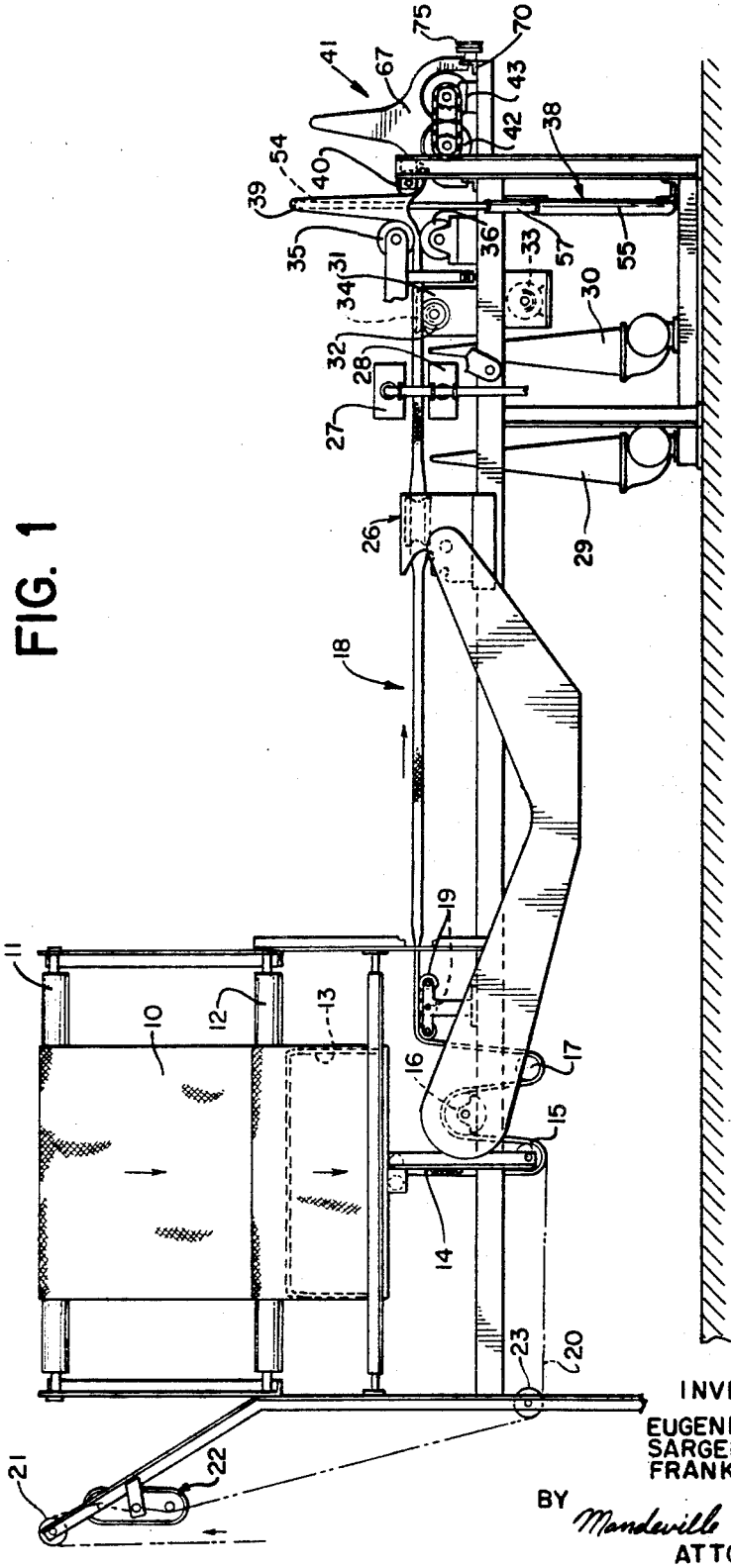
Sept. 17, 1968 E. COHN ET AL 3,401,584

METHOD AND APPARATUS FOR SLITTING AND OPENING TUBULAR KNITTED FABRIC

Filed Dec. 13, 1965 5 Sheets-Sheet 1

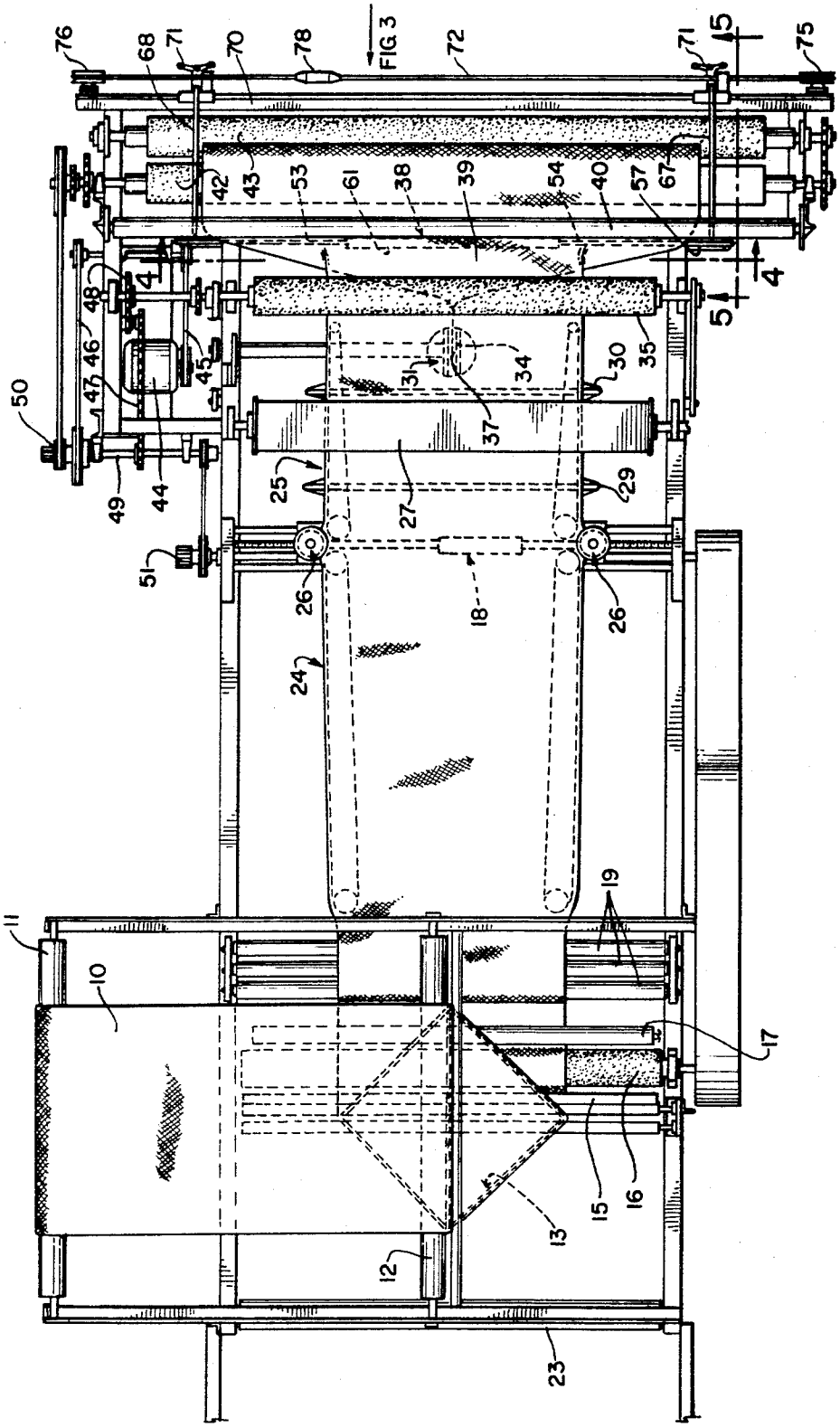
FIG. 1



