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[54] **CONTROL APPARATUS FOR RESETTING PATTERN DRUMS**

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[51] **Int. Cl.** **D04b 15/66,** D04b 15/74

[58] **Field of Search** ..... 66/50 B, 50 R, 50 A, 66/154 R, 154 A, 156, 25, 36 R, 36 A

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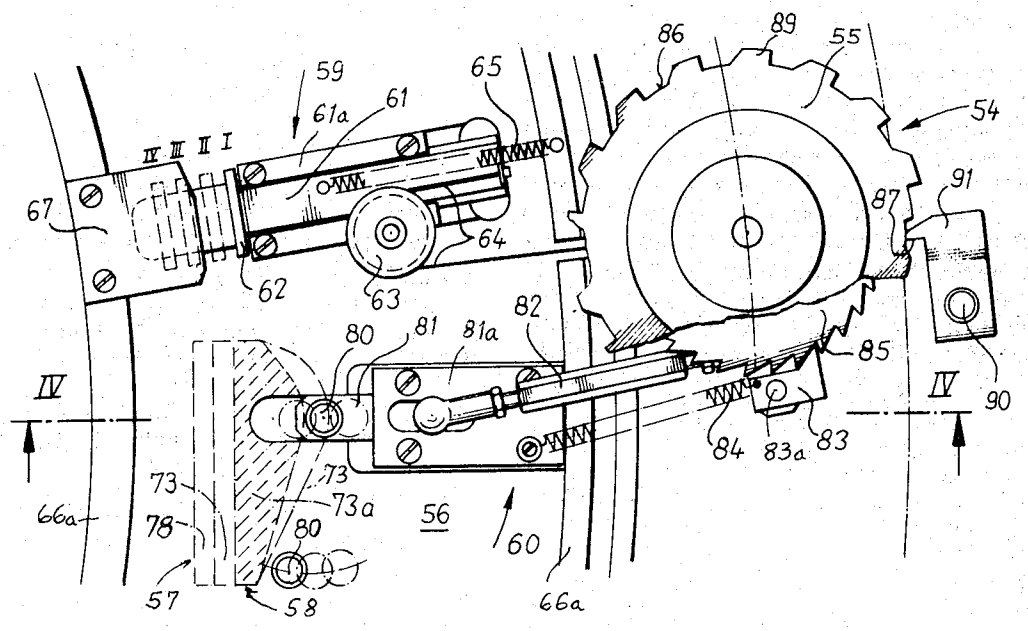
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[57] **ABSTRACT**

A pattern control device and a plurality of actuator devices are mounted on the needle cylinder of a circular knitting machine and successively pass a stationary setting device which is moved to different setting positions under the control of a pattern chain cylinder. In different setting positions, the pattern control device and the actuator devices selectively operative for shifting pattern drums and a counter wheel. The pattern drums have a predetermined number of rows of pins to which alternating recesses and projections of the counter wheel correspond, except that one projection is replaced by a special deep recess which represents the initial position of the counter wheel and of the pattern drums. When a pattern has been completed, the setting means render all actuating devices operative to shift the pattern drums with the counter wheel in double steps to the initial position until the deep recess is sensed by sensing means which place the setting device in its initial positions in which the pattern control device and all actuator devices are rendered inoperative. In order to obtain the resetting of the pattern drums during one revolution of the needle cylinder, the number of actuating devices is an integer fraction of the number of rows of pins on the pattern drums, and the actuator devices shift the pattern drums a number of angular steps which is equal to the denominator of the fraction, for example, two steps at a time.

