March 2, 1971 S. C. TITONE 3,566,619

MACHINE KNITTING

Filed Feb. 14, 1968 2 Sheets-Sheet 1

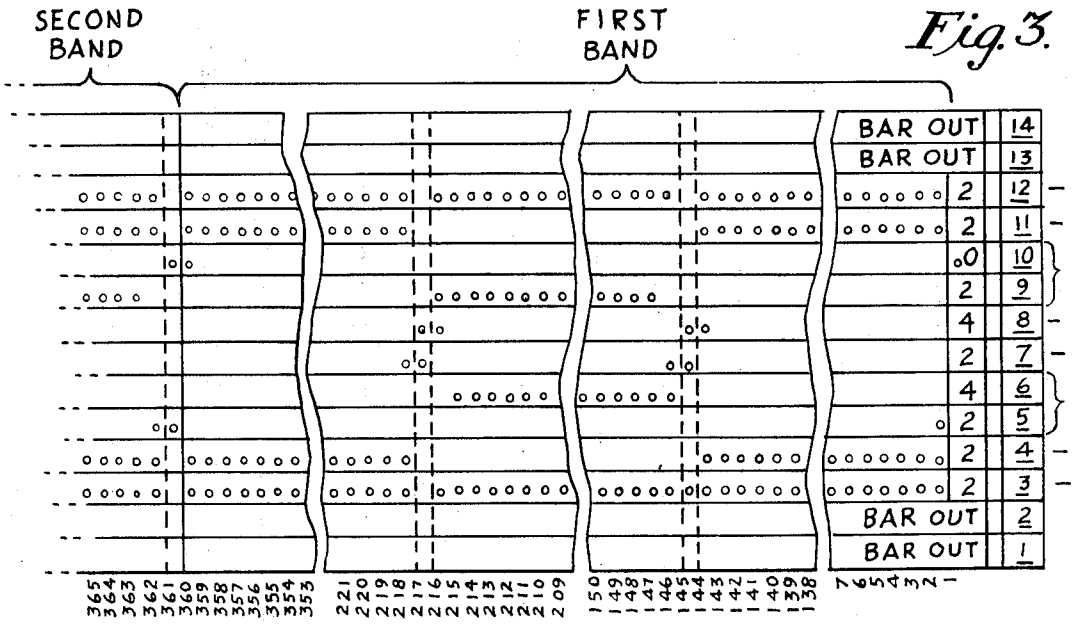


Fig. 3.

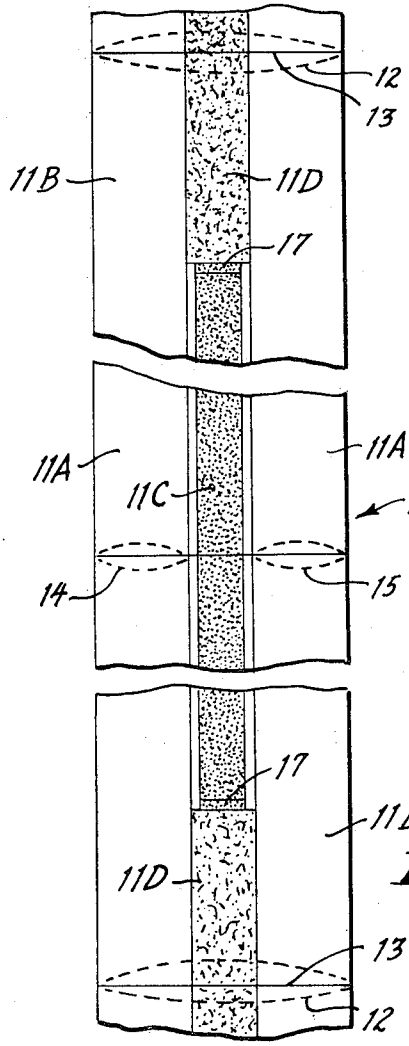


Fig. 1.

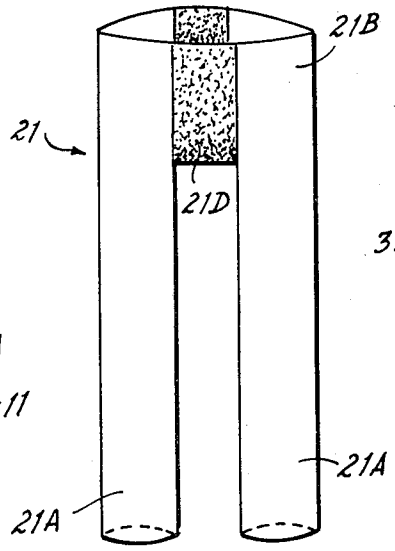


Fig. 2A.

