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3,535,892

KNITTING MACHINE WITH SLIDE LATCH NEEDLES CONTROLLED BY JACKS

Filed Feb. 13, 1968

5 Sheets-Sheet 1

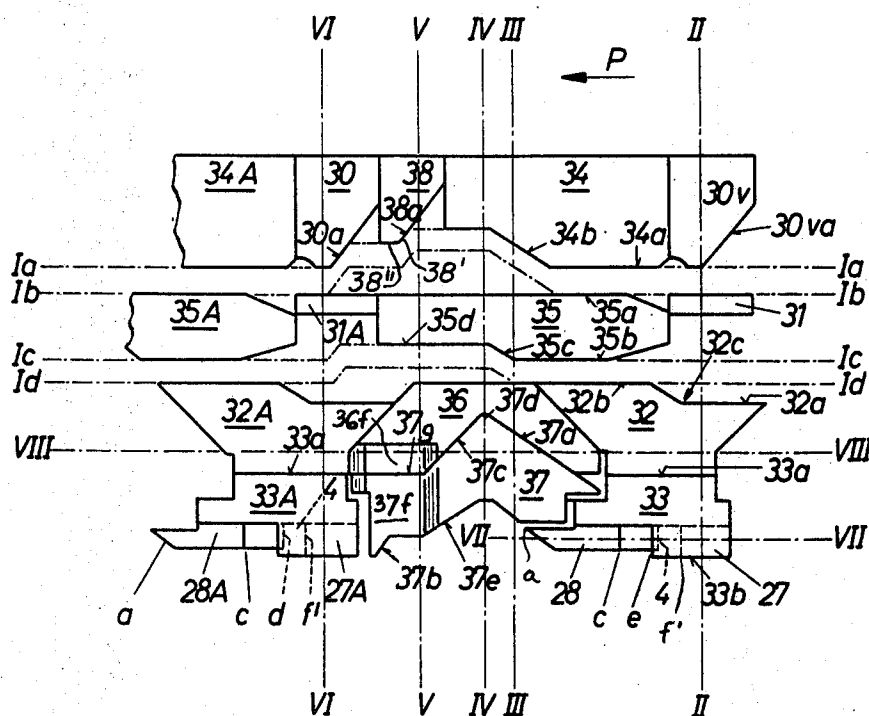


FIG. 1

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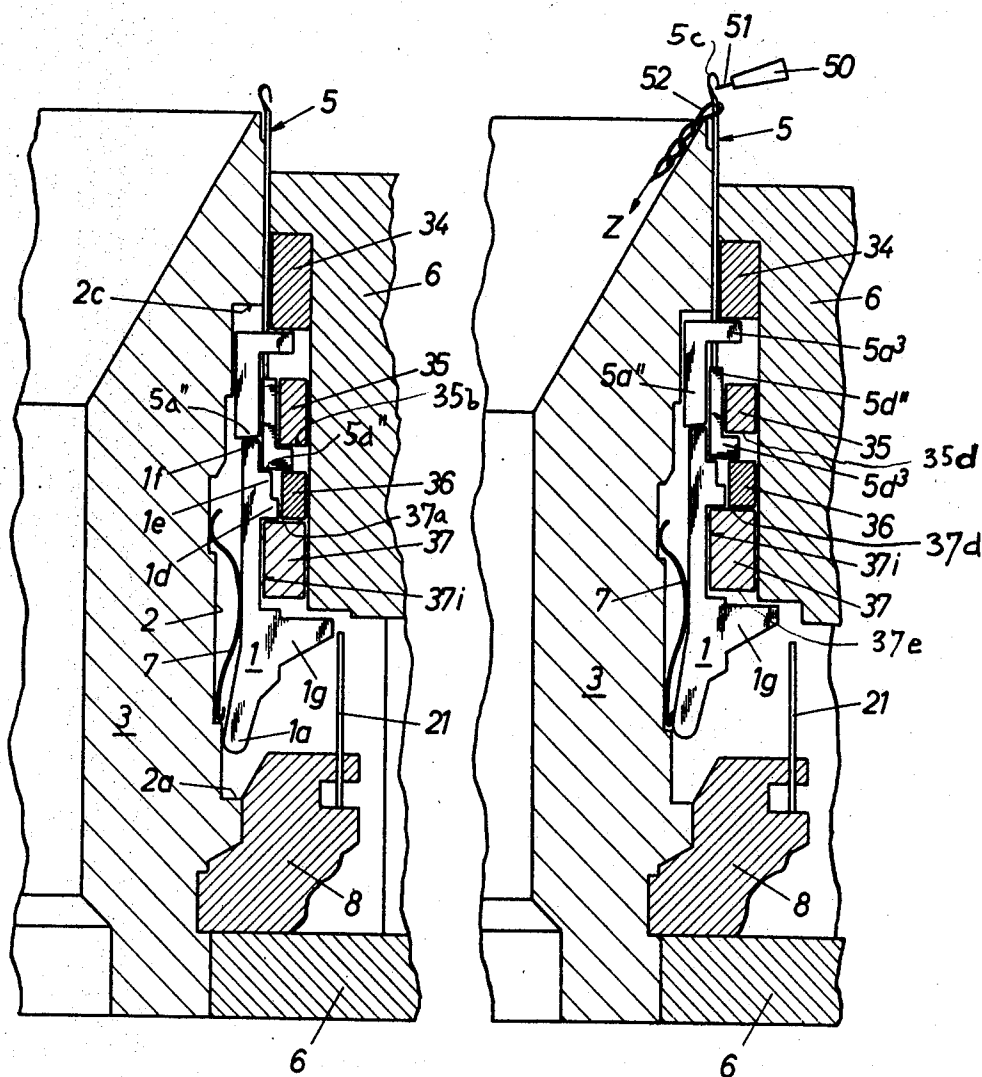