13 Claims, 14 Drawing Figures



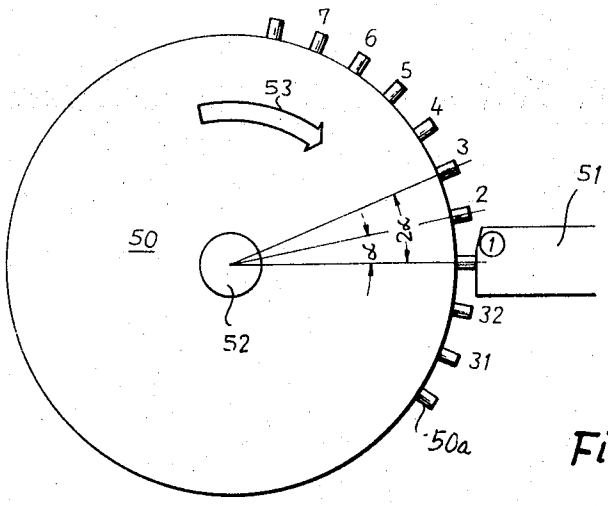


Fig. 1

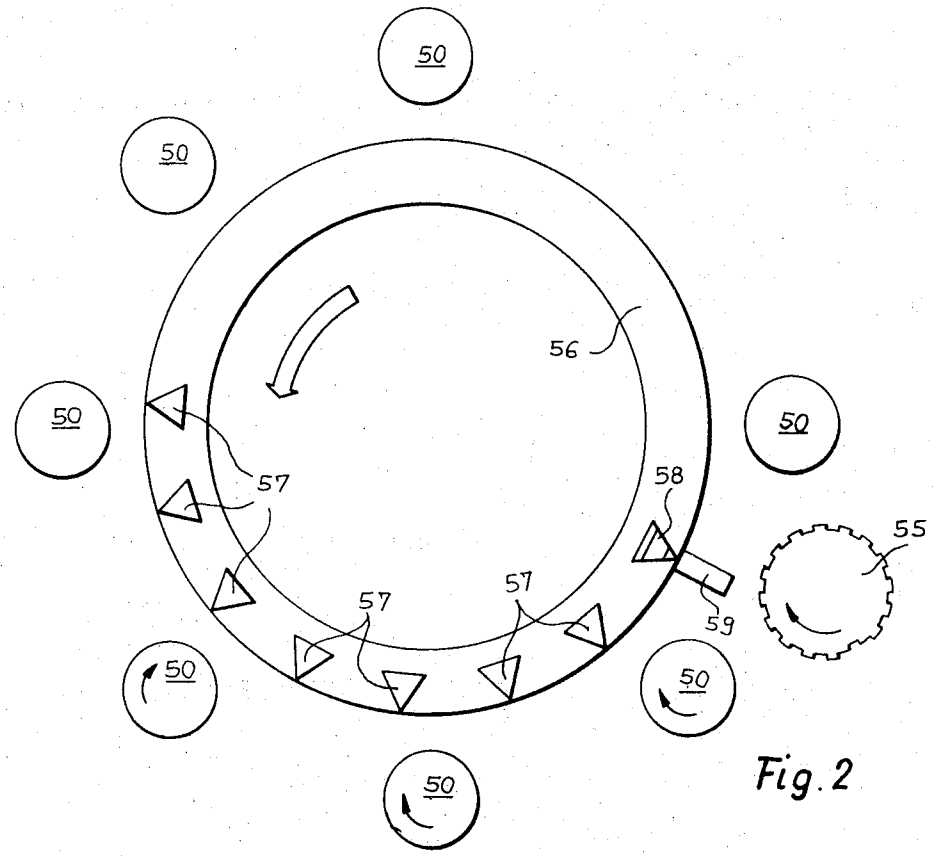


Fig. 2

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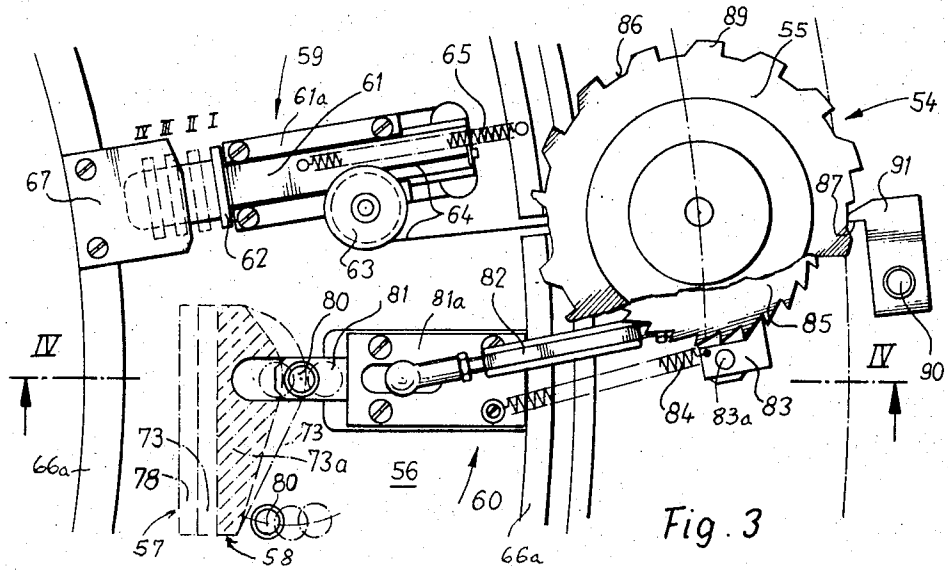


Fig. 3

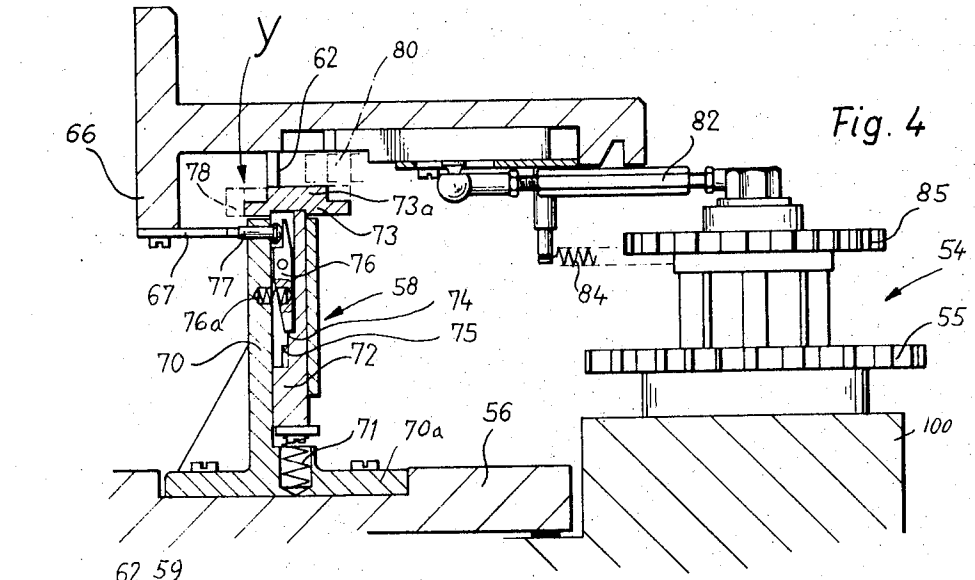


Fig. 4

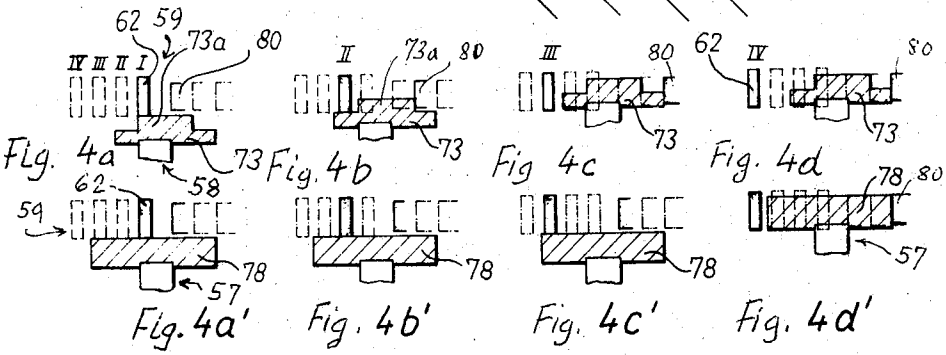


Fig. 4a Fig. 4b Fig. 4c Fig. 4d

Fig. 4a' Fig. 4b' Fig. 4c' Fig. 4d'

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Fig. 5

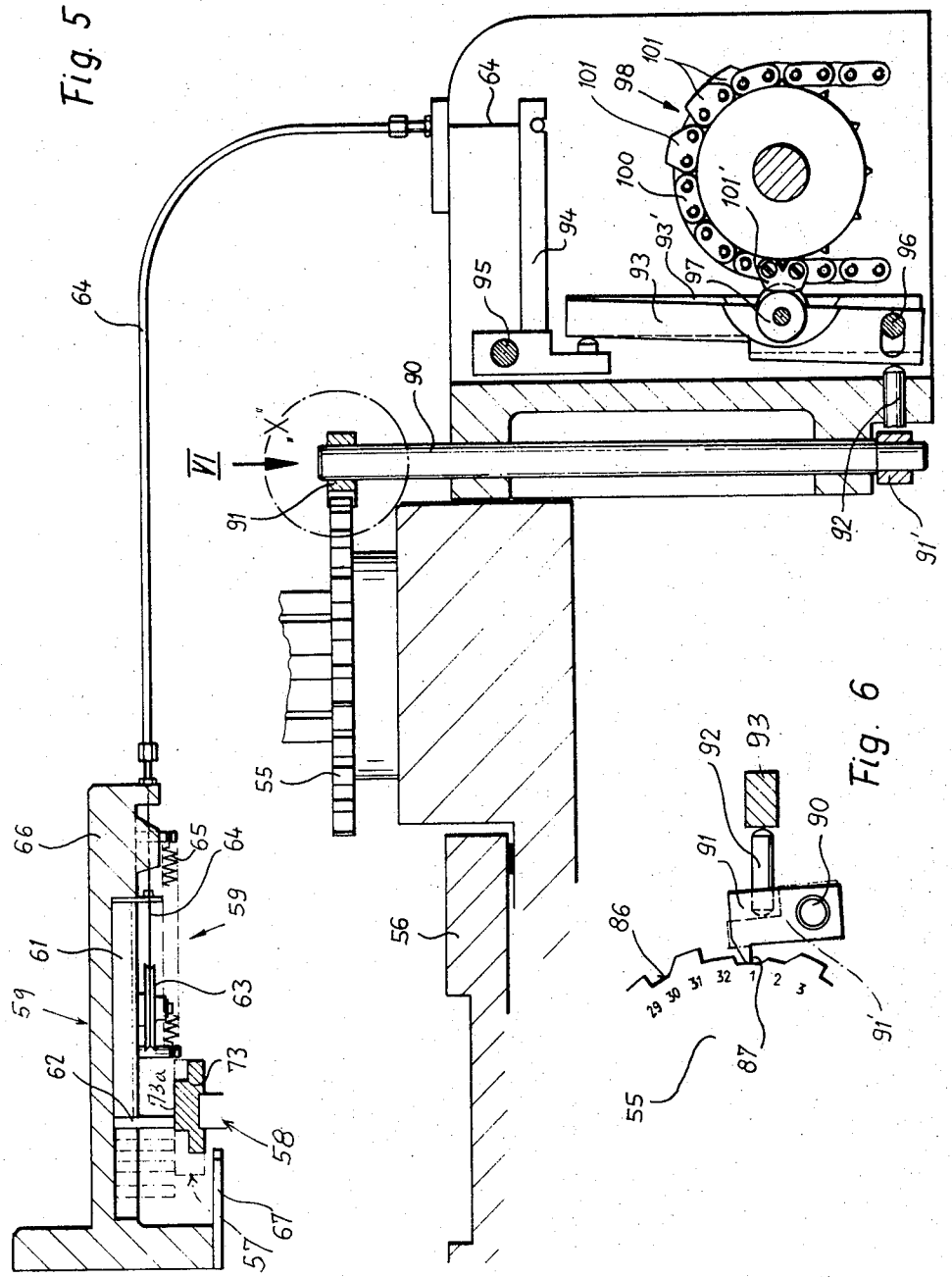


Fig. 6

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CONTROL APPARATUS FOR RESETTING PATTERN DRUMS

BACKGROUND OF THE INVENTION

The present invention relates to a control apparatus for resetting the pattern drums of a circular knitting machine which has a plurality of knitting stations provided with pattern drums controlled by a Jacquard program chain. On a circular knitting machine having a plurality of knitting stations, several identical workpieces can be successively knitted, connected by a separating course, and having the same pattern. It may occur that the last course of the workpiece does not coincide with the end of the repeated pattern while the next following workpiece is to be knitted with the repeated pattern. This means that between the last course of a workpiece, and the first course of the next following workpiece, all pattern drums have to be reset to the initial positions, either in forward or in rearward direction.

The printed German Pat. application No. 1,246,929 discloses apparatus by which, during a single revolution of the needle cylinder of a circular knitting machine, all Jacquard pattern drums are reset to the initial positions. The apparatus requires a number of actuator devices which is at least equal to the number of rows of pins on each pattern drum, minus one, so that during a single revolution of the needle cylinder, all pattern drums can be returned to the initial positions, irrespective of the number of courses of a workpiece. In some circular knitting machines, only a small number of knitting stations can be provided, while the number of rows of pins of the pattern drums is increased in order to obtain repeating patterns whose dimensions correspond to the repeating patterns of knitting machines having a greater number of knitting stations. This has the disadvantage that upon increase of the number of rows of pins of the pattern drums, the construction disclosed in the German Pat. No. 1,246,929 also requires a greater number of actuating devices for shifting the pattern drums stepwise to the initial positions. If the number of actuator devices is too great, there may not be enough space at the knitting machine, and the resetting of all pattern drums to the initial positions can only be obtained during more than one revolution of the needle cylinder.

