Jan. 25, 1955 F. R. REDMAN ET AL 2,700,202

METHOD OF TREATING TUBULAR KNITTED FABRIC

Original Filed Oct. 8, 1952 3 Sheets-Sheet 1

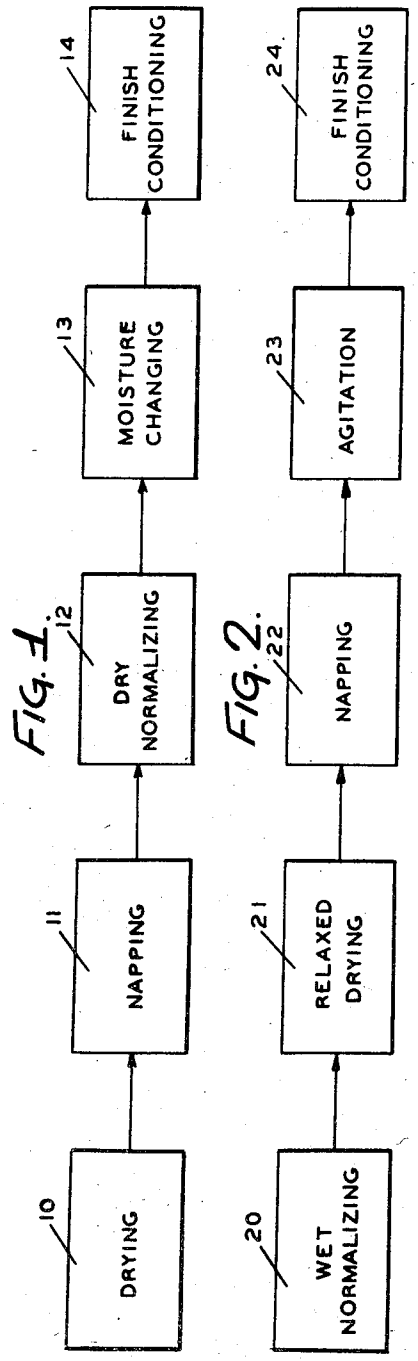

FIG. 1.

FIG. 2.

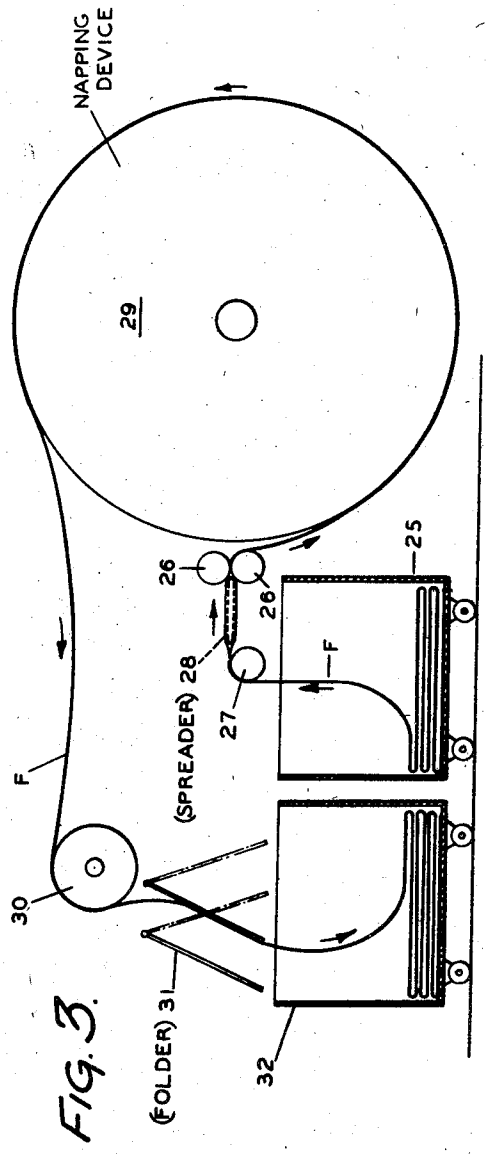

FIG. 3.

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FIG. 4.

