United States Patent [19]

Rockman et al.

[11] **3,893,213**

[45] **July 8, 1975**

[54] **METHODS FOR SEPARATING INTERCONNECTED SECTIONS OF TUBULAR KNITTED FABRIC**

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[73] Assignee: **Samcoe Holding Corporation**, Woodside, N.Y.

[22] Filed: **Dec. 19, 1973**

[21] Appl. No.: **426,216**

Related U.S. Application Data

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[52] **U.S. Cl.** ..... **28/72 CS**; 26/55 C; 83/365

[51] **Int. Cl.** **D04b 19/00**; D06h 7/02

[58] **Field of Search** ..... 26/55 R, 55 C; 28/1 CS, 28/17, 72 CS; 83/365

[56] **References Cited**

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3,166,261	1/1965	Loflen	28/17 X
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Primary Examiner—Robert R. Mackey
Attorney, Agent, or Firm—Mandeville and Schweitzer

[57] **ABSTRACT**

The invention relates to methods for separating connected-together sections of tubular knitted fabric, such as sweater bodies, for example. A spreading frame is used, which engages the tubular fabric internally and arranges it in flat form. The tubular fabric is advanced by belts engaging the internal side edges of the frame. As the fabric sections are conveyed along the spreader frame, a draw thread or connecting thread is partially withdrawn and engaged by a rotating mandrel which serves forcibly to withdraw the connecting thread from the moving fabric, thus substantially separating a pair of adjacent fabric sections.

After withdrawal of the connecting thread, adjacent fabric sections are connected together only by a "cord" of yarns, and a novel and improved method is provided for severing this yarn cord on an automatic, high-speed basis.

The method includes how the successive fabric sections are handled and conveyed to assure proper location of the yarn cord for the automatic cutting operation.