SUMMARY OF THE INVENTION

It is one object of the invention to overcome the above explained disadvantage of the prior art, and to provide a control apparatus for resetting pattern drums which requires only a small number of actuating devices for stepwise turning the pattern drums to the initial position at the completion of the knitting of a workpiece.

Another object of the invention is to provide a simple and inexpensive control apparatus for resetting the pattern drums of a circular knitting machine after completion of the workpiece.

The apparatus of the invention comprises, a plurality of actuating devices for stepwise shifting the pattern drums successively to the initial positions, and in accordance with the invention, the number of the actuating devices is an integer fraction, particularly one half of the number of rows of pins on the pattern drums, minus one. Furthermore, the actuating devices are constructed to shift the pattern drums angularly in multiple steps, each angular displacement of the pattern drums being equal to the denominator of the fraction, particularly equal to two. By arranging the actuating devices for effecting multiple steps of the patter drums during a resetting to the initial position, the number of required actuating devices can be substantially reduced, and preferably halved. Nevertheless, a control apparatus according to the present invention assures that during the regular knitting operation, an angular stepwise shifting of the pattern drums by single steps is obtained, and that during the resetting of the pattern drums in multiple steps, the pattern drums are always reset to the initial position in which the first row of pins is operative.

In accordance with the invention, the setting of the pattern control device and of the actuator devices, is obtained by stationary setting means which, depending on the position of a pattern chain and the angular position of a counter wheel, can assume different setting positions. The Jacquard bolt or slide of the setting means forms in several setting positions, an abutment for control cam means and actuator cam means which are selectively rendered operative for angularly shifting the pattern drums in accordance with the selected setting positions of the setting slide.

The pattern control cam has preferably two stepped cam portions for obtaining shifting of the pattern drum in one or two angular steps, and the actuating cam is wider than the control cam.

The pattern control cam and the actuator cam are spring-biassed and locked in the initial position by locking means operated by a stationary cam to release the respective cams when passing the region of the setting means.

The counter wheel used in the apparatus of the invention has a number of uniformly spaced peripheral portions whose number is the same as the number of rows of pins on the pattern drums, so that each angular position of the counter wheel corresponds to an angular position of the pattern drums. This number divided by the number representing the denominator of the fraction, for example, two, is the number of peripheral recesses of the counter wheel and adjacent recesses are separated by projections. However, the projection corresponding to the initial position of the pattern drum is omitted and replaced by a special recess which is deeper than the other recesses.

A sensing means senses the angular positions of the counter wheel by entering the recesses and moving over the projections and controls the setting device to move to the initial position when the sensing means senses the deep recess representing the initial position of the pattern drums obtained after resetting of the pattern drums in double steps by the operative actuator devices.

The sensing means is connected with a linkage which is on the one hand connected by Bowden cable with the slide of the setting device, and on the other hand, is operated by pattern members of different height provided on the chain.

Assuming the denominator of the above explained fraction to be two, the setting lever of the setting device has four different positions, of which the first position is the initial position and effects locking of the pattern control device and of the actuator devices, the second position permits movement of the pattern control cam

to a position obtaining a single step of the pattern drums and counter wheel, the third position effects release of the pattern control cam for turning the pattern drums and counter wheel for a double step, and the fourth position releases the cams of the actuating devices in addition to the cam of the pattern control device for effecting double steps of the pattern drums and of the counter wheels during a resetting operation.

The linkage is designed so that, if a high pattern member is effective, and the sensing means engages a recess of the counter wheel, the slide of the setting device moves to the second position, that in the normal position of the sensing device sensing projecting portions of the counter wheel whose number is not divisible by the denominator of the above-explained fraction, the setting slide is placed in the fourth position, and that when the sensing means engages a deep recess of the counter wheel corresponding to the initial position of the pattern drums, the setting slide of the setting device is placed in its initial, first position for rendering the pattern control device, and all actuator devices in operative for shifting the pattern drums and counter wheel beyond the reset initial position.

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 DRAWING

FIG. **1** is a schematic plan view illustrating a Jacquard pattern drum having a predetermined number of rows of control pins;

FIG. **2** is a schematic plan view illustrating the needle cylinder of a circular knitting machine carrying a pattern control device, a plurality of actuating devices, and a counter wheel;

FIG. **3** is a fragmentary bottom view illustrating a sector of the knitting machine provided with counter means;

FIG. **4** is a fragmentary axial section taken on line IV—IV in FIG. **3**;

FIGS. **4***a* to **4***d*, and FIGS. **4***a'* to **4***d'* are fragmentary elevations illustrating a region Y in FIG. **4** and showing different operational positions;

FIG. **5** is a fragmentary axial sectional view of the embodiment of FIGS. **2** and **3**, particularly illustrating the sensing of the positions of a counter wheel; and

FIG. **6** is a fragmentary plan view of the region X taken in the direction of the arrow VI in FIG. **5**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. **1**, a pattern drum **50** has a predetermined number of rows of pattern control pins **50***a*, for example thirtytwo rows, not all rows **50***a* being shown for the sake of simplicity. A repeat pattern always starts at the first row, and extends over any desired number of the 32 rows, the coded setting or omission of pattern control pins **50***a* producing the pattern by operating slides **51** in the usual manner. A slide **51** is provided for each pin of a row of pins **50***a*. Pattern drum **50** can rotate about a shaft **52** in the direction of the arrow **53** in steps, which is effected by a stepping mechanism, not shown. One angular step of pattern drum **50** from one row to the next row of pins **50***a*, corresponds to an angular displacement for the angle α, and a double step corresponds to an angle 2α. A pattern drum **50** is provided at each knitting station of a circular knitting machine.