FIG. 3

FIG. 4

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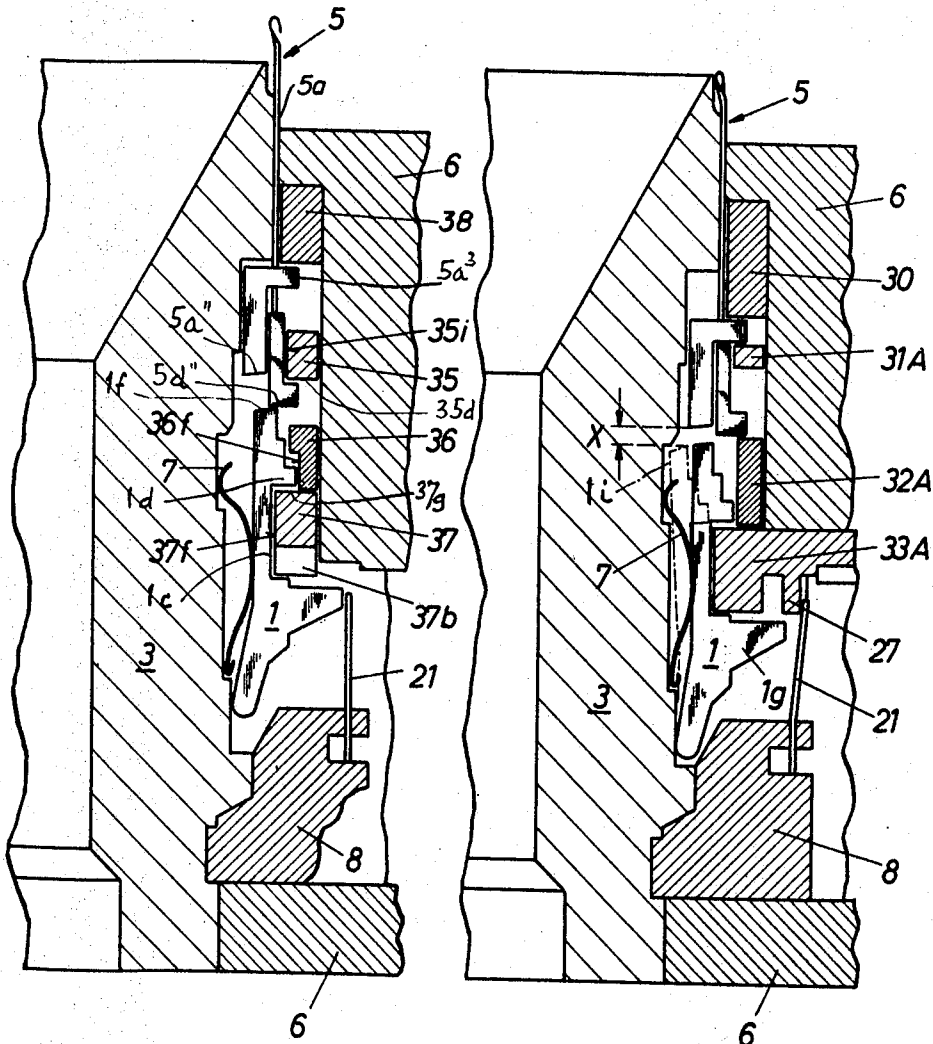


FIG. 5

FIG. 6

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5 Sheets-Sheet 5

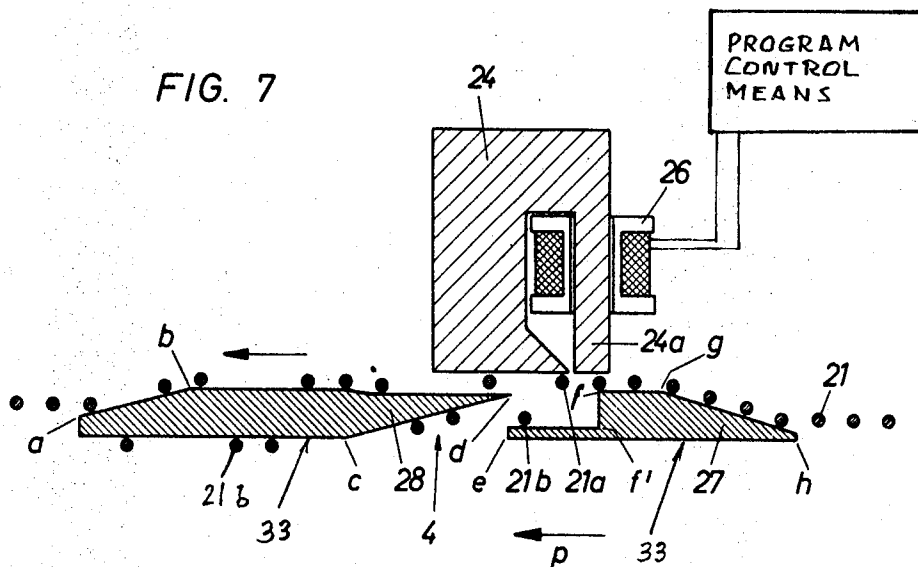
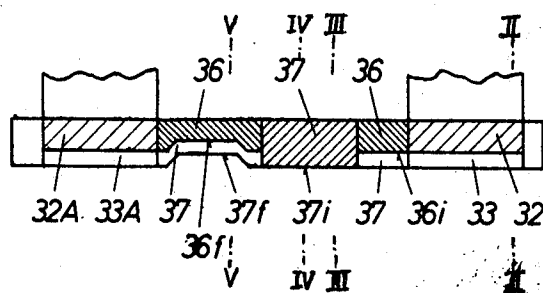