3 Claims, 10 Drawing Figures

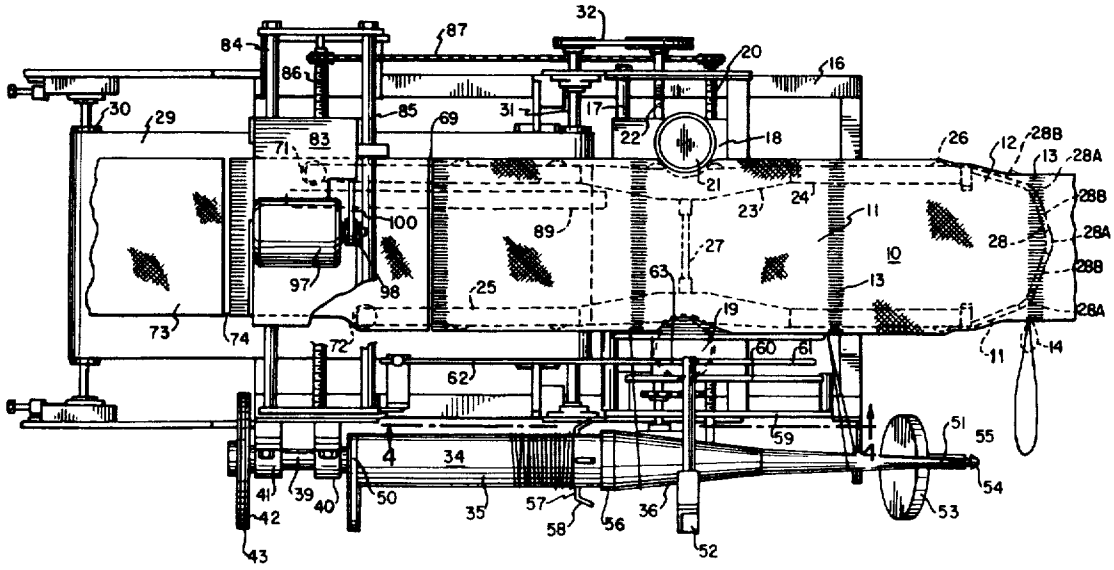

FIG. 1

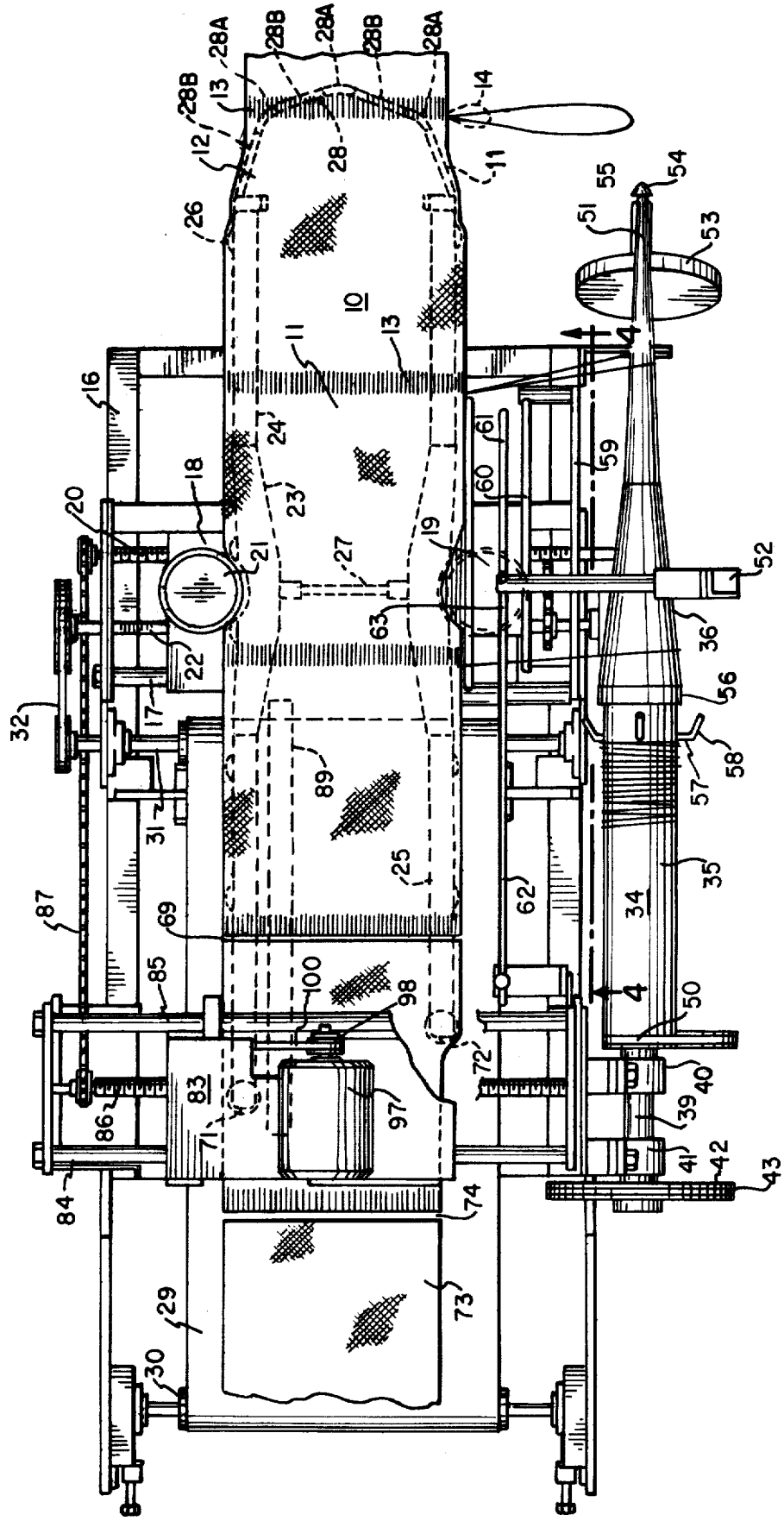
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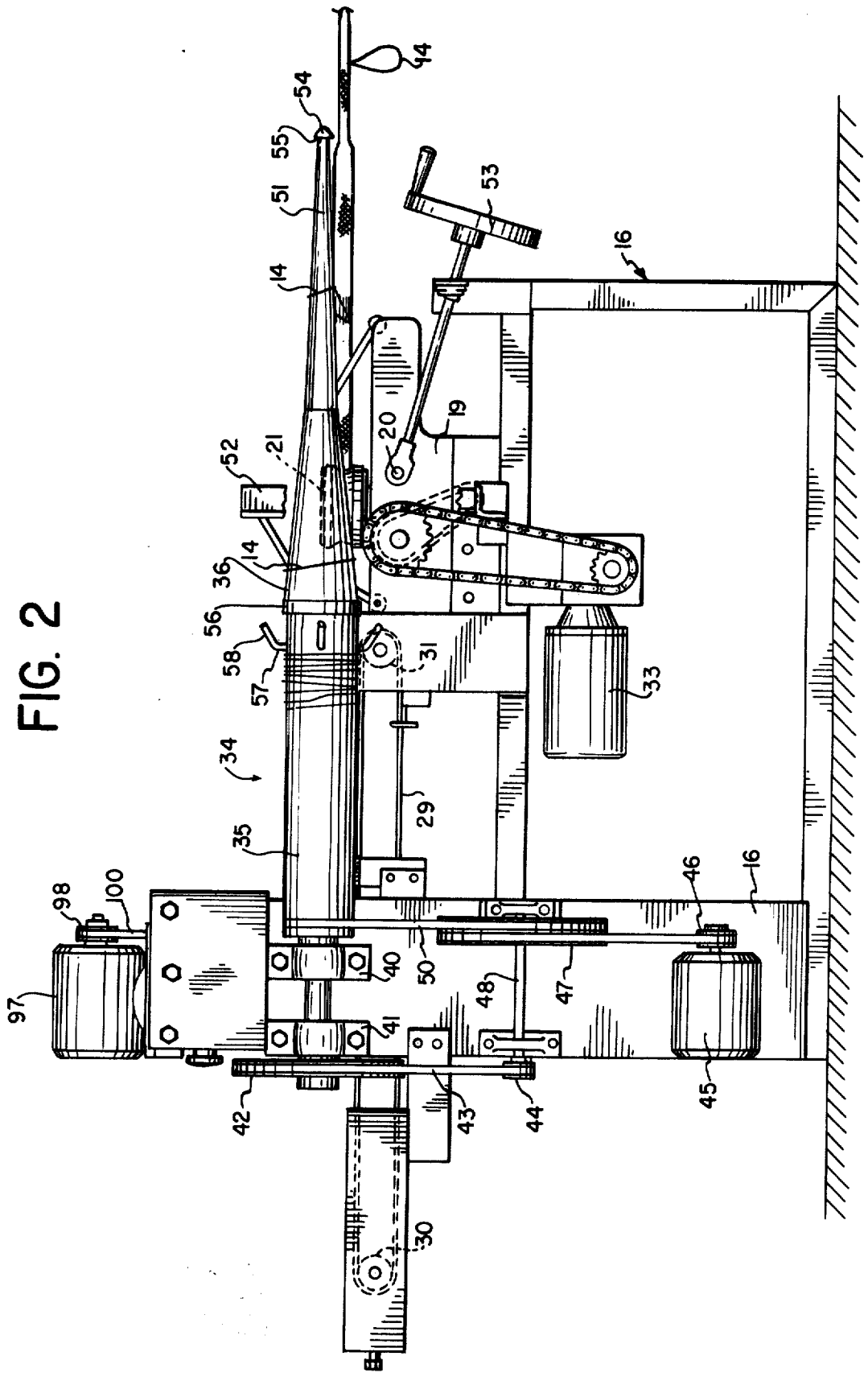
FIG. 2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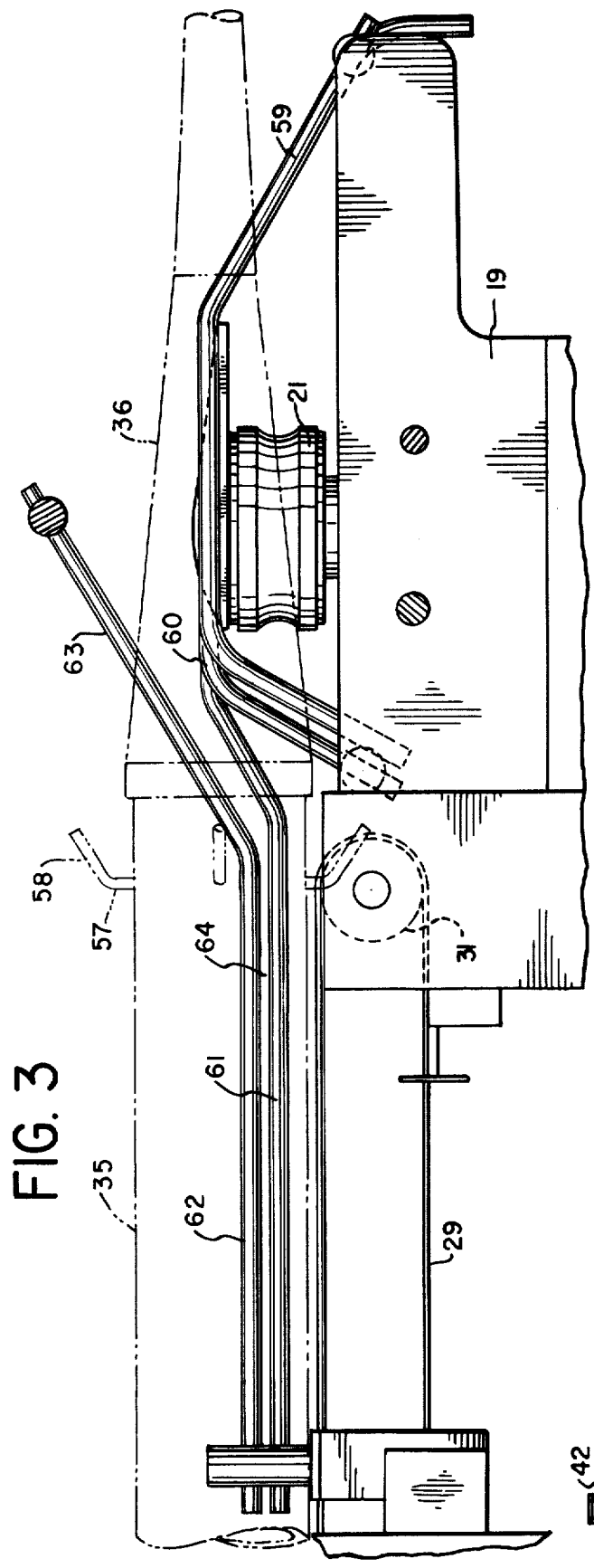
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FIG. 3

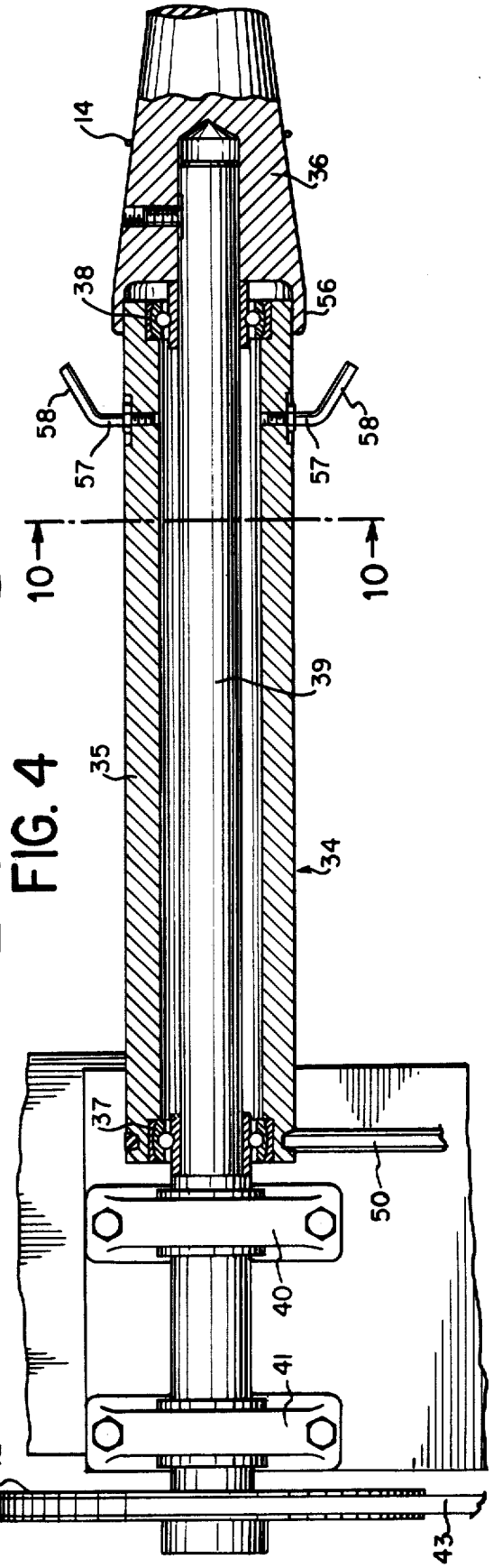
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FIG. 4