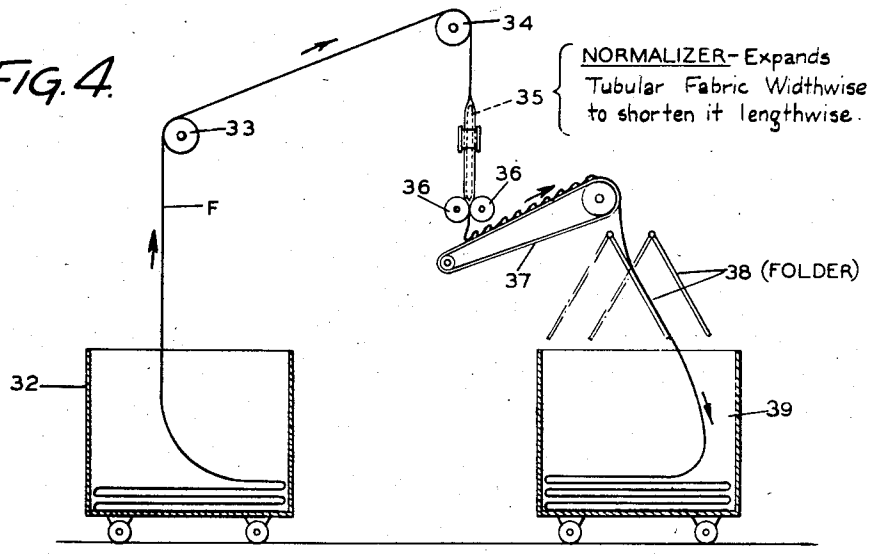


FIG. 5.

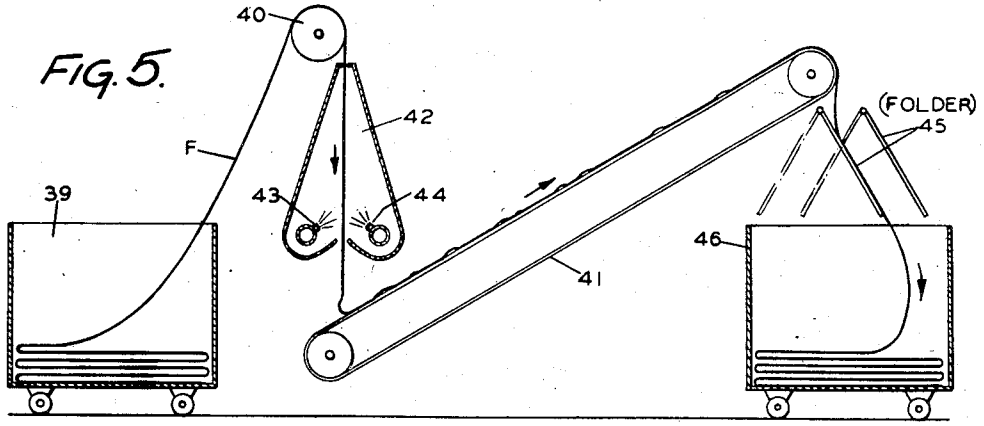
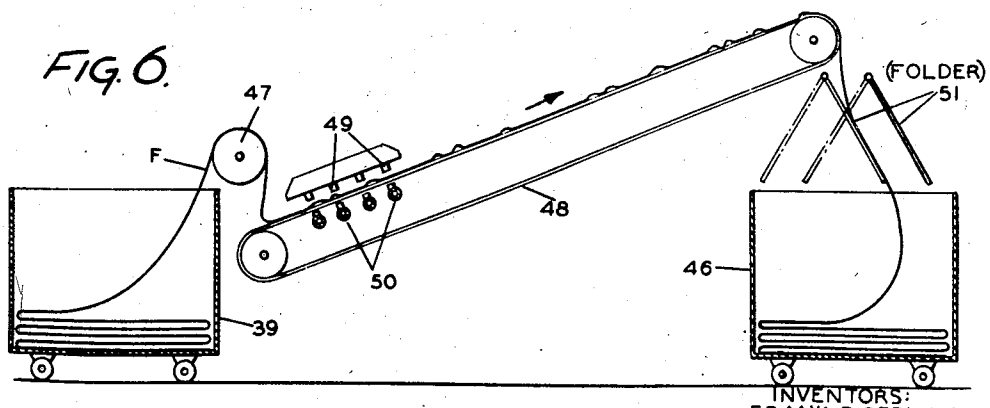


FIG. 6.



