United States Patent

[11] 3,596,333

[72] Inventors **Motohiro Tsuruta**
Kyoto-shi;
Hiroshiro Kimura, Uji-shi; Akio Koshimo, Uji-shi; Hirohisa Nara, Uji-shi; Tokuji Goto, Nara-shi; Kunio Amemiya, Uji-shi, all of, Japan

[21] Appl. No. **855,863**
[22] Filed **Sept. 8, 1969**
Continuation-in-part of Ser. No. 701,701, Jan. 30, 1968, abandoned.
[45] Patented **Aug. 3, 1971**

[73] Assignee **Nippon Rayon Kabushiki Kaisha (Nippon Rayon Co. Ltd.)**
Uji-shi, Kyoto-fu, Japan

[32] Priority **Jan. 30, 1967**
[33] **Japan**
[31] **43/5996**

[54] **APPARATUS FOR COMPRESSIVELY SHRINKING WOVEN TEXTILE FABRICS**
6 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **26/18.6**
[51] **Int. Cl.** **D06c 21/00**
[50] **Field of Search** ..... 26/18.6, 63; 28/76 E

[56] **References Cited**

UNITED STATES PATENTS

1,814,652	7/1931	Weiss	26/63
2,626,422	1/1953	Lammertse	26/63 X
3,382,553	5/1968	Davis et al.	26/18.6

Primary Examiner—Robert R. Mackey
Attorney—Meyer A. Gross

ABSTRACT: The present invention relates to a process and apparatus for treating a woven textile fabric, which comprises passing the fabric in its warp direction between at least a pair of rotatable cylindrical elastic rollers, whose surfaces make tight contact with each other, by compressing the rollers to increase its central portions relative to their ends and whose axes are curved with the same radius of curvature and in the same plane so as to shrink the fabric in its weft direction.