FIG. **2** schematically illustrates the arrangement fo a plurality of pattern drums **50** on stationary supporting means surrounding an annular needle cylinder of a circular knitting machine which rotates in the direction of the arrow. Seven pattern drums **50** are illustrated, but it is evident that the circular knitting machine may have a greater number of knitting stations and pattern drums **50.** However, the number of rows of pattern control pins **50***a* of each pattern drum is of importance, since it determines the length of the repeat pattern. In addition to the illustrated seven pattern drums **50,** a counter device including a counter wheel **55** is rotatably supported on the support of the machine. Counter wheel **55** is stepwise shifted in the same manner as the pattern drums **50,** and corresponding to the 32 rows of pattern control pins **50***a* on each pattern drum **50,** the counter wheel **55** has 32 angular positions, and is angularly shifted between the respective positions, the same angle α as the pattern drums **50.** The counter wheel **55** has 15 teeth **89** alternating with 16 recesses **86,** and one deep recess **87** which are respectively effective in the 32 angular positions of number wheel **55,** the deep recess **87** being associated with the initial position of counter wheel **55** and of the pattern drums **50** in which the first row of pins cooperates with a row of slides **51.** The counter wheel **55** is shown on a larger scale in FIG. **3.**

In accordance with the invention, the number of actuator devices **57** is an integer fraction of the predetermined number of rows **50***a* of control pins, minus one, and has a denominator of at least two. The actuator devices **57** effect angular displacement of the pattern drums **50** for a number of angular steps equal to the denominator. In the illustrated example, where each pattern drum **50** has 32 rows of pattern control pins **50***a*, the denominator of the integer fraction is selected to be two. The fraction 32 over two equals 16, when one is deducted the result is 15, so that 15 actuator devices **57** and one pattern control device **50***a* are uniformly distributed around the circumference of the needle cylinder **56.**

The rotating pattern control device **58** shifts during the knitting operation all pattern drums and the counter wheel **55** one or two angular steps, depending on the setting of the apparatus. The actuator devices **57** effect the angular shifting of the pattern drums **50** and of the counter wheel **55** to the initial position shown in FIG. **1** for the pattern drum **50** in which the first row of pattern control pins cooperates with the slides **51** when a piece of fabric has been finished on the circular knitting machine, and a new piece of fabric is to be knitted starting with the first row of the repeat pattern.

The pattern control device **58** and all actuator devices **57** are settable by a stationary setting device **59** disposed in the proximity of the counter means **54** with counter wheel **55.** The setting means **59** determine whether the pattern control device **58** and/or the actuator devices **57** are to be operative, or not.

In the operative condition, pattern control device **58** and actuator devices **57** angularly displace ratchet devices of the counter means **54** and of the pattern drums

50, only the ratchet device for the counter means 54 being shown in FIG. 3, to include a ratchet wheel 85 connected with counter wheel 55 for rotation, and being stepwise displaced by a shifting member 82. In each shifted position of ratchet wheel 85, it is arrested by a locking pawl 83 biassed by a spring 84 to turn about a pin 83a into engagement with a recess of ratchet wheel 85.

As shown in FIGS. 3 and 4, a follower roller 80 of a shifting device 60 is mounted on a slide 81 which is shiftable in a guide 81a secured to the stationary support 66a.

Follower roller 80 cooperates with cams 73*a*, 73, and 78 as will be explained hereinafter, so that slide 81 is shifted and displaces the shifting member 82 which is pivotally connected with slide 81. Depending on the shape of the controlling cam, the ratchet wheel 85, and thereby number wheel 55 will be shifted one or two steps so that a sensing means 91, mounted for angular movement on a shaft 90, can sense either recesses 86 which are respectively associated with even numbered rows of pattern control pins 2, 4, 6 and so forth, or a projection or tooth 89 representing the odd rows of pattern control pins 3, 5, 7 and so forth, or, as shown in FIG, 3, the deep recess 87 which represents the initial position of the counter wheel 55, and also of the pattern drums 50.

The setting device 59 includes a Jacquard slide 61 provided at the outer end with an abutment portion 62, and guided in a stationary guide part 61*a* for radial movement between four positions in which the abutment portion 62 assumes the positions designated I, II, III and IV. The Jacquard slide can be shifted between the four positions by a Bowden cable 64 which is guided over a guide pulley 63 so that a pull on Bowden cable 64, see also FIG. 5, will displace the slide 61 from the initial position I to one of the other three positions II, III, IV, against the action of a spring 65 which is secured to slide 61 and to the stationary support 66*a*. When the pull of the Bowden cable is relieved, spring 65 returns the displaced slide 61 to the initial position I.

As shown in FIGS. 3 and 4, a stationary cam 67 is secured to the support 66 radially aligned with the setting means 59, but does not cooperate with the abutment portion 62 which is located at a higher level, as best seen in FIG. 4.

Pattern control device 58 has a guiding support 70 with a base 70*a* secured to a flange of the rotary needle cylinder 56. A member 72 is guided in guide 70 and biassed by spring 71 to move upward. The upper end of member 72 carries a control cam which has a larger portion 73, and a smaller portion 73a, as also shown in FIG. 3 in phantom lines. The cam 78 shown in FIGS. 3 and 4 in phantom lines is not part of cams 73 and 73*a*, but is a part of an actuator control device 57, which is not completely shown, but corresponds in construction to the pattern control device 58.

Guided member 52 has two shoulders 74 and 75 which cooperate with a locking lever 76 mounted in member 72 for angular movement between positions cooperating with shoulders 74 and 75, respectively. A small spring 76*a* urges locking lever 76 to the position abutting shoulder 74 so that upward movement of member 72 with cam means 73, 73*a* is not possible. A shifting pin 77 is mounted in a horizontal bore of guide member 70 and abuts the upper end of locking lever 76. When during rotation of the needle cylinder 56, the pattern control device 58 turns to the position located under the setting device 52, shifting pin 77 engages the stationary cam 67 so that member 72 is unlocked. However, spring 71 cannot raise member 72 together with cams 73 and 73*a* to a higher position if abutment portion 62 of slide 61 is still in the position I, as shown in FIG. 4, since the pressure of spring 71 is transferred to abutment portion 62. It is evident that, if slide 61 is shifted by the Bowden cable 64 to position II, abutment portion 62 will release the upper cam 73*a* so that the same can rise to a higher position shown in FIG. 4*b*, in which abutment portion 62 abuts the lower and larger cam 73. However, in the position illustrated in the drawing, in which abutment portion 62 is in the position I, upward movement of member 72 with cams 73, 73*a* is blocked, and consequently, the locking lever 76 engages again shoulder 74 due to the action of spring 76*a* when shifting pin 77 passes beyond the stationary cam 67 during rotation of needle cylinder 56. If the pattern control device 58 is in the illustrated locked position, it has no effect on the roller 80 of the shifting device 70 and neither the counter device 74, nor the pattern drums 50 are operated by the pattern control means during the following revolution of needle cylinder 56. In this condition, even the higher cam 73*a* is located below the follower roller 80 of the shifting device, as shown in phantom lines in FIG. 4.

FIG. 3 shows the horizontal profile of the upper cam 73*a* in hatched lines, and the larger profile of cam 73 also in phantom lines.

The plurality of actuator devices 57 is not shown in FIGS. 3 and 4, with the exception of the cam 78, which is illustrated in FIGS. 3, 4 and in the lower portions of FIGS. 4*a* to 4*d*. The construction of the actuator devices 57 is substantially the same as of the pattern control device 58, but a lower shoulder 75 is omitted in the actuator devices 57. The reason for the omission of the shoulder 75 and the construction of cam 78 without a smaller stepped portion as described with reference to cams 73 and 73*a*, is the fact that the actuator devices 57 are intended to effect only double steps through angular distances 2 α of the counter wheel 55 and of the pattern drums 50, which are provided on the support 100 in positions similar to the position of the counter means 55, and include ratchet means 83, 85, shifting means 60, and follower rollers 80, as described with reference to FIGS. 3 and 4 for the pattern control device 58. However, the follower rollers 80 cooperate with cam 78. FIGS. 4*a*, 4*b*, 4*c* and 4*d* show different positions of the setting device 59 cooperating with the pattern control device 58. FIGS. 4*a'* to 4*d'* also show different positions of the setting device 59 cooperating with one of the actuator devices 57. FIGS. 4*a* and 4*a'* show the abutment portion 62 of slide 61 of the setting means 59 in the position I. In this position of the setting means 59, even the small cam portion 73*a* is blocked against upward movement to an operative position cooperating with a follower roller 80. When any one of the following actuator devices reaches the setting means, the respective cam 78 is also blocked by the abutment portion 62 and cannot rise to an operative position, cooperating with follower roller 80.

When by means of Bowden cable 64, slide 61 with abutment portion 62 is shifted to the position II, as shown in FIGS. 4*b* and 4*b'*, the small cam 73*a* can rise to the level of the follower roller 70, but the larger cam

73 is blocked. Follower roller 80 displaced by cam 73*a* causes a single step of the counter wheel 74. Due to the large size of cam 78 of the following actuator device 57, cam 78 is blocked by abutment portion 62, and remains inoperative. Consequently, as in the position of FIG. 4*a'*, the actuator devices 57 which successively pass during the revolution of the needle cylinder 56 under the setting means 59, remain all inoperative in the initial position and cannot shift the counter wheel 55, and cam 78 remains in the same position when the abutment portion 62 of the setting device 59 is shifted to the position III as shown in FIG. 4*c'*. The cam 73 of the pattern control device 58 is no longer blocked, and becomes effective to act on the follower roller 80 so that counter wheel 55 is shifted two angular steps, and the pattern drums 50 are also shifted two angular steps under the control of the operative cam 73.

In the position of the setting means IV as shown in FIGS. 4*d* and 4*d'*, the cam 73 of the pattern control device 58 can also rise to the position in which it effects two steps of the number wheel 55 and of the pattern drums 50, but the cams 78 of all following actuating devices 57 are no longer blocked by abutment portion 62 and can also rise to the operative position shown in FIG. 4*d'* to act on follower roller 80, whereby the counter wheel 55 is shifted two steps by each passing actuator device 57.

As shown in FIGS. 5 and 6, a sensing means 91 is connected by a shaft 80 with a lever 91' controlling a pin 92 abutting a lever 93 mounted by means of a slot on a shaft 96 for angular movement and having an upper end portion cooperating with an angular lever 94 mounted on a shaft 95 and having a free end connected with Bowden cable 64 by which the slide 61 is controlled to move the abutment portion 62 between the positions I to IV. as described above. Lever 93 abuts by means of a roller 97 on a high pattern member 101' which is laterally attached to the pattern chain 58 and serves for controlling the sensing means 91 of the counter wheel 55. The pattern chain 98 has high pattern members 101, and low chain links 100 cooperating with a second lever 93' mounted on shaft 96 for angular movement and having a free end abutting lever 94 in the same manner as lever 93. Lever 93' has no slot, but is pivotally mounted on shaft 96. Pattern chain 98 may also have pattern members, not shown, whose height is between the height of pattern member 101 and the height of chain links 100.

For returning all pattern drums 50 to the initial positions in which the row of control pins 1 is effective, as shown in FIG. 1, the apparatus is operated as follows when a workpiece has been completed.

At the end of the workpiece, the special pattern member 101' is attached laterally to the pattern chain 98 to cooperate only with the roller 97 of lever 93. Pattern chain 98 has at this place a low chain link 100. When the last row of a workpiece has been knitted, the high pattern member 101' engages roller 97 of lever 93 which is pressed to the left as viewed in FIG. 5 and displaces lever 94 which transmits motion through the Bowden cable 64 to the slide 61 in the setting means 59. Lever 93 also presses against pin 92. If sensing means 91 is at this moment located opposite a recess 86 of counter wheel 55 corresponding to an even numbered row of pins 50a, the movement of lever 93 is transmitted to shaft 90 and sensing means 91 moved into recess 86. Due to this movement, the fulcrum of lever 93 is displaced, and the linkage 93, 94 is designed so that due to this displacement of the fulcrum, the slide 61 of the setting means 59 is moved by Bowden cable 64 to the position II shown particularly in FIGS. 4*b* and 4*b'*. In this setting position of setting means 59, the smaller cam 73*a* can rise to an operative position due to the action of spring 71 on the guided member 72, and cooperates at this level with the follower roller 80 of the shifting device 60 to displace the counter wheel 55, and also all pattern drums 50 one step during each revolution of the needle cylinder 56.

First the counter mechanism 54, 55 which is located directly following the setting means 59 in the direction of rotation is shifted one step. During this step of the counter wheel 55, sensing means 91 is urged out of the recess 86 upon the following tooth 89 of counter wheel 55, and this movement of sensing means 91 is transmitted by shaft 90 to the pin 92 and causes an angular displacement of lever 93 about roller 97 which abuts the high pattern member 101 of pattern chain 98 so that lever 94 is also displaced and shifts the slide 61 of the setting means 59 to the position IV, particularly shown in FIGS. 4*d* and 4*d'*.

As is apparent from FIG. 4*d'*, the cams 78 of all following actuating devices 57 can rise to an operative position when the abutment member 62 is in the position IV, so that all cams 78 successively engage all follower rollers 80 whereby the counter wheel 55 and also all pattern drums 50 are shifted two steps.

Since the linkage 93, 94 is not influenced by counter wheel 55, the slide 61 with abutment portion 62 remains in the position IV, so that cams 78 of all actuating devices 57 become successively effective so that counter device 54, 55 and all pattern drums 50 successively move in angular double steps to positions corresponding to the odd numbered rows of pins 50*a* after the pattern control device has shifted the counter device 55, 54 and the pattern drums 50 from the assumed odd numbered row of pins 50*a* one step to the next even numbered row of pins 50*a*. In this manner, during a single revolution of the needle cylinder of the circular knitting machine, all pattern drums 50 and the counter device 54 are stepwise shifted toward the position corresponding to the first row 50*a* of pins 1. When this position is obtained, the sensing means 91 engages the deep recess 87 which indicates the initial position of the counter wheel 55, and due to the movement of sensing means 91, linkage 93, 94 is displaced so that Bowden cable 64 is operated to shift the slide 61 of the setting device 59 to the position I in which the abutment portion 62 in the position of FIGS. 4*a* and 4*a'* presses cams 73a, 73 and member 72 to the initial position in which they are locked by locking lever 76, and the cams 78 of the following plurality of actuator devices 57 are also pressed down by abutment portion 62, so that the actuator devices are inoperative. Consequently from the moment in which the sensing means 91 engages the deep recess 87 of the counter wheel 55, neither the counter wheel 55, nor the pattern rolls 50 are shifted, and all parts remain in the initial position until pattern chain 98 has moved forward and a set pattern member 101' indicates the beginning of the next workpiece or repeat pattern.

If the linkage 93, 94, 64 is influenced by a high pattern member 101' of pattern chain 98 at the moment in which the pattern drums are in a position in which an odd numbered row 50*a* of pins is operative, and

counter wheel **55** is in a corresponding position, sensing means **91** engages a tooth **89** of counter wheel **55** so that the motion is transmitted through the linkage **92, 93, 94, 64** to the setting device **59** to shift slide **61** directly to the position IV which permits cam **73** of the pattern control device **59,** and cams **78** of all actuator devices **57** to rise to the operative positions shown in FIGS. 4*d* and 4*d'* for operating the counter wheel **55** and the pattern drums **50** in double steps.

At the beginning of a new portion of a workpiece at which a new repeating pattern starts, the linkage **93, 94** is influenced by a high pattern member on pattern chain **98** so that slide **61** of the setting device **59** is moved to the setting position III, in which as shown in FIGS. 4*c* and 4*c'*, only cam **73** of pattern control device **58** is operative. Counter device **54** and pattern drums **50** are only operated by pattern control device **58** to perform a double step upon each revolution of the needle cylinder **56.** If a pattern member of medium height provided on the pattern chain **98** acts on the linkage **93'94,** slide **61** of setting device **59** is moved by the Bowden cable **64** to the setting position II, in which only pattern control device **58** is effective, as shown in FIGS. 4*b* and 4*b'*, but since cam **73a** is operative, only single steps of the counter mechanism **54** and of the pattern drums **50** are obtained.

High pattern members **101** and low pattern members **100** can follow each other in any sequence on pattern chain **98** in order to knit patterns with a selected number of rows **50***a* of pins on pattern wheels **50,** which in knitting machines of the prior art was only possible by differently setting the pins on the pattern drum and on a counter wheel.

By suitably constructing the pattern control device **58,** and the actuating devices **57,** it is possible to move the counter wheel **55** and the pattern drums **50** in triple steps which results in a further reduction of the number of actuating devices **57** required for returning the pattern drums to the first row **50***a* of pins.

In order to assure that for a given number of rows **50***a* of pins on each pattern drum **50,** a sufficient number of actuating devices **57** is provided for moving the pattern drums **50,** and thereby also counter wheel **55** to the initial position in which the setting means **59** are reset to the initial position due to the sensing of a deep recess **87** by sensing means **91** on the counter wheel **55,** the number of actuator devices must be an integer fraction of the number of rows of control pins **50***a* on a pattern drum minus one, and the actuator devices **57** must effect turning of the pattern drums for a number of angular steps which is equal to the denominator of the fraction. For example, in the illustrated embodiment the number of rows **50***a* of pins on the pattern drums **50** is 32, the number of actuator devices **57** is 15, and the actuator devices **57** shift pattern drums **50** in double steps toward the initial position.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of control apparatus for the pattern drums of a circular knitting machine, differing from the types described above.