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FIG. 2

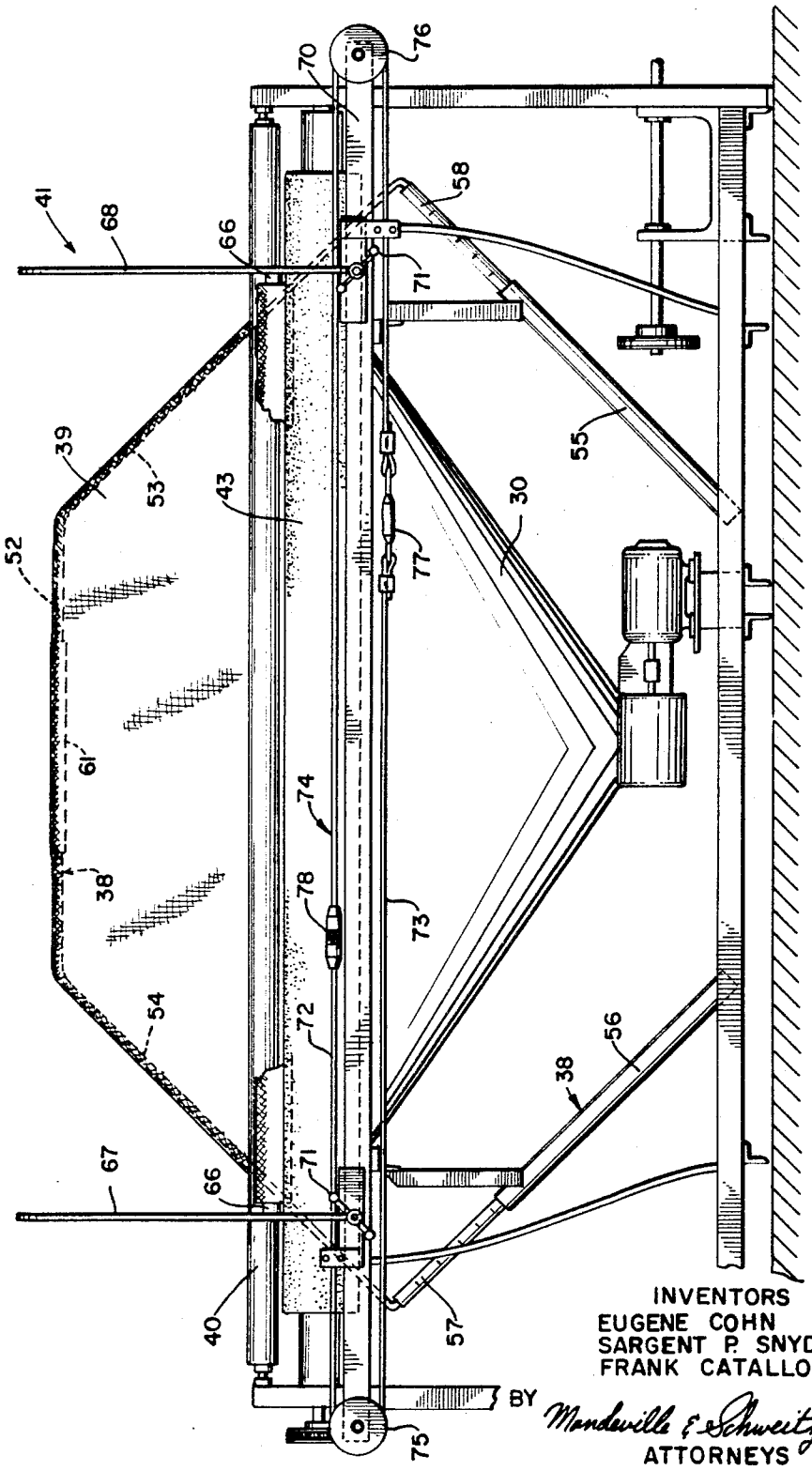

FIG 3
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METHOD AND APPARATUS FOR SLITTING AND OPENING TUBULAR KNITTED FABRIC