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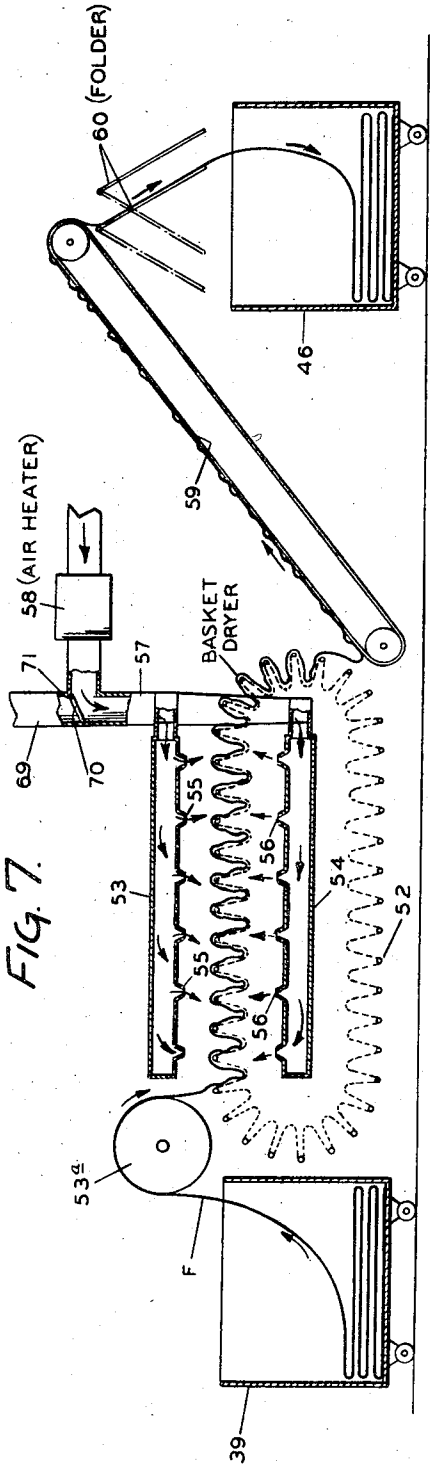

FIG. 7.

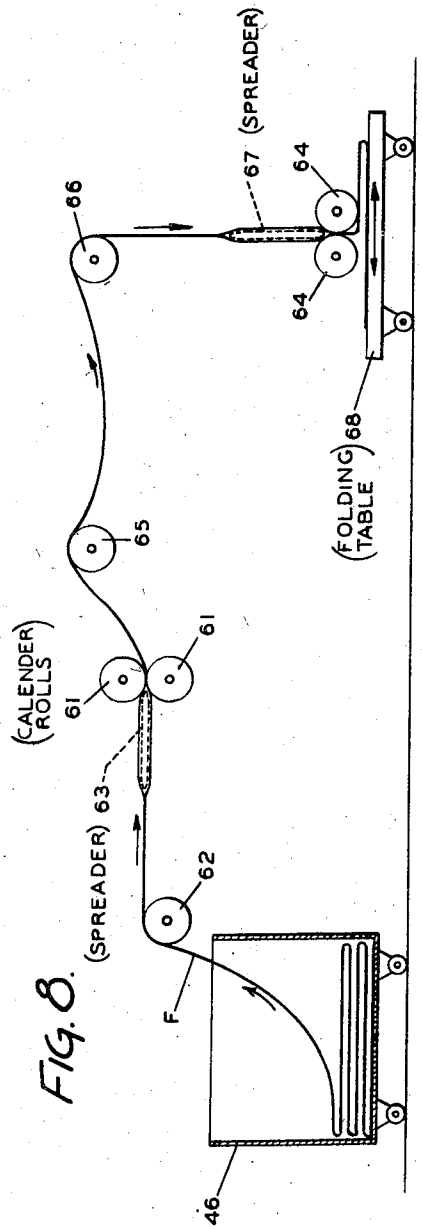

FIG. 8.