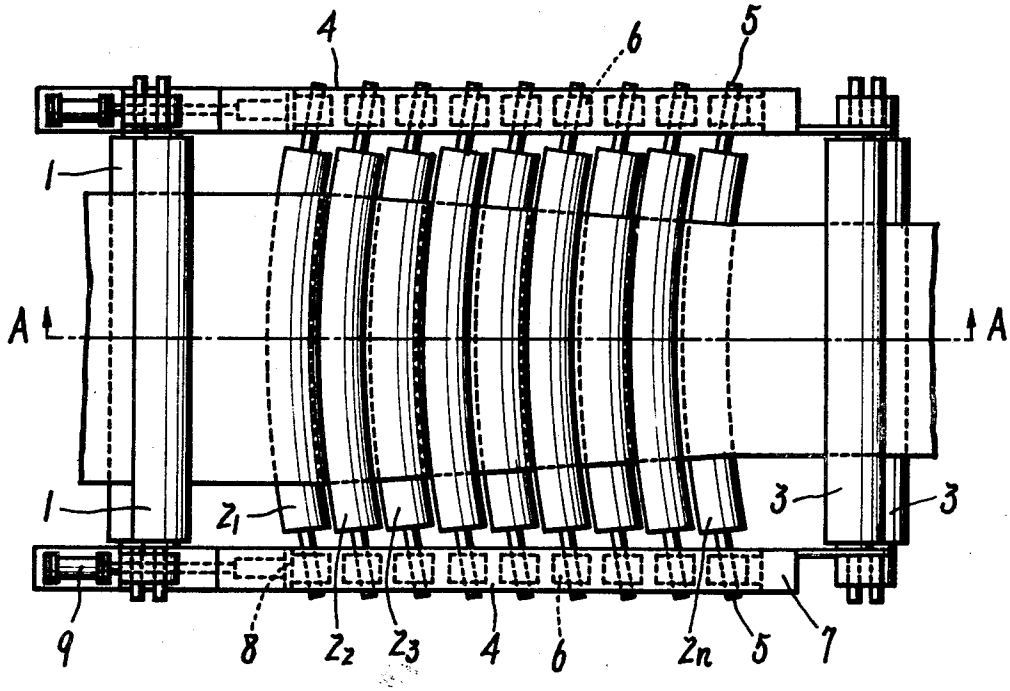


Fig. 1

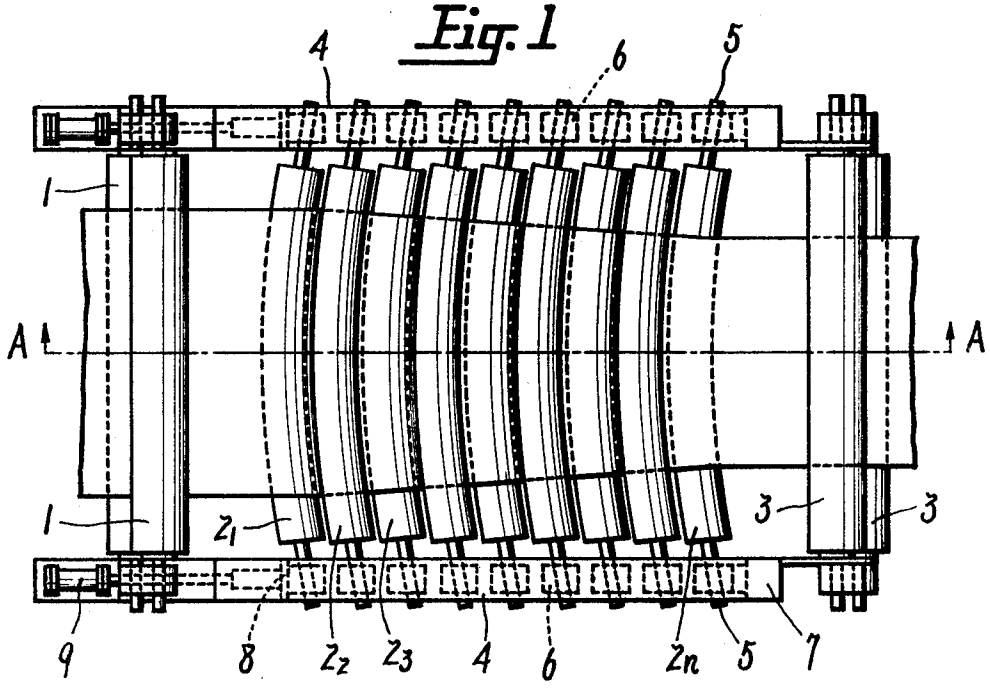


Fig. 2

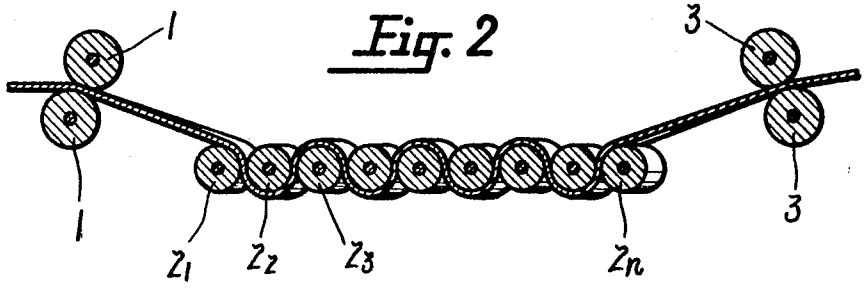
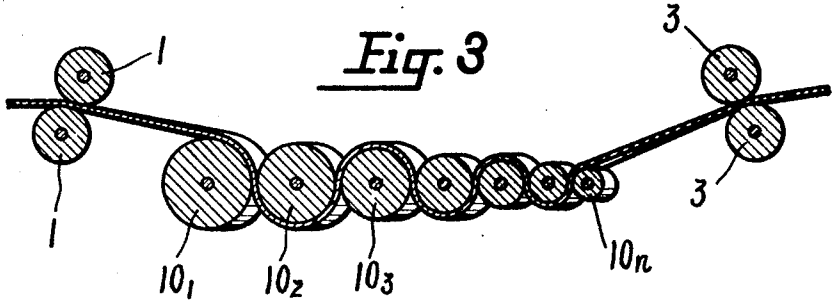


Fig. 3



APPARATUS FOR COMPRESSIVELY SHRINKING WOVEN TEXTILE FABRICS

Related Applications

The application is a continuation-in-part of Ser. No. 701,701, filed Jan. 30, 1968 and now abandoned, in behalf of the instant inventors.

BACKGROUND OF INVENTION

The present invention is concerned with a process and apparatus for treating a woven textile fabric, particularly so as to impart elasticity to the fabric in its weft direction. According to the present invention, woven textile fabric having improved elongation and elastic recovery can be prepared more easily and cheaply than hitherto by forced shrinkage of the woven textile fabric in its weft direction.

