ABSTRACT: An air-operated fabric-guiding system is disclosed. The new system is disposed along and encompasses the edge portions of a laterally disposed fabric. Sensors and actuators are provided for causing an outward discharge of air along the surface of the fabric in response to movement of the fabric from a predetermined course. The air emission on one side of the fabric causes a shifting of the fabric in the direction of the air emission, thereby realigning the fabric on the predetermined course.
PNEUMATIC FABRIC-GUIDING SYSTEM
RELATED APPLICATIONS

This application is a division of our copending application Ser. No. 611,609, for "Method and Apparatus for the Handling and Treatment of Knitted Fabrics, Particularly in the Open Width," filed Jan. 25, 1967, and now U.S. Pat. No. 3,499,011 which discloses a processing line for knitted fabrics including the guiding device of this application and specific downstream processing units.

BACKGROUND OF THE INVENTION

Knitted fabric is particularly characterized by its geometric instability, in that it is readily distortable under tensions and other forces normally applied during fabric processing. In addition, the width and length dimensions of a knitted fabric are inherently interrelated, such that lengthwise tensions applied to the fabric during normal processing result not only in elongation of the fabric but in a corresponding narrowing of the fabric width. When the fabric is processed in open width form, additional problems are presented, particularly with regard to stabilization of fabric geometry and to a tendency for the fabric edges to curl.

Heretofore, it has proven very difficult to process knitted fabric in open width form, because of the inability to maintain control over the geometry of the fabric (i.e., its length and width dimensions, stitch or loop formation, crossline configuration, etc.). And, it has been more customary to process the knitted fabrics in tubular form and thereafter to slit and open the processed tube. However, processing prior to slitting and opening results in an "edge crease" in the center of the open width fabric, which is objectionable in the finished product (e.g., often a laminating with vinyl) and is very difficult to remove. Because the edge crease problem is obviated by processing of the fabric in open width form, there has been an increasing need for processing lines and equipment suitable to this purpose.

In accordance with the foregoing objectives, the invention provides a pneumatically operated device for handling and guiding knitted fabric, most advantageously, in open width form. The new device is typically located in the processing line before processing operations such as liquid impregnation and drying of the fabric and serves to act upon the fabric to maintain it in position for proper engagement by the downstream processing units. A particularly advantageous characteristic of the new and improved fabric-guiding device is the absence of mechanical engagement of the fabric during fabric handling and alignment and the consequent absence of undesirable geometric readjustment of the unstable fabric.

SUMMARY OF THE INVENTION

In accordance with a specific aspect of the invention, novel and improved facilities are provided for initially manipulating to flat form and initially substantially aligning the flat, open width knitted fabric. The arrangement is such that the open width fabric, which is very delicate to handle and which may tend to curl badly at the edges, is drawn under control from a supply, substantially centered with respect to the principal axis of the processing line, and laid flat at the edges for proper threading into the downstream processing equipment. The new apparatus comprises novel airflow-directing means located at the opposite margins of the fabric and operative to direct forcible streams of air laterally outward along the top and bottom surfaces of the fabric. The friction between the fabric and the laterally outwardly flowing airstreams is sufficient to impart a very slight widthwise tension to the fabric, sufficient to cause it to lie flat and wrinkle-free and to flatten and at least temporarily uncurl the edge extremities.

Sensing edge position sensing means are provided in close coupled association with each of the above-described air nozzle assemblies to control the flow of air thereto in response to the position of the fabric edge. If the fabric tends to be drawn toward the right-hand side of the line axis, the edge sensing control is operative to reduce the airflow velocity at the right side nozzle or nozzles and/or to increase the airflow velocity at the left-hand nozzle or nozzles, and vice versa. The arrangement is such that an unbalancing tendency of the fabric in a given lateral direction relative to the axis of the processing line causes an automatic correction in the effective airflow velocities to maintain the fabric in a centered relationship.

The air-actuated manipulating and guiding means is particularly advantageous in connection with the handling and treatment of open width knitted fabric, because of the general difficulties of handling such fabric and initially placing it in flat, wrinkle-free form without distorting or distending it in some undesirable manner. By acting on the fabric margins by outwardly flowing airstreams only, it is possible to avoid all mechanical contact with the fabric and thus to avoid mechanically distorting the fabric or acting upon it with greater force than desired at the particular stage of the processing sequence.