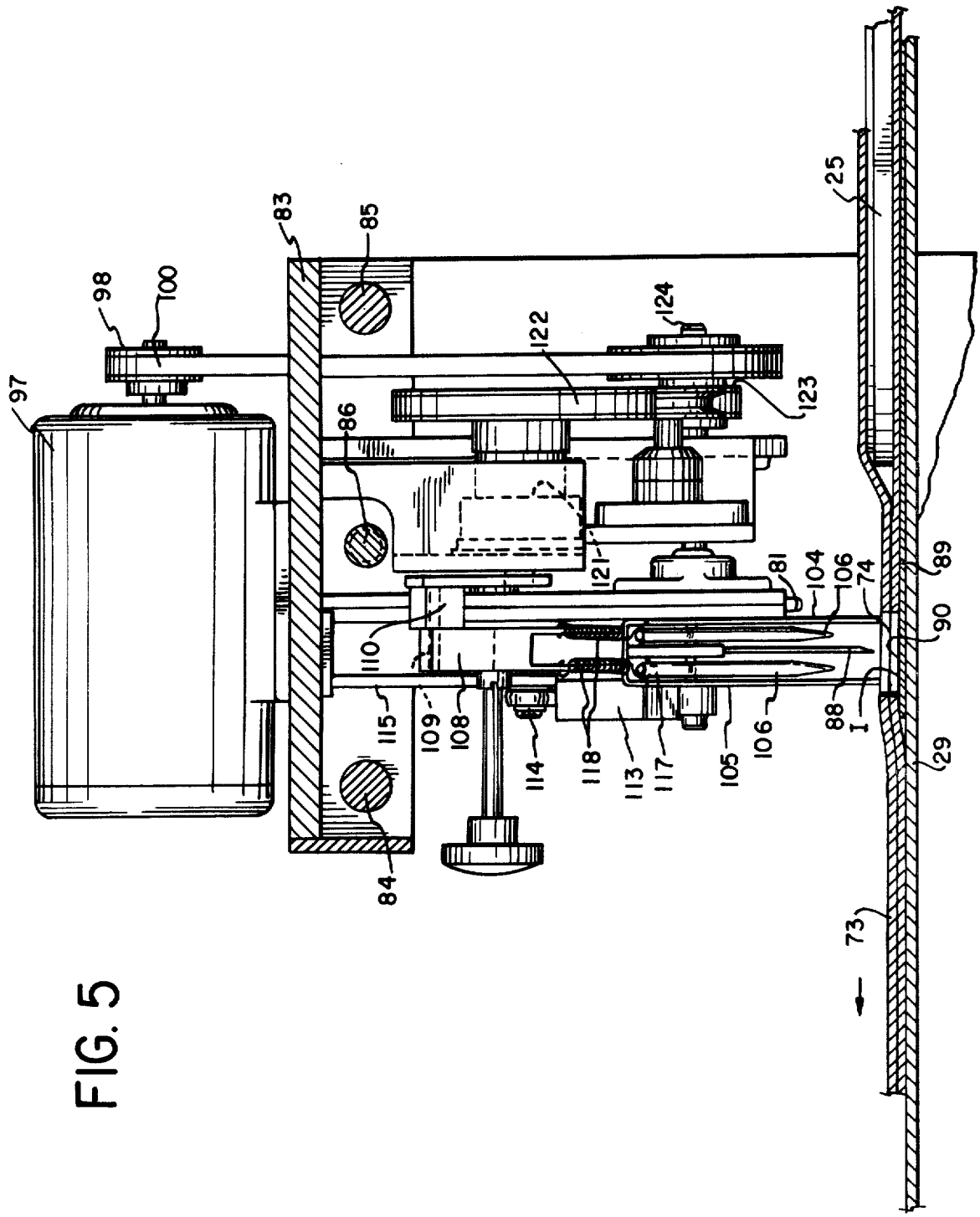
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FIG. 5

FIG. 6

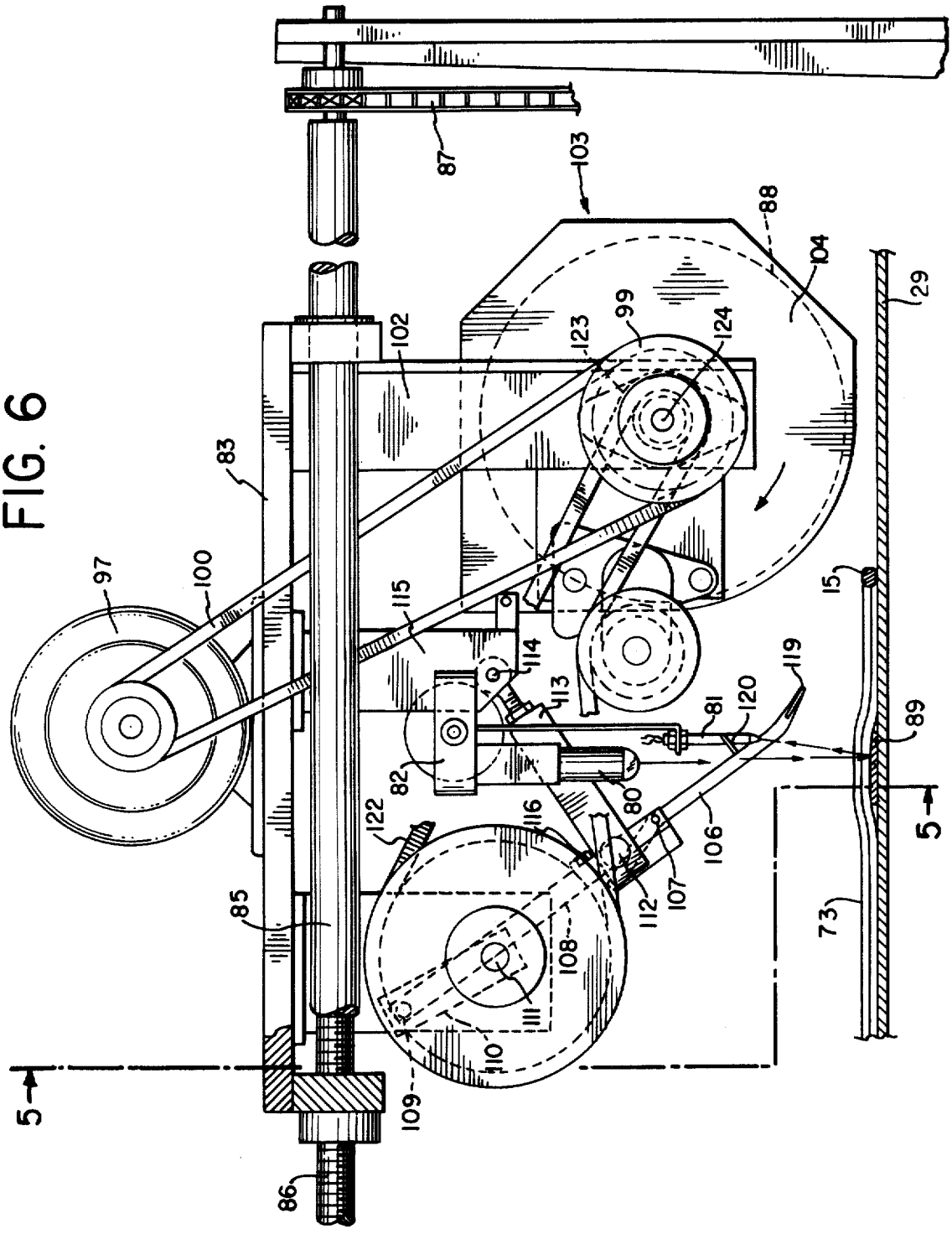
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FIG. 7

