W. E. SMITH.

CIRCULAR KNITTING MACHINE.

APPLICATION FILED APR. 10, 1919.

1,368,664. **Patented Feb. 15, 1921.**

2 SHEETS—SHEET 1.

Fig 1

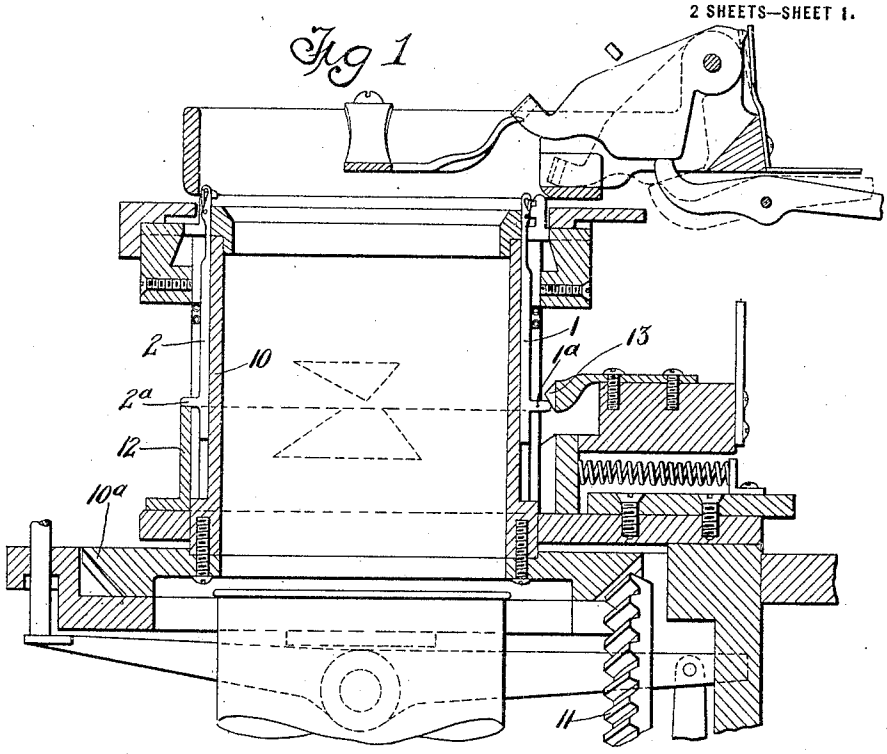


Fig: 2.

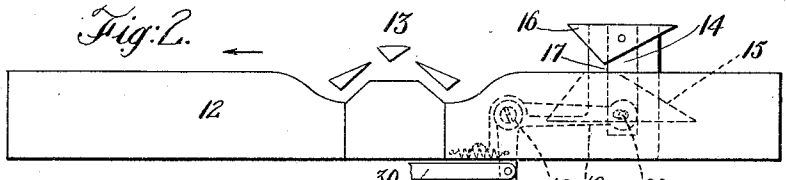


Fig: 3.

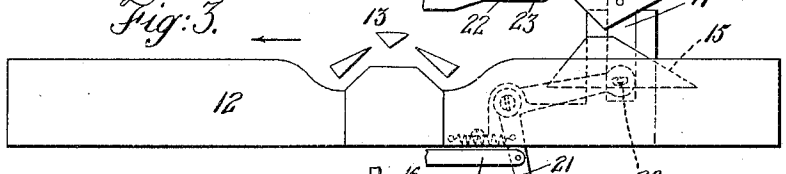


Fig: 4.

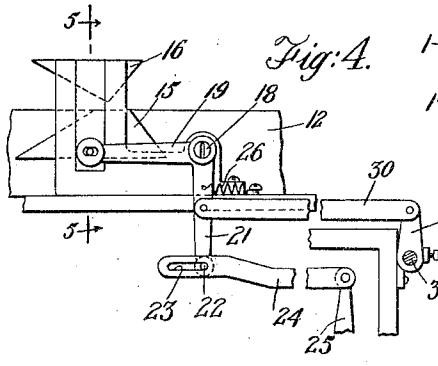
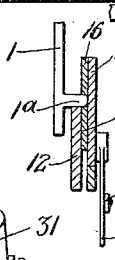


Fig: 5.



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2 SHEETS—SHEET 2.

Fig: 9.

