PLEATING PROCESS FOR FABRICS OF THERMOPLASTIC FIBERS

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This invention relates to a process for pleating fabrics of thermoplastic fibers and more particularly to a process for producing improved pleated fabrics of such thermoplastic fibers.

Thermoplastic fibers, including acrylonitrile polymer fibers particularly those containing at least 70 percent by weight of acrylonitrile, nylon, Dacron, Vinyon N, and vinyl and vinylidene halide fibers such as Vinyon, saran, etc., are being widely employed in the design and construction of textile fabrics, constituting in some cases the entire fiber content, and in other cases blended with other thermoplastic fibers and/or with one or more of the natural and non-thermoplastic fibers. Wide scale use of these fabrics is being made in clothing design and other uses where pleating in various forms is desirable. However, the appearance of the pleated fabrics has frequently not been of acceptable quality because of certain properties of the thermoplastic fibers and the nature of the pleating and pleat-setting operation as conventionally conducted.

Conventionally, pleating of textile fabrics has been conducted on a piece basis, particularly when such fabrics are to be employed in production of various types of clothing. It is the common practice to place a piece of fabric to be pleated between two sheets of paper or similar material which have been previously folded into the desired form which is desired to produce in the pleated fabric. The folded pattern sheets or templates, known as pleating patterns or pleat formers, are flattened and the fabric to be pleated placed between them in a flattened condition. After the fabric has been placed between the pattern sheets and fabric are then placed upon an unfolded sheet of paper or other suitable material and the entire assembly is rolled into cylindrical form or wrapped as a rectangular package for the pleat-setting operation. This operation is conventionally conducted in a steam chest or autoclave and the rolled cylinders or wrapped packages of fabric and pleating patterns are subjected to insufficient heat to set the fabric into the form of the pleats corresponding to the folded pleating pattern.

In the case of fabrics composed wholly or in part of thermoplastic fibers the appearance of cockle, puckers, ripple, or bubble characteristics has been observed after the standard or conventional operations outlined above. These imperfections in the fabric have rendered them unacceptable or at least of second quality. In the case of some types of pleats, such as the so-called knife pleats, the degree of sharpness desired has not been retained after the fabrics have been removed from the pleating pattern and further handled in the manufacture of clothing. Likewise, there has frequently resulted in the case of fabrics containing thermoplastic fibers, the development of shine or glaze on the surface of the pleated fabric or cloth. All these imperfections have created serious disadvantages to the use of pleating in clothing and textile design. The production of inferior, unmerchandizable pleated fabrics is extremely costly to the pleater. The occurrence of imperfections, particularly in fabrics containing thermoplastic fibers, has seriously limited the fashion and design scope of apparel manufacturers in the use of such fabrics. The difficulty of securing satisfactory pleating has likewise reduced the versatility of a large group of fabrics woven by fabric mills. Consequently, there has long been desired a successful method of pleating fabrics containing thermoplastic fibers which would produce a much lower incidence of the imperfections referred to above and, conversely, a much higher level of commercially acceptable production.

The reasons for the occurrence of the imperfections such as cockle, puckers, ripple, and bubble are many, but may largely be attributed to five principal factors. Deviations in the surface pleating pattern such as warping or bubbling in the paper of the pattern forms pockets in the pattern in which fabrics may fall and result in pleating operations, and conversely such areas in the pleating pattern which have bubbled may impress themselves upon the fabric in a manner akin to embossing. Inherent instability of the fabric construction which produces shrinkages or extensions in the cloth when exposed to conventional pleating practices including the heating required in pleat-setting are responsible for certain of the above conditions. In hand pleating the fabric lying between the bottom and top layers of the pleating patterns or formers is exposed to variations of tension due to the nature of the pleating pattern itself, in addition to inability to maintain uniform tension when folding or rolling the pleat formers or patterns. Conventional pleating practice requires the setting or baking of the pleated fabrics by placing the rolled or folded pattern containing the sandwiched fabric in a steam box or autoclave for the time necessary to set the pleats. Since the moisture of the steam and the heat do not penetrate the pleating patterns uniformly, temperature differentials are established within the pleating pattern in proportion to the variation of insulating factors such as air space, density differences in the rolled or folded pattern, the amount and type of paper or fabric used to wrap around the patterns and fabrics, etc. These factors cause the pleats to vary in sharpness and in appearance within any given assembly of fabric and pleating patterns. Because of the above non-uniformity of penetration of heat and moisture when patterns contain various reversals of the pleating planes or pleated planes of non-parallel sides or variation of the pleated planes contained in a repeat of the pleat pattern the fabric or cloth lying therein will have areas of surface which are slack or loose. More air space is found in these slack areas permitting the fabric and pattern to shift. These air spaces also allow a greater degree of moisture condensation upon the fabric thereby permitting a greater stress-strain differential and failure in taut areas of the pattern. For all the above reasons, and possibly others, pleating in the piece of fabrics containing thermoplastic fibers has presented many problems, solutions to which have long been sought.