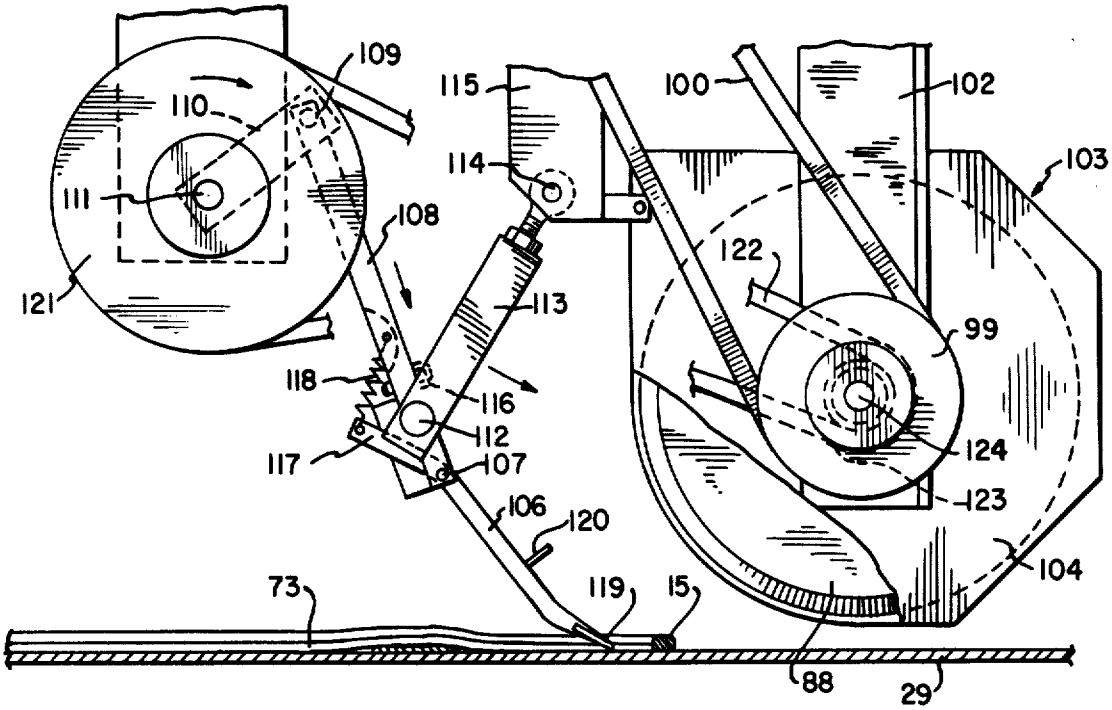
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FIG. 8

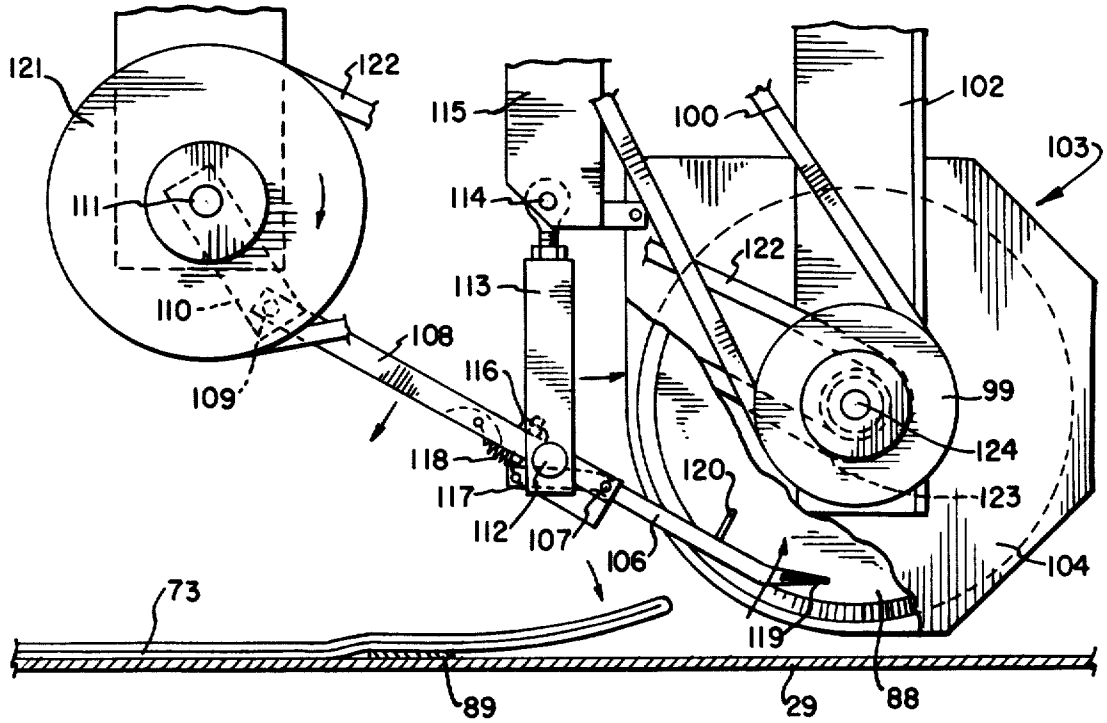
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FIG. 9

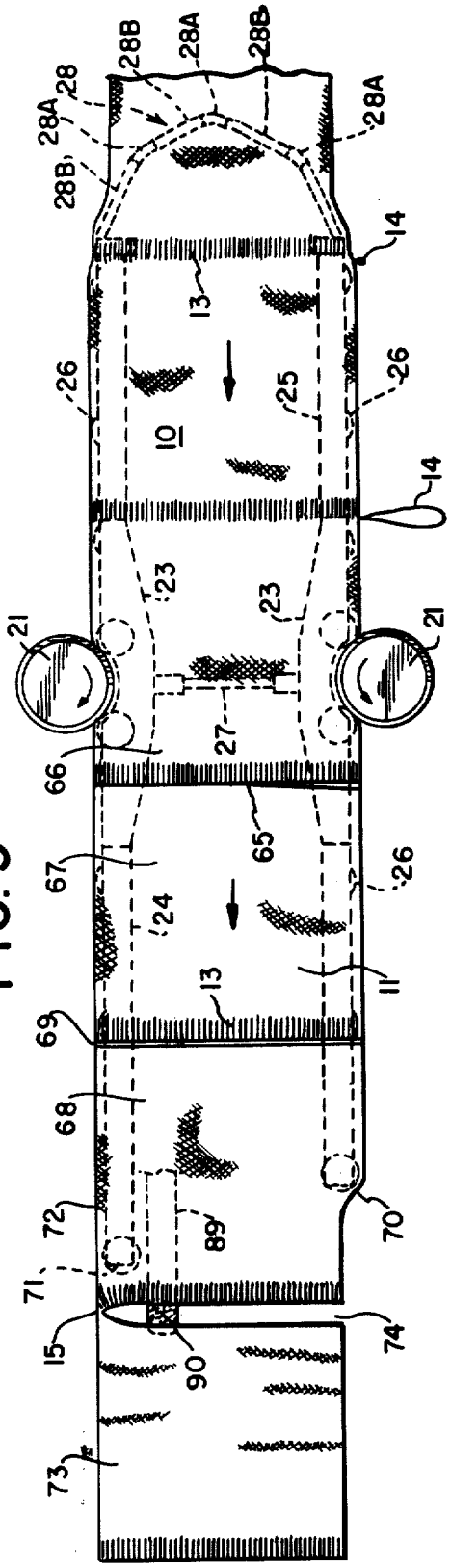
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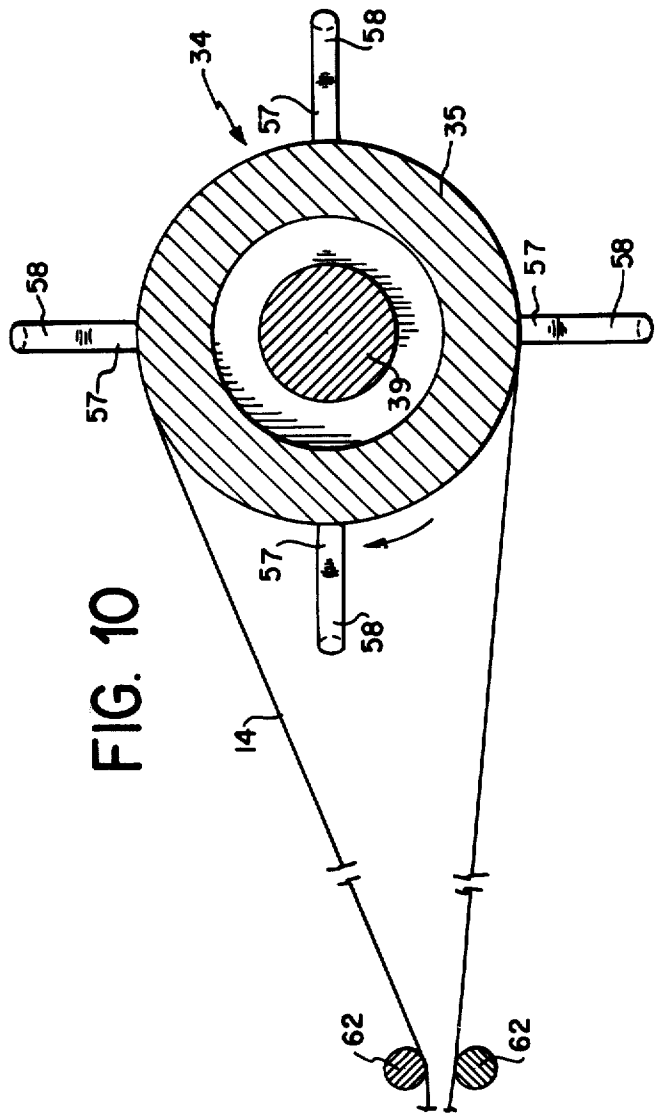
FIG. 10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METHODS FOR SEPARATING INTERCONNECTED SECTIONS OF TUBULAR KNITTED FABRIC

BACKGROUND AND PRIOR ART

This application is a division of application Ser. No. **244,050**, filed Apr. **14, 1972**, now U.S. Pat. No. **3,797,080** granted Mar. **19, 1974.**

In the manufacture of sweater blanks and other relatively short sections of tubular knit fabric, it is conventional practice to knit a continuous length of connected-together sections to facilitate handling of the fabric during the various necessary preliminary processing operations. At some stage, of course, it becomes necessary to effect separation of the connected-together sections, to enable them to be incorporated into garments. To this end, the initial knitting construction of the fabric is carried out in a manner such that some of the yarns going into the structure of the fabric section are combined together and are transferred from one section to another in a single bundle or "cord" located at one point on the circumference of the fabric tube. A special withdrawable connecting thread is also incorporated in the fabric construction at this stage and serves temporarily to join adjacent fabric sections in order to maintain the lengthwise integrity of the knitted fabric tube.

