May 31, 1932. S. L. CLUETT 1,861,422

ART OF SHRINKING FABRICS

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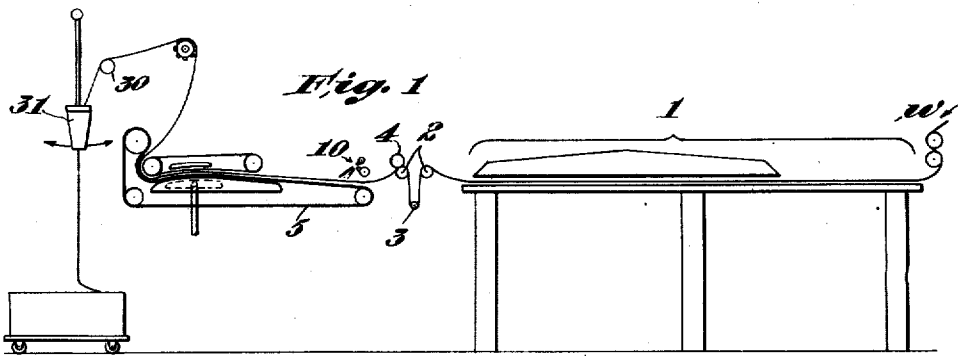


Fig. 1

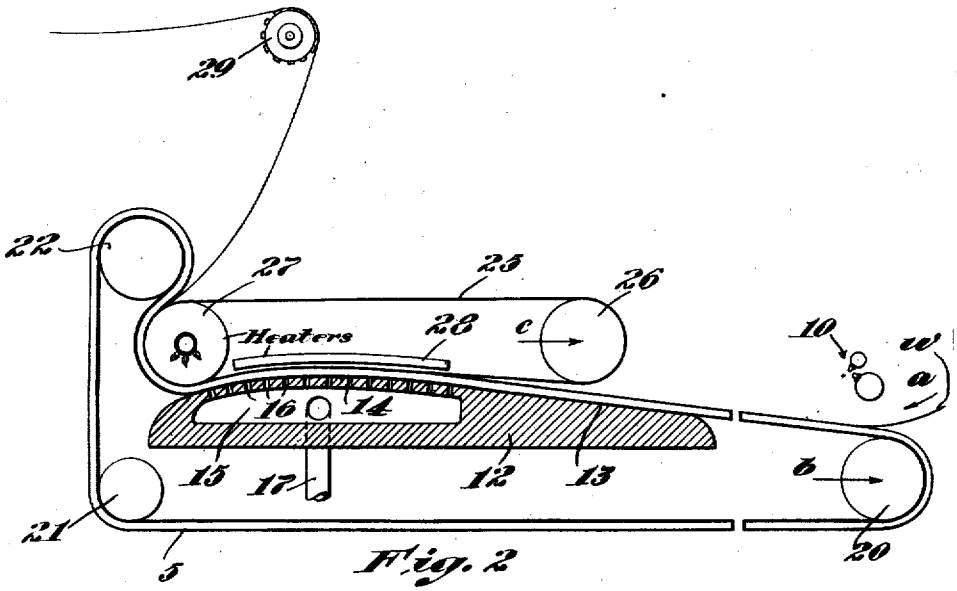


Fig. 2

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ART OF SHRINKING FABRICS

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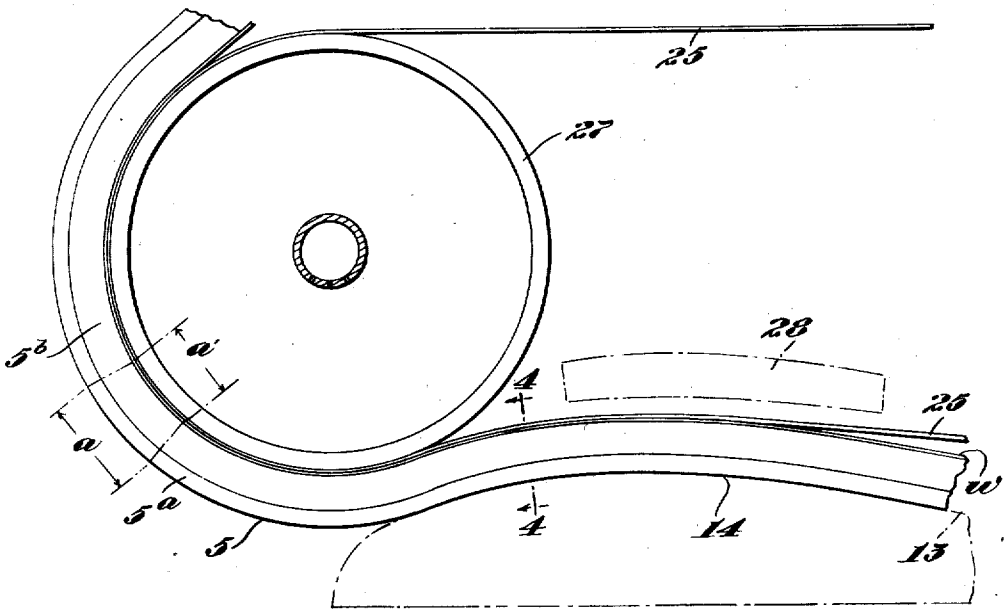


Fig. 3

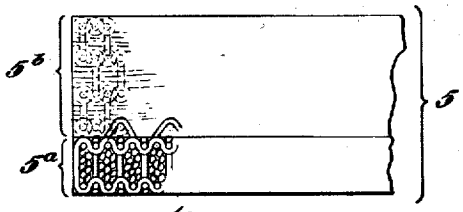


Fig. 4

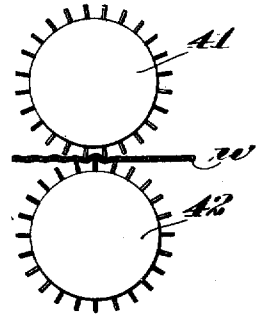
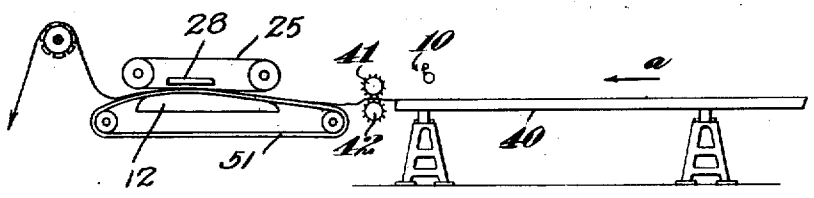


Fig. 6

Fig. 5.