The principal object of the invention is to eliminate or reduce the development of cockle, puckers, ripples, or bubble during and after the pleating of fabrics containing thermoplastic fibers. A further object is to enhance the sharpness of the pleats obtained in such pleating operations. A still further object is to reduce or eliminate the development of shine or glaze in pleated fabrics or cloths containing thermoplastic fibers. Still further objects will appear from the discussion of the instant invention hereinafter.

The above and other objects of the invention can be accomplished by a process for pleating fabrics containing thermoplastic fibers or filaments which comprises placing...
and securing one or more layers of fabric to be pleated, dampened with water, in an assembly of pleating patterns arranged in register, or pleating, relationship and extended to from 80 to 90 percent of the maximum extendible length thereof. The assembly of pleating patterns is extended to maximum extendible length and secured, thereby simultaneously applying tension to the layers of fabric securing thereto. The layered assembly of pleating patterns and fabric is then adjusted to pleat-setting position by folding or rolling so as to form pleats in the said fabric, and the said assembly wrapped and bound. Thereafter, the wrapped and bound assembly is heated at a temperature of at least 200°F. for a time sufficient to dry the fabric in the assembly, and then slowly cooled at a rate not to exceed 6°F. per minute until the temperature in the interior of the assembly is not greater than 90°F. Finally, the thus pleated fabric is separated from the assembly. It has unexpectedly been found that the above pleating process results in the elimination or substantial reduction of cockle, puckeer, ripple or bubble in the thus pleated fabrics containing thermoplastic fibers. In addition, sharpness of the resulting pleats is enhanced. Furthermore, the occurrence of shine or glaze in the thus pleated fabric is eliminated substantially reduced.

The process of the instant invention is more specifically described with reference to the attached drawing wherein:

Figure 1 is a plan view of one form of apparatus suitable for use in the instant process.

Figure 2 is a side elevation view of the apparatus shown in Figure 1.

Figure 3 is a side elevation view of the apparatus shown in Figure 1 in fully assembled, extended position.

Figure 4 is an enlarged view of the apparatus of Figure 1 illustrating the formation of pleats by adjusting the assembly of pleating patterns and fabric.

Figure 5 is a view of the wrapped and bound assembly preparatory to setting the pleats in the fabric.

With reference to Figures 1 and 2, preparatory to pleating a fabric a set of pleating patterns or pleat formers consisting of two parts, upper pleating pattern 2 and a lower pleating pattern 3, are secured at one end 4 by suitable clamping means 5 to a plane surface 6, such as a table, bench, or the like. The upper pattern 2 is shown rolled or folded back from the lower pattern 3 toward the secured end 4 to expose a sufficient area of the lower pattern 3 to accommodate the fabric that is to be pleated. The lower pattern 3 is shown extended from to 80 to 90 percent, and preferably approximately 90 percent, of its maximum extendible length and secured in that position to the plane surface 6 by clamping means 8. Pleating patterns 2 and 3 may be secured by any commonly employed clamps or other suitable mechanical means. Any type of pleating patterns or formers commonly used in commercial pleating operations, such as heavy paper, cardboard, or like sheet materials, may be employed in the practice of this invention.