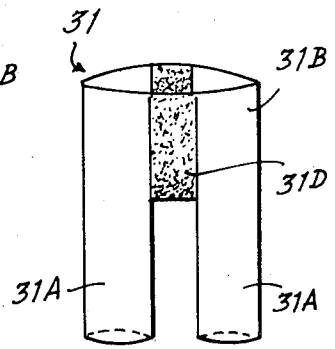


Fig. 2B.

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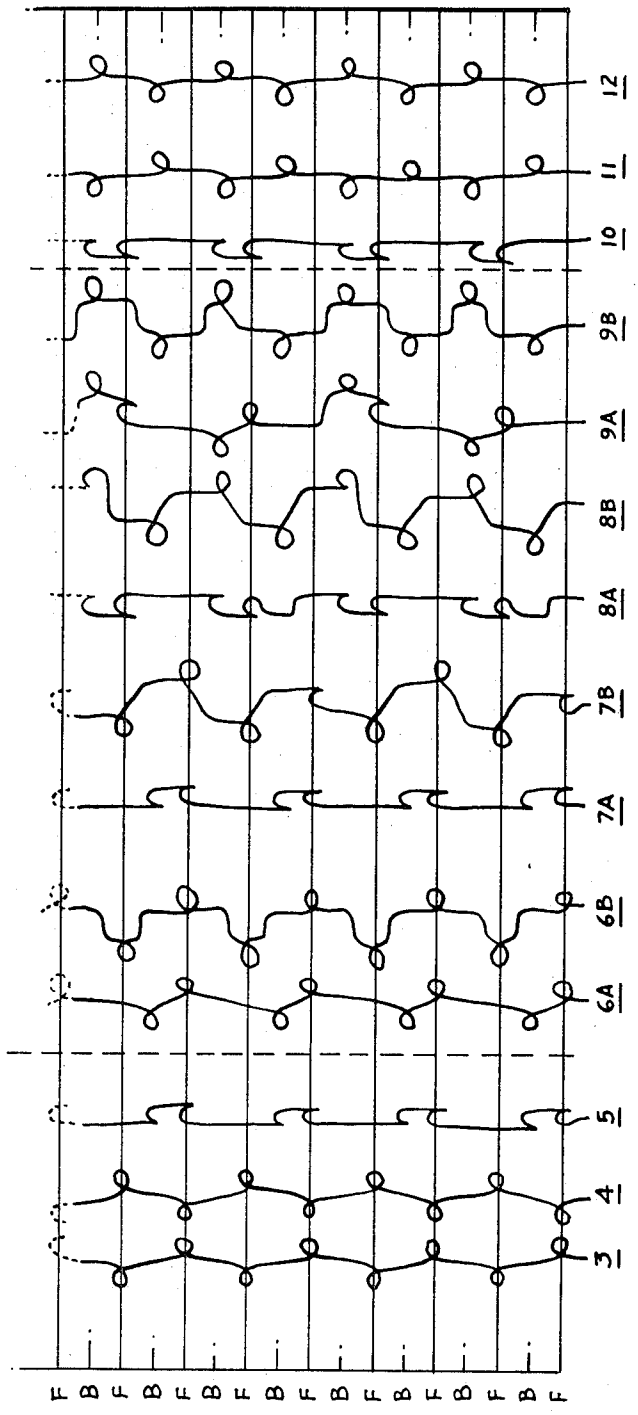


Fig. 4.

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MACHINE KNITTING

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Int. Cl. D04b 23/02
U.S. Cl. 66—87 7 Claims

ABSTRACT OF THE DISCLOSURE

Tubular fabric is warp-knitted to have a plurality of narrow tubular portions located side-by-side but spaced apart and joined endwise to a single wide tubular portion. Knit articles so formed, comprising a pair of spaced narrow tubes joined endwise to a wide tube, are useful for garments in which the wide tubular portion surrounds the trunk or body, and the narrow tubular portions surround the limbs, e.g., panty hose and panty girdles.

This invention relates to machine knitting of tubular fabric and converting at given locations along its length between forming a major tubular portion and forming at least two lesser tubular portions spaced apart side-by-side and joined endwise thereto.