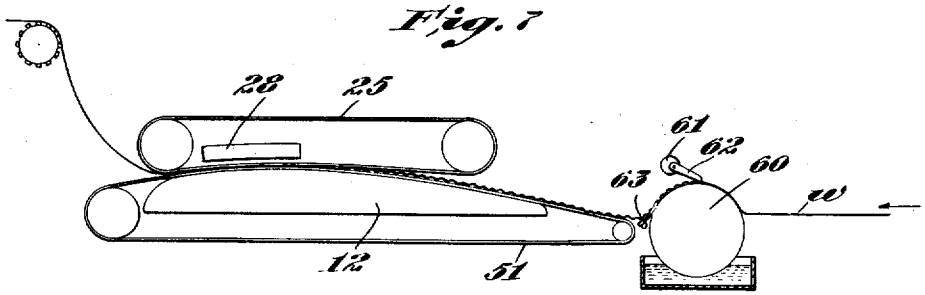
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ART OF SHRINKING FABRICS

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Fig. 7



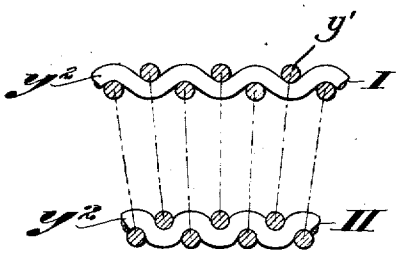


Fig. 8

Fig. 9

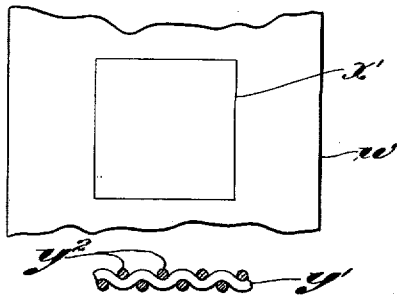


Fig. 9a

Fig. 10

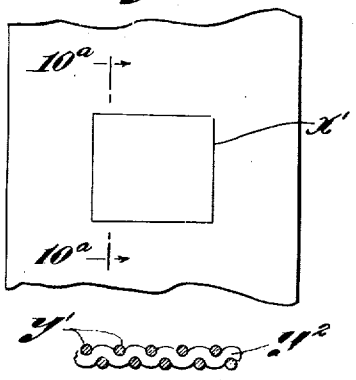


Fig. 10a

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ART OF SHRINKING FABRICS

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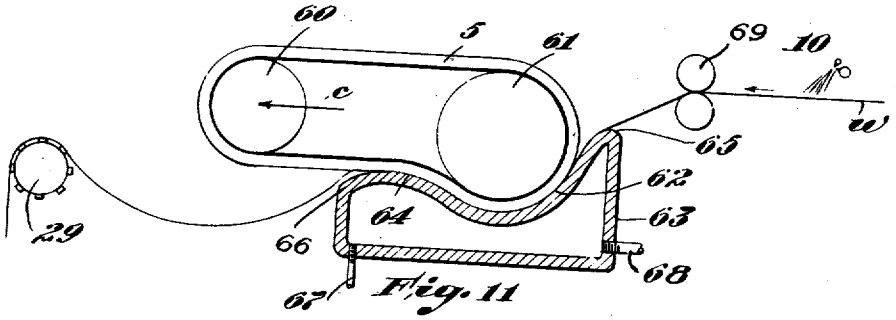


Fig. 11

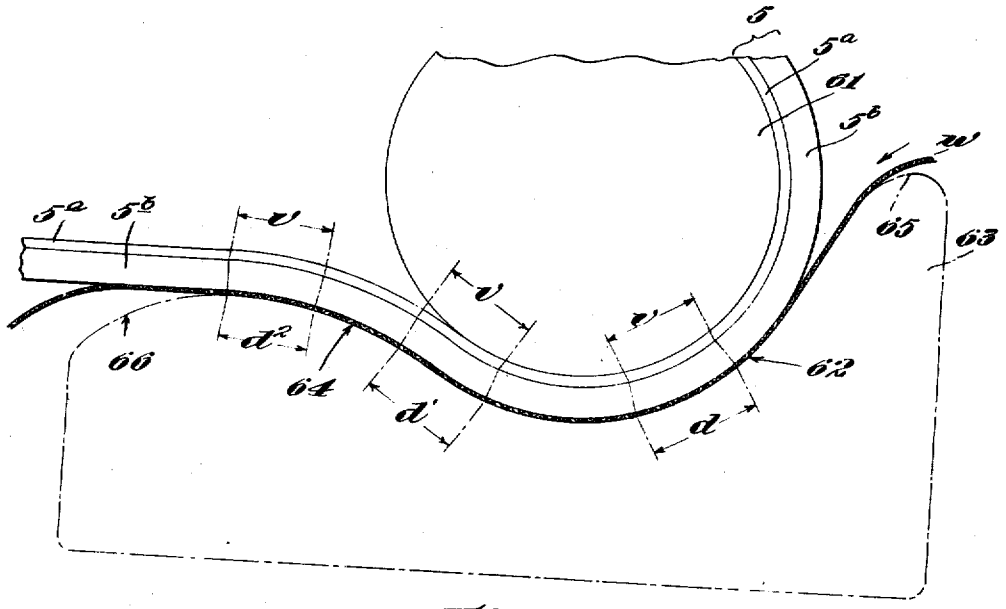


Fig. 12

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1,861,422

UNITED STATES PATENT OFFICE

SANFORD L. CLUETT, OF TROY, NEW YORK

ART OF SHRINKING FABRICS

Application filed April 18, 1930. Serial No. 445,300.

This invention relates to an art or method of shrinking textile fabrics.