FIG. 8



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KNITTING MACHINE WITH SLIDE LATCH NEEDLES CONTROLLED BY JACKS

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13 Claims

ABSTRACT OF THE DISCLOSURE

A circular knitting machine provided with axially moving slide latch needles has jacks for each needle mounted for axial and radial movement, and controlled by cam means to move in radial and axial directions between a position cooperating with the hook part, or with a latch part, or with both parts while the butts of the same are controlled by other cams whereby the slide latch needles are operated to perform knitting operations.

BACKGROUND OF THE INVENTION

Circular knitting machines provided with jacks for operating latch needles have pivoted tongues are known, and one machine of this type is described in the U.S. Pat. No. 2,158,536.

In machines of this type, the jacks are movable in axial direction for controlling the movement of the knitting needles between a knit position and a cast off position, and also movable in radial direction of the needle cylinder to an inoperative position in which the respective associated needles are not actuated so that a pattern is knitted.

Knitting machines are known in which slide latch needles are used. The term "slide latch needle" is used in the present application to describe a needle having a hook part with a stem and a hook, and a latch part which is mounted for sliding movement along the stem, which may be a tube, so that the hook of the hook part can be closed and opened. For the purpose of the present invention, it is immaterial whether the slide latch needle has a tubular stem or a solid stem. In accordance with the prior art, the hook part and the latch part of such slide latch needles are independently operated by two jacks, so that each slide latch needle requires two jacks for performing knitting operations, and the respective jacks have cam follower portions cooperating with cams in the cam box for independently moving the hook part and the latch of the slide latch needles.

The necessity of providing two jacks for operating slide latch needles is a disadvantage particularly if the needles are to be closely spaced and mounted in axially extending grooves of a needle cylinder. It is very difficult to operate two jacks in one needle channel, and the two cams for operating the two jacks cause an axial lengthening of the needle cylinder and cam box, or is not possible at all in the dial cam box of a circular knitting machine, so that the use of slide latch needles instead of pivoted latch needles is impractical in circular knitting machines, although slide latch needles have certain advantages over pivoted latch needles.

SUMMARY OF THE INVENTION

It is one object of the invention to provide a circular knitting machine with slide latch needles.

Another object of the invention is to provide a knitting machine with slide latch needles, each of which is operated by a single jack.

Another object of the invention is to operate a jack in radial direction in a groove of a needle cylinder, and in axial direction in a groove of a dial plate between positions in which the jack cooperates with the hook part or with the latch of the respective slide latch needle.

With these objects in view, the present invention relates to an improved knitting machine with slide latch needles controlled by jacks.

One embodiment of the invention comprises carrier means, for example a rotary needle cylinder having an axis and a peripheral cylindrical surface; a plurality of slide latch needles mounted on the peripheral surface for axial movement, each slide latch needle including a hook part having a needle foot and a needle butt, and a slide latch having a latch foot and a latch butt and being movable along the hook part for opening and closing the slide latch needle; a plurality of jacks having cam follower portions and being mounted on the peripheral surface respectively registering with the slide latch needles, each jack being mounted for radial movement in a groove of the needle cylinder between positions cooperating with the needle foot and the latch foot, and also for axial movement between an inoperative position spaced from the respective slide latch needle and operative positions engaging at least the latch foot or at least the needle foot, or both; and control means including cam means cooperating with the butts of said slide latch needles and with the cam follower portions of the jacks for opening and closing the slide latch needles and for raising and lowering the same in knitting operations.

Each jack is preferably mounted for pivotal movement about an end portion so that the other end portion, which is in the proximity of the respective slide latch needle, can perform the required radial movements.

It is evident that, when the present invention is applied to the dial plate of a circular knitting machine, each jack is aligned with a slide latch needle in a radial groove of the dial, and is mounted for radial movement for moving the dial slide latch needles radially outward, and for axial movement for engaging either the needle foot, or the latch foot, or both of the dial latch needle in the same groove.

The present invention will be described in the present application with reference to the rotary needle cylinder of a circular knitting machine, and it will be understood that if the invention is applied to the dial of a circular knitting machine, the words "axial" and "radial" will have to be replaced by the words "radial" and "axial."

In the preferred embodiment of the invention, at least three circumferential cams are provided. A first cam cooperates with a cam follower portions of the jacks for moving the same in radial and axial directions. A second cam cooperates with the latch butt for controlling the axial movement of the same. A third cam cooperates with the needle butt for causing closing of the needle by movement of the hook part toward the latch.

The jack preferably has a stepped end portion with first and second abutments. Each jack can be moved in radial direction between a position in which the first and second abutments respectively register with the needle foot and the latch foot, and a second position in which the first abutment registers with the needle foot in which position the third cam is effective to act on the needle butt to close the needle.

Preferably selector means are provided for selecting some of the jacks to operate the needles, and other jacks to be inoperative so that the respective associated needles are not actuated.

The selector means may include a program-controlled electromagnet having a permanent magnet core, and selector cam means for moving spring rods between two positions, in one of which the respective spring rod

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pushes the respective associated jack to an inoperative position in which the jack remains so that it cannot operate the associated needle.

Selector means of this type are well known, and have been used for controlling jacks of knitting machines employing pivoted latch needles. Consequently, the selection of operative and inoperative needles in accordance with the knitted pattern can be carried out by a conventional program control means determining the knitting pattern in accordance with coded information recorded on a program tape.

Since only one jack is used, the height of the needle cylinder does not exceed the height of a needle cylinder employing pivoted latch needles. A standard needle cylinder can be adapted to the construction of the invention by substituting slide latch needles for the pivoted latch needles, and by providing suitable circumferential cams in the cam box. Circular knitting machines having dial needles in addition to the cylinder needles, can be adapted in the same manner, by also substituting slide latch needles for the dial needles, and by changing the cams in the dial cam box.

During a cycle in which a needle moves through a knitting and feeding station associated with a circumferential section of the cam box, the following operations take place:

A rising cam track acts on the jack and a horizontal cam track acts on the needle butt until the upper end of the jack abuts the previously spaced needle foot whereupon a rising track portion guides the needle butt. The rising cam track acting on the needle butt begins at a moment in which the slide latch needle is open, and an abutment of the jack engages the latch foot, so that both needle parts are simultaneously raised whereupon the needle hook receives a yarn. Downward movement of the jack by a cam track follows until the upper end of the jack is below the latch foot which is in the highest position. Outwards radial movement of the jack into a radially outward recessed cam track portion under the action of a spring follows so that the upper end of the jack is located under the latch foot. Downward movement of the hook part by a descending cam track acting on the needle butt follows until the hook part engages the latch and closes the needle while an abutment of the latch abuts an abutment on the hook part. During continuation of the downward movement of the hook part, the descending cam track acts on the upper edge of the needle butt, and the hook part moves together with the latch while the hook remains closed by the latch.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a developed view illustrating the cam means in a circumferential section of a cylindrical cam box of a circular knitting machine having several sections, each of which has a knitting station including a feeding means for yarn and cam means for operating a needle to form a loop and to cast the same off, and also selector means for selecting some of the needles to perform operations, and to render other needles inoperative in accordance with the desired knitting pattern;

FIG. 2 is a fragmentary axial sectional view taken on line II—II and illustrating in addition to the section of the cam box of FIG. 1, a needle cylinder surrounded by the same, a slide latch needle, a jack, and selector means;

FIG. 2a is a side view illustrating a slide latch needle with a tubular hook part as used in the preferred embodiment of the invention;

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FIG. 3 is a fragmentary axial sectional view taken on line III—III in FIG. 1 and illustrating another operational position of the slide latch needles and jacks;

FIG. 4 is a fragmentary axial sectional view taken on line IV—IV in FIG. 1 and illustrating another operational position in which a yarn is supplied to a slide latch needle;

FIG. 5 is a fragmentary axial sectional view taken on line V—V and illustrating another operational position;

FIG. 6 is a fragmentary sectional view taken on line VI—VI and illustrating another operational position;

FIG. 7 is a fragmentary horizontal sectional view taken on line VII—VII in FIG. 1 and illustrating a selector station; and

FIG. 8 is a fragmentary horizontal sectional view taken on line VIII—VIII in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A needle cylinder 3 is mounted for rotation about a vertical axis, not shown, on the left side of FIG. 2, and is surrounded by a cam box 6 having cams forming circumferentially extending cam tracks, as shown in FIG. 1. The peripheral surface of needle cylinder 3 has circumferentially spaced grooves or channels in which slide latch needles 5 are mounted for axial movement.

A slide latch needle 5 is shown in FIG. 2a, and includes a tubular hook part 5a having a hook 5c and a rigid plate 5a' including a needle butt 5a³ and a needle foot 5a''. A latch 5d is movable in the tubular part 5 and has an end portion cooperating with hook 5c to open and close the same. The other end of latch 5d has a rigid plate 5d' including a latch foot 5d'' and a latch butt 5d³.

Slide latch needles having a solid stem instead of the tubular part 5a, may be substituted.

In the position of FIG. 2, needle butt 5a³ is located between a cam 30v and a cam 31, as also shown in FIG. 1 along the section line II—II. The further guidance of needle butts 5a³ by cams in cam box will be described hereinafter in greater detail, but it will be noted that chain lines 1a and 1b in FIG. 1 represent the paths of movement of the upper and lower edges of the needle butts.

End plates 5a' and 5d' are located so that the needle foot 5a'' and the latch foot 5d'' are located adjacent each other. The end plate 5a' is guided in a deeper part 2c of the respective axially extending groove or channel 2 in the surface of the needle cylinder 3.

A jack 1 registers with each slide latch needle, and has a lower end portion 1a pivotally supported on a shoulder 2a of the respective groove 2c. The upper end portion of each jack is stepped, and has an end face 1f, forming a first abutment, and two lower abutments 1e and 1d. Abutment 1d has a bottom edge 1c' which forms a horizontal lateral edge of a recess which has a vertical bottom edge 1c and another horizontal lateral edge 1c''. Edges 1c, 1c', 1c'' form a cam follower portion of jack 1 cooperating with a cam 33 in cam box 6. As also shown in FIG. 1, cam 33 has an upper cam track 33a cooperating with edge portion 1c' and a bottom cam track 33b cooperating with edge portion 1c''. As shown in FIGS. 1, 3 and 8, cam 33 is followed by a cam 37, and cam 32 is followed by cam 36. Cam 30v is followed by cam 34, and cam 31 is followed by a cam 35.

A spring 7 is mounted in each groove 2c abutting the bottom of the same and the respective jack for urging the same outward in radial direction into engagement with the respective cam in cam box 6. Each jack 1 can be pivoted about its lower end portion 1a against the action of spring 7 to an inner position 1i shown in chain lines in FIG. 6.

A ring 8 is secured to the needle cylinder 3 for rotation with the same, and carries a set of elastic wire spring rods 21 respectively aligned with projections 1g of jacks 1. As shown in FIGS. 2 and 7, each spring rod 21 is engaged

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at a selecting station 4 by a cam 27 integral with cam 33 which has a portion 33*h* secured by a screw to the supporting structure of cam box 6. A selector magnet is provided at a selecting station 4 and includes a winding 26 surrounding a core portion 24*a* of a permanently magnetic armature 24 so that core 24*a* can be de-magnetized by energization of winding 26.

When needle cylinder 3 with ring 8 and spring rods 21 rotates in the direction of the arrow P in FIG. 7, rods 21 are moved outward by the slanted face *h-g* of cam 27 and then transported along the face *g-f* into the region of core 24*a* so that the spring rods are tensioned.

If winding 26 is not energized, permanent magnet 24 attracts and holds the spring rods in the position 21*a* so that they continue movement with the needle cylinder along the surface *d-b* of a cam 28 which is also integral with cam 33. Spring rods 21*a* continue to move inward along the surface *b-a* to the normal unstressed position.

When selected spring rods 21 arrive in a position opposite core 24*a*, winding 26 is energized and core 24*a* de-magnetizes so that the respective spring rods snap inwards over shoulder *f'* and are transported further in the position 21*b* to the point *e* of cam 27. Further movement of the needle cylinder transports selected spring rods 21*b* to the slanted surface *d-c* of cam 28, and then further along surface *c* until at the end *a* of cam 28, spring rods 21*b* are free to move to the normal untensioned position. The portion *f'-e* limits resilient swinging movement of released selected spring rods 21*b*. Point *d* slightly overlaps the end portion *e* of cam 27.

Selected spring rods 21 moving in the position 21*b* along the cam face *d-c* engage the projection 1*g* of the respective jack 1 and turn the same about its pivot end portion 1*a* to the position 1*i* shown in FIG. 6. As is apparent from FIG. 1, the same function is performed by the spring rods 21 at the selector station 4 between the positions shown in FIGS. 2 and 3 which are sections along lines II—II and III—III in FIG. 1.

When a selected spring rod 21 moves the respective jack 1 to position 1*i* shown in FIG. 6, the cam follower portions 1*c*, 1*c'*, 1*c''* are no longer in engagement with cam 33 in FIG. 2 or 33*A* in FIG. 6. A jack in the inoperative position 1*i* cannot be raised by the upward slanted top edge 37*a* of cam 37 shown in FIG. 3, and cannot engage the needle foot 5*a''* or latch foot 5*b''* which is possible in the operative position of the jack shown in FIG. 3 whose associated spring rod 21 was held by the permanent magnet 24 in the position 21*a*, as explained with reference to FIG. 7. In certain circumferential positions of the jacks, the outward pivotal movement of the jacks is limited by engagement between abutment 1*d* and cam 36. Smaller angular movements of the jacks between the operative positions shown in FIGS. 4 and 5 are effected under the control of recessed horizontal cam tracks 36*f*, 37*f* of cams 36, 37, see FIG. 8, against which spring 7 urges the jacks.

In accordance with the angular position of the jack, the same is either inoperative to influence the needle position, or is in a position in which abutment 1*f* engages needle foot 5*a''* while abutment 1*e* engages latch foot 5*d''*, see FIGS. 3 and 4, or is in a position in which abutment 1*f* engages only latch foot 5*d''*, as shown in FIG. 5. The cams of the cam box 6 raise and lower the hook portion 5*a* and latch 5*d* to cause knitting operations of the slide latch needles, but in certain circumferential positions, for example at the selector station 4, the jacks and needles are guided on horizontal cam tracks in a low position so that they do not perform knitting operations.

OPERATION

During rotation of the needle cylinder 3, the jacks and needles move in circumferential direction relative to the stationary cams of cam box 6 between the positions indicated by section lines II to VI in FIG. 1 and shown in FIGS. 2-6. FIG. 1 illustrates a section of the cam box

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corresponding to a knitting or feeding station of the knitting machine in which the needles are selected in accordance with a pattern, and operated between lower and higher positions until the jacks and needles arrive in the next-following sector of the cam box so that the positions of FIGS. 2 and 6 correspond to each other. Consequently, selecting stations 4 follow section lines II and VI in FIG. 1, a selection station being shown in FIG. 7.

FIGS. 2 and 6 show the slide latch needle 5 in the lowest cast-off position, and jack 1 in a corresponding low position. The height of hook part 5*a* is determined by cams 30*v* and 31, and butt 5*a*³ was moved down to the position illustrated in FIG. 2 by the slanted cam face 30*va*. In the region of FIG. 6 the slanted portion 30*a* of cam 30 cooperating with cam 31*A* has performed the same function. The upper and lower edges of needle butt 5*a*³ are indicated in FIG. 1 by the chain lines 1*a*, 1*b*. Latch 5*d* is in a position closing hook 5*c*. However, latch 5*d* is held by friction only, and may slide down until resting on the upper track 32*a* of cam 32. Follower portions 1*c'* and 1*c''* respectively engage the upper track 33*a* and the lower track 33*b* of cam 33 so that jack 1 is held in its lowest position in which abutment 1*f* is spaced the distance *x* from the needle foot 5*a''*. Since the time during which the needle 5 is in the position illustrated in FIG. 2 is extremely short, it is unlikely that needle hook 5*c* is opened by downward movement of latch 5*d* into engagement with track 32*a*, but even if this happens, the loop in hook 5*c* cannot drop out of hook 5*c* since it is held by the weight and tension of the knitted fabric which is drawn downward into the needle cylinder by a conventional device, not shown, the position of the knitted fabric and its movement in the direction Z being shown in FIG. 4.

During movement in the direction of the arrow P in FIG. 1 out of the radial plane II—II, needle butt 5*a*³ is guided between the lower track 34*a* of cam 34 and the upper track 35*a* of cam 35 so that the hook part 5*a* is neither raised nor lowered. The latch butt 5*d*³ of latch 5*d* is guided at the same time by the lower track 35*b* of cam 35 and by the upper track 32*b* of cam 32, and since track 32*b* is higher than track 32*a*, connected with the same by a slanted portion 32*c*, the latch butt is supported, and the latch closes hook 5*c* in the event that it had previously dropped down and opened the hook.

At the following selecting station 4, a selection is carried out so that some jacks 1 are placed in the inoperative position 1*i*, see FIG. 6, by spring rods in the position 21*b*, see FIG. 7, and are spaced from the respective cams so that they do not participate in the operations required for raising and lowering the needle. The selection will be described hereinafter in detail, but for the sake of clarity, it will now be assumed that all jacks remain in the operative position on track *d-b* engaging the respective cams under the action of spring 7.

During further turning of the needle cylinder, the jacks slide from cam 33 onto a cam 37 which has a rising track 37*a* acting on follower portion 1*c'* to raise jack 1 to the position shown in FIG. 3 in which abutment 1*f* abuts needle foot 5*a''* after rising the distance *x*, whereupon the jack is further raised to the position of FIG. 4. The rising jack also engages latch foot 5*d''* with its abutment 1*e*, so that hook portion 5*a* and latch 5*d* are simultaneously raised while hook 5*c* remains open. In the position of FIG. 4, a thread guide 50 supplies a thread 51 to hook 5*c*. The rising track portion 37*a* is followed by a downward slanted track portion 37*c* so that the lower track 37*e* which is less slanted, guides the jack downward toward the position shown in FIG. 5 in which the horizontal upper track portion 37*g*, and corresponding lower track portion guide the jack in its lowest position toward cam 33*a* of the next following cam box section and knitting station.

While the jack is guided by the rising and falling slanted track portions 37*a* and 37*c*, the cam follower portion 1*d* slides in the region following the radial plane V—V

on the radially outward recessed track 36f of cam 36, see FIG. 8, the track 37f being also radially outwardly recessed to permit outward radial movement of the jack. The outward movement of the jack to the position of FIG. 5 places abutment 1f under the latch foot 5d' which is held in a corresponding position by the track 35i of cam 35. In the position of FIG. 5, abutment 1f no longer engages the foot 5a'' of the hook part of the needle.

During the movement of the jacks from the inoperative position of FIG. 2 to the positions of FIGS. 4 and 5, the needle butt 5a³ and the latch butt 5d³ are also guided by cams. When the jack is raised by track 37a a distance x into engagement with the needle foot 5a'', and then higher for raising hook portion 5a, the upper edge of needle butt 5a³ slides on the rising lower track 34b of cam 34 which is parallel to the rising track 37a of cam 37. Consequently, during the upward movement of the hook part 5a, the same is coupled with the respective jack, abutting the same, and the tracks 37a and 34b cooperate to raise the same so that the second abutment 1e abuts the latch foot 5d'' which until then was guided by latch butt 5d³ along the horizontal lower track 35b of cam 35.

Hook 5c, which was closed in the position of FIG. 2, is open in the position of FIG. 3, and both needle parts 5a and 5d are simultaneously raised by the jack to the high position shown in FIG. 4. The upper edge of latch butt 5d³ slides along the rising lower track 35c of cam 35.

It will be seen that during the upward movement, as well as during the preceding horizontal movement, the needle butts and latch butts are guided on top by the tracks of cams 35 and 34, and are controlled by the jacks sliding along the track 33a of cam 33 and track 37a of cam 37 so that the two parts of the needle cannot deviate in upward or downward direction from a path determined by the cams of the cam box.

During movement from the position of FIG. 4 to the position of FIG. 5, the downwards slanted track 37e is effective to move jack 1 downward by acting on the cam follower portion 1c''. This downward movement ends when abutment 1f is directly under the latch foot 5d''. The hook part 5a is pulled by the loop 52 of the newly-knitted fabric in the direction of the arrow Z and also held in the highest position of FIG. 4 by the tension of the new yarn 51 which is placed in hook 5c by the yarn guide 50. Latch 5d is in a position opening the hook, and cannot move further downward.

In the following position shown in FIG. 5 and indicated by the section line V—V in FIG. 1, the inner circumferential tracks 37i and 36i of cams 37 and 36 have radially outward recessed track portions 37f, and 36f, respectively, see FIG. 8, which extend for the entire height of cam 37, and over the lower part of cam 36, as best seen in FIG. 1. The recessed cam track portions 36f and 37f end at the point where the needle butt 5a³ is located between cams 38 and 30 spaced a small distance from the downward slanted track 30a.

In the position of FIG. 5, the jack has just been urged outward by spring 7 due to the fact that its cam follower portion 1c engages the recessed cam track portion 37f, and its cam follower portion 1d engages a recessed cam track portion 36f, see also FIG. 8.

Consequently, the abutment 1f of the jack assumes a position under the latch foot 5d'', while the cam follower portion 1c' slides on the horizontal cam track 37g of cam 37 and maintains latch 5d in the same horizontal position, together with the lower track 35d of cam 35.

The downward slanted track 38a of cam 38 by which the needle butt 5a³ is guided, ends in a region indicated 38' in FIG. 1. During movement along the slanted cam track 38a, needle butt 5a³ is downwardly displaced together with the hook portion 5a of the needle so that hook 5c moves downward and is closed by latch 5d which is guided for horizontal movement, as explained above. During continued movement toward the position of FIG. 6,

a horizontal portion 38'' of cam 38 is first effective to hold the hook 5c in the closed position whereupon a downward slanted lower track portion 37b of cam 37 urges jack 1 downward to its normal inoperative position shown in FIG. 6. Shortly thereafter, the recessed track portions 36f and 37f end so that the jacks are moved inwards slightly compressing springs 7 whereupon the cam portion 33a becomes effective to hold the jacks in the same inner position in which the next cycle begins in the following section of the cam box for performing knitting operations at the following feeding station.

Shortly before the position of FIG. 6 is reached, the downward slanted track 30a acts on needle butt 5a³ to move the hook portion 5a downward together with latch 5d so that the hook remains closed in the cast off position of the needle and loops are formed at the respective feeding and knitting station. As indicated by the lines 1c and 1d, the upper and lower edges of the latch butt 5d³ remain spaced from cams 31A and 32A so that the latches are held in the closed position by friction before the next cycle of operation is started, as explained with reference to FIG. 2. Cams 34A, 35A, 32A and 33A correspond to cams 34, 35, 32 and 33 of the feeding and knitting station between the lines II and VI in FIG. 1. In the above description of the loop-forming operations of the slide latch needles 5 under the control of jacks 1, it was assumed that all needles participate in the operations. However, when a pattern is to be knitted, it is necessary to render selected needles inoperative so that the same do not participate in the loop-forming operations. As shown in FIG. 2, selecting stations 4 are provided at each knitting station, and a selecting station is shown in FIG. 7.

As described above, all spring rods are guided on the radially outer surface of cam 27 to a position closely spaced from the core 24a, and when they are attracted by the permanent magnet 24, they have no effect on jacks 1 so that the same perform the above-described operations for actuating the slide latch needles.

When in accordance with the desired Jacquard pattern, certain slide latch needles 5 are not to be operated, a program tape moving in synchronism with the needle cylinder of the knitting machine, is read out in program control means in a conventional manner to provide an impulse to winding 26 whenever a spring rod 21, associated with a jack and a needle which are not to operate, reach the point f. The field produced by the energized winding 26 suppresses and compensates the field of core 24a of permanent magnet 24, so that the respective spring rods, indicated by reference numeral 21b in FIG. 7, resiliently snap to an inner position and are then guided by the radially slanted cam track d-c to a radially inner position engaging the projection 1g of the respective associated jack and turning the same against the action of spring 7 to the position 1f, see FIG. 6, in which the respective jack is held by a spring rod 21 until the same passes over the end a of the inner track of cam 28. As is apparent from FIG. 1, the end a of cam 28 is located in the region of cam 37. In this region, the respective jack is released by spring rod 21, and is urged by spring 7 to engage with abutment 1d the inner track 37i of cam 37 due to the fact that the respective inoperative jacks are not raised to the higher position shown in FIGS. 3 and 4. At the end of cam 37, spring 7 turns the respective jack outward to its normal position so that the cam follower portions 1c, 1c', 1c'' again cooperate with the cam 33A of the next-following knitting and feeding station, ready to be selected or not selected at the following selecting station 4.

A selected jack operating in this manner, will perform a slight angular movement when engaging the radially outward recessed track portion 37f, but such angular movement has no effect because the lower edges of needle butt 5a³ and 5d³ are located in the positions of FIGS.

2 and 6 above the abutment 1f of the jack so that the same cannot collide with parts of slide latch needle 5.

The downwardly slanted lower track portion 37b assures a proper engagement of cam 33 by the follower portions of the jack when the same is outwardly moved by spring 7 due to the fact that tracks 37g and 37b are at first spaced a smaller distance than follower portions 1c' and 1c''.

It will be understood that each of elements described above, or two or more together, may also find a useful application in other types of knitting machines employing slide latch needles differing from the types described above.

While the invention has been illustrated and described as embodied in a circular knitting machine provided with jacks for operating slide latch needles selected in accordance with a program, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential features of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. Knitting machine, comprising, in combination, carrier means rotatable about an axis and having a peripheral surface; a plurality of slide latch needles mounted on said peripheral surface for axial movement, each slide latch needle including a hook part having a needle foot and a needle butt, and a slide latch having a latch foot and a latch butt and being movable along said hook part for opening and closing the slide latch needle, said feet being radially spaced; a plurality of jacks having cam follower portions and being mounted on said peripheral surface respectively registering with said slide latch needles, each jack being mounted for radial movement between two positions aligned with said needle foot and said latch foot, and also for axial movement between an inoperative position spaced in axial direction from the respective needle foot and latch foot, and a plurality of axial positions engaging a selected one or both of said feet; and control means including cam means cooperating with said butts and with said cam follower portions for axially and radially moving said jacks and for axially moving said hook parts and said slide latches so that said slide latch needles are opened and closed, and raised and lowered in knitting operations.

2. Knitting machine as claimed in claim 1 wherein each of said jacks has a stepped end portion including an end abutment, and a second abutment; and wherein each jack is movable in radial and axial directions between a position in which said end abutment cooperates with said needle foot, a position in which said end abutment cooperates with said needle foot and said second abutment cooperates with said latch foot, and a position in which said end abutment cooperates with said latch foot only.

