NEEDLE SELECTION ARRANGEMENT FOR A CIRCULAR KNITTING MACHINE

Assignee: Travis Mills Corp., a part interest
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Primary Examiner—Wm. Carter Reynolds
Attorney—Breitenfeld & Levine

ABSTRACT
A flexible band carries jack actuation control means for determining when the machine jacks are moved so that their butts engage the lower cam race and cause lifting of the needles. The control means may be projections carried by the band, or holes in the band through which actuators can project, or light-transmitting regions in the band for controlling light-responsive jack actuators. The band may be endless, and trained about a drum. The jacks are moved vertically when actuated, and a magnet or spring is provided to hold the jacks down when not actuated.

2 Claims, 7 Drawing Figures
NEEDLE SELECTION ARRANGEMENT FOR A CIRCULAR KNITTING MACHINE

This invention relates to circular knitting machines, and more particularly to an arrangement for selecting in which needles are lifted to working position, and thereafter lowered, and when such needles are lifted, during each machine cycle.

In a circular knitting machine, a cylinder having a vertical longitudinal axis, about which it rotates, is provided in its outer surface with a series of vertical slots equidistantly spaced around the periphery of the cylinder. A knitting needle is arranged within each slot for vertical sliding movement, and directly beneath each needle is a jack also vertically slideable in the slot. An upper and a lower cam race surround the cylinder and are adapted to be selectively engaged by buds projecting from the needles and jacks, respectively. If a jack butt engages the lower cam race and is thereby lifted, it lifts its respective needle, causing the needle butt to engage the upper cam race, whereby the needle is lifted to working position and thereafter lowered. If the jack butt does not engage the lower cam race, neither it nor the needle is lifted, and hence the needle remains out of working position.

Engagement of the jack butts with the lower cam race is conventionally determined by selector mechanisms each comprising a vertical stack of selector pushers behind which are a vertical series of pegs. Each pusher is allocated to one or more of the jacks. If a needle is to be lifted to working position during a portion of the machine cycle, an adjustment is made in the selector mechanism controlling that portion of the cycle. Specifically, a peg is placed behind the selector pusher allocated to the jack beneath that needle, so that the pusher presses the jack inwardly to prevent its butt from engaging the lower cam race. If a needle is to be raised, the peg is removed from behind the respective selection pusher so that the jack butt is permitted to engage the lower cam race.

This conventional selection arrangement has numerous disadvantages, one of which is that the variety of pattern in the knitted goods is necessarily limited since the number of selection pushers in each stack is limited. In addition, regardless of how many pushers are provided, once the pegs are set, each needle follows the same pattern of movement during each machine cycle (each complete rotation of the cylinder), i.e., if the needle is raised at one point in a machine cycle, it will be raised at that same point in every other machine cycle. Furthermore, manipulation of the pegs to change patterns is a time-consuming and cumbersome operation.

It is an object of the present invention to overcome these and other disadvantages by providing a needle selection arrangement which theoretically offers the possibility of unlimited pattern variety in goods produced by a circular knitting machine, and which as a practical matter offers a far greater pattern variety than has heretofore been possible.

It is another object of the invention to provide in a selection arrangement quick and easy conversion of a machine from knitting one pattern to knitting another pattern.

Generally speaking, the invention accomplishes these objectives by replacing the usual selector pushers and pegs with a band, preferably an endless band, carrying projections or some other type of jack actuation control means, in a preselected pattern, for determining when a needle shall rise and when not. The band moves in timed relation to operation of the knitting machine, but since the band may be of any desired length, the needles need not necessarily repeat their pattern of movement during every successive machine cycle, i.e., the pattern of needle movement may vary from cycle to cycle.

Additional objects and features of the invention will be apparent from the following description in which reference is made to the accompanying drawings.

In the drawings:

FIG. 1 is a fragmentary vertical cross-sectional view of a circular knitting machine incorporating the invention, taken along a radius of the machine cylinder;

FIG. 2 is a vertical cross-sectional view taken on line 2—2 of FIG. 1;

FIG. 3 is a horizontal cross-sectional view taken on line 3—3 of FIG. 1;

FIG. 4 is an enlarged fragmentary cross-sectional view, similarly to the lower portion of FIG. 1, of an alternative embodiment of the invention, showing a portion of the band trained around a drum;

FIG. 5 is a cross-sectional view taken on line 5—5 of FIG. 4;

FIG. 6 is a view similar to FIG. 4 of another alternative embodiment of the invention; and

FIG. 7 is a view similar to FIG. 1 of still another alternative embodiment.

The illustrative embodiment of the invention shown in Figs. 1–3 is incorporated into a circular knitting machine having a stationary frame 10 on which a hollow cylinder 11 is supported for rotational movement about a vertical axis. Fixed to the inner surface of cylinder 11 is an annular bracket 12, a crown gear 13 being fixed to the lower face of the bracket.

Crown gear 13 meshes with the driving mechanism (not shown) of the machine, whereby cylinder 11 is rotated, each full rotation of the cylinder being referred to as a machine cycle.

The outer surface of cylinder 11 is provided with vertical slots 16 (see Figs. 2 and 3), and slidably accommodated within the upper portion of each slot is a knitting needle. For the sake of simplicity in the present illustration, five such needles 17a, 17b, 17c, 17d, and 17e are shown in five successive slots, but obviously there are many more needles and slots present around the entire periphery of the cylinder. Each needle has the usual hook-shaped top and latch 18, as well as the usual outwardly projecting butts 19a–e, respectively. Slidably arranged beneath each needle in each slot 16 is a jack; the jacks bear the reference numerals 20a–e, respectively. Each jack is also formed with an outwardly projecting butt 21 a–e.

Fixed to frame 10 and surrounding the portion of the cylinder carrying the needles is an upper cam race, only two cam parts 24 and 25 of the race being shown for simplicity. As may be seen in Figs. 1 and 2, if a needle, e.g., needle 17a, is not lifted slightly just before its butt 19a comes opposite cam 24, the butt moves below the cam and the needle is not elevated to working position. On the other hand, if a needle, e.g., needle 17c, is lifted slightly just before its butt 19c comes opposite cam 24, the butt moves along the upper surface of cam 24 (see also Fig. 3) whereby the needle is raised to working position. Thereafter, cam 25 in conjunction with butt 19c, returns the needle to its original position.

Fixed to frame 10 and surrounding the cylinder portion carrying the jacks is a lower cam race, only two cam parts 26 and 27 of the race being shown for simplicity. As may be seen in Figs. 1 and 2, if a jack, e.g., jack 20a, is not lifted slightly just before its butt 21a comes opposite cam 26, the butt moves below the cam, so that the jack and hence the needle above it are not lifted. However, if a jack, e.g., jack 20c, is lifted slightly just before its butt 21c comes opposite cam 26, the butt moves along the upper surface of cam 26, whereby jack 20c is lifted. The jack in turn engages the bottom of and lifts needle 17c, so that its butt 19c engages the upper surface of cam 24, and the needle is elevated to working position. Cam 27 in conjunction with butt 21c returns the jack to its original position. Suitable means, such as a permanent magnet 28, is located directly beneath the path of travel of the jacks 21 to pull the jacks downwardly to their lowermost positions. This insures that a jack butt will not accidentally, as a result of vibrations or otherwise, engage the upper surface of cam 26. The jack must be positively raised slightly to produce such engagement.

The present invention relates to means for selectively raising the jacks 20 slightly so that their butts 21 engage cam 26, thereby causing the associated needle 17 to be raised to working position.

In the embodiment of the invention illustrated in Figs. 1–3, frame 10 carries a bracket 30 between which and the frame a horizontal shaft 31 is journaled. Fixed to and rotatable with shaft 30 is a drum 32 and a pinion 33. The latter meshes with
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gear 13, so that when the knitting machine is in operation, drum 32 is rotated in timed relation to operation of the machine, and specifically in timed relation to rotation of cylinder 11.

A flexible, but non-stretchable band 36, only a portion of which is shown in the drawings, is trained over drum 32, and as the drum rotates, it moves the band longitudinally. If necessary, suitable means (not shown) may be provided to prevent slipping of the band on the surface of the drum. Such means might be sprocket holes along one edge of the band engaging a sprocket wheel fixed to the drum, similar to the arrangement used with motion picture film. The band may be of metal or plastic, or any other material suitable for the present purposes.

Preferably, the band 36 is endless, and its total length may be such that only a portion of the band length passes over drum 32 during one revolution of cylinder 11. Band 36 may be as long as desired, and if it is very long, tangling can be avoided by placing the knitting machine on the second or a higher floor of a building and allowing the band to pass through a hole in the floor so that it bands freely from drum 32. Of course, the band can pass over idler or guide rollers if desired. It should be mentioned that the band could be of such length that its entire length passes over drum 32 during each machine cycle. However, the longer the band, the more versatile the knitting machine becomes.

Band 36 carries jack actuation control means, in the form of knobs 37a-e, the latter being slidable from the outer surface of the band. The knobs 37a-e are, in this example, arranged in five longitudinal rows, corresponding to the five needles and jacks described above. Therefore, after band 36 completes its selection function with respect to needles 17a-e, it will perform similarly with respect to the following group of five needles on the cylinder, and then the next five needles, and so forth.

Jacks 19a-e are so arranged that, when a needle is lifted from the bed of the knitting machine, each jack 19a-e, respectively, which terminate at their lower ends directly above the rows of knobs 37a-e, respectively, of band 36. Each extension passes slidable through a guide slot in a support arm 39 projecting from bracket 12, and each extension carries a collar 40 adapted to engage the upper surface of arm 39 to define the lowermost position of each jack. When a jack, e.g., jack 20a, is in its lowest position, the lower end of its extension 38a is in the path of travel of knobs 37a, and hence the jack is lifted at each time a knob 37a engages extension 38a. Thus, in the drawings, a knob 37c is shown having engaged and lifted extension 38c and its associated jack 20c, as a result of which the butt 21c of the jack will cooperate with the upper surface cam 26 to raise the jack further. Upon raising of jack 20c, needle 17c is raised so that its butt 19c engages cam 24, whereby the needle is raised to working position. It will be seen, therefore, that each extension 38a-e constitutes a means associated with its respective jack which is responsive to the movement of one of the actuation control means 37a-e into a predetermined position for moving its respective jack.

If no knob is present beneath the lower end of a jack extension, the needle associated with that jack is not raised. Thus, it will be seen that use of band 36 offers a wide variety of needle selection. Furthermore, band 36 may readily be removed and replaced with another band bearing a different pattern of knobs, for changing the pattern of the knitted goods. Note that this change requires no time-consuming manipulation of parts, but only the simple steps of removing band 36 from drum 32 and replacement with a substitute band.

In the embodiment of the invention illustrated in FIGS. 4 and 5, the jack actuation control means are not knobs permanently fixed to the band, as in FIGS. 1–3, but instead are holes 43a-e in band 36. These holes may be located in the same relative position on band 36 as the location of knobs 37a-e on band 36.

Furthermore, in this embodiment, shaft 31' is fixed with respect to frame 10, and pinion 33 drives drum 32' via a sleeve 44 surrounding and rotatable with respect to shaft 31'.

Drum 32' has an outer wall 45, upon which band 36' rests, and an inner wall 46 spaced radially inward from the outer wall. Formed in these walls are pairs of aligned holes 47 within which pins 48a-e, are slidably located. A compression spring 49 surrounds each pin and seats at one end against inner wall 46 and at the other end against a collar 50 fixed to the pin, whereby each pin is constantly urged radially outward. Each pin also carries a shoe 51 near its inner end. Although only pins 48a-e are shown, for the sake of simplicity, these and similar pins completely surround shaft 31', as viewed in FIG. 5, so that for example about twenty pins are actually present equidistantly spaced around shaft 31' as viewed in FIG. 5.

Fixed to stationary shaft 31' are five arcuate plates 53, each being vertically aligned with one of the rows of holes 43a-e, and hence with one of the rows of pins 48a-e. If when a portion of the moving band 36' first engages drum 32', a hole 43 in the band registers with holes 47 in the drum walls, spring 49 pushes the end of the respective pin 48 through the hole in the band so that it projects beyond the surface of the band and engages the lower end of a jack extension 38, to lift the latter. Before the pin engages extension 38, its shoe 51 rides up on the outer surface of its respective plate 53, so that the pin is not depressed when it engages the jack extension.

If no hole in the band registers with a particular pair of holes 47, the respective pin is held beneath the band, against the force of its spring, and its shoe moves beneath its respective plate 53. Hence, the pin does not engage a jack extension. Thus, the positions of the holes in the band determine the selection of which needles are lifted and which are not. The band can be made of plastic or some other easily cut material, so that punching holes in it to prepare a new selection band can be done rapidly.

In the embodiment of FIG. 6, band 36' may be identical to band 36' of FIGS. 4 and 5, i.e., the jack actuation control means are holes 43a-e. In the alternative, they need not be holes, as long as they are discrete light-transmitting regions. In any case, the band, except for the light-transmitting regions, must be opaque, or at least relatively opaque to the light-responsive means employed.

Shaft 31', to which drum 32' and pinion 33 are fixed, is rotated by engagement of the pinion with a crown gear 13' fixed to bracket 12. The drum wall has holes, or other light-transmitting areas, in every location which might come into registry with a hole in the band, and within the drum is a source of light 56. A bracket 57, fixed to frame 10, carries five photoelectric cells 58a-e, or other light-responsive devices, each cell being vertically aligned with one of the longitudinal rows of holes 43a-e in band 32'. Also carried by bracket 57 are five solenoids 59a-e, electrically connected to the photoelectric cells, the solenoids being directly under one of the jack extensions 38a-e.

When a hole 43 in band 32' passes beneath a photocell, e.g., photocell 58c, the latter causes its associated solenoid 59c to be energized, whereupon the armature 60 of the latter moves upwardly engaging extension 38c and causing the respective needle to be raised to working position.

In the embodiment of FIG. 7, the band 136 is much wider than the bands previously discussed, and of course drum 132 is longer than the drums referred to above. With such a wide band, it may not be convenient to provide every jack with an extension 38, since the ends of the extensions adapted to engage the extreme rows of knobs 37 would be offset a relatively large distance from their respective jacks. To avoid this, an arm 139 projects horizontally from bracket 12, the free end of the arm being slidable accommodated within an annular channel-shaped support fixed to frame 10. The arm is furnished with a number of holes within each of which a rod 65 is slidably accommodated. A collar 66 on each rod limits its downward movement by engaging the arm. The lower end of each rod is attached to be engaged by a knob 57 in the row of knobs with which the particular rod is vertically aligned. Upon such engagement, the rod rises. This movement causes the upper end of the rod 65 to engage one end of a lever 67 pivotally mounted on arm 139. Lever 167 is thereby rotated counterclockwise, as viewed in FIG. 7, whereby it en-
gages one end of another lever 68, also pivotally mounted on arm 139, causing lever 68 to rotate clockwise. The other end of lever 68 then engages and lifts an additional butt 69 of its respective jack 120, whereby the associated needle is raised to working position.

Although only a single needle selection means, including a band 36, has been shown in each of the figures for the sake of simplicity, in an actual machine a separate needle selection means is provided for each yarn feed of the machine. Thus, in a machine having for example 24 yarn feeds, 24 needle selection means, each including a separate band 36, are provided.

The invention has been shown and described in preferred form only, and by way of example, and it is understood, therefore, that many variations may be made in the invention which will still be comprised within its spirit.

What is claimed is:

1. In a circular knitting machine having a plurality of needles, each needle having a projecting butt, a selector jack beneath each needle, each jack having at least one projecting butt, an upper cam race for engaging said needle butt only when a needle is lifted vertically by its respective jack, and a lower cam race for selective engagement with said jack butt, said jack being lifted vertically to thereby lift its respective needle, only when its butt engages said lower cam race, the improvement comprising:

   means for selectively causing said jack butts to engage or fail to engage said lower cam race, said means including an endless flexible band,
   jack actuation control means carried by said band in predetermined locations on said band,
   means for advancing said band longitudinally in timed relation to operation of said machine, said means including a hollow drum over which said band is trained,
   means associated with each of said jacks and responsive to the movement of one of said actuation control means into a predetermined position for moving its respective jack so that the butt of said jack engages said lower cam race and is lifted,
   a plurality of actuators within said drum and movable radially with respect to said drum, a hole in said drum aligned with each of said actuators,
   spring means urging said actuators radially outwardly through said holes,
   said jack actuation control means including holes in said band adapted to register with said holes in said drum,

   a stationary support plate within said drum, and
   a shoe carried by each of said actuators, said shoe engaging one surface of said plate, when a hole in said band registers with a hole in said drum aligned with its respective actuator, to thereby maintain said actuator in a position projecting through said holes, and said shoe facing the other surface of said plate when no hole in said band registers with the hole in said drum aligned with its respective actuator,

   whereby if a band hole registers with a drum hole, a part of the respective actuator projects through said holes and outwardly of said band, but if a portion of said band having no hole overlies a drum hole the respective actuator is maintained inwardly of said band.

2. In a circular knitting machine having a needle cylinder, a plurality of needles carried by the cylinder, each needle having a projecting butt, a selector jack beneath each needle, each jack having at least one projecting butt, an upper cam race for engaging said needle butt only when a needle is lifted vertically by its respective jack, and a lower cam race for selective engagement with said jack butt, said jack being lifted vertically to thereby lift its respective needle, only when its butt engages said lower cam race, the improvement comprising:

   means for selectively causing said jack butts to engage or fail to engage said lower cam race, said means including a flexible band,
   jack actuation control means movable with and projecting outwardly past the surface of said band at predetermined locations with respect to said band,
   means for advancing said band longitudinally in timed relation to operation of said machine, a lever associated with each of said jacks and arranged to be moved by at least one of said projecting control means, said lever being pivotally mounted about an axis fixed with respect to said cylinder, and
   means for mechanically transmitting movement of said lever to the butt of its respective jack so that the butt engages said lower cam race and is lifted, said transmitting means including an additional butt on said jack, and a second lever responsive to movement of said first-mentioned lever, when said jack actuation control control means moves into a predetermined position, for moving said additional butt and its respective jack.

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