The dominant characteristic of my method is, that shrinkage or dimensional contraction of a textile fabric, is produced by subjecting it, while in a plastic or internally mobile condition (induced for instance by moistening) to compressive forces or components of force applied to the cloth from without, acting in directions everywhere parallel to the cloth surfaces, to condense or crowd together the yarn components so as to enhance in degree the yarn undulation or crinkle originally produced by the weaving operation. When this contraction in web area—in one or both dimensions (warp and/or weft) has been imposed on the fabric, it is set in its determined state of shrinkage by drying, preferably under heat and pressure.

One object of the present invention is to provide for operating upon the cloth, which may already be finished in the sense of having been bleached, mercerized, printed, dyed, calendered, starched, ironed or polished, or any of these, either in the yarn or on a finished web, or both, in such a way as to secure and set in the cloth a maximum contraction in at least one dimension of the web. Another object of my invention is thus to provide for subjecting cloth to treatment causing it to take up in at least one dimension, and then to submit the cloth to steps causing the fixation of the shrinkage in that dimension, and to do this without stretching or destroying the crinkle of the yarns of the cloth which extend in the other direction.

In a preferred series of steps which can be carried out by mechanism, the invention may be exemplified by causing cloth to be subjected to a humidifying or moistening treatment tending to soften adhesions or stiffnesses caused by the inclusion of starchy or gummy dressings, and then to operate upon the cloth to cause it to collapse or lie in a shorter extent in one dimension upon a suitable carrier; and concomitantly or thereafter to fix the collapsed state of the cloth in that dimension, preferably by heat and pressure.

The invention will now be explained in connection with the accompanying drawings showing preferred steps by way of illustration of the steps of the process or art, and preferred mechanisms, and in which

Fig. 1 is a diagram in elevation of one form of apparatus upon which the method or art may be carried out;

Fig. 2 is an enlarged detail partly in longitudinal vertical section of apparatus shown in Fig. 1;

Fig. 3 is an enlarged diagram side elevation explanatory of certain steps of the treatment and of certain features of the apparatus;

Fig. 4 is an enlarged transverse section of a carrier belt relied upon for functions hereinafter explained;

Fig. 5 is a diagram side elevation of apparatus for practicing certain steps of the art or process according to a different mode of operation from that of the apparatus shown in Figs. 1, 2 and 3;

Fig. 6 is an enlarged diagram in elevation of an instrument of the said apparatus;

Fig. 7 is a diagram in side elevation of a modified apparatus practicing a modified step of the method or art;

Fig. 8 is a diagram section of the fabric comparing its condition in two stages of the treatment;

Figs. 9 and 10 are respectively comparative diagrams in plan of cloth not treated and cloth after it has been treated;

Fig. 9ª is a section either warpwise or weftwise of the said cloth in the state illustrated by Fig. 9;

Fig. 10ª is a section warpwise showing the state of the cloth illustrated by Fig. 10;

Fig. 11 is a diagram corresponding to Fig. 2 showing modified apparatus; and

Fig. 12 is an enlarged diagram detail of the apparatus shown in Fig. 11.

The art or process in its broader aspects is exemplified by operations which may be conducted with the aid of apparatus shown in Figs. 1, 2 and 3, and carried out on cloth which has not been subjected to any shrinkage operation, or has been only partially shrunken, or which has been shrunken in one direction only. For comparison, as shown

in Figs. 9 and 9ª, a typical cloth *w* of simple weave may present a warp or weft system of yarns y^1 interengaged with a crossing system of yarns y^2, the relative lie, crinkle or arrangement of the said yarns in respect to each other, whether they are longitudinally extending warps or laterally extending wefts, being such that the yarns are bent over members of the other series of yarns so as to extend from side to side of the superficial faces of the fabric and to be substantially evenly distributed on either side of a medial longitudinal plane of symmetry. If such a piece of cloth *w* should have laid off upon it at w^1 a marked square, the dimensions of the marked area would be changed by shrinkage. Such a change will not be effected in any manner without causing some different relation of the yarns y^1 to the yarns y^2. This condition is true whatever the weave-construction of the fabric may be.

Referring now to Fig. 1, a web *w* may be caused to enter the apparatus from the right of the figure, whereupon, as in apparatus diagrammatically illustrated at 1, the cloth may be operated upon to cause it to shrink laterally. To this end the apparatus 1 may comprise any ordinary kind of tenter having web-margin grasping devices approaching each other during travel from the entrance to the exit end of the device 1, the web being moist and dried before leaving the device 1 which may comprise such a tenter, and means for moistening and means for drying the goods during its progress from its entering width to the exit end of said device 1, where the effect of moistening and drying without stretching will be to fix in the cloth a narrower width than its original or normal condition illustrated in Fig. 9. There might be substituted for the apparatus mentioned, and for the steps of treatment carried out on the said apparatus, the apparatus and steps of treatment of my copending application filed of even date herewith, Case II, Ser al No. 445,299, the effect of which is to set in the fabric a shrunken width by improved means. It is not, however, any necessary part of the present art or apparatus to subject the web *w* to any treatment whatever prior to the practice of the treatment about to be described, which is, in specific illustration directed to securing a shrinkage in longitudinal dimension of a cloth web capable of any such shrinkage.

The web *w* is worked upon to secure longitudinal shrinkage, which in the preferred case is a shrinkage to a degree corresponding to that resulting from repeated laundry treatments in use; one purpose of the treatment is to provide cloth for cutting and making into garments which will reliably retain its original longitudinal dimension in use and under repeated laundry cleansings. As exemplified by operations performed by apparatus best shown in Figs. 2 and 3, this longitudinal shrinkage treatment may comprise advancing the web to gravitational engagement with a carrier 5, which may be an endless textile fabric belt capable of resisting tension in the direction of its length, but having at least a substantial portion of its thickness capable of longitudinal collapse so as to occupy a shorter longitudinal dimension when the belt is flexed in one direction than it occupies when the belt is flexed in another direction or is straight.