SUMMARY

The invention provides apparatus for treating a woven textile fabric by the foregoing process, which apparatus comprises at least one pair of rotatable cylindrical elastic rollers (a) whose surfaces make tight contact with each other by being compressed so as to alter the effective diameter of the rolls so that their central portions have an increased diameter as compared to their ends, and (b) whose axes are curved with the same radius of curvature and in the same plane as each other, and means for feeding a woven textile fabric in its warp direction between the rollers so as to shrink the fabric in its weft direction.

In a preferred embodiment, the diameter of the curved rollers decrease gradually from the feed end of the apparatus to the point of fabric withdrawal.

Each elastic curved roller according to the present invention comprises a curved axle and a cylindrical elastic body which is provided with a suitable driving means to rotate it around the axle. At least one pair of the rollers can rotate in axial alignment so that the surfaces of the rollers make tight contact with each other. A maximum elongation (or minimum shrinkage) of the surface of a roller will be found on the convex side, while a minimum elongation (or maximum shrinkage) will be found on the concave side, with regard to its curved axis. Thus, the surfaces of the elastic curved rollers are altered from a shrunk state to an elongated state and then back again by virtue of the rotation.

It is therefore possible to compressively shrink a woven textile fabric in its weft direction by passing the fabric in its warp direction between the rollers, which alter from an elongated to a shrunk state as they rotate and whose surfaces make tight contact with each other. It may be noted that the shrinkage of the woven textile fabric in its weft direction is not caused by the shrinkage of the wefts per se, but by increasing curvature of the wefts.

By fixing the woven textile fabric in its shrunk state, there can be prepared a woven textile fabric provided with improved elasticity and elastic recovery in its weft direction.

It is possible according to the apparatus of this invention to prepare elastic fabrics without the generation of creases and without the rightening troubles.

The bow curvature of the rollers should be constant in order to prevent the generation of creases and rightening movement or bowing of the fabric. This bowing effect or rightening movement is caused when fabric is subjected to shrinkage by using a curved roller. The more a fabric is brought into a bent state, the larger the rightening movement of the bent fabric becomes. However, when rollers having a constant bow curvature are arranged in a parallel relationship, free spaces are found at the central portion of each roller because of the fact that the convex side and concave side of the adjacent rollers are not well fitted with each other. It is, therefore, required to press rollers in the transverse direction so as to compress the rollers, whereby rollers are tightly contacted with each other. Thus, the side positions of the rollers are compressed as later described in the specification and drawings so that the diameter of the side position is smaller than that of the central position.

The rightening movement which may occur by using curved rollers to shrink the fabric will take a specific shape corresponding to the shape of the curved roller, i.e. the both sides of the fabric are advanced to the central position. The rightening movement can be eliminated by the difference of the feeding velocities which is created by the difference between the diameters of the side positions and central position of a roller. Since the feeding velocity of the surface of a roller is proportional to its diameter, the central position moves faster than the side positions in accordance with the difference between the diameters of the central position and side positions, whereby the rightening movement can be sufficiently eliminated.

It is advantageous to use a plurality of curved rollers having a relatively small bow curvature because a larger rightening movement may occur in the use of curved rollers having a larger bow curvature.

Further, when a fabric is shrunk in its warp direction, the spaces between warps decrease to a certain limit, and the smaller the spaces are, the more the generation of creases are. That is to say a larger generation of creases may occur according to the movement of the cloth from the supply roller to the feed out roller. It is, therefore, desirable to eliminate the generation of creases by subjecting the fabric to relatively smaller compaction as the cloth moves from the supply roller to the feed out roller. This is accomplished in a preferred embodiment by providing gradually reduced roller diameters as the cloth proceeds from the cloth feed end to the point of fabric withdrawal.

It is possible to eliminate the generation of creases by providing a plurality of curved rollers having relatively small and constant bow curvature. Furthermore, by such combination of the curved rollers in the above-mentioned manner shrinkage of the fabric can be increased because of the fact that the more a fabric is bent the larger the rightening movement of the fabric (tendency to recover its initial state of bending condition) becomes. In order to overcome this rightening movement it is necessary to nip the fabric between the rollers. Thus the greater rightening movement generated, the smaller the required space for nipping becomes so as to resist this rightening tendency. Accordingly, by providing a plurality of curved rollers having relatively small bow curvature it is possible to eliminate the rightening movement of the fabric and also to increase the shrinkage thereof.