There is then placed upon the partially extended lower pleating pattern 3 one or more layers of fabric or cloth 10 to be pleated and the said fabric properly aligned for the desired pleat design. The fabric 10 in its extended position is then secured under slight tension to the lower pleating pattern 3 at a number of points around the perimeter of the fabric by means of pins, hooks, or other suitable mechanical means such as pins, hooks, etc. Alternatively, the fabric 10 may also be secured to the lower pleating pattern 3 means of any liquid or solid adhesive which can be suitably removed from the fabric at the completion of the pleating process, the use of staples 9 as shown in drawing being by way of illustration only. The fabric 10 is secured to the lower pleating pattern 3 in such a manner that it is securely held to the partially extended lower pleating pattern with slight tension, but without producing visible stresses, strains, or distortions in the plane of the said fabric or cloth. The fabric or cloth 10 may be dampened but not over-saturated with water prior to its positioning on the lower pleating pattern 3. The preferred method, however, is to secure the dry fabric to the lower pleating pattern, as shown in Figures 1 and 2, and then to dampen the secured fabric with water by spraying, sponging, brushing, etc. Water alone, of the quality commonly available in textile processing, is the preferred method of securing the fabric to the lower pleating pattern. The fabric, when wet, is then transferred to the lower pleating pattern. Thereafter the upper pleating pattern 2 is secured to the lower pleating pattern 3 by means of staples 13 and 14, or other means, such as pins, hooks, etc. The extension of the lower pleating patterns 3 to which the fabric 10 is secured results in a simultaneous application of tension to the fabric. This additional tension of the fabric acts to minimize any inherent shrinkage or extension resulting from a particular construction of the fabric employed. It also acts to minimize any slackness or looseness in the fabric prior to forming the pleats therein.

The desired pleat design is then formed in the fabric assembled between the upper and lower pleating patterns. This forming of the pleats is accomplished by folding or rolling the patterns in their previously formed creases to the position in which the pleats are set. In the case of deep knife or accordion pleats, including sunburst or accordion pleats radiating from one selvedge of the fabric, the patterns are folded. In some knife pleat designs and box pleats the pleats are formed by tightly rolling the pleating patterns with the fabric assembled therewith. It is generally desirable that maximum uniform pressure be applied to the assembly during this operation. The resulting folded or rolled assembly is then wrapped and bound in suitable fabric, paper, or like sheet materials and secured by means of tieing, strapping, or the like.

In Figure 4 there is illustrated the formation of accordion pleats in the fabric 10 by releasing clamps 8 holding one end of the assembly of pleating patterns 2 and 3 and fabric 10 and folding the assembly into the aligned folds of the patterns. Preferably the opposite end 4 of the pleating patterns 2 and 3 are left secured by clamps 8 until the folding operation is completed in order that maximum uniform pressure may be applied to the assembly of pleating patterns and fabric during folding. In this manner a length of fabric, paper, or like sheet material, not shown in Figure 4, can be positioned on the surface 6 of the table, bench, or like form for wrapping the folded assembly. The folded assembly of pleating patterns 2 and 3 and fabric 10 is then released from clamps 8 and wrapped in the fabric, paper, or like material and bound therein by means of tieing, strapping, or the like. Figure 5 illustrates the wrapped and bound assembly 20, wherein fabric 21 has been wrapped around the folded assembly of pleating patterns 2 and 3 and the fabric 21 is then released from clamps 5 and wrapped in the fabric, paper, or like material and bound therein by means of tieing, strapping, or the like.

The wrapped and bound assembly of pleating patterns and fabric, as illustrated by Figure 5, is then transferred
to a chamber suitable for heating the assembly through-
out with either steam or dry heat to a temperature of
at least 200 °F. and for a time sufficient to dry the fabric
in the assembly. The heating chamber may take the
form of a steam box, or, preferably, an autoclave. Any
enclosure capable of maintaining a temperature of from
200 °C to 212 °F. at atmospheric pressure is suitable for
use as a steam box. The time required for substantially
drying a fabric in the pattern and fabric assembly ranges
from about 15 to about 45 minutes in the steam box,
depending on the weight of the fabric being pleated. The
heating and drying step is preferably carried out in an
autoclave capable of producing temperatures in the range
of about 225 °F. to 260 °F. The preferred range of
temperatures for use in drying and setting the fabric
being pleated is from 230 °F. to 250 °F. and for periods of
time ranging from about 10 to 15 minutes depending
upon the temperature of the autoclave and the thick-
ness of the fabric being pleated. For example, a fabric
weighing up to approximately 4 ounces per square yard
which is suitably pleated by treatment in an autoclave at 235°
F. for 10 minutes, while a fabric weighing between about
4 and about 8 ounces per square yard can be success-
fully pleated in an autoclave with a temperature of 250°
F. for 10 minutes. On the other hand, a fabric weigh-
ing about 10 ounces per square yard can be pleated
in an autoclave with a temperature of 250° F. for 15
minutes. In the case of very heavy fabrics the time in
the autoclave can be extended sufficiently to insure drying
and setting of the fabric. In general, greater times than
those indicated are to be avoided in order not to produce
shine or glare on the pleated fabric because of prolonged
heating after the fabric has become substantially dry.
When heating times are employed as set out above, any
tendency of the pleated fabric to display shine or glare has
been found to be substantially prevented.