As indicated in Fig. 1 the web of cloth *w* may be received on belt 5 by the operation of driven rolls 2, which advance it without substantial stress lengthwise of the cloth. A very light tension may be placed upon the cloth by the weight roller 3; the operation of the rolls 2 may be aided by the top roll 4; the effect of the operations upon the cloth by the rolls 2, 3 and 4 being to deliver it at a predetermined rate, which, when the operation is continuous, may be the rate of delivery of the machine 1 on to the belt 5 upon which the web *w* lies, free to adjust itself on the said belt 5, hereinafter referred to as a carrier for the cloth, except as its weight and friction hold it in contact with belt 5.

A preferred treatment of the cloth as indicated at 10, Figs. 1 and 2, comprises the direct application to the web, as shown, to its upper face, of a fine spray or mist of water, steam or other suitable saturant capable of entering the capillary spaces of the yarns. A preferred form of moistening device indicated in the drawings, is a form of air-blast atomizer using water, and adapted to apply a predetermined quantity according to the speed of passage of the cloth in order to accomplish the desired moistening or capillary filling of the yarns, and not to have any permanent detrimental effect on the attained finish of the goods, so as to leave its trade finish substantially unimpaired. I have determined by experience that these quantities can be ascertained for any particular cloth, having regard to its contained moisture when delivered to the apparatus, the temperatures of subsequent treatment, and especially the distance separating the moistening station at 10 from the place where the cloth is dried, for example by application of heat, to secure the degree of effect desired. Added water to the extent of from 5 to 10 per centum of the weight of the cloth is usually sufficient for collar and shirting cloths. The primary object of thus moistening the cloth is to prepare it for the subsequent longitudinal shrinking operation by softening it; a subsidiary result attained is a relaxation of any stressed condition of the warp or weft elements of the cloth now lying loosely on the belt 5 and some take up or shrinkage of these elements depending upon their previous condition. However the cloth is adequately prepared for the subse-

quent longitudinal shrinking operation if moistened to loosen adhesions and soften stiffening substances but not caused or allowed to relax or take up in either direction at this stage.

The effect desired is to shrink the longitudinally extending or warp system of yarns y^2 by causing take-up of the yarns y^2 and contraction of the distances separating wefts y^1 (Figs. 8 and 10^a) to or slightly beyond the degree which would be attained by repeated laundry washings of the fabric. Referring to Fig. 8, this is accomplished by so operating upon the cloth as to take-up the crinkled warp yarns illustrated by the typical warp system member y^2 at I in said figure, through a desired degree to occupy the shorter space for the said yarn as shown at II in said figure, in order to cause the cloth, as shown in Figs. 9 and 9^a, to be longitudinally shrunken as illustrated in Figs. 10 and 10^a.

In the preferred forms of the invention, such shrinking of the cloth in one direction does not necessitate a stretching and elongation of the cloth in the opposite direction. Referring to Fig. 10^a it will be observed that while the warps y^2 of the preshrunken cloth have been given an abnormal amount of crinkle, the wefts y^1 have not beeen caused to lose their normal crinkle, but on the contrary retain whatever degree of crinkle they had when warpwise condensation of the cloth began. Comparing Figs. 10^a and 9^a, the distance between the planes of the crests of the undulations in the weft yarns is approximately the same before and after warpwise shrinking. These conditions obtain in the cloth when it is in its finished preshrunken state, and without any subsequent laundering. To this end, after the applied moisture has sufficiently acted upon the cloth lying upon the carrier belt 5 to loosen adhesions and soften stiffening substances, the cloth is caused to adhere to or lie in frictional contact firmly everywhere with one face of the carrier belt; and the surface of the carrier belt and the cloth carried by it is then contracted in a longitudinal sense; the cloth is then acted upon to dry it while it is in this contracted or condensed state to fix it in that condition, as may be done by the operation of heat and transverse pressure.

Referring now to Figs. 2 and 3, one device to carry out these steps with the aid of a carrier belt may be constructed as in said figures, a preferrred belt being shown in Fig. 4, which is a transverse detail section of the said belt. The object is to provide a belt 5 in which the portion 5^a is flexible and resistant to tensile stress, whereas the portion 5^b is equally or more flexible, is not necessarily resistant to tensile stresses, and is capable of collapse upon itself to occupy shorter or longer length in accordance with a flexed state of the belt as a whole. Suitable structures of the belt 5 may comprise for the portion 5^a any ordinary multiple-ply connected woven fabric, made of yarns of sufficient size, elasticity, tensile resistance and flexibility to serve the indicated purpose. Stout cotton yarns of good quality, if desired accompanied by a longitudinal and/or transverse system of stuffer yarns, provide within the old and common knowledge of weavers a suitable fabric having the indicated qualifications. The portion 5^b may be united in any usual manner, as indicated by weft floats, to the portion 5^a, and may differ from it structurally only in materials from which it is made, or the weave structure of the woven fabric constituting it; or in both these particulars. The portion 5^b may be a fabric having one or both systems of woolen or worsted yarns, or of cotton treated to cause fluffy softness; or having a weave structure characterized by compressibility with flexibility and thickness, which qualities, however secured, will accomplish the desired effect. For example, the section 5^a may be a two-ply multiple-ply fabric interconnected by warp or weft floats; the section 5^b may be a four, six or more ply multiple-ply float-connected fabric; the section 5^b may be woven of a coarser gauge and have relatively a larger number of transverse or weftwise stuffer yarns than the section 5^a; or the section 5^b may be principally composed of longitudinally extensible stuffer yarns held between the plies of the multiple-ply structure by mere inclusion between them; in any case the portion 5^a and the portion 5^b may be interconnected by floats of the yarn system of one extending into the yarn system of the other. The belt 5 may, of course, be constructed of two separate fabrics of the specified kinds respectively not conjoined, or occasionally conjoined by sewed stitches. Where the degree of shrinkage to be secured is moderate, the surfaces of any thick cloth belt may be depended upon to contract on the concavity and stretch on the convexity of a bend in respect to a median portion which neither contracts nor stretches so that the concave face carrying the cloth frictionally or compressively adhering to it; will constrain the cloth to contract also.

Apparatus operating substantially according to the behavior of that illustrated in Fig. 2, comprises a bed or support 12 for the carrier 5, which bed 12 is preferably of metal, has a plane upper surface at 13, rising to a maximum height at a point 14, preferably in a gradual curve; the bed 12 may be hollow as at 15, perforated as at 16, and the space within it may be exhausted by any suitable suction apparatus working through a duct indicated at 17.