It is preferred to use a suitable metallic material for the curved axle, around which is provided a roller body made of a suitable elastic material such as rubber, synthetic rubber, or felt.

As the curvature of the axis and the diameter of the curved roller increase, shrinkage values of woven textile fabric treated will also increase. Excessive shrinking can give rise to increasing troubles in the woven textile fabric treated.

Curvatures of axis and diameters of elastic rollers depend upon the nature of the roller material and on the properties of the woven textile fabric to be treated. Rollers having diameters of from 50 to 500 mm. with radii of curvature of from 2 to 50 meters are suitable for practical purposes, but better results can be obtained by the use of rollers having diameters of from 100 to 300 mm. with radii of curvature of from 3 to 20 meters.

Increased effects can be achieved by the use of two or more pairs of curved elastic rollers, while a greater number of pairs of rollers are liable to cause creasing troubles. It is preferred to use from 2—20 pairs of the curved rollers.

Various means may be used for compressing the ends of the rollers so as to increase the effective diameters of their central positions and eliminate rightening movement of the fabric. For example, the curved axes of each row are journaled in bearings. A row of bearing boxes, each having a stopper and pusher, e.g. a stopping plate 7 and a pushing plate 8 as shown in FIG. 1 are movably located in the machine direction on an external support by means of, for example, guide rails.

It is possible to fix the woven textile fabric in its altered state after the shrinkage step, by use of any suitable method such as e.g., heat setting or chemical setting. The heat setting can be combined with the chemical setting using e.g. a suitable swelling agent.

If desired, the woven textile fabric can be treated before passing through the curved rolls with a resin or swelling agent capable of fixing it in its altered state.

It is also possible to fix the woven textile fabric in its altered state during the shrinkage step by maintaining the curved elastic rollers at an elevated temperature suitable for the heat setting. Alternately, these rollers may be immersed in a bath containing a suitable agent in solution, for which any of the known swelling agents, chemical fixing agents or resins can be used, thereby subjecting the woven textile fabric to be treated in a single stage to both shrinkage and form fixing.

The process according to the present invention can with advantage be applied to any woven textile fabric of the known types. Better results can be achieved when it is applied to those having a relatively small density of warps compared with the final density. It is preferred to use as starting materials those fabrics having a warp density of 30 to 90 percent, preferably from 60 to 80 percent, of the final density. The preferred woven textile fabrics are exemplified by those made of filaments of spun yarns as follows:

Thermoplastic fibers, for example, polyamide; polyester; polyacrylonitrile; polypropylene; polyvinylchloride; and polyurethane; regenerated cellulose fibers, for example, viscose rayon and acetate, natural fibers, for example, wool, silk and cotton.

According to the present invention, it is possible to prepare woven textile fabrics having an elongation of about 10—30 percent and elastic recovery of at least 90 percent in the weft direction. The elasticity obtained is not substantially reduced by conventional washing processes.

By altering the shrinkage conditions, the elasticity of the woven textile fabrics obtained can easily be adjusted.

DRAWINGS

FIG. 1 of the accompanying drawings is a plan view showing schematically the main construction of an apparatus designed for carrying out the process according to the present invention.

FIG. 2 is a sectional side view of the apparatus shown in FIG. 1, taken along the line A–A.

FIG. 3 illustrates the gradual reduction of roller diameter from fabric feed to withdrawal end.

Referring to FIG. 1, a woven textile fabric is passed in the warp direction through between one or more pairs of guide rollers 1 and then between the first pair of curved elastic rollers 2_1 and 2_2, which are driven by a suitable driving means, such as a conventional motor, not shown in the drawings, so that the woven textile fabric is shrunk in its weft direction in the manner described above. The woven textile fabric is passed in turn through sets of curved rollers shown as 2_3—2_n and is fed out from a pair of guide rollers 3. The feed-out system is not shown in the drawings.

A curved axes 5 can be adjusted along an external support 4 so as to give a suitable pressure to each pair of curved rollers for engagement of the curved rollers with the woven textile fabric. Generally a pressure of 0.5 to 1 kg./cm.^{2}, preferably 1 to 5 kg./cm.^{2}, is employed so as to decrease the diameter of the side portions to be preferably more than 0.1 percent smaller than its unpressured diameter.