While the air guide arrangement is especially suited for the guidance of open width knitted fabric in the overall processing line described herein, it will be appreciated that the inventive principles thereof will have widespread applicability in other environments and with other web material.

For a better understanding of the above and other features and advantages of the invention, reference should be made to the following detailed description and to the accompanying drawing.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a elevational view of a fabric handling and processing line incorporating various features of the invention.

FIG. 2 is a cross-sectional view taken generally along line 2—2 of FIG. 1.

FIG. 3 is an enlarged, fragmentary, cross-sectional view taken generally along line 3—3 of FIG. 2.

FIG. 4 is an enlarged, fragmentary, cross-sectional view taken generally along line 4—4 of FIG. 1.

FIG. 5 is a fragmentary, cross-sectional view taken generally along line 5—5 of FIG. 4.

DESCRIPTION OF PREFERRED EMBODIMENTS OF INVENTION

Referring now to the drawings, and initially to FIG. 1, the reference numeral 10 designates a supply container for web material to be processed in accordance with the invention. The web material 11 most advantageously is an open width knitted fabric and will be assumed to be such in the remainder of this description. However, it will be understood that at least certain aspects of the present invention may be applicable to other web materials, including tubular knitted fabrics, as will appear.

As illustrated in FIG. 1, the open width knitted fabric web 11 advantageously is guided upwardly out of the supply container 10, through a first-stage fabric handling and guiding system 12 (if necessary), and over and about an idler roll 13. The guiding and handling system 12, to be described in detail, functions to manipulate the fabric web to a substantially flat form and serves to at least approximately center the fabric web relative to the principal longitudinal axis of the processing line. After passing over the guide roller 13, the generally flat web of open width fabric travels downward to and around a flattening roll 14 and then through a second-stage fabric handling and guiding system 15 which is generally similar to the first-stage handling and guiding system 12 located directly above the supply container. The handling and guiding system 15 acts upon the fabric in a manner to present it in substantially flat, wrinkle-free form and also substantially centers the fabric along the axis of the processing line.

As will be understood, the fabric handling and guiding systems 12 and 15 perform similar functions and, in many circumstances, it might be feasible to eliminate the first system 12. However, for maximum reliability and accuracy of align-
ment, it is often advantageous to provide a pair of spaced handling and guiding systems, the first being located in a manner to act upon the fabric as received from the supply container, and the second positioned to act upon the fabric immediately prior to its entry into the principal processing apparatus.

In the processing line illustrated in FIG. 1, the spread-flat open width knit fabric is advantageously directed through a padding processor, generally designated by the numeral 20, the fabric having been decurled immediately in advance thereof, as described in our copending application Ser. No. 611,609. The padding processor may typically consist of three processing rollers 17-19, arranged to form a reservoir 20 for processing liquid, a first nip 21 for extracting the fabric (if necessary) and a processing nip 22 for padding the processing liquid. The reservoir 20 may be supplied with a suitable processing solution, such as a "permanent press" resin, with which the fabric is uniformly impregnated as it passes through the nip 22. Structurally, the processing pad 16 may be generally similar to the apparatus described in the S. Cohn et al. U.S. Pat. No. 3,207,616 and in the E. Cohn et al. U.S. Pat. No. 3,261,184, it being understood that the equipment is, in its most advantageous form, for the purposes of the present invention, adapted to accommodate and process open width knit fabric.

The resin-impregnated fabric discharged from the exit side nip 22 of the processing pad 16 is guided upward and about a speed-controlled roller 24 and thence sinusously about a plurality of support rollers of a distending or spreading apparatus generally designated by the numeral 26 which serves to laterally distend the impregnated fabric to a predetermined, uniform width as described in detail in our copending application Ser. No. 611,609.

After lateral distention to a predetermined width, the fabric, now designated by the numeral 27, is discharged over a control roller 28 and guided about an input speed roller 29 for a fabric drying and/or curing apparatus generally designated by the numeral 30. Most advantageously, the fabric drying and curing installation may be constructed in accordance with the S. Cohn et al. U.S. Pat. No. 3,102,006 and/or the S. Cohn et al. U.S. Pat. No. 3,065,551.