In this form shown the carrier 5 runs about cylindrical rolls 20, 21 and 22, one of which is suitably driven at the prescribed speed of delivery of the goods in the direction of the

arrow *a*. One of the rolls, such as 20, may be subjected to spring or gravity stress in the direction of the arrow *b* to keep the carrier belt 5 taut.

Above the table or bed 12 there is arranged an endless metallic, preferably polished and very thin band 25 of a strong heat-conducting metal. If a smooth, flat surface is desired for the material treated, band 25 is of strong, heat-conducting metal, suitably polished; but if a flat polished surface is not desired, this band may be a woven textile or wire cloth, or of metal having an engraved or roughened texture. The band 25 may travel on the surfaces of a cylindrical roll 26 which may be stressed in the direction of the arrow *c* to maintain the band 25 taut, and a hollow roll 27 which may be suitably heated, as by steam at a predetermined pressure introduced through its hollow axes, not shown. If desired, the band 25 may be further heated by a radiating heater 28 which, as indicated, may be an electric resistance heater, or might be a steam box.

The carrier belt 5, the metal band 25 and the web under treatment pass around the hot roller 27, after passing which the band 25 separates from the carrier belt 5. The web may be delivered from the nip between the belt 5 and the band 25 after passing the roll 27 to a rotated cage roll 29 and carrier roll 30, Fig. 1, which if desired may be associated with a cloth piler 31, Fig. 1.

In operation, the moistened web *w* gradually approaches the nip opposite the summit 14 of the table 12 at and from which point it is under transverse (i. e. normal) but not under any kind of lateral or longitudinal pressure by the operation of the band 25. To this end the band 25 and the belt 5 travel at the same speed. Any moistened, swelled and shrunken condition of the yarns will, it will be observed, be conserved and maintained in the region between the band 25 and the belt 5. By the application of heat through the heater 28 and the hollow roll 27, the finally attained state of the web will be fixed and preserved during passage around the roll 27. Having regard to the moisture of and the speed of travel of the web, this passage about the roll 27 is through a sufficient distance to set the fibers and dry off the moisture. The dispositions of the apparatus are such that the entering pressure opposite the summit 14 is light, but upon passage around the roll 27, the full tension of the carrier belt 5 is available transversely to press the web under the ironing heat developed.

Seizure of the web between the approaching runs of the belt 5 and band 25 in the manner indicated flattens out any small blisters or wrinkles which otherwise might be pressed back by action of the roll 27.

Referring now to Fig. 3; the bend of the belt 5 about the roll 27 is relatively acute. In order to accommodate itself to this bend, the least extensible component of the belt 5, which is at section 5^a, and which is outside on the passage of roll 27, imposes upon the part 5^b of the relatively thick carrier belt necessity to collapse. The web *w* which is by friction and pressure uniformly adherent to the contracting side of the belt 5 necessarily partakes of the collapsing motion of the inner surface of the carrier belt 5 which subjects the web to compression exerted parallel to its surfaces, condensing or shrinking it. The degree of this collapse is measured by the difference between the length of any stratum of belt 5 which remains unaltered throughout the passage about roll 27, in this case the portion 5^a of the carrier belt 5, and the interior circumferential extent of the inner surface of the collapsed portion 5^b of the belt 5. The effect of this is, as illustrated in Fig. 8 to crowd together the transversely extending yarn components of the web *w*, and to cause the collapse by a greater amplitude of crinkle of the longitudinal yarns y^a of the web *w*.

The ratio of length of the web *w* after treatment to its length before treatment is for these reasons the ratio between the like arcs of the circumference of the roll 27 as augmented by the thickness of the band 25, and of the bend about the roll of the taut run of the relatively inextensible element 5^a of the belt 5. This in turn depends upon the thickness about the roll 27 of the element 5^b of the belt 5. The expression

$$\frac{w^1}{w^2} = \frac{R^2}{R^1}$$

is valid for this relation where w^1 is the untreated length of the web, w^2 is the treated length, R^1 is the radius of the roll 27 and band 25, and R^2 is the radius of the inextensible portion of belt 5 as it goes about the roll 27. The ratio of fixed shrinkage can be altered, therefore, by changing either the thickness of the portion 5^b of belt 5, or by substituting a roll 27 of different diameter.

In the case of a belt 5 of homogeneous construction, in which at a bend the internal face collapses and the external face extends, there will be an intermediate stratum within the belt which neither extends nor collapses, and the ratio of shrinkage will be expressed by the relation of the radii of the inner surface of said belt and of said stratum which neither extends nor collapses.

When sufficient heat is maintained in the roll 27 the fabric is dried and set in this longitudinally collapsed or shrunken state when leaving the nip between the roll 27 and the belt 5. The portion 5^b at least of the belt 5 is permeable to water vapor, and any excess moisture received into this part of the carrier belt 5 has ample opportunity to dry during the long exterior run of this portion of the belt back to its receiving portion at the right-

hand end of the apparatus, as shown in Fig. 2.

At and opposite the point 14, the heater 28 acting by conduction through belt 25 may be relied upon to relieve the web *w* of excess moisture to the point of leaving in the web *w* only enough moisture to enable it to collapse along with the inner surface of the belt 5 prior to fixation by the ironing heat, also transmitted through the belt 25 at the last part of its passage around the roll 27. As indicated in Fig. 10 the effect upon the goods is to cause lengthwise shrinkage, so that the longitudinal dimension x^1 of the square marked at *x* on the web, in its normal condition, as shown in Fig. 9, will have become the lesser quantity indicated.

Referring now to Figs. 11 and 12, the belt 5 may be employed in a specifically different relation to a pressure and heating element to effect a longitudinal shrinkage. In this case the belt 5 may have its relatively inextensible element 5^a within and its extensible and compressible element without, and be supported and operated by rolls 60 and 61, of which the roll 60 may be tensed in the direction of arrow *c*. The cylindrical roll 61 may be concentric with the polished cylindrical concave surface 62 of a hollow heated ironing bed 63, which may also provide a cylindrical convex surface 64, an entering curved surface 65, and a delivery surface 66. The bed 63 may be the top of a hollow casting tapped for a steam pipe 68 and condensation drain 67.