After preliminary processing of the fabric has been completed, it is necessary to separate the individual fabric sections by withdrawing the connecting threads and severing the yarn cords. In some cases, this can be done by hand. However, for sustained production operations, it is, of course, advantageous to provide mechanical assistance and a degree of automation.

Earlier proposals for fabric section separation are reflected in the following U.S. Pat. Nos.: Weller **2,422,154**; Kastrinsky **2,779,084**; Feldstein, et al., **2,926,416**; Loflen **3,163,912** and Loflen **3,166,261.** Rights to the before-mentioned Loflen patents are owned by the assignees of this application.

Principally, the Weller, Kastrinsky and Feldstein et al. patents are directed to arrangements for mechanically assisting the withdrawal of the connecting thread. In the Weller patent, for example, the thread is engaged by meshing gears and is thereby pulled from the fabric. In the Kastrinsky patent, the connecting threads (conventionally forming loops at the edge of the fabric) are engaged by hooks on a rotatable mandrel, and the threads are withdrawn by rotation of a mandrel. In the Feldstein et al., patent, a rotating mandrel is provided with a plurality of radial fingers for engagement of looped ends of the connecting threads, enabling the threads to be withdrawn by rotation of the mandrel. The Loflen U.S. Pat. No. **3,163,912** represented an important advance in the art by introducing an advantageous arrangement for holding the tubular fabric in flat form to facilitate automatic withdrawal of the connecting threads by a power-driven mandrel. The related Loflen U.S. Pat. No. **3,166,261** is directed to a special, frusto-conical form of mandrel.

SUMMARY OF THE INVENTION

The present invention is directed to a method and improved principles of operation, providing for higher speed and more reliable operation, and an increased degree of automation of the overall operation. A mandrel arrangement is provided which facilitates the ability of the operator to apply the drawthread to the mandrel and thus enables the overall processing operation to be carried out at a higher rate of speed. Included is a spreader frame for internally engaging the fabric tube, and the operator customarily stands at the upstream or entry end of the spreader frame and applies the fabric onto it in such manner that the yarn cord is generally aligned with one edge of the spreader frame. A rotating thread-pulling mandrel is arranged to extend alongside the spreader frame, substantially to the loading station, and is arranged so the operator can conveniently apply the end loop of the connecting thread over the free end of the mandrel. The design of the mandrel is such that, at the proper time, the connecting thread is automatically engaged for effecting withdrawal; the operator is not required separately to perform this task. To this end, the mandrel has an elongated, tapered entry portion at its upstream extremity, and an adjacent associated winding portion having means for automatically engaging the connecting thread loops as the fabric advances alongside the mandrel.

The invention includes the use of a cutting knife arrangement at the discharge end of the spreading-conveying frame, arranged to engage and sever the yarn cord following withdrawal of the connecting thread. In order to assure reliable alignment of the yarn cord, the spreader frame is asymmetrically arranged, so that the side of the frame opposite the yarn cord, is shorter than the other side. Thus, as the laterally distended fabric reaches the discharge end of the frame, the entire lateral contraction of the knitted fabric will occur at the side opposite the yarn cords. Thereafter, as the fabric is discharged from the long side of the spreader frame, the yarn cord remains in its original alignment, providing maximum reliability in the cutting operation.

Proper carrying out of the yarn cord cutting operation is facilitated by providing a conveyor blanket directly under the spreader frame, traveling at a slightly higher rate of speed than that at which the fabric is being conveyed over the frame itself. Thus, after withdrawal of the connecting thread, and particularly after discharge of the fabric from the short side of the frame, the fabric will tend to be advanced at an accelerated speed by the underlying blanket. The yarn cord, however, remains connected to the principal fabric body, traveling at a slower speed. As a result, a tapered gap is opened up between adjacent fabric sections, facilitating proper meeting of the cutting knife and yarn cord with minimized opportunity for the knife to damage any part of the basic fabric body.

A cutting knife mechanism is provided, including a pair of cyclically operated fingers arranged to engage the yarn cord, between otherwise separated fabric sections, and to lift the cord quickly into a high-speed cutting knife to complete the separating operation. The operation of these fingers is effected by an advantageous arrangement of photocell and light source, which detects a fabric edge forming one side of partially separated fabric sections and effects controlled actuation of the lifting fingers in precisely timed relationship to the location of the yarn cord at such gap.

The invention is directed in important respects to new procedural or method aspects of processing connected-together fabric sections to effect their efficient separation. Among these are the manner in which the fabric is handled during its conveyance, first being lat-

erally distended and conveyed, then released at one side and conveyed at a somewhat higher speed, and then separated by yarn cord severance. This new procedure is both efficient and highly reliable, making it eminently suitable for high volume, production operations.

For a more complete understanding of the above and other advantageous features of the invention, reference should be made to the following detailed description and to the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** are top plan and side elevational views, respectively, of a fabric separating machine incorporating the principles of the invention.

FIG. **3** is an enlarged, fragmentary side elevational view of the apparatus of FIGS. **1** and **2**, with parts broken away, to show details of an advantageous guide bar arrangement.

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

FIG. **5** is an enlarged, fragmentary cross-sectional view taken generally along line **5—5** of FIG. **6**, and illustrating details of a cutting knife arrangement and photocell control.

FIGS. **6**, **7** and **8** are sequential views illustrating the operation of the cutting knife and lifting finger mechanism incorporated in the apparatus of FIGS. **1** and **2**.

FIG. **9** is a simplified top plan view of the spreading and conveying frame of the apparatus of FIGS. **1** and **2**, illustrating the manner of handling and separating connected-together tubular fabric sections according to the invention.

FIG. **10** is an enlarged cross-sectional view taken along iine **10—10** of FIG. **4**.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings, and initially to FIGS. **1** and **2** thereof, the reference numeral **10** designates generally a tubular length of knitted sweater body sections or the like **11**. Typically, the sweater body sections **11** comprise body portions **12** and waistband portions **13**. The tubular length **10** typically is knitted on a continuous basis to form the body portion **12** and waistband **13** of one body section, and then to knit the body and waistband portion of successive sections. Where the waistband portion **13** of one section connects with the body portion **12** of a subsequent section, there is conventionally provided a connecting thread or draw thread (not shown in its entirety) which includes a looped portion **14**, as shown in exaggerated form in broken lines in FIG. **1**. The looped portion enables the draw thread to be engaged and pulled from the otherwise continuous fabric tube, to effect partial separation of the successive sections.

In the continuous knitting of the connected-together sweater bodies, various of the yarns utilized in the construction of the fabric are, at the time of transition from the ending of construction of one section to the beginning of another, gathered together and transferred as a single "cord" of yarns, sometimes hereinafter referred to as the yarn cord. Such a yarn cord is evident at **15** in FIG. **6**, for example.

The above described technique for constructing connected-together sweater bodies is conventional, and the conventional sever yarn cord first procedure for separating the sections at the desired time consists of first severing the yarn cord **15** and then removing the connecting thread **14**. The method of the invention enables these operations to be carried out on a relatively high speed, automatic basis, enabling great savings in labor to be realized and overall production rates to be increased.

A basic frame structure **16** is provided supporting on suitable transverse slide rods **17**, a pair of edge drive roll carriages **18, 19** (the carriage **19** being shown in FIG. **1** with a protective cover). The near side carriage **19** is fixed while the carriage **18** is adjustable toward and away from the near side of the machine, by means of a transverse threaded shaft **20**. Each of the carriages mounts an edge drive roll **21** arranged to be rotated by a square drive shaft **22**.

