastic surface which is stretched in a longitudinal and transverse direction, releasing sufficient tension on said surface to cause it to contract in both directions and condense the fabric both longitudinally and transversely by crowding the warps and wefts of the fabric more closely together to thereby render both the warp and weft threads relaxed in the direction of their length, applying a rubber containing fluid to the surface of the textile fabric opposite to the side on which is the removable adhesive, treating the rubber-containing fluid to deposit the rubber therefrom and to cause it to assume properties that will yieldingly hold the fabric in the condensed condition, and removing the rubber treated woven fabric from the elastic surface.

4. The process of making an elastic knitted fabric comprising the steps of adhering a knitted textile fabric to a supporting surface with a removable adhesive, applying forces to the textile fabric in a direction substantially parallel to the surface of the textile fabric and in the direction of the wales, said forces being resisted by the adherence of the textile fabric to the supporting surface so as to force the rows of courses closer together and to relax the threads extending in the direction of said forces, holding the textile fabric in the condensed condition on the surface by the adhesive, applying a rubber containing fluid to the surface of the textile fabric opposite to the side on which is the removable adhesive, treating the rubber-containing fluid to deposit the rubber therefrom and to convert it into an elastic medium which adheres to and is capable of yieldingly retaining the textile fabric in its condensed condition, and removing the textile fabric with the rubber adhered thereto from the supporting surface.

5. The process of making an elastic knitted fabric comprising the steps of adhering a knitted textile fabric to a supporting surface with a re-

movable adhesive, applying forces to the textile fabric in a direction substantially parallel to the surface of the textile fabric and in the direction of the courses, said forces being resisted by the adherence of the textile fabric to the supporting surface so as to force the wales closer together and to relax the threads extending in the direction of said forces, holding the textile fabric in the condensed condition on the surface by the adhesive, applying a rubber-containing fluid to the surface of the textile fabric opposite to the side on which is the removable adhesive, treating the rubber-containing fluid to deposit the rubber therefrom and to convert it into an elastic medium which adheres to and is capable of yieldingly retaining the textile fabric in its condensed condition, and removing the textile fabric with the rubber adhered thereto from the supporting surface.

6. The process of making an elastic fabric which consists in adhering with a removable adhesive a fabric formed of interconnected threads to a surface which has been stretched under tension in at least one direction, releasing the tension upon said surface so that it will contract and condense the fabric adhered thereto by crowding the rows of threads extending transversely of the contraction of said surface more closely together to thereby render relaxed the threads connecting said rows, applying a rubber-containing fluid to the surface of the condensed textile fabric opposite to the side on which is the removable adhesive, treating the rubber containing fluid to deposit the rubber therefrom and to convert it into an elastic medium which adheres to and is capable of yieldingly retaining the textile fabric in its condensed condition, and removing the textile fabric with the rubber adhered thereto from the supporting surface.

7. The process of making an elastic fabric comprising the steps of adhering with a removable adhesive a textile fabric to an elastic surface while the elastic surface is under tension, releasing a substantial amount of the tension on said surface so that it will contract and condense the fabric adhered thereto by crowding the threads of the fabric extending transversely to the lines of contraction closer together and relaxing the threads extending in the direction of the lines of contraction, applying rubber latex composition to the surface of the fabric opposite to the side on which is the removable adhesive, treating the rubber latex composition to deposit the rubber therefrom and to convert it into an elastic medium which adheres to and is capable

of yieldingly retaining the textile fabric in its condensed condition, and removing the textile fabric with the rubber adhered thereto from the elastic surface.

8. The process of making a patterned elastic fabric comprising the steps of adhering with a removable adhesive a textile fabric to selected areas of a supporting surface and not adhering said fabric to certain other areas of said surface, condensing the fabric in one direction on said surface in the areas to which said fabric is adhered by applying forces to the textile fabric in a direction substantially parallel to the surface of the textile fabric, said forces being resisted by the adherence of the textile fabric to the supporting surface so as to crowd the threads of the textile fabric extending transversely to the forces closer together and to relax the threads extending in the direction of the forces in the adhered areas and to pucker the unadhered areas of said fabric, applying a rubber containing fluid to the surface of the textile fabric opposite to the side on which is the removable adhesive, treating the rubber-containing fluid to deposit the rubber therefrom and to convert it into an elastic medium which adheres to and is capable of yieldingly retaining said condensed portions of said fabric in their condensed condition, and removing said fabric with the rubber adhered thereto from said surface.

9. The process of making a patterned elastic fabric comprising the steps of adhering selected areas of a textile fabric to a stretched elastic surface with a removable adhesive and not adhering other areas to the elastic surface, releasing the tension on the elastic surface to permit it to contract and to condense the textile fabric only in the adhered areas by crowding in such areas the textile threads extending transversely to the direction of contraction closer together and relaxing in such areas the threads extending in the direction of contraction, holding the adhered areas of the fabric in the condensed condition on the elastic surface by the removable adhesive, applying a rubber-containing fluid to the surface of the textile fabric opposite to the surface on which is the removable adhesive, treating the rubber-containing fluid to deposit the rubber therefrom and to convert it into an elastic medium which adheres to and is capable of yieldingly retaining the textile fabric in its condensed condition, and removing the textile fabric with the rubber adhered thereto from the supporting surface.

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