Aug. 8, 1961 T. S. PAYNE ET AL 2,995,021

METHOD OF SLITTING THERMOPLASTIC KNITTED FABRIC AS IT IS BEING KNITTED

Filed April 22, 1959 4 Sheets-Sheet 1

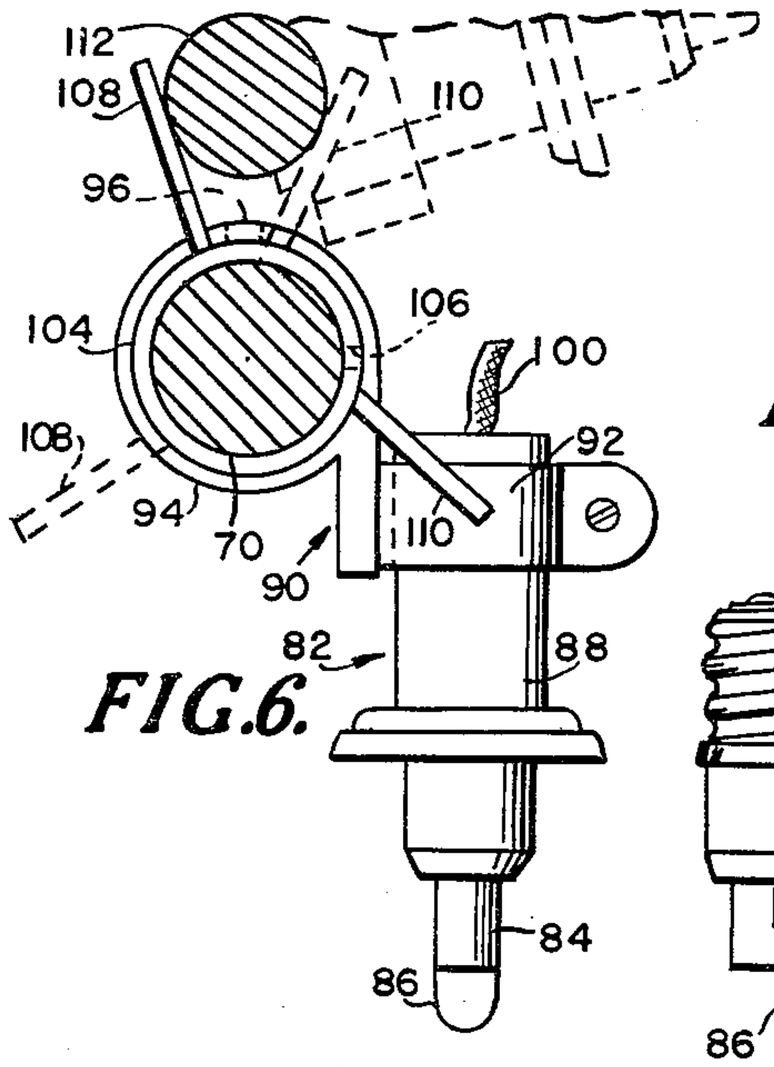


FIG.6.

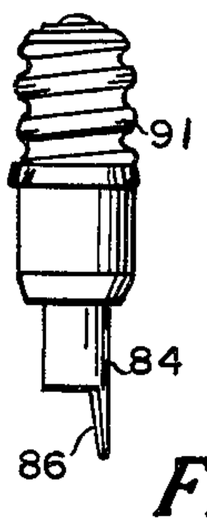


FIG.1.

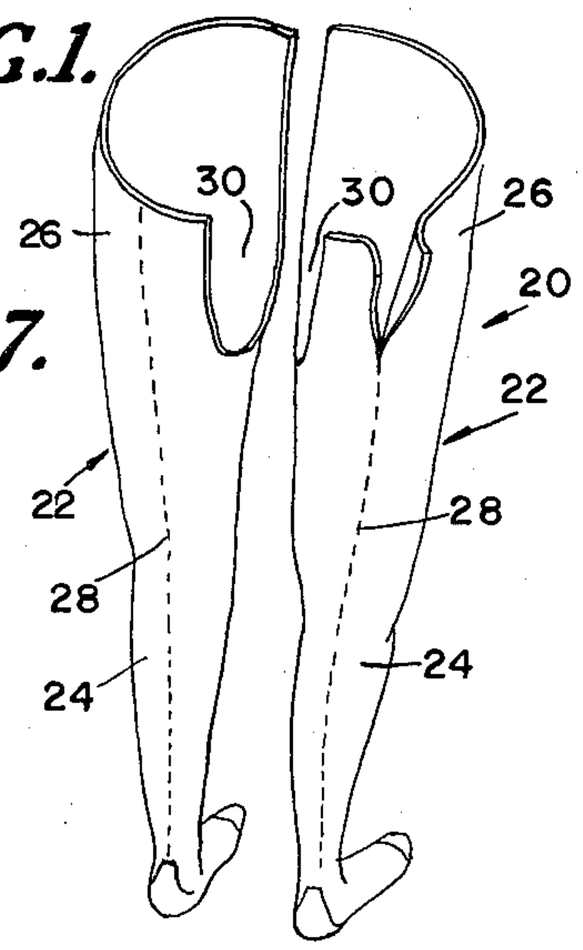


FIG.7.

FIG.4.