The edge drive rolls **21** are circumferentially grooved to engage and support a width-adjustable spreader-propeller frame, designated generally by the numeral **23**. The spreader frame **23** includes a pair of longitudinally extending frame members **24, 25** mounting a plurality of sheaves **26** carrying fabric engaging belts in a manner well-known per se. The spreader frame sections **24, 25** are supported in adjustable spacing by a connecting element **27**. The arrangement is such that, after the width of the spreader frame has been determined by adjustment of the connecting member **27**, to suit the desired processing width of the tubular fabric **10**, the spreader frame may be positioned between the spaced edge drive rolls **21** and the carriage **18** adjusted laterally to engage the spreader frame in the recessed portions of the edge drive rolls. In the area of engagement with the edge drive rolls, the spreader frame is recessed inwardly, as reflected in FIG. **1**. Accordingly, the entire frame is effectively secured in position, both vertically and horizontally, by the rolls **21**.

The carriage **19** is fixed in position, to establish a fixed reference position for the near side frame section **25** of the spreader. The front or upstream end of the spreader frame is provided with a wire guide element **28** which facilitates the entry of the incoming fabric tube over the spreader frame. The guide **28** advantageously includes wire sections **28A** connected by flexing spring sections **28B** to accommodate adjustment.

Extending underneath the back or downstream portions of the spreader frame is a supporting conveyor blanket **29**, carried by transverse rolls **30, 31** journaled in the machine frame. The width of the supporting blanket **29** is sufficient to accommodate the maximum width capacity of the equipment. At least one of the rolls **30, 31** is driven, and in the illustrated arrangement the roll **31** is driven by means of a belt **32** connected to the drive shaft **22** for the edge drive rolls. To advantage, the driving relationship between the edge drive rolls **21** and the supporting blanket **29** is such that the speed of the blanket slightly exceeds the speed at which the fabric tube is conveyed along the spreader-propeller frame by the edge drive rolls. The reason for this will become apparent hereinafter.

A single variable speed motor **33** (FIG. **2**) may be utilized to control the principal driving functions of the equipment, principally the edge drive rolls **21** and the support blanket **29**.

As shown particularly in FIG. **1**, the supporting blanket **29** commences at a point somewhat downstream of the edge drive carriages **18, 19** and extends at least slightly beyond the downstream or discharge end of the spreader frame, so that the fabric sections are sup-

ported and conveyed by the blanket **29** after being discharged from the frame. In addition, for reasons which will be made apparent, one side frame **24** of the spreader-propeller extends downstream at least a short distance beyond the terminal end of the other frame section **25**. In a typical case, the frame section **24** might extend **6** inches or so beyond the end of the frame section **25**. For purposes of reference, the side of the machine along which the longer frame section **24** extends will be referred to as the "far" side, whereas the side along which the frame section **25** extends may be considered the "near" side.

Mounted along the front side of the machine, generally at the level of the plane of the spreader frame **23**, is a thread drawing mandrel, generally designated by the reference numeral **34**. The draw mandrel **34** comprises a winding section **35** and a guiding section **36**. The winding section **35** is of tubular, generally cylindrical form and is mounted by means of bearings **37, 38** (FIG. **4**) on an elongated, longitudinally disposed shaft **39**. The shaft **39** is mounted in cantilever fashion by means of bearing pillow blocks **40, 41**, bolted to the machine frame and rotatable relative thereto. At its downstream end, the mandrel shaft **39** mounts a large diameter pulley **42** driven through a belt **43** by a small diameter pulley **44**. The pulley **44** is driven from a motor **45** through a speed reduction system including a small diameter motor pulley **46**, a large diameter pulley **47** and a shaft **48** on which the pulleys **44, 47** are carried. The shaft **39** thus is driven through a double speed reduction system at a relatively low rotational speed relative to the motor **45**.

A shaft **48** also mounts an additional pulley **49** of large diameter which drives a belt **50** engaged with a suitably grooved end portion of the winding section **35** of the mandrel. The grooved portion of the mandrel is of relatively small diameter compared to the pulley **49**, and thus is arranged to be driven at a relatively high rotational speed relative to that of the mandrel shaft **39**. The motor **45** desirably has a variable speed control, enabling the mandrel to be operated at the minimum speed appropriate for the task.

Mounted on the upstream end of the mandrel shaft **39** is the guiding section **36** of the mandrel. This is of elongated tapered configuration, extending sufficiently far in the upstream direction as to have its terminal end **51** adjacent the upstream end of the spreader frame **23**. The arrangement of the machine is such that the upstream end of the mandrel is convenient to the operator's station for the machine, at its front, upstream region. An operator stationed in this area can feed the incoming fabric tube **10** properly onto the spreader frame, and also has convenient access to a control switch housing **52** and a width control adjustment **53**.

As reflected in FIG. **2**, the guiding section **36** of the mandrel projects a substantial distance from the bearings **40, 41** mounting the mandrel shaft **39**. Since the front or upstream end of the mandrel is unsupported, the rotation of the shaft **39**, and the guiding section **36** of the mandrel is kept at a very low rate, to avoid excessive vibration and problems derived therefrom.

The arrangement of the guiding section **36** of the mandrel is such that, as successive fabric sections are drawn over the spreader-propeller frame **23**, the operator can manually engage the draw thread loops **14** as they come along in succession and draw these loops outward a sufficient distance to apply them over the upstream end of the mandrel. Desirably, the upstream extremity is provided with an enlarged tip **54** forming a rearwardly facing shoulder **55**. Thus, when an operator pulls the draw thread over the front end of the mandrel, the thread is held momentarily from sliding back off the mandrel by the enlarged tip **54**. Of course, during the normal operation of the equipment, the fabric tube is continuously traveling in a downstream direction, so that the draw thread is quickly carried toward the rear along the guiding portion of the mandrel. In this respect, the slow speed of rotation of the mandrel section **36** need be sufficient only to minimize the friction acting on the draw thread loops as the same are moved in a downstream direction along the mandrel.

As shown in FIGS. **2** and **4**, the configuration of the guiding portion of the mandrel is such that the mandrel increases in diameter in the downstream direction. It is provided with a short skirt portion **56** at its downstream end which closely surrounds the upstream end of the winding section **35**. Thus, as successive fabric sections are propelled along the spreading frame **23**, the draw threads **14** applied over the mandrel are drawn along the guiding portion and are applied on the upstream end of the winding section **35**.

As reflected particularly in FIG. **4**, the upstream portion of the mandrel section **35** is provided with a plurality (typically four) of radially extending draw pins **57**. The pins have outer portions **58** which extend at about a **45°** angle to the access of the mandrel section **35**, in an outward and upstream direction.

As successive fabric sections are conveyed along the spreader frame, the loops **14** of separating thread are advanced along the mandrel **34** up to a point where, as illustrated in FIG. **10**, one of the draw pins **57** engages a portion of the separating thread, deflects the thread in a downstream direction, and thereby causes the thread loop to straddle at least one of the draw pins. The winding section **35** of the mandrel, which is rotating at high speed, thereupon snags the loop of the draw thread and quickly and forcibly withdraws it laterally from the fabric tube, which continues to advance in the downstream direction. The fabric sections are thereupon separated, except for the yarn cord connection which remains.

In accordance with the techniques employed in the practice of the invention, the operator guiding the fabric tube onto the spreader-propeller frame **23** does it in such a way as to align the fabric cord substantially with the far edge extremity of the flattened tube. Accordingly, after removal of the separating thread, the fabric sections are connected only along the far edge of the tube.

In the construction of the machine, ample clearance is provided about the winding section **35** of the mandrel, such that a large number of successive separating threads may be engaged and withdrawn from successively advancing connected fabric sections without stopping the machine. The threads occupy little space and a great number of them may be accumulated on the surface of the mandrel section **35** without requiring removal. Typically, this may have to be done only once or twice per shift.

In order that the mandrel guided thread loops properly clear the near side edge drive roll **21** (see FIG. **3**), one or more guide bars **59–62** are mounted on the machine frame. The bars **59–62** overlie the top of the near side edge drive roll and serve to deflect the advancing

draw threads upwardly and over the top of the roll. In addition, depending on the nature of the fabric being processed, the resistance of the separating threads to being laterally withdrawn occasionally may be so great as to actually tend to draw the fabric itself laterally toward the mandrel. To prevent this happening to an excessive extent, one of the lower guide bars **61** extends in parallel relation alongside the winding section **35** of the mandrel and cooperates with an upper guide bar **62** spaced slightly above and disposed parallel to the guide bar **61.** The upstream end portion **63** of the guide bar **62** extends upwardly at an angle and forms an enlarged entrance opening to facilitate guiding the thread into the narrow, horizontal slot **64** formed between the parallel portions of the guide bars **61, 62.** As evident in FIG. **3,** the slot **64** extends from a point near the draw pins **57** in a downstream direction, for a distance sufficient under normal operating conditions to assure complete withdrawal of the thread. The width of the slot **64** is such as to easily accommodate the separating thread while preventing passage therethrough of the fabric itself in cases of extreme resistance to separating thread withdrawal. The bars **61, 62** also confine the direction of pull of the separating threads substantially to the plane of the flattened tube.