When the pleat-setting operation involving heating and
drying the fabric has been completed the assembly of
pleating patterns and fabric is removed from the heated
chamber, autoclave, or steam box, and is cooled slowly under controlled conditions of heat in order to
prevent sudden temperature drops within the assembly
and consequent condensation of moisture therein which
will tend to cause cockle, pucker, ripple, bubble, etc.,
in the pleated fabric. The assembly is cooled at a rate
not to exceed a temperature loss of about 6 °F. per
minute, and preferably at about 4 °F. per minute. This
slow and controlled cooling is continued until the tem-
perature in the core or interior of the pleated fabric
is greater than 90 °F., and preferably is about 80 °F.
The slow rate of cooling of the heat-set pleated fabric while
still in the assembly of the pleating patterns and fabric
is a very important feature of the instant process in that
imperfections which may develop in the fabric as a re-

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result of uneven cooling are prevented. After the assembly
of pleating patterns and fabric has cooled to the indicated
interior temperature the assembly may be disassembled
in well-known manner and the pleated fabric produced
suitably packaged for storage, shipment, or use, as desired.

As indicated above, the instant process for pleating
fabrics is suitable for all thermoplastic fibers and fila-
ments. It has been found particularly useful in the case
of fabrics of acrylonitrile polymer fibers and filaments,
i.e. those prepared from polymers containing at least 70
percent by weight of acrylonitrile in polymerized form,
or blends of natural or artificial fibers with such acrylo-
nitrile polymer fibers or filaments. Thus, fabrics con-
taining acrylonitrile polymer fibers alone and those fab-
rics which are blends of natural, synthetic, and artifi-
cial fibers with acrylonitrile polymer fibers can be quite successfully pleated in the substantial
absence of imperfections, such as cockle, pucker, ripple,
bubble, shine or glare and with enhanced sharpness of
the pleats obtained by the process of this invention.

Furthermore, fabrics of the other thermoplastic fibers
and filaments and blends thereof with natural and other
non-thermoplastic fibers are amenable to this process.
Fabrics containing such fibers or filaments as nylon, both
hexamethylene adipamide and polycaprolactam, poly-
esters, such as polyethylene terephthalate, Vinyon-N and
other blends of vinyl chloride and acrylonitrile polymers,
the vinyl and vinylidine halide fibers, such as Vinyon,
saran and others, polyethylene, such as polyethylene,
and the thermoplastic cellulose derivative fibers, such as
cellulose acetate, secondary cellulose acetate, and cellulose
tri-acetate, can be pleated by the process of the inven-
tion. Generally, it may be said that any fabric contain-
ing at least about 5 percent by weight, and preferably at
least 15 percent by weight, of thermoplastic fibers or
filaments are suitable for employment of the above proc-

es.

The advantages of the process of the instant invention
over those of the prior pleating art are several. The
process of the instant invention eliminates, prevents or
minimizes the effect of cockle, ripple, pucker, bubble,
etc., appearing in the pleated fabric during the pleating
operation. The uniform application of moisture on the
fabric surface enables the heat generated during the pleat-
setting operation to be conducted evenly throughout the
fabric. It also reduces the possibility of sudden or high
temperature differentials existing between the dry fabric
as in normal pleating operations, and the pleat-
setting environment. The wetting-out or dampening also pre-
vents the sudden application of wet heat to a dry fabric,
as in some normal pleating procedures, which is float-
ing or lies loosely in the pleating pattern causing un-
even, unbalanced drying of cloth during pleat-setting with
consequent distortion. Wetting-out or dampening of the
fabric prevents the fabric from slipping, sliding or shift-
ing while it is in the assembly with the pleating patterns
in the pleating operation. Inherent fabric instability due
to the design or construction thereof is minimized by the
securing of the fabric to the pleating pattern with slight
 tension and its further tensioning upon the extension of
the pattern to its maximum extensible length. Sharp-
ness of the pleats formed is enhanced because of the
tensioning and dampening of the fabric before forming
the pleats. The presence of moisture due to the dampen-
ing or wetting-out procedure substantially reduces the
tendency of the pleated fabric to shine or glare because
of prolonged heating of dry fabric as in normal pleat-
ing processes. The percentages of seconds or unaccep-
table quality, as compared with normal pleating operations,
is greatly reduced by the use of the present invention.
From the above it will be apparent that the present in-
vention provides a new and improved method of pleat-
fabrics containing thermoplastic fibers which is of
greater efficiency than the normal pleating methods and
provides a process by which many commonly occurring
fabric imperfections are eliminated or substantially re-
duced.