FIG. 3 illustrates the preferred embodiment of gradually reducing the diameter of the rollers from the feed end to the fabric withdrawal end. As shown, the rollers denoted 10 decrease in diameter, generally in a stepwise fashion of 0.5 to 3, preferably 0.75 to 1.5 cm. reductions, the latter having a diameter of 40 percent to 60 percent, e.g. 50 percent of that on the inlet end.

EXAMPLES

The following examples will serve to further illustrate the invention. In the examples, pieces of woven textile fabrics measuring 20 cm. (in the weft direction) ×5 cm. (in the warp direction) were used as samples and the elasticity of each woven textile fabric treated was determined by measuring the elongation (percent) and elastic recovery ratio (percent). The former was measured by the use of a 2 kg. weight and the elongation was calculated on the basis of the original width of 20 cm. The latter was determined by elongating the sample to 20 percent with a suitable burden in the weft direction, keeping it in the elongated state for 3 minutes, removing the weight from the sample, leaving it for 1 minute in the free state, and measuring its recovered width, which was compared with the original elongated width (20×20/100 cm.) to obtain the elastic recovery ratio. The elastic recovery ratio is 100 percent when an elongation of 20 percent is entirely recovered to give the original width of 20 cm. (100 percent) when the weight is removed.

EXAMPLE 1

An apparatus having a construction as described and including 11 curved elastic rollers was used to compressively shrink a secured woven textile fabric made of polyester and rayon yarns, which was woven under the conditions set out below. Each roller had an axis whose radius of curvature was 5 meters, and had a diameter of 2.5 kg./cm.^{2}.

It took 1 minute to compressively pass the fabric in the wet state through the system so as to give it a shrinkage of 22 percent in the weft direction. The shrunk fabric was padded with a conventional disperse dye, (such as Dianix Fast Red R available from Mitsubishi Kasei Kogyo K.K. Japan), was dried, was subjected to conventional thermosol dyeing and at the same time was set in its altered state at 170° C. for 2 minutes. After this, the fabric was finished with a conventional resin (such as Sumites Resin NS–4 available from Sumitomo Kagaku Kogyo K.K., Japan). Properties are shown in the following table. The improved properties were maintained even when the fabric was washed at 40° C. for 10 minutes with an aqueous solution containing 1 g./l. of Emal (Trade name of an alkyl sodium sulfate available from Kao Sekken Kabushiki Kaisha, Tokyo, Japan). The densities of the finished fabric were 63 yarns/inch (warp) and 51 yarns/inch (weft), respectively.

TABLE 1

Textile weaving conditions		
(Proportions of components in mixed yarns)	Warp	Weft
Polyester/rayon	63/35	63/35
Count of yarns	30/2	30/2
Density of fabric (yarns/inch)	50	52
Textile weave	tropical	
Properties obtained	**Not washed**	**Washed**
Elongation (%)	25	26
Elastic recovery ratio (%)	92.5	92

EXAMPLE 2

An apparatus having a similar construction so described and including 8 curved elastic rollers was used to compressively shrink a dyed woven textile fabric made of polyester and wool yarns, which was woven under the conditions set out below. Each roller had an axis whose radius of curvature was 6 me-

ters, and had a diameter of 180 mm. The rollers were put under compression of 2.0 kg./cm.². The apparatus was installed in a room where the atmosphere was kept at 60° C.

It took 40 seconds to carry out the forced shrinkage of the fabric to obtain a forced shrinkage of 23 percent in the weft direction. The fabric was immersed in an aqueous solution containing 0.1 weight percent of soda ash, was exposed to steam at 100° C. for 2 minutes to fix it in its altered state and was washed with an aqueous solution of 0.1 weight percent H_2O_2.

The woven textile fabric thus obtained had the following properties and was seen to have an improved elasticity in the weft direction. The densities of the finished fabric were 65 yarns/inch (warp) and 54 yarns/inch (weft), respectively.

TABLE 2

Textile weaving conditions		
Proportion of components in mixed yarns (polyester wool)		
	Warp	Weft
(polyester/wool)	50/50	50/50
Count of yarns	30/2	30/2
Density of fabric (yarns/inch)	52	54
Textile weave	tropical	

Properties obtained	Not Washed	Washed
Elongation (%)	27	25
Elastic recovery ratio (%)	91	91

EXAMPLE 3

An apparatus having a similar construction to that described and including 11 curved elastic rollers was used to compressively shrink a secured woven textile fabric made of polyester and cotton yarns, which was woven under the conditions set out below. The axes of the rollers had radii of curvature of 15 meters, and were placed under a compression pressure of 2.0 kg./cm.². The diameters of the rollers were gradually reduced from 20 cm. to 10 cm. in stepwise fashion by reductions of 1 cm. each, in the direction of travel of the fabric, i.e., from feed inlet to fabric withdrawal.