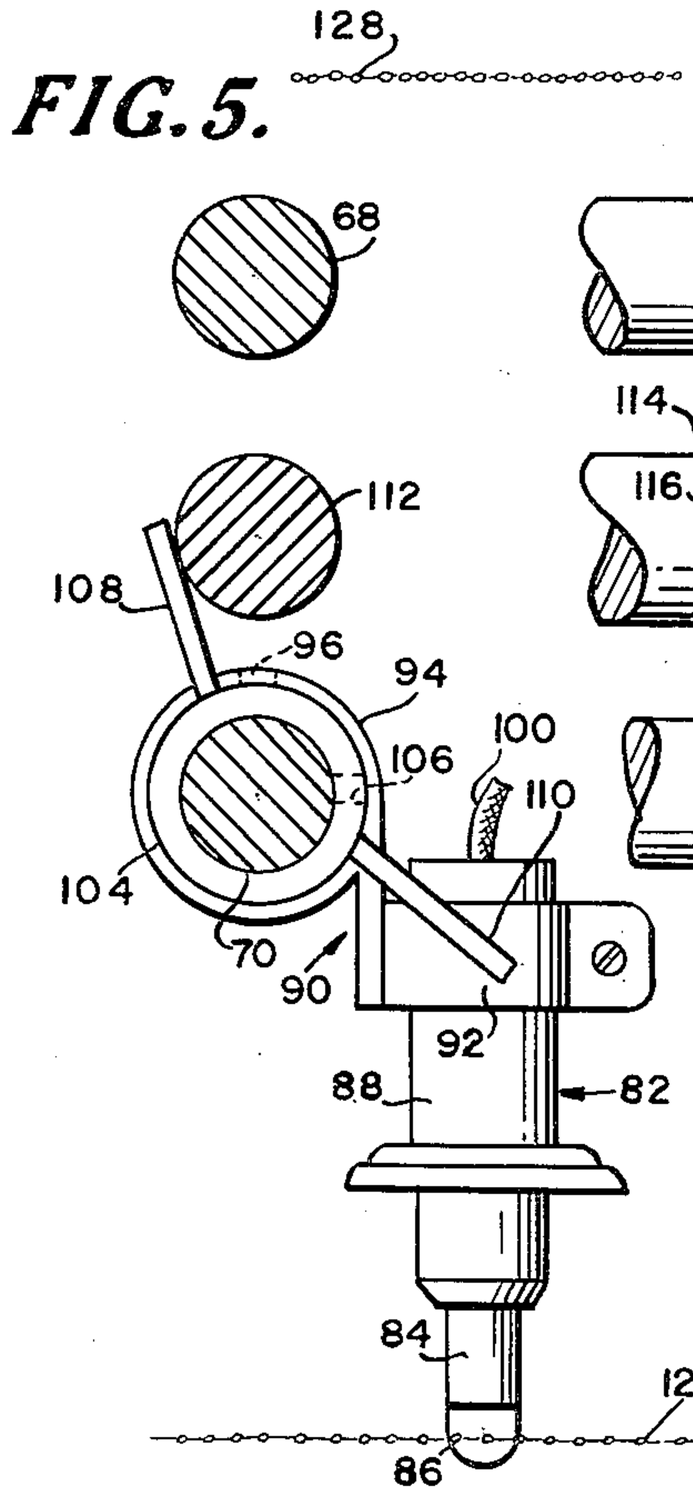


FIG.5.

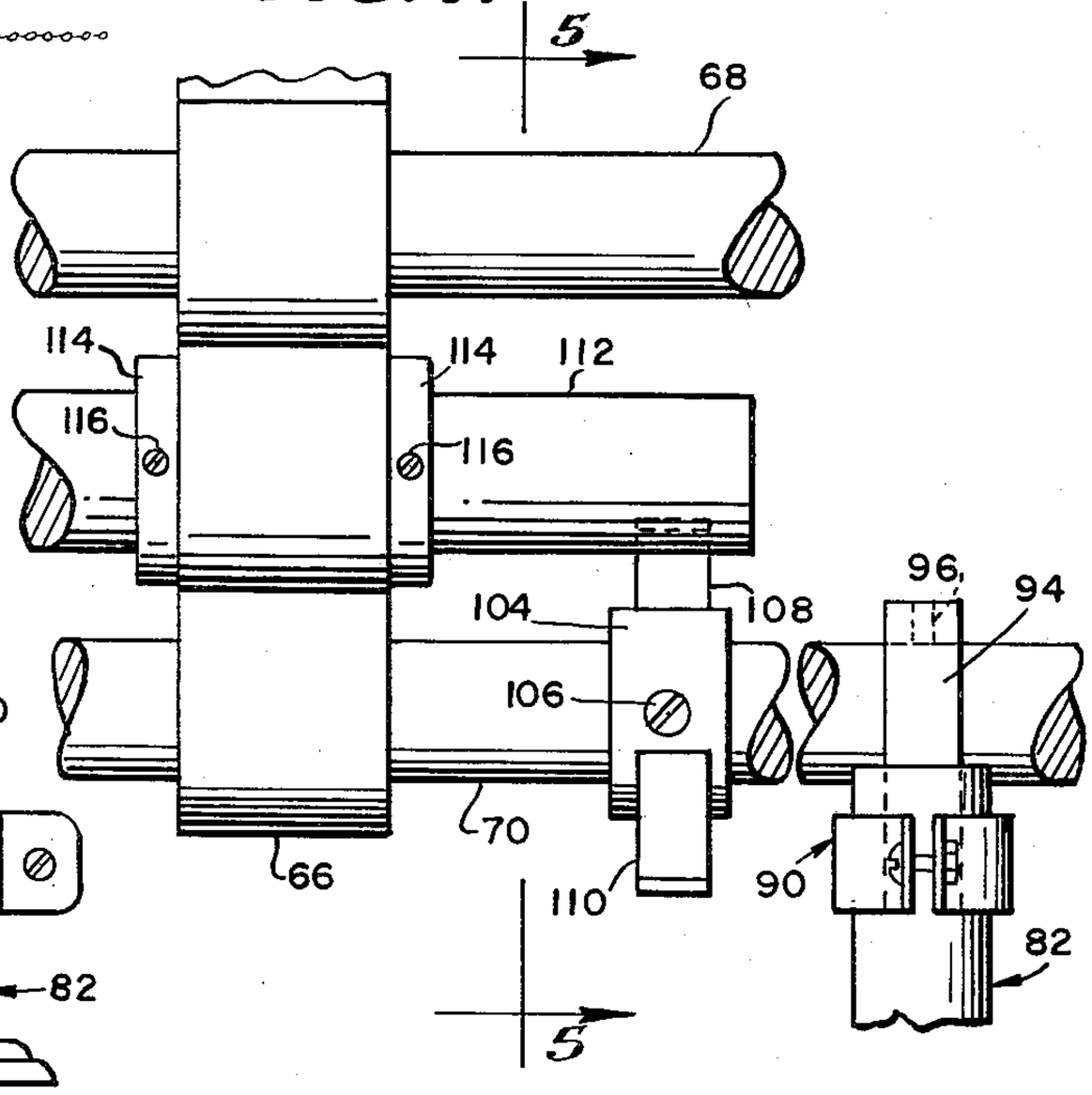


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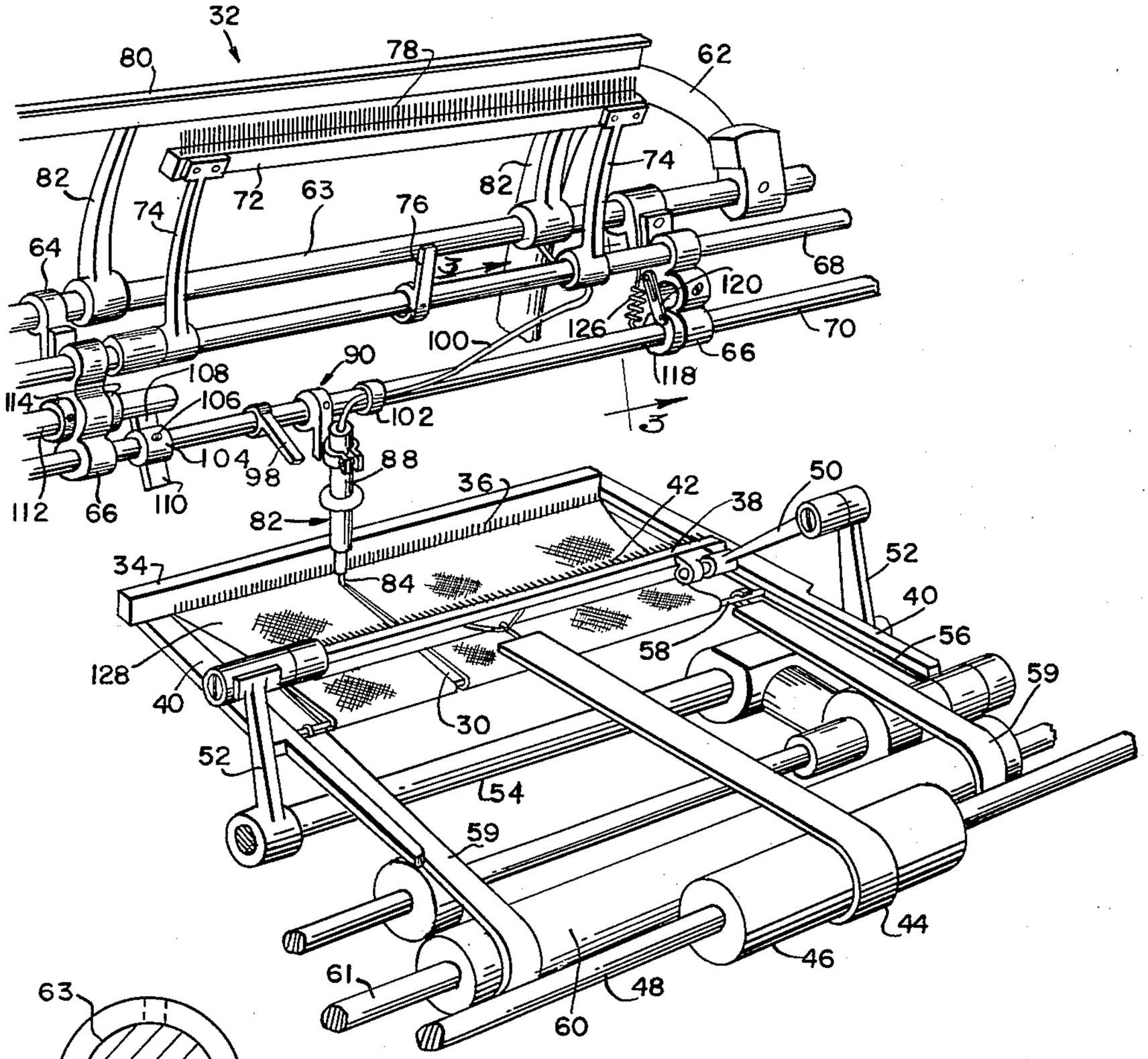
*FIG. 2.*



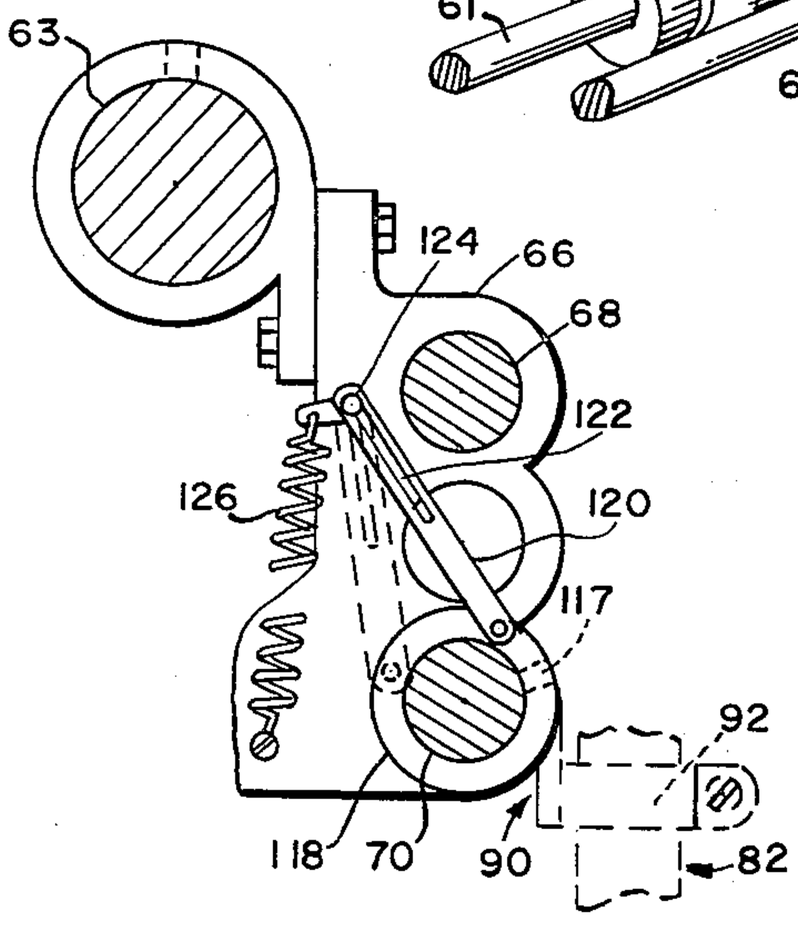




*FIG. 3.*

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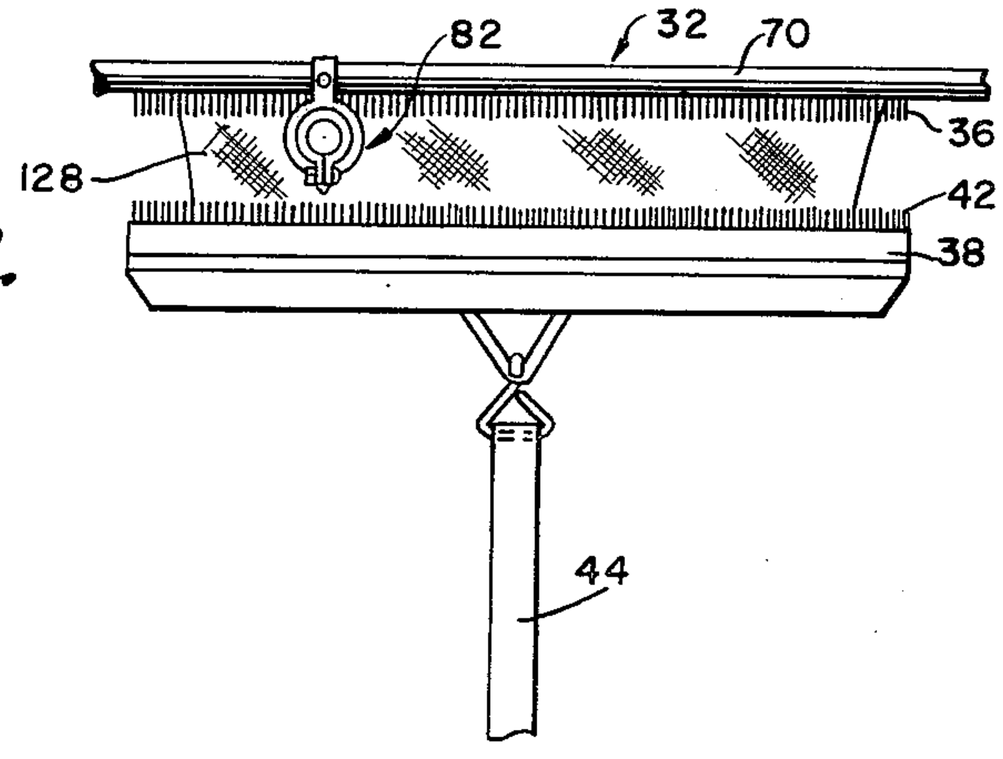


FIG. 8.

FIG. 9.

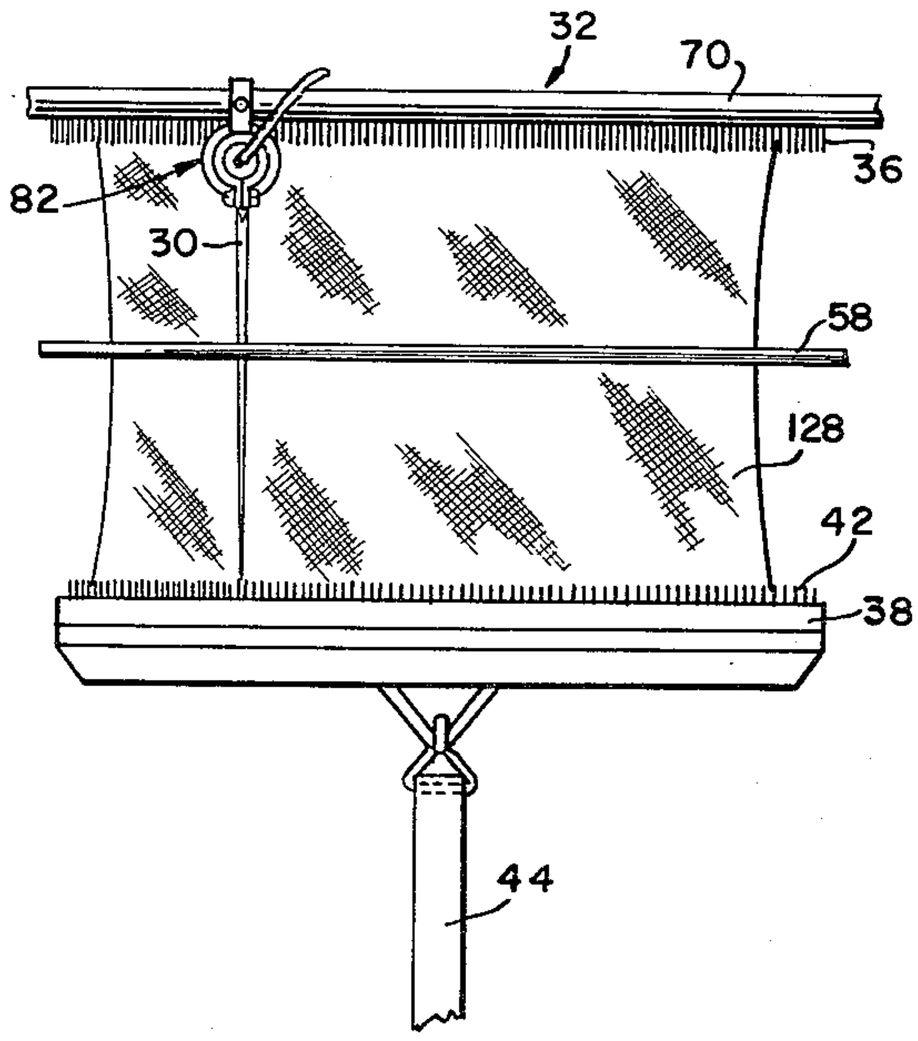


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FIG.10.

