June 30, 1936. P. A. BENTLEY ET AL 2,045,938

CIRCULAR KNITTING MACHINE AND METHOD OF KNITTING

Filed April 22, 1933 4 Sheets-Sheet 1

Fig. 1.

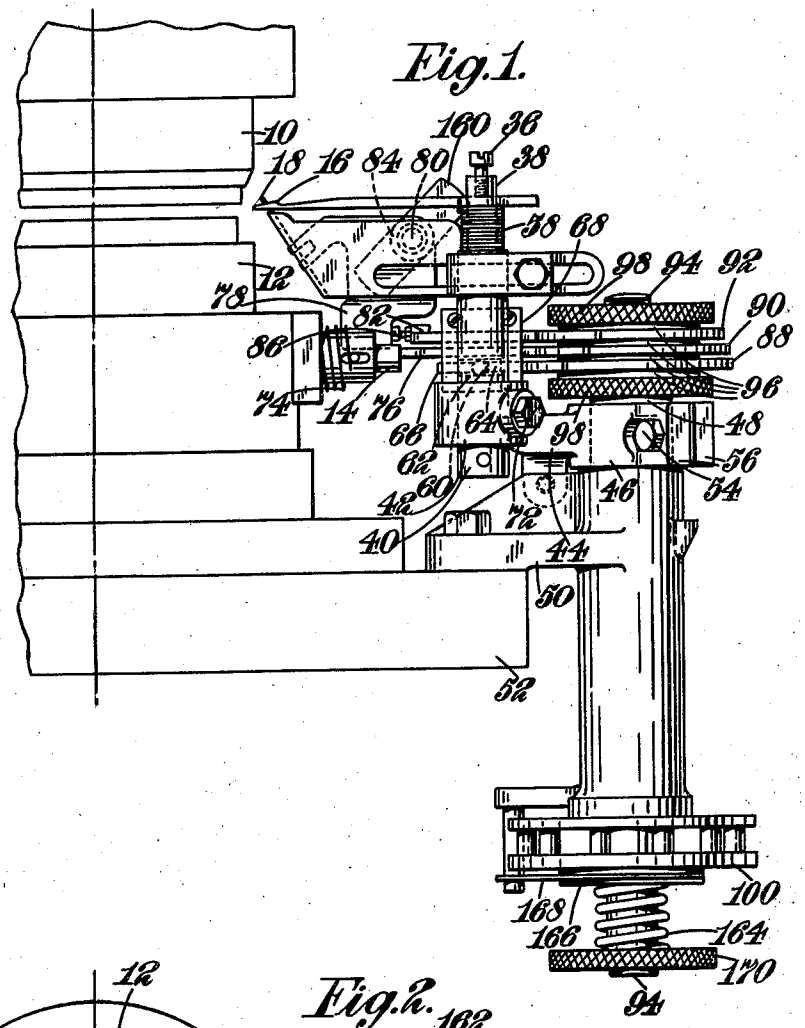
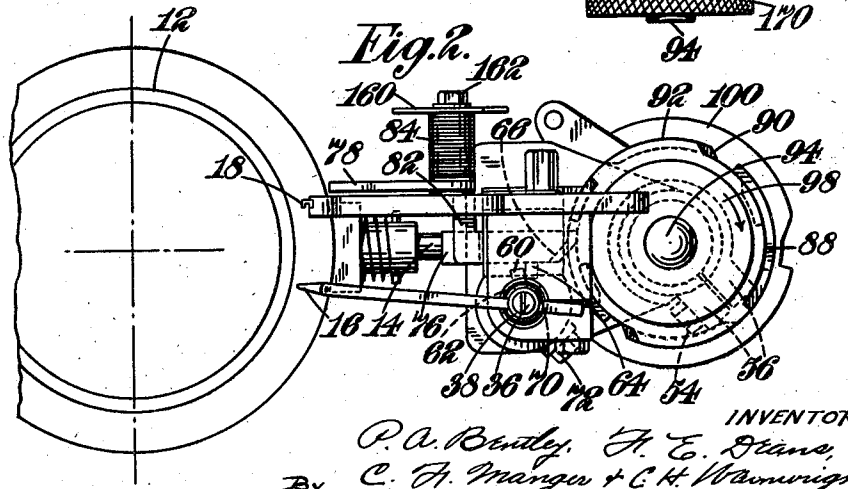


Fig. 2.



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Fig. 3.