In use, the web *w* is fed in the direction of the arrow, Fig. 11, past a moistening device 10 by rolls 69, to the entrance slope 65, whence it enters the nip between the outer, most expanded surface of belt 5 and the concave 62, by which the web is compressed against the surface 62. The lengthwise dimension of any unit length of the web corresponds to the circumference of the arc of the belt 5 to which the cloth is applied by pressure, and is represented because of the flexure of belt 5, by the dimension *d*, which brackets a lesser length *v* of the inextensible part 5^a of belt 5. The web *w* is, by pressure and friction, made uniformly adherent to the convex outer surface 5^b of the belt 5. Then travel of belt 5 toward the convex surface 64 first causes the belt 5 to straighten, and then to flex oppositely, whereupon the length of cloth represented by dimension *d* first is compressively forced to occupy the lesser dimension d^1, and then the least dimension d^2 opposite the convex surface 64.

The under face of the cloth carried by the belt 5 is rubbed against the polished surfaces of the hot bed 63, and is heated, dried and fixed in its shrunken condition after it has passed the convex surface 64, and is thence delivered from the apparatus, for instance over cage roll 29. It will be observed that the apparatus of Figs. 11 and 12 utilizes the extensible and collapsible surface of a carrier belt to shrink a moist web applied to it while said surface is in a state of extension, the web being maintained in pressure-contact with said surface during its change of state to its normal and thence to a state of collapse, the web being dried and removed after completion of hot pressure in said latter state.

It will now be apparent that in operation on a cloth web, the apparatus of Figs. 1, 2 and 3, and Figs. 11 and 12, respectively, perform the same method of effecting shrinkage of the web, and that this method is characterized by exerting on all portions of the web material a pressure, at all points in directions parallel to the web surfaces, so that it is compressively condensed in the dimension in which the compressive forces are applied. By this means a yarn component, e. g., warp, is given enhanced undulation or crinkle, while another yarn component, e. g., weft, has its individual members crowded more closely together. The confinement of the web between the contractile support (surface 5^b of belt 5) and an opposed abutting surface constrains the web to respond to the webwise exerted compressive forces by internal rearrangement of its yarn components and prevents response by wrinkling of the web as a whole.

The method of shrinkage of cloth by webwise compression may be effected in a manner specifically different from that hereinabove described. Referring to Figs. 5 and 6; the cloth web *w* is fed in the direction of the arrow over a table 40, and moistened by a spray device 10. It then passes through a web-crinkling device, comprising rolls 41, 42 equipped with radial, parallel, rounded-edged vanes, and set so that the edges of the vanes intermesh, as shown in detail in Fig. 6, and produce undulations in the web, which is then passed to the endless belt 51 which travels at a rate slower than that at which the web is fed or drawn into the crinkling vane-rolls 41, 42, so that the undulations or ridges formed in the web shall not be disturbed, either by extension or contraction. The carrier belt 51 travels over the surface of a convex bed 12 and enters the nip between said surface and a tense, flexible, endless band 25, preferably of smooth metal, which presses the cloth against the belt 51, supported by the bed 12, the band and belt traveling at the same rate, so that the pressure exerted on the web *w* shall be transverse only, i. e.—normal to its general surface. A heater, 28, is provided, as in the apparatus illustrated in Fig. 2.

The crinkled or undulated web, in which the yarns have been softened and their contained starchy or sizing materials rendered plastic by moistening, is subjected to progressively increasing transverse (i. e. nor-

mally exerted) pressure as it passes into the gradually reducing space between the belt 51 and band 25. The crests or salient features of these undulations are depressed, this depression develops a compressive component of force, exerted at all points in parallel with the surfaces of the web, which by reason of its frictional adhesion to the carrier belt 51 can not creep on the belt to any appreciable degree. The lengthwise (e. g. warp) yarn components are by this compressive force constrained to assume a more sinuous crinkle, while the widthwise (e. g. weft) yarn components are crowded more closely together. The web as a whole is dimensionally contracted, occupying in its flattened condition the same length as in its previously undulated condition. When thus flattened and compressively condensed, the moisture is eliminated, as by the heater 28.

The longitudinal state of collapse and fixation of this state of collapse of the longitudinal element of the cloth may be secured by still other means. Referring now to Fig. 7, the web *w* may be delivered in the direction of the arrow on to the surface of a moistening and tractor roll 60 to which the surface of said web adheres in the manner of wet cloth by the capillarity of the wetting fluid. While in this condition of moist adhesion, a rapidly reciprocating doctor knife 62 worked by an eccentric 61 of very slight eccentricity may act upon the cloth to detain it in fine crepe-like ridges which are retained during passage of the cloth over a doffing knife 63 on to the carrier belt 51, which may be caused to pass at a rate which is less than the rate of delivery to the roll 60, so as to conserve the ridge formation, over a bed 12 and enter under a tense band 25, between which and the belt 51 the crepe-like ridges are flattened to effect a longitudinally collapsed arrangement of the web components, which arrangement is then fixed as by heat and pressure. The heat may be supplied by the heater 28 of the apparatus above described.

In the case of endwise compressively imposed collapse of the cloth by wrinkling, as in connection with the procedure of Fig. 7, the effect of transverse pressure is, as in the procedure of Fig. 5, to cause the longitudinal system of yarns to assume a more crinkled form when the applied pressure reduces the fine and slight wrinkles to the common plane of the space between pressure devices. The length of these yarns taken up in the wrinkles or crepings, when these are flattened, is subjected to endwise compression as a result of flattening the blisters or wrinkles. A degree of wrinkling which would cause the cloth to lap on itself in folds on being subjected to transverse pressure is of course avoided.

Other modes of performing the steps of the generic method and other instances of apparatus capable of carrying out these steps will occur to those skilled in the art as a consequence of the recommendations of this specification.

Apparatus such as is illustrated in Figs. 1, 2, 3, 4, 11 and 12 of this application forms the subject matter of my copending divisional application Serial No. 605,648, filed April 16, 1932.