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METHOD OF TREATING TUBULAR KNITTED FABRIC

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Original application October 8, 1952, Serial No. 313,622, now Patent No. 2,684,519, dated July 27, 1954. Divided and this application July 17, 1953, Serial No. 374,612

2 Claims. (Cl. 26—18.5)

This invention relates to treatment of tubular knitted fabrics which require napping, the general object of the invention being to minimize or substantially eliminate shrinkage in such fabrics and also to improve the texture or "hand" of the fabrics.

This application is a division of our U. S. Patent No. 2,684,519, issued July 27, 1954.

It is now recognized in the art that shrinkage of garments made from tubular knitted fabrics is caused by an unnatural condition of the fabric at the time garments are made therefrom. To explain this, tubular knitted fabric is stretched lengthwise or elongated by the treatments to which it is subjected subsequent to knitting of the fabric and prior to the cutting thereof in the subsequent manufacture of garments. In its stretched or elongated condition, the fabric stitches are elongated lengthwise and narrowed widthwise, and they tend to acquire a distorted "set." Ordinary treatment of the fabric prior to the making of garments therefrom does not undo this distorted "set," but the laundering of garments does so due to the agitation to which the fabric is subjected in laundering. The undoing of this distorted "set" relieves the stitches and permits them to return substantially to their normal condition, i. e. the normal shape and size that the stitches had immediately after knitting of the fabric and prior to treatment thereof. Consequently, the laundering of the garments made from distorted fabric causes shrinkage of the garments, resulting in shortening and widening of the garments. It is now known that in order to minimize or substantially eliminate shrinkage of garments made from tubular knitted fabrics, it is necessary to restore the fabric substantially to its normal or natural condition prior to the making of garments therefrom.

All tubular knitted fabrics, following the knitting thereof, are subjected to so-called "wet processing" which includes scouring, bleaching and dyeing. The fabric is knitted in lengths of, for example, one hundred yards and these are fastened together in succession. As the fabric goes through the wet processing in continuous rope form, it is subjected to severe tensional forces lengthwise which impart considerable lengthwise stretch to it, the degree of stretch depending upon the type and weight of the fabric and also the type and condition of the machinery used in the wet processing. Generally speaking, the fabric will be stretched in an amount which is a substantial percentage of its length, within the range of about 8% to 35%. Lightweight fabrics will stretch within a range of about 15% to 35%, while heavyweight fabrics will stretch within a range of about 8% to 15%.

After wet processing, tubular knitted fabrics are variously treated to condition them for the making of garments, the treatment depending upon the type and weight of the fabric. It was long customary to spread the fabric to a desired width while maintaining it under tension lengthwise, and then dry and sometimes calender the fabric preparatory to the cutting of garments. This practice did nothing to alleviate the stretch or shrinkage and, in fact, it tended to promote greater shrinkage.

An important development in the treatment of tubular knitted fabric is a treatment known as "normalizing" which is the subject of U. S. Patent No. 2,597,530, issued May 20, 1952, to Frank R. Redman. The normalizing treatment comprises internally expanding the tubular knitted fabric widthwise, while it is free lengthwise, to

effect shortening or condensing of the fabric, and permitting the fabric to relax. The widthwise expansion of the fabric, while it is free lengthwise, undoes the above-mentioned distorted "set," and upon relaxing of the fabric the knitted stitches thereof return substantially to their normal size and shape, so that the fabric is then restored to its natural or normal condition. The normalizing treatment may be carried out either with the fabric dry or with some degree of moisture present in the fabric. The word "dry," as here used and as used in the appended claims, means that the fabric has only such moisture as it may have absorbed from the air. Therefore, by a fabric having some degree of moisture present therein, we mean a fabric which has at least some moisture in addition to that which it may absorb from the air. Thus, a fabric which has just come from wet processing, with the excess water removed, has a moisture content within the range of about 40% to 85% of the weight of the fabric, in excess of the dry condition, and this is referred to as a wet fabric. A moist fabric is one that has been dried and has had moisture added in a content of about 2% to 10% of the weight of the fabric.