As many apparently widely different embodiments of
this invention may be made by those skilled in the art
without departing from the spirit and scope thereof, it
is to be understood that the invention is not limited to
the specific embodiments thereof except as defined in
the appended claims.

I claim:
1. A process for pleating fabrics containing thermo-
plastic fibers or filaments which comprises placing and
securing a water dampened fabric in a pleating assembly
comprising pleating patterns arranged in pleat rela-
tionship to each other and extended to 80 to 90 percent
of the maximum extensible length thereof, extending said
pleating assembly to the maximum extensible length thereof
whereby said fabric is placed under tension, as-
sembling said pleating assembly into pleat-setting position,
wrapping and binding said assembly, heating the wrapped
and bound assembly at a temperature of at least 200°F.
for a time sufficient to dry the fabric, slowly cooling the
assembly at a rate not to exceed 6° F. per minute until the temperature in the interior of the assembly is not greater than 90° F., and thereafter separating the pleated fabric from the assembly.

2. The process as defined in claim 1 wherein the fabric is dampened with water containing in solution from 0.5 to 1.5 percent by volume of a wetting agent.

3. A process for pleating fabrics containing thermoplastic fibers or filaments which comprises placing and securing a fabric in a pleating assembly comprising pleating patterns arranged in pleating relationship to each other and extended to 80 to 90 percent of the maximum extensible length thereof, dampening the fabric with water, extending said pleating assembly to the maximum extensible length thereof whereby said fabric is placed under tension, assembling said pleating assembly into pleat-setting position, wrapping and binding said assembly, heating the wrapped and bound assembly at a temperature of at least 200° F. for a time sufficient to dry the fabric, slowly cooling the assembly at a rate not to exceed 6° F. per minute until the temperature in the interior of the assembly is not greater than 90° F., and thereafter separating the pleated fabric from the assembly.

4. The process as defined in claim 3 wherein the fabric is dampened with water containing in solution from 0.5 to 1.5 percent by volume of a wetting agent.

5. A process for pleating fabrics containing thermoplastic fibers or filaments which comprises placing and securing a water dampened fabric in a pleating assembly comprising pleating patterns arranged in pleating relationship to each other and extended to 80 to 90 percent of the maximum extensible length thereof, extending said pleating assembly to the maximum extensible length thereof whereby said fabric is placed under tension, extending said pleating assembly to the maximum extensible length thereof whereby said fabric is placed under tension, wrapping and binding said assembly, heating the wrapped and bound assembly at a temperature of at least 200° F. for a time sufficient to dry the fabric, slowly cooling the assembly at a rate not to exceed 6° F. per minute until the temperature in the interior of the assembly is not greater than 90° F., and thereafter separating the pleated fabric from the assembly.

6. A process for pleating fabrics containing thermoplastic fibers or filaments which comprises placing and securing a water dampened fabric in a pleating assembly comprising pleating patterns arranged in pleating relationship to each other and extended to 80 to 90 percent of the maximum extensible length thereof, extending said pleating assembly to the maximum extensible length thereof whereby said fabric is placed under tension, rolling said pleating assembly into pleat-setting position, wrapping and binding said assembly, heating the wrapped and bound assembly at a temperature of at least 200° F. for a time sufficient to dry the fabric, slowly cooling the assembly at a rate not to exceed 6° F. per minute until the temperature in the interior of the assembly is not greater than 90° F., and thereafter separating the pleated fabric from the assembly.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,924,361

Robert P. Nirenberg

February 9, 1960

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, lines 24 and 25, strike out "of filaments prepared from polymers containing at least 70 percent by weight".

Signed and sealed this 9th day of August 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents