This invention relates to a novel means and method for knitting sweater blanks having a laid-in stitch on automatic transfer circular knitting machines.

Knitted fabrics incorporating a laid-in stitch have been made in the past, but these knitted constructions have not been used, before this invention, in knitting articles such as sweater blanks on automatic transfer circular knitting machines because of mechanical difficulties. The knitting industry is interested in producing knitted structures which can be brushed to produce a shaggy surface appearance or napped and sheared to produce a plush effect or to incorporate a novelty yarn that cannot normally be knitted. The incorporation of a laid-in yarn into knitted sweaters greatly facilitates brushing or napping by making the fiber available in the most convenient form, because the laid-in-stitch introduces a yarn that is not an integral part of the fabric foundation.

Therefore, it is an object of this invention to provide a process and apparatus for knitting, on automatic transfer machines, sweater blanks having rib stitch portions and jersey or body stitch portions in which the body portions are provided with a laid-in stitch construction. Another object is to suitably modify conventional automatic transfer circular knitting machines to make it possible to incorporate a laid-in yarn in knitting sweater blanks on these machines. A further object is to provide new styles in circular knitwear, such as sweaters and the like, employing a laid-in-stitch construction. Another object is to provide a means for holding and controlling the laid-in yarn being fed to a circular knitting machine while the dial needles of the machine are engaging the stitch yarn. Other objects will be apparent from a description of the invention given below.

The above objects are accomplished in the knitting of sweater blanks on an automatic transfer circular knitting machine by the steps comprising feeding to the dial needles on said knitting machine stitch yarns and laid-in yarns, simultaneously raising the cylinder needles on said machine to hold back the laid-in yarn while the dial needles are engaging the stitch yarn. The invention also comprises certain apparatus for introducing a laid-in yarn in making sweater blanks, said apparatus being more fully described below, particularly with reference to the attached drawings.

FIGURE 1 illustrates a front view of a portion of the standard cylinder cam system on a conventional commercial Wildman-Jacquard T-A-4 automatic transfer circular knitting machine, illustrating the normal path of the cylinder needles in making the rib portion of a sweater blank.

FIGURE 2 is a front view of the same cam system which, after being modified in accordance with this invention, illustrates the new path followed by the cylinder needles during the knitting of the rib portion of a sweater blank.

FIGURE 3 is a front view of the same cam system which, after modification in accordance with this invention, illustrates the new path followed by the cylinder needles during the knitting of the body portion of a sweater blank.

FIGURE 4 illustrates one particular modification of stitch construction in accordance with this invention wherein the sweater blank is prepared by alternating in single succession knit yarns and laid-in yarns in the body portion of the sweater blank, after forming a 1 x 1 stitch construction in the rib portion of the sweater blank.

This figure shows a somewhat diagrammatical straight line showing of dial structure and dial needles positioned to receive the lay-in yarn, the view taken generally in the direction shown by the arrow in FIGURE 8.

FIGURE 5 is a somewhat diagrammatic showing similar to FIGURE 4 showing yarn dial structure and dial needles positioned at the next stage in forming the lay-in construction.

FIGURE 6 is another view similar to FIGURE 5 showing the yarn and other structure positioned in the next stage in the lay-in knitting procedure. The cylinder needles are shown in this figure in position to hold the lay-in yarn in position against the dial needles.

FIGURE 7 is another view similar to FIGURE 6 with the structure positioned at the final stage in the formation of the lay-in construction.

FIGURE 8 is a partial vertical cross-sectional view through dial and cylinder structure showing cooperation of the needles and cam mechanism as well as stitch position.

FIGURE 9 is a vertical sectional view taken on line 9-9 of FIGURE 5 showing the position of the lay-in yarn with respect to the ends of dial needles such as D1.

FIGURE 10 is a diagrammatic view of the dial cam and cylinder cam system illustrating the relative positioning of the cylinder and dial needles when the lay-in yarn is being received and also during the knitting of the jersey stitch portion of a sweater blank.

FIGURE 11 is an expanded view of the butt and all butt dial cam shown in FIGURE 10.

Our invention involves several critical changes in the design of the cam system on conventional automatic transfer circular knitting machines in order to make it possible for sweater blanks to be knitted having the stitch structure outlined. Referring, for example, to the cam system in a Wildman-Jacquard T-A-4 sweater knitting machine and to FIGURES 1, 2, and 3 of the drawings, cam A was cut off at the bottom to allow the cylinder needles to enter the cam system with essentially no change in vertical position. Cam D was also modified by cutting off a portion of the top surface for the same purpose. Cam B was completely eliminated from the cam system because in the first place it interfered with the proper operation of the rib knitting step by preventing the cylinder needles from rising in FIGURE 2 to pass between cam C and cam F. Secondly, it was found that in knitting the body portion of a sweater blank as shown in FIGURE 3, cam B served no function in controlling or allowing the cylinder needles to pass between cam C and cam E. Cam C was cut to a sharp point on the left side as shown in FIGURES 2 and 3 in order to be able to control the passage of the cylinder needles from a path between cams C and F when knitting the rib portion in FIGURE 2 to a path between C and E when knitting the body portion in FIGURE 3. This change in path of the cylinder needles is accomplished merely by changing a control lever (not shown) on the outside of the knitting machine to raise and lower part H and cam E when knitting the rib portion and body portion, respectively of the sweater blank. In order to impart this extra lifting motion to cam E, control post H had to be modified. The protruding knob H' on the control post had to be lowered % of inch from the top of the post and the top of the protruding surface at H'' on the control post had to be correspondingly lowered % of inch, both modifications being necessary in order to allow the cylinder needles to rise above cam C when using the stitch yarn during the cycle that knits the rib portion of the sweater blank. Also cam


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METHOD AND APPARATUS FOR LAYING IN YARN ON DIAL NEEDLES


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E had to be modified on the left end and upper surface as indicated (by the broken lines indicating the original configuration of this cam) in FIGURE 2 to raise the butt of the cylinder needles to a high enough position to pass above the newly designed sharp point on cam C in the ribbon-forming cycle of knitting the sweater blank. Essentially no changes were found necessary in cams F and G.

In the operation of the Wildman-Jacobot Type A–4 circular knitting machine in accordance with this invention, the cam revolves as a unit in a circular path. Cams A, C, D, F, and G are fixed with respect to vertical motion, while cam E is arranged to be shifted as desired up and down in a vertical direction to control the path of the cylinder needles during the rib making and body making cycles, respectively, of forming the sweater blank, as shown in FIGURES 2 and 3. Of course, when shifting from the knitting of a rib construction on both the dial and cam needles to a jersey stitch construction, it is necessary to transfer by a conventional operation all the loops on each of the cylinder needles to each of the corresponding dial needles. Contrary to existing practice, in the operation of the present invention while feeding stitch yarns and laid-in yarns during the body-forming cycle of the knitting machine, the cylinder needles are used to perform a holding function instead of a knitting function. The cylinder needles bear in such a position so as to allow the dial needles to engage the stitch yarn as shown in FIGURE 6. Without the modified cam system described above and the different function performed by the cylinder needles, the laid-in yarn would have been fed to a conventional cam system fails to be retained in the hook of the dial needle, and, therefore, does not form the desired construction of alternating knit and laid-in yarns which is the object of this invention. The modified cam action of this invention takes place in the stitch-forming cycle following the introduction of each laid-in feed.

In the operation of the present invention the laid-in yarn is fed perpendicular to the horizontally moving dial needles although in essentially the same plane as the one in which the dial needles move back and forth, as shown in FIGURE 4 by an additional yarn lead-in head (not shown). The laid-in yarn is also fed in a plane perpendicular to the vertically moving cylinder needles. The machine head or position at which the lay-in yarn is fed to the dial needles is preferably set up so that alternatively the dial needles (D2 and D4 in FIGURE 4) project from the dial to receive the lay-in thread, the other dial needles being fully retracted. This is a conventional operation in the art and is accomplished by any suitable arrangement known in the art such as providing the alternate projecting dial needle with high or longer butts than the others. U.S. Patents 2,024,174 and 2,174,439 are good examples of circular knitting machines which handle a lay-in yarn in the conventional manner over which applicants' invention represents a significant improvement. At this position each needle already carries a loop of the regular stitch yarn. Immediately following the position at which the lay-in yarn is introduced, the alternate projecting dial needles move to the fully retracted position as shown in FIGURES 5 and 9. The lay-in yarn is fed into the dial needles at a level and at a tension which causes it to take a position as shown in FIGURE 9. At the next machine head, yarn lead-in head, or position where the next stitch yarn is fed to the dial needles, the modified cylinder cams of this invention are arranged to raise the cylinder needles as shown in FIGURE 6 and then move the dial needles to their projecting positions as shown in FIGURE 6.

One of the main points of this invention is that the elevated cylinder needles such as C1, C2, C3, and C4 prevent the stitch yarn loops and the lay-in yarn from moving outwardly of the dial structure with the dial needles, and cause the stitch yarn loops and lay-in yarn which rides above every other dial needle to move behind the needle latches (FIGURE 6). The other dial needles which are the lay-in yarns they are free from the dial. With the dial needles extending from the dial the new stitch yarn loop are formed and pulled over and below alternately, the lay-in yarn and through the eye of the stitch needle and is formed into the next course and its lay-in yarn component as shown in FIGURE 7. FIGURE 10 illustrates the relative position of the dial and cylinder needles from the time at which the lay-in yarn is added through the time at which the cylinder needles are raised to hold the laid-in yarn and all the dial needles are extended outwardly to receive the next stitch yarn. The dial needle arrangement is one of alternate high and low butts around the entire dial system. This enables high butt dial needles 10 to be selected as they pass from left to right in the cam raceway and pass over the extended high butt cam HB. Section 2 shows cam HB extended to the "tuck" position which permits longer alternate high butt dial needles 10 to be extended to the tuck position to receive the lay-in yarn and allows the shorter low butt dial needles 12 to remain fully retracted (see FIGURE 4). The dial needles then can be formed into a loop or bent back to the center of Section 3 where the all butt cam AB is in the knit position, the cam moving the dial needles to the extended knit position to receive a new jersey stitch yarn. At the same time the cylinder needles have raised in position to hold the laid-in yarn in position while the new jersey stitch yarn is being accepted (see FIGURE 6). The cylinder needles were raised by contact with cam D and the needles are correspondingly pulled down out of action by contact with cam C so that they do not interfere with the knitting of the jersey stitch portion by the dial needles. FIGURE 11 is expanded view of the high butt cam HB and all butt cam AB in the tuck position wherein the longer alternate high butt needles 10 are extended to the tuck position to receive the lay-in yarn and the short or low butt dial needles 12 remain fully retracted. The number of courses of stitch yarn only, between the courses, i.e., the lay-in yarn, can be varied as desired to produce changes in the patterns produced. It is preferred that the laid-in yarn should be heavier than the stitch yarn to achieve optimum design effects. The laid-in yarn may be composed of any form of filamentary material such as a standard knitting yarn, a novelty yarn, an elastic yarn, or a moving continuous filament or it may be a spun yarn. The laid-in yarn may be bulked or unbulked, crimped or uncrimped, drawn or undrawn, twisted or untwisted, or it may be made of filamentary material which has either substantially no residual lengthwise shrinkage, or has a high percentage or residual lengthwise shrinkage, or the laid-in yarn may be made of a blend of high and low shrinkage filamentary material. An example of a yarn which is a blend of high and low shrinkage filamentary material is one formed, for example, from a mixture of both acrylic-nitrile polymer fibers which have a residual lengthwise shrinkage of 0–3% and acrylic-nitrile polymer fibers which have a residual lengthwise shrinkage of 10–40%, said residual shrinkage being realized normally after knitting by subjecting the filamentary material to heat, steam, boiling water, chemical shrinking agents, such as ethylene carbonate and the like, or other known conditions to cause shrinkage.

The stitch yarn and the laid-in yarn being fed to the knitting machine may be of the same filamentary composition or they may be a blend of two or more different compositions or filamentary forms. Examples of the compositions which may be used to prepare the yarns include synthetic materials, such as polyamides, polysters, polyurethanes, acrylic polymers and copolymers (such as
those employing acrylonitrile), vinyl polymers, hydrocarbon polymers such as polyethylene, polypropylene, and other polyolefins, fluorocarbon polymers and copolymers such as polytetrafluoroethylene, cellulose derivatives such as cellulose acetate and other cellulose esters and ethers and regenerated cellulose; as well as natural materials such as cotton, wool, glass, jute, silk, and the like.