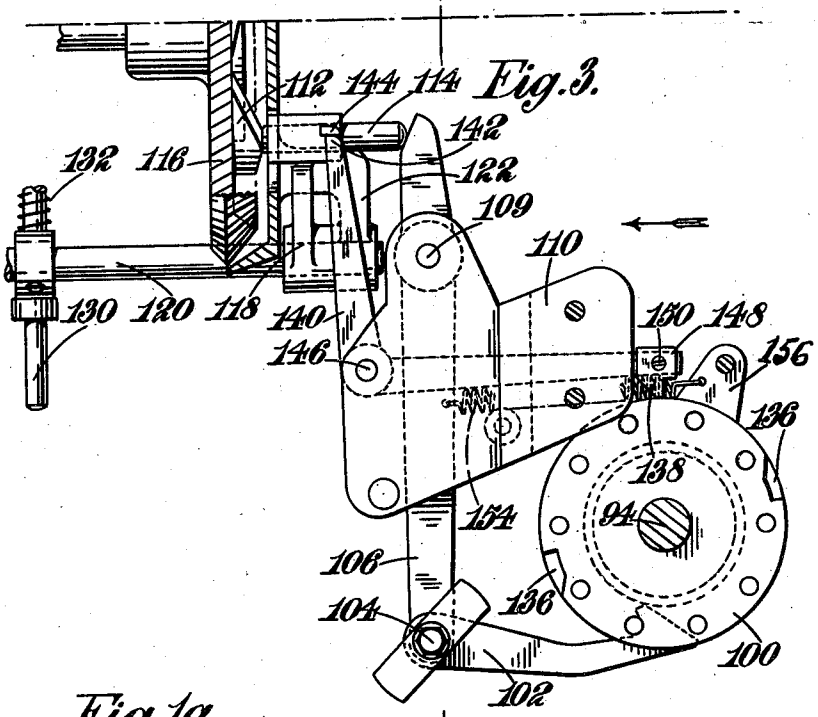
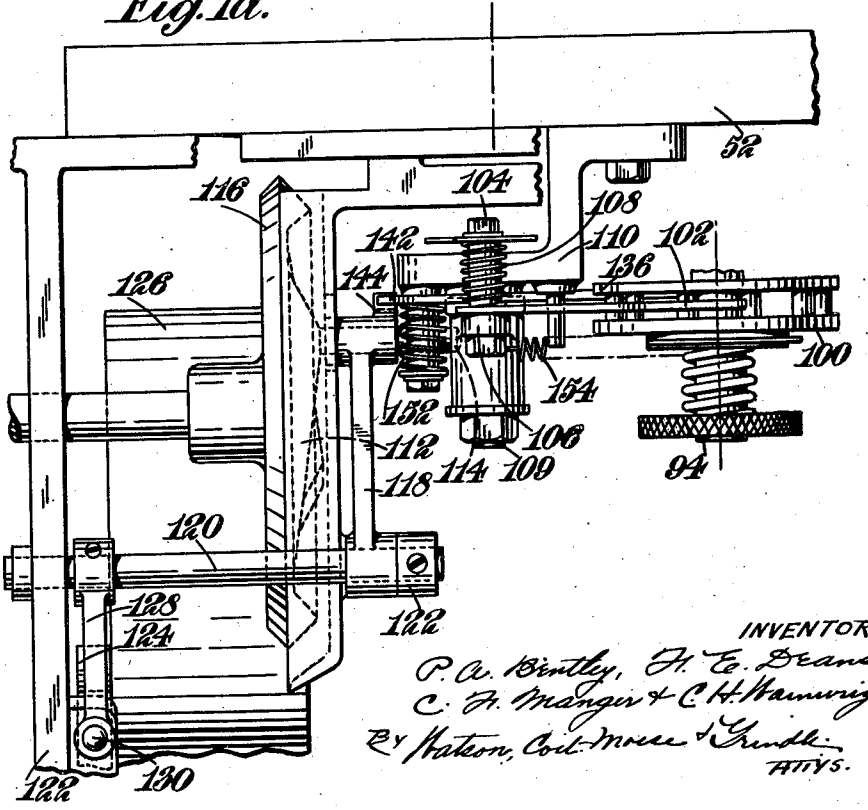


Fig. 1a.



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Fig. 6.