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FIG. 3



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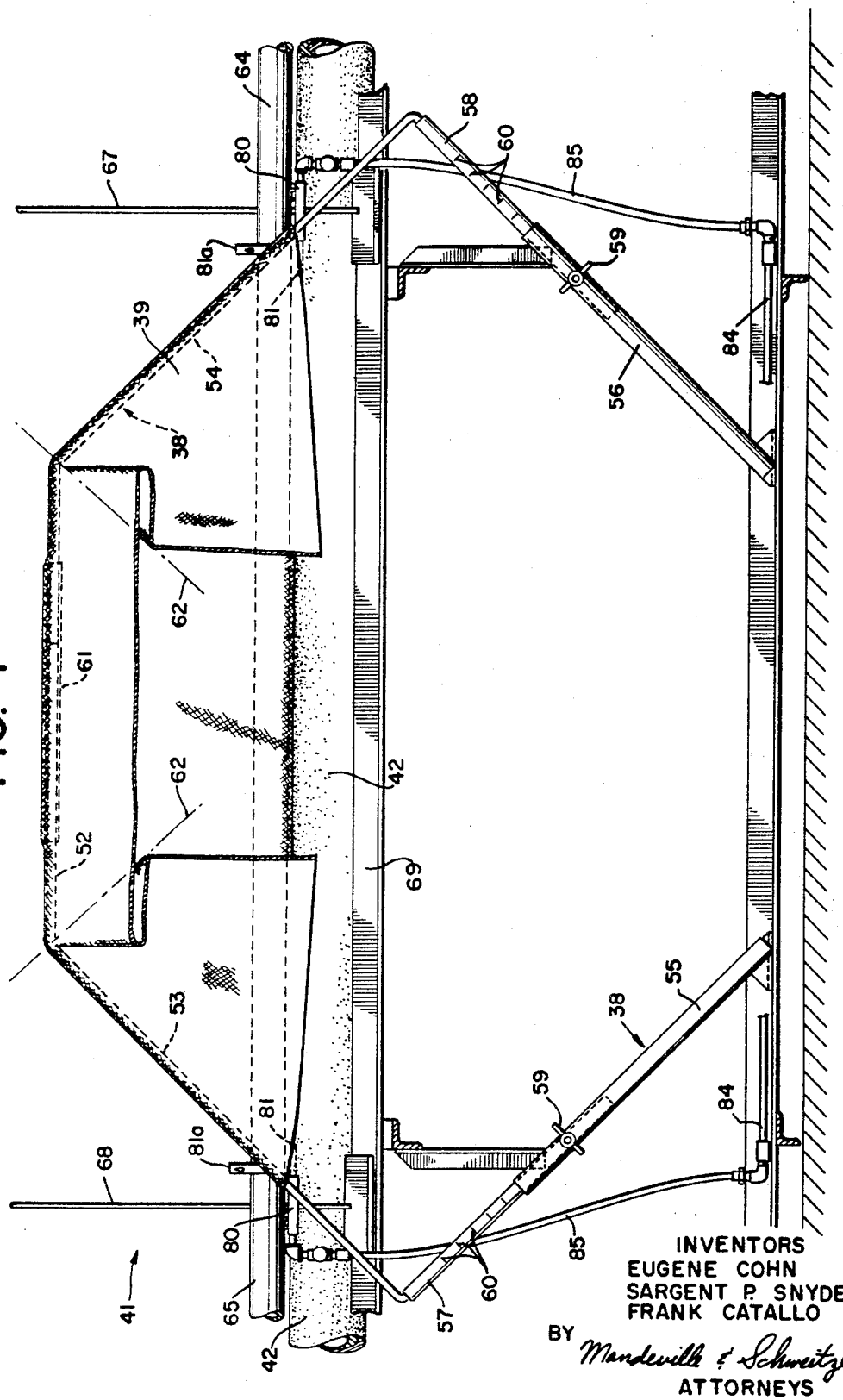
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METHOD AND APPARATUS FOR SLITTING AND OPENING TUBULAR KNITTED FABRIC

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FIG. 4



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METHOD AND APPARATUS FOR SLITTING AND OPENING TUBULAR KNITTED FABRIC

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FIG. 5

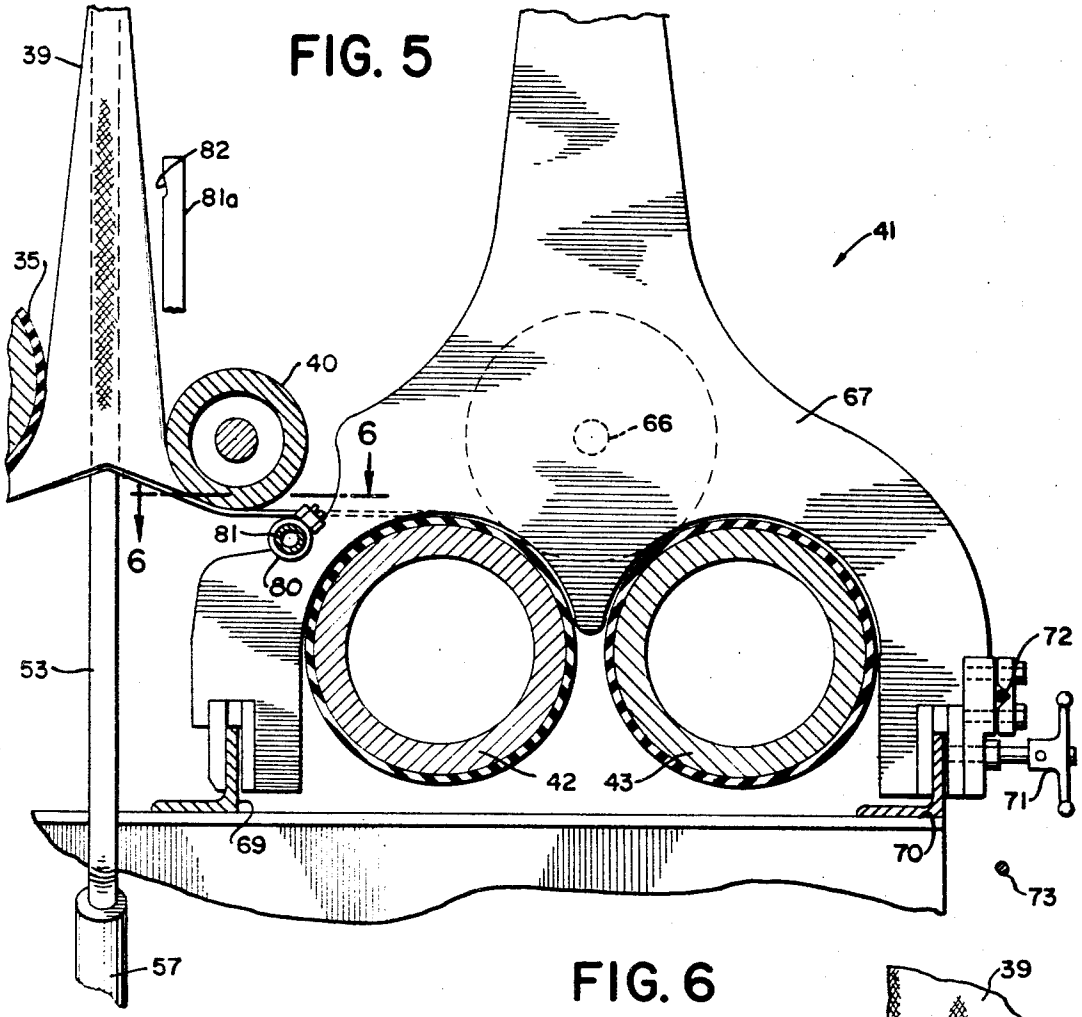


FIG. 6

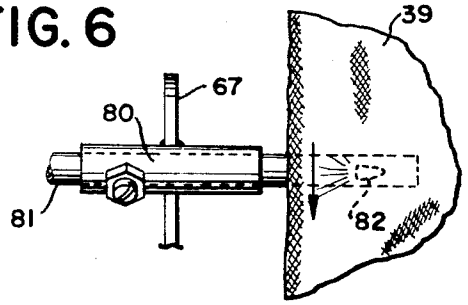
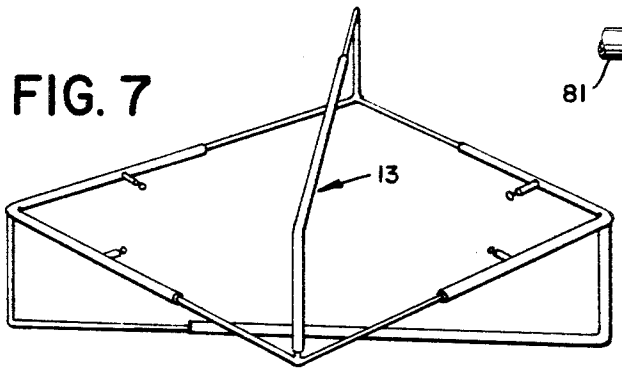