My similarly entitled patent application filed on Dec. 29, 1967 as Ser. No. 694,655, which is incorporated herein by reference, discloses means and methods for forming similar knit articles without spacing of the lesser tubular portions apart from one another at their junction to the major tubular portion. The present invention is an improvement thereover especially desirable in the formation of certain garments.

A primary object of the present invention is formation of warp-knit fabric articles having a wide tubular portion adapted to surround at least a portion of a person's body or trunk and having a plurality of narrower tubular portions adapted to surround limbs of the person.

Another object is provision of such articles having a medial part of the body portion distinguished in appearance and make-up from the limb portions.

A further object is provision of such articles in seamless construction.

Other objects of the present invention, together with means and methods for attaining the various objects, will be apparent from the following description and the accompanying diagrams.

FIG. 1 is a view of a product of this invention as produced in band form, shown partly broken away to conserve space;

FIG. 2A is a similar view of a garment, useful as panty hose, cut from the product of FIG. 1; and

FIG. 2B is a similar view of another garment, useful as a panty girdle, cut from the product of FIG. 1.

FIG. 3 is a threading diagram for the aforementioned product on a double needlebed machine; and

FIG. 4 is a stitch diagram for the respective yarn guide bars in formation of such product.

In general, the objects of the present invention are accomplished by providing yarn along an entire bandwidth on a double needlebed machine, knitting a full-width tubular portion and knitting, end-to-end thereto, a plurality of side-by-side spaced-apart partial width tubular portions and an intervening medial strip disjoined from the partial-width portions, and then severing the medial strip along the junction thereof with the base of the full-width portion between the junction of the full-width and partial-width portions.

FIG. 1 shows article band **11** as produced according to this invention, broken away at each end and with intermediate portions thereof also broken away to conserve space of illustration. It will be understood that such an article band is produced endlessly as long as the knitting machine is supplied with yarn and is operated to produce it. Large elliptical broken lines **12** indicate the circumferential extent of full-width tubular portions **11B**, and transverse solid lines **13** surrounded thereby indicate loci for severing of the band in formation of individual articles. Small elliptical broken lines **14** indicate the circumferential extent of partial-width tubular portions **11A**, and transverse solid line **15** indicates a severing locus for the partial-width tubular portions and for intervening medial strip **11C** (shown shaded), which is flanked by but disjoined from the partial-width tubular portions, while shorter transverse solid lines **17** indicate severing loci for the medial strip itself between the junction of full-width tubular portions B and partial-width tubular portions A. Each severing locus **17** is located between the junction of one of full-width tubular portions **11B** to its adjoining partial-width tubular portions A and closely adjacent base edge **11E** of medial part **11D** (shown shaded differently from medial strip C) of full-width tubular portion **11B**. The width of medial part **11D** (and of base edge E thereof) exceeds the width of medial strip **11C** slightly, i.e., by the aggregate space between the side edge of medial strip **11C** and the adjacent edges of partial-width tubular portions **11A**.

FIG. 2A shows individual article **21**, such as may be formed by severing article band **11** of FIG. 1 as indicated thereon, useful as panty hose. This article comprises tubular body portion **21B** with medial part **21D** extending from the waist or top edge down the middle of the front and back to base edge **21E** between the junctions of the body portion to tubular leg portions **21A**. The cuffs of the leg portions may be fitted with hold-down strips to fit under the feet if desired; alternatively they may be sewn shut, preferably after being cut to simulate the foot outline.

FIG. 2B shows individual article **31**, also formable by severing article band **11** of FIG. 1, useful as a panty girdle. This article differs from that of FIG. 2A in having leg portions **31A** considerably shorter, being intended to extend only part of the way down the thighs, than full-length leg portions **21A** of article **21**. Body portion **31B** thereof is narrower than body portion **21B** of the FIG. 1 article, primarily because medial part **31D** is narrower than corresponding part **21D**. The narrowing is attributable to contraction induced by spandex yarn content, primarily in the medial part but optionally present also in the rest of the garment.

The knitting method and machine for fabricating such product may be visualized readily by persons ordinarily skilled in the warp-knitting art, especially as practiced on a double needlebed machine (Raschel, tricot, or the like), through consideration of a specific example as provided below in tables of chain readings for the yarn guide bars and the starting points therefor, together with the accompanying stitch diagrams and associated description. For the exemplified construction a total of ten guide bars will suffice; when a fourteen-bar machine is employed, the guides of the two frontmost and two rearmost bars

will be left unthreaded. The reference numerals for the guide bars are underlined or italicized to distinguish them from low-numbered reference numerals for other parts.

The first table gives the starting points.

TABLE I

Drum	Bar	Link	Starting points between needles
Right	3	2	1, 2
Do	4	2	1, 2
Do	5	2	1, 2
Left	6	4	145, 146
Do	7	2	144, 145
Do	8	4	143, 144
Do	9	2	146, 147
Right	10	0	0, 1
Do	11	2	1, 2
Do	12	2	1, 2

NOTE.—All starting points are on front bed, i.e., with front needlebar up. Bars 1, 2, 13, and 14 are out.

FIG. 3 shows a preferred threading arrangement for use according to this invention. The guide bar numbers appear at the right, where brackets indicate nesting of bars **5** and **6**, and of bars **9** and **10**. Each bandwidth is 360 needles, whereupon an 1800 needle machine would be capable of producing five bands simultaneously. Threaded yarn guides of the respective bars are indicated by small dots or circles. Intermediate portions of the first band, as well as most of the second band and all of additional bands, are broken away to simplify the illustration by avoiding needless repetition. The further description is limited to a single band.

The next table gives the pattern chain readings, alternate rows being designated for the front (F) and back (B) needlebeds, respectively.

TABLE II

	Right drum			Left (double chain) drum								Right drum		
				6		7		8		9				
Guide bar No.	3	4	5	A	B	A	B	A	B	A	B	10	11	12
Needlebed:														
F	2/0	2/4	2/0	4/6	4/6	2/4	2/4	4/4	4/4	2/2	2/2	0/0	2/2	2/2
B	2/2	2/2	0/2	4/2	4/4	4/2	4/4	2/2	2/0	2/2	2/0	0/0	2/0	2/4
F	2/4	2/0	2/2	4/4	2/0	2/2	2/0	4/2	2/2	2/4	2/2	0/2	2/2	2/2
B	2/2	2/2	2/2	4/4	4/4	2/2	2/2	2/4	4/6	2/0	4/6	2/0	2/4	2/0
F	2/0	2/4	2/0	4/6	4/6	2/4	4/6	4/4	4/4	2/2	2/2	0/0	2/2	2/2
B	2/2	2/2	0/2	4/2	4/4	4/2	4/4	4/4	2/0	2/2	2/0	0/0	2/0	2/4
F	2/4	2/0	2/2	4/4	2/0	2/2	2/0	4/2	2/2	2/4	4/4	0/2	2/2	2/2
B	2/2	2/2	2/2	4/4	4/4	2/2	2/2	2/4	6/4	4/6	4/6	2/0	2/4	2/0

A suitable Raschel machine is the Kidde "Fashion Master," which has a pattern drum with two chains for each of certain guide bars and has associated mechanism to provide essentially instantaneous transfer from one set of chains to another, thereby interchanging from partial-width (A-pattern) to full-width (B-pattern) and back as desired, the interchange being accomplished at a location where the A-link for each bar is the same as its B-link. Such machine is available from Cocker Machine and Foundry Co., Gastonia, N.C. As indicated above, the centermost four guide bars have two pattern chains apiece, and the drum therefor over which the chains are transported is at the left end of the machine whereas the drum for the chains for the other guide bars is at the right end.

In visualization of a resulting fabric or in graphical representation of it, as on point paper, it should be remembered that the readings for the pattern links in the chains on the respective drums are oppositely directed, as an increase in link number indicates guide bar displacement from the corresponding drum end of the machine. A reading of 0 indicates the smallest or reference-link location of the bars, and readings of 2, 4 and 6 indicate displacement thereof past one, two, and three needles, respectively.

FIG. 4 is a stitch diagram showing for each guide bar the results of movement of its threaded guides. For bars

6, **7**, **8**, and **9** both the A-pattern and B-pattern of movement are indicated. It is apparents that bars **3** and **4** form a double-tricot stitch pattern on the front bed (except at medial positions thereof where only one of the two bars is threaded) while bars **11** and **12** do likewise in the back bed. Throughout the operation the threaded guides of bars **5** and **10** complete the same pattern at the outer edges at the extreme right and left of the band, thereby rendering those edges truly seamless.

During the A-pattern formation, i.e., when guide bars **6**, **7**, **8**, and **9** are being actuated by the links of the A-pattern chains, as set forth in Table II, threaded guides of bars **7** and **8** function along the inner edges of the double-tricot pattern in like manner as bars **5** and **10** do at the outer edges, thereby seamlessly completing the pair of narrow or partial-width tubular portions of the article being knitted. Therebetween the other threaded guides of bars **7** and **8** similarly interconnect from front bed to back bed the outer edges of the medial strip, which is not tubular in form because yarns from guide bars **6** and **9** also are interconnecting from bed to bed in a modified tricot stitch while a simple tricot stitch is being formed on the respective beds by bars **3** and **12**. During the A-pattern formation no yarn interconnects across the gap between the medial strip and the flanking partial-width tubular portions.