In accordance with broader aspects of the invention, the fabric 11, in its "as received" condition from the supply container 10, is drawn vertically upward through the handling and guiding device 12 (it being understood, however, that the device 12 may be omitted in many cases, where adequate guidance is provided by the device 15). The device 12, as will be described in more detail, serves to direct controllable airflow upward, outward and over the marginal edge portions (at least) of the fabric at opposite sides. The frictional effects of the air flowing laterally outward over the fabric surfaces tend to impart a very slight widthwise tension to the fabric, to an extent sufficient to cause the fabric to assume a generally flat, wrinkle-free form, and also to tend to remove any "curl" which may tend to appear at the edge extremities of the fabric, particularly in the case of fabric which has been knitted in tubular form and subsequently slit and laid open to flat, open width form. The fabric handling and guiding system 12 also includes means for sensing the locations of the edge extremities of the flattened fabric and for regulating the effective force and velocity of the airstreams in accordance therewith, such that the flattened fabric web tends automatically to be centered with respect to the principal axis of the processing line.

The fabric-handling and guiding system 12 functions similarly to the system 12 but serves to center the flattened fabric more accurately, by reason of the fact that the incoming fabric is already approximately centered by the action of the handling and guiding system 12, and the fabric is again flattened and decurled in preparation for its entry into the processing system.

With particular reference to FIGS. 2 and 3, the fabric-handling system 12 is shown to comprise a pair of spaced air nozzle units 31, 32, which may be of generally corresponding construction, taking into account that the separate units face in opposite directions. Each of the air nozzle units consists essentially of a flow nozzle 33, an air blower 34, and a motor 35 for driving the blower. The opposed nozzle units 31, 32 are mounted on suitable brackets 36 for transverse sliding movement on a horizontally disposed traverse bar 37, the latter being suitably secured by clamp brackets 38 to frame uprights 39. Threaded shafts 40, 41, typically controlled by means of handwheels 42, the numeral 43, are provided for adjustment of the air nozzle units 31, 32 to be independently adjusted inward and outward of the axis of the processing line to accommodate fabrics of various initial widths. Normally, the air nozzle units will be initially adjusted in symmetrical relation to the line axis, as will be understood.

The second-stage handling and guiding system 15 likewise consists of an opposed pair of air nozzle units 44, each consisting of a flow nozzle 45, blower 46, and blow motor 47 (see FIGS. 4 and 5), all generally similar in construction to the corresponding units of the first-stage handling system 12. The nozzle units of the second-stage system 15 are suitably supported by slide brackets 48 on a frame stand 49, for controlled inward and outward adjustment by means of threaded shafts 50.

With reference now to FIGS. 3-5, the respective airflow nozzles are shown to comprise a pair of discharge elements 51, 52 arranged in spaced relation to extend inwardly over the fabric edge margins, in straddling relation to the fabric web. These separate discharge elements join to form a common nozzle chamber 53, which is in direct communication with, and advantageously may be structurally supported by, the discharge outlet 54 of the blower. Each of the discharge elements includes an outside wall 55 which extends inward toward the center of the web from the inlet chamber 53, curves through a 180° arc to form an inner end wall 56, and then extends outward at 57 a short distance generally parallel to but spaced slightly from the intended plane of the fabric web 11. The discharge elements also include inside walls 58 which converge and join at the inlet chamber 53 and extend inward, toward the axis of the web, to terminal points beyond the terminal ends of the outer wall sections 57 but short of the end walls 56. Suitable sidewalks 59, 60 substantially close in the discharge elements, so that each element defines an air discharge outlet arranged for directing a controlled low-pressure stream of air at suitable, relatively low velocity in an outward transverse direction, over the surface of the fabric. As is evident in FIGS. 3-5, the opposed discharge elements of each flow nozzle unit are so spaced and arranged that the discharged airstreams are convected rather closely to the fabric surfaces over a substantial portion of the length of the nozzles so that an effective frictional force is applied to the fabric edge margins.