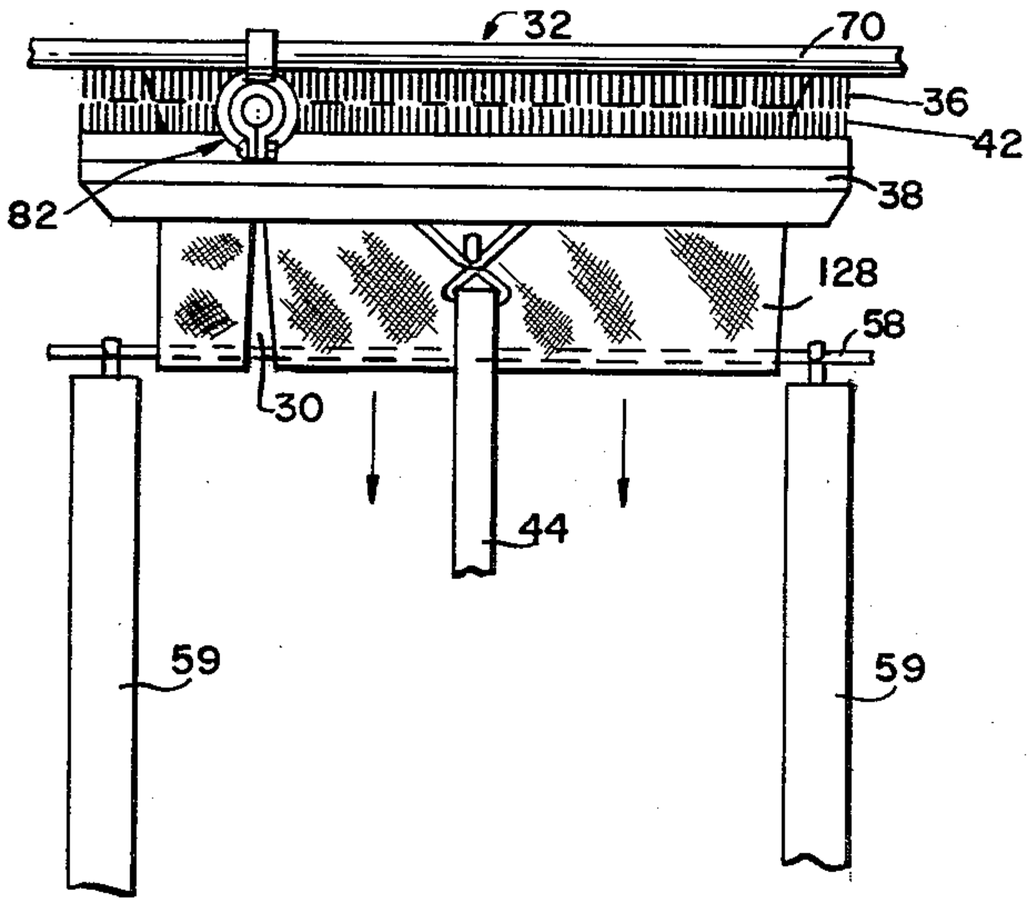
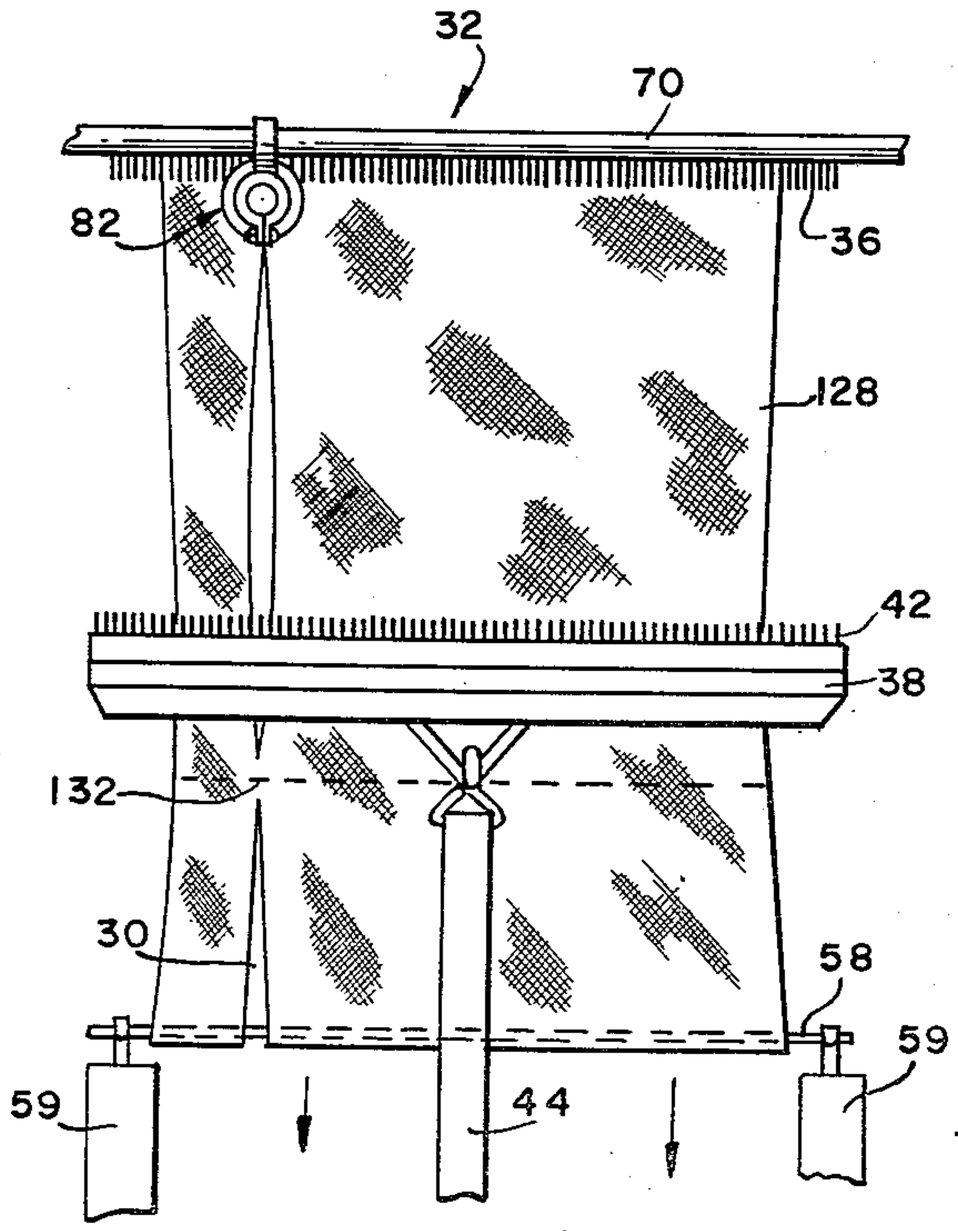



FIG.11.

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2,995,021

# METHOD OF SLITTING THERMOPLASTIC KNITTED FABRIC AS IT IS BEING KNITTED

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Filed Apr. 22, 1959, Ser. No. 808,189
6 Claims. (Cl. 66—147)

This invention relates to an improved method and apparatus for slitting knitted plastic fabric as the latter is being knitted. More particularly, this invention relates to an attachment for a flat bed or full-fashioned knitting machine for automatically slitting plastic fabric being knit on such machine.

In the fabrication of tights from knitted fabric it is customary to partially slit, and sew together, along the edges of their slits, two separate sections of knitted fabric, each having a leg portion generally in the form of a stocking, and a body portion which will cover half way around the body of the wearer up to his or her waist. These two separate sections frequently are knitted on flat bed or full-fashioned knitting machines, with the slit which appears in the body portion of the fabric being formed either by a separate operation after the section has been knit, i.e., manually with a cutting implement, such as a knife or scissors, or during the knitting operation by the use of two yarn carriers, each knitting only a portion of the fabric on opposite sides of the slit.