As reflected in FIG. **9,** the initial adjustment of the spreader-propeller frame **23** is such that the fabric **10** is laterally distended to at least some degree as it passes over the frame. This assures that the fabric is maintained in flat, wrinkle-free condition and engages the frame with sufficient force to accommodate the necessary handling and control. As the fabric travels along the spreader frame, the draw threads are successively engaged by the draw pins **57.** The reference numeral **65** in FIG. **9** reflects the partial withdrawal of a separating thread between fabric sections **66, 67.** Slightly farther downstream along the spreader frame, complete withdrawal of the separating thread has been effected between fabric sections **67, 68,** although these sections remain attached in the region indicated by the reference numeral **69,** by reason of the still-intact yarn cord **15.**

As the fabric continues to travel downstream on the spreader frame, the near edge of the fabric will be discharged from the near edge extremity **70** of the spreader frame, causing the laterally distended fabric to contract widthwise to its relaxed width dimension. In this respect, it is a feature of the invention, that by reason of the discharge end **70** of the near frame section being located upstream of the discharge end **71** of the far frame section, the entire widthwise contraction of the fabric will occur at the near edge thereof. When the fabric an instant later, is discharged from the far side of the frame, it is fully relaxed and has little or no tendency to contract further. This enables the far edge **72** of the fabric to be kept in a predetermined aligned relationship as initially established by the spreader frame itself to facilitate automatic severance of the yarn cord as will appear.

As reflected in FIG. **2,** for example, the supporting blanket **29** is disposed directly underneath the discharge end portion of the spreading frame, in a position to receive and support the fabric sections as they are discharged from the spreader. Thus, as particularly reflected in FIG. **9,** when a fabric section **73** is discharged from the near side of the spreader frame, it is immediately supported by the blanket **29** and conveyed along at the speed of the blanket, which is slightly faster than that of the spreading frame. Since the fabric section remains attached by the yarn cord **15,** at the far edge extremity, it therefore cannot travel at a faster rate of speed than the fabric being advanced over the propeller-spreader **29.** The remainder of the fabric, however, is tending to be advanced more rapidly, at the speed of the supporting blanket **29,** and this causes a converging gap **74** to open between the successive fabric sections **72, 73.** This gap, being wide at the near edge of the fabric and diminishing toward the far edge, greatly facilitates the severance of the yarn cord **15** and thereby the ultimate separation of the fabric section **73** from the oncoming material.

A cutting facility is provided to permit the automatic, accurate severance of a yarn cord **15** between successive blanks without, in turn, damaging the sweater blanks. The cutting facility shown in detail in FIGS. **5–8,** includes both a cutting means and an automatic detecting means for precisely timing the actuation of the cutting means. The timing means (see FIG. **6**) includes a specially arranged light source **80,** and a photocell **81** mounted on a bracket **82** secured to a laterally adjustable cutter carriage **83.** The cutter carriage **83** is mounted for transverse movement on a pair of spaced supporting shafts **84, 85** and is controlled as to its position by means of a transverse threaded shaft **86.** As reflected in FIG. **1,** the transverse threaded shaft **86** is connected by a chain **87** and suitable sprockets to the threaded control shaft **20** for the edge roll carriages **18,** 19. Accordingly, the cutter carriage **83,** supporting a cutting knife **88** and related mechanism to be described, as well as the photocell control bracket **83,** is laterally adjustable along with the far edge drive carriage **18,** so as to be kept at all times in a predetermined alignment relationship with the far spreader frame section **24.**

In the illustrated apparatus, an elongated thin metal blade **89** is secured to the far edge drive carriage **18** and extends downstream therefrom, resting on the upper surface of the supporting blanket **29.** The length of the blade **89** is such that its downstream extremity generally underlies the plane of the cutting knife **88.** The end area of the blade is provided with a reflecting area **90,** which may comprise a section of reflective material.

Normally, the reflecting area **90** is covered by the moving fabric being conveyed by the blanket **29.** However, when the tapered gap **74** between partially separated fabric sections, from which the draw thread has been removed, passes over the reflecting area the photocell **81** is activated to a "standby" condition. When the edge of the oncoming fabric section (i.e., the upstream edge of the gap **74**), passes under the light beam and greatly reduces the amount of reflected light reaching the photocell **81.** The "deactivation" of the photocell **81** initiates the cutting sequence described below.

With reference particularly to FIGS. **5–8,** the cutter carriage **83** is shown to mount a motor **97** driving, through a pair of pulleys **98, 99** and a belt **100,** a high speed rotary cutting knife **88.** The cutting knife **88** is journaled by suitable carriage brackets **102** and is contained in a protective housing **103.** As reflected particularly in FIG. **6,** the axis of the cutting knife is mounted in fixed relation to the carriage **83,** so that its lower edge is slightly above and to the rear of the normal position of the yarn cord **15.** As will be described, cutting

of the yarn cord is effected by causing the cord to be picked up and carried into the rotating knife blade, rather than moving the knife blade toward the yarn cord. Additionally, in this respect, the side plates **104, 105** of the knife guard **103** are of sufficient radial dimension to completely enclose the cutting knife **88,** but are spaced sufficiently far apart as to permit the pliable yarn cord **15** to be carried into the housing sufficiently far to engage the cutter.

Lifting of the yarn cord into the cutter is effected by a pair of pickup fingers **106,** which are disposed in straddling relation to the plane of the cutting knife **88** and are pivotally connected at **107** to the end of a lifting lever **108.** The lever **108** is, in turn, pivotally connected at **109** to a crank arm **110** carried by a rotary shaft **111** journaled in the cutter carriage. The lifting lever **108** is also pivotally supported, at a location **112** to a rocker arm **113,** which is pivoted at **114** in a bracket **115** suspended from the cutter carriage.

Normally, the pickup fingers **106** and lifting lever **108** are held in a predetermined geometrical relationship, as shown in FIGS. **6** and **8.** This is realized by providing a suitable adjustable stop bolt **116** positioned to act upon upper end portions **117** of the pickup fingers, in conjunction with extendable springs **118.** As viewed in FIG. **8,** for example, the springs **118** tend to pivot the pickup fingers in a clockwise direction, to bring the upper end extremities **117** into contact with the stop bolt means **116.** The pickup fingers may, however, be pivoted in a counterclockwise direction, relative to the lifting lever **108,** against the action of the springs **118,** as is reflected in FIG. **7,** for example.

A typical sequence of operation of the pickup fingers **106** is reflected in the sequential views of FIGS. **6, 7** and **8.** In FIG. **6,** for example, the crank arm **110** is shown in a rest or start position, disposed generally in alignment with the lifting lever **108** and pickup fingers **106,** but extending generally in the opposite direction. In this configuration of the mechanism, the pickup fingers **106** are in a position of maximum retraction from the surface of the supporting blanket **29.** Upon clockwise rotation of the shaft **111** and crank arm **110** to the position shown in FIG. **7,** the pivot point **109** for the lifting lever **108** has been advanced downward and toward the far side. This causes the lever **108,** whose outer end is confined by the rocker arm **113,** to be moved in a downward direction and toward the far side, and also to be rotationally reoriented in a clockwise direction. As reflected in FIG. **7,** the geometry of the elements is such that, in this configuration, the lower extremities **119** of the pickup fingers, which are desirably flattened and bent upwards somewhat, are pressed into contact with the upper surface of the supporting blanket **29.** This contact is established prior to the mechanism reaching the configuration shown in FIG. **7,** whereupon the tips **119** of the pickup fingers remain pressed against the blanket **29,** and continued movement of the lifting levers **108** is accommodated by extension of the springs **118** and pivoting of the fingers at **107.**

Continued clockwise rotation of the shaft **111** and crank arm **110** to the configuration shown in FIG. **8** causes the pivot point **112,** connecting the rocker arm **113** to the lifting lever **108,** to be advanced in an arc, in a downward direction and toward the far side. This causes the tips **119** of the lifting fingers to be advanced toward the far side along the surface of the blanket, while being urged lightly against the surface of the blanket by the extended springs **118.** Eventually, the pickup fingers slide underneath the yarn cord **15** and, with continued movement, the yarn cord becomes engaged by stop pins **120** extending upward from the pickup fingers.