It will be understood, of course, that the specific nozzle structure herein illustrated is merely representative of many possible variations, the significant consideration being that airstreams are controllably directed over opposed surfaces of the fabric margins, in a generally outward direction. This will cause the fabric to move or less float in the opposed airstreams of a nozzle unit, and a pair of such nozzle units, operating in conjunction, function in a unique manner to literally float the fabric and simultaneously apply a slight widthwise tension thereto at the edge margins, sufficient to manipulate the fabric into a flat, wrinkle-free full-width form. The fabric is handled in this most desirable manner without mechanically gripping or otherwise physically contacting the fabric and therefore without running the concurrent risk of distorting or marring the fabric. Of particular importance, the transversely outward flow of low-velocity air over the fabric edge margins serves as a wholly effective and advantageous manner to decurl the edge extremities of the fabric, so that the fabric may subsequently be processed in its fully extended open width form, free of edge folds or creases resulting from mechanically engaging the fabric without fully decurling. Of course, it will be understood that, particularly with respect to fabrics knitted in tubular form and subsequently slit and opened to full width,
the tendency for the edges to curl may be strong and recurrent, and "spot" decurling may be required at several stages of the processing operation.

As a feature of the invention, control means are provided in conjunction with the respective air nozzle units, or at least one of them, effective to sense the location of the fabric edge extremities and to control the air nozzle effectiveness in accordance therewith in a manner to compensate for any tendency of the fabric to shift off of the centerline of the equipment line. FIGS. 4 and 5 illustrate a simplified and advantageous form of edge-sensing control for the second-stage fabric-handling system 15, which may comprise a suitable mercury switch assembly (not shown) which is mounted on the nozzle unit and includes a mercury contact bulb 62 carried by a pivot shaft 63 which is journaled for free rotational movement through an arc sufficient to make and break the switch contacts of the mercury bulb 62. In the specific arrangement shown herein, the shaft 63 extends over the upper one of a pair of discharge elements and carries a plurality of downwardly extending edge-sensing fingers 64. The unbalanced weight of the sensing fingers causes them to extend straight downward, normally, but permits them to be effortlessly displaced outwardly by the fabric edge 65 (FIG. 4) should it tend to shift too far toward the outside. During operation, if the fabric should shift off the centerline, i.e., to the right in FIG. 4, or into the plane of the paper in FIG. 5, sensing elements 64 will be rotatably displaced in a counterclockwise direction (FIG. 4), causing a gravitational shift of the mercury in mercury bulb 62. The switch contacts are thereby broken, shutting off the blower motor. The consequent absence of the airflow indicated by the arrows in FIG. 4 eliminates a force tending to move the fabric to the right and consequently results in the fabric recentering itself by moving to the left, as shown in FIG. 4 or out of the plane of the paper as shown in FIG. 5.

Typically, a simplified form of fabric-handling and guiding system according to the invention includes a sensing switch mechanism along each edge of the fabric, associated with a blower motor and arranged to control the speed of the motor in response to positions of the sensing switch. Typically, the sensing elements are spaced slightly wider than the fully opened width of the fabric, in a flat, wrinkle- and curl-free condition, so that a slight tolerance for widthwise variations is accommodated. However, if the fabric web wanders beyond the tolerated limits from its intended course, one of the mercury-sensing switches is actuated to bring about a relative change in the effectiveness of the opposed air nozzle units in a manner to return the fabric web to its desired course. In its most simplified form, the sensing control may be operative to simply deenergize, or energize the blower motor on the side of the actuated switch. However, where desired or expedient, more complex and sophisticated control combinations may be employed, including means for proportioning the corrective response to the magnitude of deviation from course, all as will be readily understood and appreciated by those skilled in the art.

The edge-sensing control arrangements, shown in FIG. 3, for the first-stage fabric-handling and guiding system, are similar to those just described, as regards principles of operation, but are mechanically slightly different to accommodate the fact that the fabric travels vertically through the first-stage handling system and horizontally through the second-stage handling system. Thus, in the arrangement of FIG. 3, a mercury switch 66 is mounted on the nozzle wall 55 and has its switch bulb (not shown) carried by a horizontal pivot shaft 67. A swing arm 68 dependent from the shaft 67 and carries a plurality of edge-sensing fingers 69 which extend horizontally through the plane of the fabric web as shown in FIG. 3, the whole system being suitably counterbalanced for relatively effortless displacement of the sensing fingers 69 by an edge of a fabric web which wanders laterally from its desired course.

The new and improved fabric-guiding device is particularly advantageous for use with geometrically unstable fabrics, especially in open width form. The lack of physical engagement of the fabric by the new device, which is a significant feature of the invention, eliminates a potential source of undesirable widthwise reorientation of the fabric which is characteristic of prior art devices that physically engage the edge portions of the fabric being processed.