The fabric was immersed in an aqueous solution containing 32° Be caustic soda and was passed in the warp direction through the elastic rollers to give a 20 percent shrinkage in the weft direction. The fabric was padded with a conventional disperse dye (such as Dianix Fast Red R available from Mitsubishi Kasei Kogyo K.K., Japan), dried, dyed and at the same time fixed in its altered state at 180° C. for 2 minutes by conventional thermosol dyeing. The fabric was then finished with a conventional resin solution (such as Sumitex Resin NS-4 available from Sumitomo Kagaku Kogyo K.K., Japan). It was observed that the fabric thus obtained had excellent elasticity in the weft direction as shown in the following table. The densities of the finished fabric were 71yarns/inch (warp) and 59 yarns/inch (weft), respectively.

TABLE 3

Textile weaving conditions		
Proportion of components in mixed yarns		
	Warp	Weft
(polyester/cotton)	65/35	65/35
Count of yarns	30/2	30/2
Density of fabric (yarns/inch)	60	58
Textile weave	twill	

Properties obtained	Not Washed	Washed
Elongation (%)	22	21
Elastic recovery ratio (%)	92	92

EXAMPLE 4

An apparatus similar to that described in Example 1 was used to compressively shrink a dyed woven textile fabric made of nylon-6 and viscose yarns, which was woven under the conditions set out below. The fabric was immersed in a diethyluron resin bath solution containing the components listed below, was squeezed to 70 percent pickup, and was dried using a conventional roll dryer. It took 1 minute to pass the fabric in the warp direction through the curved elastic rollers, where the atmosphere temperature was kept at 150° C., so as to obtain a shrinkage of 21 percent in the weft direction.

The fabric was washed in a conventional open-soaper, was dried using a conventional short loop dryer, and was finished with a conventional semidecatiser to give the following properties. The fabric thus obtained was observed to have excellent elasticity in the weft direction. The densities of finished fabric were 70 yarns/inch (warp) and 64 yarns/inch (weft), respectively.

TABLE 4

Bath composition (% by weight)

Dimethyl uren resin (such as Sumitex Resin NS 4 available from Sumitomo Kagaku Kogyo K.K. Japan) 7%

Organic silicate softener 0.5 % (such as Noran Silicon Softener available from Nippon Reichhold K.K. Japan)

Polyethylene softener (such as Saibinol PN-3500 available from Saiden Kagaku Kogyo, K.K. Japan) 1%

Zinc nitrate 2% by weight

Water 89.5

Textile weaving conditions	Warp	Weft
Proportion of components in mixed yarns (nylon/rayon)	65/35	65/35
Count of yarns	30/2	40/2
Density of fabric (yarns/inch)	60	68
Textile weave	tricotine	

Properties Obtained	Not Washed	Washed
Elongation (%)	21	21
Elastic recovery ratio (%)	92	92.5

Having described the present invention, that which is sought to be protected is set forth in the following claims:

We claim:

1. Apparatus for treating a woven textile fabric, which apparatus comprises (a) at least one pair of rotatable cylindrical elastic rollers whose axes are curved with the same radius of curvature and in the same plane as each other, (b) means movably supporting the axes of the rollers in the plane thereof, (c) means for compressing the rollers so that the end portions have a smaller diameter than the central portions, to eliminate

the free space in the nip between adjacent rollers, (d) means for feeding a woven textile fabric in its warp direction between the rollers so as to compressively shrink the fabric in its weft direction, and (e) means for withdrawing said fabric without creasing from said rollers.

2. Apparatus as claimed in claim 1 wherein the axes of said rollers have a radius of curvature of from 2 to 50 meters.

3. Apparatus as claimed in claim 1 wherein said cylindrical rollers have a diameter of from 50 to 500 millimeters.

4. Apparatus as claimed in claim 1 which has from 2 to 20 pairs of curved rollers.

5. Apparatus as claimed in claim 1 wherein the diameter of said cylindrical rollers gradually decrease from the fabric feed end to the fabric withdrawal end of said apparatus.

6. Apparatus as claimed in claim 1 where said compression means are adjustable as to vary the relative decrease of diameter of the end portions of said rollers as compared to the central portions.