While the invention has been illustrated and described as embodied in a control apparatus for returning the pattern drums of a circular knitting machine to an initial position after completing of a workpiece or of a repeating pattern, 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 characteristics 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.

1. In a circular knitting machine having a series of knitting stations, and including a stationary support, a rotary carrier, and a turnable pattern drum at each knitting station having an initial position and a predetermined number of rows of control elements, in combination, a control apparatus for said pattern drums comprising a pattern control device mounted on said carrier and having an inoperative initial position, and an operative position for angularly displacing said pattern drums during each revolution of said carrier for rendering said rows successively operative so that a pattern is knitted; a plurality of actuator devices mounted on said carrier, each having an inoperative initial position, and an actuating position for stepwise angularly shifting said pattern drums, the number of said actuating devices being an integer fraction of said predetermined number of rows of control elements minus one, said fraction having a denominator of at least two, said actuator devices in said operative position shifting said pattern drums a number of angular steps equal to said denominator; a counter device mounted on said support and including a counter wheel having said predetermined number of angular positions, said counter wheel being turned in angular steps out of an initial position by said pattern control device and said actuating devices in said operative positions so that the angular positions of said counter wheel correspond to the angular positions of said pattern drums; setting means mounted on said support movable between an initial position and a plurality of setting positions for setting said pattern control device and said actuator devices to said operative and actuating positions, respectively, for displacing said counter wheel and pattern drums in angular steps; pattern program means for moving said setting means to selected setting positions; and sensing means for sensing said angular positions of said counter wheel and controlling said setting means to move to said initial position when said sensing means senses the initial position of said counter wheel whereby said pattern control device and said actuator devices are moved by said setting means to said initial positions thereof when said pattern drums and said counter wheel are in said initial positions thereof so that an other pattern can be started.

2. Control apparatus as claimed in claim **1** wherein said setting means includes a slide movable between said initial and setting positions, wherein said pattern program means includes a pattern chain having pattern members, and linkage means operated by said pattern members and connected with said slide for moving said slide between said setting positions.

3. Control apparatus as claimed in claim **2** wherein said pattern control device includes control cam means biassed to said operative position; wherein said actua-

tor devices include actuating cam means biassed to said actuating position; wherein said slide of said setting means blocks in said initial position thereof movement of said control and actuating cam means to said operative and actuating positions, respectively, and permits in said setting positions selective movements to said operative and actuating positions; wherein said setting slide is movable in radial direction, and said control cam means and actuating cam means are movable in axial direction of said rotary carrier; and wherein said control cam means are narrower in said radial direction than said actuating cam means; and including shifting means operated by said cam means for stepwise turning said pattern drums and said counter wheel.

4. Control apparatus as claimed in claim **3** wherein said control cam means includes two control cams of different radial width located at different axial levels for displacing said pattern drums and said counter wheel different numbers of angular steps.

5. Control apparatus as claimed in claim **4,** wherein said pattern control device and said actuator devices include spring means for biassing said control cam means and said actuating cam means, and locking means for locking said control cam means and actuating cam means in said initial positions thereof, respectively; and wherein said support includes a stationary cam cooperating with said locking means for releasing said control cam means and actuating cam means when said pattern control device and said actuator device pass said setting means and said slide so that the displacement of said cam means is determined by the setting position of said slide.

6. Control apparatus as claimed in claim **1** wherein said counter wheel has peripheral recesses and projections whose total number is equal to the number of said rows of control elements of said pattern drums, respectively, and which are sensed by said sensing means, the recess representing the initial position of said pattern drums being deeper than the other recesses so that said sensing means moves said setting means to said initial position when sensing said deep recess.

7. Control apparatus as claimed in claim **6** wherein said recesses are circumferentially spaced a number of angular distances corresponding to the number represented by said denominator; and wherein said projections are circumferentially spaced a number of angular distances corresponding to the number represented by said denominator, except one projection which is replaced by said deep recess.

8. Control apparatus as claimed in claim **6** comprising a linkage connected with said setting means; wherein said pattern program means include a pattern chain having pattern members cooperating with said linkage for operating said setting means; wherein said sensing means is connected with said linkage; and wherein said pattern chain has a special lateral pattern member cooperating with said linkage for operating said sensing means.

9. Control apparatus as claimed in claim **8** wherein said setting means includes a setting slide movable between said initial and setting positions; wherein said linkage includes Bowden cable means connected with said slide.

10. Control apparatus as claimed in claim **1** wherein said denominator is two; wherein said setting means has four positions including said initial position and three setting positions; wherein said setting means in said initial position holds said pattern control device and said actuator device in said initial positions thereof while passing said setting means due to rotation of said carrier; wherein said setting means in the first setting position places said pattern control device and actuator device in an operative position for shifting said pattern drums and counter wheel one angular step; wherein said setting means in the second setting position places said pattern control device in an operative position for shifting said pattern drums and counter wheel two angular steps; wherein said setting means in said third setting position places said pattern control device in the operative position for shifting said pattern drums and counter wheel two steps, and places said actuator devices successively in said actuating positions for shifting said pattern drums and counter wheel two steps; and wherein said setting means in said first and second setting positions holds said actuator devices in said initial positions.

11. Control apparatus as claimed in claim **10** wherein said counter wheel has alternate normal recesses and projections except one deep recess between two of said normal recesses and being sensed by said sensing means in said initial position of said pattern drums for placing said setting means in said initial position thereof.

12. Control apparatus as claimed in claim **11** wherein said sensing means when sensing one of said normal recesses places said setting means in said first setting position, and when sensing one of said projections places said setting means in said third setting position.

13. Control apparatus as claimed in claim **1** comprising linkage means connecting said pattern program means and said sensing means with said setting means; and wherein said pattern program means include a pattern chain with pattern members controlling said setting means, and a special pattern member representing the beginning of a new pattern and cooperating with said sensing means.

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