At the conversion from A-pattern to B-pattern formation and thereafter during the B-pattern, guide bars **6**, **7**, **8**, and **9** all abandon their interconnecting movements between beds and form a pattern of jersey stitching, bars **6** and **7** on the front bed only and bars **8** and **9** on the back bed only. Although they are shogged past two needles, instead of only one as are bars **4** and **11** in the respective beds, they move likewise so that the edges of their patterns fit thereinto with partial overlapping. The B-pattern results in a single full-width tubular portion having seamless lateral edges and a distinguishable medial part comprising front and back panels extending from the front and back edges to meet in a knitted junction at the base edge thereof, where the medial strip extending between the partial-width portions also joins.

As indicated in FIG. 1, an article band as it comes off the machine comprises an endless series of full-width tubular portions and partial-width portions joined end-to-end, with a medial strip joined at each end to the base edge of an adjacent full-width portion and disjoined from the flanking partial-width portions. Such band then is severed transversely across the full-width portion and across the partial-width portions, and the medial strip is severed transversely at its opposite ends closely adjacent the base edge junctions. The resulting article may be turned inside out to conceal the latter cut edges if desired.

The yarns furnished to the guides participiating in formation of the partial-width tubular portions normally will be uniform. Those furnished to the guides participating in formation of the medial part of the full-width tubular portion may be, and preferably will be, different therefrom. The medial part normally will contain not only more ends of yarn and, thus, more yarn per unit

area, but also at least some of such yarn (such as that furnished to bars **6** and **9** in the exemplified construction) may be heavier, of different color or luster, or of different elasticity, for example.

One desirable result of such difference in composition is that the medial part usually will be rendered opaque. When the end use of the article is as panty hose (see FIG. 2A) it often will be desired that the hose or partial-width tubular portions be quite sheer, as is completely possible by use of sufficiently fine denier yarn and fine-gauge machines. Alternatively, the hose portion may be made relatively heavy, as in leotard and ski-pants uses, for example.

Incorporation of spandex yarn in the medial part of the panty or full-width tubular portion (as by furnishing it to the guides of bar **6** and optionally bar **9** also) will produce an article having figure-forming or girdle properties because of the contractile force attributable to the content of such yarn. This may be done in either the long (FIG. 2A) or short (FIG. 2B) leg article. The latter or panty-girdle style is more usual with large concentrations of spandex yarn.

Not only may spandex yarn be used in the medial part, as aforementioned, it also may be incorporated throughout the article if desired. The degree of elasticity in the rest of the garment normally will (but need not) be less than in the medial part. Any leg length may be so composed. An overall elasticity or "stretch" property is especially desired in ski-pants, for example.

It will be understood, of course, that the illustration and description of panty hose and panty girdles is not exhaustive of the types of articles that may be produced according to this invention. Instead of utilizing the partial-width tubular portions as hose they may be used as sleeves, with the full-width tubular portion covering the upper portion of the trunk or body rather than the lower portion. In that event the base edge of the full-width portion is left open for introduction of the head and neck, as may be done readily by forming the portion between the two side partial-width tubular portions into a third tubular portion and severing it at such location as will provide a desirable collar configuration. Alternatively, such medial portion may be formed into two strips, one on each needlebed, and be similarly severed.

A complete body covering or leotard may be formed by two sets of partial-width tubular portions as limb coverings and the interconnecting double-length full-width tubular portion covering the entire trunk. The stitching on the medial portion may be altered intermediately from a closed to an open configuration so as to form a closed crotch at one base edge and an open neck at the other base edge. Appropriate adjustment of yarn tension and of drawdown tension, as will be apparent to those persons ordinarily skilled in the warp-knitting art, can aid the subsequent reorientation of sleeve portions with respect to the body portion. Judicious use of spandex yarns is also useful in that regard.

More than two partial-width tubular portions per bandwidth would be employed in the manufacture of gloves, for instance, where the interspacing feature of this invention would be most important in the instance of the thumb portion, and the finger portions might be unspaced as in a construction of my aforementioned disclosure. Greater pluralities of tubular portions may be useful in industrial uses, such as insulating coverings for conduits or piping, the products of this invention not being limited to garment uses, of course.