FIG. 7



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United States Patent Office 3,401,584 Patented Sept. 17, 1968

3,401,584

METHOD AND APPARATUS FOR SLITTING AND OPENING TUBULAR KNITTED FABRIC

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Filed Dec. 13, 1965, Ser. No. 513,516
17 Claims. (Cl. 83—15)

ABSTRACT OF THE DISCLOSURE

The invention is concerned with a method and apparatus for converting tubular fabrics to open width form. The invention provides a trapezoidal converting frame over which the tubular fabric is drawn after it is slit. This converting frame guides and supports the edge and center portions of the fabric during the opening operation, resulting in a dimensionally stable, open width product that requires a minimum, if any, edge trimming.

The present invention relates to the processing and treatment of tubular knitted fabric, and is directed more specifically to novel and advantageous procedures and equipment for converting tubular knitted fabric to open width form by slitting the fabric tube and opening the tube to the desired flat form, all in a novel and improved manner capable consistently of achieving superior end results. The apparatus and procedure of the present invention are particularly applicable in connection with, although not necessarily limited to the method and means described and claimed in our copending application Ser. No. 508,699, filed Nov. 19, 1965, for "Method and Means for Converting Tubular Knitted Fabric to Open Width."

A widespread and apparently increasing industrial demand exists for knitted fabrics in flat or open width form. Although it is possible and advantageous in some instances to produce open width knitted fabric by initially knitting the fabric in the desired flat form, it is often more desirable and expeditious to produce the open width knitted fabric by conversion of fabric inititally knitted in circular or tubular form. The generalities of this procedure, which are well known, involve slitting the fabric tube longitudinally, manipulating the slit tube to convert the fabric to flat, open width form, and gathering the flat fabric. In many cases, the area of the tubular knitted fabric to be slit is "gummed" to prevent curling and distortion of the slit edge areas, as well as to facilitate subsequent handling of the fabric by its edge margins, which would correspond to the selvages of a typical woven fabric, for example.

Although the generalities of converting tubular fabric to flat, open width form, involving slitting, opening and gathering, have been known for many years, the actual performance of the conversion procedures has prevented many difficulties to the fabric processor and convertor. By way of example, in a typical conversion procedure in which the slit and open fabric is gathered in the form of a roll, it is very important as regards subsequent processing operations that the finished roll of fabric have a uniform and regular end formation. Otherwise, the rolls have to be trimmed back to the "solid" part of the roll, which heretofore has resulted in significant production losses.

The problem of achieving a uniform roll end structure, for example, which in reality merely reflects an exacting performance of the conversion procedures, has proved to be extremely difficult in connection with tubular knitted fabrics, because of the inherent geometric instability of knitted fabric, as well as such persistent problems as the inherent tendency for the slit edges to curl. Knitted fabric, unlike woven fabric, for example, is elastically distortable in all directions and has a characteristic interdependence of length and width dimensions. Accordingly, tensions applied widthwise to a knitted fabric can effect significant reductions in the length of the fabric, giving rise to difficulties in delivering fabric, particularly slit and open fabric, at a uniform width. Further, tensions applied non-uniformly to various linear areas of a slit knitted fabric, for example, introduce undesirable distortions in the stitch formations, irregularities in the cross lines, curling of the edges, and other fabric formations which are deemed undesirable to the finisher.

In accordance with basic aspects of the present invention, tubular knitted fabric is so directed and handled, in accordance with method aspects of the invention and by means of apparatus aspects of the invention, that the fabric is first uniformly conditioned, then slit longitudinally substantially midway between the edges of the flat tube. Thereafter, the fabric is converted to flat, open width form in the shortest practicable distance, under a maximum of positive control, and under circumstances which maintain the fabric free of non-uniform distortions while it is undergoing conversion and is being gathered in a precise, uniform manner, usually in a roll. A basic feature of the invention resides in the provision of a specifically novel and unique converting frame structure which guides the slot fabric through a conversion stage from its slit, tubular form to its flat, open width form in such a way that the fabric travels through a virtually irrewhich guides the slit fabric through a conversion stage and, at the same time, in such a way that all incremental portions of the fabric travel through equal distances, at equal speeds, so that distorting tensions are isolated from the fabric during the critical conversion stage.

As a more specific aspect of the invention, a novel and significantly improved converting frame facility is provided for converting slit tubular knitted fabric into open width fabric, which comprises a generally flat frame structure which is disposed in a plane advantageously related at right angles to the plane of a flattened tube of fabric being advanced for slitting and conversion. The flat frame has an effective outline of trapezoidal configuration, in which the effective base of the trapezoid lies generally in or near the plane of the incoming fabric and has a width of approximately twice the width of the incoming fabric. The top of the trapezoid is parallel to the bottom, approximately half its width—that is, equal to the width of the incoming tubular fabric—and is symmetrically related to the bottom. The ends of the trapezoid are symmetrical and are disposed at approximately 45°. In accordance with the invention, the fabric is maintained in is flat, two-layered, tubular form, substantially up to the right angularly related plane of the trapezoidal converting frame. As the fabric approaches the frame, the center portion of the fabric, constituting one-half of its overall width, is diverted sharply upward, over and about the upper, horizontal edge of the trapezoidal frame. The slit edegs of the fabric are diverted sharply outward and around the lower portions of the angular end edges of the frame. The fabric passing around the edges of the flat converting frame is in substantially open width condition, but is not yet in flat form. On the exit side of the converting frame, the principal center portion of the fabric is guided sharply downward, while the outer margins of the substantially open fabric are directed sharply downward and slightly outward to the side until the edge extremities reach the maximum, flat width of the fabric. At this point, the fabric is brought under dimensional control across its width and is guided directly to a gathering station.

In accordance with the invention, the arrangement and disposition of the trapezoidal converting frame and the fabric guide rolls directly related thereto is such that,

to the greatest practicable extent, the travel of the unslit center portions of the fabric during conversion is limited to a diversion path equal in length to approximately one-half of the width of the fabric. At the same time, the travel of the slit edges of the fabric is an equal distance, directed substantially right angularly outward from the axis of the slit to the edge margins of the flat, open width fabric. The theoretical ideal of a one-half fabric width linear travel during conversion, although very closely approached in the method and apparatus of the present invention, is not, of course, entirely achieved, because of accommodations made for the relative movement of the fabric layers one over the other and because of radii involved in the fabric guide rolls, conversion frame sections, etc., which represent physical departures from ideal geometric conditions. Nevertheless, the ideal is sufficiently approached to bring about significant improvements in the nature and condition of the gathered, slit and opened material, which is a premium grade material significantly free of losses due to edge trimming.

In accordance with another and more significant aspect of the present invention, a novel converting frame of the type and having the characteristics mentioned above is provided which is readily adjustable in its pertinent dimensions relative to the corresponding adjustment of fabric spreading means provided to guide, direct and condition the incoming fabric. Thus, the horizontal upper edge of the trapezoidal frame may at all times be adjusted to be substantially equal to the width of the spreading facility. At the same time, the base and vertical dimensions of the trapezoidal frame are automatically and simultaneously changed in the desired, appropriate proportion.

For a full understanding of the above and other important features of the invention, reference should be made to the following detailed specification and to the accompanying drawing, in which:

FIG. 1 is a side elevational view of a complete installation, incorporating features of the invention, for converting tubular knitted fabric into premium grade, flat, open width fabric;

FIG. 2 is a top plan view of the overall apparatus of FIG. 1;

FIG. 3 is an end elevation illustrating the discharge end of the apparatus of FIGS. 1 and 2;

FIG. 4 is a cross-sectional view of the apparatus of the invention, taken generally along line **4—4** of FIG. 2;

FIG. 5 is an enlarged, fragmentary, cross-sectional view taken generally along line **5—5** of FIG. 2;

FIG. 6 is an enlarged, fragmentary, cross-sectional view taken generally along line **6—6** of FIG. 5; and

FIG. 7 is a simplified, perspective illustration of a fabric reorienting frame advantageously utilized in conjunction with the apparatus of the invention.

Referring now to the drawing and initially to FIGS. 1 and 2 thereof, the reference numeral **10** designates generally a tubular knitted fabric being conveyed in from a suitable supply (not specifically shown) and being directed over guide rollers **11**, **12** and onto a fabric reorienting frame generally designated by the reference numeral **13** and specifically illustrated in FIG. 7. The frame **13**, which forms more specific subject matter of the copending application of Frank Catallo et al., Ser. No. 466,026, filed June 22, 1965, realigns the side edges of the fabric tube, for purposes described in the before-mentioned application, and delivers the reoriented fabric **14** over guide rollers **15**, **16** and movable dancer roll **17** onto a spreader frame generally designated by the reference numeral **18**.

If desired, the reoriented fabric may be directed through a set of tension rollers **19**. Likewise, if desired, the reorientation stage may be bypassed in appropriate cases, in which case incoming tubular fabric **20**, in flat, tubular form, is guided over a roller **21**, flattening device **22** and roller **23** to the roller **15**, which otherwise receives fabric from the reorienting frame **13**.

The spreader frame **18**, which may be generally in accordance with the S. Cohn et al. Patent No. 2,589,345, typically consists of first and second spreader stages **24**, **25** engaged by edge drive roll assemblies **26**. The edge drive rolls **26** are arranged to drive internal spreader belt assemblies (not specifically shown) at equal or slightly differing speeds, typically at a slightly lower speed in the second stage than in the first stage. As the fabric passes over the spreader assembly **18**, it is distended to flat, two-layered form and is set at a predetermined, uniform width, determined substantially by the width of the second stage. The overall width of the spreader and its separate stages **24**, **25** is adjustable, however, in accordance with known principles and techniques, to accommodate tubular knitted fabrics of various basic diameters and of various processed widths. The second stage of the spreader assembly is equipped with steam boxes **27**, **28** disposed above and below the plane of the advancing, distended fabric. Likewise, air nozzles **29**, **30** are advantageously disposed on opposite sides of the steam boxes **27**, **28**, arranged to direct streams of air forcibly upward during steaming operations, to confine the steam generally to the desired area of the fabric and to carry the spent steam away from the equipment.

On the exit side of the steam boxes, advantageously disposed as close as practicable to the exit side air blower **30**, is a fabric slitting assembly generally designated by the reference numeral **31**. The slitter may be of a more or less conventional construction, including a rotating slitting knife **32** driven at high speed by a motor **33** and cooperating with a guide element **34**. As illustrated in FIG. 1, the guide element **34** is received internally of the tube, while the tube is still being guided by the spreader frame **18**, and the relationship between the guide element **34** and the cutting disk **32** is such that the lower layer of fabric is slit along the longitudinal center-line of the advancing fabric tube.

A pair of driven control rollers **35**, **36**, arranged above and below the principal plane of the fabric tube, are disposed immediately adjacent the discharge end of the spreader **18** such that the fabric is engaged by the control rolls substantially immediately as it leaves the spreader frame. In addition, the terminal end of the spreader frame advantageously is located closely behind the slitting assembly **31**, such that the control rolls **35**, **36** are disposed in closely coupled relation to the point **37** at which the fabric is slit. The control rolls **35**, **36** advantageously are provided with a roughened latex or felt covering, so as to establish firm and effective gripping contact with the fabric. However, for reasons pointed out in the before-mentioned copending application of Eugene Cohn et al., the control rolls **35**, **36** advantageously are adjusted to be slightly separated, so as not to actually "nip" the fabric passing therebetween.

Disposed immediately adjacent the control rollers **35**, **36** is a converting frame assembly, generally designated by the reference numeral **38**, to be described in greater detail, which advantageously is disposed in a substantially vertical plane, to lie at right angles to the horizontal plane of the advancing flat tube of fabric. It will be understood, of course, that references herein to the disposition of components as being horizontal, vertical, etc., are intended only to facilitate description and not to be limiting. It will be apparent to the skilled person in the art that the equipment as a whole may be oriented in a variety of ways, and the advantages of the invention may be retained and realized as long as certain relationships are observed. As shown in FIG. 1, the converting frame **38** is arranged to divert and direct individual longitudinal portions of the slit fabric **39** so as to convert it from its slit, tubular form to a flat, open width form, in a manner to be more particularly described.

Immediately adjacent the exit side of the conversion frame **38** is a guiding roller **40**, which flattens and straightens the open fabric and directs it onto a wind-up device generally desingated by the numeral **41**, which includes a pair of driven wind-up rollers **42, 43**, arranged to support and rotate a roll of gathered, open width fabric.

Most advantageously, the "machine speed" of the apparatus is set by the control rollers **35, 36**, which are driven directly by a motor **44** (FIG. 2), through a series of belts **45, 46** and chains **47, 48**. The motor **44** may be designed for variable speed operation or may include suitable mechanical variable speed arrangements in its drive output, in order to provide for appropriate variation of the overall machine speed. The windup rolls **42, 43** and the spreader frame **18** are driven from a main shaft **49**, operated at machine speed, through variable speed pulleys **50, 51**, respectively, so that the windup and spreader may be independently adjusted to operate slightly above or below the principal machine speed as may be appropriate under a particular set of circumstances. In this respect, the apparatus of the invention is intended to be useful in the conversion of a wide variety of tubular knitted fabrics, or various sizes, weights, and constructions, such that independent speed adjustment of the spreader and windup relative to machine speed, provides a desirable and advantageous flexibility of operation.

Input of the fabric to the spreader frame **18** may be under the control of the draw roll **16**, arranged to be driven at a speed controlled by the movable dancer roll **17**, on a demand basis. Thus, as the dancer roll **17** is drawn in an upward direction, the speed of the draw roll **16** tends to increase, to feed fabric to the dancer roll at a faster rate. This arrangement, which may be of conventional construction, draws the fabric over the roller **16** at an average rate which tends to keep the dancer roll **17** approximately in the position indicated in FIG. 1.

In accordance with significant aspects of the invention, the conversion frame **38**, which is illustrated in more detail in FIGS. 3 and 4, is of generally trapezoidal configuration, comprising an upper, horizontal bar **52** and end bars **53, 54** extending downward and outward at 45° from the axis of the top bar **52**. The top and end bars **52–54** are disposed in a vertical plane and are symmetrically disposed relative to the centerline of the spreader frame **18**.

As shown in FIGS. 3 and 4, the top bar **52** of the conversion frame may be telescopically elongated along its principal axis. In addition, the end bars **53, 54** are mounted for adjustment within the vertical plane of the frame as a whole and along axes disposed at right angles to the axes of the respective end bars. This provides for adjustment of the conversion frame to accommodate tubular knitted fabric of various sizes, in such a manner that the desired geometric relationships are maintained at all times.

In the illustrated apparatus, the conversion frame includes a pair of tubular supports **55, 56**, which may be rigidly secured to the machine frame, extending upward and outward at an angle of 45° from the vertical. Each of the tubular supports telescopically receives an extension arm **57, 58**, adapted to be releasably locked in any extended position by means of a suitable clamping element **59**. The extension arms **57, 58** advantageously bear appropriate graduation marks **60**, which may be referenced to the spread width of the tubular fabric being converted, to facilitate the proper setting of the frame geometry by a machine operator.

The end bars **53, 54** of the conversion frame are secured at their lower ends to the respective extension arms **57, 58**, and the upper ends of the bars advantageously are bent inward at 45° to form the end portions of the top frame bar **52**. At least one of the end portions of the frame bar **52** is telescopically received in a tubular section **61**, which is rigidly secured to the other end portion of the bar.

In accordance with the invention, the base of the trapezoidal conversion frame lies along an imaginary horizontal line substantially in the plane of the advancing fabric tube being discharged from the end of the spreader frame **18**. Ideally and theoretically, the base width of the conversion frame, as represented by such an imaginary line, is equal to the flat, open width dimension of the fabric. The top bar **52** of the frame is centered relative to the base and has an ideal dimension equal to one-half the open width of the fabric (i.e., equal to the tubular width of the fabric as supplied by the spreader frame). The height of the top bar **52** above the imaginary base line is equal to one-fourth of the open width dimension of the fabric.

As a theoretical ideal, the fabric, after slitting, would be diverted sharply at right angles at the base line of the conversion frame, and the center portion of the fabric, equal to one-half of its open width, would travel a quarter-width distance vertically upward and a quarter-width distance vertically downward. The slit edge extremities ideally would be diverted at right angles to their original axis of advancement and would travel directly outward, in a horizontal plane, for a distance of one-half of the open width dimension of the fabric. At that point, the slit edges would be diverted again at right angles and would then form the outer edges of the flat, open width fabric. The fabric margins, intermediate the edge extremities and the principal center portion of the fabric, would be diverted upward, substantially to diagonal axes indicated in FIGS. 3 and 4 by the reference numeral **62**, then horizontally outward to the end edges of the trapezoidal frame, at which point the fabric would be redirected vertically downward on the opposite side of the frame.

Thus, in accordance with the theoretically ideal conditions, all longitudinal portions of the fabric would travel through a precise distance equal to one-half of the open width dimension of the fabric, from the point of initial diversion of the fabric from its slit tubular form to the point at which the fabric was disposed in its desired, flat, open width form. The apparatus of the invention looks toward the realization of these theoretical ideals to the greatest practicable extent, taking into account, however, practical considerations such as the fact that the fabric in passing around the control roller **35** and the guide roller **40** must pass around a substantial radius and cannot be sharply diverted at right angles. Further, at some areas of the incoming side of the conversion frame, adjacent layers of fabric are traveling in different directions, and it is desirable to separate the layers slightly to prevent excessive drag. Accordingly, as illustrated in FIGS. 1 and 5, the respective rolls **35** and **40** are spaced away from the conversion frame so that the fabric makes a slight angle therewith in traveling up to and down from the top bar **52**. Typically, the gap between the rolls **35, 40** and the sides of the conversion frame may be on the order of an inch, for example.

A shown particularly in FIGS. 1 and 2, the slit fabric tends to retain its initial tubular form until it passes through the control rollers **35, 36**. Thereupon, as the top layer of the fabric travels around and in an upward direction about the top roller **35**, the slit edges are diverted sharply outward. Although theoretically the slit edges should be directed outward in a horizontal plane, it is more practical in some instances to offset the conversion frame **38** slightly upward so that, in fact, the slit edges travel outward to the outer edge of the conversion frame along a slightly upwardly inclined path, as is evident in FIGS. 1 and 5, for example. Thus, in practical apparatus, the control and guiding rolls **35, 40** may be arranged so that their lower extremities are substantially on the same level, and the edge extremities of the fabric will thus travel outward and slightly upward to the edges of the conversion frame, and then downward to pass around the guide roller **40**.

Adjustment of the conversion frame **38** to accommodate fabric tubes of different widths is accommodated by making equal adjustments in the extension arms **57, 58** to extend or reduce the length of the top bar **52**, such that its adjusted width equals the spread width of the incoming fabric tube. As will be understood, such adjustment of the extension arms **57, 58** serves simultaneously to increase the effective height of the conversion frame, as well as its width, so that the desired geometric relationships are automatically retained. Advantageously, the graduations or calibrations **60** are keyed to the spread width of the fabric.

If desired, an appropriate load adjustment facility may be provided for raising and lowering the conversion frame as a unit, so that the frame may be adjustably offset above or below its theoretically ideal position, as may be required by the peculiarities of various fabrics to be accommodated by the equipment.

Flat, open width fabric advancing around the guide roll **40** is wrapped about a core mandrel **66** (FIG. 3). The fabric and mandrel, cradled between the windup rolls **42, 43**, are rotated at a predetermined speed to gather the open width fabric in the form of a wound roll, in accordance with generally known procedures. To facilitate guiding and centering the mandrel **66**, the equipment of the invention advantageously incorporates a pair of end guide plates **67, 68** in the windup section, which are disposed in straddling relation to the windup rolls and are arranged to be brought into abutting relation to the ends of the core mandrel **66**. As shown in FIG. 5, the guide plates are slidably supported for widthwise movement on guide rails **69, 70** and are arranged to be clamped in a preadjusted position by a suitable means such as a screw clamp **71**.

For automatic centering of the core mandrel **66**, the slidable end guide plates **67, 68** advantageously are fixed to the upper and lower cable reaches **72, 73** of an endless cable assembly **74** which extends widthwise across the machine and is supported by pulleys **75, 76** at opposite sides of the machine. After initial adjustment of the guide plates **67, 68** to be precisely equi-distant from the centerline of the machine, the respective plates are secured to the upper and lower reaches of the cable, which is maintained suitably taut by a turnbuckle assembly **77**. Thereafter, the guide plates may be quickly and easily moved toward or away from each other while being maintained in precisely symmetrical relation to the centerline axis of the equipment, by manual manipulation of the endless cable assembly, as by means of a manual grip **78** secured to a convenient place on one of the cable reaches.

In the initial centering of a core mandrel, the guide plates **67, 68** are initially opened wider than necessary, by movement of the hand grip **78** to the left as viewed in FIG. 3. The mandrel **66** is then simply rested between the windup rollers **42, 43** and the manual grip **78** is moved to the right, as viewed in FIG. 3, until both guide plates abut the end of the mandrel. At this point, the mandrel is precisely centered and guided, and the hand screws **71** may be tightened down to fix the guide plates in their adjusted, center positions.

Although it is contemplated that some of the tubular knitted fabrics to be accommodated by the apparatus of the invention will be "gummed" along the slitting axis to impart body and stiffness to the slit edges, many of the fabrics to be accommodated will be processed without gumming. Where the fabrics are not so gummed, there is an inherent tendency for the fabrics edges to curl, even though every precaution is taken to minimize such tendency, as by close coupling of the slitting and windup operations and by the careful avoidance of tensions and distortions in the fabric. To assure that the fabric does not contain any edge curl at the moment of fabric windup and to smooth out any wrinkles tending to form in margins of the fabric, the apparatus of the present invention incorporates a novel and advantageous arrangement for directing air jets downward and/or outward against the fabric edge margins immediately prior to engagement of the fabric with the first windup roll **42**. Thereafter, the fabric is kept under control by the windup rolls and the winding roll of gathered fabric, so that no further opportunity is provided for the fabric to curl at its edges.

Advantageously, the above-mentioned air jet arrangements are carried by the windup guide plates **67, 68**, the arrangement being such that, upon manipulation of the guide plates to center and guide a mandrel **66**, the air jets automatically are positioned in proper relation to the margins and edge extremities of the fabric to be wound up. Referring particularly to FIGS. 4–6, each of the guide plates **67, 68** may be provided adjacent the incoming or entering side of the first windup roll **42** with a guide sleeve **80** disposed generally horizontally and arranged to receive and slidably support an air tube **81**. The discharge end of the air tube **81** is formed in a manner to provide a discharge nozzle **82** arranged to direct a high pressure jet of air outward against the "curl" along the lower surface of the fabric edges, immediately adjacent the surface of the windup roll **42**. Thus, as the fabric comes into contact with the windup roll, its edge extremities are being held out flat by the action of the air jet, to assure that the fabric is flat and free of curl at the windup stage. Vertically disposed tubes **81***a* also may be provided to direct air jets downward on the fabric edge margins passing over the opening frame, as indicated in FIG. 4.

As shown in FIG. 4, the air tubes **81** are connected to air supply conduits **84** through suitable flexible hoses **85** which accommodate widthwise adjustment of the tubes along with the guide plates **67, 68**.

The apparatus and procedure of the invention enable tubular knitted fabrics to be slit and converted to flat, open width form in an economical and expeditious manner which assures a minimum of waste and, at the same time, provides the fabric finisher with a superior open width product. In part, the advantages of the invention are realized by providing a novel arrangement and disposition of converting frame means, such that the travel of the fabric between slitting and windup approaches an irreducible minimum. This arrangement affords a minimum opportunity for the inherently geometrically unstable knitted fabric to become distorted, skewed, misaligned, or otherwise out of control.

One of the important specific aspects of the invention resides in the provision of a novel converting frame structure for guiding the knitted fabric from its slit tubular form to its flat, open width form. The improved frame structure has the form of an isosceles trapezoid, which is disposed in transverse relation to the advancement of the tubular fabric and bears a predetermined geometric and dimensional relationship to the dimensions of the incoming fabric tube, such that the fabric after slitting is diverted over and about the trapezoidal frame in a way which directs the individual fabric portions to their flat, open width condition in the shortest practicable distance and in the absence of undesirable and non-uniform tensions which would distort one portion of the fabric relative to another. Most advantageously, from the standpoint of compactness of the equipment, the trapezoidal converting frame is disposed in a plane at right angles to the direction of the oncoming fabric, although it will be understood that there is no theoretical necessity for such right angular disposition; all that is required is that the fabric be directed along one side of the frame, turned through approximately 180° over the "top" of the frame, and returned along the other side.

One of the further advantageous features of the invention resides in the provision of control rollers directly in advance of the converting frame which, while not necessarily (and advantageously not) nipping the slit tubular fabric, will nevertheless exert a significant gripping

control thereover, such that the fabric is guided accurately onto the conversion frame. Control at this stage of the process is particularly important in the achievement of a wound up roll of open width fabric in which the edges are accurately aligned and uniform. Even relatively slight wandering of the fabric from side to side and/or variation in width of the fabric through non-uniform tensions will result in a wound up roll with uneven ends, which must be trimmed off square and can represent a significant economic loss.

In addition to providing a novel and advantageous form of conversion frame, having the effective outline of an isosceles trapezoid, a more specific aspect of the invention resides in the provision of such a conversion frame which is of inherently simplified construction and which may be quickly and easily adjusted in all of its pertinent geometrical relationships to accommodate fabric tubes of various widths. In this connection, facilities are provided for adjusting the end elements of the converting frame outward and upward at an angle of 45°. The top element of the frame, which is telescopically extensible, is connected to the respective end elements, so that upward and outward adjustment of the end elements, as specified, simultaneously increases the width and heights of the frame in the manner desired.

As will be understood, many of the various features of the invention may be utilized to advantage individually, as well as in combination with other described features. Likewise, it will be understood that the specific forms of the inventive features herein illustrated and described are intended to be representative only, as certain changes may be made therein without departing from the clear teachings of the disclosure. Accordingly, reference should be made to the following appended claims in determining the full scope of the invention.

We claim:

1. The method of converting tubular knitted fabric to open width form, which comprises

(a) guiding and directing the fabric in flat, two-layer tubular form,

(b) slitting one layer of the fabric longitudinally, substantially along the center line axis of the flat tube,

(c) directing the slit fabric to a trapezoidal converting frame in the form of an isosceles trapezoid having an upper member, generally parallel to the plane of the advancing fabric, and a pair of side members of substantially equal length,

(d) simultaneously diverting the edge portions of the slit fabric over the side members of said trapezoidal converting frame and the center portion of said slit fabric over said upper member of said trapezoidal converting frame,

(e) gathering the open width fabric.