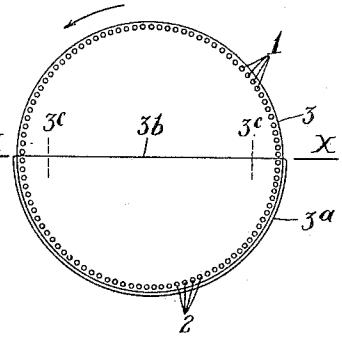

Fig: 8.

Fig: 7.

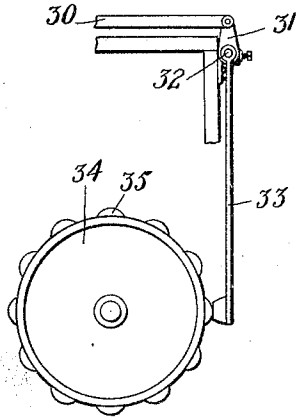

Fig: 6.

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UNITED STATES PATENT OFFICE.

WILLIAM E. SMITH, OF MILLTOWN, NEW JERSEY, ASSIGNOR TO THE INTERWOVEN MILLS, INC., OF NEW BRUNSWICK, NEW JERSEY, A CORPORATION OF NEW JERSEY.

CIRCULAR-KNITTING MACHINE.

1,368,664. Specification of Letters Patent. Patented Feb. 15, 1921.

Application filed April 10, 1919. Serial No. 288,994.

To all whom it may concern:

Be it known that I, WILLIAM E. SMITH, a citizen of the United States, residing at Milltown, in the county of Middlesex and State of New Jersey, have invented certain new and useful Improvements in Circular-Knitting Machines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention consists in the novel features hereinafter described reference being had to the accompanying drawings which illustrate an embodiment of my invention selected by me for purposes of illustration, and the said invention is fully disclosed in the following description and claims.

The object of my invention is to provide simple mechanism for knitting seamless tubular fabric by circular knitting in which a segmental portion of the tubular fabric may be made shorter than another segmental portion of the fabric by omitting partial courses of stitches through the shorter segment of the fabric, and thereby forming partial courses of stitches in the segment to be lengthened, between adjacent circular courses of stitches. More specifically, my invention relates to a stocking knitter and contemplates the provision of means whereby the top portion of the foot of a stocking is made shorter than the corresponding sole portion of the foot, by omitting partial courses of the circular knitting through the top of the foot, and thereby knitting partial courses in the sole portion of the foot between adjacent circular courses so that the top portion of the foot shall be from a half size to a size shorter than the corresponding sole portion of the foot, to fashion the stocking to the shape of the foot, and prevent the formation of wrinkles upon the top of the foot and instep when the stocking is worn. To this end my invention consists in providing mechanism whereby during the knitting of circular work, as in the formation of the foot of the stocking those needles which knit the segmental portion of the tubular fabric forming the top of the foot are, at predetermined times, prevented from forming stitches with the main knitting thread, which is supplied to all the needles, and preferably by placing such needles in an inoperative position with respect to the knitting cam or cams therefor and feeding the thread thereto below the latches thereof, so that when the needles are again operated normally for the drawing of a stitch, they will cast off the thread delivered to them below their latches, thus throwing it to the center of the tube where it forms a float and is subsequently cut out, thus eliminating or omitting a certain number of partial courses from that segment of the tubular fabric which forms the top of the foot of the stocking.

In the accompanying drawings,

Figure 1 represents a partial sectional view of a stocking knitter of the type known as the Banner machine, in which I have contemplated embodying my invention.

Fig. 2 is a plan view of a cam ring of such machine as it would appear if cut and spread out in a plane, and showing the cams for raising and lowering certain of the needles of the circular series into and out of inoperative position with respect to the knitting cam, said raising and lowering cams being illustrated in their lowest positions.

Fig. 3 is a view similar to Fig. 2 showing the raising and lowering cams for said needles in their raised positions.

Fig. 4 is a front view of the cam ring detached, showing the operating mechanism for the raising and lowering cams.

Fig. 5 represents a partial sectional view showing the relation of the raising and lowering cams to the long nib needles operated thereby.

Fig. 6 is a detail view illustrating one form of pattern mechanism for controlling the operation of the raising and lowering cams during circular work.

Fig. 7 is a diagrammatic view representing the different relative positions of the long and short nib needles during circular work when a partial course is to be omitted from a segment of the tubular fabric and the position of the main knitting thread as it is fed to said needles.

Fig. 8 is a diagrammatic view of a stocking produced by the mechanism shown in the preceding figures.

Fig. 9 represents diagrammatically the circular series of needles and illustrates the manner in which the main knitting thread is fed to and knit thereby during the production of circular and partial courses during circular work.

In Fig. 1, which illustrates a partial sec-

tional view of the well known Banner machine, 10 represents the cylinder which is provided with a circular series of needles which may be considered as divided into two groups, to wit, the needles 1 indicated diagrammatically in Fig. 9, and being those needles which knit the front of the leg of the stocking and the top portion of the foot and which are provided with a long nib 1^a, and the needles 2 which are employed during circular work to knit the rear portion of the leg and the sole of the foot, and which are employed during reciprocating work to knit the heel and toe pockets in a wellknown manner by narrowing and widening, and which are provided with short nibs indicated at 2^a. The needle cylinder is provided with a horizontal gear 10^a which is driven by gear 11 in the usual manner to rotate the cylinder and the needles carried thereby within a non-rotatable cam ring 12, which is provided with the usual knitting cam indicated at 13 in Figs. 1, 2, 3. The arrows in Figs. 2, 3 illustrate the direction of travel of the needle cylinder and needles with respect to the cam ring 12.

The cam ring 12 is provided in advance of the knitting cam 13 and preferably at the front of the machine, as indicated in dotted lines in Fig. 1, with an elevating cam 15, and a depressing cam 16 carried on a vertically movable slide 14 supported and guided in the cam 12, the cams 15 and 16 being so located that they engage only the long nibs of the needles 1 and do not engage the short nibs of the needles 2. The slide 14 and the cams 15, 16 are raised at the commencement of reciprocating work and depressed at the conclusion of the reciprocating work, in making the heel or toe pocket, and to effect this operation, I have shown a bell crank lever pivoted at 18 and provided with an arm 19 having a slot in its outer end engaging a pin 20 on the slide 14, said bell crank lever having an arm 21 carrying a pin 22 which is engaged by a slot 23 in a link 24 connected with an actuating arm 25 which is moved by cam mechanism (not shown) for the purpose of raising the slide 14 so as to bring the cam 15 into position to engage the long nibs of the needles 1 and raise them out of operative relation with the knitting cam 13 during reciprocating work, in a well known way, so that these needles 1 shall hold their stitches during the formation of the heel and toe pocket. At the conclusion of reciprocating work, the arm 25 is caused to move in the opposite direction, thereby releasing the pin 22 and the slide 14 is drawn down to its normal position by means of a spring 26 connected with the bell crank arm 21 to enable the cam 16 to engage the long nibs 1^a of the needles 1 and restore the needles 1 to operative relation with the main knitting cam 13 for circular work. During reciprocating work in will be understood that the heel and toe pockets will be narrowed and widened in the usual manner by means of pickers (not shown) which, however, form no part of my present invention, and will not therefore be particularly illustrated or described. It will be seen that the bell crank lever when released by the link 24 and arm 25 is in such position that it may be independently operated either by hand or by suitable mechanism provided therefor to raise and lower or permit the lowering of the slide 14 and its cams 15, 16 during circular work. For this purpose I prefer to provide suitable mechanism controlled by the pattern mechanism of the machine, and in this instance I have shown a link 30 pivoted at one end to the arm 21 of the bell crank lever and at the other end to an actuating arm 31 on a rock shaft 32, which is actuated in one direction at the beginning of a circular course of knitting to raise the slide 14 and is actuated in the opposite direction at the conclusion of the circular course under the control of pattern mechanism. For example, in Fig. 6 I have shown a pattern wheel 34 provided with projections 35 disposed at predetermined positions thereon, for actuating the arm 33 connected with the rock shaft 32 to raise the slide 14 and hold it raised during a single circular course, that is to say, during a single revolution of the cylinder 10, and to permit the slide 14 to be restored to its lowest position by its spring 26 at the conclusion of said revolution. This illustration in Fig. 6. is however, diagrammatic, and the specific pattern mechanism employed to operate the rock shaft 32 may be varied in different machines, and the pattern mechanism may be so constructed as to operate the slide 14 at any desired intervals, as for example every other revolution for a plurality of revolutions, or for a single revolution after any desired number of circular courses, etc., for the purpose of distributing the partial courses knit as hereinafter described in one segment of the fabric, as may be desired, through the length of such circular knit fabric as the foot of a stocking, so that they may be thrown in at any desired interval, or may be grouped at one or two or more points, as may be desired.

In the operation of my improved machine, in the knitting of a stocking such as illustrated, for example, in Fig. 8, the slide 14 being in its lowest position, the ribbed top indicated at A in Fig. 8, is applied to the circular series of needles in the usual manner if a man's hose is to be knit, and the leg portion B is knit by circular knitting with a single thread, which may be one thread or a plurality of threads fed as one thread to all of the needles. If desired, a reinforcing thread may be thrown in at the

back of the leg above the heel at the point indicated at F, to form what is termed the high splice, or such reinforcing thread may be omitted as desired. Circular knitting proceeds down to the point indicated by the dotted line 6—7—8, when the slide 14 is raised by the actuating arm 25 to bring the cam 15 into the path of the long nibs 1^a of the needles 1, and elevate all of the long nib needles out of operative relation of the knitting cam 13 while the needle cylinder is reciprocated or oscillated instead of being rotated, and the thread, which may be the main knitting thread or a different heel thread is supplied only to the needles 2 during reciprocating work, certain of the needles 2 at each side being thrown successively out of operation to produce narrowing and then restored to operative position successively to produce widening, by means of suitable pickers (not shown) in the usual and well known manner, to form the heel pocket D. The actuating arm 25 is them moved to release the bell crank arm 21 and the spring 26 restores the slide 14 to its lowest position, bringing the draw-down cam 16 into position to engage the long nibs 1^a of the needles 1, and restore them to operative relation with the knitting cam 13, at which time circular knitting is again resumed, and the main knitting thread is fed to all the needles circularly to form circular courses of stitches. In order to make the upper portion C of the foot of the stocking shorter than the lower portion C′, certain partial courses of stitches are omitted in the upper part C of the foot, and this is accomplished either by hand or under the control of the pattern mechanism, by elevating the slide 14 at the commencement of a circular course of knitting, thereby bringing the cam 15 in position to engage the long nibs 1^a of the needles 1 and elevate them into inoperative position with respect to the knitting cam, as indicated in Fig. 7, while the needles 2 remain in operative position with respect to the knitting cam. As the main knitting thread, indicated at 3^a with which the preceding circular course of stitches was knit, is fed to all the needles, as it is of necessity during circular work, it will be fed to the needles 1 below the latches thereof, as clearly shown in Fig. 3, thus causing the needles 2 to knit a partial course, and preventing the formation of stitches on the needles 1, thus omitting a partial course from the top of the foot C. At the termination of this revolution of the cylinder, the slide 14 is restored to normal position by its spring 26 (or by hand), and the cam 16 will restore all the needles 1 to operative relation with the knitting cam before they reach the knitting cam. As the needles 1 descend into operative position, they receive the thread for the next course, in their hooks, and are operated by the knitting cam to form stitches, while the thread previously placed thereon below the latches thereof will slide up into contact with the latches and will pass over the latches and over the tops of the needles, and will pass to the interior of the needle cylinder and extend across the same as a float, which is afterward cut out. The thread is also fed to the needles 2 during this revolution, so as to form a circular course of stitches upon the partial course, and the portion of the preceding circular course not engaged by the stitches of the partial course.

It will thus be seen that every time the slide 14 is raised during circular work the needles 2 will knit a partial course through the sole of the foot, the other part of the course being omitted through the top of the foot, thus making the top portion of the foot, shorter than the corresponding sole portion of the foot. In Fig. 8 I have represented the circular courses by the numeral 3 and the parital courses by 3^a, and these partial courses may be distributed at any desired intervals or grouped at special portions of the sole, as at C^2 and C^3, or both, according to the desire of the manufacturer, it being only necessary to provide pattern mechanism which will raise and lower the slide 14, at the proper intervals during circular knitting. In Fig. 9 I have shown diagrammaticaly the needles 1 and 2, the operation of the main knitting thread forming the complete circular courses, indicated at 3, and that forming the partial course being indicated at 3^a. The portion of the main knitting thread forming the floats is indicated at 3^b, the floats being afterward cut away, as indicated at 3^c by dotted lines.

It will be noted that in the resulting tubular fabric produced by circular knitting and containing circular and partial courses, all of the courses whether circular or partial are knit with the same thread, and therefore present entire uniformity in knitting and in the manner in which they take the dye. My invention also provides for the manufacture of stockings having the upper part of the foot shorter than the lower part, either without the necessity of introducing an extra thread through the sole of the foot, although such extra thread may be introduced as a reinforcing thread, in the usual manner if desired. After forming the foot of the stocking, the toe pocket E will be knit in the usual manner by reciprocating work and narrowing and widening, and the stocking will be completed by cutting out the floats 3^b, and by joining the upper edge of the toe pocket to the outer edge of the top portion C of the foot by means of looping, as at *e*, in the usual and wellknown manner.