With respect to fabrics which must be napped, the napping must be done while the fabric is in dry condition, and therefore, it is necessary to dry the fabric preparatory to napping. The normalizing treatment is useful in conjuction with all types and kinds of tubular knitted fabrics including those which are to be napped. It has been found, however, that napping itself distorts the fabric and the knitted stitches thereof to an appreciable extent and, therefore, tends to cause shrinkage of garments made from the fabric.

The principal object of the present invention is to provide an improved process for the treatment of tubular knitted fabrics that are to be napped, to the ends that the finished fabric will have substantially a zero-zero condition, i. e. no distortion either lengthwise or widthwise, and that the texture or "hand" of the fabric will be improved.

Reference is now made to the accompanying drawings wherein

Figs. 1 and 2 are block diagrams indicating sequence treatments, according to the present invention, of different fabrics as hereinafter explained; and

Figs. 3 to 8 are diagrammatic illustrations of devices which may be employed in the sequence treatments according to Figs. 1 and 2.

In order to afford a clear understanding of the treatment sequences indicated in Figs. 1 and 2, and the reasons for providing such treatment sequences for different fabrics, it is desirable, first, to set forth the distinction between the different fabrics so far as the present invention is concerned. From the standpoint of treatment according to the present invention, tubular knitted fabrics may be divided into two types or classes, as follows:

(1) Those fabrics which are stretched in the wet processing to a relatively great degree or extent; and

(2) Those fabrics which are stretched in the wet processing to a substantially lesser degree or extent.

The degree or extent to which any tubular knitted fabric will be stretched in the wet processing is dependent upon a number of factors which include the weight or density of the fabric, the stitch construction, the yarn cut and count and the type of wet processing to which the fabric is subjected. Generally speaking, lightweight and medium weight fabrics will be stretched from about 15% to about 35% of their original length, while heavyweight fabrics will be stretched from about 8% to about 15% of their original length. However, as indicated, the amount of stretch depends upon certain factors in addition to the weight of the fabric.

As previously mentioned, it is highly desirable to normalize all tubular knitted fabric by the normalizing treatment, including tubular knitted fabrics which require napping and with which the present invention is concerned. Furthermore, it should be noted here that the normalizing treatment is more easily carried out with the tubular knitted fabric in wet condition. However, in the case of the fabrics of type (1) above, i. e. fabrics which stretch greatly, it has been found that in the course of napping

such fabrics, the napping tends to stretch the fabric to a very substantial degree. Therefore, if such fabrics are first wet normalized and dried, and are then napped, the napping tends to defeat the purpose of the normalizing in that it puts back into the fabric at least a substantial part of the stretch which was removed by the wet normalizing. Therefore, it is necessary again to normalize the fabric, and this involves undesirable duplication. According to the present invention, this objection is overcome by the treatment sequence indicated in Fig. 1 in which the fabric is normalized only after napping, at which time the fabric is dry, and the dry normalizing is followed by a moisture changing step, as hereinafter specifically described. The treatment sequence of Fig. 1 is claimed in the aforementioned patent.

In the case of the fabrics of type (2) above, if such fabrics are wet normalized and dried and then napped, the napping does not greatly stretch the fabric and does not defeat the purpose of the wet normalizing, although it does impart some stretch to the fabric. According to the present invention, such fabrics are treated according to the sequence indicated in Fig. 2, in which the napping operation is followed by an agitation step, as hereinafter specifically described, which is effective to remove the stretch imparted to the fabric by the napping. The treatment sequence of Fig. 2 is claimed herein.

In the treatment of tubular knitted fabrics of type (1) above, as indicated in Fig. 1, the fabric is subjected successively to drying in stage **10**, napping in stage **11**, dry normalizing in stage **12**, moisture changing in stage **13** and finish conditioning in stage **14**.

In the treatment of tubular knitted fabrics of type (2) above, as indicated in Fig. 2, the fabric is subjected successively to wet normalizing in stage **20**, relaxed drying in stage **21**, napping in stage **22**, agitation in stage **23** and finish conditioning in stage **24**.

Figs. 3 to 8 show, diagrammatically, various devices which may be employed in treatment steps or stages of the treatment sequences represented or indicated in Figs. 1 and 2. For simplicity of illustration, in Figs. 3 to 8 the treatment step or stage illustrated in each instance is depicted as a complete process in itself in which the fabric F is drawn from a truck and is passed through the treatment stage and is then fed to some receiving means, such as a second truck. However, in actual practice of the treatment sequences indicated in Figs. 1 and 2, the overall process could be continuous, and handling of the fabric would be minimized. As far as is possible, therefore, the fabric could be fed from one treatment stage directly into the next treatment stage.