2. The method of claim **1**, further characterized by

(a) the fabric being guided in a first plane during slitting,

(b) the slit fabric being diverted generally at right angles and thereafter directed to the converting frame.

3. Apparatus for converting tubular knitted fabric to flat, open width form, which comprises

(a) means to advance the fabric in flat, tubular form in a first predetermined plane,

(b) means to slit the fabric along the centerline of one flat layer,

(c) a converting frame of isosceles trapezoidal configuration positioned in a second predetermined plane to receive the slit fabric,

(d) said frame having a first side substantially equal in width to the width of the flat, unslit fabric and ends extending at about 45° to said first side, and

(e) said first side being substantially parallel to the first predetermined plane of the advancing fabric,

(f) means to receive fabric from said frame and gather it in flat, open width form.

4. Apparatus for converting tubular material to open width form, including a converting frame, which comprises

(a) a pair of frame sockets extending upward and outward at an angle of about 45°,

(b) a pair of extension bars telescopically received and adapted to be adjustably secured in said frame sockets,

(c) a pair of frame end bars fixed to and extending upward and inward from the respective extension bars, substantially at right angles thereto, and

(d) a top bar extending horizontally between the upper end extremities of the end bars,

(e) said top bar being telescopically extensible to accommodate inward and outward adjustment of said extension bars and frame end bars.

5. Apparatus according to claim **4**, further including

(a) a first control roll disposed adjacent the side of said frame from which tubular fabric is supplied,

(b) said top and end frame bars and an edge of said control roll outlining a substantially isosceles trapezoid,

(c) the top edge of said trapezoid being substantially one-half the width of its base.

6. Apparatus according to claim **4**, adapted particularly for the processing of tubular knitted fabric and further including

(a) fabric spreader means disposed in front of said converting frame and arranged for discharging flat tubular fabrics directly onto said frame,

(b) means for steaming fabric on the discharge end portions of said spreader means, and

(c) means to slit the spread and steamed fabric on said spreading means, substantially along the centerline of one layer of the fabric immediately in advance of the discharge of said fabric onto said frame.

7. Apparatus according to claim **6**, further characterized by

(a) said converting frame being disposed at right angles to said centerline.

8. Apparatus according to claim **7**, further characterized by

(a) said converting frame being disposed in a plane normal to said centerline.

9. Apparatus for converting tubular knitted fabric to flat, open width form, which comprises

(a) means for spreading the fabric to flat, two-layer form and to a predetermined, uniform width,

(b) means for steaming the spread fabric,

(c) slitting means in advance of the discharge end of the spreading means for slitting the spread and steamed fabric longitudinally substantially along the centerline of one flat layer of the fabric,

(d) a planar converting frame of isosceles trapezoid form positioned immediately adjacent the discharge end of the spreading means,

(e) said converting frame being positioned in a single plane,

(f) means to guide the unslit flat fabric layer over the short side of said converting frame and the side margins formed by the slit fabric layer over the ends of the frame, and

(g) means for gathering the slit fabric in a roll on the discharge side of the converting frame.

10. The apparatus of claim **9**, further characterized by

(a) the short side of said converting frame having a length substantially equal to one-half the width of the slit fabric,

(b) the ends of said converting frame extending outward from the ends of said short side at an angle on the order of 45°.

11. The method of converting tubular knitted fabric to open width form, which comprises

(a) guiding and directing the fabric in flat, two-layer tubular form,

(b) said fabric having a predetermined width when in flat, unslit form,

(c) directing the slit fabric over a converting frame in the form of an isosceles trapezoid to convert the fabric from slit, tubular form to flat, open width form,

(d) said trapezoidal frame having a first side substantially equal in width to the flat, unslit fabric, ends extending at an angle of substantially 45°, and a base side spaced from said first side a distance of approximately one-half the width of the flat, unslit fabric,

(e) said slit fabric being so directed and guided over said frame that center portions of the fabric pass over said first side and edge margins of the fabric pass over said ends, and

(f) gathering the open width fabric.

12. Apparatus for converting tubular knitted fabric to flat, open width form, which comprises

(a) means to present the fabric in flat, tubular form in a first predetermined plane,

(b) means to slit the fabric along the centerline of one flat layer,

(c) a converting frame of isosceles trapezoidal configuration positioned to receive the slit fabric, being disposed in a second predetermined plane at substantially right angles to said first predetermined plane,

(d) the base of the trapezoidal converting frame being disposed generally adjacent said first plane,

(e) said frame having a first side substantially equal in width to the width of the flat, unslit fabric and ends extending at about 45° to said first side,

(f) means to receive fabric from said frame and gather it in flat, open width form.

13. An apparatus according to claim **12**, further characterized by

(a) a first control roller disposed between the discharge end of said fabric spreader and the base of said frame for diverting said fabric from said first to said second plane, and

(b) a second control roller disposed on the discharge side of said converting frame for diverting said fabric from said second plane and toward said means to receive and gather the fabric.

14. Apparatus for converting tubular knitted fabric to flat, open width form, which comprises

(a) means for spreading the fabric to flat, two-layer form and to a predetermined, uniform width,

(b) means for steaming the spread fabric,

(c) slitting means in advance of the discharge end of the spreading means for slitting the spread and steamed fabric longitudinally substantially along the centerline of one flat layer of the fabric,

(d) a converting frame of isosceles trapezoid form positioned immediately adjacent the discharge end of the spreading means,

(e) the short side of said converting frame having a length substantially equal to one-half the width of the slit fabric,

(f) the ends of said converting frame extending outward from the ends of said short side at an angle on the order of 45°,

(g) said means to guide including a driven control roller,

(h) one side of said control roller forming, in effect at least, the long side or base of said trapezoidal frame.

15. Apparatus for converting tubular knitted fabric to flat, open width form, comprising

(a) means for presenting the fabric in flat, two-layer form,

(b) slitting means for slitting the fabric longitudinally substantially along the centerline of one flat layer of the fabric,

(c) a flat planar converting frame having a trapezoidal configuration and positioned to receive the slit fabric,

(d) said converting frame having parallel short and long sides,

(e) said short side disposed to contact the slit fabric after it passes said long side,

(f) means to guide the unslit fabric layer of the slit tubular fabric over said short side and the side margins formed by the slit fabric layer over the ends of the frame.

16. The apparatus of claim **15**, wherein

(a) said short side of the converting frame is substantially the same width as, and parallel to the plane of, the unopened slit tubular fabric.

17. The apparatus of claim **15**, wherein

(a) said converting frame is disposed in a plane substantially at right angles to the plane of the slit tubular fabric.

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