Apparatus such as is illustrated in Figs. 5, 6 and 7 of this application forms the subject matter of my copending divisional application Serial No. 605,649, filed April 16, 1932.

I claim:

1. Art of treating textile webs comprising causing the said web to adhere to a support while in a moist state, causing said support to decrease in length in one dimension, and fixing in the web the resulting rearrangement of its component strands by drying the web with the aid of heat.

2. Art of treating textile webs comprising causing the said web to adhere to a support while in a moist state, causing said support to decrease in length in one dimension, and fixing in the web the resulting rearrangement of its component strands by drying the web with the aid of heat and transverse pressure.

3. Art of treating textile webs comprising causing the web to adhere to a support, moistening the web, collapsing the support, subjecting the web to pressure between the collapsed support and a hot surface to fix the collapsed rearrangement of the component yarns, and separating the web from the support.

4. Art of treating textile webs comprising causing the web to adhere to a support, moistening the web, collapsing the support and the web on it in the direction of the length of the web during travel of the web and support, fixing the collapsed state of the web by drying while in said collapsed state, and doffing the web from the support.

5. Art of treating textile webs for the purpose of imposing a lengthwise shrunken condition comprising as steps, applying the web to a carrier belt having substantial thickness, moistening the web, subjecting the web to pressure causing it to adhere to the carrier belt, and causing the web and the surface of the belt carrying the web to collapse longitudinally by flexing said belt toward the surface carrying the web, concomitantly with acting upon the belt to dry it.

6. Art of treating textile webs for the purpose of imposing a lengthwise shrunken condition comprising as steps, applying the web to a carrier belt having substantial thickness, moistening the web, subjecting the web to pressure causing it to adhere to the carrier belt, and causing the web and the surface of the belt carrying the web to collapse longi-

tudinally by moving said belt in a curved path, concave toward the surface carrying the web, concomitantly with acting upon the belt to dry it.

7. Art of treating textile webs for the purpose of imposing a lengthwise shrunken condition comprising as steps, applying the web to a carrier belt having substantial thickness, moistening the web, subjecting the web to pressure causing it to adhere to the carrier belt, and causing the web and the surface of the belt carrying the web to collapse longitudinally by flexing said belt toward the surface carrying the web, concomitantly with acting upon the web to dry it by a hot surface held in contact with the web, and then separating the web from said belt and said hot surface.

8. Art of treating textile webs for the purpose of imposing a lengthwise shrunken condition comprising as steps, applying the web to a carrier belt having substantial thickness, moistening the web, subjecting the web to pressure causing it to adhere to the carrier belt, and causing the web and the surface of the belt carrying the web to collapse longitudinally by moving said belt in a path curved in respect to the surface carrying the web, and holding the web against an unyielding hot surface adjacent to the path of said web and belt until the shrunken condition of the web is fixed.

9. Art of shrinking textile webs comprising as steps, moistening the web, applying the web to an extended surface of a carrier belt having a surface capable of extension and collapse, subjecting the web on the carrier belt to heat and pressure, and flexing the belt and web to cause collapse of said belt and web during maintenance of said heat and pressure.

10. Art of treating textile webs, characterized by rendering the yarn components of a web plastic, diminishing the superficial extent of the web by compression exerted on its material in directions parallel with the surfaces of the web, and setting the web in its diminished superficies.

11. Art of treating textile webs, characterized by rendering the yarn components of a web plastic, diminishing the superficial extent of the web by compression exerted on its material in directions parallel with the surfaces of the web, exerting transverse pressure on the web, and setting the web in its diminished superficies.

12. Art of treating textile webs, characterized by moistening the web, diminishing the superficial extent of the web by compression exerted on its material in directions parallel with the surfaces of the web, and setting the web in its diminished superficies by drying and heating.

13. Art of treating textile webs, characterized by moistening the web, diminishing the superficial extent of the web by compression exerted on its material in directions parallel with the surfaces of the web, while exerting transverse pressure on the web, and setting the web in its diminished superficies by drying and heating.

14. Art of treating textile webs, characterized by rendering the yarn components of the web plastic, diminishing the web in warpwise dimension by compression exerted on its yarn components warpwise and parallel with the web surfaces, and setting the web in its diminished dimension.

15. Art of treating textile webs, characterized by rendering the yarn components of the web plastic, diminishing the web in warpwise dimension by compression exerted on its yarn components warpwise and parallel with the web surfaces while exerting transverse pressure on the web, and setting the web in its diminished dimension.

16. Art of treating textile webs, characterized by affixing a web at all points to a support alterable in its superficial extent, altering the superficial extent of the support and that of the attached web, and fixing the web in its altered state.

17. Art of treating textile webs, characterized by affixing a moistened web at all points to a support alterable in its superficial extent, altering the superficial extent of the support and that of the attached web, and fixing the web in its altered state.

18. Art of treating textile webs, characterized by affixing a web at all points to a support alterable in its superficial extent, altering the superficial extent of the support and that of the attached web, while maintaining transverse pressure on the web, and fixing the web in its altered state.

19. Art of treating textile webs, characterized by affixing a moistened web at all points to a support alterable in its superficial extent, altering the superficial extent of the support and that of the attached web, while maintaining transverse pressure on the web, and fixing the web in its altered state.

20. Art of treating textile webs, characterized by affixing a web at all points to a contractible support, contracting the support and the web with it, and fixing the web in its contracted state.

21. Art of treating textile webs, characterized by affixing a moistened web at all points to a contractible support, contracting the support and the web with it, and fixing the web in its contracted state by drying.

22. Art of treating textile webs, characterized by affixing a web at all points to a contractible support, contracting the support and the web with it while maintaining transverse pressure on the web, and fixing the web in its contracted state.

23. Art of treating textile webs, characterized by affixing a moistened web at all points to a contractible support, contracting the sup-

port and the web with it while maintaining transverse pressure on the web, and fixing the web in its contracted state by drying.

24. Art of treating textile webs, characterized by diminishing the superficial extent of the web by compression exerted on its material in directions parallel with the surfaces of the web, and setting the web in its diminished superficies.