It is obvious that the pattern mechanism may be so constructed as to hold up the rais-

ing and depressing cams 15, 16 during two or more revolutions of the cylinder before permitting it to return to normal position, so as to knit two or more partial courses between adjacent circular courses, if it should be desired to do so. In practice, however, it will be found more desirable to form only a single partial course between adjacent circular courses and to distribute these partial courses at any desired intervals along the circular knit fabric.

What I claim and desire to secure by Letters Patent is:—

1. In a circular knitting machine, the combination with a circular series of needles, and stitch forming mechanism adapted to actuate each needle of the series once during circular work, means for feeding a thread circularly to all of said needles during circular work, and means operable during circular work for moving a group of consecutive needles for knitting a segment of the tube, out of engagement with the stitch forming mechanism, during a single course, and for returning them to operative relation with the stitch forming mechanism for the knitting of the next adjacent course, whereby partial courses may be omitted intermittently between circular courses in a segment of the tube, to make it shorter than the other portions of the tube.

2. In a stocking knitter, the combination with a circular series of needles, including a segmental group for knitting the front of the leg and top of the foot of the stocking, and a segmental group for knitting the back of the leg, and heel, sole and toe, stitch forming mechanism for actuating each needle of the series once during a circular course during circular knitting, means for moving the first mentioned group of needles out of operative relation with the stitch forming mechanism during a single course of circular work in the foot of the stocking, and for restoring them to operative relation for the next adjacent course, whereby partial courses will be omitted in the top of the foot between adjacent circular courses, thereby making the sole portion longer than the top portion of the foot and fashioning the stocking.

3. In a stocking knitter, the combination with a circular series of needles, including a segmental group for knitting the front of the leg and top of the foot of the stocking, and a segmental group for knitting the back of the leg, and heel, sole and toe, stitch forming mechanism for actuating each needle of the series once during a circular course during circular knitting, means for moving the first mentioned group of needles out of operative relation with the stitch forming mechanism, during reciprocating work for knitting the heel and toe, and for restoring them to normal position at the conclusion of reciprocating work, and auxiliary actuating mechanism for said means, for operating said means intermittently between the formation of circular courses of circular work to suppress partial courses in the top of the foot and make the top of the foot shorter than the sole portion, to fashion the stocking.

4. In a circular stocking knitter, the combination with a series of needles, and stitch forming mechanism adapted to actuate each needle of the series once during circular work, a segmental group of consecutive needles which knit the front of the leg and top of the foot being provided with a longer nib than the needles for knitting the back of the leg and sole, heel and toe, means for feeding a thread circularly to all of said needles during circular work, raising and lowering cam mechanism for engaging said long nib needles and moving them into and out of inoperative position, said cam mechanism being normally in inoperative position, and means for bringing said cam mechanism into operative position during reciprocating work, for holding said front group of needles in inoperative position, of independent means for moving said cam mechanism into and out of operative position during a single course of circular work, whereby the formation of stitches on the front needles will be prevented, and a partial course will be formed on the remaining needles, between adjacent circular courses.

5. In a circular stocking knitter, the combination with a series of needles, and stitch forming mechanism adapted to actuate each needle of the series once during circular work, a segmental group of consecutive needles which knit the front of the leg and top of the foot being provided with a longer nib than the needles for knitting the back of the leg and sole, heel and toe, means for feeding a thread circularly to all of said needles during circular work, raising and lowering cams for engaging said long nib needles, a vertically movable slide, means for operating said slide during reciprocating work, for holding the front segment of needles out of operative position, auxiliary means for actuating said slide to move said cams into and out of operative position during a course of circular work, whereby the formation of stitches on the front segment of needles is prevented and a partial course is formed on the remaining needles between adjacent circular courses.

6. In a circular stocking knitter, the combination with a series of needles, and stitch forming mechanism adapted to actuate each needle of the series once during circular work, a segmental group of consecutive needles which knit the front of the leg and top of the foot being provided with a longer nib than the needles for knitting the back of the leg and sole, heel and toe, means for

feeding a thread circularly to all of said needles during circular work, raising and lowering cams for engaging said long nib needles, a slide carrying said cams, actuating mechanism for said slide, operable during reciprocating work, and including a slotted part permitting independent movement of the cam slide, auxiliary means operable during circular work for actuating said slide to move said cams into and out of operative position during a single course of circular knitting, whereby the formation of stitches on the front needles is prevented and a partial course of stitches is formed on the rear needles between adjacent circular courses.

In testimony whereof I affix my signature.

WILLIAM E. SMITH.