3. Knitting machine as claimed in claim 1 wherein each jack has a stepped end portion in the proximity of the rear end of said slide latch needle, each end portion having an end face forming a first abutment and a radial shoulder forming a second abutment; wherein said cam means include a first cam cooperating with said cam follower portions of said jacks and having cam tracks for moving the jacks in axial direction and other cam tracks for moving said jacks in radial direction, a second cam cooperating with said latch butts and including fall-

ing and rising cam track portions for moving said latches in axial direction, and a third cam having a rising and falling cam track cooperating with said needle butts for moving said hook portions in axial direction; and wherein said first cam moves said jacks between a first position in which said first and second abutments are aligned with but axially spaced from said needle butt and latch butt, a second position in which said first abutment abuts said needle foot, a third position in which said first abutment abuts said needle foot and said second abutment abuts said latch foot for simultaneously moving said hook part and said latch in open position in axial direction to a knit position, a fourth position in which said first abutment abuts said latch foot only while said third cam acts on said needle butt for moving said hook part in axial direction to close the respective slide latch needle in a cast off position; and wherein said control means includes a spring for urging the respective jack outward into engagement with said first cam.

4. Knitting machine as claimed in claim 1 wherein said cam means are circular and located outward of said peripheral surface of said carrier means and have circumferential cam tracks for moving said hook parts, said latches and said jacks in axial direction, and said jacks also in radial direction so that said slide latch needles open and close and move in axial direction during rotation of said carrier means whereby knitting operations are carried out by said slide latch needles; and wherein said control means include spring means mounted on said carrier means for biasing said jacks outward into engagement with said cam means.

5. Knitting machine as claimed in claim 4 wherein said cam means include a circumferentially extending cam; and wherein each jack has a recess bounded by said cam follower portions and being urged by said spring means to move to a position in which said cam is located in said recess, said cam having cam tracks for rising and lowering the jacks and for moving the same in radial direction.

6. Knitting machine as claimed in claim 5 wherein said recess is rectangular and bounded by a pair of radial upper and lower edges and an axially extending edge between the same; and wherein said cam has an axially rising and falling upper track cooperating with one of said radial edges for raising and lowering said jack, and a radially recessed inner cam track cooperating with said axial edge for moving the jacks in radial direction between a position cooperating with said needle foot and said latch foot, and a position cooperating with said latch foot only for raising and lowering the same under control of said rising and falling cam track of said cam.

7. Knitting machine as claimed in claim 1 wherein each jack has one end cooperating with said needle foot and said latch foot, and another end mounting the jack for pivotal movement in radial direction.

8. A knitting machine as claimed in claim 1 wherein said cam means are located outward of said peripheral surface of said carrier means and have axially rising and falling cam tracks engaging said needle butts and latch butts and said cam follower portions of said jacks for axially moving said hook parts, said latches, and said jacks, and radially recessed cam tracks engaging said cam follower portions for moving said jacks in radial direction; and wherein each of said jacks has a first abutment aligned in one radial position of said jack with said needle foot, a second abutment aligned with said latch foot in an axial position of said jack in which said first abutment engages said needle foot, said jack having another radial position in which said first abutment cooperates with said latch foot.

9. Knitting machine as claimed in claim 1 wherein said cam means include a first cam cooperating with said cam follower portions for moving said jacks in axial and radial directions; a second cam cooperating with said latch butt for controlling the axial movement of said

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latch, and a third cam cooperating with said needle butt for controlling the axial position of said hook part.

10. Knitting machine as claimed in claim 9 wherein said first cam moves said jack in radial direction to a position aligned with said needle foot and said latch foot, and then moves said jack in axial direction for simultaneously moving said hook part and said latch to a position for receiving a yarn whereupon said third cam acting on said needle butt moves said hook part to a position engaging said latch for closing said slide latch needle in a cast off position.

11. Knitting machine as claimed in claim 1 comprising selector means for moving some of said jacks in radial direction to an inoperative position and for holding the same in said inoperative position so that the respective jacks do not register with said slide latch needles during rotation of said carrier means.

12. Knitting machine as claimed in claim 11 wherein said selector means include a spring rod cooperating with each jack, electromagnetic selector means for moving nonselected spring rods to a first position while resiliently deforming the same, and permitting selected spring rods to remain in a second position; and cam means for moving said selected spring rods to a position engaging the respective jack and moving the same to inoperative position.

13. Knitting machine comprising, in combination, carrier means rotatable about an axis and having a peripheral surface; a plurality of latch needles mounted on said peripheral surface for axial movement, each slide latch needle including an axially movable hook part having a needle foot and a needle butt, and a slide latch having a latch foot and a latch butt, and being movable along said hook part for opening and closing the slide latch needle; a plurality of jacks having cam follower portions and

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being mounted on said peripheral surface registering with said latch needles, respectively, each jack being mounted for radial movement between two control positions aligned in axial direction with both said needle foot and said latch foot, and with only one of said feet, respectively, and being also mounted for axial movement in said control positions between an inoperative position spaced from the respective needle foot and latch foot and three operative positions engaging both feet, said needle foot only, and said latch foot only; and control means including cam means engaging said needle butts, said latch butts, and said cam follower portions for moving said hook parts and said latches in axial direction, and said jacks in axial direction between said inoperative and operative positions, and also in radial direction between said control positions so that said slide latch needles are opened and closed and moved in axial direction whereby knitting operations are carried out by said slide latch needles.

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