The stitch yarn and laid-in yarn used in the present invention may be composed of blends of two or more synthetic fibers or blends of synthetic and natural fibers. In addition to preparing the yarns from any of the above listed synthetic or natural fibers, the yarns may also be composed of composite filaments such as, for example, those described in the copending application of Breen, Serial No. 621,443, filed November 9, 1956, now abandoned, or such as two acrylonitrile polymers differing in ionizable group content as described in the copending application of Taylor, Serial No. 640,722, filed February 18, 1957, now abandoned. The yarns may also be composed of synthetic fibers or filaments which are either textured or untextured in/on or are composed of fibers or filaments having modified cross-sections as those possessing a tri-lobe cross-section, exemplified by the filaments of U.S. 2,539,201 and 2,539,202. Another advantage is the process and apparatus modifications of this invention made possible new constructions in sweaters as well as producing new novelty effects, stitch effects, and styling in the sweater field. This invention facilitates the production of brushed or napped sweaters on machines normally only capable of producing plain jersey sweaters. Another advantage is the modifications necessary on the commercial circular knitting machines can be accomplished at a nominal cost. Sweaters can be produced in accordance with this invention that have a woven-like appearance. The laid-in construction of this invention can be carried out on the standard circular knitting dial and cylinder machines continuously to produce circular knit tubular sweater blanks having alternating knit rib portions and laid-in body portions.

The process and apparatus of this invention may be used to make a variety of circular knit fabrics, particularly sweaters, in a variety of styles. The laid-in yarn may be a synthetic yarn such that made from acrylonitrile polymer fibers which after knitting may be napped and brushed or the laid-in yarn may be a fancy nub, slub, flake, boucle, or multiple component novelty twisted yarn which may be used in accordance with this invention to introduce novelty effects that have never before been made on automatic transfer circular knit sweater machines.

While we have shown and described our invention in connection with a preferred embodiment, it will be understood that other applications, and modifications may be made therein without departing from the spirit and scope of the invention as set forth in the following claims:

We claim:

1. The improved method of knitting sweater blanks on automatic transfer circular knitting machines having a plurality of dial needles having hooks and latches, a plurality of cylinder needles having hooks and latches and means for actuating said needles to produce jersey stitch and rib stitch material which comprises

(a) knitting rib construction on both said dial and said cylinder needles,

(b) transferring all the loops on each of said cylinder needles to each of the corresponding dial needles,

(c) forming a jersey stitch construction on said dial needles,

(d) projecting certain dial needles in an extended position while maintaining the other of said dial needles in a retracted position,

(e) feeding a lay-in yarn to said extended dial needles,

(f) retracting said extended dial needles to position said lay-in yarn below the nose portion of said other dial needles,

(g) the improvement comprising at this point in time, elevating said cylinder needles, and extending all of said dial needles, said elevated cylinder needles maintaining said lay-in yarn substantially in its laid-in position to insure that said extended dial needles pass above said lay-in yarn,

(h) lowering said cylinder needles and

(i) thereafter continuously knitting.

2. In a conventional automatic transfer circular knitting machine comprising a plurality of dial needles having hooks and latches, a plurality of cylinder needles having hooks and latches, and a plurality of means for actuating said needles to produce alternating jersey stitch and rib stitches continuously, the method comprises

(a) said actuating means comprises means for manipulating said dial and said cylinder needles of said jersey stitch fabric on said dial needles so that an additional yarn is laid-in over and along each course of knitted stitch yarn with periodic loops passing below the knitted loops below said jersey stitch yarn to secure the laid-in yarn to said jersey stitch fabric,

(b) one of said means for manipulating said dial and cylinder needles comprising means for maintaining certain of said dial needles retracted during the feeding of said lay-in yarn to the hooks of the remainder of the extended dial needles and then retracting all of said needles and

(c) the improvement wherein another of said means for manipulating said dial and cylinder needles further comprises cam means for elevating said cylinder needles just prior to extending said dial needles for the feeding to said extended dial needles of the next new stitch yarn, said cam means elevating said cylinder needles at this point in time to maintain said laid-in yarn substantially in its laid-in position to insure that said certain dial needles pass uniformly under said laid-in yarn and the remainder pass uniformly over said laid-in yarn during extending movement, said cam means further maintaining said cylinder needles in an elevated position for a period of time sufficient to insure that said elevated cylinder needles cooperate with said extending dial needles to cause each lay-in yarn and loops of stitch yarn on said dial needles to be moved uniformly axially relatively of said extended dial needles behind the dial needle latches as the dial needle hooks extend to receive the new stitch yarn fed in at the next course.

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