25. Art of treating textile webs, characterized by diminishing the superficial extent of the web by compression exerted on its material in directions parallel with the surfaces of the web, exerting transverse pressure on the web, and setting the web in its diminished superficies.

26. Art of treating textile webs, characterized by laying the web, in undulations, upon a support, flattening the undulations by pressure generally normal to the support, thereby diminishing the superficial extent of the web, and setting the web in its diminished superficies.

27. Art of treating textile webs, characterized by producing transverse undulations in a web, laying the web in its undulated condition upon a support, flattening the undulations by pressure generally normal to the support, thereby diminishing the superficial area of the web, and setting the web in its diminished superficies.

28. Art of treating textile webs, comprising affixing the web to a contractible support by pressure, then causing the support to contract while the web remains affixed thereto, and setting the web in its altered state.

29. Art of treating textile webs, comprising affixing the web to a contractible support by ironing pressure, then causing the support to contract while the web remains affixed thereto, and setting the web in its altered state.

30. Art of treating textile webs, comprising affixing a moistened web to a contractible support by pressure, then causing the support to contract while the web remains affixed thereto, and setting the web in its altered state.

31. Art of treating textile webs, comprising affixing a moistened web to a contractible support by ironing pressure, then causing the support to contract while the web remains affixed thereto, and setting the web in its altered state.

32. Art of treating textile webs, comprising affixing the web to a contractible support by pressure, then causing the support to contract, holding the web affixed to the contracting and contracted support by pressure, and setting the web in its altered state.

33. Art of treating textile webs, comprising affixing a moistened web to a contractible support by pressure, then causing the support to contract, holding the web affixed to the contracting and contracted support by pressure, and setting the web in its altered state.

34. Art of treating textile webs, comprising affixing the web to a contractible support by ironing pressure, then causing the support to contract, holding the web affixed to the contracting and contracted support by ironing pressure, and setting the web in its altered state.

35. Art of treating textile webs, comprising affixing a moistened web to a contractible support by ironing pressure, then causing the support to contract, holding the web affixed to the contracting and contracted support by ironing pressure, and setting the web in its altered state.

36. A woven textile fabric of ordinarily shrinkable material rendered substantially non-shrinkable in one dimension by mechanically rearranging its constituent yarns after weaving, and having its original trade finish substantially unimpaired, the yarns of one of its yarn components being crowded together closer than in the web as woven, the yarns of its other yarn component having an abnormal amount of crinkle sufficient substantially to prevent shrinkage of the fabric in the direction of these abnormally crinkled yarns when the latter tend to shorten upon subsequent laundering, and the said yarns which are crowded together having at least approximately a normal amount of crinkle.

37. A woven textile fabric of ordinarily shrinkable material rendered substantially non-shrinkable in one dimension by mechanically rearranging its constituent yarns after weaving, and having its original trade finish substantially unimpaired, the weft yarns being crowded together closer than in the web as woven, the warp yarns having an abnormal amount of crinkle sufficient substantially to prevent shrinkage of the fabric in the direction of these abnormally crinkled yarns when the latter tend to shorten upon subsequent laundering, and the said weft yarns having at least approximately a normal amount of crinkle.

38. A woven textile fabric of ordinarily shrinkable material rendered substantially non-shrinkable in one dimension by mechanically rearranging its constituent yarns after weaving, the yarns of one of its yarn components being crowded together closer than in the web as woven, the yarns of its other yarn component having an abnormal amount of crinkle sufficient substantially to prevent shrinkage of the fabric in the direction of these abnormally crinkled yarns when the latter tend to shorten upon subsequent laundering, and the said yarns which are crowded together having in the finished preshrunken state of the fabric and before subsequent laundering at least approximately a normal amount of crinkle.

39. A woven textile fabric of ordinarily shrinkable material rendered substantially

non-shrinkable in one dimension by mechanically rearranging its constituent yarns after weaving, the weft yarns being crowded together closer than in the web as woven, the warp yarns having an abnormal amount of crinkle sufficient substantially to prevent shrinkage of the fabric in the direction of these abnormally crinkled yarns when the latter tend to shorten upon subsequent laundering, and the said weft yarns having in the finished preshrunken state of the fabric and before subsequent laundering at least approximately a normal amount of crinkle.

40. Art of treating textile webs comprising affixing the web to a contractible support by pressure maintained until the support is contracted, then causing the support to contract with the web remaining affixed thereon and fixing the web in its altered state.

41. Art of treating textile webs comprising affixing the web to a contractible support by ironing pressure maintained until the support is contracted, then causing the support to contract with the web remaining affixed thereon and fixing the web in its altered state.

42. Art of treating textile webs comprising affixing a moistened web to a contractible support by pressure maintained until the support is contracted, then causing the support to contract with the web remaining affixed thereon and fixing the web in its altered state.

43. Art of treating textile webs comprising affixing a moistened web to a contractible support by ironing pressure maintained until the support is contracted, then causing the support to contract with the web remaining affixed thereon and fixing the web in its altered state.

44. Art of treating textile webs comprising as steps: exerting compressive stress on the web in directions parallel with the surface thereof, and restraining the web against undulatory flexure of its surface while producing by said compressive stress increased undulation of the component yarns of the web.

45. Art of treating textile webs comprising as steps: exerting compressive stress on the web in directions parallel with the surface thereof, and confining the web by pressure exerted normally to its surface to prevent undulation of the web, while producing by said compressive stress an increased undulation of the component yarns of the web.

46. Art of treating textile webs comprising as steps: affixing a web to a moving superficially contractible carrier and maintaining pressure on the web until the surface of the carrier is made to contract, and during and after contraction thereof, causing said carrier to contract in superficial extent, thereby producing an increase in undulation of component yarns of the web while preventing undulatory distortion of the web as such.

47. Method of treating textile webs comprising causing take-up of the weft yarn components of the web, then causing take-up of the warp components by compression exerted on the web parallel with its surface, and setting the web in its altered state.

48. Method of treating textile webs comprising causing take-up of the weft yarn components of the web, confining the web against a support contractible in its superficial extent, diminishing the superficial extent of the support while the web is confined thereagainst, and setting the web in its altered state.

Signed by me at Troy, New York, this first day of April, 1930.

SANFORD L. CLUETT.