Manual formation of the above-described slit in the fabric increases both the cost of manufacture, because of the necessity of a separate manual operation, and the time of manufacture. The manual cutting of a slit in the fabric also gives rise somewhat to the problem of ravelling during subsequent handling, particularly during the operation of sewing the two sections of fabric together along their slits. On the other hand, the formation of the slit during the knitting operation by the use of two yarn carriers also has disadvantages. In the first place, the use of the two yarn carriers requires a reduction in speed of operation of a full-fashioned knitting machine. For example, the knitting of a medium-size fabric section of the type under consideration without a slit requires about 28 minutes on a modern full-fashioned knitting machine. Adapting the same machine to knit the slit into the same size fabric section, by using two yarn carriers, requires the machine to be slowed down to such an extent that it requires an additional four minutes to complete the section. Moreover, the use of two yarn carriers increases needle breakage, requires a relatively expensive set-up time in adapting a machine from one to two yarn carriers, and also requires a relatively large yarn inventory for operating the machine with two yarn carriers.

Accordingly, it is an object of this invention to provide an improved method and an improved apparatus for forming the required slit in a fabric section, of the type under consideration, while the same is being knitted with plastic yarn on a full-fashioned knitting machine.

It is another object of this invention to provide an improved apparatus and method for the above purpose that will produce the required slit in the fabric without requiring a reduction in the normal operating speed of the knitting machine, and without introducing any ravelling problem in the resulting fabric.

It is another object of this invention to provide a relatively inexpensive attachment for a full-fashioned knitting machine for automatically producing the necessary slit in a fabric section of the type described, and which attachment can be applied rapidly to a knitting machine without any extensive modification thereof.

Other objects and advantages of the invention will



become apparent from the following description and accompanying drawings in which:

FIGURE 1 is an exploded perspective view of tights knit by the method and apparatus embodying this invention.

FIGURE 2 is a somewhat diagrammatic fragmentary perspective view of a full-fashioned knitting machine equipped with an attachment embodying this invention.

FIGURE 3 is an enlarged fragmentary sectional view taken substantially on line 3—3 of FIGURE 2.

FIGURE 4 is an enlarged front view of a portion of the apparatus shown in FIGURE 2.

FIGURE 5 is a sectional view taken substantially along 5—5 of FIGURE 4.

FIGURE 6 is a view corresponding to FIGURE 5 illustrating a different position of the parts.

FIGURE 7 is a side view of the slitter tip shown in FIGURES 5 and 6.

FIGURES 8 to 11 are fragmentary plan views of parts of the machine shown in FIGURE 1, illustrating successive steps in the knitting and slitting of fabric in accordance with this invention.

Referring now to the drawings there is shown in FIGURE 1 a pair of knitted tights 20 that are originally knitted in two separate sections or halves 22, each having a foot and leg portion 24, generally in the form of a stocking, and a body portion 26 adapted to cover the body of a wearer, on one side of the vertical center line thereof, up to the wearer's waist. The fabric for each of the sections 22 usually is knitted on a full-fashioned knitting machine which produces a flat blank that is sewn together along its opposite edges to form a section 22 which has a seam 28 extending along the backs of the leg and body portions 24 and 26. The body portion 26 of each section 22 is slit longitudinally, as at 30, at substantially 90 degrees to the seam 28, and the edges of the slits of the two sections are sewn together to form the complete pair of tights 20. For this invention to be applicable, the fabric forming the sections 22 is knitted from yarn formed of synthetic plastic fibers, preferably nylon. The fabric may even be of the well-known stretch type, but in any event is made with a plastic yarn that has a melting point which is attained before burning.

Referring now to FIGURE 2 of the drawings, there is shown apparatus embodying this invention for simultaneously knitting and slitting a fabric section 22 of the type shown in FIGURE 1. The apparatus includes a full-fashioned knitting machine having, as is well known in the art, a plurality of knitting sections 32, only one of which is shown. Each knitting section 32 is provided with the usual knitting elements in the form of sinkers and dividers, carried in the usual sinker head 34, and between which vertically reciprocate needles carried on the usual needle bar (not shown). The knitting elements, i.e., sinkers, dividers, and needles, are generally indicated in common by the reference character 36.

The machine also embodies automatic welt turning mechanism that includes the usual welt bar 38 slidable toward and away from the knitting elements 36 on rails 40 that extend forwardly and normally of the knitting field. The welt bar 38, equipped with welt hooks 42, customarily is urged forwardly away from the sinker head 34 by a strap 44 hooked centrally to the welt bar and extending over a drum 46 fastened onto a shaft 48 that extends the length of the machine past all its knitting sections 32 and is urged by a weight (not shown) to turn in a direction to wind up the strap 44. During the conventional and automatic operation of turning the welt, the welt bar 38 is adapted to be pushed forwardly toward the knitting elements 36 by links 50 pivotally connected to the ends of levers 52 fixed to a rock shaft 54 that is operated at certain timed stages of the knitting

operation by conventional adjustable pattern mechanism (not shown) of the machine. The rails 40 also are provided with longitudinal grooves 56 in their inner opposed faces within which slides a welt rod 58 that is introduced into the machine at a certain stage of the knitting operation. Draw-off straps 59 hooked onto the opposite ends of the rod 58 extend over a drum 60 fixed to another shaft 61 urged to turn by a weight (not shown) in a direction to wind up the straps 59 and so draw off the fabric from the knitting field.

Such automatic welt turning and draw-off mechanism is shown in greater detail in the patents to Bitzer 2,413,601 and 2,431,160. Patent 2,413,601 also clearly discloses adjustable pattern mechanism of the type above referred to, such mechanism including an endless chain to which actuator buttons can be attached at selected intervals. Since such mechanism is well-known in the art no illustration is believed necessary here.