The treatment sequences indicated in Figs. 1 and 2 will now be specifically described, with reference to the specific devices shown in Figs. 3 to 8.

Referring first to the treatment sequence indicated in Fig. 1, as hereinbefore stated, this treatment sequence is utilized for the treatment of tubular knitted fabrics of type (1) above, i. e. fabrics which are stretched in the wet processing to a relatively great degree or extent. As the fabric comes from the wet processing, it is first dried in stage **10** preparatory to napping. The drying of the fabric may be carried out in any conventional dryer, although it could be carried out in a relaxation dryer of the character represented in Fig. 7 hereinafter described and shown in U. S. Patent No. 2,597,490, issued May 20, 1952, to A. O. Hurxthal. The significant point here is that relaxation drying is unnecessary because it is immaterial whether the fabric is further stretched in the drying operation, since the subsequent normalizing will remove whatever stretch has been imparted to the fabric.

Following the drying of the fabric, it is napped by means of a conventional napping device, as diagrammatically represented in Fig. 3. In the illustration of Fig. 3 the fabric is shown as being drawn from a truck **25** by nip rolls **26** over an idler roll **27** and over a spreader **28**. The nip rolls **26** feed the fabric to the napping device represented at **29**, from which it is drawn by a roll or drum **30** to a conventional folding device **31** which folds it into the truck **32**.

Following the napping operation, the fabric is dry normalized by means of apparatus of the character disclosed in the above-mentioned Redman patent. Fig. 4 shows, diagrammatically, the normalizing operation. In this showing the fabric is drawn from the truck **32** over idler rolls **33** and **34** and over the normalizing device **35** by means of nip rolls **36** which feed the fabric onto a conveyer **37**, the latter serving to carry the fabric in relaxed condition to a folding device **38** which folds it into a truck **39**. As described in the above-mentioned Redman patent, the normalizing device expands the fabric widthwise, while it is free lengthwise, to effect lengthwise shortening or condensing of the fabric, after which the fabric is relaxed and its stitches return substantially to their normal size and shape. In the arrangement of Fig. 4, the fabric is overfed onto the conveyer **37** by the nip rolls **36**, in order to relax the fabric on the conveyer.

The dry normalizing is effective substantially to remove the stretch imparted to the fabric by the wet processing and by the napping, but it has been found that dry normalizing leaves the fabric somewhat stretched in width and that the stitches do not readily assume their normal or natural condition, apparently due to the fact that the fabric is dry. We have discovered that the fabric may be greatly improved, both from the standpoint of widthwise normalization and from the standpoint of texture, by temporarily changing the moisture content of the fabric after the dry normalizing treatment represented in Fig. 4. Moreover, we have discovered that the same result may be achieved either by adding moisture to the dry fabric or by expelling all of the moisture which is present in the dry fabric to bring about a "bone dry" condition. Apparently, the act of temporarily changing the moisture content of the fabric relieves the stitches and permits them to assume fully their normal condition, whether the change of moisture content be an increase or a decrease of moisture.

While we do not wish to be bound by any particular theory as to why a temporary change of moisture content of the fabric produces the results above stated, the following is offered as a plausible explanation. It is well known that a change of moisture content of a single fiber or thread, whether the change be an increase or a decrease of moisture, will produce swelling or contraction of the thread. In the case of fabric comprising a multiplicity of fibers or threads forming the yarns which are knitted to form the stitches, a change of moisture content of the fabric, apparently causes the threads to twist tighter or looser, and relieves any stress in the stitches due to effective movement of the yarns caused by swelling or contraction of the constituent fibers or threads which are twisted together and compose the yarn. Therefore, the step of temporarily changing the moisture content of the fabric serves as an adjunct to the dry normalizing by relieving any stress which may remain in the stitches of the fabric after the dry normalizing.