By the time the mechanism has reached the position of FIG. **8,** the lifting lever **108** has been rotationally reoriented in a counter-clockwise direction and has caused the pickup fingers **106** to be lifted off the surface of the supporting blanket **29** and carried to the cutter housing **103.** As is apparent in FIG. **5,** the tips of the pickup fingers **106** are received in the lateral clearance spaces between the cutter blade **88** and the housing walls **104, 105.**

A yarn cord **15** engaged by the pickup fingers **106** and the stop pins **120** will be carried into and beyond the outer edge extremity of the cutting blade **88** (see FIG. **8**) and thus will be reliably severed, allowing the now separated fabric section **73** to be conveyed away at an accelerated speed by the supporting blanket **29** and permitting the next successive sweater blank to resume its normal advancement. Continued clockwise rotation of the shaft **111** and the crank arm **110** results in a retraction of the lifting lever **108** and rocker arm **113** and an eventual return to the condition of the apparatus reflected in FIG. **6.**

To effect proper, timed actuation of the crank arm **110,** there is provided a single revolution clutch **121** driven by a belt **122** from a pulley **123.** The pulley **123** is, in turn, driven from a shaft **124** mounting the cutter blade **88.** The belt **122** is driven continuously by the pulley **123** and, upon appropriate signal from the photocell control **80–82,** the single revolution clutch is actuated to cause the crank arm **110** to be advanced at high speed through a single revolution, starting and finishing generally in the position shown in FIG. **6.**

SUMMARY OF OPERATION AND ADVANTAGES

In normal operation, a machine operator is typically stationed in the region of the front or upstream end, at the near side of the machine. A more or less continuous length of connected-together tubular fabric sections is drawn by the operator from a suitable supply (not shown), oriented to align the yarn cord **15** with the far edge of the spreader-propeller frame, and applied over the front end of the frame. The width of the frame is adjusted, along with the positioning of the far side edge drive roll **21,** to impart a slight width-wise distention to the fabric and to cause it to be advanced along the frame by engagement with internal belts. As successive connecting threads **14** appear at the upstream end of the frame, the operator engages the draw thread loops **14** and pulls them laterally outward and somewhat in a downstream direction over the shouldered tip **54** of the mandrel guide section **36.**

As the sweater sections are advanced along the propeller frame, the draw thread loops are guided along the mandrel section **36,** onto a winding section **35.** There, the successive loops are engaged by the draw pins **57** rotating at a suitably adjusted high speed with the winding section **35** of the mandrel, and the draw threads are quickly and forcibly withdrawn from the fabric to partially separate successive sections. The guide bars **59–63** assure proper control over the draw threads prior to the actual withdrawal operation, and, moreover, serve to prevent possible engagement be-

tween the draw pins **57** and the fabric sections themselves, in the case of severe resistance to removal of the draw thread.

After removal of the draw thread, the fabric sections continue along on the spreader-propeller frame until dropped off of the near side bar of the spreader onto the surface of conveyor blanket **29** and permitted to contract laterally to a relaxed condition, with all of the contractions occurring from the near side toward the far side. Since the fabric section is advancing at a more rapid rate on the conveyor blanket **29** than on the spreader-propeller frame, a converging gap **74** is opened up between fabric sections in the vicinity of the cutter. The upstream edge of this gap is detected by the photocell control **80–81,** causing the pickup fingers **106** to be actuated to engage the exposed yarn cord **15** and lift it into the rapidly rotating cutter **88.** In this connection, the tapered configuration of the gap between adjacent sweater blanks facilitates movement of the pickup fingers **106** into a proper relationship with the yarn cord **15** and accurate guidance of the fabric, for effecting precise cutoff.

The method of the invention greatly expedites the separation of successive, connected-together fabric sections from a continuous length of tubular knitted fabric and significantly reduce the manpower requirements for this operation. In general, the production may be carried out on high speed, substantially continuous basis, by means of a single operator, whose primary responsibility is to properly align the incoming tube of fabric and to initially apply the draw thread loop over the upstream end of the mandrel.

A feature of particular significance is the manner in which the fabric is handled and controlled after removal of the draw threads, enabling the remaining yarn cord to be severed on an entirely automatic basis, without further operator intervention. In this respect, the mounting of the pickup fingers **106** is such that the tips **119** thereof are lowered into lightly pressing engagement with the surface of the conveyor blanket **29** and caused to slide laterally along the surface of the blanket, against the force of the extended springs **118,** so as to reliably slide underneath the yarn cord **15.** Further, the manipulation of the fabric sections to form a converging gap toward the yarn cord facilitates proper initial lowering of the pickup fingers into the open gap, without contacting the surface of the fabric itself through minor mis-alignment. Thereafter, by reason of the pressure of the fingers against the conveyor blanket **29,** at least a limited degree of self-alignment of the fabric with respect to the pickup fingers is provided for, assuring precise positioning of the yarn cord at the moment of cutting.

The winding mandrel arrangement is advantageous in that its two-section, two-speed construction permits the mandrel to extend from a cantilever mounting, near the downstream end of the machine, over a significantly long unsupported distance, such that the free end extremity of the mandrel is positioned adjacent the upstream end of the spreader frame, at a convenient location for the operator. This enables the operator, stationed to orient and apply the incoming fabric over the spreader-propeller frame, also to conveniently engage the draw thread loops and apply them successively over the tip of the mandrel. The upstream or guiding section of the mandrel is supported for rotation at as low a speed as practicable, consistent with the need to minimize sliding friction of the bar thread loop and permit the loop to advance along the length of the mandrel as the fabric is conveyed along the spreader-propeller frame. The winding portion of the mandrel, on the other hand, is arranged to be driven at a higher rotational speed, to effect removal of the draw thread as it travels along the length of the drawing station.

To enable automatic severance of the yarn cord to be accomplished on a reliable high speed production basis, the propeller-spreader frame is of an asymmetrical configuration, with the near side of the frame being effectively shorter than the far side. The laterally distended fabric sections being advanced along the spreader frame are discharged from the near side thereof slightly in advance of the far side. As a result, the lateral relaxation of the fabric is derived entirely by contraction of its near edge toward its far edge, while the far edge remains guided by the far section of the spreader frame. Thus, the yarn cord, aligned with the far edge of the frame, retains its predetermined longitudinal alignment with the cutting apparatus, so that the eventual cut-off operation may be carried out in a reliable and precise manner. In addition, by providing for the conveyor blanket **29** to be operated at a slightly higher rate of speed than the propeller-spreader frame, the fabric sections supported by the blanket will tend to accelerate slightly as they are discharged from the spreader frame. However, since the sections remain attached at the yarn cord prior to severance thereof, such tendency to accelerate serve to open up a tapered gap, converging toward the yarn cord. This facilitates and renders more reliable not only the photocell actuated triggering of the cut-off operation, but also the mechanical operations involved in the cut-off.

It will be understood, of course, that the specific form of the invention herein illustrated and described is intended to be representative only, as many 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. A method for automatically separating connected-together tubular knitted fabric sections in a continuous manner, adjacent fabric sections being connected by a removable draw thread and a yarn transition transfer cord, the steps which comprise

a. continuously advancing the said connected-together fabric with the sections in predetermined yarn cord alignment;

b. laterally distending the advancing fabric and effecting removal of successive draw threads therefrom;

c. maintaining said predetermined yarn cord alignment on one side of said advancing fabric while releasing the opposite side thereof;

d. accelerating the forward advance of said fabric after said maintaining step to partially separate adjacent fabric sections to provide tapered spaced apart gaps therebetween during continued advancement of the fabric;

e. detecting said tapered spaced apart gaps between said fabric sections to initiate sequential severance of said yarn cord between adjacent fabric sections; and

f. sequentially severing the yarn cord between adjacent fabric sections in response to said detecting step.

2. The method as described in claim **1**, in which

a. said detecting step is carried out by optically detecting sequentially the downstream and upstream edge of each said tapered gap;

b. the detection of said downstream edge initiating a make-ready position for said severing step; and

c. the detection of said upstream edge initiating said severing step.

3. A method for separating adjacent fabric sections of a tubular knitted fabric web in a continuous manner, said sections being connected together by a yarn transition transfer cord and a removable draw thread, the steps which comprise

a. continuously advancing said web of connected together sections in predetermined yarn cord alignment;

b. laterally distending said advancing web and effecting removal of successive draw threads therefrom;

c. maintaining said predetermined yarn cord alignment on one side of said advancing web;

d. accelerating the forward advance of said web sections after removal of said successive draw threads and releasing said distended fabric to partially separate said adjacent fabric sections to provide tapered spaced apart gaps therebetween; and

e. maintaining said accelerated forward advance of said partially separated web sections while severing said yarn cord sequentially between said adjacent sections as each successive tapered gap is formed.

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