It should be noted in regard to a specific preferred embodiment and that many variations might be made without departing from the inventive concepts disclosed herein. For instance, the new air guide system could be arranged to act substantially across the full width of the fabric, rather than at opposed margins, being so arranged as to direct airflow outward from the center area of the fabric. However, in all cases, the airflow advantageously is of low pressure and velocity, sufficient to guide and control the fabric but not significantly in excess of these minimum requirements.

We claim:

1. Means for handling and guiding web materials such as open width knitted fabric, comprising:
   a. air nozzle means disposed adjacent at least opposite side edges of the web material and embracing at least the side edge margins thereof in straddling relation,
   b. said air nozzle means being arranged to direct controlled flows of air transversely outward over the opposed surfaces of the web material toward the edge extremities thereof,
   c. means to sense the edge extremities of the web material, and
   d. means to control the effectiveness of the respective air nozzle means to maintain the web material substantially centered relative to said nozzle means.

2. The handling and guiding means of claim 1, further characterized by
   a. separate air blowers being provided for the separate air nozzle means, and
   b. said means for controlling the effectiveness of said air nozzle means including power control means for said blowers, whereby the effective blower power applied to a given side margin of the web material is reduced, relative to power applied at the opposite side, in response to wandering of the web toward said given side.

3. The handling and guiding means of claim 1, further characterized by
   a. the effective dimensions of said air nozzle means, transverse of the web material, being substantially less than the maximum width capacity of the equipment, and
   b. means being provided for adjusting the separate air nozzle means toward and away from a center axis to accommodate web materials of various width dimensions.

4. The handling and guiding means of claim 1, further characterized by
   a. the separate air nozzle means being in the structural form of an elongated U in external configuration, with the legs of the U closely embracing the side margins of the web material facing opposing surfaces thereof,
   b. each of the legs of the U being divided internally to form a first flow passage for flowing air inward toward the center axis of the web material and a second flow passage for redirecting the airflow outwardly toward the edges of the web,
   c. said second flow passage terminating in a flow discharge opening spaced inward from the edge of the web.

5. The handling and guiding means of claim 1, further characterized by
   a. said sensing means comprising a freely pivoted mercury switch or the like,
   b. a sensing arm connected to the mercury switch and maintained by gravity in a sensing position,
   c. said switch and sensing arm being counterbalanced for substantially effortless displacement by edges of highly flexible web material,
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d. said sensing arm being located immediately adjacent the outer portions of said air nozzle means whereby, at the moments of sensing, the web material edges are urged into flat and fully extended relation by the flowing airstreams discharged from said nozzle means.

6. Apparatus for handling and guiding web materials such as open width knitted fabric, comprising
  a. air nozzle means disposed adjacent at least opposite side edges of the web material and embracing at least the side edge margins thereof in straddling relation,
  b. said air nozzle means being arranged to direct controlled flows of air transversely outward over the opposed surfaces of the web material toward the edge extremities thereof,
  c. means to sense the position of the web material, and
  d. control means to control the flow of air from said air nozzle means,

7. The handling and guiding means of claim 6, further characterized by
  a. the separate air nozzle means being in the structural form of an elongated U in external configuration, with the legs of the U closely embracing the side margins of the web material facing opposing surfaces thereof.

8. The handling and guiding means of claim 7, wherein

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a. each of said legs of the U is divided internally to form a first flow passage for flowing air inward toward the center axis of the web material and a second flow passage for redirecting the airflow outwardly toward the edges of the web,

b. said second flow passage terminating in a flow discharge opening spaced inward from the edge of the web.

9. The method of flattening and centering an advancing web of highly flexible and distortable material, such as open width knitted fabric, which comprises
  a. mechanically conveying the web material in a forward direction,
  b. at opposite edge margins of the conveyed material, directing controlled airstreams in a transversely outward direction over opposed surfaces of the web material to impart a slight widthwise tension to the web material to place it in flat, full-width form,
  c. continuously monitoring the locations of the edge extremities of the web material, in the immediate region of the airstreams, and
d. controlling the relative effectiveness of said airstreams on said web material in a manner to maintain said web material substantially continuously centered between predetermined limits.

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