The knitting machine also includes a conventional narrowing machine that has upwardly and forwardly curved arms or levers 62 that are pivoted at their lower ends on a back narrowing shaft (not shown) and at their upper and forward ends are secured to the usual front narrowing shaft 63. The front narrowing shaft 63 is supported on upright lifting links 64 pivotally connected at their upper ends to the shaft 63. The lower ends of the links 64 are connected to mechanism (not shown) well known in the art which lifts and lowers the front narrowing shaft 63 at timed intervals during the narrowing cycle under the control of the aforementioned adjustable pattern mechanism. Bearing brackets 66 secured to the front narrowing shaft 63 between the knitting sections 32 usually support three shafts arranged one above the other parallel to and somewhat in front of the front narrowing shaft and above the knitting field. Only the upper 68 and lower 70 of such three shafts are shown because the middle shaft is not used for the purposes of this invention and is removed from the machine, for reasons later apparent. A lace or picot bar 72 usually is supported, by arms 74, on the upper shaft 68, and is arranged so that it can be swung, by rotating the shaft 68 manually with a handle 76 fixed thereon, from a position wherein the points 78 on such bar are adjacent the knitting elements 36 to the position shown in FIGURE 2 wherein the points are closely adjacent a guard rail 80 which is carried, by arms 82, on the front narrowing shaft 63. The lower shaft 70 usually supports a covering knife or special lace points (neither being shown) details of which are shown, for example, in the patent to Anke 2,578,164. For the purposes of this invention such instrumentalities are removed from the shaft 70.

At each knitting section 32 of the knitting machine there is secured on the shaft 70 of the narrowing machine, a slitter 82, best shown in FIGURES 5 to 7. The slitter 82 has a metal tip 84 adapted to be heated to a temperature sufficient to melt plastic fabric and provided with a relatively sharp edge 86 adapted to be engaged with and slit such fabric as it is being drawn off from the knitting elements 36. In actual practice, the slitter 82 has taken the form of a commercially available 23-watt, 110-volt electric soldering iron having a body or handle portion 88 provided with an interiorly threaded socket (not shown) within which is engaged the usual exterior thread 91 on a detachable tip 84 that has been ground to form the relatively sharp edge 86. The slitter 82 is fastened to the shaft 70 by a bracket 90 having a clamping split sleeve portion 92 which embraces the slitter body 88 and a collar portion 94 mounted on the shaft 70 and securable in any adjusted position thereon by means of a set screw 96.

In its normal operating position the slitter 82 is in the upright position shown in FIGURES 2 to 6 wherein the tip 84 depends below the shaft 70 in close proximity to the knitting field in position to slit, by a semi-cutting and melting process, plastic fabric being drawn thereby. In



such operating position the slitter 82 is moved automatically into engagement with the fabric, as shown in FIGURES 2 and 5, and out of such engagement, as shown in FIGURE 6, as the shaft 70 is moved to its respective lower and upper positions by movement of the lifting links 64 of the narrowing machine. In addition to being movable into and out of engagement with the fabric by down and up movements of the shaft 70 of the narrowing machine, the slitter 82 is adapted to be swung forwardly and upwardly to an inoperative position, shown in dotted lines in FIGURE 6, by rotation of the shaft 70. For this purpose, the latter is provided, at appropriate intervals therealong, e.g., at every other knitting section 32, with collared operating handles 98 for rotating such shaft 70 to swing all the slitters 82 between their operative and inoperative positions. In this connection it will be noted that the previously-mentioned third shaft, adapted to be carried in the brackets 66, is removed so as not to interfere with movement of the slitters 82 into their inoperative position. The usual electric cord 100 for the heating elements of each slitter 82 may be taped to the shaft 70, as at 102, and thence run behind the shafts 68 and 63 up to a common electric supply line (not shown) which is secured to and extends along the back of the guard rail 80.

The slitters 82 are yieldably retained in either their operative or inoperative positions, shown in solid and dotted lines, respectively, in FIGURE 6, by any appropriate detent mechanism. As shown herein, such mechanism may include a suitable number, e.g., four, stop collars 104 secured at appropriate intervals along the shaft 70 as by set screws 106, and having pairs of circumferentially spaced, radial stop flanges 108 and 110 thereon adapted to alternatively engage stub shafts 112 (one for each collar 104) mounted in the brackets 66 in place of the aforementioned removed third shaft. Such alternative engagement obviously restrains rotation of the shaft 70 beyond positions corresponding to the operative and inoperative positions of the slitters. Each stub shaft 112 may be retained in place in its bracket 66 by a pair of collars 114 secured to the stub shaft, as by set screws 116, on opposite sides of the bracket 66. Secured to the shaft 70, as by a set screw 116, adjacent a bracket 66 which does not have a stub shaft 112 therein, is a collar 118, best shown in FIGURE 3. A link 120 has one end thereof pivotally connected to the collar 118 and a longitudinal slot 122 in the other end thereof slidably engaged with a pin 124 on the side of the bracket 66. A coil tension spring 126, secured to the slotted end of the link 120 and to the side of the bracket 66 below the pin 124, constantly urges the link to move toward the shaft 70. Consequently, it will be seen that this spring and linkage arrangement yieldably restrains the shaft 70 against rotation from either of its angular positions to the other corresponding to the operative and inoperative slitter positions.

The aforedescribed modification of a conventional full-fashioned knitting machine to adapt the same to slit fabric in accordance with this invention can be accomplished rapidly and at very little expense. In fact, the cost of apparatus necessary to effect modification of all of the knitting sections of a normal size full-fashioned knitting machine is only about $100 and the modification can be accomplished in about 8 hours. In order to modify the machine, the upper covering knife shaft, i.e., the middle shaft, usually carried in the brackets 66 of the narrowing machine is removed and replaced by the stub shafts 112 and their retaining collars 114. The lower covering knife shaft 70 likewise is removed, but is replaced in a manner so that there can be mounted and secured thereon, the slitter brackets 90, handles 98, stop collars 104, and collar 118 with its link 120. The proper bracket 66 is then drilled to receive the pin 124 and tapped for an anchoring screw for one end of the spring 126. The latter then is installed, the slitters 82 clamped in their

brackets 90, and the necessary electric connections made. It also is necessary to add certain buttons to the chain of the adjustable pattern mechanism of the knitting machine in order to operate the narrowing machine to move its shaft 70 down at certain points of the knitting operation and to move it up at other points, in addition to the normal up and down movements effected during the narrowing operations.

At the start of the knitting operation, the shaft 70 of the narrowing machine normally is in its up position, and the slitters 82 are swung up to their inoperative position. The knitting operation is begun and the fabric hooked onto the welt hooks 42 of the welt bar 38 in a conventional manner. After the first course has been knit, the picot bars 72 are raised manually and the slitters 82 are swung down to their operative position by rotating the shaft 70 by means of the handles 98. At this time, however, the shaft 70 of the narrowing machine will be in its up position so that the tip 84 of the slitter 82 will not contact the welt bar 32 or its hooks 42. Knitting then progresses in normal fashion for about 30 courses, i.e., about one inch or until sufficient fabric has been knit so that the welt bar 32 is out of the way of the slitter 82 and it can be moved down into contact with the fabric closely adjacent the knitting elements 36, as shown in FIGURE 8. Such contact is automatically effected at this time by an appropriate button on the chain of the pattern mechanism which causes the shaft 70 of the narrowing machine to move to its down position. Hence, the slitter 82 will contact and commence to slit the fabric, as at 30, as it is drawn past the slitter, as shown in FIGURE 9.