As to the character of the moisture change, that is, whether it is a moisture increase or a moisture decrease, this is more or less a matter of choice. If moisture increase is selected, it may be carried out in any suitable apparatus such as the alternative forms shown in Figs. 5 and 6. In the showing of Fig. 5, the fabric is drawn from the truck **39** by a driven roll or drum **40** which overfeeds the fabric onto a conveyer **41** through a moistening chamber **42**. Within the moistening chamber there are water or steam spray jets **43** and **44** directed against the opposite sides of the fabric. The moistened fabric is carried by the conveyer **41** in relaxed condition to a folding device **45** which folds the fabric into a truck **46**.

In the alternative showing of Fig. 6, the fabric is drawn from the truck **39** by a driven roll or drum **47** which overfeeds it onto a power-driven conveyer **48**. The conveyer carries the fabric between water or steam jets **49** and **50**, the conveyer being of foraminous form to permit moistening of both sides of the fabric. The conveyer carries the fabric in relaxed condition to a folding device **51** which folds the fabric into the truck **46**.

We have discovered further that better results may be achieved by combining some agitation of the fabric with the change of moisture content thereof. Apparently, the agitation helps to relieve the stress in the stitches. If agitation is employed in the arrangement of either Fig. 5 or Fig. 6, it may be effected as the fabric is carried along on the conveyer by impinging pressurized air on the fabric from spaced nozzles (not shown).

If it is desired to employ moisture decrease or expulsion, instead of moisture addition, the moisture expulsion may be carried out in a basket dryer of the character shown in the above-mentioned Hurxthal patent. In such apparatus the fabric is loosely deposited in basket loops of a basket conveyer, and it is subjected to pressurized heated air. In the diagrammatic showing of Fig. 7, the

basket conveyer is represented at **52**. In this showing the fabric is drawn from truck **39** by a power-driven roll or drum **53***a* and is loosely deposited in the successive basket loops of the moving basket conveyer. As it is carried along by the conveyer, the fabric is subjected to pressurized heated air from ducts **53** and **54** having spaced outlet nozzles **55** and **56**. The pressurized air enters the ducts through a common conduit **57** and an air heater **58**. In the arrangement shown, the fabric is overfed by the basket conveyer onto a plane conveyer **59** which carries the fabric in relaxed condition to a folding device **60**, the latter folding the fabric into the truck **46**.

It should be remembered that the fabric is in the dry condition as it leaves the normalizing stage **12** of Fig. 1, i. e. the fabric contains only such moisture as it may have absorbed from the air. The temporary moisture expulsion treatment carried out in the apparatus represented in Fig. 7 serves to drive substantially all of the moisture from the fabric to bring about a "bone dry" condition thereof. This may be readily achieved in the apparatus of Fig. 7, by using enough pressurized heated air and by operating the basket conveyor at a proper speed.

Following the moisture changing step, the fabric is subjected to finish conditioning which is the final operation prior to cutting of the fabric for the making of garments. By "finish conditioning," as used here and in the appended claims, we mean folding or rolling of the fabric with or without calendering thereof. In the specific illustration of Fig. 8 the finish conditioning operation is shown as involving calendering and folding of the fabric. In the illustration, the fabric is drawn from the truck **46** by calender rolls **61** over an idler roll **62** and over a spreader **63**. From the calender rolls the fabric is drawn by nip rolls **64** over idler rolls **65** and **66** and over a spreader **67**. The nip rolls **64** supply the fabric to a driven folding table **68** which may be of conventional form. After being folded on the folding table **68**, the fabric is ready for the cutting thereof preparatory to the making of garments.

Referring now to the treatment sequence indicated in Fig. 2, as previously mentioned, this treatment sequence is utilized, according to the present invention, for the treatment of fabrics of type (2) hereinbefore mentioned, i. e. those fabrics which are stretched in the wet processing to a substantially lesser degree or extent than the fabric of type (1). Generally speaking, tubular knitted fabrics of relatively heavy weight will be among those identified as type (2). However, as previously mentioned, the degree or extent to which a fabric stretches in the wet processing is determined by factors in addition to the weight of the fabric.