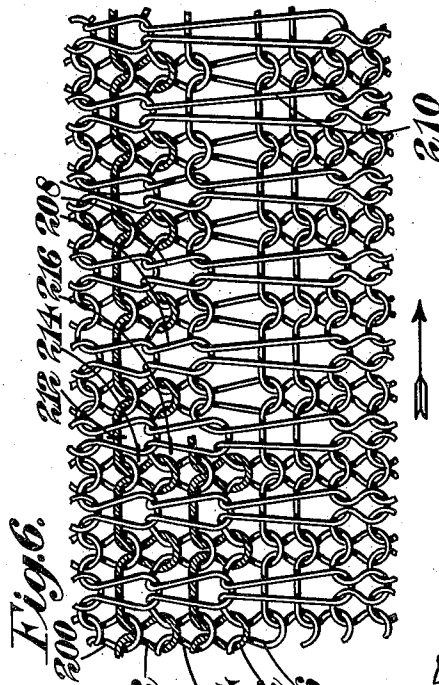
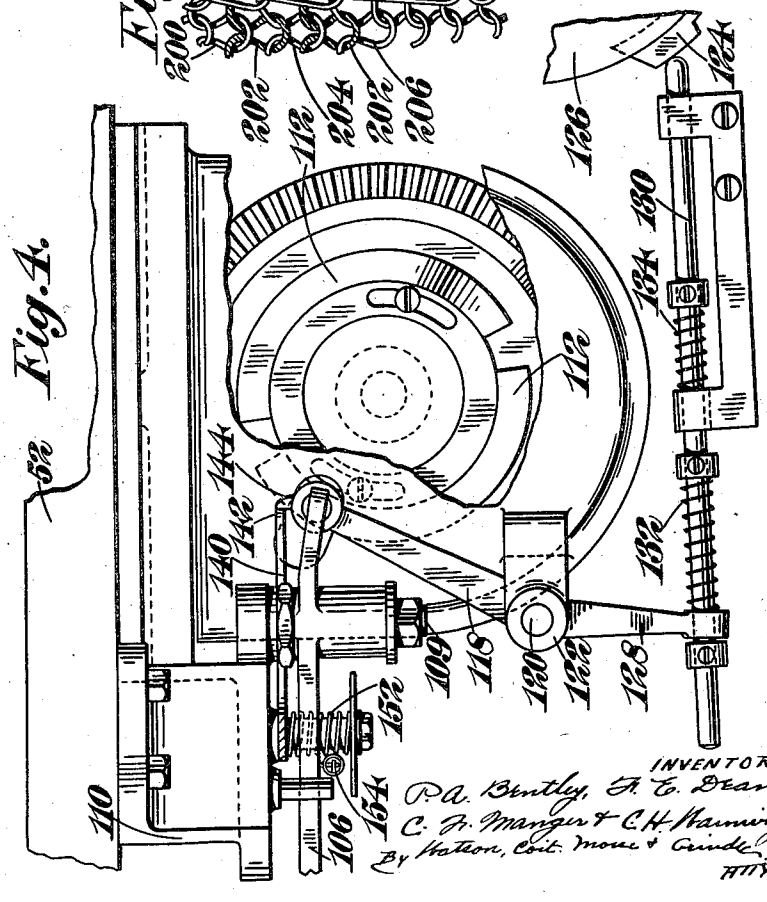


Fig. 4.



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CIRCULAR KNITTING MACHINE AND METHOD OF KNITTING

Filed April 22, 1933 4 Sheets-Sheet 4

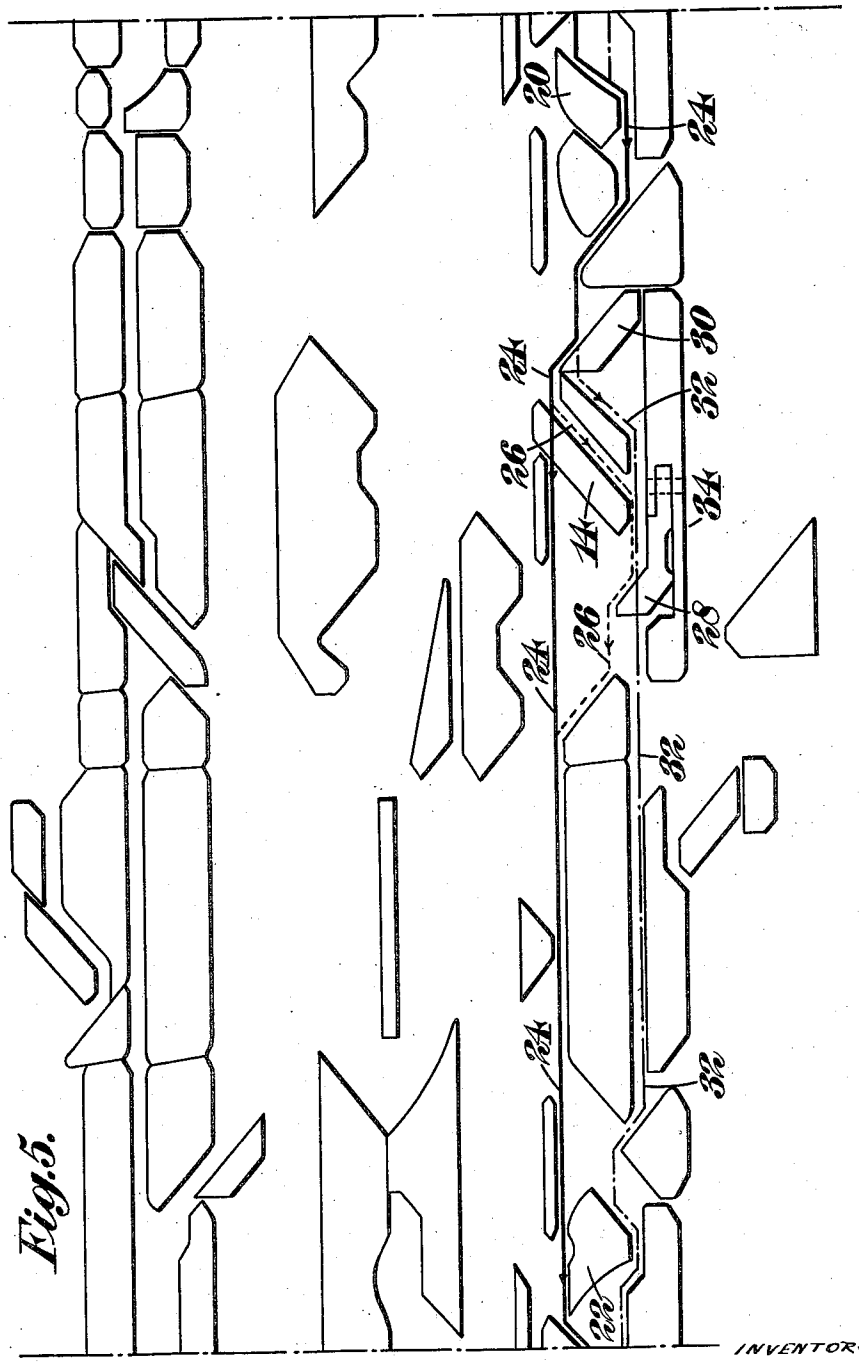


Fig. 5.

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UNITED STATES PATENT OFFICE

2,045,938

CIRCULAR KNITTING MACHINE AND METHOD OF KNITTING

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Application April 22, 1933, Serial No. 667,444
In Great Britain April 27, 1932

5 Claims. (Cl. 66—1)

This invention is concerned with improvements in or relating to circular knitting machines, and is particularly although not exclusively applicable to the superposed cylinder type of machine which is exemplified in the specifications of British Letters Patent Nos. 15008/1900; 24290/1912; and 171,483.

In circular knitting machines, the work (hose, half-hose etc.) is usually produced in string formation, that is to say, each article following the first article knitted is joined to the article immediately preceding it in the order of knitting, by a few idle knitted courses. To separate the articles of the "string", these idle courses are cut by hand, with the result that a somewhat ragged and rather unsightly finish is frequently given to the articles.

An object of the present invention is to provide a method of knitting by which the articles of the string can be separated from one another with facility and without the production of the ragged finish just mentioned.

A feature of the invention is, in the knitting by machine of articles in string formation, a method of rendering easily separable the individual articles of the string which consists in knitting into the work at the location where separation between the articles is to be effected, one or more courses of special thread of a character such that it may be withdrawn from the work, thereby to separate the articles it connects, without binding unduly with the loops of the work-thread with which it has been interlinked in the knitting operation.

The characteristic possessed by said special thread, namely, that it is readily withdrawable from the work, may be due to the fact that it is interlinked with but a few of the loops of the work thread, in which case the course of special thread, or each course if there are several such courses, will be composed of separate lengths of such thread, each length, apart from a possible slight overlap with another length, being interlinked with a group of loops of work-thread different from the group of said loops that is engaged by another of said lengths. With this arrangement, when all the separate lengths are withdrawn from the work, the articles previously connected by the special threads will be separated from one another.

Alternatively, but a single length of special thread may be employed and the nature of the material of which it is composed relied upon for the ready withdrawal of the thread from the work. For instance, the special thread may be composed of a hard cotton yarn knitted into the work in one, or slightly more than one, course of the knitting. A single thread is preferred for the reason that it utilizes but one of the several yarn feeders with which knitting machines are usually provided, or needs the provision of but one extra yarn feeder.

In employing a special thread according to the invention in work provided with a welt, the special thread is preferably knitted into the work immediately preceding the knitting of the welt itself, as by this procedure the welt forms a finishing end to the article after the special thread has been withdrawn to separate the article from its preceding companion in the string of articles.

In cases where the work is being made on a rib-knitting machine where the welt is made on 1/1 rib fabric, the special thread of the present invention is preferably knitted into the work by one only of the two sets of needles, say the needles of the lower or plain cylinder in a machine of the superposed cylinder type. The special thread is thus knitted into the ribbed fabric by every alternate needle only of the machine. After the special thread has been knitted in, the machine forms the welt in the usual manner. To separate articles of the string when knitted as just mentioned, the special thread is withdrawn, and the loops of work thread can easily be pulled out, as these loops are slackened by the withdrawal of the special thread. A convenient procedure in the separation of the articles is described hereinafter.

In all the several cases above-mentioned, the special thread may be different in colour from the work thread so as to render it readily distinguishable therefrom.

The invention comprises also mechanism for feeding to and knitting by certain of the needles of the machine, a special thread as hereinbefore mentioned. The illustrative construction hereinafter described provides for the application to a knitting machine, for the purpose of dealing with such a thread, of a stitch cam, thread feeder, and thread cutting and trapping device all additional to the corresponding devices with which the machine is provided and all located at different points in the needle circle from the locations occupied by said corresponding devices. Such an arrangement is advantageous, as it not only readily enables the special thread to be knitted (as is desirable in some cases) by one only of the two sets of needles in a machine provided with two such sets, but also tends to avoid overcrowding of parts at the feeding point which fre-

quently is already occupied by as many feeders as it will comfortably accommodate.

A convenient construction of mechanism for providing the work with the special thread before-mentioned, which may be termed a draw thread, will now be described by way of example and by the aid of the accompanying drawings as applied to a knitting machine of the superposed cylinder type having co-axial revolving needle cylinders and stationary cam boxes.

In the accompanying drawings:—

Figures 1 and 1*a* are elevations of part of the machine showing mechanism constituting an additional feed point which is provided for the draw-thread;

Figure 2 is a plan of parts shown in Figure 1;

Figure 3 is a plan of parts shown in Figure 1*a*;

Figure 4 is an elevation of parts shown in Figure 3, looking in the direction indicated by the arrow in Figure 3;

Figure 5 is a development of cams in the upper and lower cam boxes as seen from the inner side of said boxes; and

Figure 6 is a diagram of knitted fabric including a draw thread and is illustrative of a method according to the invention of knitting the draw thread into the fabric and of cutting the draw thread and the work thread to permit ready separation of the knitted articles of the string.

In the drawings the upper and lower needle cylinders of the machine are indicated respectively at **10** and **12**, see Figure 1. For the draw thread, the machine is provided with an additional feed point which comprises a stitch cam **14**, a thread feeder **16**, and a thread trapper and cutter device **18** which is similar to the corresponding device described in application Serial No. 468,168, filed July 15, 1930. The additional feed point is located at a different part of the needle circle from that at which is located the usual feed point for the yarn or yarns normally knitted into the work; see Figure 5 which shows the position which the draw thread stitch cam **14** occupies in relation to the usual stitch cams **20** and **22** which are employed in the normal operation of the machine during rotary and reciprocatory knitting respectively. In the present construction, the draw thread is intended to be introduced into the work just prior to the formation of a welt on 1/1 rib knitting and the draw thread is knitted by the needles of the plain cylinder only. The stitch cam **14** for the draw thread is therefore located in the lower cam box, i. e. the cam box relating to the plain needle cylinder, and is shown as a bolt cam which is movable at predetermined times, by mechanism presently to be described, into and out of a position in which it actuates the needles of the plain cylinder.

In the present construction the needle-actuating cams in the upper and lower cam boxes are arranged for the knitting of the draw thread, for plain and rib knitting and for the formation of heel and toe pouches and a welt, and the welt may be knitted either by the needles of the plain cylinder or (as described in U. S. Letters Patent 1,910,457 granted May 23, 1933) by the needles of the rib cylinder. In Figure 5, the path which the butts of the plain needle sliders follow during plain knitting is indicated by the full line **24**. When a draw thread is to be knitted, the stitch cam **14** is moved inwardly towards the needle cylinder causing the butts to follow the path indicated by the dotted line **26**. When the welt is to be knitted by the needles of the rib cylinder, two cams **28** and **30** are withdrawn from the path of the butts so that the butts then follow the dot-and-dash line **32**, the needles of the plain cylinder at this time merely holding their loops. The cam **30** is preferably a bolt cam. The cam **28** is arranged to swing about a vertical axis **34**, is spring-pressed outwardly from the needle cylinder, and is moved inwardly into butt-engaging position by an extension from the cam **14** which extension is on that part of the cam **14** that is on the outer side of the cam box.

The draw thread feeder **16** (Figures 1 and 2) is adjustably secured by the set-screw **36** in the upper end of a spindle **38** which is rotatable in a tubular portion of a vertical post **40** fixed adjustably in a boss **42** of a casting **44**. This casting has a split portion **46** encircling a reduced part **48** turned on a casting **50** which is carried on a fixed part **52** of the machine. The split portion **46** of the casting **44** is contracted to grip the reduced part **48** of the casting **50** by means of the screw **54** engaging lugs **56** on said split portion. The thread feeder **16** is moved into the feeding position shown in Figure 2 against the action of a spring **58** by means of a pin **60** secured to the feeder spindle **38**, which pin passes through a slot **62** in the post **40** and engages a projection **64** on a cam follower **66** which is mounted in a guide block **68** on the casting **44**. The end **70** of the slot **62** forms a stop for the pin **60** so that the position of the feeder **16** when adjacent the trapper and cutter device **18** may be set by circumferential adjustment of the post **40**, a set screw **72** serving to maintain the adjustment.

The draw thread stitch cam **14** is pressed outwardly of the cam box by a spring **74** which forces it against a second cam follower **76** in the guide block **68**.

The trapper and cutter device **18** is operatively connected, by a lever **78** pivoted at **80** upon said device, to a cam follower **82** in the guide block **68**, a spring **84** tending to maintain the lever in contact with the follower. For purposes of adjustment the lever does not engage the follower directly but engages a screw **86** threaded in the follower **82**. The three cam followers **66**, **76**, and **82** bear respectively against three cams **88**, **90**, and **92**. These cams are mounted on the upper end of a vertical shaft **94** and are gripped between washers **96** by nuts **98**. The end of the shaft **94** where the cams **88**, **90**, **92** are located is made D-shaped in cross-section by having a flat formed on it and the washers **96** have D-shaped holes to fit the shaft so that their rotation on the shaft is prevented. The cams **88**, **90**, **92** have round holes and may be adjusted circumferentially on the shaft **94** and locked in their desired position by the washers **96** and nuts **98**. On the lower end of the shaft **94** is a ratchet wheel **100** which is operated by a pawl **102**, pivoted at **104** (Figure 3) on a lever **106**, a spring **108** (Figure 1*a*) tending to maintain the pawl **102** in engagement with the ratchet wheel. The lever **106** is pivoted at **109** on a bracket **110** secured to the fixed part **52**. The lever **106** is actuated by a cam **112** through the agency of a push rod **114**. The cam **112** has two rises and falls and is attached to a part of the machine (a bevel gear wheel **116**) which revolves at the same speed as the needle cylinder and so gives two movements to the vertical shaft **94** for every revolution of the needle cylinder. The push rod **114** is mounted to slide in a guideway formed in a lever **118** which is fixed on a shaft **120**, journalled in bearings **122** on

a fixed part of the machine frame. The lever 118 is moved by connections between it and a cam 124 (Figure 4) on the control drum 126 of the machine so that at predetermined times it moves the push rod 114 into and out of the path of the cam 112. The idle track for the push rod 114 is round the outside of the cam 112. The connections between the control drum 126 and the lever 118 comprise a lever 128 fixed on to the shaft 120, and a push rod 130, which passes through an eye in the end of the lever 128 and is operated by the cam 124 on the control drum 126. The push rod 130 operates the lever 128 through a spring 132, so that, should the cam 124 come into operation (either when the control drum 126 is being turned by hand, or otherwise) at a time when the push rod 114 is in its idle track, i. e. on the outer side of the cam 112, the push rod 114 will be pressed against the side of the cam 112 and the spring 132 will be compressed until the end of the cam 112 has passed the push rod 114 when the latter will spring into the track of the cam 112. A spring 134 serves to return the push rod 114 to its idle track after the required number of turning movements has been given to the vertical shaft 94 by the mechanism just described.

In order to ensure that the five movements of the vertical shaft 94, which make up the complete cycle of operations for one draw thread, shall take place, even though the control drum 126 may have been moved on so that the push rod 130 is free to fall off the end of the cam 124, two notches 136 are formed in the ratchet wheel 100, five teeth apart (i. e. diametrically opposite one another, as there are ten teeth in the wheel) and a tooth 138 at one end of a bell-crank lever 140 is adapted to engage these notches while the other end 142 of said lever lies alongside a projection 144 on the lever 118 if the push rod 114 in that lever is in its idle track. The lever 140 is pivoted at 146 on the bracket 110 and the tooth 138, for the purpose of adjustment may, as shown, be formed on a block 148 adjustably secured to the lever end by a screw 150. In the position just described the vertical shaft 94 cannot be rotated as the projection 144 prevents the lever 140 from being turned in a direction which would remove the tooth 138 from the notch 136 with which it is engaged. When the lever 118 is moved into the operative position by the action of the cam 124 on the control drum 126, the first movement of the ratchet wheel 100 places the end 142 of the lever 140 behind (i. e. as shown in Figure 3), the projection 144. The lever 118 is thereby held in its operative position, irrespective of the position of the control drum 126 until the tooth 138 on the lever 140 falls into a notch 136 by the action of a spring 152. The push rod 114 is then sprung back to its idle track by the action of the spring 134. A spring 154 (Figure 3) connected to the lever 106 and to a fixed part 156 tends to keep the lever pressed against the push rod 114.

In order that the tension of the spring 84 (Figure 2), that acts upon the lever 78 of the trapper and cutter device 18, may readily be varied, one end of the spring 84 engages a plate 160 which is secured to the pivot pin 80 by a screw 162 while the other end of the spring engages the lever 78. By slacking back the screw 162 the plate 160 may be turned to adjust the tension of the spring 84 and then the adjustment maintained by tightening up the screw 162 again. A similar arrangement is adopted in connection with the springs 108 and 152. To prevent overthrow of the ratchet wheel 100 under action of the pawl 102 there is arranged upon the shaft 94 below the ratchet wheel a friction device comprising a spring 164, friction plates 166, 168 and a nut 170 for adjusting the degree of compression of the spring 164.

In the operation of the mechanism the first movement of the vertical shaft 94 causes the stitch cam 14 to be moved by the cam 90 to a position where it will engage the long butts of the needle sliders but not the short butts (the long and short butts being those which are normally used in connection with the knitting of heels and toes). This movement takes place while the short butts are passing the stitch cam 14. The same movement of the vertical shaft 94 also causes the draw thread feeder 16 to be swung by the cam 88 into its feeding position shown in Figure 2. The draw thread now lies from the feeder 16 to the trapper and cutter device 18 across the needles but is not yet taken by the needles as at this time they are moving past the feeder at a constant level, i. e. without any vertical movement. As soon as the first needle whose slider has a long butt reaches the stitch cam 14, however, this needle descends and receives the draw-thread in its hook. The following needles, whose sliders also have long butts, also receive the draw-thread. The second movement of the vertical shaft 94 now takes place and the bolt cam 14 is thereby moved farther in so as to engage the short as well as the long butts. At the same time the trapper and cutter device 18 is opened by the cam 92 to release the end of the draw-thread. This is timed to take place as soon as the first needle, whose slider has a long butt, has safely received the draw-thread. The needle cylinders continue to revolve and the needles to knit the draw-thread and the trapper and cutter device 18 to remain open until the long butts are again passing the stitch cam 14. A further movement of the vertical shaft 94 allows the stitch cam 14 to spring out to a position where it continues to operate the long butts but will not operate the short butts. At this point the feeder 16 still continues to feed the draw thread to the needles and the trapper and cutter device 18 continues to remain open. The next movement of the vertical shaft 94 causes the feeder 16 to move to the inoperative position (i. e. adjacent the device 18) as soon as the last needle with a slider having a long butt has knitted the draw-thread. The thread is taken by the last needle which knitted it and by the feeder 16 into the trapper and cutter device 18 which then, by reason of another movement of the vertical shaft 94, closes and cuts and holds the thread, and the stitch cam 14 springs out to the inoperative position. The vertical shaft 94 now ceases its movements and the mechanism remains idle until another draw-thread is required.

The machine now starts to knit the welt by suspending knitting by the needles in either the top or bottom cylinder according to whether a reverse welt or an ordinary welt is being made. It is desirable to make the welt close up to the draw-thread so that the welt forms a perfectly clean finish to the article, and the closest possible position is obtained if the needle immediately following the last needle which knitted the draw-thread is the first one to suspend knitting for the welt; but if this is done, after the draw-thread has been withdrawn, the end of the yarn has only to be pulled through one loop and a hole in the welt thereby formed. In order to avoid this occurrence, the first needle to suspend knitting

for the welt is about the third or fourth needle after the last one which knitted the draw-thread. A few loops of 1/1 rib are thus formed between the end of the draw-thread and the beginning of the welt and these serve to lock the end of the yarn.