Thereafter, knitting and slitting of the fabric 128 progresses in normal fashion until sufficient fabric has been knit to form a welt so that a welt rod 58 can be positioned properly in each knitting section 32 of the machine, as illustrated in FIGURE 9. About one course or so before the operation of turning the welt, the shaft 70 of the narrowing machine is raised automatically, by an appropriate button on the chain of the pattern mechanism, so that the slitters 82 are raised out of contact with the fabric 128 in each knitting section 32. The automatic welt turning mechanism of the machine then operates to turn the welt in the manner illustrated in FIGURE 10 and hook the draw-off straps 59 onto the welt rod 58. Knitting then recommences and continues for about 30 courses, i.e., until the welt bar 38 has again been moved out of the way of the slitters 82. At this time the shaft 70 is again lowered automatically by an appropriate button on the pattern chain so that the slitters 82 again move down into engagement with the fabric 128 to continue the slit 30 therein as additional fabric is knit and is drawn off from the knitting elements 36 of the machine.

As best shown in FIGURE 11, the slit 30 is interrupted, as at 132, for a short distance at the junction of the welt with the body of the fabric 128 because the slitters 82 must be raised out of contact with the fabric during the welt turning operation and until a few courses have been knit thereafter. After this interrupted portion 132 of the slit 30 has moved forwardly beyond the welt bar 38, however, as knitting continues and the fabric becomes detached from the welt hooks 42, the interrupted portion can readily be cut through with scissors by an operator while the fabric 128 is still on the machine.

Automatic elevation of the shaft 70 of the narrowing machine to raise the slitters 82 out of engagement with the fabric 128 after a slit 30 of the desired length has been formed also is effected by an appropriate button on the pattern chain. This automatically occurs before the narrowing operation begins because the slit 30 is formed only in the body portion 26 of a fabric section 22 and narrowing does not occur until the subsequent knitting of the leg portion 24. At this time, the slitters 82 are swung to their inoperative position, by manually rotating the shaft 70 by the handle 98, so that the slitter will not engage the fabric during the dipping movements of the shaft 70 of the narrowing machine during the subsequent narrowing operations.



It is obvious that some safety device (not shown), rendered inoperative by movement of the shaft 70 in swinging the slitters 82 from their operative to their inoperative positions, can be applied to the knitting machine for positively preventing movement of the shaft 70 of the narrowing machine to its lower position for narrowing purposes unless the slitters have been turned up to their inoperative positions. Such a device would positively prevent the accidental engagement of the slitters 82 with the fabric, during a narrowing operation, because of the failure of an operator to swing the slitters into their inoperative position after the desired slit has been formed in the fabric. In this same connection, it is evident that the supply of electric power to the slitters 82 desirably may be controlled by a switch (not shown) that is operable by the pattern mechanism of the knitting machine and such mechanism adjusted to shut off the current supply automatically after the slit has been formed, and also to re-establish the supply at about the start of knitting the foot portion of the fabric sections 22 so that the slitters will be up to operating temperature at the start of the knitting of subsequent fabric sections on the machine.

It is evident that the slitters 82 can be adjusted longitudinally along the shaft 70 to position them properly for slitting fabric sections 22 of different size. In this connection, instead of adjusting the slitters 82 longitudinally along the shaft 70, the entire shaft 70 can be moved longitudinally in its bearing brackets 66 to shift all of the slitters of the several knitting sections 32 of the machine simultaneously. In actual practice, for slitting nylon fabric, the tips 84 of the slitters 82 are heated to a temperature of the order of about 700° F. At this temperature it is found that the slitters "cut" very easily through the fabric without causing any pile up thereof or any undue loading of the knitting needles. An unheated knife edge, if employed as a slitter, might not create much of a ravelling problem, but such an unheated sharp edge would tend to pile up the fabric in front of the edge, unduly load the knitting needles, and also create a relatively ragged selvage at the sides of the slit. On the other hand, a heated slitter embodying this invention eliminates all of the foregoing disadvantages and, in addition, provides a smooth, fused selvage, that is much better for subsequent seaming operations. In this connection, because the selvages are smooth, very fine seams can be sewn when sewing together the edges of slits 30 in two fabric sections 32. Furthermore, in actual practice, it has been found that there is only an extremely small deposit of melted or semi-burned nylon on the slitter tips 84, so that such tips need be cleaned off, as with a wire brush, only about twice a day.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing specific embodiment has been shown and described only for the purpose of illustrating the principles of this invention and is subject to extensive change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

We claim:

1. The method of slitting knitted thermoplastic fabric, the steps comprising: initially knitting several courses of thermoplastic yarn on a full-fashioned knitting machine while drawing off the resulting knitted fabric from the knitting elements of the machine; interposing a thin slitter, heated to a temperature sufficient to melt the fabric, in the path of draw-off movement of the fabric closely adjacent the knitting elements to thereby slit the fabric as it is drawn past the slitter; continuing to knit the yarn and draw off the fabric while slitting the same until suffi-

cient fabric has been knit to form a welt; moving the slitter out of the path; turning the welt; knitting several courses of the yarn onto the welt while drawing off the fabric; re-interposing the slitter in the path; and continuing to knit the yarn and draw off the fabric while slitting the same as it is drawn past the slitter.

2. The method defined in claim 1 in which the yarn is nylon.

3. The method defined in claim 1 including the additional and subsequent step of manually slitting the unslit portion of the fabric, adjacent the juncture of the welt with the remainder of the fabric, in alignment with the slit formed by the slitter.

4. The method defined in claim 1 including the additional and subsequent step of moving the slitter out of the path after a predetermined length of fabric has been knit while continuing to knit the yarn and draw off the fabric.

5. The method defined in claim 4 in which both steps of moving the slitter out of the path and the steps of interposing and re-interposing the slitter in the path are accomplished automatically.

6. The method defined in claim 1 including the additional and subsequent steps of manually slitting the unslit portion of the fabric, adjacent the juncture of the welt with the remainder of the fabric, in alignment with the slit formed by the slitter, and moving the slitter out of the path after a predetermined length of fabric has been knit while continuing to knit the yarn and draw off the fabric.




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