The treatment sequence indicated in Fig. 2 is applicable to tubular knitted fabrics of type (2) principally because the napping of such fabrics does not greatly stretch the fabric, although it does impart some stretch thereto. Accordingly, in the treatment of such fabrics it is desirable, first, to normalize the fabric in the wet condition as it comes from the wet processing. The wet normalizing is performed by means of apparatus of the character disclosed in the above-mentioned Redman patent, or as diagrammatically represented in Fig. 4. This normalizing treatment is identical with that previously described, the only difference being that the fabric is in wet condition instead of being in dry condition. As previously indicated, wet normalizing of a fabric is desirable because the fabric yarns and stitches, when in wet condition, are more responsive to the normalizing treatment, and the stitches are better able to assume their normal or natural condition upon relaxation of the fabric after the widthwise expansion thereof.

Following the wet normalizing step in the treatment sequence of Fig. 2, the fabric is dried in a relaxed condition. This relaxed drying step may be carried out in apparatus of the character disclosed in the above-mentioned Hurxthal patent, or as shown diagrammatically in Fig. 7. In such apparatus the fabric is fed to the basket conveyer and is subjected to the drying action of pressurized heated air impinged against the fabric, as previously described. This drying step, however, is to be distinguished from the moisture expulsion treatment previously described in connection with the moisture changing step

in the sequence of Fig. 1. In the relaxed drying step of the sequence of Fig. 2 now being considered, it is desired only to bring about a dry condition of the fabric, i. e. a condition in which the fabric contains only such moisture as it may absorb from the surrounding air.

After relaxed drying, the fabric is napped by means of a conventional napping device such as diagrammatically represented in Fig. 3. As previously mentioned, the napping of fabric of type (2), with which we are here concerned, does not defeat the purpose of the previous wet normalizing of the fabric, but it does impart some stretch to the fabric. With such fabrics, the napping elongates the knitted stitches to some extent but not nearly to the extent that they were elongated in the wet processing. Moreover, the napping does not cause the stitches to acquire a distorted "set."

We have discovered that the stretch and distortion produced by napping fabrics of this type can be substantially eliminated by agitating the fabric after the napping operation. Apparently, the agitation relieves the stitches and permits them to return to their normal condition. Accordingly, as indicated in Fig. 2, the napping step is followed by an agitation step which is effective to eliminate the stretch imparted to the fabric by napping. This agitation step can be carried out in any suitable apparatus, and the agitation may be effected in various ways such as air agitation, mechanical agitation. etc. By way of example, the agitation step may be carried out in an apparatus of the character represented in Fig. 7, using air impingement to effect the agitation. As drying is not involved, it is unnecessary that the air be heated. As shown in Fig. 7, provision may be made for supplying pressurized unheated air to the ducts **53** and **54** from a conduit **69**. An air-flow controlling member or vane **70**, pivoted at **71**, may be moved to the broken line position to shut off conduit **57** and to open conduit **69**. By supplying unheated air at suitable velocity, the fabric may be agitated sufficiently for the intended purpose mentioned above.

Following the agitation step, the fabric is subjected to finish conditioning which is similar to the final step in the treatment sequence of Fig. 1 as described above.

From the foregoing description it will be seen that the invention provides novel treatment sequence for various tubular knitted fabrics that are to be napped, and the treatment sequence which is applicable in any instance serves to so condition the fabric that the stitches thereof are substantially in their natural or normal condition, thus substantially preventing shrinkage of garments made from the fabric.

It will be understood, of course, that the invention is not limited to the specific disclosure, but is susceptible to such modifications as will occur to those skilled in the art.

We claim:

1. A method of treating tubular knitted fabric as it comes from wet processing, which comprises: internally expanding the wet fabric widthwise while it is sufficiently free lengthwise to permit lengthwise shortening or condensing thereof, then permitting the fabric to relax; drying the fabric in relaxed condition; napping the fabric; agitating the napped fabric; and finish conditioning of the fabric for the cutting thereof in subsequent manufacture of garments.

2. A method of treating tubular knitted fabric as it comes from wet processing, which comprises: internally expanding the wet fabric widthwise while it is sufficiently free lengthwise to permit lengthwise shortening or condensing thereof, then permitting the fabric to relax; drying the fabric in relaxed condition; napping the fabric; agitating the napped fabric; calendering the fabric; and packaging the fabric for the cutting thereof in subsequent manufacture of garments.

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