The stitch constructions specified herein are exemplary, and many other stitch constructions, with or without laid-in yarns for decorative or other purposes may be employed. Moreover, especially where more complex patterns make demands on the number of guide bars it can be helpful to omit needles at the edges of the bands as disclosed in my similarly entitled patent application filed on Jan. 26, 1968 as Ser. No. 700,768.

It also may be advantageous, especially when using spandex or other expensive yarns in the medial part of the full-width tubular portion, to pattern the bars whose guides are furnished with such yarn so that the yarn does not enter essentially into formation of the medial strip between the partial-width tubular portions. Doing so leaves those ends of yarn relatively free and, of course, utilizes less length thereof than otherwise. Such yarns are severed together with the medial strip proper in the vicinity of the base edge of the full-width tubular portion or may be clipped separately.

Notwithstanding the foregoing illustration and description of one or more embodiments and alternatives, other modifications may be made, as by adding, combining, subdividing, or substituting components, parts, patterns, or steps while retaining some or all of the advantages and benefits of this invention, which itself is defined in the following claims.

The claimed invention:

1. In double needlebed machine knitting of an article having a single full-width tubular portion extending for part of its length and a plurality of side-by-side partial-width tubular portions extending for an adjacent part of its length, wherein each of the partial-width portions is joined with knitting stitch continuity to the full-width portion at one end of each, the improvement comprising knitting a pair of side-by-side partial-width tubular portions spaced apart from one another by a portion of the width of the base of the full-width tubular portion, their combined width being exceeded by the width of the full-width tubular portion at their junction to the base thereof, and including the step of forming between the adjacent pair of spaced apart side-by-side partial-width tubular portions a strip of fabric joined endwise to the base of the full-width tubular portion by being knitted thereto and disjoined from the adjacent partial-width portions.

2. Machine knitting according to claim **1** wherein each of the partial-width tubular portions is less than half as wide as the full-width tubular portion and including the step of forming distinguishable medial front and rear strip-like parts of the full-width tubular portion joined endwise to that strip of fabric.

3. Process of making a tubular machine-knit article comprising knitting an article according to claim **1**, and including also a finishing step of severing, from the base of the full-width tubular portion of the article, the strip of fabric formed between the adjacent pair of partial-width tubular portions.

4. In warp-knitting of seamless tubular articles wherein yarn is provided along an entire bandwidth, the improvement comprising knitting a single full-width tubular portion having a width in wales equal to the number of wales produced on the full bandwidth and having a given length, then at an end of the full-width portion knitting a pair of side-by-side partial-width tubular portions joined at an end thereof with knitting stitch continuity to the end of the full-width tubular portion and spaced apart by a distance corresponding to a number of wales by which their combined width in wales is exceeded by the width in wales of the full-width tubular portion, wherein the ends of yarn provided along the medial part during the knitting of the adjacent pair of partial-width tubular portions are knitted into a single strip joined longitudinally with stitch continuity to an end of the full-width tubular portion and disjoined laterally from the adjacent pair of partial-width tbular portions.

5. Warp-knitting according to claim **4**, including the step of rendering at least a medial part of the full-width tubular portion opaque relative to the partial-width tubular portions and wherein yarn of finer denier is provided to form the partial-width portions than is provided along the intervening medial part of the bandwidth.

6. Warp-knitting according to claim **4**, including the step of rendering at least a medial part of the full-width tubular portion elastic relative to the partial-width tubular

portions and wherein spandex yarn is provided along the medial part, whereupon elastic panels are formed therewith along the medial part of the full-width tubular portion.

7. Warp-knitting according to claim 4, wherein some of the ends of yarn provided along the medial part during the knitting of the adjacent pair of partial-width tubular portions are left unknitted until the junction with the full-width tubular portion and are knitted together therealong.

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RONALD FELDBAUM, Primary Examiner

U.S. Cl. X.R.

66—177

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,566,619 Dated March 2, 1971

Inventor(s) Seymour C. Titone

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 2, "apparents" should read -- apparent --; line 69, "participiating" should read -- participating -- Column 6, line 66, "tbular" should read -- tubular --. Reference numerals for guide bars should be underlined in eacl of the following locations, Column 3, Table I, all numerals i column marked "Bar"; Column 4, all numerals in each of the following lines: 1, 2, 4, 7, 11, 13, 14, 18, 21, 23, 28, 31 and 33; Column 5, all numerals in lines 2 and 16.

Signed and sealed this 14th day of September 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patent