Figure 6 is a diagram showing a portion of fabric including a draw thread all knitted in accordance with a method of the present invention. In this diagram, which shows the structure of the fabric in the region near the end of the draw thread and the beginning of the welt as seen from the inner side of the fabric, the fabric is shown laid out flat and not in the condition it assumes when knitted, and the lengths of the loops are exaggerated for the sake of clearness. The loops in each course are formed in succession in the direction indicated by the arrow.

Course **200** is 1/1 rib fabric knitted at the main feed point and the draw thread **202** is knitted at the additional feed point into the plain loops (i. e. the loops formed by the needles of the plain cylinder) of this course **200**. When the needles which have knitted the draw thread **202** next reach the main feed point, 1/1 rib knitting is again knitted and course **204** is formed in which the plain loops are drawn through the draw thread loops and the rib loops (i. e. the loops formed by the needles of the rib cylinder) are drawn through the rib loops of course **200**. This operation continues for the full length of the draw thread which is knitted into one course and a half or thereabouts. During this period the plain needles knit two courses—one at each feed point—and the rib needles knit one course, this explains why the rib loops appear longer than the plain loops. Course **206** is a continuation of course **204** as far as the end of the draw thread **202**. At the end of the draw thread and to prevent a hole appearing in the welt as previously explained, a few rib and plain needles form 1/1 rib fabric the rib loops of which are indicated at **208**. This secures the beginning end of the welt, the first loop of which is shown at **210**. In the operation of separating the articles of the string, the draw thread is cut at about the point **212** and courses **200** and **204** are cut at about the same wale, say at points **214** and **216** respectively. The draw thread **202** to the right of the cut at **212** is pulled out, and course **200** to the right of the cut at **214** and course **204** to the left of the cut at **216** are then pulled out, thus leaving the welt clear with a few 1/1 loops at the beginning of the welt.

We claim:—

1. A knitting machine comprising a stitch cam movable between a needle-actuating position and an idle position, a thread feeder movable between a thread feeding position and an idle position, a thread trapper and cutter device operable to trap and cut and to release thread fed from said thread feeder, mechanism for actuating said stitch cam, thread feeder, and trapper and cutter device in a series of steps, a pattern control device for starting said mechanism into operation, and means for ensuring that said mechanism having been thus started shall complete said series of steps even if the control of said mechanism by said pattern control device ceases.

2. A knitting machine according to claim 1, comprising a continuously moving cam, a pawl and ratchet device, operative connections between said cam and device whereby said device is adapted to be driven by said cam, a disconnectable element in said operative connections under control of said pattern control device, and a locking device operated by the pawl and ratchet device for maintaining said element in connecting position until said series of steps is completed.

3. A knitting machine comprising a stitch cam movable between a needle-actuating position and an idle position, a thread feeder movable between a thread feeding position and an idle position, a thread trapper and cutter device operable to trap and cut and to release thread fed from said thread feeder, and mechanism for actuating said stitch cam, thread feeder, and trapper and cutter device comprising a shaft, a series of cams mounted on said shaft and adjustable circumferentially thereon, a washer between each of said cams, interengaging surfaces on said shaft and washers preventing rotation of the washers on said shaft, and means for exerting and maintaining pressure on said cams and washers in a direction axially of the shaft to secure the cams in adjusted position on the shaft.

4. A method of rendering easily separable the individual articles of a series of articles knitted in string formation by a circular knitting machine having upper and lower needle cylinders and having separate yarn feeding positions spaced circumferentially of the needle cylinders, which comprises forming the fabric by knitting a thread with the needles of both cylinders at one feeding position, and knitting a draw thread for at least a course at a second feeding position with the needles of one cylinder only, continuing the knitting of the fabric with all needles, and subsequently removing the draw thread to slacken certain of the loops of the fabric.

5. A method of rendering easily separable the individual articles of a series of articles knitted in string formation by a circular knitting machine having upper and lower needle cylinders and having separate yarn feeding positions spaced circumferentially of the needle cylinders, which comprises forming the fabric by knitting a thread with the needles of both cylinders at one feeding position, and introducing a draw thread at a second feeding position with the needles of one cylinder, the loops of the draw thread interlocking with the loops formed at said first feeding position by the same cylinder, whereby two courses are knitted by one cylinder and one course by the other cylinder simultaneously, and subsequently removing the draw thread to slacken certain of the loops of the fabric.

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